



# **Facilities Management Design & Construction Standards**

**For all Construction & Renovation Projects**



**Version 6.0  
December 1, 2014**

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## **Division 00: Introduction**

The creation of this building standards document was a joint effort between the Northern Kentucky University (NKU) departments of Architecture, Engineering & Construction Management, Campus & Space Planning, Operations & Maintenance, Information Technology, and Procurement Services. As NKU's growth continues to accelerate, this single, comprehensive guideline document was developed for design/construction teams undertaking new design and renovation projects for the university.

Until these standards were created, the bulk of information transferred from NKU to the respective design teams typically occurred through the initial building program document, and then as-needed from various NKU personnel during design and construction. This worked to an extent, but a consistent delivery path of information from NKU to the design/construction teams has never existed, and most project team members rarely had the opportunity to review the initial program document. As a result, unnecessary changes occurred during construction to replace items not conforming to NKU's typical systems, or worse, NKU was forced to accept and attempt to maintain an unfamiliar system or building component. Hence, the primary intent with providing this building standards document is to communicate, identify, and define NKU's current infrastructure, facilities, buildings, and various product/building component "standards".

The standards contained within this document shall be considered contract requirements for every project unless otherwise stated in writing from the assigned NKU project manager. In the event of conflicting language between a specification issued for a particular project and these standards, this building standard document shall govern. In addition, design/construction teams will receive no additional compensation for changes necessary to correct an unapproved deviation from these standards.

All specifications created and issued for new building and renovation projects at Northern Kentucky University shall be organized using the 2004 MasterFormat Edition. The Table of Contents for this NKU Building Standards document parallels the 2004 MasterFormat Edition division numbers and titles. Aligning the NKU Building Standard information with the MasterFormat specification sections organizes all the information in a logical and familiar format, and provides the design/construction teams (as well as NKU personnel) a framework for review and cross-checking during design and construction.

## **Division 01: General Requirements**

Northern Kentucky University's construction activity is reviewed by the Commonwealth of Kentucky Department for Housing, Buildings, & Construction with regards to all building code enforcement, building plan review/approval during design, and building inspections during construction. Local building permits are not required and university property is exempt from compliance with local zoning regulations. During construction, the assigned state building inspector is considered the fire marshal until the Certificate of Occupancy is issued. At that time, the building is then referred to the state fire marshal's control. As of Spring 2012, the following state inspectors are assigned to all construction projects at NKU:

**State Building Inspector:**

Bill Amato  
(606) 584-0566  
william.amato@ky.gov

**State Electrical Inspector:**

Kathy Harrod-Scheduler  
502-573-1797

**State Plumbing Inspector:**

502-573-0397

Other agencies that require notification, permits, registrations, and coordination for the project are:

- Sanitary District No. 1 (SD1)
- Northern Kentucky Water District
- Duke Energy
- Central Campbell County Fire District
- Northern Kentucky Health Department
- Kentucky Transportation Cabinet

Whenever a campus project is located on the fringe of university property and/or the project will affect surrounding property owners and public utilities, these agencies are more actively involved in the planning, design, and review process. In addition, SD1 does require NKU to apply for their typical series of permits, as they always need to monitor NKU's resulting storm water and sanitary sewer outflows on their systems downstream. The NKU project manager will help coordinate the exact involvement of these agencies based on the specific scope and requirements for each particular project.

Contractors shall obtain all permits, and licenses, necessary for any or all parts of the work from the authorities governing such work. Evidence that such permits have been issued shall be furnished to the project manager before beginning work and during ongoing work as applicable. All contractors are responsible for paying all required inspection fee costs associated with their scope of work, and they shall include these inspection fee costs in their bid price.

**Scheduled Campus Utility Outages and/or Building Shutdowns:**

All necessary utility shutdowns necessary for existing NKU buildings to complete project construction work shall be at the convenience of NKU. The actual times of utility shutdowns could need to happen on third shift and/or weekends to avoid disruption of campus schedules. A minimum of a 48 hour notice is required.

**Utility Consumption Meters:**

All new building projects shall include consumption meters for all incoming utilities serving that particular building. All meters shall be IP addressable and shall all be connected via TC/IP to the central campus BMS system at the Central Plant. Coordinate with the NKU project manager on any direct connection/integration desired with the Intelligent Building System at Griffin Hall. Coordinate level of expectation and acceptable quality/brands of meters with NKU project manager.

**Attic Stock & Replacement Parts:**

For all project materials and systems, attic stock quantities consistent with accepted industry standards for college campuses shall be included in the project specifications. Replacement parts necessary from contractors/vendors shall either be in stock or available within 24 hours.

The following minimum level of attic stock quantities shall be included in the project specifications:

- (1) complete replacement cycle of filters for all HVAC equipment
- (1) replacement belt for each device or piece of HVAC equipment
- 5% ballasts/lamps
- 5% plumbing parts
- 3% floor base
- 3% floor tiles
- 3% ceiling tiles

**NKU General Safety Requirements:**

Also included in this section are also some general safety requirements every member of the design and construction team must follow when visiting/working on NKU's campus.

**NKU CAD and Mapping Standards & Building Information Modeling (BIM):**

This section includes the requirements for all CAD file deliverables created and provided to NKU for new projects. In addition to this collection of CAD standards for traditional 2D drawings, NKU also requires the use of Building Information Modeling (BIM) to drive and leverage the coordination process starting during design and continuing through construction. The entire design and construction management team is required to use BIM technology during the design and construction phases of this project. NKU requires the use of Revit for the Building Information Modeling process.

The selected design team will be responsible for developing a complete BIM implementation plan for the project in conjunction with NKU. This strategy shall include developing, defining, and documenting: the collective project goals and specific project uses regarding BIM, the BIM process for all project

parties (both consultants and contractors), the BIM model elements and level of detail required to implement and exchange information between all parties and protocols, the Owner of the model at each project phase, the electronic/coordination communication procedures (e.g., file naming conventions, file structures, and file permissions), the hardware/software/network infrastructure required, and finally the BIM process quality control procedures to ensure all project participants follow the rules and meet all defined requirements.

The BIM model developed by the consultants during the design phase will be used by the Construction Manager to fully coordinate the work of subcontractors during construction. The Construction Manager will be responsible for organizing, arranging, and developing the BIM coordination among all the subcontractors during construction. At the conclusion of the project, the final BIM model shall be delivered to NKU as part of the record documents submittal.

### **NKU General Safety Requirements**

The University strives to continuously maintain both a safe and secure work environment for its students, employees, and the employees of all Contractors assigned to our campus. Therefore, it is essential the following criteria be met by all Contractors (and all their subcontractors) working at NKU.

#### **BACKGROUND CHECKS:**

The Contractor shall furnish the University with written documentation that verifies each of their employees working on the property of the University has cleared a background check, has no felony convictions, is not a sex offender, and has the legal right to work in the United States.

#### **DRUG-FREE WORKPLACE:**

Northern Kentucky University is a drug-free and alcohol-free workplace, and all employees of Contractors and subcontractors are subject to this policy while working on University property. If there is verifiable suspicion or probable cause that an employee of the contractor or subcontractor is under the influence of drugs or alcohol, the University reserves the right to require the Contractor to have the employee tested immediately at no expense to the University. If the test results are positive the employee will be prohibited from working on University property for a period of one (1) year from the positive test, or the duration of the project, whichever is longer. The banned employee of the Contractor must pass a drug and alcohol test before working again on university property.

#### **CONTRACTOR PRESENCE ON CAMPUS:**

All persons working for (or on behalf of) the Contractor whose duties bring them on campus shall obey the rules and regulations that are established by the University and shall comply with the reasonable directions of the University representatives. Contractor's employees shall never enter or use existing areas of campus where they are not required to be performing work. Contractors and subcontractors are always responsible for providing and maintaining portable restroom facilities for all their workers working on the project.

Contractor shall be responsible for the acts of his employees and agents while on campus. Accordingly, Contractor agrees to take all necessary measures to prevent injury and loss to persons or property located on campus. Contractor shall be responsible for all damages to persons or property caused by Contractor or any of his agents or employees. Contractor shall promptly repair any damage that he, or his employees or agent may cause to the campus or to the University equipment.

Contractor agrees that in event of an accident or incident of any kind on university property, Contractor will immediately notify the University's Department of Public Safety (859-572-5500), who will prepare and furnish a full written report of the accident or incident.

All Contractor employees and subcontractors shall present a neat and clean appearance while on University property, and be able to present proper individual and company identification upon request.

**PROJECT WORK SITE SAFETY & SECURITY:**

The University does not, and will not, assume any responsibility for any tools, materials, equipment, or property belonging to the Contractor, his employees or agents, which may be lost or stolen from University property. All contractors and subcontractors are solely responsible for properly securing and protecting their tools and equipment.

When working within or on top of an existing building, the Contractor shall work with the assigned University project manager in developing a strategy for securing the project work site and protecting the campus staff and community from the project work site. When working in an open area on campus, the Contractor shall provide securable barricades/fencing around the project site to protect the campus community from the dangers within the project work site. The Contractor shall maintain this project work site protection 24hours a day, 7 days a week for the duration of the project.

**GENERAL PROJECT COORDINATION:**

All work and information requests by the Contractor shall be coordinated through the assigned NKU Project Manager. Any direction provided by the campus Operations & Maintenance Staff and/or the project user group shall **NOT** be considered official direction from the University unless authorized in writing from the assigned NKU Project Manager. Contractor will **NOT** be compensated for work performed without written authorization from the assigned NKU Project Manager or NKU-hired Architect of Record.

As a general rule, utilities required by the Contractor to perform their work can be obtained from the University. However, the University reserves the right to require the Contractor to furnish a meter to record the usage of each provided utility for the duration of the project. For projects requiring utility metering, a deduct change order will be issued at the end of the Project to reimburse the University for the Contractor utility usage. The Contractor is responsible for determining and coordinating the procurement of any utility where the University cannot reasonably provide.

Unless noted otherwise for a specific project, at least seven (7) calendar day notice is required for any campus utility shutdowns and/or any road/parking lot closures necessary for the Contractor to perform their work. All utility shutdowns and closures shall be coordinated with the assigned NKU Project Manager, and the University reserves the right to schedule these shutdowns and closures at night and/or on weekends to minimize disruptions to the campus community.

The NKU project manager will research and provide whatever information is available and known for the existing utilities in the area of concern. However, NKU generally prefers the contractor hire an outside utility locating service for marking the location of all existing utilities. Outside utility locating services will be required for locating all public utilities (when applicable), and most of the underground utilities on campus are private "house" lines owned & maintained of NKU. All requests for assistance from NKU's Operations & Maintenance staff in locating existing utilities shall also be submitted to the assigned NKU project manager at least (3) calendar days in advance.



## Northern Kentucky University CAD and Mapping Standards

Northern Kentucky University (NKU) has adopted the National CAD Standards Version 4.0 as of July 01, 2008, and requires all deliverables to be in accordance with the National CAD Standards. In addition, all submittals must adhere to any additional standards as specified in contracts with the University. Contact the department of Facilities Management: University Architect, Design and Construction Management (referred to herein as A & C) for more information regarding any project-specific requirements. A copy of the National CAD Standard may be obtained by entering the following web address in your web URL location:

The outlined CAD Standards are necessary in order to maintain and establish a common set of guidelines and/or definitions to be used for the production and maintenance of all electronic data. Adherence to these standards allows NKU to streamline the project processes by:

- Reducing additional University effort to produce electronic drawings for manipulation and/or modification
- Creating consistency and quality between NKU and its vendors
- Establishing a shared ground which will allow the University to share and transfer CAD data easily with other internal departments within the University and with external consultants working on new construction/renovation projects.

NKU depends on various types of data, which includes: existing "As-Builts," design documents, and maps that are of varied in order to make decisions regarding project activities or future plans for the campus. The data is also used for daily operations of the facilities as necessary by many internal departments. Therefore, detail, scale and accuracy/reliability are a must.

In order to improve the accuracy and accessibility of all relevant data: CAD, drafting and map-related information, the department of A & C would like to establish the following standards for acquisition and maintenance of CAD and mapping data to enable and support the development of a campus base map for future use. The map would be used in conjunction with geographic information system (GIS) data as a tool to support the management of daily NKU operational activities and future growth.

In order to eliminate discrepancies in the CAD and mapping products delivered to the University by contractors, NKU has established the following standards, which are to be utilized for use in developing all graphic data and information. These standards will streamline internal efforts. They will also create a dependable data library with which contractors may use for project activities.

It is the intent of this Department to use the electronic data created in CAD and/or mapping format as a basis for maintenance of the existing campus infrastructure, along with use for future planning and design efforts. The following information contained within this document outlines the basic preparation of all CAD and map files.

### **General Guidelines**

#### CAD System Requirements & Translation Issues

NKU currently uses the AutoCAD platform Release 2007. If a consultant is NOT using at a minimum AutoCAD Release 2000, a translation test must be performed with A & C before any CAD documentation is prepared. This test should cover any object types (i.e., polylines, polygons, arcs, circles, ellipse, rectangles, etc.). The test should also cover the following: fonts, blocks, hatching, entity - colors, layers, layer names and linetypes.

In the event a non-AutoCAD source is not able to translate certain object types, NKU reserves the right to reject the consultant's CAD platform, if it is deemed UNACCEPTABLE for use in preparing CAD documentation. A & C will determine on a case-by-case basis whether this limitation is significant enough for the proposed CAD system to be rejected.

### Electronic File Categories

#### **Buildings**

An electronic drawing for a building shall contain all the appropriate information (architectural, electrical, interior design, mechanical, plumbing, etc.) in plan view for related its floor or level. The absolute final drawing submitted to NKU shall contain "As-Built" information of the completed project, which will be used for maintenance of daily operations and/or as a basis for future projects. The user coordinate systems will be identical between levels, such that, each related level inserted on another shall be aligned appropriately from drawing to drawing. The default scale for text and symbology will be: 1/8"=1' with a linetype scale of 96. North shall always be the top or right side of the drawing area. The lowest southeastern corner of the drawing shall be located at 0, 0.

#### **Exterior Utilities and Site Plans**

All exterior utilities and site plans shall be created in model space. New construction projects that involve undisturbed geography may create these elements in a new drawing. New construction projects that require disturbance of existing utilized geographic locations shall begin their basis from existing NKU data, which will require field verification of said data. Both projects types will be required to integrate their final "As- Built" utility and site plan data into NKU's existing campus base plan. All drawings shall reference the same coordinate system. All drawings shall be in accordance with NCS guidelines.

### Drawing Requirements

#### **Prototypes & Blocks**

Prototype drawings and a block library are available from A & C to further aid in streamlining project processes.

NKU has established the following guidelines to be used in the development of all electronic drawings:

- All CAD elements must be drawn to the most accurate dimensions available
- Every layer must be uniquely named and its use based according to NCS guidelines.
- All entities, layers and linetypes must be defined as "BYLAYER".
- All blocks shall be created on layer "0". No nested blocks will be allowed.
- The font shall be ARIAL.shx for all applications. Alternate fonts may be used at the approval of NKU A & C, however, special fonts which are not packaged with AutoCAD are not allowed.
- Dimensioning styles shall be consistent and associative. This will allow AutoCAD to automatically reflect changes to the entity it is associated to and will therefore allow for greater accuracy. Under certain circumstances it may be necessary to override AutoCAD's dimension, this shall be completed as follows: explode the dimension blocks or disable the AutoCAD dimension variable (Dimaso) for associative dimensioning.
- All bound layers shall be renamed to the original layer name and must adhere to NCS guidelines.
- All drawings and drawing extents shall not contain any objects outside the drawing limits. All drawings shall be submitted such that the extents are in full view upon opening the electronic file.
- All unreferenced layers, linetypes and blocks shall be deleted prior to submittal using the purge command.



- **No electronic CAD drawing submitted to NKU will be accepted if it contains references to external source drawings (Xrefs). All externally referenced data used during drawing production shall be inserted and bound, resulting in a fully self-contained drawing file.**
- Each final plotted drawing sheet must correlate to its separate electronic drawing file mate.
- Every final drawing sheet shall have a unique name and shall be in accordance with NCS naming conventions.
- **Each sheet is to be clearly marked whether it is an As-Built or a Record Drawing.**

### Model Space vs. Paper Space

AutoCAD operates between two different drawing environments known as: model space and paper space layout). All drawings are to be produced in Model space. This includes all physical components of the project, such as, walls, topography, pipes, trees, doors, windows, columns, beams, outlets, ducts, etc., or any component(s) necessary for construction. Paper space is for plotting various views and scale. Each sheet shall represent one plotted drawing - plotted at full scale (1=1). All drawings submitted to NKU shall be produced with the following approaches for using model space and paper space:

#### **Model Space**

The primary drawing or model shall be created in model space. This includes all base plan elements, which must be drawn to full scale. Any additional items required to define the model or clarify model data, such as, dimensions, elevations, notes, room numbers and names, schedules, sections and/or details, etc., shall be drawn to full scale within model space. Elements shall be consistently relative to their correlating layer assignments.

#### **Paper Space**

All subsequent drawing elements, such as, title blocks, legends, key plans, plan titles, riser diagrams and schematic diagrams, along with sheet-specific notes shall be created in Paper Space. All model space features will be represented here at an appropriate scale to fit on the plotted sheet.

### As-Built Data

#### **Methods & Implementation**

The Contractor is responsible for the following at their expense for the reproduction of (1) full size blue-line print of each contract sheet within the project's entire complete drawing package. This original reproduction shall be marked accordingly to reflect all deviations incurred during the actual construction phase of the project, which differs from the contract drawings. All marks shall be made and must be permanent. The color green shall be used to indicate all additions and red to indicate all deletions. The re-marked data must indicate all deviations without exception, which include the following required data.

- All utility locations, such as electric transmission lines, gas lines, etc., along with related description of said elements.
- All existing components of any kind or description must be noted to exist within the project's construction boundaries. The data shall include position relative to permanent features by using appropriate dimension guidelines.
- The locations and dimension of any Changes to the building or structure, which includes changes to: dimension or location shall be included.
- All underground utilities and/or facilities shall be accurately located, which includes dimensions relative to permanent structural features.
- Any changes to topography, drainage grade, elevations, structures, utilities, roads, road alignment or any other physical feature, which deviate from the contract plans. This includes all additions and deletions, along with any change that may affect drainage patterns due to the projects scope.
- Any deviations, additions or deletions to any project design detail, which includes any information related to working drawings specified to be provided by and/or furnished by the

Contractor.

- All information related to the Contractor's furnishment and/or provision of: fabrication, erection, installation, and placing details along with size specifics, (i.e., such as pipes, insulation material, etc.),
- All changes and/or modifications which differ from the original design intent or from final inspection.
- Indication of option used in construction where contract documents and drawings allow for options.
- All options not used for construction shall be deleted.
- All deviations shall be indicated consistently and in accordance as the general detail and information utilized in the contract drawings. Continuous effort shall be made consistently without fail during construction to keep all "As-Built" marks up to date through and until the completion of work has been exercised. All data sheets are to be marked as "As-Built Field Marks" and shall not be used for purposes. This information shall be available at all times for review by the University's designated representative as identified in the project contract. NKU will require a joint review of all marks as defined in the project contract. Failure to maintain current marks is considered sufficient justification to withhold a monetary retainage from the monthly pay applications until marks are brought current to date.

All "As-Built Field Marks" drawings will be returned for correction, if upon review the University deems them to be in error and/or exists with omissions. Deficiencies, error and/or omissions must be corrected immediately. The drawings must be returned to NKU's designated representative within 10 calendar days upon receipt of returned drawings noting all said corrections. Production of all record drawings shall include joint efforts between the Project Architect/Engineer and Contractor. The Architect/Engineer is responsible for review and verification of said documents and must note any necessary revision to reflect "as-built" conditions based upon observations of the project work. The Contractor shall be responsible for incorporating all comments made by the Architect/Engineer. The Contractor may opt to contract the project Architect/Engineer to produce the project's As-Built CAD files. The Contractor must coordinate with NKU's designated representative to determine how to achieve this task for all projects designed in-house by the University.

### **Submittal Requirements**

The As-Built data is to be submitted to the University Architect or designated NKU representative for review, as identified in contract documents. Substantial Completion will not be granted until these items are received and approved in writing by Northern Kentucky University.

- (1) Electronic set of scanned tiff files for each drawing sheet from the related original "As-Built Field Marks" sheet contained on a compact disc. Multiple discs may be used if necessary. Files may be zipped as long as the compressing process does not damage the file when unzipped. Each drawing/sheet will be scanned to a 400 dpi TIFF / CCITT Group 4 format (black and white). Each scanned tiff file shall be named the same as the drawing sheet number and marked as, "As-Built Field Marks."
- (4) Sets of hardcopy drawings from CAD as-Built.
- (1) Electronic set of PDF files created for each sheet of the CAD as-Built contained on a compact disc. Multiple discs may be used if necessary. Files may be zipped as long as the compressing process does not damage the file when unzipped.
- (1) Electronic set of all CAD drawings each sheet within contained on a compact disc. Multiple discs may be used if necessary. Files may be zipped as long as the compressing process does not damage the file or its intelligence when unzipped. All drawings shall comply with the current NKU standards.

## **Division 02: NKU Master Plan Guidelines & LEED**

In Spring 2009, the university adopted the latest version of the NKU Master Plan, completing a process started in the fall 2007 with Campus Studio. A major focus of the Master Plan, in addition to anticipating and planning for future growth, is a conscious attempt to “green” the campus, both in terms of landscape architecture as well as sustainability efforts. When considering landscape architecture, the Master Plan focuses on transforming the current physical NKU environment and creating a more “campus” quality. The goal is to offset and balance all the existing hard surfaces, as well as the angular nature of the built environment with increased (but still appropriate) amounts of soft landscape and lawn areas. All new projects should embrace this goal and make a significant contribution to this realization. Included in this section are some other general guidelines resulting from the Master Plan efforts to date when designing new projects at NKU. In addition, new projects must always comply with KRS sections 56.777-.784.

### **LEED Certification & High Performance Building Standards:**

Pursuant to KRS 56.770-784 and 200 KAR 6:070 High Performance Building Standards, construction and major renovation projects under the ownership of the Commonwealth of Kentucky must adhere to this new sustainable design criteria. In addition, NKU signed and adopted the American College and University Presidents Climate Commitment in December of 2007. As a signatory to this commitment, NKU agreed to establish a policy that all new campus construction projects will meet the requirements of the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) certification standards (or equivalent).

As a result, NKU is committed to achieve some level of LEED certification on all applicable new building and/or renovation projects. The specific level of LEED certification (and applicable version to follow) will vary depending on budgeted project size:

1. All new construction and major renovation building projects in the amount of \$25 million or more in budget shall be designed, built and submitted for certification to achieve LEED Silver level or higher.
2. All new construction and major renovation building projects between \$5 million and \$25 million in budget shall be designed; built and submitted for certification to achieve LEED Certified level or higher.
3. All new construction and major renovation building projects greater than \$5 million in budget shall additionally achieve a minimum of 7 points for new and for existing buildings under the LEED Energy and Atmosphere Credit 1, Optimize Energy Performance.
4. All new construction and major renovation building projects between \$600,000 and \$5 million in budget shall be designed and built using the LEED Rating System as guidance.

Final determination for each new project shall be coordinated with the NKU Project manager. In all cases however, the university will always strive to maximize energy efficiency for all new and renovated/retrofitted building systems. For renovation projects where the budget exceeds half the **replacement** value of the building being renovated, such projects are to be considered “major renovation.”

### **Life Cycle costing:**

Designer shall perform a life cycle cost analysis of selected HVAC and other building systems to demonstrate that the most cost effective systems are being selected.

## A. Design Guidelines

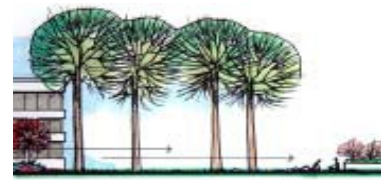
As a relatively young institution, Northern Kentucky University is striving to build a sustainable tradition of educational excellence expressed throughout the whole of the campus environment and architecture. The overall goal is to create buildings and a campus landscape that are timeless; are respectful of, in context with, and build upon the university's unique design history; contribute to the quality of the campus as a place; and, help create a memorable environment with engaging, vibrant places for interaction and socialization, contributing to the collegiality of the campus. Campus Design Guidelines, which are based upon the Master Plan Principles, will be fundamental to creating an exemplary campus setting, reflective of university priorities and a commitment to students, faculty and staff. The following guidelines, which should be interpreted in concert with the university's Design and Construction Standards document, provide for an integrated implementation program to guide the growth and transformation of the campus including: architectural layout; open space and pedestrian circulation; transportation and parking; and, utility improvements.



Potential Site Treatments

### 1. Open Space

- Where possible, buildings should be clustered around a major open space with connecting pedestrian pathways placed in a manner that maximizes green space and encourages social interaction.
- Primary open spaces should preferably be 2 acres but not less than 1 1/2 acres in size.
- Spaces should reflect the scale of the buildings which define them. The width of a major space should be equal to or greater than 1/2 the height of the tallest contiguous building.
- All buildings should have a primary entrance fronting on a major open space.
- Buildings should include secondary entrances where necessary to accommodate open space and building-to-building pedestrian patterns. These entrances could be at grade and/or at an upper or lower level; where feasible, these entrances are to be accessible to the disabled.
- Open spaces should foster a sense of campus and community: they should be memorable and comfortable.
- Most buildings in the Plan should be sited to support the creation of outdoor rooms. Other buildings are focal points for long vistas or serve as the terminus of an outdoor space.



## 2. Landscaping



- Create a sustainable campus.
- Site improvements are to be a part of all building projects and budgets.
- Use landscaping to increase the sense of place, to assist wayfinding and to create comfortable yet safe outdoor rooms.

- Landscapes should result in simple bold patterns, creating large patterns of color.
- Use hardy, low-maintenance and proven native plant species capable of withstanding the ph, soils, exposure, and climactic conditions of Northern Kentucky, and more specifically the microclimate and exposure surrounding buildings.



- Utilize appropriately placed, hardy plant materials to enhance and define spaces, provide shade, and control views.



- Use a variety of evergreen, deciduous, and flowering plant materials. Employ grasses and perennials in areas requiring additional interest.



- For security purposes, shrubbery or other opaque materials more than 2' in height at maturity should be set back a minimum of 15' from any pedestrian walkway, bike racks, and building entrances.

- To balance an abundance of existing concrete, hardscape design should include colorful pavers.
- Concrete walls should be carefully designed to minimize their impact on the campus environment; avoid using concrete walls unless needed for functional reasons.



Looking North at Central Plaza

### 3. Building Consistency



- Buildings should be sited to create exterior public spaces.
- There should be consistency of building form, architectural style, and materials throughout campus.
- New buildings and building additions should be sympathetic in color and materials to existing buildings, while being expressive of current architectural styles.
- New buildings should be designed with qualities of permanence, welcome-ness and vibrancy, creating places of energy and interest.
- Building projects, regardless of size, should be constructed of quality, enduring materials that are easy to maintain.
- Designs should be responsive to the needs of a building's specific users, but also to the needs and requirements of the university as a whole, and in addition, the design must be adaptable over time to changes in the function and operation of the building.



Looking East to the Library

- Design decisions should be based upon the best long-term value; generally, this implies that the least expensive solution is not always the best solution.
- Energy efficient systems and building components are a priority. Designs should consider all aspects of environmental impact, both on campus and in terms of from where materials are acquired.



Elevated Walkway Linking Business-Education-Psychology Center and University Center

#### 4. Site Efficiency

- New buildings should average 4 or more stories above grade.
- Loading zones; short term and handicapped parking; and, drop-off drives should be sited to serve multiple buildings.

#### 5. Site Grading

- Use grading to enhance or disguise views.
- Minimize grading disturbance in areas with existing vegetation.
- Gently grade areas and avoid the use of steps when possible.
- Concrete walls should be carefully designed to minimize their impact on the campus environment; avoid using concrete walls unless needed to resolve grading problems or other functional reasons.



#### 6. Safety and Lighting



- Install lighting at all building entrances, pedestrian routes and parking lots.
- Light areas beyond sidewalks for safety.

- Dense vegetation, walls, and other obstructions inhibiting visibility must be no closer than 15' from pedestrian pathways and building entrances.



- Carefully locate light fixtures to allow for even distribution and consistency of lighting. Avoid creation of dark areas and hot spots.
- Select high quality pedestrian-scaled fixtures.
- Light fixtures should be appropriate for their intended use and aesthetically pleasing.
- Strive for a pedestrian-safe campus by maintaining vehicular traffic on the edge of campus.

## 7. Wayfinding



- Establish intuitive wayfinding with consistency of signage, materials, lighting, and site furnishings.
- Include critical information along pedestrian routes and building entries in Braille.
- The university's signage standards should govern all signage installations.

## 8. Universal Access

- Adopt a "universal access" strategy.
- Provide equal access into buildings from major vehicular and pedestrian routes; use noticeable pavement changes at cross walks, steps, and building entries.



## 9. Bicycles



- Encourage bicycle use by providing bike racks; locate racks an appropriate distance from building entries.
- Provide screening around bicycle racks.
- Clearly designate bike paths with signage and striping.
- Where possible, separate bicycle traffic from pedestrians by providing separate paved paths.
- When combined paths for bicycles and pedestrians cannot be avoided, dedicated (striped) bike lanes should be delineated and the combined path should be 10' or more in width.
- Restrict bicycles in highly-used pedestrian areas such as the Central Plaza. It is proposed that the Central Plaza and other areas where large numbers of students gather be identified as "walk only areas".





## 10. Pedestrian Connectivity



- Develop a comprehensive pedestrian corridor system linking all campus destinations.
- Create nodes at pedestrian intersections to encourage social interaction.
- When transitioning grade levels, avoid designs that require stairs.



- Consider elevated walkways to ensure pedestrian safety at busy intersections and roadways and to overcome elevation challenges between buildings.

- Provide strong pedestrian connections between the campus and nearby services, transportation and commercial destinations.
- Consider tree-lined pedestrian corridors to provide shade, scale and campus continuity.



Special area gateways



## 11. Campus Housing



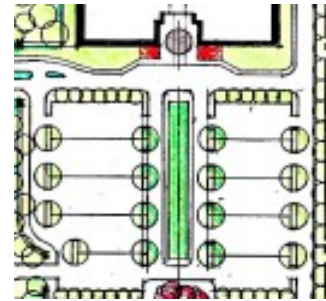
- Work with developers and the community to increase housing opportunities.
- Select sites that provide a variety of open spaces for gathering and recreational use.
- Provide safe pedestrian connections to campus.
- Planting in the residential areas should reinforce a sense of community while creating a more intimate scale.

## 12. Athletic Facilities

- Locate athletic facilities in areas that are within walking distance of student housing.
- Choose sites that are accessible for community use.
- Facilities with large anticipated spectator attendance should be within easy access to and from major campus vehicular access routes.
- Design athletic facilities to minimize traffic impact on neighboring residential land uses.
- Mitigate lighting spillover to adjacent residential neighborhoods.
- Provide buffers along residential edges.

## 13. Parking Lots and Garages

- Locate parking facilities within a 10-minute walk to major campus destinations.
- Construct large, remote parking lots and begin a shuttle system to the center of campus.

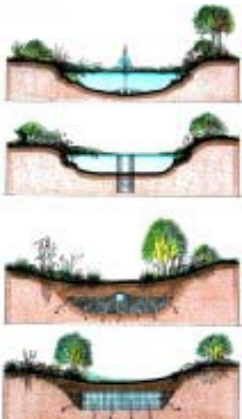


- Provide connections to a minimum of 2 access roads in order to distribute traffic.
- Incorporate safe crosswalks.
- Create parking lot pods with a maximum capacity of 250 vehicles. Separate parking pods with 20' wide landscaped areas.

- Include parking for car-poolers, as well as alternative fuel re-fueling station for low-emission/fuel efficient vehicles.
- Provide visitor parking within a 5-minute walk of major destinations.
- Design parking garages to blend with surrounding buildings.
- Maximize natural ventilation in garages by locating in sloped areas.
- Encourage efforts that reduce on-campus parking demand, and provide convenient drop-off areas for mass transit.

#### 14. Stewardship and Sustainability

- All new buildings shall be LEED certifiable.
- All construction projects, including renovations, shall incorporate sustainable practices.
- Preserve natural vegetation on building sites, where possible
- Consider less destructive options such as terracing, and reducing building footprint.



- Utilize Best Management Practices (BMP's) to reduce storm water runoff by incorporating green roofs, rain gardens and bio-swales into construction projects to reduce use of potable water for irrigation by harvesting roof water.

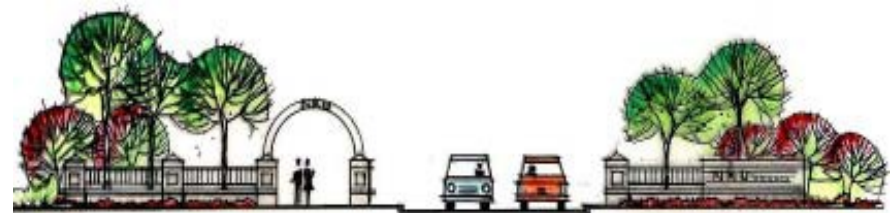
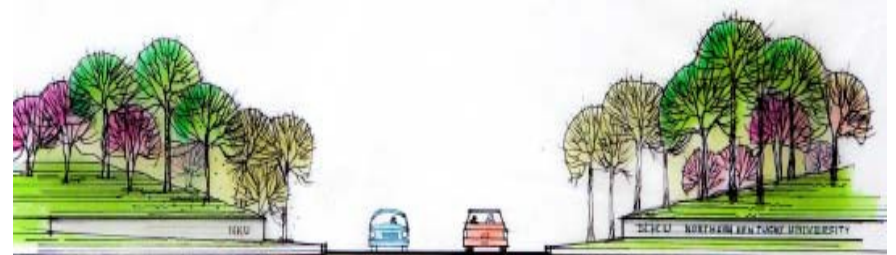
- Incorporate permeable pavement technologies in future hard surface areas, both vehicular and pedestrian.

- Efforts should be made to avoid light pollution (over-lighting).
- Select energy-efficient fixtures.



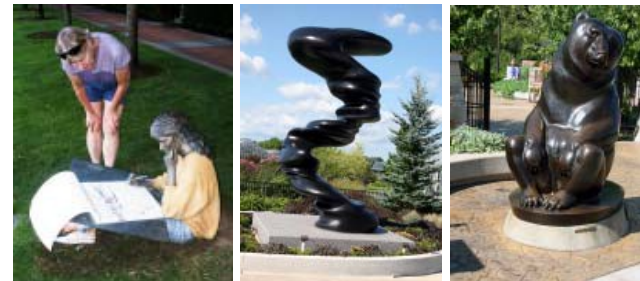
#### 15. Neighborhood Gateways/ Campus Portals

- Provide a hierarchy of campus entrance/gateways designed to promote a strong campus identity, creating a sense of welcome for students and visitors.



#### 16. Public Art

- Find opportunities to thoughtfully integrate art into the university's living and learning environment.
- Select pieces which are visually appealing as well as artistically appropriate.



## **Division 08: Openings & Building Envelope**

The following guidelines represent preferences typically requested by NKU for various building components constituting the interior and exterior of new buildings. These should be considered basic requirements, as there are always situations and conditions warranting exceptions or slight deviations away from these guidelines. However, any deviation from the following guidelines shall be coordinated with and approved by the NKU project manager.

### **Exterior Building Envelope:**

- NKU requires thermal testing for the finished building envelope prior to final acceptance.
- Design teams shall incorporate an appropriate mixture of exposed concrete, glazing, and metal panels on the exterior envelope to remain consistent with the surrounding architecture. Depending on the project location, an appropriate and acceptable proportion of each material will likely vary, and shall be coordinated with the NKU project manager.
- All exterior glass should be treated to reflect ultraviolet radiation and should be as energy efficient as feasible. Provide sun screens or otherwise shade glazing, particularly on the west and south facades.
- In several existing campus buildings, the exterior windows are higher in elevation relative to the office/classroom floor level, and while these windows do allow light to enter, they do not provide views to the exterior for office/classroom occupants. Whenever possible and appropriate, windows should be sized and located to provide both the combined benefit of day lighting and views to the exterior.
- All building entrances should be designed with an airlock for energy conservation. To make the airlock most effective, provide enough distance between sets of doors to allow the user to open one door while the other door is still closed.
- All exterior doors should be recessed. In several locations on campus, strong prevailing winds interfere with proper door operation. This will be particularly true on the west side of the building.
- Exterior doors should be out-swinging and should be equipped with butt hinges (non-ferrous) or offset pivots. Center pivots and Adams Rite type locking devices are not acceptable (all panic devices should be of the push pad type; cross bar devices should not be used). Storefront systems should be of medium stile design.
- All building entrances located on ADA accessible routes must be equipped with an automatic push button door opener to facilitate access for people with disabilities. Automatic door openers are also required for any doors leading to common lobbies, passageways, etc. along an ADA accessible route.
- Roofing systems are NOT required to meet any special Factory Mutual requirements. NKU's insurance carrier simply requires the roofing construction conforms to all current/applicable building codes.
- For roof drains, NKU prefers a roof drain with no-hub-type clamp for attaching the pipe to the roof drain fixture, and not slip into the roof drain fixture. The Westerman Herrmann Science Center roof drains appear to leak after they go through a heating and cooling cycle, and those roof drains appear to be made with a pipe that slips into a gasket on the roof drain fixture.

### **Exterior & Interior Glazing:**

Provide ample exterior and interior glazing to provide a sense of openness in the building. It is desirable to always see forms of activity as one walks through campus buildings. The more public an area, the more a sense of energy can be achieved through judicious use of exterior and interior glazing. For all interior glass doors/walls, coordinate with NKU project manager on how to implement manual/motorized blinds, as well as blinds potentially integrally sandwiched in glass. With long interior corridors, place exterior glazing at the end of the corridor to diminish perceived length.

### **Interior Doors:**

- All doors should be either hollow metal with welded seams filled and ground smooth or high quality wood doors. All doors should be a minimum of 36" in width.
- Wherever possible, restrooms should be designed with offset walls at entrances to preclude the need for doors. When restroom doors are necessary, at least one set of toilet rooms per floor shall be equipped with automatic push button door openers to facilitate access for people with disabilities.
- All interior doors to offices, classrooms, labs and lounges shall have a small vision window of clear glass (either in the door panel or as a side light) to provide personal security for all room and/or office occupants and visitors.
- For ADA accessibility and general maintenance, all double doors should be provided without center posts. At double door locations, install a concealed vertical rod in the inactive leaf and equip the active leaf with mortise panic device. If a wide, single door (42" wide, for example) would serve the same purpose as a double door, provide the single wider door.
- Doors providing access to rooms which will receive significant cart traffic, or where items are likely to be moved in and out, should be designed and equipped with ample plate protection for at least half the height of the door.
- Provide an attractive, durable coat hook where noted in the program. Place door stop away from wall a sufficient distance to prevent coat hook damage to door. Provide floor mounted doorstops for all doors not equipped with overhead controls.
- After-set door frames are preferred instead of pre-fabricated welded frames.
- The following are NOT acceptable door manufacturers: Am-weld, Kewanee, and Pioneer.

### **Door Hardware:**

Attached at the end of this section is a collection of NKU door hardware standards. The following provides a brief summary, as well as additional requirements:

- For the automatic push button door openers, the pushbuttons should be mounted a minimum of ~3-4' from the door, and 26" above finish floor (26" is the preferred height, but a height up to 36" is also acceptable). Mounting of buttons on rails is not an acceptable solution, and every effort should be considered to achieve wall-mounting of push button door operators. The Dor-A-Matic Senior Swing model is recommended, and the push-and-go feature is preferred.
- Refer to Division 28 for details on NKU's standards for controlled access card systems for interior and exterior doors. Provide a key bypass integrated for all doors outfitted with card readers.
- For doors involving card readers, provide both position switches and request to exit switches:
  - Position Switch: Recessed Honeywell 947-75TWH
  - Request to Exit: Honeywell Intellisense IS-310
- All locks should be mortise locks except where panic devices are required.
- Mortise locks should be heavy duty; Best, Sargent, or Corbin Russwin are the preferred manufacturers. Schlage mortise locksets are not permitted, but Schlage Gr 1 cylindrical locksets are acceptable.
- All cylinders for locksets should be Best Peaks Patented, as NKU utilizes a propriety Best Peak Patented keyway. For the project, NKU will purchase the cores directly from Best and install the permanent cores independent of the contractor.
- Contractor shall furnish (3) key blanks per lock/cylinder to NKU.
- All lock trim should be of lever handle design that meets all ADA and fire code requirements. Mechanical rooms and other hazardous areas should have knurled handles or some other warning surface (per ADA requirement) for those with sight -impairments.
- Aluminum (US28) finish on hardware or aluminum hardware is not acceptable. A durable finish should be specified. Finish on all locks (exterior and interior) should be US26D (polished chrome) for durability.
- All panic devices shall be touch pad type. NKU's preference for panic device application is as follows, in order of preference:

#### **For Pairs of Doors:**

1. Two surface mounted vertical rod devices.
2. If there is a mullion, then use rim devices.
3. If there is an inactive door, use a flush bolt on the inactive side.

4. From a maintenance perspective, concealed devices are not preferred.
5. Exceptions/Other:
  - For interior hollow metal or wood pairs, provide two surface vertical rod devices (with the less bottom rod option).
  - For exterior hollow metal pairs, provide a mullion and two rim devices.
  - For exterior aluminum storefront pairs, provide a concealed vertical rod device with top and bottom latching.
- NKU's preference for panic device manufacturers are as follows, in order of preference:
  1. Von Duprin
  2. Precision 1200 Series (New series precludes 1100 as originally listed)
  3. Sargent 80 Series
- Provide door closers only when required by the building code, and in-floor (recessed) closers shall never be specified.
- When door closers are required, NKU's preferred closer manufacturers are as follows, in order of preference:
  1. LCN
  2. Sargent
  3. Norton
- Full continuous hinges, such as Select or Roton are preferred; offset hinges are not desirable. Storefront doors should not be equipped with center or butt hinges.
- Weather stripping should be a brush type. Basis for reference is National Guard Products 601A or DkB or DkB, 602A or DkB, etc.
- Bronze thresholds are preferred in all entrance doors; with specific approval of the project manager an aluminum threshold may be used.
- NKU no longer permits door handle wall stops, as the carpenter shop was spending way too much time repairing drywall. As a result, NKU now exclusively uses floor stops, and NKU's preference is the Ives FS434 Floor Stop (Part #: FS434 IVES).

**Northern Kentucky University**  
Highlands Heights, Kentucky 41099

**DOOR HARDWARE**  
SPECIFICATION GUIDELINES  
SECTION 08710

June 2007  
**Revised: May 2012**

**Northern Kentucky University**  
Highlands Heights, Kentucky 41099 Contact: Sonny Barker  
Title: University Locksmith  
Ph: 859.572.5674 Fax: 859.572.6083

**DOOR HARDWARE**  
**SPECIFICATION GUIDELINE**  
SECTION 08710

Edit Date: June 2007  
**Revision Date: May 2012**

The purpose of this booklet is to support the facility's building standards for door hardware. The facility maintains the following hardware and is currently stocking replacement parts. The products listed in this booklet are to be used without substitution on new construction and modernization projects unless products are listed in this package as an alternate.

It is the intent of this booklet to provide guidelines for the architect's specification section 08710, for product groups and the hardware schedule. It remains the architect's responsibility to coordinate these products to meet the applicable building codes, life safety codes, and ADA requirements.

Section 08710 door hardware preamble must specify the following:

Door and frame prep

Before hardware installation, verify that all doors and frames are properly prepared to receive the specified hardware. Hollow metal frames shall be prepared for ANSI strike plates per A115.1-2 (4-7/8" high), hinge preps will be mortised and reinforced with a minimum of 10 gauge reinforcement material; minimum of 14 gauge reinforcement material for closer. Hollow metal doors shall be properly prepared and reinforced with a minimum of 16 gauge material for either mortised or cylindrical locks as specified. It is preferred that all hollow metal doors receiving door closers have 14-gauge reinforcement. If this is not possible, the use of sex bolts is mandatory. Wood doors shall be factory prepared to receive the scheduled hardware.

Hardware installation

The manufacturer's representative for the locking devices and closing devices must inspect and approve, in writing, the installation of their products. Hardware installed incorrectly must be reported to the architect prior to the architect's final punch list.



# SPECIFICATION GUIDELINE Manufacturers and Products

## Northern Kentucky University Substitutions or Alternates not permitted unless noted below.

Edit Date: June 2007  
**Revision Date: May 2012**

### DOOR HARDWARE

Description	Manufacturer	Model / Series	Finish
<b><u>Hanging Devices</u></b>			
<u>Mortise Hinge</u>	Stanley	FBB199 Drs over 36" as required (Ext high use doors) FBB191 Drs up to 36" (Ext low use doors) FBB168 Interior Drs over 36" (Int high use doors) FBB179 Interior Drs up to 36" (Int low use doors) *NRP (Non Removable Pin) at Reverse bevel locked Doors	US32D US32D US26D US26D
<i>Alternate</i>	Hager		
<i>Alternate</i>	Bommer		
<u>Continuous Hinge</u>	Select	Geared: SL 11SD (Std Duty) / SL 11HD (Hvy Duty) Geared: SL 24SD (Std Duty) / SL 24HD (Hvy Duty) *Continuous Hinge use at selected or Alum Doors	AL AL
Alternate	No Substitution		
<b><u>Securing Devices</u></b>			
<u>Mortise Lock Set</u>	Best	45h X 15h	626
	<b><u>Lock Function</u></b>	<b><u>Lock Type</u></b>	
	AB	Entrance Lock or Office	
	R	Classroom Function	
	INL, IND	Intruder Function	
	D	Storeroom Function	
	N	Passage	
	L	Privacy	
		*Provide lock functions as required for project as appropriate	
<i>Alternate</i>	Corbin/Ruswin		
<i>Alternate</i>	Sargent		
<u>Mortise Deadbolt</u>	Best	48H Series	626
<i>Alternate</i>	Corbin/Ruswin		
<i>Alternate</i>	Sargent		

SPECIFICATION GUIDELINE  
**Manufacturers and Products**  
**Northern Kentucky University**

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DOOR HARDWARE

<u>Description</u>	<u>Manufacturer</u>	<u>Model / Series</u>	<u>Finish</u>
<u>Electrified Lock</u>	Best	45HW x 15H	626
	Lock Function	Lock Type	
	DEU	Electrically unlocked (Fail Secure)	
	DEL	Electrically locked (Fail Safe)	
<i>Alternate</i>	Corbin/Russwin		
<i>Alternate</i>	Sargent		
<u>Cylinders</u>	Best	Mortise 1E74 x RP3 x cam required	626
		Rim 1E72 x RP	626
		*Provide as necessary to operate locking hardware	
<i>Alternate</i>	No Substitution		
<u>Key System</u>	Best	Removable/Interchangeable Core	626
		7-pin Best "Peaks" Existing key system	
		2 keys per lockset	
		All Cylinder and cores must be manufactured by BEST	
		All locks and cylinders must be supplied with permanent cores, with two keys each	
<i>Alternate</i>	No Substitution		
<u>Exit Device</u>	Von Duprin	99 series	626
		996L lever trim where applicable	
<i>Alternate</i>	Precision	2100 Rim Series	630
<u>Flush Bolts</u>	Ives	FB458 (Manual) (metal doors)	626
		FB358 (Manual) (wood doors)	626
		FB31P (Automatic) (metal doors)	626
		FB41P (Automatic) (wood doors)	626
		*Use automatic flush bolts where required by fire code or IBC	
		*Provide coordinator and brackets as required to meet fire door requirements	
		*Dust Proof strike as required	
<i>Alternate</i>	Trimco		

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DOOR HARDWARE

<b>Description</b>	<b>Manufacturer</b>	<b>Model / Series</b>	<b>Finish</b>
<u>Coordinator</u>	Ives	COR Series Mounting brackets as required	600
<i>Alternate</i>	Trimco		
<i>Alternate</i>	Rockwood		
<b><u>Closing Device</u></b>			
<u>Closer</u>	LCN	4040 XP Series *Provide standard duty Parallel arms interior/low traffic *Provide heavy duty S-CUSH or EDA Parallel arms at exterior and high traffic *All door frames to be reinforced *"SNB" Sex Nuts and Bolts at label doors as required	689
<i>Alternate</i>	No Substitution		
<b><u>Automatic Operators</u></b>			
<u>Automatic Operator</u>	Von Duprin	Senior Swing with digital control box *Provide at ADA required locations	680
<u>Actuation</u>	BEA	10 PBR1	
<i>Alternate</i>	No Substitution		
<b><u>Stops &amp; Holders</u></b>			
<u>Door Stop</u>	Ives	FS438 floor stop (use only as required) WS406CCV (Concave) / WS406CVX (Convex) wall stop *Allow for maximum swing of doors	626 630
<i>Alternate</i>	Trimco		
<i>Alternate</i>	Rockwood		
<u>Overhead Stops</u>	ABH	9000 Series	630
<i>Alternate</i>	Rockwood		

SPECIFICATION GUIDELINE  
**Manufacturers and Products**  
**Northern Kentucky University**

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DOOR HARDWARE

Description	Manufacturer	Model / Series	Finish
<b><u>Accessories</u></b>			
<u>Offset Pull</u>	Ives	8190-0 10" CTC *At Exterior doors	630
<i>Alternate</i>	Trimco		
<i>Alternate</i>	Rockwood		
<u>Straight Pull</u>	Ives	8103-0 10" CTC *Where no hindrance to operation of cylinder	630
<i>Alternate</i>	Trimco		
<i>Alternate</i>	Rockwood		
<u>Push Plate</u>	Ives	8200 4" x 16"	630
<i>Alternate</i>	Trimco		
<i>Alternate</i>	Rockwood		
<u>Kick Plate</u>	Ives	8400 10" x 2" LDW x B4E (Single doors) 8400 10" x 1" LDW x B4E (Pair doors)	630 630
<i>Alternate</i>	Trimco		
<i>Alternate</i>	Rockwood		
<u>Armor Plates</u>	Ives	8400 32" High x 2" LDW x B4E	630
<i>Alternate</i>	Trimco		
<i>Alternate</i>	Rockwood		
<u>Mop Plates</u>	Ives	8400 4" High x 1" LDW x B4E	630
<i>Alternate</i>	Trimco		
<i>Alternate</i>	Rockwood		
<u>Threshold</u>	Pemko	171A (1/2" x 5" Saddle threshold) *Furnished as detailed on drawings, if shown	
<i>Alternate</i>	Reese		
<u>Door Sweep</u>	Pemko	18100 CNB (interior) 345 ANB (exterior)	

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DOOR HARDWARE

<u>Description</u>	<u>Manufacturer</u>	<u>Model / Series</u>	<u>Finish</u>
<i>Alternate</i>	Reese		
<u>Smoke Seal</u>	Pemko	S88 (verify color)	
<i>Alternate</i>	Reese		
<u>Sound Seal</u>	Pemko	*Use double row of S88 for Sound Seal at Music Rooms	
<i>Alternate</i>	Reese		
<u>Light Seal</u>	Pemko	379 CS (at head and jambs) Door bottom and threshold as required *Used at Dark Rooms	
<i>Alternate</i>	Reese		
<u>Weather Seal</u>	Pemko	18041 CNB (at head and jambs)	
<i>Alternate</i>	Reese		
<b><u>Miscellaneous</u></b>			
<u>Key Control Software</u>	Best	Keystone 600 N	
<u>Pad Lock</u>	Best	21B722L	
<i>Alternate</i>	No Substitution		
<u>Key Cabinet</u>	Lund	1200 Wall mounted series, Dual key tag *Capacity 50% over lock quantity	
<i>Alternate</i>	No Substitution		
<u>Fire Dept Lock Box</u>	Knox Box	3200 - As required	

**Access Control**

Access Control: Coordinate electro-mechanical hardware requirements such as Locks and Electrified Exits with Access Control Supplier. Access control requirements to be determined by Architect/Owner at time specification is written.

## **Division 09: Interior Finishes**

The following guidelines represent the interior finishes typically preferred and requested by NKU. Any deviation from the following guidelines shall be coordinated with the NKU project manager. In general, all materials and equipment specified must meet the highest standards possible within budgetary constraints. The finishes must be durable and easily maintained, and yet serve the functional purposes and requirements of the area while also conveying an appropriate level of quality.

- **Walls:** Generally, painted gypsum board is acceptable. Some areas may dictate a harder or more durable finish. Use ceramic tile on restroom walls as appropriate. Wall studs in corridor walls should be at 16" centers. Provide sound alteration blankets in every wall and two beads of sealant beneath all wall bottom plates. Wall details used successfully on previous projects to ensure acoustic privacy for faculty offices and department chair suites can be provided by the project manager upon request. Install corner guards on wall corners likely to receive abuse.
- **Paint:** All paint is to be water-based. Do not paint concrete. The campus standard is Sherwin Williams Super Paint for gypsum board and ICI Glidden Devflex for metal surfaces. The design team should also consider the use of the Sherwin Williams "ProGreen 200 Low VOC" product line as well.
- **Paint Colors:** NKU has an existing color palette of over 200 colors from existing buildings and previous projects. Paint colors shall be considered and proposed from this existing color palette, and all final color selections shall be coordinated with the university's in-house Interior designer and the project manager. Some color selections for existing and new buildings originated from previous paint manufacturers. However, NKU's local Sherwin Williams store near campus has NKU's entire campus color palette on file, and they will be able to provide the corresponding Sherwin Williams color to match these legacy colors. The store number is 859-431-5345 (ask for Jason or Paul). All ceilings and soffits shall receive a flat white ceiling paint.
- **Floors:** The carpet specified should be the highest quality available within budgetary constraints.
- **Hard surface:** Terrazzo, ceramic or porcelain tile, Forbo Marmoleum, or other high quality, attractive, easily maintained hard surface flooring in public areas. Exposed concrete or stained concrete is appropriate for certain areas (see program detail). Use hard surface flooring in all high traffic areas, including any vending areas.
- **Ceilings:** All lay-in ceilings should be on a 2' X 2' grid. Use reveal edge ceiling tile.
- **Building Entrance/Walk-off Mats:** Waterhog by Andersen or Musson Premier 7/16" thick tiles.
- **Window Treatments & Curtains:** Motorized/powerd window treatments and theater curtains shall be included in the base construction contract scope of work to ensure proper coordination of the electrical requirements. When manual window treatments and/or theater curtains are requested, NKU will usually purchase them directly from the project FFE budget. The current campus standard for window treatments is "MechoShades" (1300 Series/5% openness factor) with a clear anodized fascia and a shade fabric color of 1010 light grey. However, different fabric colors, styles, and openness factors have been used on previous projects, so final selection of all window treatments shall be verified with the NKU project manager.
- **Motorized Projector Screens:** All motorized/powerd projector screens shall be included in the base construction contract scope of work to ensure proper coordination of the electrical requirements. All manual projector screens will be purchased through the project FFE budget.
- For all spaces programmed as "multi-purpose" rooms, specify flooring materials that can handle tables and chairs for special events or meal functions as well as normal sports/fitness/club activities.
- For all large and/or "multipurpose" spaces (>1,500 sf), specify a large screen/projector drop from the ceiling with cable TV access to watch an event with a large group of people. This should be considered a minimum technology requirement, as the building program will likely require an additional level of technology needs.
- Ensure all finishes on walls and fabrics for furniture are durable enough to handle sunlight without fading right away if several windows are installed. Some of the more recent campus buildings with increased amounts of glass have had fabrics faded due to the amount of sunlight exposure.

## Division 10: Toilet Room Accessories

The following guidelines represent the preferences typically requested by NKU for toilet room accessories. NKU typically provides and installs certain components after move-in as part of a blanket, campus-wide accessory contract with an outside vendor. Anything deviating from the following guidelines shall be coordinated with the NKU project manager.

Accessory	Provided & Installed by NKU	Provided & Installed by Contractor	Surface Mount or Built-in	Comments
Roll paper towel dispenser	X		SM	Approximately 18"W x 24"H
Trash receptacle	X			Freestanding
Soap dispenser	X		SM	
Sanitary napkin dispenser	X		SM	
Toilet Tissue dispenser	X		SM	
Mirrors		X	SM	Provide individual mirrors to allow soap dispensers to be mounted proximate to sinks.
Shelf		X	SM	For books and personal items. Laminate covered
Baby changing shelf		X	SM	

On new projects, the NKU standard is to not install paper towel dispensers in toilet rooms and to instead rely solely on electric hand dryers (see below for products). Any other spaces needing paper towel and/or soap dispensers besides toilet rooms will be furnished and installed by NKU. The following represents a listing of the current accessories furnished and installed by NKU Custodial Services:

- Toilet Paper: Kimberly Clark model #09608, Paper Towel Sanitouch #09990
- Paper Towels: Levermatic #09765.
- Dual Napkin/Tampon Dispenser: Rochester Midland Corporation
- Feminine Napkin Disposal Unit: Sanisac

Whenever possible, design restrooms with wall offsets so entry doors are not necessary, as this design provides much easier accessibility for handicapped, strollers, custodial equipment. A successful and preferred restroom entry layout exists in the Dorothy Westerman Herrmann Natural Science Center (commonly referred to as New Science), the Student Union, and the bottom three floors of Griffin Hall. Toilet room plan layouts used successfully on these previous projects to preclude the need for entry doors can be provided by the project manager upon request. If restroom entry door are necessary, provide an automatic door opener (push-button type) on the door to each men's and women's restroom to facilitate access by the disabled (refer to Division 08 for info on automatic door opener buttons).

All new toilet rooms shall be equipped with (2) electric hand dryers. The current campus standard model is Xlerator by Excel Dryer, Inc. (Model #XL), but other acceptable manufacturers/models can be listed as American Specialties Turbo-Dri (Model #0197) and the Dyson Airblade (Model #AB02). The design team shall review the wall offset, open entries described above coupled with the desire for electric hand dryers and implement any necessary acoustic provisions to preclude excessive sound transmission into adjacent spaces.

**Other Toilet Room Accessory Preferences:**

- Drop-in sinks with a durable countertop are preferred. Specify energy efficient faucets, urinals and toilets.
- Provide sufficient space between mirrors to hang soap dispensers.
- Toilet partitions should be floor mounted with overhead head rail bracing. Toilet partitions should be solid composite partitions whenever possible, but other durable type partitions will be considered.
- Doors to accessible stalls should swing outward, be easy to open, self-closing and should be equipped with a handle that is mounted on the inside of the door approximately 5" below the latch and 7" from the door edge. The Rockwood #102 handle, in a bright or brushed chrome finish, is suggested.
- Provide a 62" spacing between the front edge of the toilet and the stall door in the accessible stalls to allow sufficient room to maneuver a wheelchair in the stall. These dimensions exceed code requirements. A simple solution is to place the accessible stall at the end and place the door at the end of the aisle way, which provides access to the stalls.

**Division 11: Service Loading Areas & Custodial**

All buildings need some type of service delivery access for NKU Operations and Maintenance personnel, as well as for deliveries from outside vendors. A trash collection point (dumpster & compactor) is typically preferred, but some building locations and orientations obviously cause some difficulty in achieving this goal. Refer to each project program for more direction on the specific service area and trash collection requirements for each individual project.

**Service Docks:**

If the new building is planned to connect into the existing tunnel system (see Division 33), and the new tunnel connection provided adequate accommodation for a cushman cart or a tow motor, then a new service dock is not required at the new building. In this case, garbage and deliveries can pass to/from the building through the new tunnel connection. However, some consideration and coordination should occur with the NKU project manager to ensure adequate trash collection space is included within the building program when a dedicated service dock area is not required.

If a new tunnel connection is not possible, a new building service dock is normally the only alternative. In this case, the dock service area should be wide enough to accommodate a delivery from a 24-foot box truck, and provide the standard dock height necessary for a tractor trailer. Provide the follow minimum level of utilities at all service dock areas:

- Convenience exterior power outlet receptacles
- Convenience exterior domestic water hook-up

Depending on the nature of the building served, some service docks might require the design team to accommodate the the following:

- Space to house an (8) yard, trash compactor (closed top).
- 208V 3 phase electrical service for the trash compactor.
- When food service is provided, determine and provide adequate space allocation and access at dock areas for grease containers/removal.

**Custodial Closets:**

Locate custodial closets within the building in close proximity to the restrooms on each floor. Slop sinks shall be provided in the custodial closet on each floor, and custodial closets shall have FRP board put on the wall surrounding the sink at least 3-4 feet high. Always include a main custodial closet in the program at the lowest building level at the tunnel connection level or near the service dock. This main custodial closet will serve as the primary storage location for a two week stock of custodial supplies, all tools, equipment, and special floor care equipment necessary for that building. This main custodial closet shall also include a slop sink, and all custodial closets shall be designed with sufficient ventilation.



### **Vending Machines:**

At all programmed vending machine locations, provide 1 power duplex and "1D" (1 data jack) per vending machine unit. As of Spring 2012, the standard vending machine provided is 72" high x 37" wide x 34" deep, and each unit draws approximately 3 amps of power. Coordinate exact vending machine dimensions and requirements for each project with NKU project manager.

## **Division 12: Building Signage & Room Numbering**

### **Building Signage:**

All NKU projects require the interior building signage to conform to a set of campus standards developed by the NKU Interior Designer (coordinate with NKU project manager). Code required interior building signage shall be provided as part of the base building package, while all other interior directional and way finding signage is typically coordinated and procured directly by NKU as part of the project FFE budget. For ADA accessibility, all corridor/pathway material should include possible tactile clues for clear paths of accessible travel, both inside and outside the building.

### **Room Numbering Guidelines:**

The following room numbering guidelines represent the thought process and strategy typically followed through the history of construction and renovation at NKU. These should be considered basic requirements, as there are always situations and conditions warranting exceptions or slight deviations from these guidelines. However, any room numbering schemes deviating from the following guidelines shall be coordinated with the NKU project manager. All room numbering schemes shall also be reviewed by the Director of Campus & Space Planning.

### **Room Numbering for New Buildings:**

- First floor: 100's, Second floor: 200's, etc.
- The basement is the first floor; in the situation of a tunnel that is below the first occupiable level of a building, use 001, 002, etc. Thus, the first digit indicates the floor on which a room is located.
- Use 3 numerical digits plus an alpha suffix, if needed. Attempt to divide the building into zones that start on the "10", i.e. 110, 120, 130, etc.
- In the situation of a double-loaded corridor, place odd numbers on one side of the corridor and even numbers on the other side of a corridor.
- While it sometimes is logical to start numbering at the main entrance, at other times it makes more sense to start at one end of a building and work your way to the other end: use a scheme that eases way-finding. Room numbers should flow in ascending order from the point of beginning.
- For elevators, electrical rooms, data closets, and mechanical rooms that are stacked: try to use the same number on each floor, but change the first digit (for ex. 109, 209, etc.). Sometime we have used a suffix for these rooms, other times we haven't---so, that's open. Thus, rooms with the same digits in the last 2 positions should be located in about the same plan location in the building as long as this does not create other inconsistencies. This goal of vertical coordination of room numbering is helpful for way-finding, but sometimes the building layout precludes it.
- Sometimes we use "M" for mechanical room as a suffix, "E" for electrical room, "D" for Data room, etc. but not always.
- For stairs, it makes most sense, since the number doesn't need to follow in a sequence, for the stairs to be all 100 or all 199 (and thus, 200 or 299, etc.---or some other unique number) with unique suffixes. Thus, if there are four sets of stairs, it might be 199A, 199B, 199C, and 199D; 299A, 299B, or 199N, 199S, 299N, 299S, etc.
- Male restrooms carry a number plus a suffix of "M"
- Women's restrooms carry a number plus a suffix of "W"
- Use suite numbering when it makes sense to do so: 101A, 101B, 101C, etc. The logic is that if you can find 101, then 101F must be nearby; finding 101 doesn't tell you how to find

106. Typically, rooms entered from a main corridor or lobby receive numbers with no suffix (121, 210, etc.) and the rooms within the suite are numbered with the common entrance number and an alpha suffix (121A, 121B, etc.) beginning with the room closest to the main entry and proceeding clockwise around the entry space.

- If you must enter one room to find the next room, generally the second room should carry the suffix "A". Similarly a closet or storage room which opens from another room, would be " \_ \_ \_ A".
- Corridors: sometimes corridors need a unique number, and that number is actually on the wall, adjacent to a door. Other times, the corridor number is just for inventory purposes and the number is not hung on the wall. In the latter case, it makes sense for the corridor number to be an adjacent room number plus the suffix "H".
- Unused numbers should be provided for future use, especially when the floor plan and room sizes suggest opportunities for division into smaller spaces in the future. If there's an area that could be renovated in the future to add rooms, skipping numbers makes sense (to allow for numbers that can be added, without re-numbering the floor). For example, the space before and after two meeting rooms might allow for numbers to be added, if the meeting rooms become something else.

### **Room Numbering for Existing Buildings:**

Generally, NKU adamantly avoids renumbering rooms in existing buildings, as a domino effect of additional changes results for multiple other building systems and components. The following represents a sampling of the challenges:

- The campus room database and all record drawing floor plans would need to be changed. The database for TMA would also need to be changed to reflect the new room numbers--- basically, delete old numbers and re-enter the new ones. All associated work order forms, web pages, and system modules would also need to be updated. This is always a significant work effort.
- The specific date when the room numbering change is implemented needs to be coordinated with the planning and publication dates of class schedules. The course scheduling software would also need to be updated.
- Everyone who has an understanding of the building, and room numbers, would have to be re-educated....i.e. classroom numbers would change.
- All telephone and data jacks in individual rooms, as well as in data closets, are numbered according to the room number....these would have to be relabeled, at a significant cost. All network switches would have to be relabeled---this would involve an extensive amount of relabeling and documentation updates. Re-programming would have to occur at the telephone switch.
- If the building uses a DDC system, it would need to be re-labeled and re-organized according to the new room numbers, and reprogramming would be a significant cost.
- All lock and key records would need to be changed and/or updated. For example, changing the room numbers throughout BEP will result in 2,331 key records being updated in the Paradox system. These updates are necessary because this is the vital data base that is used to provide a "quick link" to keys and room numbers. It is used by Work Control, Key Control and the Lock Shop. Additional updates and changes would also be required in the "Blue Book", which links all room numbers and key numbers for various buildings. The task to change all "hard" copies of key receipts would be very time consuming, if not impractical.

## **Division 14: Stairs & Elevators**

### **Stairs:**

As a general rule, design vertical circulation in new buildings to encourage the use of stairs as much as possible by making stairs open, inviting and accessible. Stairs should be located convenient to a building's predominant traffic pattern and should be sufficiently wide enough to allow users to comfortably pass each other when traveling in opposite directions. In terms of use, the design team should assume building occupants can routinely walk up or down one flight of stairs when interpreting loose programmed adjacencies. The finish for standard egress stairways can be painted or exposed/sealed concrete.

### **Elevators:**

Provide passenger and freight elevator(s) as required in the building code and to support the specific project program. Locate passenger elevators carefully, as they should be secondary in location compared to stairs, but they still must be considered convenient for building occupants. Unless approved in writing by the NKU project manager, all buildings must provide at least (2) passenger elevators; however, the design team need not locate these elevators side by side.

Passenger elevator finishes should be attractive and durable, including the floor which should be hard surface. Elevators should be wide enough to provide sufficient space in them for normal, everyday maintenance/custodial activities, as well as adequate space for people using wheelchairs. Project specifications shall include provisions for the contractor to provide protective blankets and floor mats, as necessary, when elevators need to be used during construction, renovation, and/or move-in activities.

The need for a special service/freight elevator will be defined in the project program, along with the required size and capacity. When required, service/freight elevators shall be designed as key-operated only. The interior finishes in the service/freight elevator can be utilitarian, but the finish materials used must be durable and easily cleaned.

The emergency phones provided with all elevators need to involve special coordination between the elevator contractor, the NKU project manager, and the NKU telecommunications department. All emergency buttons in existing campus elevators direct dial NKU's Department of Public Safety when the alarm button is pressed. When answering the trouble call, the DPS dispatcher immediately sees the NKU building code and specific elevator number, and the dispatcher can also immediately converse with the elevator occupant making the call. All pre-programmed elevator distress messages must be disabled.

For the hydraulic cylinders, provide factory applied polyvinyl chloride shields sealed at the bottom and sealed to jack unit at the top. PVC casing and seals shall be watertight. Two small, elbowed tube openings shall be provided into PVC casing. These shall be accessible from elevator pit. At time of installation, PVC casing shall be filled with oil to level of top seal, thus creating watertight oil barrier around jack unit. Once installed, two small tubes shall be capped.

MRL-type elevators are permitted, and NKU/State of Kentucky does not require any additional provisions beyond the required ASME 2005 supplemental requirements.

If possible, the elevators should be keyed to match an existing elevator key (most on campus are Dover). In addition, all key switches utilized for restricting/permitting elevator access to certain levels, such as the attic, penthouses, mechanical levels, and other restricted areas shall keyed using the standard, maintenance master key system for the building.

For elevators in new Parking Garages, the initial design shall specify an extra length for the hydraulic pistons to accommodate potential, future vertical expansion of the parking levels. Typically, NKU requires the initial structural design for new Parking Structure to assume 1-2 future level additions. Obviously, individual project budgets always will ultimately decide how much expansion NKU can plan for during the initial design and construction, and the specific future expansion details shall be coordinated with the NKU Project Manager.

To promote better accessibility for people with disabilities, NKU generally prefers to provide/install digital voice annunciators at elevators.

### **Elevator Maintenance:**

NKU generally prefers hydraulic elevators, but for future NKU maintenance purposes, ALL elevator equipment must be NON-proprietary. Any elevator equipment installed shall not require any special tools, software programs, or equipment for routine and/or repair maintenance. The university has a campus-wide contract for elevator maintenance and service with a local elevator company, and when the service provider changes after a periodic re-bid, the new company must be able to service the operational software for ALL elevators on campus.

In the project specifications, the initial, 12 month elevator maintenance period shall be included in the project base bid, coinciding with the standard, 1-year construction warranty. After the first 12 months, the university will roll the maintenance of the new elevator(s) into the blanket, campus-wide elevator maintenance contract.

## **Division 21: Fire Suppression**

The following section provides a brief collection of general preferences for the Fire Suppression systems in new buildings. Any deviation from the following guidelines shall be coordinated with the NKU project manager.

- Install sprinkler system inside building for fire safety. Avoid dry-type system, except where required. Equip the sprinkler system with tamper switches and provide at least one shut-off per floor so each floor can be drained independently of the others. These shut-offs and all fire lines shall be easily accessible. If valves are located above ceiling, the ceiling shall be marked to indicate valve location.
- NKU prefers quick response sprinkler heads in order to minimize the required amount of portable extinguishers/cabinets.
- Elevator shafts shall not have sprinkler heads installed at the top of the hoistways and machine room where allowed to be omitted by code or applicable exemption.
- Where portable extinguishers are necessary in public spaces, provide them in a surface mounted cabinet, similar to the Student Union. Any extinguishers required in mechanical/maintenance spaces do not need a cabinet.
- All sprinkler valves located in exterior water pits shall have submersible, plug type tamper switches installed. (example: Potter PTS-C)
- Water motor gongs or other audible alarms separate from the fire alarm system should not be included as part of any water based suppression system.
- For all hose cabinet/riser connections, Old Cincinnati thread style is the campus standard.
- The fire department connection shall be a single 5" locking storz connection. The bottom of the connection shall be between 36"-42" off finished grade.
- The Fire Department Connection shall be marked to indicate the building it supplies.
- The fire department connection shall be located within 50' of the nearest hydrant.
- All new NKU campus fire hydrants shall adhere to the following criteria from the Central Campbell County Fire District (serving Highland Heights & NKU):
  1. All hydrants shall have (2) – 2½-inch hose nozzles with Old Cincinnati Thread and (1) steamer or pumper connection. Steamer/pumper nozzle shall be 4½" with adapter to a 5" locking Storz connection. The operating nut and the nuts of the nozzle caps shall be square, measuring one (1) inch from side to side.
  2. Hydrant body shall be painted yellow.

3. All hydrants shall be right hand open, clockwise, and shall have a direction arrow of operation cast into the dome of the hydrant.
  4. Acceptable fire hydrant models/brands:
    - a) Dresser M&H Style 129 (4-1/2" – 5-1/2")
    - b) Mueller D1 Centurion (4-1/2" – 5-1/4")
    - c) Kennedy K11 (5").
- All fire suppression systems installed shall be tested per NFPA 13 code requirements, and per the direction of the Commonwealth of Kentucky state fire marshal's office.
  - Once a preliminary building design is developed, the design team will be expected to meet with the local fire department (Central Campbell County Fire District) and NKU Safety & Environmental Compliance to review the systems and obtain an overall general knowledge of the systems. Potential items for discussion include, but are not limited to, hydrant locations, fire truck access, building fire panel location, sprinkler valve location, etc.
  - All compressors for dry pipe fire suppression systems shall be of the tank variety. They shall have an automatic condensation release device installed on the tank and the compressor shall have vibration isolation pads at each bolt. Compressors shall have the air storage pressure set to a minimum of 20 psi higher than the dry pipe air pressure. The air compressor shall also be located in a mechanical area of the building, preferably the fire pump room if equipped.
  - Campus building fire suppression systems are not required to meet any special Factory Mutual requirements. NKU's insurance carrier requires the fire suppression system conform to all current/applicable building codes.

## **Division 22: Plumbing**

The following section describes the overall infrastructure strategy, as well as general preferences for the plumbing systems currently used throughout campus. Any deviation from the following guidelines shall be coordinated with the NKU project manager.

### **Campus Infrastructure for Domestic Water:**

Primary domestic water service from the Northern Kentucky Water District is fed into the campus water loop at the following (3) supply locations:

- 8" line located at Johns Hill & Kenton Drive
- 8" line located at Campbell near the maintenance building
- 12" line located down the hill southeast of the Central Plant. The water line is actually a NKYWD main through NKU's campus, and this line was actually relocated along the east side of University Drive to the Roundabout, across University Drive, and then along the south side of Nunn Drive towards Stealy Library. This relocation project was completed as part of the Welcome Center Garage project in the Spring of 2008.

Consistent with the plumbing code, NKU requires backflow preventers on each building feed, as well as lines feeding irrigation systems. Previous engineering analysis indicates the following pressure drop summary:

- 77 psi = Theoretical static pressure available at elevation 830 (12" city main)
- 55 psi = Pressure available from 10" campus main flow test
- -10 psi = loss through water meter at building
- -15 psi = loss through back flow preventor at building
- - 5 psi = friction loss in building piping
- 25 psi = available pressure in building without booster pump

### **Campus Infrastructure for Natural Gas:**

Natural gas service to campus is provided by Duke Energy, and there are (2) primary feeds provided to campus:

1. The Central Plant is fed with a plastic 40 lb line originating from a buried regulator station at the southeast corner of the Nunn Drive/University Drive intersection Roundabout near the Bank of Kentucky Center. Duke's feed for this buried regulator station comes from the east along the north side of Nunn Drive and crosses below Nunn Drive before the buried

regulator station. NKU's 40lb "house" line extends from the buried regulator station and proceeds underneath University Drive up towards Steely Library along the south side of Nunn Drive. The line then wraps around the western and southern portion of the parking lot (Lot D in 2012) back towards the Central Plant. This line was relocated to its present location during the Bank of Kentucky and Welcome Center Garage construction projects, and only serves the Central plant. The Bank of Kentucky Center is fed with a 5lb line originating from the same buried regulator station at the Nunn Drive/University Drive intersection Roundabout.

2. The remaining buildings on campus are fed by a separate 5lb, 6" line that originates at the Duke Energy meter/regulator caged area located between the Student Union and the Albright Health Center. Duke's feed for this station comes from the south along the east side of Kenton Drive.

There have been a collection of gas line relocation projects over the years, and the campus gas lines are currently a mixture of steel and plastic. The campus standard is to install all new gas lines with new plastic line, per Duke Energy standards.

Refer to attached memo from Duke Energy for more specific information regarding new natural gas service installations. All gas piping after the meter is considered "house" piping (customer owned piping), but NKU requires all contractors to follow all requirements of the current Duke Energy Gas Installer's Manual, which can be downloaded from Duke Energy's website. All gas pipe installation inspections and pressure tests shall be scheduled through Duke Energy by calling (513) 651-0444.

#### **General Plumbing Preferences:**

- Every effort should be made to install water service lines outside of paved areas and at a normal depth of 4 to 5 feet.
- All new domestic water service installation must have a RPZ back-flow device (Watts Preferred) plus gallon type readable meter installed at a proper height and location for service. The back-flow device must be tested and a copy all test reports will be sent to NKWD and NKU before water is turned on for service.
- Faucets, toilets, urinals, and water closets shall be energy efficient models with a preference for automatic/ sensor-actuated operation. However, design team shall ensure automatic sensors are durable, reliable, and provide consistent operation for users.
- Instantaneous hot water heaters shall be not used for building restrooms. Instantaneous hot water heaters are permissible in custodial closets, but they shall be sized to handle full flow of faucets served.
- Within each new building, provide only the minimum amount of water fountains required by the building code.
- For all water fountain locations, specify local chillers. Remote chiller locations just lead to more piping to maintain with no real benefit.
- Provide (1) water bottle filling station at each bi-level set of water fountains. NKU's preference is to specify the Elkay EXH20 System (model #LZS8WS/LZSTL(R)8WS series) similar to Griffin Hall. However, NKU is open to entertaining alternate manufacturers and styles.
- All flush valves must be a diaphragm type, auto flush, must flush with the handle, be battery operated, and must be designed for low water consumption.
- All plastic underground water service of any type must have tracer wire installed on pipe. (mains and laterals)
- Ceramic disc fixtures (not rubber seals) are preferred for all faucet types (Delta Commercial type).
- No-hub roof drains are preferred.
- All copper piping must have copper hangers/straps or insulated hangers/straps.
- Grundfos type domestic water booster pumps preferred.
- All restrooms, labs, janitor closets, mechanical rooms, kitchens, break areas, outside hose bibbs or any areas that require water fixtures must have individual isolation valves per water line per room.

- Floor drains are required in all toilet rooms, and any other rooms with a better than average potential for flooding.
- Plumbing for toilets and sinks must be accessible for repairs; either situate restrooms back-to-back with an accessible, walk-in plumbing chase separating them, or provide strategically placed access panels.
- At a minimum, provide one valve to shut off hot water and one valve to shut off cold water to the sinks for each restroom. Also, provide a separate shut valve to turn off water to the urinals and toilets for each toilet room. These shutoff valves need to be easily & quickly accessible in the event of a major leak, and they can be installed in the ceilings or in the hallway in front of the restrooms.
- For all areas with limited space for a walk-in chase, stop the interior drywall just above the hung ceiling and provide access to the high piping. This will also provide visual access to the plumbing below and a decent way to pinpoint the exact location of leak.
- All drain clean outs must be accessible for serviceability. Provide a clean out for each drain on the sinks.
- All domestic water valves must be full port type ball valves.
- All acid piping installed for any building will be Orion Type Schedule 40 Flame Retardant BlueLine piping and fittings.
- The quantity of handicap fixtures and stalls for restrooms shall be per the Kentucky Plumbing Code.
- All water heaters installed will be energy efficient and carry a minimum warranty of (6) years on the tank and (1) year on parts and labor. Natural gas or steam water heaters are preferred, but the design team shall always consider and determine the applicable payback for implementing solar powered heaters whenever feasible. Water heater will include a low water pressure cut off device and a properly sized expansion tank. All water heaters shall be connected and wired to the building automation system to allow remote reading at the Central Plant.
- All domestic water piping will be properly tagged for direction of water flow, and hot water piping must be insulated with 1" insulation.
- Generally, drop-in sinks with a durable countertop are preferred.
- Do not specify any type of external mechanical trap on urinals. The Student Union building has this type, and NKU has had nothing but problems.
- Provide a minimum of (1) exterior wall hydrant/hose bib at the building load dock area, as well as (1) wall hydrant/hose bib location along each building face.
- For any wall hydrants/hose bibs provided along the building exterior, provide an isolation shut off valve somewhere nearby within the building so NKU can isolate and drain the exterior system as necessary.

#### **Acceptable Plumbing Fixture Manufacturers:**

(Substitutions are not permitted unless authorized in writing from NKU project manager)

#### Urinals and Water Closets:

1. American Standard
2. Eljer
3. Gerber
4. Kohler
5. Mansfield
6. Zurn "Nano Pint" 1/8 GPF (Model #Z5708)

#### Sinks:

1. American Standard
2. Eljer
3. Elkay
4. Kohler
5. ~~Moen~~
6. Gerber

Mop Basins: (with solid brass Drain Body)

1. Crane/Fiat Products
2. Florestone Products
3. Stern-Williams Co.
4. Mustee

Water Coolers:

1. Elkay
2. Halsey Taylor
3. EBCO Manufacturing Co.
4. HAWS Drinking faucet Co.
5. Sunroc

Toilet Seats:

1. Bemis Mfg. Co.
2. Beneke Products
3. Church Seat Co.
4. Kohler Co.
5. ToTo Company.
6. Olsonite corp.

Flush Valves: (closet 1.6 gpf) (urinal 1.0 gpf)

1. Sloan Valve Co. (royle and regal only, **NOT** GEM 2)
2. Zurn Industries
3. Delta

Faucets: (0.5 gpm aerators included on faucet)

1. American Standard
2. ~~Moen~~
3. Delta
4. Chicago
5. Kohler
6. T&S
7. Symmons

Supports:

1. Ancon Co.
2. Josam Co.
3. Wade Div.
4. Zurn Ind.
5. Watts
6. JR Smith

Domestic Water Booster Pumps:

1. Grundfos Pump MFG.

**See Attachment A – Duke Energy Gas Installers Manual**



## **Division 23: Heating, Ventilation, & Air Conditioning**

The following section describes the overall infrastructure strategy, as well as general preferences for all the Heating, Ventilation, and Air Conditioning systems currently used throughout campus. Any deviation from the following guidelines shall be coordinated with the NKU project manager.

### **Campus Infrastructure for HVAC:**

The NKU Central Plant, which is located across University Drive from the Bank of Kentucky Center and just east from the Applied Science and Technology (AS&T) building, produces steam and chilled water for heating and cooling most of the campus buildings. However, some of the smaller campus buildings continue to operate from stand-alone mechanical units.

A network of underground utility tunnels (see Division 33 for an overall campus tunnel layout) typically distribute steam and chilled water throughout campus, and connecting/expanding into the existing tunnel system for distribution towards new buildings is always the preferred option. Although not preferred, direct burial of branch steam and chilled water lines has been acceptable to NKU on previous projects to reconcile anticipated budget shortfalls. When a full size tunnel is not feasible, other options, such as an accessible trench, should be investigated. All piping and systems must be sized in consideration of all planned future growth and potential extensions of the system.

As of May 2012, the Central Plant operates with (3) boilers and (3) chillers, with enough physical space within the main Central Plant floor to add (1) more of each. The building could also be extended to the south when necessary to accommodate additional equipment.

The emergency generator located outside of the Applied Science & Technology (AS&T) building is tied into and is adequately sized to temporarily power the Central Plant boilers when necessary. However, there are no emergency backup provisions for powering the chillers.

General information associated with the Central Plant chiller and boiler capacity (as of May 2012) is provided in the next two sections. Also refer to the campus steam and chilled water infrastructure schematic provided at the end of this section. Given NKU's recent rapid growth however, the design team should always coordinate/verify the current Central Plant loads and demands for all new projects with the NKU project manager.

### **Chiller & Cooling Tower Information:**

In terms of chiller capacity, there are currently (1) 1500 ton chiller and (2) 2500 ton chillers for a total peak chiller capacity of 6500 tons. However, the original Central Plant construction only resulted in the installation of (8) cooling towers, so the maximum cooling capacity of the Central Plant from the original design was only 4300 tons. In addition to the (8) original cooling towers, the initial building design provided enough physical space on the Central Plant roof to accommodate (6) more cooling towers. In the Summer of 2009, (2) additional cooling towers were added to the Central Plant roof to increase the cooling tower capacity and overall peak cooling capacity of the Central Plant to approximately 5400 tons. After adding the Bank of Kentucky Center, the Student Union, and Griffin Hall onto the system, the peak cooling demand monitored was observed at approximately 4500 tons in spring 2012.

All of the Central Plant chillers are centrifugal type and use refrigerant R123. The necessary refrigerant charges are 2,950 lbs for chiller #1, 4,200 lbs for chiller #2, and 4,200 lbs for chiller #2. The existing cooling towers on the Power Plant roof are "TowerTech", and variable frequency drives should be specified for any additional cooling towers to help silence the noise impact on surrounding property owners.

NKU typically does not operate the chillers until temperatures are consistently in the 60's, which generally means the chillers run 24/7 between March and November. More specifically, NKU generally will operate

the chillers when temperatures reach 60 degrees on a sunny day and 64 degrees on an overcast day. Two of the cooling towers on the roof do have basin heat tracing, so there is capability to run chilled water during the winter months for isolated cooling loads throughout campus when necessary.

In terms of operating parameters (temperature, pressure, schedule of the campus chilled water loop), the chilled water loop typically runs at 42 degrees and approximately 50-55 psi (+/-5 psi). The chilled water pumps in each building help increase the pressure at each building. The current setup for connecting buildings to the campus chilled water loop is primary/secondary with tertiary loops at each building.

### **Boiler & Steam Information:**

In terms of boiler capacity, an average winter day at NKU will generally require the operation of Central Plant boiler running at approximately 50% capacity, and this operating level provides enough steam to heat the entire campus. During the few winter days when low temperatures drop into the single digits, the (1) boiler operates at approximately 70% capacity. These demands were observed in late January 2009, and this includes the loads from both the Bank of Kentucky Center and the Student Union. In general, heating the entire campus requires approximately 26,000 pounds of steam per hour, and each boiler can produce approximately 50,000 pounds of steam per hour. The pressure in the campus steam loop is approximately 90 psi, and steam is available and provided in the campus steam loop year round.

NKU records steam production totals per hour, day, and month if needed. For calculating NKU's true cost for steam, they simply review the Central Plant natural gas consumption and cost data. They use this natural gas consumption data to calculate \$/MCF and then convert MCF to BTU.

### **General HVAC preferences:**

- NKU typically does not like fan coil units, but we have used them in the past. Discuss this option with the NKU project manager if this strategy appears to make the most sense for a particular project.
- Building air intakes must be located to ensure building/equipment exhaust air (or vehicle exhaust from loading/parking areas) is not inadvertently pulled back into a building.

Similarly, exhaust(s) should be placed so that exhaust air from one building is not accidentally drawn into any adjacent buildings.

- While it is the University's preference that the permanent HVAC system not be used during construction, if it is used, the contractor will be held accountable for cleaning air handlers, ducts, etc. prior to Substantial Completion.
- Chilled water and steam usage meters must be installed for each building, and provisions shall be included in the design for connecting these meters into the campus building automation system.
- When considering alternate HVAC options for remote, smaller buildings, life cycle cost and energy efficiency will be primary concerns of NKU. Alternate methods and strategies, such as geothermal technologies, are encouraged.
- The mechanical systems in all rooms, but especially in any sound sensitive rooms such as classrooms and conference rooms, should be quiet. A noise coefficient rating of NC 25 is the goal.
- It is essential that the air handling units or other equipment be located on isolated slabs and that other measures be employed to ensure that resulting building vibration is not a problem. Similarly, mechanical rooms housing air handling units within the building must be designed to ensure no noise transfer to adjacent spaces.
- Generally, design all storage rooms with HVAC and ventilation occupancy greater than the storage use itself would demand. Often, storage rooms are converted to office use and the lack of much mechanical system design in these spaces is a recurring problem on older campus buildings.
- For some buildings, the mechanical systems will need to be zoned to provide for diversity of use. For example, some smaller areas of buildings are used when the rest of the building is closed. The mechanical engineer shall coordinate any special occupancy needs regarding zones and the operation of the building HVAC system with the NKU project manager.
- Some multipurpose spaces will require systems to accommodate load diversity in a seamless manner, whether the load is externally or internally generated, all of which might be altered by

activity of room occupants (or lack of activity). The control systems for these types of spaces must be designed to provide separate temperature control capability, especially if the space can be subdivided into smaller rooms with operable partitions.

- Adjustable thermostats should be specified where appropriate to give occupants the ability to modestly modulate local temperature settings. Specify a thermostat with a "cooler-warmer" slide to accomplish this goal.
- Mechanical system design in all food areas must anticipate the certainty of future changes; size all ducts, systems and components, as appropriate, in consideration of the renovation that is certain to occur in these areas.
- NKU's current campus-wide service agreement provides all rust inhibitor chemicals needed for after construction completion, so the contractor does not need to furnish any additional rust inhibitor chemicals after initial installation.
- The contractor does not need to furnish a portable spectrometer to NKU as part of their project deliverables.
- All valves shall be located to provide adequate maintenance access. When valves are located higher than 8'-0" above finish floor, specify chain wheels for operating the valves from the ground. Specify Babbitt adjustable sprockets (#2.5), which should fit valve wheels measuring 9.25"-12.5".
- At the building steam pressure reducing station, provide cast iron steam safety relief valves.
- All new campus buildings shall include braided flex piping/connections for hot/cold water distribution to VAV boxes.
- At all new steam line valve locations, a small bypass shall be installed from one side of the valve to the other to facilitate "line warm up" for whenever a valve needs to be reopened after an extended closed period.
- **ALL** freeze stats shall be hard-wired to the AHU associated supply and return fan VFD's.
- **ALL** safeties shall be hard-wired into the fan starter circuit such that the safety shall function whether the start selector switch is in the hand or automatic position. In other words, **ALL** safeties shall be hard-wired to their devices and shall not rely on DDC system software for operation.
- Victaulic fittings shall **NOT** be permitted on any steam, hot water, or chilled water lines.
- NKU may entertain permitting Victaulic fittings on condenser water piping in mechanical rooms or other unfinished spaces.

CT 1-8 = 540x8 = 4320 (ORIGINAL)  
 CT 9-10 = 540x2 = 1080 (ADDS 2009)

CT 1-10 = 5400 TONS  
 CURRENT POWER PLANT  
 COOLING CAPACITY

CT 11-14 ~ 540 \* 4 = 2160 TONS

SPACE TO ADD  
 4 COOLING TOWERS  
 ON ROOF

EXISTING  
 CHILLER CAPACITY:  
 $1500 + 2500 + 2500 = 6500$   
 TONS

(POWER PLANT COOLING  
 CAPACITY LIMITED TO  
 COOLING TOWERS... SEE ABOVE)

CURRENT CAMPUS  
 COOLING DEMAND:

EARLY FALL = 4,500 TONS (OBSERVED BY  
 NIU W/ BOE  
 #50)  
 EARLY FALL  
 2011 + 460 TONS (GH DESIGN  
 PEAK DEMAND)  
 = 4,960 TONS

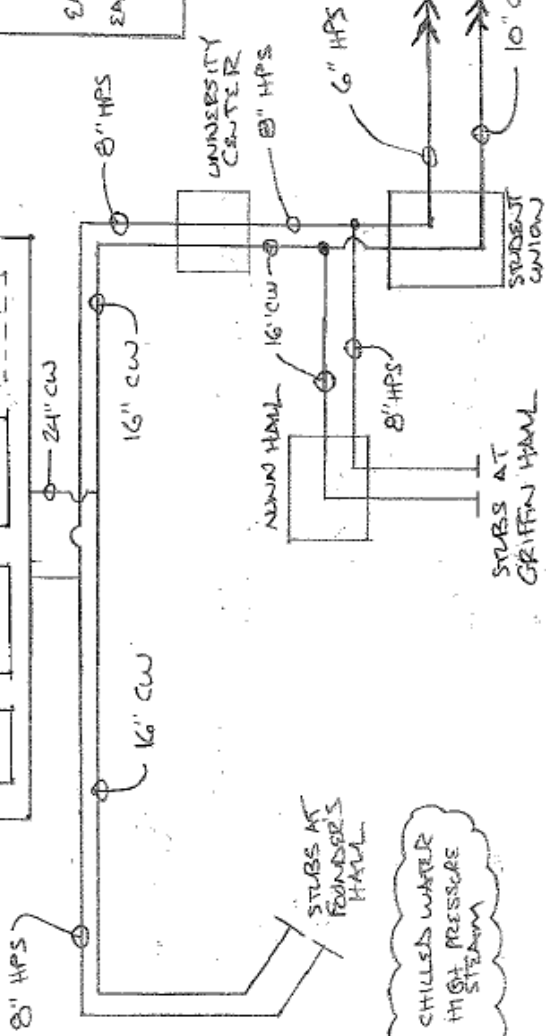
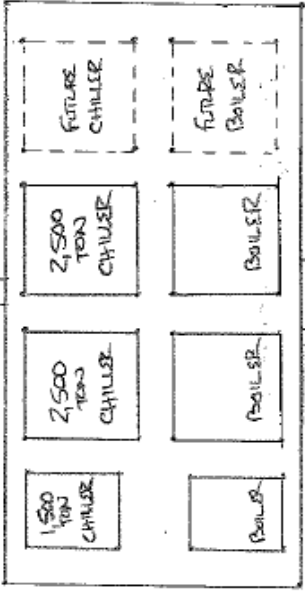
WHAT DOES NIU  
 OBSERVE NOW AS  
 "PEAK DEMAND"?

THROUGH STUDENT UNION TO  
 REGRITS # ALBRIGHT

12-0330  
 NIU  
 RLK

COOLING TOWER	CT 2	CT 3	CT 5	CT 7	CT 9	FUTURE CT 11	FUTURE CT 13
540 TONS	540 TONS	540 TONS	540 TONS	540 TONS	540 TONS		
	CT 4	CT 6	CT 8	CT 10		FUTURE CT 12	FUTURE CT 14
	540 TONS	540 TONS	540 TONS	540 TONS			

POWER PLANT  
 ROOF



CW = CHILLED WATER  
 HPS = HIGH PRESSURE  
 STEAM

## **Division 25: Building Automation System**

The following section describes the requirements for properly integrating with our existing campus building automation and monitoring systems. Any deviation from the following guidelines shall be coordinated with the NKU project manager.

### SECTION 250400 - CONTROL - DIRECT DIGITAL

#### **PART 1 – GENERAL:**

- 1.1 The bid for Temperature Controls for this project shall include an allowance. Refer to bid documents for allowance. Schneider Electric shall fully integrate the new temperature controls system for this project into the existing Schneider SmartStruxure server/front-end system in the Physical Plant. It is the responsibility of the contractor to coordinate with the temperature control contractor schedules and scope of work. The Allowance for Schneider and the TCC shall be a subcontractor to the mechanical contractor. Refer to Part 2 for scope details for the Allowance.
- 1.2 The temperature controls for this project shall fully integrate and seamlessly interface to the existing the SmartStruxure front end system in the Physical Plant via BACnet IP protocol. NKU has an on-going service contract with Schneider Electric. Interface and graphics generation on the university's DDC system server is included in this project and shall be consistent with the existing. Windowing between different computers/systems, or loading separate building energy management system software on the existing Operator Workstations for interface to the existing Building Energy Management system will NOT be permitted or accepted.
- 1.3 All application specific controllers on all network controllers shall be configurable, commissionable and downloadable through the Server or Network Controller IP connection.
- 1.4 All unitary and field controllers shall be commissioned, uploadable and downloadable from the university SmartStruxure server. BACnet IP objects descriptions that are a jumble of letter/numbers are not acceptable. The TCC shall provide a list of points, object descriptions and coordinate with Schneider Electric.
- 1.5 All unitary and field controllers shall be commissioned, up-loadable and downloadable from the university host network automation engine. LON/BACnet/MODBUS object descriptions that are a jumble of letter/numbers are not acceptable.
- 1.6 The controls system for this project shall be a web-based digital controls system. All controllers, control interface hardware, services, installation, warranty, training, etc., shall be included as hereinafter specified. The system shall utilize a network controller and unitary" type controllers. Including such minor details not specifically mentioned or shown, as may be necessary for the complete operation of the system.
- 1.7 A pre-programming meeting shall be held with the TCC, Engineer, Owner and Schneider Electric to discuss program variable names, room name scheme LON and system structure.
- 1.8 The Temperature Control Contractor (TCC) shall furnish all labor, materials, equipment, and service necessary for a complete and operating Building Automation System (BAS), utilizing Web Based Direct Digital Controls. All labor, materials, tools, equipment, software, software licenses, software configurations and database entries, interfaces, wiring, tubing, installation, labeling, engineering, calibration, documentation, samples, submittals, testing, commissioning, training services, permits and licenses, transportation, shipping, handling, administration, supervision, management, insurance, temporary protection, cleaning, cutting and patching, warranties, services, and items, even though these may not be specifically mentioned shall be included for the complete, fully functional and commissioned temperature controls system.

#### CONTROL - DIRECT DIGITAL (WEB BASED)

- 1.9 The TCC shall provide all items, articles, materials, devices, operations or methods listed, mentioned or scheduled on the drawings including all labor, materials, equipment and incidentals necessary and required for their completion to provide a complete and operating temperature control system. This will include connecting to any mechanical equipment furnished with a control interface device and contacting the equipment suppliers and/or manufacturers for information for the proper interface to the equipment being furnished.
- 1.10 These apparatus' shall consist of, but not limited to, all necessary thermostats, sensing devices, valves, automatic dampers, damper motors, actuators, (except automatic dampers, valves, and damper motors furnished with HVAC equipment), and with the necessary accessories for the complete control of all equipment hereinafter specified.
- 1.11 Control sequences are specified at the end of this section. Provide all control equipment required to perform sequences described. Coordinate all dampers with the sheet metal contractor and equipment provider. It is the responsibility of the control contractor to ensure all required dampers in the sequence of operations are provided.
- 1.12 Coordinate wells, flow meters, valves with mechanical contractor.
- 1.13 Include all power wiring and cabling for the operation of the controls system. Refer to Electrical Division Specifications for additional requirements.
- 1.14 Manufacturer's: Schneider, Johnson Controls factory Branch Office, and Siemens Factory Branch Office. These TCCs/manufacturers have prior approval with the Owner and Engineer and are the only allowed suppliers and/or installing TCCs.
- 1.15 The TCC shall have an established working relationship with the control manufacturer of not less than five years and shall have prior approval from the Owner and Engineer and are the only allowed suppliers and/or installing contractors. The TCC shall have a local office within 50 miles of the project site and provide service and/or replacement parts within a 24 hour notification of a control failure. The Building Management System contractor shall be staffed with engineers trained and certified by the manufacturer in the configuration, programming and service of the automation system. The contractor's technicians shall be fully capable of providing instructions and routine emergency maintenance service on all system components.
- 1.16 A mandatory pre-installation meeting shall occur prior to the TCC beginning any work on site. This meeting shall be attended minimally the prime contractor, mechanical contractor superintendent, TCC superintendent, Engineer, Owner and Architect. The purpose of the meeting is to have the controls installer communicate their understanding of the system design and how the system is intended operate to the Engineer and get the Engineer's input and agreement. The agreement between the TCC and the mechanical engineer is to be thoroughly documented by the TCC for later reference.
- 1.17 The installation shall comply with the Local Authorities and State Fire Marshal code requirements, including normal operating and smoke mode functions (where applicable). The installation shall comply with the requirements of the NEC, NFPA, UL and the Building Codes, including referenced mechanical, electrical, energy codes, etc.
- 1.18 Abbreviations
  - TCC – Temperature Control Contractor
  - BAS – Building Automation System
- 1.19 The TCC shall list the following cost breakdowns, material and labor, on the official project schedule of values:

## CONTROL - DIRECT DIGITAL (WEB BASED)

- Controls shop drawings
- Controls materials and labor
- Controls startup, commissioning, testing, documentation (2.5% of controls contract value)
- Controls training and Owner acceptance (2.5% of controls contract value)

**PART 2 – ALLOWANCE:**

- 1.20 Northern Kentucky University has elected to utilize Schneider Electric as their System Integrator to connect controls provided under this contract with the existing Schneider Electric SmartStruxure Facility Management System front-end platform. The successful Building Automation contractor must utilize, contract and coordinate all system integration functions listed within this specification.

**Schneider Electric contact information is as follows:**

Ron Epp Schneider Electric 9928 Windisch Rd  
West Chester, OH 45069

Direct: (513) 770-5716  
Cell: (513) 518-3927  
Email: Ron.Epp@Schneider-Electric.com

- 1.21 The BAS allowance shall provide control, alarm detection, scheduling, reporting and information management for the entire facility.
- 1.22 It will be the responsibility of Schneider Electric to implement this project onto the SmartStruxure server with no damage to the existing projects.
- 1.23 Allowance shall include mapping all the BACnet IP objects from the temperature control network controller and the power monitor to the SmartStruxure server/front-end system in the Physical Plant.
- 1.24 If TCC needs to update or revise any of the existing software, to allow their software to operate seamlessly with the owners existing server, it will be completed by Schneider Electric as a part of this allowance.
- 1.25 If the existing building head end software needs to be updated or revised to communicate with TCC's software it is to be completed Schneider Electric as part of the allowance.
- 1.26 All new software, graphics, terminology, operation, trending, scheduling etc. is match any existing systems and any changes needed to accomplish this will be the responsibility of the TCC.
- 1.27 Allowance shall include Graphics, refer to PART
- 1.28 Allowance shall include Alarms and Trends, refer to PART
- 1.29 Allowance shall include mapping the power meter into the SmartStruxure, refer to PART
- 1.30 The TCC shall provide all CAT5 or CAT6 cabling network cabling for power meter MODbus TCP/IP connection. This shall include cabling to the Owner's data drop. The main system data drop will be provided by others.
- 1.31 The BAS shall include trend logging screens accessible from tabs on the home page for building utilities usage.

**CONTROL - DIRECT DIGITAL (WEB BASED)**

### **PART 3 - GENERAL SYSTEM REQUIREMENTS:**

- 3.1 All labeling for this system shall utilize actual final room names and numbers. The room names and numbers on the Contract Documents may not be the Owner's exact requirements. Coordinate with the Owner to insure compliance.
- 3.2 Include in the bid for the Controls Contractor to perform additional 40 on-site hours of on-site programming, adjustments, modifications, etc. as requested by the Engineer during the warranty period after the date of substantial completion for the project.
- 3.3 All points of user interface shall be on standard PCs that do not require the purchase of any special software from the control's manufacturer for use as a building operations terminal. The primary point of interface on these PCs will be a standard Web Browser.
- 3.4 The intent of this specification is to provide a peer-to-peer networked, stand-alone, distributed control system integrated utilizing ANSI/ASHRAE Standard 135-2001 BACnet, LONWorks technology, OBIX TCP/IP, MODBUS, OPC, and other open and proprietary communication protocols in one open, interoperable system.
- 3.5 The TCC shall connect to any mechanical and electrical (power monitoring) equipment furnished with a control interface device. The TCC shall contact the equipment suppliers and/or manufacturers for information for the proper interface to the equipment being furnished. All points not provided with the equipment control interface are the responsibility of the TCC.
- 3.6 The operating system shall be based on a distributed control system in accordance with specifications. All building controllers, application controllers and all input/output devices shall communicate LonMark/LonTalk communication protocol. Network controller shall communicate via BACnet over Ethernet (IP). BACnet MS/TP is NOT an approved communication protocol.
- 3.7 The TCC contractor shall provide access to the system from a location determined by the Owner and from the Consulting Engineer's office (CMTA, Inc.). This shall include remote access requirements, set-up, passwords and any software necessary to access the BAS system.
- 3.8 The TCC shall all have access to various types of WEB browsers (i.e. Netscape, IE, etc.), which shall be included for access to the Direct Digital Control (DDC) system via the Owner's Wide Area Network (WAN) and/or Local Area Network (LAN).
- 3.9 The TCC shall be responsible for coordination with the Owner's IT staff to ensure that their system will perform in the Owner's environment without disruption to any of the other activities taking place on that WAN/LAN.
- 3.10 On Static pressure safeties during smoke purge, fireman override's etc., the Fire Alarm contractor shall be responsible for providing contacts and wiring to override applicable safety controls.

### **PART 4 – SUBMITTALS:**

- 4.1 The TCC shall not start the project installation until the shop drawing submittals have been reviewed by the Engineer.
- 4.2 Submittals shall include hardware, end devices, ancillary control components, a written operating sequence, unitary control wiring, building floor plans showing communication

CONTROL - DIRECT DIGITAL (WEB BASED)



cabling and labels as well as logic flow diagrams. All submittals shall be provided on paper and electronically in PDF format.

- 4.3 Submittals shall contain one control drawing per specified system and equipment. Drawing shall include point descriptors (DI, DO, AI, AO), addressing, and point names. Each point names shall be unique (within a system and between systems). For example, the point named for the mixed air temperature for AHU #1, AHU #2, and AHU #3 shall not be MAT but should be named AHU#1MAT, AHU#2MAT, and AHU#3MAT. The point names should be logical and consistent between systems and AHU's. The abbreviation or short hand notation (e.g., MAT) shall be clearly defined in writing by the TCC.
- 4.4 Control diagrams shall identify: System being controlled (attach abbreviated control logic text, all digital points, analog points, virtual points, all functions (logic, math, and control) within control loop, legend for graphical icons or symbols, definition of variables or point names and detailed electric connections to all control devices and sensors.
- 4.5 Points list shall include all physical input/output. Points list shall be provided in both hard copy and in electronic format and shall include: Name, address, engineering units, high and low alarm values and alarm differentials for return to normal condition, default value to be used when the normal controlling value is not reporting, message and alarm reporting as specified, identification of all adjustable points and description of all points.
- 4.6 Submittals shall contain floor plans depicting DDC control devices (control units, network devices, LAN interface devices, and power transformers as well as static pressure sensor in duct and temperature sensors in rooms) in relation to mechanical rooms, HVAC equipment, and building footprint.
- 4.7 Submittals shall contain DDC system architecture diagram indicating schematic location of all control units, LAN Interface devices, etc. Indicate address and type for each control unit, Indicate protocol, baud rate, and type of LAN per control unit.
- 4.8 Electrical wiring diagrams shall include motor start, control, and safety circuits and detailed digital interface panel control point termination diagrams with all wire numbers and terminal block numbers identified. Indicate all required electrical wiring. Provide panel termination drawings on separate drawings. Clearly differentiate between portions of wiring that are existing, factory-installed and portions to be field-installed.
- 4.9 Show all electric connections of the controls system to equipment furnished by others complete to terminal points identified with manufacturer's terminal recommendations.
- 4.10 TCC shall provide one complete drawing that shows the control-wiring interface with equipment provided by others.
- 4.11 Submittals shall include project specific graphic screens for each system including a picture of the screen with a list of the variables to be placed on the screen. (ALLOWANCE)
- 4.12 Submittals shall include TCC's hardware checkout sheets and test reports.
- 4.13 Submittals shall include the agenda for approval by the engineer and owner of the specified training periods.
- 4.14 See training section for requirements.
- 4.15 Provide complete panel drawings that are:
  - Clearly labeled and schematic or drawn to scale.

CONTROL - DIRECT DIGITAL (WEB BASED)

- Show the internal and external component arrangement so that the operators can identify the components by their position if the labels come off.
  - Wiring access routes shall also be identified so that Class 1 wiring is separated from Class 2 and 3 and so high voltage wiring is segregated from low voltage wiring.
  - Complete identification of all control devices (manufacturer's type, number, and function).
  - Provide details for labeling all wiring, control devices, and controllers.
  - Material and equipment descriptive material such as catalog cuts, diagrams, performance curves, and other data to demonstrate conformance with specifications shall be provided.
- 4.16 Include room schedule including a separate line for each terminal unit, heat pump, etc. indicating location and address.
- 4.17 Include control valve schedules including a separate line for each valve provided under this section and a column for each of the valve attributes: code number, configuration, fail position, pipe size, valve size, body configuration, close-off pressure, capacity, valve Cv, design pressure, and actuator type.
- 4.18 Include control damper schedule including a separate line for each damper provided under this section and a column for each of the damper attributes, including: code number, fail position, damper type, damper operator, duct size, damper size, mounting, and actuator type.

#### **PART 5 – O&M MANUALS AND CLOSEOUT DOCUMENTS:**

- 5.1 Refer to Mechanical Specification Section – REQUIRED SHOP DRAWINGS, ETC. for additional requirements.
- 5.2 Operating instructions, maintenance procedures, parts and repair manuals shall be supplied. Repair manuals shall include detailed instructions in the setup, calibration, repair and maintenance of all equipment furnished. Also supplied with these manuals will be a complete parts listing of all devices supplied which is to include part numbers and model numbers of all parts and component parts along with exploded views of devices.
- 5.3 All as built drawings (wiring diagrams, flowcharts, floor plans, etc.) shall also be supplied to the owner electronically in PDF format.
- 5.4 System specific wiring, control diagrams, sequence of operation and points lists shall be as installed in each control panel. This means as-built drawings, not design (submittal) drawings.
- 5.5 Supply all software necessary for configuration of, modification, editing or communicating to any of the unitary devices. Software shall be capable of uploading and down-loading the entire unitary data base or any part of the automated system for backup or archiving.
- 5.6 Supply one copy of the software programming manual (hard copy and PDF format). The manual shall describe all furnished software. The manual shall be oriented to programmers and shall describe calling requirements, data exchange requirements, data file requirements, and other information necessary to enable proper integration, loading, testing, and program execution.
- 5.7 Provide a Bill of Materials with each schematic drawing. List all devices/equipment and match to schematic and actual field labeling. Provide quantity, manufacturer, actual product ordering number, description, size, accuracy, operating ranges (voltage,

CONTROL - DIRECT DIGITAL (WEB BASED)

temperature, pressure, etc.), input/output parameters, etc.

- 5.8 Maintenance manual shall include copies of signed-off acceptance test forms, commissioning reports, start-up reports, etc.
- 5.9 The TCC shall turn over to owner two (2) sets of computerized back-ups of the complete temperature control system.

**PART 6 – WARRANTY & SOFTWARE LICENSES:**

- 6.1 Labor and materials for the control system specified shall be warranted free from defects for a period of 12 months after substantial completion and acceptance. Control system failures during the warranty period shall be adjusted, repaired, or replaced at no additional cost or reduction in service to the Owner.
- 6.2 The TCC shall respond to the Owner's request for warranty service within 24 hours during normal business hours. The TCC shall respond to the Owner's request for Emergency service (defined as life-threatening or creating the potential to cause property damage) during the warranty period within 4 hours.
- 6.3 The TCC shall provide technical phone support to the owner during the warranty period for warranty related issues and for two years after the warranty period. If the technical support location of the TCC is outside of the toll free calling area for the customer, the TCC shall have a toll free number or accept collect calls for the purpose of providing technical support.
- 6.4 During the warranty period, standard parts for the DDC system shall arrive at the facility within 48 hours of placing an order. Non-standard parts (requiring re-manufacturing or ordering from another supplier) shall be shipped within 96 hours.
- 6.5 Operator workstation software, project-specific software, graphic software, database software, and firmware updates which resolve known software deficiencies as identified by the TCC shall be provided and correctly installed at no charge during the warranty period.
- 6.6 Provide licensed electronic copies of all software for each workstation, laptop, and server. This includes, but is not limited to: project graphic images (editing/modifying/creating), project database, trouble-shooting and debugging programs, project-specific programming code and all other software required to operate and modify the programming code (including software at system level, primary control units, secondary control units, and all communication software). Any hardware devices (cables, protection devices) required to operate the software/hardware shall also be provided.
- 6.7 All additional licensing needed for this project shall be supplied by TCC. Software license shall not expire or utilize any sort of protection hardware device for its use. In any case owner shall be free to direct the modification of any software license, regardless of supplier to allow open access to all controllers. Owner shall hold the software and firmware licensing. Software license shall not expire or utilize any sort of protection hardware device for its use.
- 6.8 System software shall be the latest version available with upgrades provided at the end of the warranty period, and shall be fully licensed to the Owner for the entire system. Supply all software necessary for configuration of, modification, editing or communicating to any of the unitary devices. Software shall be capable of uploading and down-loading the entire unitary data base or any part of the automated system for backup or archiving. Software shall be "IBM compatible".

CONTROL - DIRECT DIGITAL (WEB BASED)

## **PART 7 – TRAINING:**

- 7.1 FACTORY TRAINING -- Provide training at a Manufacturer's Factory Training Center on the operation of the system for two NKU staff members. Minimum 4 days of training. Control Contractor shall pay travel (air fare if training center is greater than 400 miles from project site or vehicle mileage at \$0.45/mile), lodging, and registration fees. Coordinate with NKU on itinerary to avoid travel that will require extended travel time other than regular NKU working hours. Coordinate with NKU as to which Manufacturer training they will receive training from, and which course. At the option of the Owner, in lieu of the factory training as specified above, a cash payment of \$6,000 shall be made to NKU due upon request. This amount will be to offset any cost associated with 3rd party training or Owner supplied training. Provide close-out documentation for training and warranty obligations.
- 7.2 A formal on-site "Hands On" training session shall be conducted for the owner's maintenance personnel. This session shall be a minimum of one (1) eight (8) hour days to train the staff on setup, operation, and maintenance of all system(s) and/or devices. This will be at a time and location selected by the owner. One (1) additional eight (8) hour session shall be provided as "opposite season" training – generally 6 months into the warranty period. One (1) additional eight (8) hour session shall be provided at a later date. (This may be requested any time during the warranty period.) All training materials and books shall be provided. Both sessions shall be given by the manufacturers "factory" technical representative. (This is defined as someone other than the installing contractor's representative.) All expenses are to be provided by the TCC. All training sessions shall be scheduled at owner's request.
- 7.3 TCC shall conduct training courses for designated personnel in operation and maintenance of system. Training shall be oriented to specific system being installed under his contract and shall be digitally recorded and submitted on DVD by the TCC.
- 7.4 Training shall be a mix of, test exercises, and actual keyboard entry and screen viewing at the operator's terminal. A curriculum shall be discussed and implemented based on the level of expertise of the employees. Hands-on experience and problem solving shall be emphasized.
- 7.5 If during any training session, the trainer/owner finds more than three (3) items that need repair, the training session will be immediately terminated. The session will be rescheduled for another date. The re-scheduled training session will be carried out at no additional cost to the Owner.
- 7.6 The training shall be oriented to making the owner self sufficient in the day-to-day use and operation of the DDC system.
- 7.7 Additionally, the training shall include:
- System start-up, shutdowns, power outage and restart routines, alarms, security levels, changing setpoints, changing schedules and other parameters, overrides, freeze protection, manual operation, return to automatic operation, and resetting equipment.
  - All screens shall be discussed, allowing time for questions.
  - Information specifically focused on showing the owner methods of troubleshooting the mechanical systems using the DDC.
  - Use of laptop and hand-held operator interface device, if applicable.
  - Creating, modifying, viewing, downloading, and reloading, trend logs.
  - Remote access to the system.
  - The other training sessions shall be oriented toward answering specific questions

CONTROL - DIRECT DIGITAL (WEB BASED)

- from Owner's staff.
  - The trainer must be well grounded in both DDC system operation and in mechanical systems service and shall be the programmer.
- 7.8 This documentation and process shall be complete, approved and accepted by Engineer and Owner prior to acceptance. This information shall be documented as completed. A copy shall be delivered to the Engineer and Owner and included in the O&M manuals.
- 7.9 Coordinate training schedule with the project commissioning agent.

**PART 8 – COMMISSIONING & VERIFICATION, FUNCTIONAL PERFORMANCE TESTING & CHECKLISTS:**

- 8.1 100% compliance with the requirements of this section is a condition of the Owner's acceptance and start of the warranty period.
- 8.2 The TCC shall be responsible for completion of (1) their hardware checkout sheets and test reports, (2) Point- by-point confirmations of ALL points – this includes visual inspection of installed components, and (3) sequence of operation confirmation.
- 8.3 This documentation and process shall be complete, approved and accepted by Engineer and Owner prior to acceptance. This information shall be documented as completed. A copy shall be delivered to the Engineer and Owner and included in the O&M manuals. Each subcontractor shall be responsible for completion of their own System Verification Checklists/Manufacturer's Checklists. Sample checklists shall be submitted to the Engineer and Testing Agent for approval.
- 8.4 Provide the Commissioning, configuration and diagnostic tool (CCDT), color display personnel computer, software, and interfaces to provide uploading/downloading of High Point Count Controllers (AAC), Unitary Equipment Controllers (UEC) and VAV controllers (VAVDDC) monitoring all objects, monitoring overrides of all controller physical input/output points, and editing of controller resident time schedules.
- 8.5 Air and water balancing shall be completed (and discrepancies resolved) before the TCC's final system check and before the acceptance test to be conducted in the presence of the Engineer.
- 8.6 Refer to Mechanical Specification Section – GENERAL PROVISIONS for additional information and requirements.

**PART 9 – WIRE MANAGEMENT, ELECTRICAL POWER, ETC:**

- 9.1 Refer to CABLING section of this specification for additional requirements.
- 9.2 Electrical work required for system interlock and installation of the temperature control system shall be included in the bid and installed per all applicable codes. Coordinate with other trades as required for installation of a complete system.
- 9.3 All wiring and cabling in mechanical and electrical rooms shall be in conduit. No wiring or conduit can be exposed to view in any other area. Conceal all wiring and cabling in conduit in wall from thermostats or other controls devices to above ceiling. Install conduit in wall from wall thermostats to above ceiling for cabling. Route wiring directly to cable tray from control points above the ceiling. Rough-in for control devices shall be in compliance with the requirements of the ELECTRICAL SPECIFICATIONS.
- 9.4 Any power for controls shall be fed from dedicated circuits in emergency electrical panels,

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when provided for a project, and shall not be obtained from receptacles, lighting, or equipment circuits. Unitary control power may be obtained from the equipment served. If power is obtained from the equipment served, the power may not be interrupted to the electronics if the equipment is off for any reason.

- 9.5 Electrical trade to provide all necessary 120vac emergency/normal circuits required for BAS control panel power in each mechanical room where BAS panels are located. BAS controls contractor to extend the 120vac circuits from central location in mechanical room to each BAS control panel.
- 9.6 The TCC shall be responsible for the power source to any control panels, unitary controllers, etc. on any controlled equipment and all other control power requirements. This includes circuit breakers, wiring, conduit, etc. installed in strict accordance with NEC. The TCC may contract with the electrical contractor for the power wiring installation.
- 9.7 Prior to installation, insure through coordination with all trades, that appropriate clearances (36" minimum) as required by the N.E.C. are maintained at all control panels, including unitary controllers for VAV terminals, heat pumps, etc.
- 9.8 The TCC shall provide all CAT5 or CAT6 cabling network cabling for a complete system. This shall include cabling to the Owner's data drop. The main system data drop will be provided by others.
- 9.9 All control circuits within the electrical panels shall be marked to indicate equipment served.
- 9.10 The TCC shall perform all temperature control interlock wiring. This shall include control valves, dampers, thermostats, indoor/outdoor HVAC systems, etc. Electrical work required for system interlock and installation of the temperature control system shall be included in the bid and installed per all applicable codes. Coordinate with other trades as required for installation of a complete system.
- 9.11 The TCC shall be responsible for any power required for the unitary controls or control panels. This includes circuit breakers, wiring, conduit, etc. installed in strict accordance with NEC. The TCC may contract with the electrical contractor for the power wiring installation.
- 9.12 Provide one duplex outlet mounted inside the control panel and separately fused with a non-time delay fuse at 15 A at any panel location containing electronic control components. This receptacle may be served from the control panel 120 VAC power source.
- 9.13 All wiring shall be continuous runs. Any junctions must be made in metal enclosure.
- 9.14 Grounding terminals shall be color coded green and yellow and shall be compatible with the other specialty terminals specified above and shall mount on the same DIN rail system. Units shall be arranged so that the wiring connected to them is grounded to the enclosure via the mounting rail. These terminals shall be provided for grounding cable shields at the points where the cables enter a control panel and terminate on the control panel terminal strip. Terminals shall be Entrelec M 4/5.3A.PI or equivalent by Weidmuller, Phoenix, or Allen Bradley.
- 9.15 The Department of Housing, Building and Construction's Electrical Division requires that all new lighting control panels, new Building Automation Systems control panels, and new conventional HVAC control panels be certified as being constructed and wired in accordance with NFPA 70 110.3 (a) (1) and article 409.
- 9.16 Contractor shall insure control panels have an identification label stating the "Certification

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Agency" such as UL, CSA, CE, etc. or a label of certification for each control panel by a Professional Engineer (P.E.) registered in the State of Kentucky, stating that the design of the control panel was under their direct supervisory control. Include with shop drawings.

- 9.17 The Electrical Advisory Council for the State of Kentucky requires that only an electrical contractor licensed by the State of Kentucky with a licensed Master Electrician and a licensed on-site electrician can install the electrical wiring for lighting controls systems or Building Automation Systems (BAS).

#### **PART 10 – CABLING:**

- 10.1 Refer to WIRE MANAGEMENT section of this specification for additional requirements.
- 10.2 ALL CONTROL WIRING SHALL BE INSTALLED IN A WIRE MANAGEMENT SYSTEM TO INCLUDE CABLE TRAYS, BRIDLE RINGS, & CONDUITS. NO EXCEPTIONS! COORDINATE WITH ELECTRICAL CONTRACTOR TO INSURE A COMPLETE WIRE MANGEMENT SYSTEM.
- 10.3 Acceptable cable manufacturers are Belden, West Penn or Alpha.
- 10.4 A complete cabling system shall be furnished and installed, which shall adhere to the highest workmanlike standard of quality and appearance. Cabling shall be installed square with building lines and contained within a wire management system.
- 10.5 All sizing of cabling shall be according to manufacturer's recommendations, but shall be a minimum of 18 AWG.
- 10.6 Furnish a floor plan of the building indicating communication cable labeling and routing as well as addresses and branch wiring from the unitary devices. All cabling shall be labeled on both ends. The type, size and label of all cabling shall be indicated on submittal floor plan drawings.
- 10.7 Wall space temperature sensor cabling (from the sensor to the unitary controller) shall have a minimum of four (4) conductors.
- 10.8 All cabling shall be stranded. "NO" solid conductors will be accepted. All cabling shall be 100% shielded with appropriate drain wire and insulation.
- 10.9 All cable connections shall be continuous run (including shield). Any junctions must be made in a metal enclosure, connections must be soldered, taped and the metal enclosure must be mechanically attached to the nearest ground. No wire nuts or crimped connections will be accepted. Note location of junction boxes on the as built floor plans. All cabling networking unitary controllers, and other networked equipment, shall be in soldered.
- 10.10 All shields must be terminated as per manufacturer's recommendation. Shield termination requirements by the manufacturer must be provided with submittals.
- 10.11 Wireless controllers are not approved.

#### **PART 11 – SYSTEM SOFTWARE:**

- 11.1 System software will be the latest version available with upgrades provided for full warranty period, and shall be fully licensed to the owner for all network controllers and servers. Refer to WARRANTY section of this specification for additional requirements.
- 11.2 System software shall, at a minimum, provide:

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- Monitor and supervise all control points.
  - Add new points and edit system database.
  - Change control setpoints, timing parameters and loop tuning of PID coefficients in all control loops in all control units.
  - Enter programmed start/stop schedules.
  - Modify existing control logic (or sequence of operation) in all control units.
  - Upload/Download programs, databases, control parameters, etc.
  - Modify graphic screens.
- 11.3 Sequence of operation programming methodology - The application software shall be user programmable. Application programming shall be (1) Line type programming that uses text programming in a language similar to BASIC or FORTRAN, or (2) graphical block programming - The method of programming shall be by manipulation of graphic icon "blocks." Each block represents a subroutine containing the programming necessary to execute the function of the device that the block represents.
- 11.4 Unitary Control Unit Database Archiving - The host software shall provide capability to upload sequence of operation, database, and other control parameters from each controller. Uploaded programs shall be retained on hard disk for system backup. Programs may be modified using Editor-functions, and downloaded to individual controllers as desired. Downloading of databases shall not interrupt other multi-tasked functions that are ongoing.
- 11.5 Third Party Software Packages - The host software shall provide the capacity to run third party software packages for word processing, spreadsheets, or database management programs. Use of third party software shall not suspend operation of background tasks of multi-tasking operating system, such as alarm logging, and report generation.

## **PART 12 – COLOR GRAPHIC DISPLAYS (ALLOWANCE):**

- 12.1 Scheduling provided by the allowance.
- 12.2 The color graphics shall reside on the Schneider SmartStructure server and are included in the allowance. All graphics shall be consistence with NKU graphic standards.
- 12.3 All graphics screens shall be submitted for review by Engineer. Provide the following animated, color graphics screens minimally:
- 12.4 Entire floor plan home screen with OAT, Time and Date displays.
- Floor plan showing major zones,
  - Graphics shall include a floor plan with zone temperature and a matrix view for each floor showing room number: VAV Zone Number, Room Number, CFM, Space Temperature, Discharge Air Temperature, Damper Position and Reheat % at a minimum. Heat Pump Zone Number, Room Number, Space Temperature, Discharge Air Temperature, Heating / Cooling mode.
  - Click major zone displays enlarged floor plan of the zone showing individual heat pump zones & numbers.
  - Include link to respective mechanical room.
  - Click individual zone shows heat pump graphic. Display all data points from points list, occ/unocc schedule and setpoints, VAV cfm and setpoint, OAT, Time and Date.
- 12.5 Color Graphic Screens to match existing shall be designed the Dashboard in the Steam Plant and shall include the following:
- Electric power metering demand and consumption
  - Steam metering demand and consumption

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- Gas meters demand and consumption
  - Chilled water demand and consumption
  - Domestic water demand and consumption
  -
- 12.6 Color Graphic Screens shall be designed for all mechanical systems and shall include the following:
- A graphic shall be the starting page with the building graphically indicated. Break up the floor plan into zones to match Contract Documents. The building shall be the point of reference to enter into the respective building control system.
  - All heat pump units including pumps, filters, associated VAV boxes, etc.
  - All terminal equipment including but not limited to VAV boxes, reheat coils, zone dampers, etc.
  - All AHU and OA units.
  - Domestic hot water heaters and pumps.
  - Pool Dehumidification Unit
  - The summation of all supply OA for each unit shall be displayed on the AHU graphic pages.
- 12.7 Graphics to include floor plans with room numbers (as-built room numbers) and thermostat locations, links to flow diagrams for heat pumps, zone dampers, hydronic loop systems, outside air systems, domestic hot water and lighting controls.
- 12.8 All new graphics shall match the existing system graphics, unless noted otherwise.
- 12.9 The graphical programming software shall allow for interactive mouse-driven placement of block icons on the graphic screen and connection of block inputs to block outputs by means of drawing lines to form a graphic logic diagram. The user shall not have to manually input text to assign block input/output interconnections. Blocks shall allow entry of adjustable settings and parameters via pop-up windows.
- 12.10 Using the mouse, operators shall be able to adjust setpoints, start or stop equipment, modify PID loop parameters, or change schedules.
- 12.11 All data fields must indicate a unit of measure; DegF, %, ppm, etc.
- 12.12 The clarity of sequence shall be such that the user has the ability to verify that the system programming meets the specs without having to learn or interpret a manufacturer's unique programming language. Provide a means for testing and/or debugging the control programs off-line (not communicating with control units) using operator entered values for physical inputs and time. Provide a means for testing and/or debugging the control programs on-line (communicating with control units), showing actual physical inputs and all block outputs in real time.
- 12.13 Provide a utility that shall allow the graphic logic diagrams to be directly compiled into application programs. Logic diagrams shall be viewable either off-line, or on-line with real-time output values.
- Ability to link graphic displays through user defined objects, alarm testing, or the result of a mathematical expression. Operators must be able to change from one graphic to another by selecting an object with a mouse - no menus will be required.
- 12.14 All graphic software shall be in the html web browser format and support multiple simultaneous screens to be opened and resizable in a "Windows" type environment. All functions, except text entry, shall be executable with a mouse. Graphic software shall provide for multitasking such that third party programs can be used while the Operator Workstation Software is on-line. Provide the ability to alarm graphically even when operator is in another

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software package. The software shall allow for Owner to create user defined, color graphic displays of geographic maps, building plans, floor plans, and mechanical and electrical system schematics.

- 12.15 The contractor shall provide libraries of pre-engineered screens and symbols depicting standard air handling unit components (e.g. fans, coils, filters, dampers, etc.), mechanical system components (e.g., pumps, heat pumps, etc.), complete mechanical systems (e.g. VAV, etc.) and electrical symbols. It shall be possible to create and save graphical components and JavaScript code in reusable and transferrable, customized libraries.
- 12.16 All applicable control points must have "Forced by Operator" or "Manual Mode" properties that are clearly displayed on individual graphic pages for each point accessible from the graphic page. This is displayed by a "M" in the data field.
- 12.17 The graphic development package shall use a mouse or similar pointing device to allow the user to perform the following:
- Define symbols
  - Position items on graphic screens
  - Attach physical or virtual points to a graphic
  - Define background screens
  - Define connecting lines and curves
  - Locate, orient and size descriptive text
  - Define and display colors for all elements
  - Establish correlation between symbols or text and associated system points or other displays.
  - Create hot spots or link triggers to other graphic displays or other functions in the software
- 12.18 The system shall allow for the creation of user defined, color graphic displays for the viewing of mechanical and electrical systems, or building schematics. These graphics shall contain point information from the database including any attributes associated with the point (engineering units, etc.). In addition operators shall be able to command equipment or change setpoints from a graphic through the use of the mouse.
- 12.19 A matrix view for all Heat Pump's and VAV's must be provided in addition to individualized Heat Pump and VAV pages. VAV Graphics must:
- Have an individual graphic page along with a floor/building matrix page
  - Provide linking between individualized Heat Pump/ VAV pages to the floor plan and the conceding matrix page. Linking must also be established to previous and succeeding Heat Pump/ VAV boxes through the use of up/down arrows.
  - All Heat Pump fans, pumps, heating and cooling controls need to be force-able at the operators discretion from the graphic pages
  - All VAV dampers, valves and airflow controls need to be force-able at the operators discretion from the graphic pages.
  - "Global" HP setpoints to multiple HP's shall be performed from a single location on the graphics page.
  - "Global" VAV setpoints to multiple VAV's shall be performed from a single location on the graphics page.
  - Each graphic page must be individualized; a "Master" may not be used as a template for similar zones/controllers so that zone or area specific instructions/notes can be added to each graphic.

### **PART 13 – ALARMS AND TRENDS (ALLOWANCE)**

- 13.1 Scheduling provided by the allowance

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- 13.2 The alarms and trends shall reside on the Schneider Smartstructure server or the Schneider I/NET server and are included in the allowance. All alarms and trends shall be consistent with NKU standards.
- 13.3 All alarms must be displayed in the alarm queue and also on the coinciding graphic page with a red flashing alarm indication in the data field and/or similar graphic presentation.
- 13.4 Status changes or alarm conditions must be able to be highlighted by objects changing screen location, size, color, text, blinking or changing from one display to another. Start/Stop and Status points must indicate a graphical and color change in state, (green to black) or similar presentation using the same color scheme.
- 13.5 All temperature sensors must have a High & Low Level Alarm Limit Set. These alarm limits shall be discussed with NKU prior to implementation of programming of resident I/O's
- 13.6 Trending of control points must be available on all control & monitoring points and accessible through graphic pages. Ability to add and delete trending data shall also be made available through graphical displays.
- 13.7 The TCC shall include programming of 25 point trends as directed by the Engineer. These can be requested at any time during the project including the warranty period. Trend "change of state" for digital inputs. Trend analog points in 30 minute increments. Maintain trend history for 30 days. Include the following:
- Outside air temperature
  - OA unit leaving air temperatures for each unit
  - Summation of all VAV boxes connected to a unit
  - VFD speeds (OA & EA)
  - Geothermal wellfield main supply and return temperatures
  - Geothermal wellfield main flow rate
  - Water to water unit main supply and return temperatures (load side)
  - Critical room space temperatures
  - Domestic hot water supply temperatures
  - Makeup water flow rate
  - Electrical power kW and kWh
  - Others as directed in the field

## **PART 14 – SYSTEM ARCHITECTURE**

- 14.1 The Building Automation System (BAS) shall consist of Network Controllers and a family of Standalone Digital Control Units.
- 14.1.1 The system shall be designed with a top-level 10/100bT Ethernet network, using the BACnet/IP.. A sub- network of Standalone Digital Unitary Controller using the LonTalk FTT-10A, and/or Modbus RTU protocol shall connect the local, stand-alone controllers with Ethernet-level Network Server Controllers/IP Routers.
- 14.1.2 All Network Controllers shall be capable of residing directly on the owner's Ethernet TCP/IP LAN/WAN with **no required gateways**. Furthermore, the Network Controller shall be capable of using standard, commercially available, off-the-shelf Ethernet infrastructure components such as routers, switches and hubs. With this design the owner may utilize the investment of an existing or new enterprise network or structured cabling system. This also allows the option of the maintenance of the LAN/WAN to be performed by the owner's Information Systems Department as all devices utilize standard TCP/IP components.

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14.1.3 Gateway's are not approved on this project.

## **PART 15 – NETWORK CONTROLLER**

- 15.1 The University's existing enterprise level control system between buildings shall maintain TCP/IP for communications of building data with the server-based graphical user interface and enterprise information system. Coordinate with the university's IT department on locations for Ethernet communication cabling and TCP/IP addresses. It is intended to minimize control system traffic over the University's shared Ethernet network. IT is intended that only one Network "Building Level" Controller and its associated TCP/IP address be used per building. Each building shall have its own subnet and Broadcast Management Device (BBMD). The University shall provide the Ethernet switch and port. No other IP switches shall be permitted. The TCC shall provide raceway for the University provided cabling between the switch and the Network "Building Level" Controller. Control systems shall not rely on University Ethernet communications for control sequences.
- 15.2 The TCP/IP layer connects all of the buildings on a single Wide Area Network (WAN) isolated behind the campus firewall. Fixed IP addresses for connection to the campus WAN shall be used for the Network Controller that connects to the WAN.
- 15.3 Install the Network Controller in a surface mounted panel, NEMA type 12 enclosures, with a removable hinged door. Provide a flush mounted key lock. All control panels must be painted the same color and identified. The boxes are to be made from 16 gauge material. Panels should not be provided with knockouts.
- 15.4 For each panel, provide a UPS power supply to help with brief power outages and power surges
- 15.5 Web-based operation shall be supported directly by the Network Controller and require no additional software, other than a Java supported network browser.
- 15.6 Control panels shall be constructed by a UL approved panel manufacturer. The standard used shall be UL508A. All proper labels are to be attached. Panel shall meet the requirements of UL512 and be arc flash compliant panels.
- 15.7 The Network Controller shall be web-based and communicate BACnet IP. It shall issue all time schedules, summer/winter commands, customized trending, holiday scheduling, alarm handling, clock or other shared commands to all unitary controllers within the building network. If for any reason communications between the unitary(s) and the Network Controller is lost, the unitary(s) shall operate in a stand-alone manner (in day operation) until communications is restored. It shall also operate in the "summer" or "winter" mode as last commanded.
- 15.8 The Network Controller shall be integrated and interoperable with the facility infrastructure and include user access to all system data locally over the Local Area Network (LAN) / Wide Area Network (WAN) within the building and remotely by a standard Web Browser over the Internet. Any computer connected to the network, utilizing a web browser and having the proper password.
- 15.9 The Network Controller shall be a fully user-programmable, supervisory controller. It shall monitor the network of distributed unitary controllers, provide global strategy and direction, and communicate on a peer-to- peer basis with other Network Controllers.

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- 15.10 The Network Controller shall have UPS back-up to allow a minimum of seven days of operation. The Network Controller shall be composed of one or more independent, stand-alone, microprocessor to manage the network strategies described in Application software section. The network controller shall have ample memory to support its operating system, database and programming requirements. The operating system of the Network Controller shall manage the input and output communications signals to allow distributed unitary controllers to share real and virtual point information and allow central monitoring and alarms. The database and custom programming routines of the Network Controller shall be editable from a single operator station.
- 15.11 The Network Controller shall be remotely monitored via the internet. Additionally, it shall include automatic emailing and texting out alarms, gathering alarms, reports and logs, programming and downloading database.
- 15.12 The Network Controller shall continually check the status of all processor and memory circuits. If a failure is detected, the controller shall:
- Assume a predetermined failure mode.
  - Emit an alarm.
  - Display card failure identification.
- 15.13 Under no circumstance shall more than 75% of the total number of sensor and control points be connected through a single Network Controller. Each DDC system component shall provide for the future addition of at least 20% of each type of the number of sensor and control points connected to that component including a minimum of one universal input and one universal output.

## **PART 16 – UNITARY CONTROLLER**

- 16.1 Unless otherwise specified, each piece of equipment shall have its own Unitary Controller (i.e., heat pump, AHU, terminal unit, etc.). The Unitary Controller for each piece of equipment shall be mounted on the side of the unit. The Unitary Controller for all other equipment shall be mounted in a panel and properly labeled.
- 16.2 Panels in mechanical rooms subject to water damage from above shall be installed in a surface mounted panel, NEMA type 12 enclosures, with a removable hinged door. Provide a flush mounted key lock. All control panels must be painted the same color and identified. The boxes are to be made from 16 gauge material. Panels should not be provided with knockouts. NEMA 1 panels are acceptable in remaining locations.
- 16.3 Each Central Station Air Handler and/or Outside Air Unit shall have its own Unitary Controller mounted where shown on the drawings. If an installation location is not clear, the Contractor shall notify the Engineer for clarification prior to installation.
- 16.4 Unitary Controllers used in conditioned ambient shall be mounted in dust-proof enclosures, and shall be rated for operation at 32 degrees F to 120 degrees F. All Unitary Controllers shall have an RJ-11 or similar type connection for monitoring or programming access by room or local equipment level with access to any unitary within the network without modification.
- 16.5 Control panels shall be constructed by a UL approved panel manufacturer. The standard used shall be UL508A. All proper labels are to be attached. Panel shall meet the requirements of UL512 and be arc flash compliant panels.

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- 16.6 Unitary Controllers utilized in the network shall have full stand-alone capability including time of day and holiday scheduling as well as all energy management functions such as optimal start/stop, duty cycling, etc. The terminal unit Unitary Controllers may be pre-programmed with the project specific sequence of operation as specified for the application. Any re-programming of the electronics shall be performed on location using a portable personal computer with appropriate software or through the Network Controller. The entire unitary data base shall have the capability of being backed up and or downloaded locally.
- 16.7 All points to have a unique digital input to the BAS system. The use of digital point count expanders is not an acceptable replacement to digital inputs to the unitary controller. The conversion of a single universal input channel to accept up to multiple voltage free contacts such as relay contacts, auxiliary starter contacts, differential pressure switches, etc. IS NOT ACCEPTABLE.
- 16.7.1 The Fieldbus layer shall be support all of the following types of Standalone Digital Unitary Controller's:
- 16.7.2 LonWorks Standalone Digital Unitary Controller requirements: The system shall consist of one or more LonWorks FTT-10A field buses managed by the Network Controller. Minimum speed shall be 76.8kbps. The field bus layer shall use peer-to-peer, event-driven communication for operation of HVAC and lighting equipment.
- 16.7.3 Modbus Standalone Digital Unitary Controller requirements: The system shall consist of one or more Modbus RTU (RS-485 or RS-232) field buses managed by the Network Controller.
- 16.8 All Unitary Controllers shall be fully application programmable. All control sequences within or programmed into the unitary controller shall be stored in non-volatile memory, which is not dependent upon the presence of a battery shall be retained.
- 16.9 Unitary Controllers shall have a 10% spare point capacity to be provided for all applications.
- 16.10 The Unitary Controller for each VAV box shall be mounted on the side of the unit. The unitary controller for all other equipment shall be mounted in a panel and properly labeled. Prior to installation, insure through coordination with all trades, that appropriate clearances (36" minimum) as required by the N.E.C. are maintained at all control panels, including unitary controllers for VAV terminals, etc.
- 16.11 After a power failure, the Unitary Controller shall operate the control application using the current setpoints and configuration. Reverting to default or factory setpoints are not acceptable.

## **PART 17 – SENSORS AND MISCELLANEOUS DEVICES:**

- 17.1 WEATHER STATION HOUSING: Provide Kele Model A21 Outdoor Aspirated Humidity/Temperature housing. NEMA 3R enclosure is painted white to reduce the effect of radiation, and the enclosure has a lockable latch for security. The outdoor air sensor will be installed on the north wall in the shade as not to be effected by sunlight, building ventilation or weather. This location shall be indicated on the control drawings. Installation in outside air ductwork or louvers is not acceptable. If not installed to provide "accurate" temperature readings, it shall be relocated (at the TCC's expense) until a suitable location is found.
- 17.2 SENSOR RESOLUTION: All temperature sensors shall have a minimum resolution of 1/10th of 1 degree F. (0.1 degree F.) Sensor stability shall be 0.24 degrees over a year period.

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Space sensors shall be tested and accurate to within 0.75 degrees F. Outside air, water and duct sensors shall be tested and accurate to within 2.0 degrees F.

17.3 SPACE SENSORS AND THERMOSTATS:

- Refer to the drawings for proper type and location.
- All room temperature sensors shall be typical to those used currently throughout the campus. Room Temperature sensors must have blank covers with no LCD display.
- Programmed set-point shall be locally adjustable limited to 2 degrees above set-point and 2 degrees below set-point for supervised areas.
- Unsupervised areas shall have non-adjustable set-point.
- Generally, thermostats/sensors shall be installed 5'-0" above the finished floor.
- Where thermostats/sensors are to be mounted next to a light switch, install at the same height as the light switch.
- Sensors in hallways, vestibules, Gymnasiums, open fitness areas, stairways, restrooms and locker rooms shall utilize a stainless steel surface mount temperature sensor installed on an interior wall or partition (2"x4" blank plate). Care must be taken in the installation of these sensors to ensure proper insulation from the wall temperatures in order to properly sense space temperature.
- If there is a question consult engineer prior to rough-in.

17.4 WATER SENSORS: Temperature sensors for water lines are to be the well type. Wells are to be threaded brass (same manufacturer as the temperature sensor) with the sensor coated with a heat transfer compound. Strap on sensors will not be acceptable.

17.5 MIXED AIR SENSORS: These sensors shall be bendable averaging, type made of copper or aluminum elements. In unit ventilators, these sensors shall be at least five (5) feet in length and installed in the discharge air of the unit. For Air Handling Units, Outside Air Units, etc. the sensors shall be at least 20 feet in length.

17.6 DISCHARGE AIR AND DUCT ROOM RETURN AIR SENSORS: Shall be rigid insertion type. In all applications, care shall be taken to insure that the sensors are securely mounted as not to allow any vibration and installed in such a manner as to indicate the truest possible temperature.

17.7 FREEZE/LOW-LIMIT THERMOSTAT: Provide a freeze/low-limit thermostat in each Air Handling Unit, Outside Air Unit, etc with a water coil for freeze protection. These devices shall be the manual reset, DPDT type. . All Low Limits shall be hard-wired to AHU associated supply and return fan VFD's or starters. An alarm shall also be provided as status to the Schneider Electric front-end Control System. This device shall be wired by using a normally closed contact in series with the motor starting circuit and a normally open set of contacts as an input to the unitary controller. The element shall be constructed of copper and be at least 20 feet in length. It shall be installed serpentine across the air entering the coil. In some cases it may require being installed after the coil. Each application should be closely evaluated before installation. The device shall sense the lowest temperature by any one foot section of its element.

17.8 HUMIDITY SENSORS: These devices shall be 100% solid state, linear and temperature compensated with scaling 0-100% RH range with LED or LCD Display. Accuracy at 25°C from 10-80% RH\*  $\pm 2\%$ , operating Humidity Range 0 to 100% RH (non-condensing), Stability  $\pm 1\%$  @ 20°C (68°F) annually, for two years, Hysteresis 1.5% typical, Temperature Effect  $\pm 0.1\%$  RH/°C above or below 25°C (typical), 1% accuracy between 0% - 90% RH, Operating Temperature Range -40° to 50°C (-40° to 122°F) +/- 1%.-Do not submit products that do not meet this range. The output of the device shall utilize an analog output 4-20 mA, 2-wire, polarity insensitive, (clipped and capped), The device shall use a power supply of 24 VAC or VDC. Duct mounted sensors shall have at least 4" insertion

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probe with a 16 gauge steel enclosure. NIST traceable certification shall be provided to the Engineer as part of the shop drawings. For wall mounted sensors the enclosure shall be polystyrene plastic mounted next to and at the same height as the temperature sensor in that area. Both shall have the same appearance. Provide protective cages in fitness and common areas.

- 17.9 COMBINATION TEMPERATURE/HUMIDITY SENSORS: All temperature sensors shall have a minimum resolution of 1/10th of 1 degree F. (0.1 degree F.) Sensor stability shall be 0.24 degrees over a year period. Space sensors shall be tested and accurate to within 0.75 degrees F. The humidity sensing device shall be 100% solid state, linear and temperature compensated with a 0-100% RH range. The response time shall be a minimum of 30 seconds for a 60% change. They shall have a minimum of 2% accuracy minimum accuracy of +/-2% RH minimum rangeability 5 to 95% RH non-condensing and maximum hysteresis +/-1.5% RH. Do not submit products that do not meet this range. The output of the device must utilize a 0-10 VDC or 4-20mA signal as required. The device must use a power supply of 24 VAC or VDC. Duct mounted sensors shall have at least 4" insertion probe with a 16 gauge steel enclosure. NIST traceable certification shall be provided to the Engineer as part of the shop drawings. For wall mounted sensors the enclosure shall be polystyrene plastic mounted next to and at the same height as the temperature sensor in that area. Both shall have the same appearance. Provide protective cages in fitness and common areas.
- 17.10 LOW PRESSURE TRANSDUCERS: These devices shall be 100% solid state, linear and temperature compensated. Accuracy shall be no less than plus or minus 1% of its full range. Linearity, repeatability and hysteresis shall be no less than plus or minus 0.1%. All pressure sensors shall utilize output averaging/output clipping to adjust and stabilize any fluctuations in the output. The output of the device shall utilize a 0 - 10 VDC signal. The device shall use a power supply of 24 VAC or VDC. The enclosure 16 gauge steel. For sensing internal static pressure of air handling ducts utilize sensors with a range of 0 to 5 inches water column. For sensing building static pressures (building compared to atmospheric) utilize a sensor with a range of -0.25 to +0.25 inches water column.
- 17.11 RELAYS: Relays for starting and stopping fractional horsepower motors shall be rated as follows:
- 1/4 horsepower motors or less use 15 ampere rated relays,
  - 1/3 horsepower motors use 20 ampere rated relays,
  - 1/2 horsepower motors use 30 ampere rated relays,
  - Relays used for pilot duty service shall be rated at a minimum of 10 amperes.
  - Provide auxiliary pilot duty relays on motor starters as required for control function.
  - Do not install control and status relays in packaged equipment control panel enclosures containing Class 1 starters.
- 17.12 CENTRAL STATION AIR HANDLERS: All Central Station Air Handlers, Outside Air Units, etc shall be provided with a D.A.P. (differential air pressure) switch across each the supply fan to provide fan status for each air handler.
- 17.13 SMOKE SHUTDOWN: All AHUs, OA units, Heat Pump Units, etc with fans of greater than 2,000 CFM are required to have smoke shutdown safeties as required by the Building Code. The Fire Alarm Systems shall NOT provide outputs to notify the BMS of fire alarms. Those signals shall stay within the FA System. All units must be provided with a current sensor to provide fan status for each air handler and heat pump. Coordinate with the Fire Alarm Contractor to insure a complete, code compliant installation.
- 17.14 CURRENT SENSING DEVICES: Veris Industries model Hx08 Series and H701 or equal. All current sensors shall be capable of alarming to the BAS for belt losses, pump coupling shear or other mechanical failure on loads.

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- 17.15 STEAM FLOW METER: Onicon Model F-2500 series vortex Meter. Accuracy +/-1% volumetric and +/- 1.5% mass; Install flow meter with sufficient pipe diameters as recommended by manufacturer. Provide factory authorized start-up verification of operation and calibration. Provide with remote display where indicated.
- 17.16 NATURAL GAS METER: Sage Integral Prime In-line style with NPT end connections Model Number SIP-\_\_\_\_-DC24-NG. Coordinate Flow body sizing with manufacturer.
- 17.17 SINGLE DIRECTION WATER FLOW METER: Onicon Model F-1200 series dual turbine insertion flow meter. 50:1 turn down with 2% accuracy with 0.4 to 20 fps range. Install flow meter with sufficient pipe diameters as recommended by manufacturer. Provide factory authorized start-up verification of operation and calibration. Provide with remote display where indicated.
- 17.18 BI-DIRECTIONAL WATER FLOW METER: Onicon Model FB-1200 series dual turbine insertion flow meter. 50:1 turn down with 2% accuracy with 0.4 to 20 fps range. Install flow meter with sufficient pipe diameters as recommended by manufacturer. Provide factory authorized start-up verification of operation and calibration. Provide with remote display where indicated.
- 17.19 POTABLE WATER FLOW METER: Onicon Model F-1330/F-1130 series dual turbine insertion flow meter suitable for potable water applications. 50:1 turn down with 2% accuracy with 0.4 to 20 fps range. Install flow meter with sufficient pipe diameters as recommended by manufacturer. Provide factory authorized start-up verification of operation and calibration. Provide with remote display where indicated.
- 17.20 BTU METER: Provide and install ONICON System -10 MTU Meter system, including F-1200 dual turbine insertion flow meter, supply and return temperature sensors and wells and control panel. The entire system shall be factory calibrated and programmed for particular system where installed (geothermal system and 2-pipe system) and shall be re-programmable at the control panel keypad. Furnish a certificate of calibration for each BTU meter. Interface the control panel into the DDC controls system to obtain energy totals, flow rates, temperatures (supply and return) for trending. Install flow meter with sufficient pipe diameters as recommended by manufacturer. Provide factory authorized start-up verification of operation and calibration. Provide with remote display where indicated.
- 17.21 DIFFERENTIAL PRESSURE TRANSMITTERS: Provide Rosemount (ITT Bell & Gossett ST-102R) or Johnson Controls Setra DPT 2302-050-V field mounted differential pressure sensor transmitters as indicated on the plans. Range shall be 0-25 psig. Accuracy shall be .025% full span.
- 17.22 CARBON DIOXIDE SENSORS: This sensor shall have a range of 0-2000/ 500 ppm programmable. Accuracy  $\pm 30$  ppm  $\pm 2\%$  of measured value\*, Repeatability  $\pm 20$  ppm  $\pm 1\%$  of measured value, Response Time <60 seconds for 90% step change, Input Power 20 to 30VDC/24VAC; 100mA max., Analog Output 4-20mA, (clipped & capped)/0-5VDC/0-10VDC (selectable), Operating Temperature Range 0° to 50°C (32° to 122°F), 5-year calibration, Low ambient sensitivity, Power shall be 24VAC. Sensor shall not be provided with a LED or LCD display. Vulcain 90DM4SM-C-2000 or equal. Provide protective cages in fitness, gymnasiums and common areas.
- 17.23 MINIMUM OUTSIDE AIR – AIR FLOW MEASURING STATION: Ebtron Model P+ GTC116, airflow measurement: Accuracy:  $\pm 2\%$  of reading, Calibrated range: 0 to 5,000 fpm, NIST traceable calibration; Temperature measurement Accuracy:  $\pm 0.15$  deg F, Calibrated range: 20 to 160 deg F, NIST traceable calibration. Coordinate cable length with

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manufacturer. Two isolated analog output signals (field selectable/scalable 0-5/0-10 VDC or 4-20mA).

#### **PART 18 - VALVES, DAMPERS AND ACTUATORS:**

- 18.1 Unless otherwise specified, valves shall be furnished and sized by the TCC. The valves are to provide the required capacity and the close off rating shall be in excess of the system pressures encountered (minimum 40 psi differential). Proportioning-type valve bodies shall be packed type with throttling type inner valve (quick close plug shall not be acceptable). Proportional type valves to be rated at 125 psi static pressure. Modulating control valves shall be selected within a 3-5 psig pressure drop range. Two position control valves (open/close) shall be line size.
- 18.2 Dampers for various units requiring field mounting shall be tight closing, "ultra low leakage", opposed blade with side and edge seals. They shall be sized and furnished under this section. Installation of dampers shall be by the sheet metal contractor, coordinated by the TCC. Frames shall be no less than 16 gauge galvanized steel and furnished with mounting holes for duct mounting. Damper blades shall be no less than 14 gauge galvanized steel with maximum blade width of 8 inches. Blades shall be secured to 1/2 inch zinc plated axles and hardware with nylon bearings. Provide thrust bearings at the end of each blade. **All dampers shall have end switches to positively prove damper position. No Exceptions!**
- 18.3 All damper and valve actuators shall be fail safe spring return type with sufficient force to operate the dampers or valves under all normal operating conditions. They shall return to the normally open position upon a loss of power. Exceptions to the spring return applications are (1) face and bypass actuators, (2) boiler 3-way loop mixing valves, (2) boiler room seasonal changeover valves. Actuators for fan coil units, terminal units, etc. shall fail in the last position.
- 18.4 "ALL" Actuators shall be of the same manufacturer and have internal feedback circuitry to provide a positive action to insure proper positioning of the damper or valve through the entire sequence. Actuators shall have an adjustable starting point to accurately set the range of travel to the output of the controller. All actuators shall also utilize the same input signal (6-9 VDC, 0-010V, 2-10 VDC, 4-20 MA) in order to maintain some consistency in the control application. Analog actuation is 6-9 VDC, 0-010V, 2-10 VDC or 4-20 MA, floating point control with 2 digital outputs is NOT approved as analog actuation.
- 18.5 Actuators may be factory installed. If not factory installed they shall be installed as per instructions by the terminal equipment manufacturer.
- 18.6 Locations mounted above ceiling shall be marked on ceiling grid.
- 18.7 Install damper motors on the outside of the duct in warm areas where possible, not in air stream or locations exposed to outdoor conditions.

#### **PART 19 - VARIABLE FREQUENCY DRIVES (VFDs):**

- 19.1 The work includes all labor, materials, and related items to completely furnish and install, start up and test, and place into service the Variable Frequency Drives (VFDs) indicated and scheduled on the Drawings and described in the Specifications.
- 19.2 VFDs shall be as manufactured by ABB or approved equal. This is the only acceptable manufacturers. All VFDs for the project shall be by the same manufacturer (no exceptions).

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- 19.3 VFDs shall be consist of a pulse width modulated (PWM) inverter designed for use on a standard NEMA Design B induction motor.
- 19.4 The VFD shall be capable of operation form AC voltage in two rages 208–240 VAC  $\pm$  10%, or 380–480 VAC  $\pm$  10%. 50/60 HZ operation,  $\pm$  2 hertz.
- 19.5 The VFD enclosure shall be rated UL type 1 and shall be UL listed as a plenum rated, suitable operating conditions: 0 – 40<sup>0</sup> C continuous. Drives that have thermal cut out circuits, or that cannot operate continuously at 40<sup>0</sup> C shall not be acceptable. Altitude 0 to 3300 feet above sea level, up to 95% humidity, non-condensing.
- 19.6 The VFD shall produce an adjustable AC voltage/frequency output for step less motor speed control utilizing sine wave coded Pulse Width Modulation (PWM) The Drive shall provide automatic power factor correction and a .98 displacement power factor by incorporating a full wave diode bridge rectifier. The VFD shall have an overload rating of 110% of nominal rated current for 1 minute out of every 10 minutes of operation, which is an acceptable overload for centrifugal loads.
- 19.7 The VFD shall include a built-in first environment RFI/EMI filter and be CE and UL labeled. It shall also meet the CE requirement of EN61800-3 which provides an actual test procedure that shows that the VFD is immune from RFI/EMI interference and at the same time does not emit RFI/EMI noise that would interfere with other sensitive equipment near the VFD.
- 19.8 The VFD shall include as a minimum a 5% dual DC link or AC line reactor for a clean harmonic signature, which aides in complying with IEEE-519-1992 recommended levels. The VFD manufacturer and representative shall assist in ensuring that the VFD's applied meet IEEE-519-1992 by completing a computer aided Harmonic Analysis of the complete system.
- 19.9 The VFD shall include as a standard a built in digital keypad/display panel. This panel shall provide "Hand" off "Auto" selection, and a manual speed adjustment via up and down arrows. All faults and warnings shall be provided in "Plain English" for operation without a manual. The drive shall have a complete manual stored in memory that can be accessed with a single keystroke. This display shall be password protected and allow all setup parameters to be adjusted only by authorized personnel.
- 19.10 The VFD shall include built in Startup, Diagnostic, and Maintenance assistants, which allow for step-by-step startup procedures, troubleshooting, and the ability to indicate when the VFD and the system it is applied to needs preventive maintenance performed.
- 19.11 The VFD shall include a real time clock with a day/date stamp for troubleshooting purposes. In addition with the use of this clock the drive shall be capable of stand-alone operation and act as a unitary controller.
- 19.12 The VFD shall include (2) Analog inputs either 4–20 mADC or 0-10 vdc, (6) programmable Digital Inputs, (2) Programmable analog Outputs, (3) Form C Relay output rated 2 amps continuous minimum, and (2) PID Process controllers.
- 19.13 The VFD keypad shall include a backlit LCD display. The display shall be in complete English words for programming and fault diagnostics (LED and alpha-numeric codes are not acceptable). All VFD faults shall be displayed in English words.
- 19.14 BYPASS – As scheduled on the drawings, the drive shall be provided with an integral Bypass circuit which includes a pair of 115V electrically interlocked contactors for drive and bypass operation. The drive shall include a main input circuit breaker, drive input

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service/isolation switch, and motor overload protection adjustable for either Class 10, 20 or 30 operation. The bypass shall include a built in status display which shows via colored LED's the system operational status including safeties and run permissives for ease of operation. The Bypass shall have its own interactive, programmable keypad. The Bypass shall provide single- phase protection for the motor while operating in bypass. Bypass that does not protect the motor from single- phase operation shall not be acceptable.

- 19.15 The drive and bypass system shall have embedded serial communication capabilities that allow direct connection to Modbus, Johnson Controls, Siemens and BACnet automation systems as part of the drives software suite without the need for extra hardware cards or gateways. The connection shall be tested by the BACnet Testing Labs (BTL) and be BTL Listed. The BACnet interface shall conform to the BACnet standard device type of an Applications Specific Controller (B-ASC). In addition, the drive shall be capable of interfacing with Lonworks with the addition of a communication module.
- 19.16 All VFDs shall be provided and installed in strict accordance with the manufacturer's recommendations.
- 19.17 The VFDs serving RF-2 and RF-3 shall be provided with auxiliary contact interlock
- 19.18 Factory-authorized startup for each drive is mandatory. Provide a written record of the startup of each unit. Start up and programming by a factory-authorized technician. At startup, lockout any speed with the VFD that does not meet the vibration allowed of the equipment manufacturers.
- 19.19 A parts and labor warranty of **3 years from startup and 2 years from the date of substantial completion** shall be included. Warranty shall include travel time and expenses.

**PART 20 - TIME SCHEDULES (ALL TIMES SHALL BE USER ADJUSTABLE) (ALLOWANCE):**

- 20.1 Scheduling provided by the allowance.
- 20.2 During construction, the time schedule (for all equipment except OA unit) will be Occupied at 5:00 AM, Unoccupied at 10:30 PM. seven (7) days a week.
- 20.3 When the system is fully tested and operational and after the Owner's staff have been fully instructed as to the operation of the system the schedule shall be as follows unless otherwise instructed:
- 20.4 AHU-1 areas: Monday through Friday Occupied mode at 7:15 AM, Unoccupied mode at 5:30 PM. Unoccupied for Saturday and Sunday.
- 20.5 AHU-2A/2B areas: Monday through Friday Occupied mode at 7:15 AM, Unoccupied mode at 5:30 PM. Unoccupied for Saturday and Sunday.
- 20.6 AHU-3A areas: Monday through Friday Occupied mode at 7:15 AM, Unoccupied mode at 5:30 PM. Unoccupied for Saturday and Sunday.
- 20.7 AHU-3B areas: Monday through Friday Occupied mode at 7:15 AM, Unoccupied mode at 5:30 PM. Unoccupied for Saturday and Sunday.
- 20.8 Existing Gyms: Monday through Sunday: Occupied mode at 6:00 AM, Unoccupied mode at 11:00 PM.
- 20.9 Gyms 155: Monday through Sunday: Occupied mode at 6:00 AM, Unoccupied mode at

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11:00 PM.

- 20.10 MAC: Monday through Sunday: Occupied mode at 6:00 AM, Unoccupied mode at 11:00 PM.
- 20.11 OA-3, Pool DHU-1, New Lockers: Monday through Sunday: Occupied mode at 6:00 AM, Unoccupied mode at 11:00 PM.
- 20.12 EF-2 shall be occupied when AHU-2A/2B, AHU-3A or AHU-3B is in occupied mode
- 20.13 Remainder of the recreation center including OA-2: Monday through Sunday: Occupied mode at 6:00 AM, Unoccupied mode at 11:00 PM.
- 20.14 Domestic water heating units DHP-1 & DHP-2: Monday through Sunday: Occupied mode at 5:30 A.M. Unoccupied mode at 11:00 P.M.
- 20.15 Each piece of equipment shall have its own adjustable time schedule.
- 20.16 All schedules shall be adjustable, coordinated and confirmed with the Owner prior to final implementation.

**PART 21 - OUTSIDE AIR HANDLING UNIT (OA-1):**

- 21.1 OA-1-major components as follows: a constant flow supply fan and exhaust fan, energy recovery wheel, chilled water coil, hot water coil, outside air and exhaust air dampers. Coordinate with the test and balance contractor for to set the face and bypass damper at a maximum airflow across the coil of 60%. When the damper is full to the face of the coil it is 60% of the total airflow crossing the coil.
- 21.2 OA-1 serves existing locker rooms on 1st and 2nd floors.
- 21.3 The system shall operate under the control of a local, stand-alone, microprocessor based DDC controller. The DDC controller shall be provided by the TCC.
- 21.4 Each system shall be placed into the occupied/unoccupied mode based upon the user adjustable schedule at the Network Control Panel. These systems shall be in the occupied mode during regular business hours only. The unit shall be off when scheduled as unoccupied and warm-up.
- 21.5 If communication is lost between the Network Control Panel and the Outside Air System Controller, then the Outside Air System shall be placed into the occupied mode until communication is restored.
- 21.6 In the unoccupied mode the supply/exhaust fan and energy recovery wheel shall be OFF and the outside/ exhaust air damper shall be fully closed. Chilled and hot water valves shall be closed.
- 21.7 When placed into the occupied mode, the following shall occur in sequential order:
- 21.8 The energy recovery wheel shall be turned on, outside air damper and exhaust air damper shall fully open and be proved via end switch.
- 21.9 Exhaust Fan Control: The TCC shall provide the VFD for the exhaust fan. The exhaust fan VFD shall provide a soft start. Coordinate VFD setting with test and balance contractor. VFD setting shall NOT be adjustable. . The exhaust fan shall start and operation shall be proved via current sensor. Provide a 3 minute (adj.) time delay prior to starting the supply

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fan.

- 21.10 Supply Fan Control: The TCC shall provide the VFD for the supply fan. The supply fan VFD shall provide a soft start. Coordinate VFD setting with test and balance contractor. VFD setting shall NOT be adjustable. The supply fan shall start and operation shall be proved via current sensor or status contacts on the VFD. Engineer or commissioning agent shall be present for final balancing
- 21.11 Each system will be placed into a Mode of Operation based upon the following adjustable temperature schedule:

<u>Outside Air Temperature</u>	<u>Mode of Operation</u>
65 deg F or greater (adj.)	Cooling Mode
Between 55 deg F and 65 deg F (adj.)	Economizer Mode
55 deg F or less (adj.)	Heating Mode

Note: if exhaust air dew point rises above 57 deg F, unit shall enter dehumidification mode

21.12 In cooling mode:

- 21.12.1 In the cooling mode 2-way, modulating chilled water control valve shall modulate to maintain 55 degrees off the cooling coil and the face and bypass dampers shall modulate to maintain discharge air temperature setpoint.
- 21.12.2 If the exhaust air dew point exceeds 57 deg F the unit shall enter dehumidification mode.

21.13 In the economizer mode:

- 21.13.1 If the outside air temperature is between 55 deg F (adj.) and 65 deg F (adj.), the chilled water and hot water valves shall be closed. The discharge air temperature shall float until the system is placed in another mode of operation.
- 21.13.2 If the exhaust air dew point exceeds 57 deg F the unit shall enter dehumidification mode.

21.14 In the heating mode:

- 21.14.1 In the heating mode 2-way, modulating hot water control valve shall modulate to maintain 95 degrees (adj.) off the hot water coil and the face and bypass dampers shall modulate to maintain discharge air temperature setpoint.

21.15 The discharge temperature in the heating mode shall vary linearly. When the outside air temperature is 55 deg F (adj.) the discharge temperature shall be 65 deg F (adj.). When the outside air temperature is 0 deg F (adj.) the discharge temperature shall be 68 deg F (adj.).

21.16 Dehumidification Control:

- 21.16.1 In the dehumidification mode, the face and bypass dampers shall be full to the face of the coil, the 2-way modulating chilled water control valve shall modulate to maintain 55 degrees off the cooling coil. The heating modulating hot water control valve shall modulate to maintain discharge air temperature setpoint.

- 21.17 The system shall not start if any one component does not prove operation.
- 21.18 A differential air pressure sensor shall be installed across each filter bank on the outside air units. When the differential pressure exceeds 0.8"wg (adjustable), then an alarm shall be generated indicating filter changing is necessary. Set exact alarm setting per the filter manufacturer's recommendations.
- 21.19 A manual reset low limit installed downstream of the heating coil shall stop the operation of the system if the discharge temperature falls below 38 deg F.
- 21.20 Unit safeties shall include low limit located prior to the cooling coil, high outside air duct static pressure and low exhaust duct static pressure. If the alarm is detected the system shall shut off and the outside air and exhaust air dampers shall close.
- 21.21 A smoke detector shall be located in each air stream. If smoke is detected, then the system shall shutoff and an audio/visual alarm shall activate. Upon correction of the problem, the system shall be reset and shall return to normal operation. Coordinate with Fire Alarm System.

**PART 22 – HOT WATER REHEAT COILS (SERVED BY OA-1):**

- 22.1 When there is a call for heating the NEW 2-way control valves shall modulate to maintain room setpoint.
- 22.2 The maximum discharge air temperature from the heating coil shall be 95 deg F (adj).

**PART 23 - OUTSIDE AIR HANDLING UNIT (OA-2/ CU-2 and OA-3/ CU-3):**

- 23.1 OA-2/ CU-2 and OA-3/ CU-3 major components as follows: a variable flow supply fan and exhaust fan, DX coil, electric heating element, face and bypass damper, condensing unit, outside air and exhaust air dampers. Coordinate with the test and balance contractor for to set the face and bypass damper at a maximum airflow across the coil of 60%. When the damper is full to the face of the coil it is 60% of the total airflow crossing the coil.
- 23.2 The system shall operate under the control of a local, stand-alone, microprocessor based DDC controller. The DDC controller shall be provided by the TCC.
- 23.3 Each system shall be placed into the occupied/unoccupied mode based upon the user adjustable schedule at the Network Control Panel. These systems shall be in the occupied mode during regular business hours only. The unit shall be off when scheduled as unoccupied and warm-up.
- 23.4 If communication is lost between the Network Control Panel and the Outside Air System Controller, then the Outside Air System shall be placed into the occupied mode until communication is restored.
- 23.5 In the unoccupied mode the supply/exhaust fan and energy recovery wheel shall be OFF and the outside/ exhaust air damper shall be fully closed. Heat Pump condensing unit shall be off.
- 23.6 When placed into the occupied mode, the following shall occur in sequential order:
  - 23.6.1 The energy recovery wheel shall be turned on, outside air damper and exhaust air damper shall fully open and be proved via end switch.

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23.6.2 Exhaust Fan Control: The TCC shall provide the VFD for the exhaust fan. The exhaust fan VFD shall be controlled to lag the supply fan by 10% (adj). The control contractor shall coordinate with the test and balance contractor to set fan tracking percentage. Engineer or commissioning agent shall be present for final balancing. The exhaust fan shall start and operation shall be proved via current sensor. Provide a 3 minute (adj.) time delay prior to starting the supply fan.

23.6.3 Supply Fan Control: The TCC shall provide the VFD for the supply fan. The supply fan VFD shall be controlled to maintain an initial 1" duct static pressure setpoint. Refer to plans for duct static pressure sensor location. The supply fan shall start and operation shall be proved via current sensor or status contacts on the VFD. DDC system determines VAV box with greatest damper open position once every ten minutes. Unit's supply air static pressure setpoint decreased by 0.1" WC if VAV box with greatest damper open position 65% or less; increased by 0.1" we if it's greater than 95%. Setpoint is reset between minimum and maximum setpoint of 0.5" and 1.5".

23.7 Each system will be placed into a Mode of Operation based upon the following adjustable temperature schedule:

<u>Outside Air Temperature</u>	<u>Mode of Operation</u>
65 deg F or greater (adj.)	Cooling Mode
Between 55 deg F and 65 deg F (adj.)	Economizer Mode
55 deg F or less (adj.)	Heating Mode

Note: if exhaust air dew point rises above 57 deg F, unit shall enter dehumidification mode

23.8 In cooling mode:

23.8.1 In the cooling mode, stage the condensing unit compressors to maintain 52 +/- 5 degrees off the cooling coil and the face and bypass dampers shall modulate to maintain discharge air temperature setpoint.

23.8.2 If the exhaust air dew point exceeds 57 deg F the unit shall enter dehumidification mode.

23.9 In the economizer mode:

23.9.1 If the outside air temperature is between 55 deg F (adj.) and 65 deg F (adj.), the heating shall be off and the DX cooling off. The discharge air temperature shall float until the system is placed in another mode of operation.

23.9.2 If the exhaust air dew point exceeds 57 deg F the unit shall enter dehumidification mode.

23.10 In the heating mode:

23.10.1 In the heating mode, when the outside air is below 55 deg F (adj.) the SCR electric heat shall modulate to maintain a heating element leaving air temperature of 95 deg F (adj.) and the face and bypass dampers shall modulate to maintain discharge air temperature setpoint.



23.10.2 The discharge temperature in the heating mode shall vary linearly. When the outside air temperature is 55 deg F (adj.) the discharge temperature shall be 65 deg F (adj.). When the outside air temperature is 0 deg F (adj.) the discharge temperature shall be 68 deg F (adj.).

23.11 Dehumidification Control:

23.11.1 In the dehumidification mode, the face and bypass dampers shall be full to the face of the coil, stage heat pump compressors to maintain 50 +/- 5 degrees off the cooling coil. Modulate the SCR electric heat to maintain discharge air temperature setpoint

23.12 The system shall not start if any one component does not prove operation.

23.13 A differential air pressure sensor shall be installed across each filter bank on the outside air units. When the differential pressure exceeds 0.8"wg (adjustable), then an alarm shall be generated indicating filter changing is necessary. Set exact alarm setting per the filter manufacturer's recommendations.

23.14 A manual reset low limit installed downstream of the electric heating element shall stop the operation of the system if the discharge temperature falls below 38 deg F.

23.15 Unit safeties shall include low limit, high outside air duct static pressure and low exhaust duct static pressure.

23.16 If the alarm is detected the system shall shut off and the outside air and exhaust air dampers shall close.

23.17 A smoke detector shall be located in each air stream. If smoke is detected, then the system shall shutoff and an audio/visual alarm shall activate. Upon correction of the problem, the system shall be reset and shall return to normal operation. Coordinate with Fire Alarm System.

**PART 24 - TOILET EXHAUST (OA-3) AND LOCKER EXHAUST CONTROL (OA-3) CONTROL:**

24.1 OA-3: Exhaust air from Locker/ Toilet rooms shall maintain a constant flow. This shall be accomplished through the use of one modulating control damper and an AFD (air flow damper). (Refer to plans for locations of control dampers.) The modulating control damper shall maintain a airflow volume at the AFD. Set in conjunction with the test and balance contractor.

**PART 25 - OUTSIDE AIR VARIABLE AIR VOLUME (VAV) BOX:**

25.1 Outside air is provided to the zone through the ducted connection to the return air or directly to the space served.

25.2 If the zone is in occupied mode from the BAS, the damper shall open to provide design CFM to enter the heat pump return air stream or serve directly to the space.

25.3 In zones indicated on the plans, space occupancy sensors are installed by others, however, wiring shall be installed by the TCC from the sensor to a DDC controller provided by the TCC.

25.4 During the building occupied mode, when the space is occupied per the occupancy sensor, then the damper shall be opened to allow the design CFM to enter the heat pump return air stream or the space. The inlet flow ring shall be used to set this CFM. The

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outside VAV air damper shall be at minimum when the space is in unoccupied mode per the occupancy sensor status.

25.4.1 The following rooms outside air shall be controlled by occupancy sensors:

- Green Room – 158
- Multipurpose Classroom – 283
- Spinning Studio – 288
- Large Studio – 290
- Medium Studio - 295
- Racquetball Courts – 152 &154

25.5 Zones indicated are to be provided with a CO2 sensor and variable air volume (VAV) terminal box to control the amount OA introduced into the zone. Each VAV box has minimum and maximum set points. The outdoor air to the space is varied linearly between the minimum and maximum set points based on the space CO2 level. Refer to plans for minimum and maximum set points.

25.6 The CO2 algorithm shall be triggered on when the CO2 differential between indoors and outdoors reaches 700 ppm or greater.

25.7 The CO2 algorithm shall be triggered off when the CO2 differential between indoors and outdoors falls to 600 ppm or less.

25.8 When the CO2 algorithm is triggered on, the corresponding VAV box shall allowed to modulate open to its maximum position based on the following formula:

25.9 Use the Following Demand Control Ventilation Proportional Control Algorithm for the Fitness and Running Track

25.9.1  $C_i$  = Indoor CO<sub>2</sub> concentration level

25.9.2  $C_o$  = Outdoor CO<sub>2</sub> concentration level

25.9.3 Existing Gyms – 141=>  $V_{dcv}$  = 1775 CFM

25.9.4 MAC – 144=>  $V_{dcv}$  = 735 CFM

25.9.5 Gyms – 155=>  $V_{dcv}$  = 420 CFM

25.9.6 Large Studio – 290=>  $V_{dcv} = 200 + (1700 - 200) * ((C_i + 1,000) / (C_o + 1,950))$

25.9.7 Medium Studio – 295=>  $V_{dcv} = 125 + (1200 - 125) * ((C_i + 1,000) / (C_o + 1,950))$

25.9.8 Weight Fitness – 297 (Two VAV Boxes), =>  $V_{dcv} = 520 + (1900 - 520) * ((C_i + 1,000) / (C_o + 1,950))$

25.10 The corresponding motorized damper at the heat pump return air shall modulate with the VAV box position. When the CO2 algorithm is trigger off, the return air damper shall be 100% open. When the CO2 algorithm is triggered on, the return air damper shall modulate towards closed in conjunction with the VAV box position.

25.11 The above algorithm is based on CO2-based Demand-Controlled Ventilation Utilizing ASHRAE 62: Optimizing Energy Use and Ventilation by Schnell, Turner, Shim (TO-98-21-1).

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25.12 CO2 sensor shall wire to the OA VAV unitary controller serving the area.

**PART 26 – AIR HANDLING UNIT (AHU-1, 2A/ 2B, 3A and 3B) – VARIABLE AIR VOLUME:**

26.1 AHU-1, AHU-2A/AHU-2B (operate in tandem), AHU-3A and AHU-3B major components as follows: a variable flow supply fan, remote relief fan with isolation damper, chilled water coil, hot water coil, and separate minimum and economizer outside air dampers.

26.2 Supply Fan Control: The TCC shall provide the VFD for the supply fan. The supply fan VFD shall be controlled to maintain an initial 1" duct static pressure setpoint. Refer to plans for duct static pressure sensor location. The supply fan shall start and operation shall be proved via current sensor or status contacts on the VFD. DDC system determines VAV box with greatest damper open position once every ten minutes. Unit's supply air static pressure setpoint decreased by 0.1" WC if VAV box with greatest damper open position 65% or less; increased by 0.1" we if it's greater than 95%. Setpoint is reset between minimum and maximum setpoint of 0.5" and 1.5".

26.3 Relief Fan Control: The TCC shall provide the VFD for the relief fan. The relief damper shall open the the relief fan VFD shall be controlled to maintain slightly positive building pressure. Initially this shall control to 0.01" (adj). Relief fan points shall be wired to the controller for the associated air handling unit.

26.4 Occupied ventilation mode:

26.4.1 The minimum outside air damper shall open only when scheduled occupied in the ventilation schedule.

26.4.2 The return air damper shall modulate to maintain design minimum outside setpoint as indicated at the Ebtron airflow measuring station. The return air damper shall have a field calibrated minimum position determined when all the VAV terminal units are at minimum position, the return damper shall be limited to the minimum position to insure the minimum outside air is maintained.

AHU	MIN OA duct size	MIN OAAE	FPM Range	Ebtron AFMS	#Probes/# Sensors	Mounting Style
1	20x16	1700-2275	675-1020	GTC116-P+	2/3	Insertion
2A/2B	36x22	3830-6500	696-1180	GTC116-P+	1/8	Insertion
3A	24x20	1850-3400	555-1020	GTC116-P+	2/3	Insertion
3B	24x14	1270-2070	550-887	GTC116-P+	1/6	Insertion

26.4.3 Refer to AHU schedules for minimum outside air settings.

26.5 Unoccupied ventilation mode:

26.5.1 The minimum outside air damper shall closed and return air damper open.

26.6 Supply Air Temperature Controls: A duct mounted, discharge air temperature sensor shall control the unit's 2- way chilled water valve (AHU-1, AHU-2A/ AHU-2B, AHU-3A) and 3-way chilled water valve (AHU-3B), 2- way hot water valve(AHU-1, AHU-2A/ AHU-2B, AHU-3A) and 3-way hot water valve (AHU-3B), return and relief dampers and outside air economizer damper.

26.7 When cooling is required, and the outdoor air temperature is above 65 degrees F

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(adjustable), the 2-way/3-way chilled water control valve shall modulate as required to maintain 55 degrees F (adj.) supply air temperature. The minimum outside air damper shall be open, economizer damper closed, relief air dampers shall be closed, and the return air damper shall modulate to maintain minimum outside air.

- 26.8 When cooling is required, and the outdoor air temperature is below 65 degrees F (adj.), economizer outside air damper, and return air damper shall modulate as required to maintain 55 degrees F (adj.) supply air temperature. The minimum outside air damper is open. Normally under this condition, the chilled water 2-way or 3-way control valve shall be closed, however, if further cooling is required, the 2-way or 3-way chilled water control valve shall modulate as required.
- 26.9 When heating is required to maintain the supply air temperature at 55 degrees F (adj.), then the 2-way hot water control valve shall modulate as required to maintain 55 degrees F (adj.) supply air temperature. The relief air damper and economizer damper shall be closed, the minimum outside air damper shall be open and return air damper shall be modulate to maintain minimum outside air CFM.
- 26.10 Discharge Air Reset: When the outside air temperature is below 55 degrees. The discharge air temperature is reset to from 55 degree to a 60 degrees (adj) . If any zone is unable to satisfy the cooling set-point within 2 degrees (adj) the discharge air will be reset to 55 degrees until the space is satisfied.
- 26.11 Mixed Air Temperature Control: Modulate the minimum outside air damper to maintain a minimum mixed air temperature of 45 degrees (adj.).
- 26.12 Freeze Protection: A low limit temperature sensor shall be located on the upstream side of the chilled water coil. If a temperature of 40 degrees F (adjustable) or less is detected, then the outside air and relief air dampers shall fully close and the return air damper shall fully open, and an audio/visual alarm shall activate. Upon correction of the problem, the system shall be reset and shall return to normal operation. The freeze protection wire shall be serpentine across the entire face of the coil every six inches on center.
- 26.13 Smoke Shutdown: A smoke detector shall be located in the supply and return air stream. If smoke is detected, the supply and return fans shall de-activate and an audio/visual alarm shall activate. Upon correction of the problem, the system shall be reset and unit shall return to normal operation.
- 26.14 Over Pressurization Control: A static pressure sensor shall be located at the AHU supply air outlet and return air inlet, before any fire dampers. The return air sensor shall be located in the return air duct. If the pressure in the supply duct exceeds 3.5" W.G. (adj.) in the supply air duct or -2.0" W.G. (adj.) in the return air duct, the fan shall be de-activated. Upon correction of the problem, the system shall be reset and unit shall return to normal operation.
- 26.15 Filters: A differential air pressure sensor shall be installed across the filter bank. When the differential pressure exceeds 0.7"wg (adjustable), then an alarm shall be generated at the front-end PC indicating filter changing is necessary. Set exact alarm setting per the filter manufacturer's recommendations.

#### **PART 27 - VARIABLE AIR VOLUME (VAV) BOX:**

- 27.1 The box shall have a pressure independent control system.
- 27.2 A wall mounted thermostat shall control the VAV box.

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- 27.3 When cooling is required, the variable air inlet damper shall modulate between the minimum cooling and maximum cooling air flow rates to maintain room air temperature setpoint. The 2-way hot water control valve shall be closed.
- 27.4 When heating is required, the variable air inlet damper shall be in the minimum heating air flow rate position and the 2-way hot water control valve modulated to maintain room setpoint.
- 27.5 Primary air CFM shall be monitored by the DDC control system.
- 27.6 All VAV boxes with reheat shall be provided with discharge air temperature sensor.
- 27.7 During the occupied mode, all VAV boxes serving a single zone shall have occupancy sensor control, if the occupancy sensor detects no occupancy in the rooms supplied by the VAV box, the unit shall operate in a standby mode. The cooling mode the temperature will be allowed to rise to 3 deg F (adj.) and in the heating mode the temperature will, be allowed to fall to 3 degrees F (adj.). Occupancy sensor to be provided by electrical contractor with 2 sets of contacts for BAS monitoring.
- 27.8 Standby Mode / Demand Control Ventilation:
  - 27.8.1 During the occupied mode, the space is unoccupied per the occupancy sensor; the VAV shall close and reset space temperature setpoint to standby mode. Standby mode setpoint shall be 3 deg F (adj.) above occupied cooling and 3 deg (adj.) below occupied heating temperature setpoint. When the space reaches the standby temperature the box shall modulate open to maintain the standby temperature setpoint.
  - 27.8.2 The minimum outside air CFM shall be reduced per the following table: AHU-1- Minimum Outside Air- 2,275 CFM

Room	CFM
112	575 CFM

AHU-2A/2B Minimum Outside Air- 6,500 CFM

Room	CFM
208	360
210	360
212	360
214	360
215	310
243	230
245	150
249	120
250A	120
250C	120
250D	180

AHU-3A Minimum Outside Air- 3,400 CFM

Room	CFM
350	280
352	230
353	340
365	350
375	350

AHU-3B Minimum Outside Air- 2,070 CFM

Room	CFM
314	200
316	300
318	300

**PART 28 - GEOTHERMAL HEAT PUMPS SEQUENCE OF OPERATION:**

- 28.1 Each unit shall operate under the control of a local, stand-alone, microprocessor based DDC controller field installed adjacent to unit.
- 28.2 Each unit shall be placed into the occupied/unoccupied mode based upon the BAS Time Schedule.
- 28.3 If communication is lost between the Global Time Schedule and the Heat Pump Controller, then the Heat Pump Controller shall be placed into the occupied mode until communication is restored.
- 28.4 A smoke detector shall be located in the return air stream of units greater than 2,000 cfm (5 tons and larger). If smoke is detected, then the system shall shutoff and an audio/visual alarm shall activate. Upon correction of the problem, the system shall be reset and shall return to normal operation. Coordinate with Fire Alarm System.
- 28.5 Space occupancy sensors are installed by others, however, wiring shall be installed by the TCC from the sensor to a DDC controller provided by the TCC. See plans for zones requiring occupancy sensor control.
- 28.6 Multiple sensors are to be implemented when a heat pump serves multiple or large spaces, such that not more than two spaces are represented per one sensor. Thus a heat pump serving 3 spaces shall have 2 room sensors. Programming shall be selectable between using the high, low or average value for controlling the heat pump serving multiple spaces.
- 28.7 During the unoccupied mode, the heat pump shall not operate unless the space temperature falls outside unoccupied set points.
  - 28.7.1 During the occupied mode, the space is unoccupied per the occupancy sensor, reset space temperature setpoint to temporary unoccupied mode. Occupancy sensor unoccupied mode setpoint shall be 3 deg F (adj.) above occupied cooling and 3 deg (adj.) below occupied heating temperature setpoint. After the space is unoccupied for 2 hours the setpoint shall automatically reset to the unoccupied heating and cooling set points.
- 28.8 During the occupied mode, the space is occupied based on room occupancy sensor, and the ventilation is ducted directly to the space. The valve shall be open and the associated heat pump compressor and fan shall cycle as required to satisfy space thermostat/ sensor set point. The units shall automatically change from heating to cooling. For two stage units, the fan/compressor shall cycle between high/low/off based on space demand. To prevent short

cycling a minimum of 5 minute delay when transitioning between heat and cool modes. Current sensor to monitor fan status.

- 28.8.1 During the occupied mode, the space is occupied based on room occupancy sensor, and the ventilation is ducted to the heat pump return. The valve shall be open and the associated heat pump compressor shall cycle as required to satisfy space thermostat/ sensor setpoint. The fan shall run continuous. The units shall automatically change from heating to cooling. For two stage units, the fan/compressor shall cycle between high/low/off based on space demand to prevent short cycling a minimum of 5 minute delay when transitioning between heat and cool modes. Current sensor to monitor fan status.
- 28.9 If the heat pump is unable to maintain space setpoint the supplemental SCR electric duct heater shall modulate to maintain space temperature setpoint. The following units shall have electric duct heaters, refer to plans for heater requirements:
- Green Room 148
  - Circulation and Social Area 160
  - Main Lobby 100.
- 28.9.1 Heat pumps VHP-120 and VHP-180 are provided with VFD supply fans. Coordinate with the manufacturer and TAB for low and high speed fan settings based on heat pump compressor staging.
- 28.9.2 The heat pump fan in the MAC shall run continuously to monitor temperature and return humidity.
- 28.9.3 The heat pump fan in the racquetball shall run continuously to monitor temperature. The unit shall be off when it is not activated by the building control panel or the occupancy sensor indicates both courts are unoccupied.
- 28.10 The heat pumps in the IDF closets (196D, 198E, IT132, 157D) shall maintain a maximum temperature of 80 deg F. When the building is scheduled unoccupied the building geothermal pumps shall be started if any of these room space temperature reaches 78 deg F (adj) to ensure system flow prior to the heat pump compressor staging on.
- 28.11 The dedicated valve shall be open and prove prior to starting the compressor. It is the responsibility of the control contractor to field wire the valve to the heat pump controller digital output and wiring for valve status. Valve shall be proven prior to compressor.
- 28.12 The TCC shall provide a wall thermostat or temperature sensor as noted on the drawings.
- 28.13 Dehumidification mode: Refer to plans for heat pumps provided with hot gas reheat. Upon zone humidity reaching maximum set point of 60% (adj.) the heat pump shall enter cooling mode with both stages/ compressors and the hot gas reheat shall maintain space temperature. When the humidity is 5% (adj.) below the maximum zone humidity set point then the heat pump will return to normal operation. Heat pumps without a zone humidity sensor shall be controlled based on return air humidity.
- 28.14 The heat pump fan shall run continuously for all heat pumps with the ventilation VAV terminal dampers to the heat pump return. Compressors shall cycle to maintain space temperature.
- 28.15 Console heat pumps shall operate on return air temperature control if thermostat is not indicated on plans.
- 28.16 In the occupied mode the Racquetball Courts heat pump fan shall run continuous and the heat pump shall be staged to satisfy return air temperature set point

28.17 The heat pumps in the GYMs shall operate as follows:

28.17.1 Units shall operate lead-lag.

28.17.2 During the occupied heating mode in the supply fans shall operate at high speed and run continuously. Compressors shall cycle to maintain space set point.

28.17.3 During the occupied cooling mode in the supply fans shall stage/ cycle as required to satisfy space thermostat/ sensor set point. Compressors shall cycle to maintain space set point.

28.17.4 The units shall be staged as follows:

Zone Served	Mode	Heat Pump Number
Gym 155	Cooling Stage 1	Upper Heat Pump- 1 <sup>st</sup> compressor
	Cooling Stage 2	Lower Heat Pump- 1 <sup>st</sup> compressor
	Cooling Stage 3	Upper Heat Pump- 2 <sup>nd</sup> compressor
	Cooling Stage 4	Lower Heat Pump- 2 <sup>nd</sup> compressor
Gym 155	Heating Stage 1	Lower Heat Pump- 1 <sup>st</sup> compressor
	Heating Stage 2	Lower Heat Pump- 2 <sup>nd</sup> compressor
	Heating Stage 3	Upper Heat Pump- 1 <sup>st</sup> compressor
	Heating Stage 4	Upper Heat Pump- 2 <sup>nd</sup> compressor

Gym 155 Notes:

1. If the thermostat located in weight/ fitness 281 has a call for cooling and the Gym 155 is in heating mode. The HVLV fans shall start and operate until the 281 thermostat is satisfied.
2. Provide an override at the Building control panel to disable the fans for events that do not allow fan operation. (ON-OFF-AUTO)

Zone Served	Mode	Heat Pump Number
Existing Gym North	Stage 1	Interior Zone Heat Pump- 1 <sup>st</sup> compressor
	Stage 2	Interior Zone Heat Pumps- 2 <sup>nd</sup> compressor
	Stage 1	Exterior Zone Heat Pump- 1 <sup>st</sup> compressor
	Stage 2	Exterior Zone Heat Pumps- 2 <sup>nd</sup> compressor
Existing Gym South	Stage 1	Interior Zone Heat Pump- 1 <sup>st</sup> compressor
	Stage 2	Interior Zone Heat Pumps- 2 <sup>nd</sup> compressor
	Stage 1	Exterior Zone Heat Pump- 1 <sup>st</sup> compressor
	Stage 2	Exterior Zone Heat Pumps- 2 <sup>nd</sup> compressor

Existing Gym Notes:

1. If the temperature sensor located at running track has a call for cooling and the Existing Gym is in heating mode. The HVLV fans shall start and operate until the running track temperature is satisfied. The fan is required to be in AUTO mode at the building control panel.



## **PART 29 – NATATORIUM UNIT – DHU-1:**

- 29.1 The natatorium air-handling unit shall be placed into operation by the factory provided stand-alone, microprocessor based DDC controller DDC system and shall operate continuously under its own factory control panel.
- 29.2 The TCC shall furnish and install interlock wiring to the Dry Cooler and Circulating Pump.
- 29.3 When placed into the occupied mode, through the DDC system, the unit shall operate continuously. The exhaust air fan normally will be on. A current sensor shall prove each fan status. The outside air damper shall open to its minimum position per the plans and return air damper shall be open.
- 29.4 The unit shall be provided with LON protocol to communicate with the BAS and a CAT6 cable with IP address for the manufacturer to have remote access. The manufacturer communication cable shall be installed by the TCC.
- 29.5 The unit shall have the ability to heat the pool. Refer to the heating sequence of operation for details.
- 29.6 All operating and logic controls shall be factory-mounted and wired in the unit. Control sequences shall be designed specifically to control swimming pool environmental conditions.
- 29.7 Supply Air Fan: The fan shall run continuously. Due to the humidity control required in the pool space, only the outside air flow and space temperatures shall change modes. Monitor fan status
  - 29.7.1 Outside air control shall modulate the units motorized damper to switch from the scheduled airflow to zero for the occupied/unoccupied modes.
  - 29.7.2 A wall mounted temperature sensor and humidity sensor shall provide an input to the unit's control panel to maintain room setpoint at 84 degrees F (adj.) and 50 % RH (adj.)
- 29.8 Control system shall provide modulation of heat recovery/heating system by proportional control of dry bulb temperature, relative humidity, cold wall surface condensation prevention humidity reset and ventilation air volume.
- 29.9 Controls shall automatically operate heating, dehumidification and heat recovery system in response to greatest requirement and adjust unit outputs to maintain building conditions. Unit and controls shall be capable of providing full heating capacity to either air or water. Controls shall be capable of proportional control of heating and dehumidification by loading stages of compressor capacity as necessary. As building requirements are satisfied, unit shall unload and shut off compressors.
- 29.10 Minimum Outdoor Air Flow Control: In conjunction with the Test and Balance Contractor, set the minimum outside air position to obtain cfm minimum outside air. The exact damper setting shall be field adjusted.
- 29.11 Room Temperature Control: A space temperature and humidity sensor shall control the maintain setpoint of 84°F and 55% RH at all times. Setpoints shall be adjustable through the LON interface.
- 29.12 Temperature Indication: Provide air temperature indication in the supply and return ducts and entering/leaving air temperature to each water coil. Provide water temperature indication for water temperature to each coil.

- 29.13 Freeze Protection: A low limit temperature sensor shall be located on the downstream side of the gas fired heat exchanger. If a temperature of 40 degrees F (adj.), or less is detected, then the outside air and relief air dampers shall fully close and the return air damper shall fully open, and an audio/visual alarm shall activate at the main control panel. Upon correction of the problem, the system shall be reset and shall return to normal operation. The freeze protection wire shall be serpentine across the entire face of the heat exchanger every six inches on center.
- 29.14 Smoke Shutdown: A smoke detector shall be located in the supply and return air stream. If smoke is detected, the supply and return fans shall de-activate and an audio/visual alarm shall activate. Upon correction of the problem, the system shall be reset and unit shall return to normal operation.
- 29.15 Filters: A differential air pressure sensor shall be installed across the 30% filter bank. When the differential pressure exceeds 0.7"wg (adjustable), then an alarm shall be generated at the front-end PC indicating filter changing.
- 29.16 Provide all analog and binary control points as listed on the attached points list. If others are required to provide sequences, provide these points as required.
- 29.17 Unit shall provide the following functions:
- 29.18 Ventilation Mode: Provide outdoor ventilation air to satisfy minimum ventilation air requirements per equipment schedule.
- 29.19 Occupied/Unoccupied Control Mode: Microprocessor-based, 7-day, 24-hour operation controls manage the occupied/unoccupied mode operation during heating season. During unoccupied times the outside air dampers shall be closed to minimize the air-heating load.
- 29.20 Space Heating: Full proportional control of space dry bulb temperature shall be maintained by staging compressor loading of unit capacity, natural gas heat, with humidity override. Automatic mechanical heat recovery from pool room return air as required by building and water temperatures. Automatic switching and proportioning outputs for control of auxiliary air heating shall be performed.
- 29.21 Pool Water Heating: If the space temperature is at or above set point and the pool water temperature is below the set point; hot gas is directed to the pool water condenser when the compressor is running. At times when the pool water requires heat, the pool unit activates the main pool water heater. See schedule for amount of heat rejection provided by the pool water condenser.
- 29.22 Smart Pump Control for Pool Water Heating: The pump circulating water to the pool water condenser shall be deactivated by a signal from the dehumidifier control panel when the pool water condenser is not being used to heat pool water. This option requires the pool water temperature sensor to be shipped loose and field installed (by others) in a location where it can sense pool water temperature under all conditions.
- 29.23 Humidity Control: Full proportional control of humidity is done by staging unit capacity. The humidity controller energizes the compressor and directs hot gas to the air reheat condenser if the space requires heating or the pool water condenser if pool water temperature is below set point.
- 29.24 If dehumidification is required and the air/water temperatures are satisfied, then the hot gas is directed to the air-cooled condenser.

- 29.25 DX Cooling with Remote Air-Cooled Condenser: On a call for space cooling, the refrigeration system is energized. The return air passing through the unit's evaporator coil is cooled. The cooled air is delivered to the natatorium by the supply fan. The heat recovered by the evaporator and compressor is directed to the remote air-cooled condenser.
- 29.26 Condensation Prevention: Cold-Wall Temperature Sensor Humidity Reset Control: When the temperature of the interior surface at the wall sensor drops to within 5 degrees F of the dew point temperature of the space air, the relative humidity set point is offset downward. This condition causes the dehumidifier system to activate humidity control to lower the space dew point and hinder the formation of condensation on the cold wall or glass surfaces.
- 29.27 BAS Connection: The dehumidifier control panel shall be capable of direct connection to a Building Automation System. With proper connection to the Ethernet network, the dehumidifier shall appear as a native device. Coordinate interface with the TCC.
- 29.28 SAFETY (DISCONNECT) SWITCH: UL-approved, NEMA 3R, fusible, safety (disconnect) switch of appropriate voltage and current shall be supplied for the specified unit based on MOP of same. Safety (disconnect) switch to be field-mounted and wired by others.
- 29.29 Auto-reset faults:
- 29.29.1 Power failure.
  - 29.29.2 Blocked filter bank.
  - 29.29.3 Freezestat.
  - 29.29.4 Supply air temperature high limit.
  - 29.29.5 Pool water supply temperature above 120°F for 5 minutes.
- 29.30 Manual reset faults:
- 29.30.1 Blower failure.
  - 29.30.2 Refrigerant low pressure.
  - 29.30.3 Refrigerant high pressure.
  - 29.30.4 Microprocessor failure.
  - 29.30.5 Electrical overload.

**PART 30 – HIGH VOLUME LOW VELOCITY FANS:**

- 30.1 The BAS shall enable/ disable the fans refer to Building Control Panel. Provide analog output for speed control. Each fan shall be controlled independently from the control panel with a ON-OFF-AUTO modes.
- 30.2 When the fans are enabled the set point will automatically reset to 75 degrees (adj.) in the cooling mode.
- 30.3 Fans shall operate when the outside air is less than 40 degrees (adj).
- 30.4 The BAS shall receive a set of contacts from the fire alarm system to shutdown fans when provided an alarm from the Fire Control Panel. Wiring from the fire alarm contacts to the BAS panel is the responsibility of the TCC.

### **PART 31 – EXHAUST FANS:**

- 31.1 CEF-1: (Elevator Machine Room/ Electric Rooms): Exhaust fan shall operate via room mounted temperature sensor to maintain setpoint of 85 deg F (adj). The DDC system shall read the fan status via current sensor and indicate the fan operation and room temperature graphically.
- 31.2 EF-1: (Pool Chemical Storage): Exhaust fan shall operate continuously. The DDC system shall read the fan status via current sensor and indicate the fan operation.
- 31.3 EF-2: (Albright Center 2nd/3rd Floor Restrooms): Exhaust fan shall operate on the schedule for the AHU-2A, AHU-2B, AHU-3A and AHU-3B

### **PART 32 –ELECTRIC HEATERS (EH-1 & 2):**

- 32.1 Electric heaters shall stage to maintain space temperature setpoint of 65F. They shall be schedule enabled when the outside air is below 50 deg F (adj.)

### **PART 33 –EXISTING STAIRWELL ELECTRIC HEATERS:**

- 33.1 Electric heaters enabled/ disabled from the BAS. They shall be schedule enabled when the outside air is below 50 deg F (adj.).

### **PART 34 – GEOTHERMAL HEAT PUMP WATER LOOP CONTROL:**

- 34.1 The Geothermal Heat Pump Water Loop System consists of circulating pumps (P-7, P-8, P-9) associated pump VFD's. Controller for P-7 shall be on emergency power.
- 34.2 HEAT PUMP LOOP WATER DISTRIBUTION: The heat pump water distribution is accomplished by pumps P-7, P-8 and P-9. Generally two pumps are required to satisfy the building load; the third pump is for reserve. All three pumps shall operate on a lead/lag/ reserve basis. Lead/lag/ reserve operation shall rotate on a weekly (adjustable) basis. The lead/lag pumps shall be capable of operating if required by the demand. The pumps are to be variable flow and a variable speed pump controller unit (VFD) is provided by the the TCC contractor to control the speed of the pumps.
- 34.3 Two differential pressure sensors are located on the drawings to measure water differential pressure. This contractor shall provide all control wiring necessary for proper system operation. The differential pressure sensor shall be monitored by the unitary controller for the distribution pumps.
- 34.4 The heat pump controller shall continuously survey the two differential pressure sensors with independent setpoints. The differential pressure shall be set at 12 p.s.i. (adj.) for each differential pressure sensor. If the pump controller senses that if either differential pressure is below the pressure setpoint, the speed of the lead pump shall increase. If one pump rises above 80% (adj.), then two pumps are required to operate. The lag pump shall ramp-up and the lead pump shall ramp down to the same speed to meet the pressure setpoint. The pumps must operate at the same speed and their speed shall be increased/ decreased in tandem to maintain differential pressure setpoint. If both pumps are operating at 35% (adj.) or less and differential pressure setpoint is satisfied, then the lag pump shall shut-off and the lead pump shall increase speed to maintain differential pressure setpoint.
- 34.5 If no water flow is sensed by a pumps current sensor, then an alarm signal shall be generated and the lag pump shall be engaged. A thirty second time delay relay shall be provided for the pumps to prevent false alarms. After the cause of the alarm has been eliminated, the system shall be capable of resetting and re-establishing the lead pump.

- 34.6 If all circulating pumps are commanded on and fail, a signal shall be sent to disable all the heat pumps and alarm at the BAS.

**PART 35 – GEOTHERMAL LOOP ENERGY MONITORING:**

- 35.1 Install temperature sensors on the supply and return of the geothermal loop to the building to be trended at the BAS.
- 35.2 Install temperature sensors on the supply and return of the geothermal loop to the MOB to be trended at the BAS.
- 35.3 Install flow meters in the returns of the geothermal loop from the building to be trended at the BAS. Coordinate pipe diameters required before and after the flow meter with manufacturer.
- 35.4 Provide and install a packaged BTUH meter system for the geothermal loop serving the building. The BAS shall measure and record gpm, “peek” gpm with time and date, BTUs, instantaneous BTUH, “peek” BTUH with time and date & OA temperature.

**PART 36 – GEOTHERMAL FLOW METER ALARM AND EMERGENCY SHUTDOWN FOR MAKE-UP WATER:**

- 36.1 On the make-up water line, a two-way, two-position, normally open valve shall close if (after a time delay of 2 minutes) the make-up water continues flowing at a rate of 3 gallons per minute while the system switch is in the normal operating position. An alarm shall be sent to through the DDC system. An audible alarm mounted on the control panel (mounted very near the make-up network) shall sound and an indicator light will provide visual indication of a problem. A momentary push button on the panel shall be used to silence/acknowledge the alarm and reset system for normal operation after any necessary repairs are made. A switch mounted on the panel shall be used to shut down the alarm while normal system fill operations are performed. This switch and all panel mounted devices are to be appropriately labeled. Provide and coordinate installation by mechanical contractor the valve and ONICON Model F-1310 Inline Turbine Flow meter. Flow meter to be 1 inch union body, scaled 0-10 GPM range is 0-10 volt output.

**PART 37 – CHILLED WATER SYSTEM (EXISTING PUMPS P-5/P-6):**

- 37.1 Chilled water is provided by the Central Chilled Water Plant. Local pumping is accomplished through 2 existing Lead-Standby pumps. Building shall utilize existing chilled water pumps with VFD's. The BAS shall provide start, stop, status and speed control for the existing pumps.
- 37.2 A differential pressure sensor shall be installed at AHU-3B. If the differential pressure at AHU-3B drops below 5 psi. (adj.). The secondary pumps VFD's will increase flow to achieve minimum setpoint.
- 37.3 Install the packaged BTU meter system including supply and return water temperature sensors and water flow meter. Install per manufacturer's recommendations and maintain minimum pipe diameters before and after flow meter.
- 37.4 Set up for the DDC system to provide monthly chilled water energy consumption is “KBTUH” format.

**PART 38 - HOT WATER HEATING SYSTEM WITH VARIABLE FLOW PUMPING SYSTEM (EXISTING PUMPS P-1/P-2/P-3/P-4):**

- 38.1 The hot water system consists of existing steam-to-hot-water heat exchanger, and existing

hot water pumps with VFD's.

- 38.2 There are two hot water distribution loops for the heating equipment in the system. The pumps serve the perimeter fin tube pumps (P-1/P-2) with VFDs and existing pumps (P-3/P-4) serves with VFDs HVAC hot water reheat. One pump is required to satisfy the existing reheat building load and one pump is required to satisfy the fin tube heating loads.
- 38.3 The BAS shall provide start, stop, status and speed control for the existing pumps.
- 38.4 Existing Pumps P-3 / P-4: A differential pressure sensor shall be installed at AHU-3B. If the differential pressure at AHU-3B drops below 5 psi. (adj.). The VFD will increase/decrease flow to achieve minimum setpoint. . The actual differential pressure setpoint shall be field determined in conjunction with the Test and Balance Contractor.
- 38.5 The perimeter fin tube heating pump shall start when the outside air is less than 32 deg F. (adj). The 3-way valve shall modulate to maintain a linear reset schedule of 100 deg F hot water supply temperature at 0 deg F (adj.) and 80 deg F (adj.) hot water supply temperature at 32 deg F (adj.). Reset supply water temperature linearly between these temperature ranges. This reset schedule shall be fully adjustable at the host computer.
- 38.6 The BAS shall control the existing steam valves.
- 38.7 The control of the hot water supply temperature via the steam heat exchanger shall be via an inverse/reset schedule. The steam control valves for the heat exchanger shall maintain hot water supply temperature. The heat exchangers two steam control valves are piped in parallel. Valves are 1/3 and 2/3 of scheduled steam capacity. Supply water temperature shall be 180 degrees F (adjustable) when the outdoor air temperature is 25 degrees F (adjustable) or less. When the outdoor air temperature is 65 degrees F (adjustable) or greater, the supply water temperature shall be 140 degrees F (adjustable). Reset supply water temperature linearly between these temperature ranges. This reset schedule shall be fully adjustable at the host computer.
- 38.8 If the building is in morning warm-up mode, then the heat exchanger supply water temperature shall be reset to 180 deg F (adj.), until the average temperature in the building reaches 68 deg F (adj.). Once the average temperature is reached, the water temperature shall be controlled via the inverse/reset schedule previously specified.
- 38.9 The two existing boiler emergency shutoff buttons located by the mechanical room exits shall remain and stay in operation. Verify operation and notify owner is repairs are required
- 38.10 If no water flow is sensed by a current sensor at the pumps, then an alarm signal shall be generated and the lag pump shall be engaged. A thirty second time delay relay shall be provided for the hot water pumps to prevent false alarms. After the cause of the alarm has been eliminated, the system shall be capable of resetting and re- establishing the lead pump.
- 38.11 Set up for the DDC system to provide monthly steam consumption (steam meter) in "KBTUH" format.

#### **PART 39 – POOL WATER HEATING:**

- 39.1 The existing pool is heated via the existing hot water boiler/heat exchanger and the new Natatorium HVAC Unit (DHU-1).
- 39.2 These systems shall maintain the pool water temperature at 82°F. Pool recirculation pump status is on from the VFD contacts prior to enabling pool heating.

- 39.3 Stage 1: When the Natatorium HVAC unit (DHU-1) is operating in pool water heating mode, this shall be the first stage of water heating for the pool. The associated new Pump P-10 shall operate. If this unit cannot maintain setpoint, 82°F (adj.) the hot water system shall be allowed to operate. If no water flow is sensed by a new differential water pressure sensor at P-10, then an alarm shall be generated at the DDC system.
- 39.4 Stage 2: From the Pool Boiler B-1, integral pump shall deliver 140°F to the existing "Pool Water Heat Exchanger".
- 39.5 120°F is the allowable discharge setpoint to protect the plastic piping. If no water flow is sensed by a new differential water pressure sensor at P-10, then an alarm shall be generated at the DDC system.
- 39.6 Provide wiring to high limit and pool water temperature sensor.
- 39.7 BOILER OPERATION
- 39.8 Whenever the boiler is activated, the integral hot water pump shall be activated. The pump shall be started/stopped thru interlock to the boiler. Provide flow switch in the boiler supply. Locate flow switch in horizontal piping and coordinate location with mechanical contractor.
- 39.9
- 39.10 Heater shall be electrically interlocked with sample flow cell and main pool circulation pump to initiate normal shut down sequence upon being signaled.
- 39.11 The control contractor is to provide a boiler emergency shut off button located by the boiler room exit as indicated on the drawings, and in accordance with Paragraph HG-634, Article 6, Section 4 of the ASME Heating Boiler Code. Provide with cover and label "Boiler Emergency Shut Down". The activation of this switch shall shut down the gas trains to the boiler. The push buttons shall be "Red Mushroom" type to avoid any confusion with light switches.
- 39.12 Whenever the boiler is operating, one pump shall operate. The pump shall be selected at the BAS.
- 39.13 Provide water temperature sensors in the hot water supply and return to the hot water pipe mains serving the pool.
- 39.14 Provide hot water system supply/return water temperature indication thru DDC system.
- 39.15 The TCC shall wire safety switches to the boiler control panel.
- 39.16 The control contractor is to provide a boiler on/off switch located by the spa. Provide with cover and label "Pool Shut Down". The activation of this switch shall shut down the heating from the boiler.
- 39.17 Furnish and install the pool pump VFDs VFD-PP1 / VFD-PP2 / VFD-PP3 and provide interlock wiring to the pool control panel provided by others.

#### **PART 41 - HEAT PUMP SPA HEATING SYSTEM**

- 41.1 The heat pump spa water heating system for the spa consists of the following equipment:
- 41.1.1 HPC-1 & HPC-2 Geothermal heat pump.
- 41.1.2 Hot water circulating pumps (P-11/P-12).

- 41.2 The system shall operate under the control of a local, stand-alone, microprocessor based BAS controller field installed adjacent to units. If communication is lost between the BAS and the Controller, then the Controller shall be placed into the occupied mode until communication is restored.
- 41.3 When placed into the operation, the following shall occur in sequential order prior to starting air handling system:
- Spa pool recirculation pump status or the spa jet pumps is on from the VFD contacts.
  - HPC-1 Lead Geothermal valve shall open and be proven.
  - HPC-1 Lead Hot Water Pump shall start and operation shall be proven via current sensor. If no water flow is sensed by a current sensor at the pump, then an alarm signal shall be generated
  - HPC-1 shall start and operation shall be proved via leaving water temperature.
  - The system shall not start if any one component does not prove operation.
  -
- 41.4 Once set point of 104 deg F spa return water temperature is reached, the HPC's shall stage on/off as specified.
- 41.5 HPC-1 shall start and operate based on return water temperatures according to the following schedule:
- HPC-1 – Compressor stages 1  
HPC-2 - Compressor stages 1 & 2 (lead/lag) Heating Mode of Operation:  
Return Water Temperature Compressor Stages  
Above 103 deg F (adj.)HPC-1  
103 deg F (adj.) to 102 deg F (adj.)  
HPC-1 & HPC-2 stage 1 Below 102 deg F (adj.)  
HPC-1 & HPC-2 stage 1 & 2
- 41.6 There shall be a 5 minute adjustable time delay before an additional compressor can be staged on or off. The return water temperature control shall be via a PID loop and the return water temperature percentage shall be used to stage the equipment and prevent short cycling.
- 41.7 If any one component of the system does not prove operation, then an alarm shall be generated.
- 41.8 There shall be a 5 minute adjustable time delay before an additional compressor can be staged on or off.
- 41.9 BTUH shall be calculated and trended at the BAS for the spa pool heating. The flow is constant and temperature sensors shall be located per plans in the HWS supply and return. The BAS shall display the peak gpm, BTUH and corresponding date, time and outside air temperature.
- 41.10 The DDC System shall monitor the Spa pool recirculation pump and spa pool jet pump status from the VFD.
- 41.11 Furnish and install the spa recirculation pump VFD and provide interlock wiring to the spa control panel provided by others.
- 41.12 Furnish and install the spa jet pump VFD and provide interlock wiring to the spa control panel provided by others.
- 41.13 The control contractor is to provide a HPC-1/HPC-2 on/ off switch located by the spa. Provide with cover and label "Spa Shut Down". The activation of this switch shall shut down heating from HPC-1/HPC-2.
- 41.14 Provide a high limit sensor downstream of the Spa Heater connection. If the water



temperature exceeds 105°F, the HPC-1 and HPC-2 shall be shut-down and an alarm sent.

**PART 42 – DRYER - LAUNDRY:**

- 42.1 The DDC system shall monitor the status of the dryers and the position of the 2-position make-up air damper.
- 42.2 The TCC shall interlock the dryer to open the make-up air damper. When the dryer is running the damper shall be open. If the dryer is ON and the damper does not prove open an alarm shall be indicated at the BAS and the dryer shall not operate.

**PART 43 - HEAT PUMP BUILDING DOMESTIC WATER HEATING SYSTEM**

- 43.1 The heat pump domestic water heating system for the building consists of the following equipment:
  - 43.1.1 DHP-1 and DHP-2 geothermal domestic water heaters.
  - 43.1.2 2-way valves
  - 43.1.3 DP-1 domestic hot water circulating pumps.
- 43.2 Whenever a unit is activated, its respective geothermal dedicated in-line pump shall be ON and hot water circulating pump shall be activated. The configuration is as follows:
- 43.3 Each system shall operate per the following:
- 43.4 If any geothermal domestic water heater is not required to operate, the associated geothermal dedicated in-line pump shall be OFF and domestic water circulating pump shall be off.
- 43.5 When placed into the occupied mode, the following shall occur in sequential order prior to starting the outside air systems:
  - 43.5.1 The lead geothermal dedicated in-line pump shall be ON prior to starting of DHP units.
  - 43.5.2 The lead water heater shall start as required and operation shall be proved via leaving water temperature.
  - 43.5.3 If any one component of the lead system does not prove operation, then the lag system shall active according to the same sequence and an alarm shall be generated.
- 43.6 Domestic hot water circulating pump shall start and operation shall be proved via current sensor.
- 43.7 The water heaters shall operate in a lead/lag sequence. Lead/lag operation shall rotate on a weekly (adjustable) basis. The lead unit shall be selected by the DDC system.
- 43.8 The DDC System shall monitor domestic hot water storage tank temperature.
- 43.9 Water Heating Mode of Operation:

<u>Storage Tank Water Temp</u>	<u>Lead HPC</u>	<u>Lag HPC Above 120 deg</u>
F .....	All compressors off .....	All compressors off
110 deg F – 120 deg F .....	Comp #1 on .....	All compressors off
Less than 110 deg F .....	Comp #1 on .....	Comp #2 on

- 43.10 There shall be a 5 minute adjustable time delay before an additional compressor can be staged on or off.

**PART 44 - DOMESTIC WATER BOOSTER PUMP**

- 44.1 The DDC System shall monitor BP-1 status, domestic hot water inlet and outlet pressure.

**PART 45 – SUMP PUMPS**

- 45.1 The DDC System shall monitor elevator and pool foundation drainage status and alarm.

**PART 46 - THE ELECTRICAL SWITCHGEAR/POWER INTERFACE:**

- 46.1 The electrical switchgear shall be monitored through the DDC system via Modbus communication protocol.

Refer to M5.3

Point Name	Hardware Points				Software Points					Show On Graphic
	AI	AO	BI	BO	AV	BV	Sched	Trend	Alarm	
Current Phase A					x			x		x
Current Phase B					x			x		x
Current Phase C					x			x		x
Current Neutral					x			x		x
Voltage A-B					x			x		x
Voltage B-C					x			x		x
Voltage C-A					x			x		x
Voltage A-N					x			x		x
Voltage B-N					x			x		x
Voltage C-N					x			x		x
Real Power - kW					x			x		x
Apparent Power -					x			x		x
Power Factor					x			x		x
Frequency					x			x		x
Real Energy - kWh					x			x		x

**PART 47- BUILDING CONTROL PANEL**

- 47.1 The TCC shall provide recessed stainless steel panel with ON-OFF AUTO switches for building control. The building control panel shall provide an override for the items indicated. The panel is to be located at check-in. Coordinate final location with architect and owner. Shop drawing must include the letter font, colors, and switch cut sheets. LED indicator lights for engineering and owner approval. Refer to mechanical details for panel layout. The switches shall include the following:

- 47.1.1 Each court HVLV fan or fans with ON-OFF-AUTO switch. Coordinate court naming with owner.

- ON-override ON
- OFF- override OFF
- AUTO-The fan will run when called for by the BAS sequences

47.1.2 Lighting ON-OFF-AUTO

- ON-override ON
- OFF- override OFF
- AUTO-The fan will run when called for by the Occupancy Sensor

**PART 48 – EMERGENCY GENERATOR:**

- 48.1 The generator shall be provided with a Modbus Interface. The BAS shall monitor the attached points through the BAS.
- 48.2 Provide gas meter and monitor gas consumption from the emergency generator at the BAS.

**PART 49 – UTILITY METERS:**

- 49.1 Provide gas meter and monitor gas building usage and totalize consumption at the BAS.
- 49.2 Provide chilled water meter and monitor chilled water usage and totalize consumption.
- 49.3 Provide domestic water meter and monitor water usage and totalize consumption.

**PART 50 – LIGHTING CONTROLS SYSTEMS:**

- 50.1 The TCC will be responsible for a LON communication trunk to three (3) lighting control panels. Verify communication protocol with electrical contractor.
- 50.2 There are 3 lighting control relay panels with a maximum 16 lighting relays. The TCC shall map the control of the lighting circuits to the BAS.
- 50.3 Provide number of relays as follows:
  - Relay Panel LRL1A (Main Electrical Room 157E) – 8 Relays
  - Relay Panel LRL1B (Electrical Room 196E) – 5 Relays
  - Relay Panel LRL1C (Electrical Room 198D)- 11 Relays
- 50.4 The TCC is responsible for lighting monitoring and enable/ disable of the occupancy sensors in the following locations:
  - Large GYM
  - Small GYM
  - MAC
  - Racquetball courts 1 and 2
- 50.5 The building control panel will provide ON-OFF-AUTO control for the lighting.
  - ON-override ON
  - OFF- override OFF
  - AUTO-The lights will run when called for by the Occupancy Sensor
- 50.6 Provide a full graphic page of the building and site lighting zones, indicating the different zones that can be scheduled. A graphic “light bulb” located in the specific area shall indicate whether lights are on or off. The each zones shall be independently scheduled. Refer to electrical plans E6.4 and E6.5.

**PART 51- VITAL SIGNS (ALTERNATE 5):**

- 51.1 The following vital sign pages generated/created by a Computer Graphic Artist sub-contracted by this Contractor shall be displayed. The quality of graphics shall be equivalent to the energy dashboard by Quality Automation Graphics. Example:
- <http://qagraphics.com/energy-efficiency-education-dashboard.html>
  - <http://kes.siemens.greentouchscreen.com/>
- 51.2 The Vital Signs Page shall be a flash or equivalent interactive interfaced targeted toward students. The page shall be a embedded html page and all content shall be organized for future upgrades and shall reside on the school file server and/or BAS computer. Provide as I.P. Address for intranet and internet connectivity to provide real-time data display as all pages. Provide Gateway interface coordinated with BAS programming language.
- 51.2.1 Energy Usage
- Title
  - Floor plan animated color graphic.
  - Instantaneous kW usage.
  - Calendar month kWh.
  - Calendar month energy cost → (kWh x\$0.06 (adj.)) = \$/month.
  - Cost comparison to District Average energy cost.
  - Monthly and yearly accumulative bar graph showing Utility kwh vs Solar PV kwh. Also subtracting the difference for Net Solar PV impact.
  - Outside air temperature & humidity.
  - Steam Usage
  - Chilled Water Usage
  - Domestic Water Usage
- 51.2.2 Geothermal HVAC System
- Custom color animated graphic with pumps, heat pump, ductwork, wellfield, building section.
  - Wellfield supply/return.
  - Heat transfer to earth-(BTU meter).
  - Outside air temperature and humidity.
- 51.2.3 Spa Heating System
- Custom color animated graphic with pumps, heat pump, piping, etc.
  - Spa Water supply/return temperatures
  - Heat pump HPC -1 supply/return temperatures
  - Heat pump HPC -2 supply/return temperatures
  - Heat transfer (BTU calculated).
- 51.2.4 Pool Heating System
- Custom color animated graphic with DHU-1, Boiler, pumps, piping, etc.
  - Boiler - supply/return temperatures
  - DHU-1 supply/return temperatures
  - Pool Water supply/return temperatures.
  - Heat transfer (BTU calculated).
- 51.2.5 Green Tips
- Main index thumbnail page with touchable thumbnail links to each page 20 tips in total. The 20 graphics pages with navigation links back and to main index page. Owner to provide Powerpoint of the Green tips for use by the contractor

## **Division 26: Electrical**

The following section describes the overall infrastructure strategy, as well as general preferences for the electrical systems currently used throughout campus. Anything deviating from the following guidelines shall be coordinated with the NKU project manager.

Electrical contractor shall obtain all permits, and licenses, necessary for any or all parts of the work from the authorities governing such work. Evidence that such permits have been issued shall be furnished to the project manager before beginning work and during ongoing work as applicable. Electrical contractor is responsible for paying all required inspection fee costs associated with their scope of work, and they shall include these inspection fee costs in their bid price.

### **Campus Infrastructure for Electrical:**

NKU receives Duke Energy's primary power feed at a single campus substation, which is located at the corner of Kenton and Campbell Drives. At this substation, Duke has the capability to provide (2) separate primary feeds for NKU, and Duke Energy's names for these primary feeds are "KY University 41" and "Marshall 41". The "KY University 41" feeder serves as the primary with "Marshall 41" serving as the backup. However, NKU does not currently have the ability to automatically switch over to the backup feed, as there is no "reserved capacity" agreement in place with Duke Energy (as of Spring 2009). NKU must receive permission from Duke Energy prior to switching over to the backup feed.

The main campus 15KV switchgear is located just outside of Duke's substation fence (towards the south) and receives a primary feed from the Duke Energy substation for distributing power through a network of underground manholes for the most of the campus buildings. Refer to Division 33 for an overall campus view of this underground power infrastructure system. The Bank of Kentucky Center, Callahan Hall, and a collection of other small buildings/houses on the fringe of campus receive independent power feeds directly from Duke Energy.

At the main campus switchgear, NKU receive pulses from Duke's (2) main meters to monitor our overall campus load. These are tied into our Central Plant BMS system, but only to monitor peak campus load and NKU does not use info for any energy management function. Each door on the switchgear has a meter too, but we currently only use the meter monitoring the "Dorms" loop. This specific meter is slightly different than the rest, and NKU uses this meter to record the monthly consumption of this loop feeding the Dorms. All of the switchgear door meters have the capability to be tied into a computer system, but they are not networked into any other system yet.

The main campus distribution switchgear was completely replaced in the Spring of 2009, and a significant portion of the main underground cables were replaced in Summer 2009. The design team shall request a current copy of the campus riser from the NKU project manager. All campus buildings except the Central Plant, Ceramics and the Dorms are connected within a (2) loop design configuration (named "A" & "B"). This allows NKU to manipulate switch positions at various locations within the campus electrical infrastructure network in order to minimize outage durations when portions of campus need to undergo maintenance. The Central Plant, Ceramics, and the Dorms are all on independent "radial feeds", but a few changes were made during the switchgear replacement project of Spring of 2009 to help improve this situation. Namely, a 4- way switch was installed next to the first manhole to help manipulate the Ceramics and Dorm radial feeds when necessary for future maintenance activities. Also, one set of feeders running to the Central Plant was moved to the other side of the main switch within the main Central Plant electrical room. These changes, coupled with the design configuration of the new Switchgear, will hopefully help minimize outage durations for future maintenance activities.

The main campus loop voltages are 12,470 volts. Within the campus, underground power infrastructure system, each primary building service to the main switchgear is (3) separate #4/0 wires with a separate #2 ground wire (4 total wires, and NOT 3 triplex-style wires with a ground integrated with each wire). The following represents instantaneous meter readings observed for all of the loops served by the main campus distribution switchgear on November 24, 2009. These readings were taken prior to the construction of Griffin Hall.

The format is:

- Switch/Feeder Name
- #/#/# (A/B/C) phases (units are in amps)
- First row of values is maximum amps
- Second row of values is DMD amps

C-2 Ceramics 21/19/20  
15/12/13

Loop A 70/69/69  
54/55/53

Loop B 62/62/63  
50/48/48

P-1                      Powerplant (400A Fuse)  
299/264/323  
47/48/50

P-2                      Powerplant  
49/46/56  
15/16/15

Loop A 44/45/48  
36/34/38

Loop B 64/62/65  
51/48/51  
Dorm 22/25/24  
19/21/21

**Special Electrical Requirements (per KY State Electrical Inspector):**

- It is the Electrical Contractor's responsibility to contact the Kentucky State Electrical Inspector for all electrical inspections. All electrical work subject to concealment such as above ceiling, in-wall and below ground shall be inspected prior to concealment. A Master electrician highly familiar with the project shall be present for all electrical inspections and to sign and receive copies of inspections.
- All electrical wiring, devices and equipment shall be de-energized and will be properly Locked Out/Tagged Out by the electrical contractor except for testing purposes in order to prevent usage by end user until passing a Final Electrical Inspection. Only the Electrical Inspector can make exceptions as necessary in writing.
- All Electrical Contractors must have a valid active Kentucky Contractor's license and Master's license to perform work. A minimum of one Kentucky Electrical licensed person shall be on the work site at all times during performance of electrical work. Larger jobs may require more than one licensed person.
- Electrical Contractors shall supply a copy of all electrical inspections to the Construction Manager/General Contractor within 2 days of each inspection. Electrical Contractor must also identify any non-electrical violations from that inspection to the Construction Manager/General Contractor within this same 2 day period.
- All data/voice installations shall be completed and ready for inspection at the time of any Above Ceiling, In Wall, In Ground and Electrical Final Inspections.
- Certified lightning protection installers shall perform all work requiring or affecting lightning protection. Certification/Recertification documentation of lightning protections systems shall be provided to the electrical inspector and owner at the time of the Electrical Final Inspection.
- All installed electrical equipment/devices shall be listed individually and large electrical

equipment containing such listed devices shall be listed as an assembly by a certified testing laboratory.

- No electrical equipment/devices/raceways/wiring shall be abandoned and left in place unless approved by the owner for future use and then such shall be clearly tagged "For Future Use".
- All electrical circuits shall have a "wire" green grounding conductor pulled with them. No raceway shall be accepted as a grounding conductor. This includes any work using existing circuits, in which case a wire-grounding conductor (if not available) will be installed back to the applicable electrical panel and terminated on the grounding bar. If no grounding bar exists, one shall be installed.
- GFCI protection shall be used by all trades to protect all 120-volt tools and equipment during all phases of construction/renovation projects.
- All recessed fluorescent lighting fixtures (troffers) shall be independently and directly supported from the structure above with a minimum of 2 support wires, and shall also be attached to the ceiling with 4 listed clips or screws.
- MC or FMC raceways shall NOT be installed in new walls being constructed. Only EMT or Rigid will be accepted within walls. EMT and Rigid raceways shall be a minimum size of ¾ inch. Metal clad (MC) cable is acceptable for use in suspended ceilings as long as it is only a pigtail from a junction box to a lighting fixture.
- All Safety Switches, Electrical Panels, Switchboards, Control Panels, Meter Sockets and Motor Control Centers shall have clearly visible warning labels on their front side warning of Arc Flash Hazards.
- Any Electrical Panel ledgers affected by construction/renovation shall be replaced with newly typed updated ledgers.
- All wall/floor/ceiling penetrations shall be sealed and fire-stopped with material equivalent to the surrounding surfaces or fire caulked with approved material for fire-rated areas in accordance with the current edition of the National Electric Code 300.21.

#### **Electrical Raceway Requirements:**

- All electrical outlet and switch receptacle cover plates shall be stainless steel. Plastic is NOT acceptable.
- All electrical panels shall be clearly labeled to identify the specific circuit, electrical outlet, and/or room each breaker location feeds. Also, label each device as to the panel from which they are fed. Install mechanical identification to properly identify every system and its components.
- In all electrical closets, provide wire access troughs above all electrical panels between the top of the panel and the bottom of the distribution conduits. Refer to Griffin Hall electrical closets for a good example.
- All power receptacles and switch cover plates shall be clearly labeled with the source panel identification & circuit number on the face of the cover plates.
- All electrical wiring shall be placed within in ¾" or larger conduit, wireway, or raceway.
- Exposed raceway in finished areas shall be in 750 or larger wire mold.
- All conduits provided for data wiring shall be 1" or larger conduit, wire way, or raceway.
- All new floor boxes for above grade floor levels shall be W irem old Evolution (6 AT or 8 AT) Series Pok e-Thru, unless directed otherwise by NKU project manager. Specific floor boxes for installation within a slab on grade situation shall be coordinated with NKU project manager.
- In general, all necessary wire ways, cable trays, conduits, junction boxes, and rough-in outlet boxes necessary for data/communications wiring distribution shall be furnished and installed by the project electrical contractor. However, all the data/communications wiring, terminations, and face plates will be furnished and installed by a special data/communications wiring contractor hired directly and separately by NKU.
- Electrical contractor shall furnish and install all grounding/bonding required for all data/communications pathways (conduits & wire way/cable tray).
- Surface Metal Raceway shall be two piece type, base mounted with snap-on cover as manufactured by wire mold or equal. Raceway installation shall be in accordance with manufacturer's instructions using adapters and fittings specifically designed and manufactured for the raceway used.
- Except in mechanical/electrical rooms and data/communication closets, all conduits shall be

concealed unless otherwise specified and approved in writing by the NKU Project Manager. Conduits not concealed must be surface mounted metal raceway unless otherwise noted in the written exception. All conduit, wire mold and junction boxes (if not factory finished to match existing surface color), shall be painted to match existing surface except in mechanical/electrical rooms and data/communication closets.

- Liquid tight flexible metallic conduit shall be light gray in color (if left unpainted). It shall have seal tight fittings and shall be equal to American Brass "Sealtite" Type UA.
- Plastic conduit shall be high impact, high grade, self-extinguishing polyvinyl chloride (PVC) schedule 40, 90 deg. C, U.L. rated. Conduit fitting and elbows shall have the same requirements as the conduit.

### **Electrical Distribution Requirements:**

- As permitted by all applicable codes, the main building switchgear shall be designed to permit closed transition changeovers without kirk key interlock devices.
- All 15kv splicing shall only use the heat shrink polymeric splicing kit. The use of any pre-molded, cold shrink rubber splicing kits is unacceptable.
- Whenever possible, electrical rooms/closets should be stacked vertically, and all electrical panels shall be located inside the rooms/closets with no accessibility to the general campus community.
- At a minimum, provide a duplex power outlet (unless more power is specified) near every data drop location specified on the drawings. When 3 or more data jacks are provided at a data outlet location, provide an adjacent quad power outlet. This general rule of thumb applies to wall outlets as well as floor box locations.
- Provide (1) GFCI duplex outlet near the sinks in each restroom.
- Provide (1) GFCI duplex outlet every 30' on center in all new sections of underground tunnel.
- Provide a minimum of (1) exterior duplex power outlet at the building load dock area, as well as (1) exterior duplex power outlet along each building face. At each building entrance, provide a minimum of (1) exterior quad power outlet and (1) empty duplex rough-in box with empty conduit for future data or Audiovisual wiring.
- Corridor outlets shall be provided at a maximum spacing of 25 feet and each 120 volt receptacle shall be individually protected by a 20 amp breaker and GFI receptacle. In common areas with lounge/student seating and informal gathering space potential, more frequent outlets should be provided to facilitate the use of laptops and other portable electronic equipment.
- All Fire Alarm, Security Alarm, Communications Equipment, Elevator Controllers (minimum of 1 elevator per building), Life Safety (including emergency lights, exit lights and combination emergency\exit lights), Handicap Access, Mechanical and Electrical Room lights and receptacles, and other similar systems shall be supplied by emergency generator distribution panels. Note: Due to battery maintenance cost, do not specify battery backup emergency/exit lighting unless the University specifically requests this strategy in writing.
- All wiring shall be 98% conductivity copper. All buss and buss duct conductors shall be 98% conductivity tin plated copper. Aluminum or aluminum alloy connectors shall not be used on copper.
- Wire size, #12 AWG minimum for power circuits. All wiring shall have THHN insulation minimum for installation in conduit.
- Conductors #16 and larger, as well as all branch circuits, shall be stranded copper.
- Driven ground rods shall be 5/8" X 8'-0" copper weld.
- All panel boards shall have both neutral and ground bus separate. All panel boards shall use bolt-on breakers, only. Square D is the panel manufacturer most preferred by NKU.
- No plastic anchors are to be used to support electrical conduit and/or equipment. Use metallic expansion type anchors. Do not use lead anchors. No explosive type install anchors shall be used.
- Filtered/conditioned power and backup UPS shall be provided for all locations required by the project room data sheets.
- At all vending machine locations, provide 1 power duplex and "1D" (1 data jack) per vending machine unit.
- Standard mounting height of devices:



- Receptacles 18" A.F.F.
- Light Switches 48" A.F.F.
- Fire Alarm Manual Stations 48" A.F.F.
- Fire Alarm Horns 84" A.F.F. (If the audible appliance is combined with the visual notification appliance, provide both at 80" above finish floor.)
- Thermostats 48" A.F.F.

### **Electrical Interior Lighting & Lighting Control Requirements:**

- For interior lighting systems, explore the following options and coordinate final decisions for each project with the project manager:
  - Lutron is the lighting control system currently utilized in existing campus buildings. NKU's preference is for all new lighting control system platforms to be windows-based using a PC/server setup similar to Griffin Hall.
  - Where appropriate, design interior lighting systems with a programmed on/off schedule equipped with an override switch capability at main entry areas to allow occupants to operate the lights (as necessary) during programmed "off" times.
  - When appropriate, implement occupancy/motion detector type light activation devices.
  - Consult room data sheets for information about rooms where specialized dimming or banking of lights is requested.
  - Consider LED lighting whenever feasible.
  - Provide LED exit lighting.
- The University prefers 2'x4' or 2'x2' T-8 or T-5 (depending on budget considerations) fluorescent light fixtures. Where appropriate, other types of fixtures can be used, but all fixtures should be energy efficient. Specified light bulbs should be 3500K, Neutral Color Spectrum. The University is planning to standardize with the 735 bulb. The current standard recessed fluorescent light fixtures is: Cooper "RDI" Series (direct/indirect nominally 6" regressed depth, electrostatically baked on white painted enamel finish after fabrication, round perforated white steel center basket, 2 ballast for bi-level control, 277V, (3) Bx40 lamp)
- For classroom/lab/meeting/conference rooms, ensure that the presenter can conveniently adjust light levels from (or near) the podium, and ensure the lighting levels are glare-free in any rooms where desktop or laptop computers will be used.
- For lighting within new tunnel sections, provide lighting circuitry so that only every third light fixture remains on at all times. Design the circuitry so the other lights will be activated by occupancy sensors when someone enters the tunnel from either end.
- Lighting fixtures shall not be daisy chained between fixtures. For repair, maintenance, and trouble-shooting, the intent is to go directly to the appropriate J box and open up the connection versus going into another fixture.
- Every light in the building needs to be controllable by a lighting control system panel scene push button, conventional switch, or by an occupancy sensor. Whichever option is selected, control shall be located in the actual space containing the light. Under no circumstances shall any light in the building be left on 24/7/365 without controllability.
- All mechanical, electrical, custodial, and data closets should have a manual light switch for normal light operation. In addition, an occupancy sensor should also be included in these spaces to automatically turn off the lights if someone happens to leave the space without turning off the lights.
- All light locations shall be carefully considered during design to allow easy access for future maintenance.
- If a room has more than one entrance, there should be lighting control at each entrance.

### **Electrical Exterior Lighting Requirements:**

- Ample exterior lighting is required to ensure safety of all pedestrian traffic, especially when walking through garages. There should be no dark spots in areas where students will need to walk.
- All new road and parking lot light poles/fixtures shall be Circa CR 20 or CR 25 (Gardco Lighting) to match the existing poles and fixtures along Nunn Drive and on the Welcome Center Garage site.

- All new smaller, pedestrian-path light poles/fixtures shall be B ega 8676P or 8101M H, which are both present on the Bank of Kentucky Center site. Coordinate exact models for specific new project application with NKU project manager.
- Vibration dampeners shall be included in all site lighting poles to avoid vibration stress failure of the pole standard itself. This can be provided as either a spring-mounted, stiff pendulum dampener mounted in the center of the pole or a chain dampening mechanism hung from top to bottom inside the pole.
- Typically, building exterior lighting, site lighting, parking lot, and parking garage lighting should be designed to operate as “on at dusk” / “off at sunrise” via a photocell. However, some darker locations within parking garages will require certain lights on 24/7, and this schedule shall be coordinated with the NKU Project manager. In 2008, NKU began an energy conservation program involving the complete closure of certain parking lots, garages, and other low traffic areas during holiday breaks and other low occupancy periods. The design team shall coordinate any special electrical feed requirements for various project areas to accommodate this energy conservation program.
- All exterior lights installed on the building should be equipped with a photo-cell activation device and must be accessible from a 10' ladder, or from inside the building.
- In-ground accent lighting should be avoided, as all such fixtures installed here have held water. Use a fixture which can be mounted above ground.

#### **Emergency Generator:**

- Provide a natural gas-fired emergency generator for each new building. Carefully locate the generator so the noise resulting from the weekly operating test does not disturb nearby, occupied spaces.
- Provide 20% extra design capacity in the emergency generator reserved for future loads.
- In addition to providing emergency power to all building code-required life safety systems, each project will likely involve building-specific needs to potentially design enough generator capacity to provide emergency power for the following, non-life safety items. Coordinate exact project-specific requirements with NKU project manager:
  - Main (Data) Distribution Facility room (MDF or ER)
  - Intermediate (Data) Distribution Facility rooms(s) (IDF or TR)
  - Any building-specific, isolated cooling units serving data rooms.
  - One elevator for a 2 hour minimum period after loss of power.
  - Main building air handling units (as applicable)
- The primary data network equipment housed within all building data rooms is increasingly becoming mission critical for the operation of the primary building systems. Other data, video, special networks, security access control network, lighting control, and other computer electronic devices/systems also tend to need the presence of emergency generator power as well. The design team shall coordinate the specific emergency generator power loads for each project with NKU project manager.
- The emergency generator control interface shall be tied into the Central Plant building automation system just like every other building on campus. This will provide the Central Plant operator the ability to remote start/stop and change the test/exercise schedule of the generator as appropriate. Once this capability is provided, the actual time clock on the generator can then be disabled.

#### **Other Miscellaneous Electrical Requirements:**

- During construction, cover all equipment subject to mechanical damage or contamination in any way.
- Provide utility markers inside buildings, structures and facilities to identify exposed and concealed utilities, including electric.
- All electrical equipment shall be UL listed for the application in which it is used.
- Do not provide any devices which contain mercury unless there is not a mercury free device on the market which will perform the same function.
- Motor efficiency shall be as noted below:

- 1-10 HP 91% minimum
- 10-15 HP 93% minimum
- 15-99 HP 95% minimum
- 100-199 HP 96% minimum
- Greater than 200 HP Greater than 96%.
- A specific motor efficiency should be selected for a particular project based on duty of motor. Efficiencies specified shall be according to US efficiency test protocol. Efficiencies shall be stamped on the motor nameplate.
- Combination starter/disconnects must be equipped with a factory disconnect micro switch and this switch must be wired into control circuit to de-energize the starter before disconnect opens.
- Provide power factor correction capacitors on induction motors of 10 H. P. or above.
- Provide a disconnect switch for each capacitor bank.
- All 3 phase electric motors, (5 Hp. and larger), shall be protected against single phasing.
- Transformers to be a minimum of 95% efficient. Acceptable manufacturers are TP-1 and Powersmith. Coordinate any alternate manufacturers with NKU project manager.
- All new buildings must have lightning protection systems specified per the governing building code and applicable NEC standards, including a properly documented grounding system. Lightning damage has been a problem in various campus buildings due to the high elevation of campus relative to the surrounding area.
- All buildings shall have ground rods and ground planes to meet the requirements of NEC 250 and also the grounding requirements of equipment within the building. All main ground points shall be meggered. If more than 5 OHMS, additional ground rods shall be driven. Additional ground rods shall not be less than 6 ft. apart.

## **Division 27: Communications, Audio Visual Systems, & NKU IT Standards**

The following section describes the overall infrastructure strategy, as well as general preferences for all the miscellaneous low voltage communication systems used throughout campus. This section shall be consulted and coordinated in concert with Division 28 (Electronic Safety, Security & Fire Alarm). Any deviation from the following guidelines shall be coordinated with the NKU project manager.

### **Campus Infrastructure for Communications:**

All new buildings shall be connected to the campus data and telephone infrastructure and networks. The main telephone demarcation point for the entire campus is located in the penthouse of Nunn Hall. The main data entry point is located in room 370 of the **Applied Science & Technology** building. The main feeds from these locations to the new project site should run through the existing campus underground tunnel system, whenever practical.

A campus map showing the distribution of existing communication infrastructure lines is available, and the new feed for each building project shall be designed to accommodate future growth in accordance with the current NKU Master Plan, whenever possible.

NKU typically prefers to separate out the data telecommunication wiring, cabling, and infrastructure equipment and solicit/award this scope of work as an Owner FFE bid package independent of the overall construction project managed by the Construction Manager. However, the design team shall still design the systems and provide drawings and specifications for this scope of work. The data/communication wire-installation contractor hired by NKU will be expected to adhere to the construction manager's coordination and safety requirements for the overall project.

Contractors shall have demonstrated qualifications to install and test a 1000BaseTX/FX intra/inter-building backbone. All station and riser cabling shall be tested and certified by the contractor to support 1000BaseTX/FX technology.

Refer to Division 26 Electrical more information regarding Emergency Generator requirements and preferences regarding Data & Communications networks.

### **General Communications Requirements:**

The NKU Department of Information Technology maintains a comprehensive set of standards for all new communication, phone and data wiring, cabling, equipment, and any other communication infrastructure necessary for installation in any NKU facility. The latest version of these standards is provided in their entirety at the end of this Division 27 section, and the following represents a **brief overview**:

### **Data/Communications Rooms:**

- In some older campus buildings, data and voice equipment and terminations are located in mechanical/electrical rooms, and sometimes within custodial closets or plumbing chases. With the proliferation and dependency of data/technology in recent years, these locations are obviously no longer acceptable. Provide a dedicated, secure data/communications room on each floor, and more rooms per floor when necessary.

### **Communications Distribution:**

- In general, all necessary wire ways, cable trays, conduits, junction boxes, and rough-in outlet boxes necessary for data/communications wiring distribution shall be furnished and installed by the project electrical contractor. However, all the data/communications wiring, terminations, and face plates will be furnished and installed by a special data/communications wiring contractor hired directly and separately by NKU.
- Electrical contractor shall furnish and install all grounding/bonding required for all data/communications pathways (conduits & wire way/cable tray).
- All data jacks are combination data/voice outlets. Where appropriate, such as offices, a combination data/voice/power faceplate should be used. In every case, there should be a duplex power outlet adjacent to the data/voice outlet.
- For offices, a minimum of (2) data drop locations shall be provided within each office on opposite walls. Each data drop "location" shall involve (2) data jacks, so there will be (4) total data connection jacks provided in each office.

### **TV System:**

- As of April 2009, NKU receives cable service from (2) different local service providers: Cincinnati Bell and Insight Communications.
- On campus, the main cable feed from Cincinnati Bell is located at the Nunn Hall penthouse, and this cable feed currently serves only the needs for the Student Union. The Callahan Hall dormitory, which is remote from main campus on Martha Layne Collins Blvd, also receives cable service from Cincinnati Bell, but this is an independent feed.
- The cable feed from Insight Communications serves University Center, Landrum Academic Center, Albright Health Center, Bank of Kentucky Center, and the older dormitories located at the northwest corner of campus (University Suites, Norse Commons, etc.).
- NKU has a channel (18) reserved on the standard Insight Communications lineup solely dedicated to Norse Media, which is a cable TV station produced by NKU's School of Communication. As of April 2009, the head end for Norse Media is located in Landrum Academic Center, so Insight provides a direct feed into Landrum, and also receives an incoming broadcast feed from the Norse Media head end in Landrum. However, the program for the new Center for Informatics building calls for relocating this Norse Media head end from Landrum over to the new building.
- If the project program requires commercial cable TV service (Fox News, CNN, ESPN, etc), the design team shall coordinate with the NKU project manager on which local cable provider (Cincinnati Bell or Insight Communications) makes the most sense for the new service feed.
- Refer to the project room data sheets for specific locations requiring cable TV outlets, but at a minimum, provide cable outlets in all classrooms, seminar and conference rooms.
- A Cable TV tuner is required if the TV receiving cable service does not have a digital tuner, or if the user desires high definition (HD) quality. As of Spring 2012, the current tuner provided by Cincinnati Bell is a Motorola set top box (model# DCX32007280/013)

### **Campus Clock System:**

- NKU employs a standard, campus-wide clock system linked and synchronized to a central repeater located in Nunn Hall.
- All new clock locations within new and renovated buildings shall be coordinated with the NKU project manager. Refer to the project room data sheets for specific locations requiring clock locations, but at a minimum, plan for them in all corridors, classrooms, seminar, and conference rooms.
- All clocks will be purchased separately from the project FFE budget. The standard clock is a 12.5" diameter, battery-operated clock (Model #14155C) with custom dial face. The batteries used are model #14885.

#### **Audio Visual Systems:**

- Coordinate exact Audio Visual requirements for the project with NKU project manager.
- NKU utilizes Crestron equipment and gear for controlling and driving all classroom and conference room Audio Visual systems.

#### **PREFERRED PRODUCTS & SPECIFICATIONS:**

- The following list specifies acceptable models of equipment in order to provide consistency and ease of support by NKU IT. Substitutions for discontinued items must be of the same manufacturer and be the current replacement for that model.
  - Spectrum Link Lectern 36" model with Heavy Duty Casters
  - Crestron Control System MP2E
  - Crestron 12-button Keypad control
  - Chief Universal mounting hardware compatible with projectors
  - TOA Integrated Mixer/Amplifier A-706
  - JBL Control23 Speakers Control23-WH
  - Sony DVD/VCR combo SLV-D370P
  - Mid Atlantic 9 Outlet Rack Mount Power Center PD-915R
  - Da-Lite 84"nominal diagonal projection screen manual
  - For classroom and conference room Audio Visual designs, the Amplifier specified should provide 60 watts for each pair of Speakers in the room (30 watts per speaker).
- The vendor is expected to be pro-active in advising NKU in the improvements of relevant AV technology and pricing in a timely manner, and to provide demonstration samples for testing and evaluation in actual use.
- All Audio Visual equipment specified shall be of current design and consist of standard products established manufacturers, carrying valid manufacturer's standard USA warranties.
- All items must be new. Used, including demonstrator equipment is unacceptable.
- The smart controls shall be designed to provide optimum usability for all controllable equipment. They shall imitate the design and functionality of Crestron 12-button type user interface for the University's existing systems.
- ADDITIONAL HARDWARE REQUIREMENTS: Additional requirements include extension cables from podium interior (equipment location) to podium surface to allow convenient plug-in of additional equipment; cable-pack to include two VGA (for desktop PC and laptop connections), composite video, S-Video, audio (for desktop PC and laptop), USB and Fire wire, connector plates, plugs, 20' cables, other required hardware, and installation to allow podium to be moved around the front of the room (i.e. "umbilical cord" with plugs at both ends, to connect podium equipment to wall for power, network, projector, and speakers.
- The following table represents the cable color standards utilized in the Griffin Hall construction for the Audio Visual systems. This is the closest NKU has to color cable standards for Audio Visual systems.

Signal Category	Cable Part Number	Signal Type	Color
<b>Video</b>			
	1855A	SDI (router to patch)	BLUE
	1855A	HD (router to patch)	YELLOW
	1855A	Pulse/Ref (router to	WHITE
	1855A	Tri-Level (router to	WHITE
	1694A	Analog	BLACK
	1694A	SDI	BLUE
	1694A	HD	YELLOW
	1694A	Pulse/Ref	WHITE
	1694A	Tri-Level	WHITE
<b>Audio</b>			
	9451	Analog Line Level	BLACK
	9451	Analog Line Level	BLACK
	1800B	110Ohm AES Channel	VIOLET
<b>Control</b>			
	8723	422	GRAY
	8723	232	GRAY
	82723	422 Plenum	GRAY
	82723	232 Plenum	GRAY
	1694A	DPS FS Crtl/RSWR	BLACK
	CAT6a	NETWORK	BLUE
<b>Intercom</b>			
	9451	2 wire	GREEN
	??	4 wire	GREEN

**See Attachment B for the NKU Technology Infrastructure Cabling Standards**

**See Attachment C for the Audio Visual System Standards**

### **Division 28: Electronic Safety, Security, & Fire Alarm**

The following section describes the requirements for properly integrating with NKU's existing campus electronic safety, security, and fire alarm systems. This section shall be consulted and coordinated in concert with Division 27 (Communications). Any deviation from the following guidelines shall be coordinated with the NKU project manager.

#### **Card Reader Access Control System:**

All card reader controlled access equipment specified for NKU buildings shall be compatible with the existing campus DSX Card Reader Access System, which is designed as a mag-stripe system programmed to read Track 2 only. Providing this same equipment for all new card readers is necessary to ensure the new card reader systems will be compatible with the existing campus card reader access system, as well as the university's current student/staff ID cards (NKU All- Card). Proximity-style reader systems are **NOT** compatible and are **NOT** permitted on any NKU projects.

The general preference for card reader installation is to power the controller via a hard wire electrical connection, especially for controllers serving doors under 24/7 security monitoring by NKU's Department of Public Safety (DPS). In other cases where card readers are installed for convenience access only, the controller can simply be plugged into a conventional wall receptacle (if necessary), but written approval from the NKU project manager is still required for this deviation.

The campus-wide card reader administration system is located on a central server in NKU's Maintenance Building; thus, a data connection is required for each controller location to link back to the central system administration server. Each card reader installation requires a specific NKU individual to act as the card reader "authority", who is responsible for granting access privileges for each individual card reader. The assigned NKU authority will provide the names and ISO numbers to NKU O&M for initial programming and access privileges.

The following represents the specifications required for ensuring all new card reader systems are compatible with the existing campus All-Card system:

1. Access card reader system must be DSX, and the system must read track 2 (Encoding can only be on the 2nd track of 3-track magnetic stripe).
2. Standard ABA encoding format
3. 16-digit ISO 2.
4. (4) digit expiration number
5. Cards are 60/40 composite
6. CR-80, 30 mil (standard)
7. 3-track high coercivity magnetic stripe
8. 2750 oersted
9. Sample encoding: ;6012670002392747=4912?
10. 22 gage, 9 wire (250' max reach)
11. Shielded cable from card reader to data closet
12. Wire from door strike back to data closet
13. Card Reader - DSX-MR-10
14. Panels – DSX 1048 Series
15. Network Communications – DSX-LAN

### **Fire Alarm System:**

During design, all fire alarm/suppression/prevention systems, layout, and overall site access will need to be reviewed by the Commonwealth of Kentucky's Department of Housing, Building, and Construction, as well as the local fire department (Central Campbell County Fire District) and NKU Safety & Environmental Compliance.

The fire alarm system for each building on NKU's campus is part of an EST-3 Class A network with monitoring stations located at the NKU University Police Dispatch Center and at the NKU Power Plant. NKU has a listed proprietary monitoring station and serves as its own fire alarm monitoring service utilizing EST FireWorks front ends at both monitoring stations. All panels must be EST-3 to maintain compatibility with the current system. The project specifications shall require fire alarm warranty service 24 hours a day, 7 days a week at no premium charge.

For connecting a new building fire alarm panel into the existing loop, the contractor shall coordinate with the NKU project manager, NKU IT and NKU Safety & Environmental Compliance to identify and locate the 2 panels/nodes that will be used for connection and the connection type. NKU's current fire alarm network is a blend of copper connections and single and multi-mode fiber optic connections. The preferred connection method is single mode fiber optics. For fiber optic connections, fiber will be supplied by IT cabling contractor for the project, type to be specified by NKU. For copper connections, the fire alarm contractor will be required to supply and run (4)-16 gage twisted, shielded pair from the new panel to the two identified panels. Copper connections will not be used if path is underground at any point. Regardless of connection type, all panels will have two EST fiber cards installed.

Within each building, the fire alarm annunciator panel shall be located as close as possible to the main building entrance and be easily accessible for firefighters. In buildings using fiber optics for the fire alarm networking, EST keypad part number KPDISP will be an acceptable remote annunciator.

All new panels shall be equipped with a feature to disable the outputs of the EST-3 panel. Disable buttons shall be segregated into the following functions: Elevator recall and associated functions; HVAC shutdown and related functions, fire door release, Audible/Visual outputs and pre-action sprinkler system(s) if

equipped. Alarm Silence shall be programmed so that the strobes remain active but the voice announcements cease.

All new initiating devices shall be intelligent and programmed accordingly. Duct Detectors shall be programmed as latching supervisory alarms. Locks on all fire alarm hardware will be keyed with EST Cat-45 key. All new audible indicating devices shall be speakers or speaker/strobes. All audio amplification shall be accomplished using only EST-3 amplifiers. If existing fire alarm panels are used, the proper boards shall be furnished to allow for intelligent devices and amplifiers for voice announcements. Fire alarm panels must also be tied into the mass notification system (Federal System UVIC) and programmed to turn off announcements and strobes and allow the mass notification system to transmit audio through the ASU to all fire alarm speakers.

New fire alarm panels shall be programmed such that they only display messages from the building in which they are installed. The FireWorks computers shall be programmed at both monitoring stations within 3 business days of a building's fire alarm being brought online on the campus network.

Programming the new fire alarm panel is a coordinated effort. Before the end of each day during programming, the contractor shall make sure that the updated data file is left at the Power Plant prior to leaving.

During construction, contractors shall closely coordinate with the NKU project manager whenever work could potentially trigger a false fire alarm. The fire alarm can usually be disabled with a 24 hour notice so as to avoid false alarms. The NKU project manager will notify the Power Plant and the NKU Police Department and let them know the details and schedule of the work.

#### **Emergency Call Boxes:**

NKU currently maintains a network of emergency call boxes across campus to ensure the safety of pedestrians during all hours of the day. The campus standard is the S-Series Mark III Wireless Call Box manufactured by Call24 Wireless Callbox Systems. Specific call box quantities and locations shall be coordinated with the NKU project manager during design. The preferred configuration is to provide a stand-alone pole and foundation independent of other structures or poles whenever possible.

The call boxes typically operate on 120V hard-wire power, but they can run on other power sources up to 277V with the addition of a small step-down transformer. The preference is to provide continuous "on" hard-wire power, but re-chargeable battery packs can be installed if the only practical power supply available is a site lighting circuit operating via "on/off" photocells.

No phone line is required, as the call box technology relies on a 2-way radio frequency for communication with the NKU Police Department when someone in trouble pushes the emergency button.

To ensure the proper location is relayed to the NKU Police Department when the button is pushed, a location description needs to be provided by the contractor for each call box when ordering the new call boxes. Each specific call box number and location description shall be coordinated with the NKU project manager prior to programming the computer chip for each box. Ideally, the location descriptions should be coordinated during design and included in the project specifications, but the NKU project manager can also coordinate the actual location descriptions with the contractor during construction. After installation, NKU will perform a push test at each box to ensure the NKU PD Dispatch receives the correct location description from each new call box.

#### **Panic Buttons (under counter & within elevators):**

Under counter, panic push-style buttons are typically required only for offices/spaces involving cash transactions, and/or high-traffic areas involving only a single worker. Currently, the panic buttons are wired via a copper telephone line, and the Department of Public Safety simply receives an alarm with the specific location. The required locations for all panic buttons will be provided in the project room data sheets.



Emergency "phones" (panic buttons) provided within elevators need to involve special coordination between the elevator contractor, the NKU project manager, and the NKU telecommunications department. All emergency buttons in existing campus elevators direct dial NKU's Department of Public Safety when the alarm button is pressed. When answering the trouble call, the DPS dispatcher immediately sees the NKU building code and specific elevator number, and the dispatcher can also immediately converse with the elevator occupant making the call. All pre-programmed elevator distress messages must be disabled.

### **Security Cameras:**

When required by the project room data sheets, security camera systems shall match the hardware/software requirements of the current campus system. Typical locations requiring security cameras include building entrances, loading docks, and some corridors near rooms containing expensive equipment.

At a minimum, provide security camera locations at each exterior building entry door, any egress-only exit door leading to the building exterior. Also provide a camera where the tunnel enters the building when a tunnel connection is provided. At entry/exit door locations, each security camera location, the camera should be mounted within the building and angled to capture the person's face/front side when entering the building.

The following represents a summary of the current campus security camera system requirements:

- DVR – Pelco 4600 Series, 16 Channel DVR w/1.0TB Hard Drive and RWCD, network capable
- Camera - American Dynamics Fixed Camera pack, Color, True Day/Night, auto iris; lens size, mounting and housing dependent on camera location. Camera model number is ADCDH3895C (with ADCMWALL as necessary).
- Accessories – Camera power supply, UPS capable of 4 hour back-up minimum, rack Mountable surge protector for any exterior cameras, supply rack system if one is not provided by owner.
- Provide conduit from all entrance door frames to a common 6"x6"x4" junction box mounted above the ceiling at the location for the building fire alarm enunciator panel for the future addition of a security panel. Connect the above ceiling junction box to the
- FMS panel with a one inch conduit.
- The central DVR system for this surveillance/security camera system can be located in whichever data/communications closet is the most practical (coordinate with NKU project manager).
- Other miscellaneous system notes:
- Install additional camera locations as indicated by project data sheets.
- One central DVR system can accommodate feeds from 16 cameras.
- Power to cameras is provided by wire running from the central DVR system to each camera location via Pelco MCS1610.
- From each location, provide a Siamese RG59-18/2 cable from the camera back to the central DVR unit. Right now, NKU does not use any IP-based (cat 5e or 6a) security cameras.
- All wiring/cabling must meet NKU IT standards.
- Contractor is responsible for all required permits and inspections.

### **Emergency Mass Notification System:**

NKU installed a campus-wide, emergency mass notification system in the Fall of 2008, and all new projects must be designed with all the necessary provisions for connecting into the existing system. The following represents a summary of the current campus notification system, which assumes an EST3 Fire Alarm Panel with audible speakers is installed:

- Federal Signal Corporation's UltraVoice controller (UVICU) shall be designed and installed by Federal Signal Corporation.
- The UVICU will be located as near as practical to the fire alarm panel.
- Power source needs and specifications to be provided by Federal Signal Corporation.
- Supervisory circuit and audio circuit will be provided to fire alarm service provider from the UVICU.

- Fire alarm service provider will provide Federal Signal Corporation any end-of-line resistors needed to monitor the supervisory circuit.
- Fire alarm service provider will make final termination at fire alarm panel and reprogram the system to disable all fire alarm strobes, horns and messages and allow audio from the UVICU to operate across fire alarm system speakers when the UVICU is activated for a warning.
- Fire alarm service provider will program fire alarm panel to auto-reset after a mass notification system activation when the relay opens and return to original status.
- All wires and termination points are to be labeled at both ends.
- All wiring/cablings must meet NKU IT standards.
- Contractor is responsible for all required permits and inspections.

### **Division 31: Earthwork**

Over the years, many buildings on NKU's main campus have developed problems resulting from expansive shale subsoil materials. The ability of underground water to reach pockets of expansive shale causes the shale to expand vertically, resulting in upward lift of floor slabs in various areas. In some cases, this is a significant problem. Efforts to arrest or mitigate the occurrence of this problem have seemingly met with little success. Specific strategies for dealing with this potential expansive shale problem should be identified in the geotechnical investigation report.

Spoils from excavation can potentially be moved to open areas on campus for use on other concurrent or future construction projects. These available areas and overall campus need for extra fill material varies throughout the years, so any possible relocation of spoils to other areas on campus should be coordinated with the NKU project manager.

### **Division 32: Landscaping & Irrigation**

The following section describes the overall strategy and general preferences for Landscaping, as well as the Irrigation systems currently used throughout campus. Any deviation from the following guidelines shall be coordinated with the NKU project manager.

#### **General Landscaping Preferences:**

A good landscaping plan is critical to the success of every new project on NKU's campuses. The university is interested in an attractive, but still easily maintained, landscaping scheme. The landscaping and other site amenities should convey a sense of quality as well as a feeling of welcome. For the past 5-7 years, the University has focused energies toward increasing the perceived quality of the campus as a place through place making strategies, particularly through creation of superior landscapes and "greening" the campus. To the extent that seems reasonable in terms of overall budget constraints, this project should include investment in landscape and site improvements. The goal is to impart a "campus" quality to the campus and to offset and balance the hard surfaces and angular nature of the built environment with landscape and lawn areas.

Landscape materials should be selected for ease of maintenance and ability to thrive in the Northern Kentucky environment. Previous landscape designs for NKU have been over-planted initially, which has resulted in more long term maintenance issues and problems. Ongoing issues on campus include ease of care, quantity of species already on campus, previously successful/unsuccessful species plants, and the potential introduction of new species.

In general, the university always seeks to add color and interest to the landscape year round. The university requests intimate involvement from the university's Roads & Grounds superintendent (and main horticulturist) during design for participation in decisions involving the selection of plant materials appropriate for this project.

The following represents some general campus landscaping guidelines:

- Planter beds (i.e. planting soil mixture) should be a minimum of 12" deep for shrubs and 24" deep for trees.

- All new turf areas shall be initially installed as sod. Seeding will only be permitted if approved by the NKU project manager.
- Topsoil should be imported and spread a minimum of 6" deep in areas to receive seed or sod.
- Migration of rock upward from poor subsoil below through a minimal layer of topsoil has been a problem in the past. Removal of all rocks from the topsoil is essential to healthy turf growth, and NKU will review the topsoil for rocks frequently.
- Design initial planting bed density to allow for future growth. Do not provide an initial density to accelerate the perception of growth.
- Provide 5" (minimum) caliper for all new tree locations.
- If seeding is permitted, the seed mixture shall be: Tall and Fine Fescue (*Festuca arundinacea* and *Festuca rubra*) varieties such as Falcon II, Shenandoah II, Scorpion, Fine Fescue, Nordic Hard, K-2 Chewings, etc.
- Due to strength of prevailing winds on campus, we have had marginal success with use of straw to protect newly seeded lawn areas. Use of netting, hydro-seeding or a similar process is recommended.
- The use of fertilizer, sulfur and lime should be based upon soil testing.
- Design team shall include very specific and strict verbiage in the specifications regarding responsibility and frequency of temporary watering by contractors during construction. NKU has had bad experiences with previous contractors on keeping up with the proper amounts and frequency of necessary watering.

#### **General Irrigation Preferences:**

In general, NKU prefers an underground irrigation system for all lawn and planting areas. Typically, existing irrigation systems are fed from the main campus water loop. NKU currently does not employ any system or storage devices for detaining storm water and reusing for irrigation purposes. However, NKU is receptive to the idea and encourages design teams to explore and propose systems as applicable and practical for new projects.

The main line feeding new irrigation systems shall be installed with a separate shut-off valve and readable consumption meter, as well as a RPZ-type, back-flow device. Both the consumption meter and back-flow device shall be located in an area that is easily serviceable by NKU O&M staff and protected from freezing.

The following represents some general campus irrigation system design guidelines:

- Provide a full irrigation system design within the project construction documents, as the design-build methodology has resulted in subpar and unacceptable irrigation systems on previous projects. NKU will want to review and comment on the irrigation system design prior to bidding.
- Provide the irrigation system main as a full loop around the site whenever possible.
- NKU prefers (2) 4" sleeves for each hard scape crossing (1 for irrigation piping and 1 for wiring). For main routing under roads, provide (2) - 6" sleeves.
- The sleeve installation contractor shall provide the GPS coordinates and elevation for each end of any provided sleeves. This will help future contractors and/or NKU locate the sleeves when necessary in the future.
- Provide tracer wire for all mains and laterals in the irrigation system.
- For irrigation control, the system must use a 2 wire system, and not a multi-strand system. The irrigation controller provided must come with a 3 year manufacture warranty.
- NKU prefers the Tucor RKD model for the irrigation controller/decoder system, and all controller/decoder-manufacturer-standard wiring shall be installed for complete, integrated system. NKU hopes to control all systems remotely via TC/IP in the near future, so all new controllers/decoders shall include this capability.
- Provide a minimum of (4) quick coupler connections in the irrigation system for each specific project site.
- All irrigation system rotors shall come with a 5 year manufacture warranty, and shall utilize swing joint (PVC or Marlex) connections (not just funny pipe).
- All valve boxes shall be a minimum of 10".

- Before gluing pipe, use a purple cleaner. (This makes it very easy to inspect that all joints have been glued)
- Before any part of the irrigation system is backfilled, it must be inspected by the NKU project manager and a member of the university's Roads & Grounds Department.
- In open trenches, use a 1" thick bed of sand under the pipe and 3"-4" above the pipe. Then, use typical backfill material to fill the remaining trench volume.
- Furnish and install, grounding rods every 500 to 600 feet, at the controller and at terminal ends of wire. The top of the grounding rods should be in a 10 inch round box. The grounding rods are to be 6-8 feet in length. A grounding plate may be substituted at the controller instead of a grounding rod.
- Furnish and install, surge protectors every 500 to 600 feet or at each zone valve and two at the controller. The surge protectors should be put in an existing 10" box or put in a separate box.

### **Division 33: Underground Site Utilities & Tunnel System**

#### **Underground Site Utilities:**

Documenting, marking, and locating site utilities throughout campus have been an ongoing challenge throughout the history of NKU. The creation of this building standards document provides an ideal opportunity to hedge the problem as NKU continues to grow, modify, and expand the underground campus infrastructure.

The NKU project manager will research and provide whatever information is available and known for the existing utilities in the area of concern. However, NKU generally prefers the contractor hire an outside utility locating service for marking the location of all existing utilities. Outside utility locating services will be required for locating all public utilities (when applicable), and most of the underground utilities on campus are private "house" lines owned & maintained of NKU. All requests for assistance from NKU's Operations & Maintenance staff in locating existing utilities shall also be submitted to the assigned NKU project manager at least (3) calendar days in advance.

The following information shall be included in the project specifications for work associated with underground site utilities:

- Permanent utility markers should be installed to mark the location of all underground utilities. See utility marker standards included in this section.
- All existing utility lines determined not necessary or previously abandoned shall be completely removed and discarded by the contractor. Any "abandoned" lines shall not be left in place.
- All plastic underground utilities of any type must have tracer wire installed on pipe (mains and laterals).
- Contractors shall determine and provide GPS coordinates on the record drawings for all underground utilities, including but not limited to: valves, valve boxes, manholes, catch basins, quazite boxes, etc.
- Provide a physical separation of 12" MINIMUM between power and telecom duct banks to prevent interference from the power cables to the copper telecomm cables. This means that the duct banks must be physically separated (i.e. not combined in the same pour). All duct banks shall be formed in the trench during initial installation, and each duct bank concrete shall include a colored dye to identify and differentiate between specific duct banks during future excavations. Electric duct banks shall be colored red and telecommunication duct banks shall be colored blue (?).
- Contractors installing underground natural gas piping must have proper certification and training from Duke Energy. In addition, all installed piping must be inspected by Duke Energy and the NKU Plumbing Department prior to burial. Refer to Division 22 for more specific information regarding natural gas services.
- Fill all utility trenches and footing over excavations with flowable fill to combat the potential for expansive shale problems.

#### **Tunnel System:**

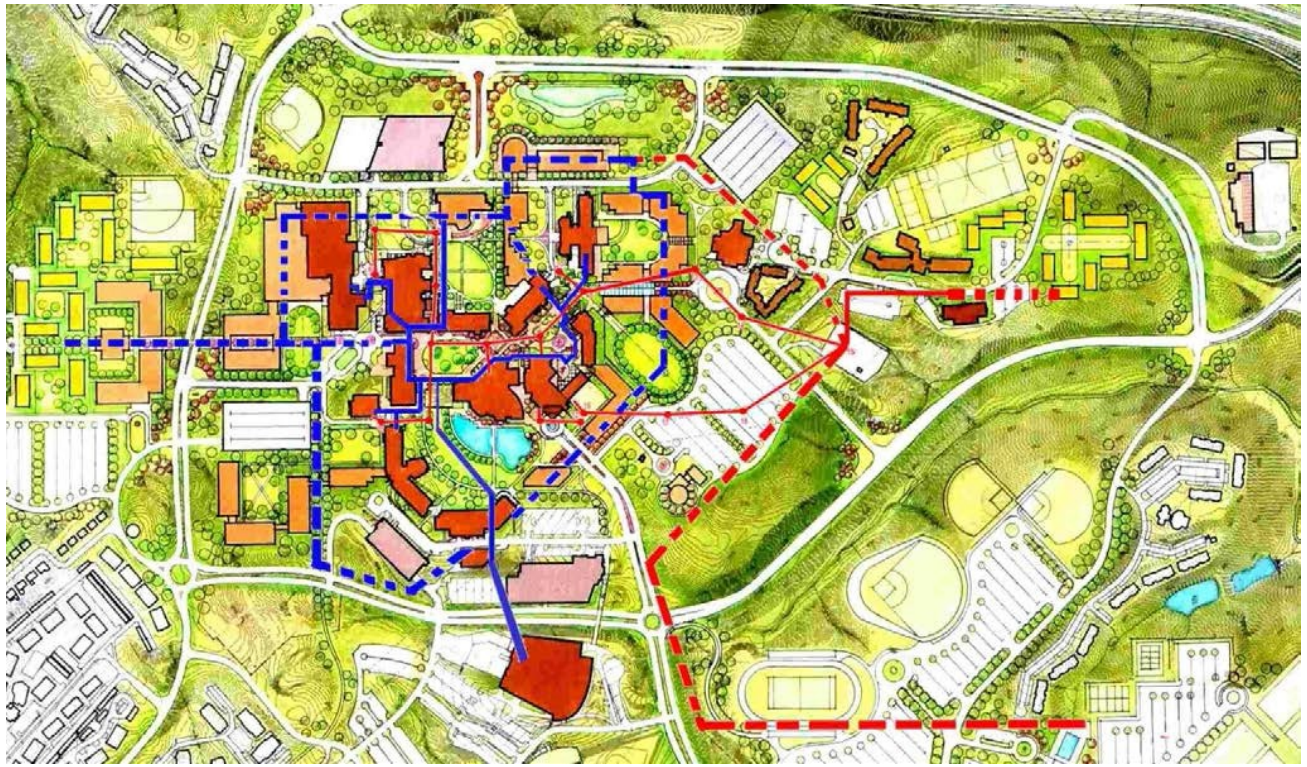
Whenever appropriate and economically feasible, NKU prefers to extend and connect into the existing campus underground tunnel system. The primary purpose of the existing tunnel system is to distribute

steam and chilled water (and other miscellaneous utilities) throughout campus. Currently, there are no sacred minimum dimensions required for the underground tunnels, as the existing tunnel system involves various inside widths and heights. However, the tunnel leading from Founders Hall over to the Dorothy Westerman Hermann Natural Science Center (commonly referred to simply as "New Science") is considered an acceptable and reasonable size. Another acceptable tunnel design is the tunnel extension from Nunn Hall heading out to connect Griffin Hall. Ideally, the tunnel width and height should provide enough room to accommodate current project utility conveyance needs and a reasonable amount of space for routing future utilities, while always leaving room for the passage of a golf/utility cart. Every effort should be made within the tunnels to achieve changes in elevation with ramps, but lifts and/or freight elevators (with an associated steps or ladder) have been an acceptable, but definitely not preferred, solution.









For the main sections of tunnel containing the main chilled water (16" diameter) and steam (8" supply/4" condensate) primary distribution loop "trunk" lines, the following represents the approximate structural design loads for the steel support cross beams:

- 16" chilled water supply and return, 175#/ft each
- 8" steam supply 75 #/ft
- 4" condensate return 25#/ft

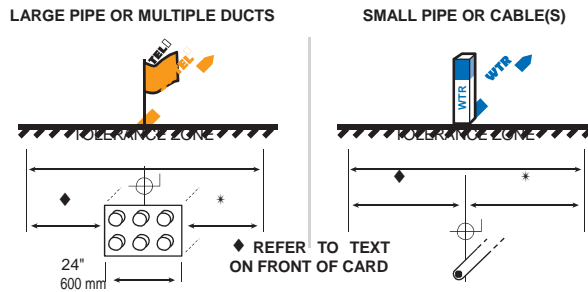
The diagram on the next page shows an overall campus view of the existing tunnel system with the solid blue lines representing the existing tunnel layout as of Spring 2012. All dotted blue lines represent future tunnel extensions as proposed in the 2009 NKU Master Plan. The primary underground power infrastructure system is also shown on this diagram as well, with solid red lines representing the existing system (Spring 2012). And similarly, red dotted lines represent future power infrastructure/manhole extensions as proposed in the 2009 NKU Master Plan.



# APWA UNIFORM COLOR CODE

	<b>WHITE</b> - Proposed Excavation
	<b>PINK</b> - Temporary Survey Markings
	<b>RED</b> - Electric Power Lines, Cables, Conduit and Lighting Cables
	<b>YELLOW</b> - Gas, Oil, Steam, Petroleum or Gaseous Materials
	<b>ORANGE</b> - Communication, Alarm or Signal Lines, Cables or Conduit
	<b>BLUE</b> - Potable Water
	<b>PURPLE</b> - Reclaimed Water, Irrigation and Slurry Lines
	<b>GREEN</b> - Sewers and Drain Lines

## TYPICAL MARKING



Customize with your center's  
phone and address information  
6/5/2012

# **GUIDELINES FOR UNIFORM TEMPORARY MARKING OF UNDERGROUND FACILITIES**

This marking guide provides for universal use and understanding of the temporary marking of subsurface facilities to prevent accidents and damage or service interruption by contractors, excavators, utility companies, municipalities or any others working on or near underground facilities.

## **ONE-CALL SYSTEMS**

The One-Call damage prevention system shall be contacted prior to excavation.

## **PROPOSED EXCAVATION**

Use white marks to show the location, route or boundary of proposed excavation. Surface marks on roadways do not exceed 1.5" by 18" (40 mm by 450 mm). The facility color and facility owner identity may be added to white flags or stakes.

## **USE OF TEMPORARY MARKING**

Use color-coded surface marks (i.e., paint or chalk) to indicate the location or route of active and out-of-service buried lines. To increase visibility, color coded vertical markers (i.e., stakes or flags) should supplement surface marks. Marks and markers indicate the name, initials or logo of the company that owns or operates the line, and width of the facility if it is greater than 2" (50 mm). Marks placed by other than line owner/operator or its agent indicate the identity of the designating firm. Multiple lines in joint trench are marked in tandem. If the surface over the buried line is to be removed, supplementary offset markings are used. Offset markings are on a uniform alignment and clearly indicate the actual facility is a specific distance away.

## **TOLERANCE ZONE**

Any excavation within the tolerance zone is performed with non-powered hand tools or non-invasive method until the marked facility is exposed. The width of the tolerance zone may be specified in law or code. If not, a tolerance zone including the width of the facility plus 18" (450 mm) measured horizontally from each side of the facility is recommended.

## **ADOPT UNIFORM COLOR CODE**

The American Public Works Association encourages public agencies, utilities, contractors, other associations, manufacturers and all others involved in excavation to adopt the APWA Uniform Color Code, using ANSI standard Z535.1 Safety Colors for temporary marking and facility



identification.

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Rev. 4/99

6/5/2012

# GAS

## Installer's Manual



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## **SECTION A** **INTRODUCTION**

Duke Energy publishes this manual for persons or firms that plan to install gas piping or connect appliances within the Company's service area. We recommend that you take the time to read this Manual completely so that you become familiar with its contents. It provides a reference for installation, approved materials, cathodic protection, inspection and testing of gas piping.

The rules and information contained in this publication are not intended to cover all possible situations. Local laws, ordinances and government regulations, in addition to Company requirements, and National Fuel Gas Code ANSI Z223.1/NFPA54, will govern such work where applicable. It is suggested that interested persons consult with the Company in this regard before proceeding with their work.

Each of the regulatory commissions having jurisdiction within our service area requires that new customers apply for permission to use natural gas. Before proceeding with any new gas installation, call Duke Energy for details.

The National Fuel Gas Code ANSI Z223.1/NFPA 54 is an integral part of this manual. This code covers gas piping from the outlet of the gas meter to the inlet of the gas appliance, including appliance installations.

The Company does not assume responsibility for any defective material and/or faulty workmanship in the installation or repair of customer's piping when others perform such work or for any loss or damage resulting from such material or workmanship.

This Manual is updated periodically. The Company assumes no liability for failure of the installers to utilize current revisions.

Representatives of Duke Energy are available for additional advice and guidance. (See telephone numbers in Section C.)

## **SECTION B** **DEFINITIONS**

Anode - used to protect underground metallic piping from corrosion.

Approved - the materials or procedures so designated are accepted by the Company for use in accordance with this manual.

Company - Duke Energy Corp and subsidiary companies.

CSST – an acronym for Corrugated Stainless Steel Tubing, a flexible gas house piping system.

Curb to Meter (C-M) – that portion of service piping that extends from the curb to the meter set assembly excluding regulating and measurement equipment.

Cubic Feet Per Hour (CFH) - the flow of gas, 1 CFH equals approximately 1000 BTU/hour.

Gas Main - the Company's distribution piping to which the Company's service piping is connected.

House Piping - that portion of the piping from the outlet of the meter set assembly to the points where appliances are connected. House piping is owned and maintained by the customer.

House Piping Inspection - a visual check and a pressure test of the gas house piping.

Joint Service Trench - trench where the gas piping, electric, telephone, and television cable are installed in the same trench.

Main to Curb (M-C) – that portion of the service piping which extends from the gas main to the curb.

Meter Set Assembly - the piping, fittings and meter shut-off valve, including the meter and the service regulator (where required). The meter set assembly is owned, installed and maintained by the Company.

Other Utilities – include electric, water, television cable, telephone, communications, security, septic systems, sprinkler systems, sewers, drains, conduits, ducts, lines or pipes not associated with gas facilities.

Pressure Piping - the house piping operated at an elevated pressure at 1 PSIG or greater.

Pressure Test - the application of air pressure to a piping system in order to discover leaks and/or faulty components.

Service Piping – gas piping connecting the meter set assembly to the gas main.

Service Riser - that portion of the curb to meter service piping extending from below grade to the meter set assembly.

Standard Pressure - the normal pressure as delivered to the customer, which is 0.25 PSIG at the outlet of the meter.



Tie-In - to make a connection to an existing gas main or piping.

Visual Service Piping Inspection - a visual check of the customer service piping.

**SECTION C**  
**IMPORTANT TELEPHONE NUMBERS**

Duke Energy Gas & Electric Services

For information regarding installation specifications.

Call	(513) 651-0444
Toll Free	1-800-262-3000 Extension 3866

To Report Gas Trouble

Call	(513) 651-4466
Toll Free	1-800-634-4300

For All Inspections and Meter Sets

All gas meter sets, applications, inspections and to inquire on the status of existing requests for these services.

Toll Free	(513) 651-0444
	1-800-262-3000 Extension 3866

For Locations of any Underground Utility

Call Before You Dig – Ohio	1-800-362-2764
Call Before You Dig - Kentucky	1-800-752-6007
Call Before You Dig - Indiana	1-800-382-5544

Call the Utilities Protection Service at least two (2) working days in advance.

**SECTION D**  
**CUSTOMER ASSISTANCE**

Duke Energy provides customer assistance without charge to assist you in obtaining the maximum benefits from natural gas. They will advise you on gas application, piping arrangements, venting requirements and will furnish general information on the use and economics of natural gas for residential, commercial and industrial applications.

See Section C for telephone numbers.

**SECTION E**  
**CUSTOMER SERVICE PIPING INSTALLATION REQUIREMENTS**

**1. GENERAL**

Effective January 1, 2007, in the Commonwealth of Kentucky and July 1, 2008 in the State of Ohio the Company is responsible for installing service piping to new buildings and established buildings not served by gas. This section will explain the customer's responsibilities.

The location of the customer's service piping shall be subject to the rules and regulations contained herein and subject to "Inspection and Testing" as provided in Section H.

Mobile home and free standing meter installations shall also comply with the requirements contained in Sections H and J.

**1.1 Typical Sequence of Events for Instituting and Establishing Gas Service**

The following is a typical sequence of events for a gas service, house piping and meter installation. The customer must follow through each step in order to complete the installation.

- (1) Request for Service - The customer, property owner or their agent should make request for service as soon as the gas installation is planned.
- (2) Acceptance - Company approval must be obtained before digging the gas service trench. If a gas main extension is required for the service, Duke Energy will provide details to the customer.
- (3) Install C-M Service Casing - Customer's installer digs trench, installs a casing pipe, backfills the trench leaving the ends open and contacts Company for installation of the gas service.
- (4) Install Service Main to Meter - Company will install the service from the gas main to the proposed meter location. The C-M portion of the service will be inserted through the installed casing. Company will install a meter bracket at the proposed meter location.
- (5) Install House Line - After the meter bracket is installed, the customer's installer completes the house line installation. Contact the local building inspection department for house line inspection. If the local building inspection department does not perform house line inspections, contact the Company for inspection and test.
- (6) Install Meter - The Company will install the gas meter between the service line and the house line after the house line is approved.

The sequence of events for multiple meter installations, and or industrial/commercial customers may vary from the above. Contact the company prior to any multiple meter installations.

The above is a typical, but by no means the only sequence of events for establishing gas service.

## 2. **SIZING REQUIREMENTS**

### 2.1 **General**

The size of service pipe is dependent upon:

- (1) The distance from the gas main to the gas meter,
- (2) The pressure in the gas main,
- (3) The required or requested gas load, and
- (4) The possibility of future increases in the gas load.

All are important factors in determining the size of the gas service pipe. You must contact Duke Energy prior to installation of any gas service line.

## 3. **CAUTION BEFORE DIGGING**

### 3.1 **Locating Utilities**

The Customer or Customer's Installer must call the Utilities Protection Service (811 in Kentucky and Ohio) at least two days in advance of excavating to have gas piping and other underground utility facilities located that may be buried in the vicinity of the planned service path. The Customer is responsible for any damage to utilities caused by Customer excavation activities.

### 3.2 **Permits**

The Company is responsible for any local or state permits required for work in public road right of ways. Customer is responsible for any local or state permits for work on Customer property beyond road right of ways.

## 4. **LOCATION OF SERVICE PIPING AND METER**

### 4.1 **General**

When service piping is needed, contact the Duke Energy representative in your area before installing C-M service conduit.

Upon request, a Company representative will mark the required termination points of the service piping conduit.

The service piping conduit shall terminate near the building to allow for a meter connection. For assistance in determining proper meter or service location, call Duke Energy.

The customer's service piping conduit must be installed in a trench that is separate from other utilities except as noted in Section E 5.4. The trench shall also be of sufficient depth and width to accommodate the conduit. The trench bottom shall be smooth (no voids), continuous and compact (not loose).

If the gas service piping will be installed parallel to other utilities, the conduit shall be installed at least three (3) feet away from the others. If the service piping must cross over, under or be near other utilities, a twelve (12) inch minimum separation must be maintained.

Exception 1: Polyethylene plastic pipe cannot be installed within five (5) feet parallel or crossing an underground steam line.

Exception 2: Gas service piping in joint service trench must not be installed closer than six (6) inches to shared trench utilities. See Section E 5.4.

When selecting a service route, consider the effects of water drainage, ground movement, and traffic loads. Avoid installing gas service piping under railroad tracks, streams, or buildings. If these or other unusual circumstances cannot be avoided, contact your Duke Energy representative for installation requirements.

#### 4.2 **Prohibited Gas Service Piping Locations**

The service piping shall not be installed in, under or through the following:

- (1) Steps
- (2) Solid Porches
- (3) Crawl Spaces
- (4) Entranceways to Buildings

The service piping shall not be terminated nor the meter set:

- (1) Within thirty (30) inches of the left side of a basement window or twelve (12) inches of the right side of the basement window, as you face the window.
- (2) Within three (3) feet of any source of ignition.
- (3) Within three (3) feet of an air duct.
- (4) Below and within eight (8) feet of an air duct.
- (5) Below and within eight (8) feet of a window that can be opened.
- (6) Where it will be subject to damage, or
- (7) In any location that would require the connection to the main to be made under a driveway, tree or other obstruction.

See Sketch 4, Section L.

Conditions such as multiple meter installations may exist that require other restrictions or distances. Large meter installations require ten (10) foot separation from sources of ignition, operable windows and air ducts. Large meters shall not be placed under operable windows and air ducts. Generally, a large meter installation is any load that is 2200 CFH or greater. For assistance, call Duke Energy, telephone numbers are listed in Section C.

For large meter installations requiring concrete support pads, contact the Company representative in your area. (Location varies for size and type of meter)

## 5. **INSTALLING THE SERVICE**

### 5.1 **General**

Casing shall be provided for all risers installed through hard paving. See Sketch 2, Section L. The customer is responsible and must bear all expenses for the protection of the riser and meter set assembly from damage.

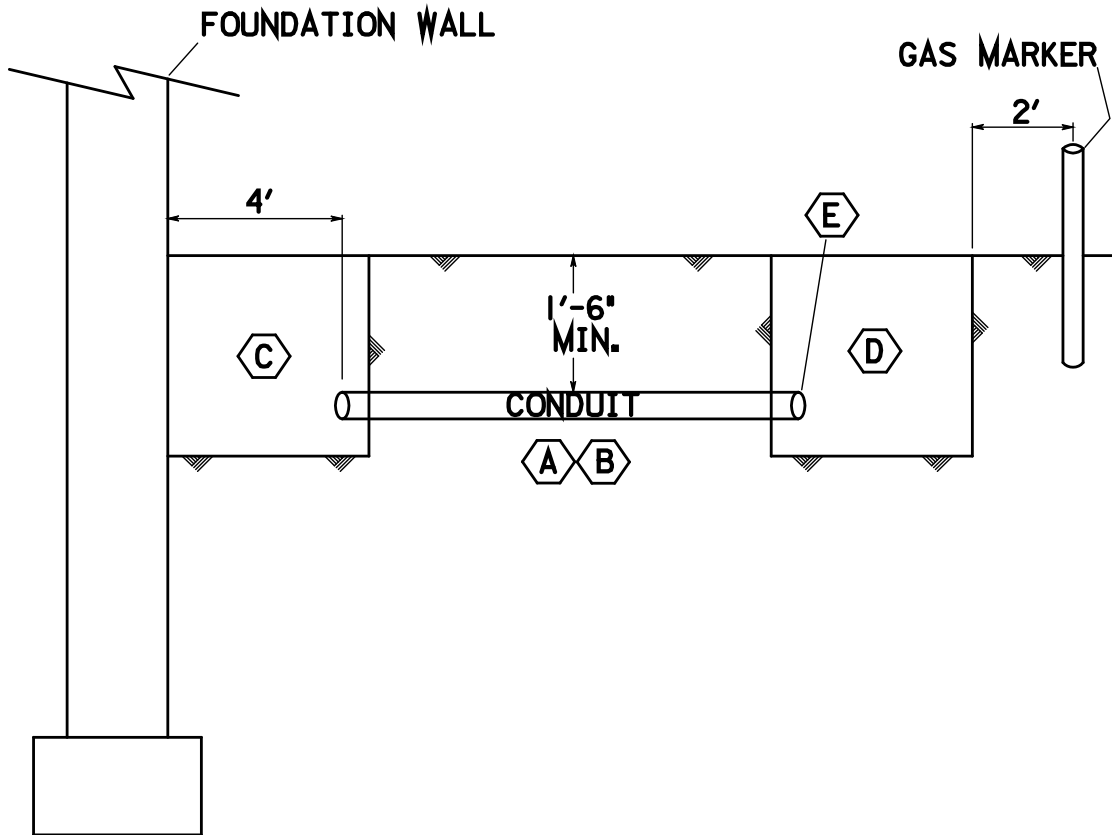
### 5.2 **Installation of 2 Inch and Smaller Services**

For most new construction, the Company will insert 2 inch and smaller diameter services through conduit provided and installed by Customer. See Exhibit A and notes on the next page for typical conduit installation by Customer.

Existing buildings may not be required to have the conduit installed prior to Duke Energy installing the service. This will be decided on a case by case basis. In many cases, the Company is able to install the gas service by directional drill.

If 2 or 3 single residential building lots share a common ingress/egress roadway (flag lots), the customer(s) may install conduit from their gas meter location to the Company's existing gas main on the public street or roadway. This conduit may be installed in a common trench with a minimum of twelve (12) inches minimum separation between each conduit. Where more than one gas service occupies a common trench, other utilities must be installed in a separate trench with at least 3'-0" of trench separation. If more than 3 lots share a common ingress/egress roadway, a gas main must be installed per Duke Energy's approved policies and procedures.

## EXHIBIT A – TYPICAL CONDUIT INSTALLATION BY CUSTOMER



## Notes:

- A. Customer shall install and backfill 4 inch conduit (with a smooth wall interior) at a depth of at least 18 inches of cover. Customer shall temporarily seal both ends of the conduit. Customer shall leave both ends of conduit uncovered. Company will install gas service through conduit and place 1 foot of customer provided backfill above the gas services at both ends of the conduit. Customer shall finish the backfilling and grading. Customer provided backfill shall be sand or the soil free of coarse material such as rocks. Backfill material shall be located in the vicinity of the excavation but no closer than 2 feet of the trench.
- B. Conduit length shall be limited to 100 feet. A series of conduits are required for longer services or where more turns are necessary. Intermediate pull excavations (4 feet x 2 feet) are required every 100 feet for longer services. One 90 degree (minimum bend radius = 3 feet) change in direction is permitted for 1-1/4 inch and smaller services. Turns are not permitted on conduit for 2 inch services.
- C. Customer shall install buried gas line caution tape at 6 inches above the conduit. The tape must be bright yellow in color and a minimum of 2 inches wide with black 1 inch lettering. Customer shall leave a minimum of 2 feet of caution tape exposed on each end of the conduit. If the caution tape is not visible on each end of the conduit, Company will not install the gas service. An example of buried gas main caution tape can be seen in Exhibit B.



- D. Excavation area at the foundation wall shall be 4 feet x 3 feet. Bottom of excavation shall be within 2 feet of final grade to provide proper service riser support. Customer shall mark final grade on the foundation wall to aid in the proper placement of the service riser. End of the conduit shall be located 4 feet from the foundation wall.
- E. Excavation area at the street end of the gas service shall be 4 feet x 2 feet. Edge of excavation shall be located no more than 2 feet from gas supply location. Company will excavate and expose gas supply.
- F. Customer shall provide a pull string through conduit. Pull string shall have a minimum tensile strength of 100 pounds.

#### EXHIBIT B – SAMPLE BURIED GAS LINE CAUTION TAPE



**CAUTION: BURIED GAS LINE BELOW**

#### 5.3 Installation of 3 Inch and Larger Services

Company will install 3 inch and larger diameter services in a Customer excavated trench. Trench shall be 1 to 1-1/2 feet wide by 3 feet nominal depth. Customer shall provide sand or other suitable backfill material that is free of coarse material such as rocks. Backfill material shall be located in the vicinity of the excavation but no closer than 2 feet.

Excavation area at the foundation wall shall be 4 feet x 3 feet. Bottom of excavation at foundation wall shall be 3 feet from final grade to provide proper riser support. Customer shall mark final grade on the foundation wall to aid in the proper placement of the service riser.

Excavation at gas supply location shall be 4 feet x 2 feet. Edge of excavation shall be located no more than 2 feet from the gas supply location. Company will excavate and expose the gas supply.

Company will install the service piping and supervise the backfilling of the excavation by Customer.

After Company has padded the service, Customer shall finish backfilling the excavation and complete final restoration.

#### 5.4 Joint Service Trench

One (1) gas service can be installed in a joint service trench with electric service cable in conduit, telephone cable, and television cable. The pipe must not be installed closer than twelve (12) inches from these cables. See Sketch 1, Section L.

Only electric, telephone, and cable television utilities are permitted in the same trench with gas piping. There are no exceptions. When other utilities parallel gas piping, three (3) feet of separation between trenches shall be maintained with undisturbed native soil between trenches. If the gas piping must cross a facility other than shared trench occupants, a twelve (12) inch minimum separation must be maintained.

Gas piping and electric service cable must enter the building above ground level.

Contact your cable television company and your telephone company for their requirements.

## 6. METERS

### 6.1 General

Provisions shall be made for a suitable outdoor location of metering equipment on the customer's premise (See this Section E. 4.2). The Customer or their agent shall not connect or disconnect any meter or metering equipment or in any way alter or interfere with the Company's metering equipment. All metering equipment shall remain the property of the Company.

### 6.2 Installation

The Company shall in all cases supply, install and maintain the gas metering equipment. On all multiple meter branch house lines, a permanent metal tag must be installed by the customer on each house line as close to meter as possible to identify the area being served.

### 6.3 Access to Premise

The properly authorized agents of the Company shall at all reasonable hours, after displaying an identification badge (Company Pass), have access to the premises for the purpose of inspecting the customer's house line, examining, reading, repairing or removing the Company's meters, or other property and all other purposes required for the supply of gas service. Reasonable hours are from 7:30 AM to 7:30 PM except for emergencies.

## 7. FIRE SEPARATIONS

### 7.1 General

Only one gas service will be installed into any individual dwelling, building or building unit, unless the units are sectionalized by acceptable fire separation, regardless of the number of customers to be served therein.

## 7.2 Fire Separations

An acceptable fire separation is a wall that meets or exceeds the requirements for a fire separation as established by local building codes.

## 7.3 Building Plan

A customer desiring multiple gas services to a dwelling unit, building or building unit must submit to the Company a copy of the building plan showing the fire separations and the proposed gas service lines and meter locations.

### SPECIFICATION ABBREVIATIONS

ANSI	- American National Standards Institute
API	- American Petroleum Institute
ASTM	- American Society of Testing Materials
CTS	- Copper Tubing Size
DR	- Dimension Ratio of plastic pipe = Pipe outside diameter in inches divided by wall thickness in inches
IPS	- Iron Pipe Size
PC	- Protective Coating
PE	- Polyethylene
PE 2406	- Material designation for medium density PE manufactured under ASTM Specification D 2513
SCH	- Schedule

### IMPORTANT TELEPHONE NUMBERS

For information regarding installation specifications, inspections and meter sets:

Call	513-651-0444
Toll Free	800-262-3000 Extension 3866

To report gas trouble:

Call	513-651-4466
Toll Free	800-634-4300

**SECTION F**  
**CUSTOMER HOUSE PIPING AND EQUIPMENT**

**1. GENERAL**

The Company, in the interest of safe and reliable service, has adopted the following requirements for the installation, operation, and maintenance of gas piping and equipment. All local, state and federal ordinances, rules and regulations, shall be followed.

Certain local governments have assumed the responsibility for house piping inspections and testing. Please contact the local building department for installation requirements. In these instances, the Company requires an approved house piping inspection & pressure test performed by the local inspection department before the Company turns on a meter.

**1.1 Ownership and Responsibility**

The customer, at his own expense, shall have house piping installed by qualified personnel. The house piping consists of pipe and fittings from the outlet of the meter to the equipment shutoff valve. The customer will be responsible for the installation and maintenance of the house piping and the customer assumes all risk resulting from defects therein.

**2. GAS PIPING SYSTEM DESIGN**

**2.1 Sizing**

Gas piping shall be designed and installed in accordance with accepted engineering practice. The gas house piping system shall be sized large enough to provide a supply of gas to meet the maximum expected demand and to provide the needed pressure at the equipment. Standard pressure black iron piping systems should be sized such that the pressure loss between the meter and the equipment does not exceed 0.3 inch water column (W.C.).

**2.2 Piping Extensions**

When remodeling or extending existing house piping, connections shall be made so that sizes can be maintained in accordance with the provisions of this section. Where the pressure drop exceeds 0.3 inch W.C., a separate pipe from the meter shall be installed to supply the additional load requirements. Any pipe extension greater than 10 feet in length or with 3 or more fittings, must be inspected and pressure tested. For inspection and testing requirements see Section G.

**2.3 Minimum Pipe Size**

No pipe smaller than standard 1/2 inch IPS shall be used in house piping. Gas piping to an appliance shall not be smaller than the manifold size or connection at the appliance.

### 3. MATERIAL

#### 3.1 General

Each length of pipe shall be examined before connecting and any dirt or obstructions removed. Any burrs left by the cutting tool shall be removed.

Customer's installer shall replace any defective pipe or fittings.

Material and installation requirements for Corrugated Stainless Steel Tubing (CSST) are detailed in Section I.

If copper house piping is used, it must be installed per International Fuel Gas Code Requirements.

Plastic piping shall only be used outside and underground. See Section J.

#### 3.2 Pipe

Steel gas pipe shall be at least standard weight (Schedule 40) and shall comply with ASTM A53 or ASTM A106.

#### 3.3 Fittings

All threaded fittings except stopcocks and valves shall be steel, brass, bronze, or black malleable iron, standard weight of the banded and beaded type. Except as noted in Section F 3.4, threaded fittings are acceptable on 4" and smaller diameter steel pipe operating at 5 PSIG or less. Bushings, all-thread nipples, saddles, and cast iron connections are not permitted. Unions are permitted only as follows:

1. A union must be installed between a shutoff valve and a permanently installed appliance.
2. Unions may be installed to connect buried piping to above ground piping.
3. Unions must be installed downstream of pressure reducing regulators, fire suppression valves, automatic shutoff valves, solenoids, etc.

Fittings for plastic pipe shall be installed only outside and underground. Mechanical fittings must be a compression type specifically designed and manufactured for use on polyethylene pipe and tube.

#### 3.4 Pressure Piping

1. General - Piping operating at 1 PSIG or more is considered Pressure Piping. If pressure gas is required, it is provided in 1 PSI increments starting at 1 PSIG.

2. Sizing - The recommended allowable pressure drop in pressure piping is 10% of the delivery pressure. The pressure drop is measured from the meter outlet to the appliance valve. (Ex. 5 PSIG delivery pressure - 0.5 PSI pressure drop allowable)
3. Steel Joints - Although welding is preferred, threaded joints and fittings are permitted for pipe sizes up to and including 4" operating at 5 PSIG or less. Pressure piping larger than 4" and all pressure piping above 5 PSIG regardless of size must be welded or flanged. Backwelding of threaded piping for new installations is not permitted.
4. Pressure Rating of Customer Regulators - For a given delivery pressure at the regulator inlet, the emergency pressure rating must meet or exceed the following requirements. The Emergency Pressure Rating or Emergency Exposure Limit is the pressure at which pressure beyond this limit may cause damage to regulator components or cause the regulator to malfunction.

<u>Pressure Delivered (PSIG)</u>	<u>Minimum Pressure Rating - Emergency (PSIG)</u>
1 – 2	10
3 – 8	15
9 – 15	25
16 – 40	60
41 – 50	75

5. Pressure Boosters - Piping installed downstream of a pressure booster shall conform to the same rules as pressure piping if the booster pressure is 1 PSIG or above. The piping design pressure will be the high pressure shut-off limit for the pressure booster. When a pressure booster is used, back pressure and low pressure protection must be provided.

### 3.5 Valves

All house piping valves shall be of the type approved for use on natural gas.

## 4. INSTALLATION

### 4.1 General

A sediment trap must be installed at the base of all permanently installed appliance drops to catch dirt or other foreign materials. The sediment trap shall be of the same size as the pipe to which it is attached. The sediment trap should be installed as close as practical to the inlet of the equipment, preferably downstream of the equipment shutoff valve. See Sketch 3 Section L.

Where passing through any exterior wall or any masonry wall, above ground piping shall be protected against corrosion by coating or wrapping with an inert material.

Customer is responsible for connecting the house piping to the outlet of the meter assembly.

#### 4.2 Prohibited Locations

Except as otherwise provided in this section, gas piping shall not be installed in or pass through any air conditioning, heating or ventilating duct system, clothes chute, chimney, flue, elevator shaft, or any combustion air ducts.

House piping may enter a duct system only when all the following conditions are met:

1. The gas utilization equipment is used to pre-heat outside make-up air.
2. The gas utilization equipment is approved for such use.
3. The use is confined to commercial/industrial occupancies.
4. The installation meets all local, state, or federal code.

#### 4.3 Supporting House Pipe

Gas piping shall be supported with the proper size metal pipe hooks, metal pipe straps, bands or hangers. The supports must be of adequate strength and quality, and located at proper intervals, so that the piping cannot be moved accidentally from the installed position. The building structure shall not be weakened by the installation of any gas piping. Gas piping shall not be supported by other piping. Spacing of supports in gas piping installations shall not be greater than shown in the following table:

Steel Pipe Nominal Size (Inches)	Spacing of Supports (Feet)	Nominal Size of Tubing (Inches)	Spacing of Supports (Feet)
1/2	6	1/2	4
3/4 or 1	8	5/8 or 3/4	6
1 1/4 or larger (horizontal)	10	7/8 or 1	8
1 1/4 or larger (vertical)	Every floor level		

#### 4.4 Outlets

All piping outlets shall be installed to provide sufficient clearance from ceilings, walls and floors to permit use of a pipe wrench of suitable size without straining or bending the pipe. The outlet fitting or piping shall not be placed behind doors.

Each outlet, including pipe terminating with a valve, shall be securely closed gas-tight with an approved threaded plug, threaded cap, or listed convenience outlet immediately after installation and shall be left closed until an appliance is connected.

#### 4.5 Concealed House Pipe and Fittings

When installing house piping that will be concealed, the number of fittings shall be kept to a minimum. Unions, left and right couplings and compression couplings shall not be concealed.

When gas piping within the perimeter of a building is to be concealed underground, or within concrete or other solid construction the piping shall be properly cased or channeled. The entire installation shall be such that the gas piping can be readily replaced.

Channel shall be suitably covered providing protection to the pipe from moisture and corrosive substances.

#### 4.6 House Piping Between Buildings

For underground house piping installations, see Section J.

For corrosion protection on underground house piping, see Section K.

In industrial or large commercial establishments, or where it is not practicable to install piping underground, alternate methods may be used as permitted by code requirements.

#### 4.7 House Piping Installed on Rooftops

Rooftop piping shall be elevated above the rooftop surface, supported on materials designed for outdoor use such as treated lumber. Recommended pipe support is a treated lumber 4" x 4" - 1' long. Attach pipe to support with pipe straps or bands. For spacing of supports, see table in Section F-4.3.

### 5. HOUSE PIPING SHUTOFF VALVES

#### 5.1 General

The Company will install a shutoff valve on the inlet line to every meter installation. In those instances where the meter is not located at the building, a shut off valve



shall be installed, by the customer, in the house piping at the building wall in an accessible location.

## 5.2 Multiple House Piping

In multiple tenant buildings supplied through a master meter or where the meter is not readily accessible from the appliance location, an individual shutoff valve for each apartment or for each house piping system shall be provided at a convenient point of general accessibility. Each valve must be plainly marked with a permanent tag by the installing agency so the individual gas piping systems can be readily identified.

## 6. APPLIANCES

### 6.1 General

Appliances shall be connected to the gas piping system with rigid pipe or UL, CSA/US, or Company approved flexible metal appliance connectors. An approved shut off valve shall be installed by the customer on the rigid pipe section of the house piping system ahead of the appliance controls, the union, flanges, or the approved flexible connector as the particular case may warrant. The valve shall be in an accessible location, and within six (6) feet of the appliance. Where local building departments invoke *CABO One and Two Family Dwelling Code*, the valve shall be installed within three (3) feet and in the same room as the appliance.

### 6.2 Gas Fireplaces/Log Lighter/Fire Place Piping

An approved shut off valve shall be installed by the customer on the rigid pipe section of the house piping system ahead of the appliance controls. The valve shall be in an accessible location within six (6) feet of the appliance. Where local building departments invoke *CABO One and Two Family Dwelling Code*, the valve shall be installed within three (3) feet and in the same room as the appliance.

In the event the valve is in a finished basement or adjacent room, the valve shall be accessible through a door or open area. This valve shall be identified.

Equipment shutoff valves shall not be located in fireplaces used for solid fuel burning.

Shut off valves supplied with gas log lighters are considered appliance controls and, therefore, require a separate approved shut off valve.

Casing is not required to sleeve gas piping serving a fireplace through core-drilled concrete, brick or rock hearth wall. Casing must be provided when concrete is poured around piping. Screw fitting joints are not permitted to be enclosed in core hole or casing.

### 6.3 Non-Portable Appliances

Central heating, unit heaters, room heaters, water heaters, incinerators and similar non-portable equipment shall be connected to the customer's gas pipe with approved rigid pipe and fittings. Exception: In an area where a heater or infra-red heater is subject to vibration, an approved flexible connector should be used to connect the appliance.

### 6.4 Portable Appliances

Domestic gas ranges, room heaters, refrigerators, fireplace heaters, clothes dryers, hot plates and similar equipment shall be connected to the customer's gas pipe with rigid pipe, or UL, CSA/US, or Company approved flexible metal appliance connectors. When a flexible connector is used, the connection shall be made to an outlet in the same room as the appliance and the connector shall not be in a concealed location.

### 6.5 Temporary Portable Construction Heaters

Portable construction heaters must be connected to the gas piping with an UL, CSA/US, or Company approved gas hose rated at 150 P.S.I. minimum; the hose, in this case, may exceed the six (6) foot limit in length, but no longer than necessary. The hose shall be connected to hard piping in the same room being heated. It shall not pass through any walls, partitions, ceilings or floor and must not be concealed. The rigid piping shall be installed in the same manner as permanent piping. The hose must be controlled by a stopcock where connected to the hard piping and have a stopcock at the appliance end. The hose shall be protected from damage and excessive heat.

### 6.6 Fully Portable Appliances

UL, CSA/US, or Company approved flexible gas hose may be used on fully portable gas appliances, such as irons, flat irons, Bunsen burners, hand torches, dentist torches and similar appliances. The flexible gas hose shall not exceed six (6) feet in length and shall not extend from one room to another nor pass through any walls, partitions, ceilings or floors and shall not be concealed from view.

### 6.7 Diaphragm Breather Vents

Diaphragm breather vents shall be piped to outside locations unless the built-in capacity of the breather vent is less than 2.5 CFH and the breather vent is located in a ventilated area. Diaphragm breather vents for equipment operating at pressures greater than 2 PSIG shall be piped to outside locations.

Appliance regulators with vent connections must be vented separately to an outside location in accordance with the following table.

Minimum Piping Sizes for Appliance Regulator Diaphragm Breather Vents	
Length	Minimum Size
0 - 10 Feet	Same size as Manufacturer's Connection
10 - 40 Feet	One pipe size larger than manufacturer's connection
40 - 100 Feet	Two pipe sizes larger than Manufacturers connection
Over 100 Feet	Manufacturer's recommendations

Minimum sizes listed above are to be used in the absence of manufacturer's recommendations. Where a manufacturer recommends larger sizes, their guidelines should be followed. Additionally, the above sizes are for diaphragm breather lines only. Vent piping for relief valves are sized based on manufacture's recommendations.

Excessive vent piping restricts the ability of a regulator to breathe and, therefore, may affect its performance. By increasing two pipes sizes, restrictions are decreased significantly and regulator performance should not be affected for vent lengths up to 100 feet.

Every effort should be made to pipe diaphragm breather vents separately to an outside location. Where separate venting is not practical, manifold venting in accordance with Sketch 5, Section L may be used. This manifold venting system is designed to prevent multiple failures from a single event.

## 7. ELECTRICAL BONDING, GROUNDING AND CIRCUITS

### 7.1 Gas Piping Bonding and Grounding

Each aboveground portion of a gas piping system upstream from the equipment shutoff valve shall be electrically continuous and bonded to any grounding electrode, as defined by the *National Electrical Code*. ANSI/NFPA 70.

### 7.2 Electrical Grounding

Gas piping shall not be used as a grounding electrode.

### 7.3 Electrical Circuits

Electrical circuits shall not utilize gas piping or components as conductors.

*Exception:* Low-voltage (50 volts or less) control circuits, ignition circuits, and electric flame detection device circuits shall be permitted to make use of piping or components for a part of an electrical circuit.

## 8. EXCEPTIONS TO NATIONAL FUEL GAS CODE

When installing house piping refer to the National Fuel Gas Code, ANSI Z223.1/NFPA 54 except for the following modifications.

1. The Company does not accept wrought iron pipe, ductile iron pipe, brass pipe, brass tubing, aluminum pipe, or aluminum tubing.
2. Fittings used with steel pipe shall be steel, brass, bronze, or malleable iron.
3. Gland-type compression fittings must be restrained to prevent pull out.
4. The Company requires tracer wire to be a minimum of AWG 12.
5. The Company does not permit the use of a fuel gas for testing of new pipe.
6. Unvented space heaters must be equipped with an oxygen depletion safety shut off device.
7. When converting BTU to cubic foot, The Company recommends using 1,000 BTU per cubic foot.

## **SECTION G**

### **INSPECTION AND TESTING**

#### **1. GENERAL**

This section provides the minimum testing requirements for gas service piping and house piping.

All testing shall conform to the latest requirements of the Company and/or the local jurisdiction. The current National and International Fuel Gas Code and/or local codes and ordinances shall apply. It is the responsibility of the installer to insure that the pipe is installed and tested in accordance with the prevailing local requirements at the time of installation.

The Company shall not be responsible for any defective material or faulty workmanship or for any loss or damage arising from such defective material or faulty workmanship by the customer or their agent.

Certain local governments have assumed the responsibility for house piping inspections and testing. Contact the local building department for requirements where the local jurisdiction is responsible for inspection and testing. In these instances, the local inspection department performs an approved house piping inspection & pressure test before the Company installs a meter.

#### **2. GAS HOUSE PIPING**

##### **2.1 Visual Inspections – Gas House Piping**

All customer house piping must pass a visual inspection and pressure test by the Company or the authority having jurisdiction before the meter is set and the line placed in service. At the time the meter is installed, the Company will perform a meter check to insure that the customer house piping is gas tight.

The customer must provide access to gas lines and equipment on roofs.

Partial visual inspections for buried house piping must be requested prior to backfilling any portion of the pipe to be buried. There is no charge for this inspection unless the piping fails the inspection and a second call must be made.

Approved house piping will be marked with a white tag, Exhibit 3. Approved partial house piping will be marked with a blue tag, Exhibit 2. House piping not approved will be marked with a red tag, Exhibit 4. The tag will be placed on the house piping as near the meter connection as possible.

##### **2.2 Pressure Testing Above Ground and Below Ground Gas House Piping**

The following are the Company's minimum test requirements in locations where the Company performs inspection and testing of house piping.

Minimum House Piping Testing Requirements		
House Piping Volume	Delivery Pressure	Testing Requirements
Residential	Standard Pressure	3 PSIG for 10 Minutes
	1 and 2 PSIG Systems	10 PSIG for 15 Minutes
	CSST Systems Standard or 2 PSIG	10 PSIG for 15 Minutes
Commercial/Industrial Less than 10 cubic feet See Volume Chart	Standard Pressure	3 PSIG for 10 Minutes
	CSST Systems Standard Pressure	10 PSIG for 15 Minutes
	1 PSIG to 10 PSIG	30 PSIG for 30 Minutes
Commercial/Industrial 10 to 500 cubic feet See Volume Chart	Standard Pressure	3 PSIG for 30 Minutes
	1 PSIG to 10 PSIG	30 PSIG for 30 Minutes
Churches, schools, hospitals and other buildings with high occupancy rates	Any delivery pressure up to 20 PSIG	30 PSIG for 30 Minutes

Contact Duke Energy for test requirements for house piping operating above 10 PSIG and/or having volumes greater than 500 cubic feet.

House piping with a connected load of 10,000 CFH or greater shall be tested at a minimum of 30 psig for 30 minutes.

House piping in churches, schools, hospitals, etc. where there can be a large concentration of people shall be tested at a minimum of 30 PSIG for 30 minutes. In the opinion of the Company, other house piping may justify being tested at a minimum of 30 PSIG for 30 minutes.

All pressure reducing regulators, fire suppression valves, check valves, pressure boosters, etc. must be physically disconnected from the piping being tested and replaced with a spool piece prior to the pressure test.

Additions, repairs, modifications, and other changes to the house piping system must be tested according to the above specifications. Tie-in connections need only to be tested with a liquid leak finding solution. The Company does not need to inspect or witness the pressure test for modifications, appliance tie-ins, or repairs that are less than 10' or have 3 or fewer mechanical joints.

Where house piping is 2" size or larger, or where the minimum test pressure is greater than 10 PSIG, the test pressure must be applied by the customer or customer's agent. Provision must be made for the Company to install the Company's pressure gage to verify test pressure results.

Piping systems longer than those listed below have volumes greater than 10 cubic feet and must be tested for at least 30 minutes.

Volume Chart 10 Cubic Feet	
Piping Size	Piping Length (Ft.)
1 1/4"	1000
2"	430
2 1/2"	300
3"	200
4"	110

EXHIBIT 1

**HOUSE PIPE INSPECTION CHECKLIST**

A-893-R-1

DISAPPROVED \_\_\_\_\_

**HOUSE PIPE INSPECTION CHECK-LIST**

ADDRESS \_\_\_\_\_ NAME \_\_\_\_\_ DATE WANTED \_\_\_\_\_

SIZE \_\_\_\_\_ TEST AT \_\_\_\_\_ LBS. FOR \_\_\_\_\_ MIN.

COMPLETE \_\_\_\_\_ PARTIAL \_\_\_\_\_ NUMBER OF CHARGES \_\_\_\_\_

COMPANY: CG&E \_\_\_\_\_ ULH&P \_\_\_\_\_ LWBG \_\_\_\_\_

	YES / NO		YES / NO
Ready for inspection	___ ___	UNDER GROUND HOUSE LINE	___ ___
Holds pressure	___ ___	Proper depth min 18"/max 24"	___ ___
Totally exposed	___ ___	Properly cased	___ ___
Properly sized	___ ___	Properly coated	___ ___
Properly supported	___ ___	Anode connected properly	___ ___
Proper fittings & piping	___ ___	Insulated fittings	___ ___
Dirt Legs	___ ___	Properly controlled	___ ___
Metal tag on multiple	___ ___	House line tied in	___ ___
Valves, Union, Swing Joints Accessible	___ ___	Meter set	___ ___
Gas Is On	___ ___	Refer to Supervisor _____	

REMARKS: \_\_\_\_\_

SIGNATURE \_\_\_\_\_ DATE \_\_\_\_\_ TIME \_\_\_\_\_



SECTION G

EXHIBIT 2

BLUE LABEL

This form should be used for partial inspection approvals.

ADDRESS		CITY			
APT./FLR.	TESTED AT	PSIG	FOR	MINUTES	
PARTIAL INSP. <input type="checkbox"/>		VISUAL INSP. <input type="checkbox"/>			
<b>APPROVED</b> <input type="checkbox"/>					
A-130-GAS		SIGNATURE		DATE	

EXHIBIT 3

WHITE LABEL

This form should be used for service and houseline approvals.

ADDRESS		CITY			
APT./FLR.	TESTED AT	PSIG	FOR	MINUTES	
FINAL INSP. <input type="checkbox"/>					
<b>APPROVED</b> <input type="checkbox"/>					
LA 128		SIGNATURE		DATE	

EXHIBIT 4

RED LABEL

This form is to be used when service or houseline is not approved.

ADDRESS		CITY			
APT./FLR.	TESTED AT	PSIG	FOR	MINUTES	
PARTIAL INSP. <input type="checkbox"/>	FINAL INSP. <input type="checkbox"/>	VISUAL INSP. <input type="checkbox"/>			
<b>NOT APPROVED</b> <input type="checkbox"/>		<b>CALL 421-9500</b>			
REASON:					
A-116-R-2-GAS		SIGNATURE		DATE	

**SECTION H**  
**MOBILE HOMES AND FREESTANDING METER INSTALLATIONS**

**1. GENERAL**

All mobile homes to be served with natural gas shall be adequately supported by underpinning, placed upon a substantial hard surface, such as concrete pads, sufficient to support the entire weight of the mobile home. The weight of the mobile home shall not rest on wheels.

Piping installations in mobile homes must be installed in accordance with this manual and must comply with the regulations in the "National Fuel Gas Code" ANSI Z223.1/NFPA 54. Gas connections to the mobile home must comply with the "Standard for the Standard Installation of Mobile Homes" ANSI/NFPA 501A.

**2. CUSTOMER SERVICE PIPING**

2.1 Typically the house piping connector is located in the rear third of the mobile home. Piping shall not be buried under any portion of the mobile home, stand or patio slab unless properly cased and vented.

2.2 Customer service piping shall be installed by Duke Energy. See Section E for service installation instructions.

**3. METER SET ASSEMBLY SUPPORT**

3.1 At the service riser location, a 4 foot long painted metal post will be installed by the Company for meter support.

**4. HOUSE PIPING**

4.1 Gas piping shall be designed in accordance with accepted engineering practice to be of such size and installed to provide a supply of gas to meet the maximum expected demand. Standard pressure piping systems should be sized such that the pressure loss does not exceed 0.3 inch water column (W.C.). The minimum pipe size to adequately supply gas from the meter to a mobile home is 3/4".

4.2 The meter outlet or house pipe riser should be no more than two (2) feet from the mobile home nor closer than eighteen (18) inches. Service piping shall not be installed underground beneath a mobile home stand or patio slab.

4.3 For meters located more than two (2) feet from the mobile home the house line must be properly supported and protected by the customer per section F 4.3. Any lengths that require more than one support must be buried. See section J for installation requirements for buried house piping.

4.4 Customer connections to the mobile home must be made with approved piping materials or a UL, CSA/US, or Company approved flexible mobile home connector (not an appliance connector) of sufficient capacity and no longer than four (4) feet in

length. The flexible connector shall not run through the skirting. Rigid piping must run through the skirting and be securely fastened to the home. In addition, the flexible connector must be installed with some slack allowing for movement and must not contain sharp bends.

**SECTION I**  
**DUKE ENERGY AND SUBSIDIARY COMPANIES**  
**CORRUGATED STAINLESS STEEL TUBING (CSST)**

1. **GENERAL**

In the interest of safe and reliable service, Duke Energy has adopted these requirements for the installation, operation, and maintenance of Corrugated Stainless Steel Tubing (CSST) house piping. House piping consists of pipe and fittings from the outlet of the meter to the equipment shutoff valve. If any provision herein conflicts with any local, state or federal ordinance, rule or regulation, the latter shall govern in the area in which the installation is made.

The *National Fuel Gas Code ANSI Z223.1 NFPA 54*, is an integral part of these requirements. This code covers gas piping from the outlet of the gas meter to the inlet of the gas appliance, including appliance installations. Duke Energy requirements replace *National Fuel Gas Code* requirements when they differ.

Certain local governments have the responsibility for house piping inspections and testing. Please contact the local building department for installation requirements. In these instances, Duke Energy requires an approved house piping inspection & pressure test performed by the local inspection department before turning on a meter.

Qualified personnel shall install house piping at customer's expense. Customer is responsible for the installation and maintenance of the house piping and assumes all risk resulting from defects therein.

2. **IMPORTANT TELEPHONE NUMBERS**

**Duke Energy Gas & Electric Services**

For information regarding installation specifications.

Call	(513) 651-0444
Toll Free	1-800-262-3000 Extension 3866

**To Report Gas Trouble**

Call	(513) 651-4466
Toll Free	1-800-634-4300

**For All Inspections and Meter Sets**

All gas meter sets, applications, inspections, and to inquire on status of existing requests for these services, call Duke Energy Gas & Electric Services (513) 651-0444

Toll Free	1-800-262-3000 Extension 3866
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**For Locations of any Underground Utility**

Call Before You Dig – Ohio	1-800-362-2764
Call Before You Dig – Kentucky	1-800-752-6007
Call Before You Dig – Indiana	1-800-382-5544

Call the Utilities Protection Service at least two (2) working days in advance.

### 3. CSST GAS PIPING SYSTEM DESIGN

#### 3.1 Sizing

The qualified installer is responsible for sizing CSST installations in accordance with the manufacturer's installation requirements. Duke Energy does not size or verify the size of CSST installations. Meter outlet to building wall piping shall be 1" size steel or larger. Other steel piping sections such as manifolds and sediment traps shall be ½" size or larger.

#### 3.2 Delivery Pressure

Standard delivery pressure is approximately 7 inches water column at the meter. An optional elevated delivery pressure of 2 psig is approved for CSST systems where available. Contact Duke Energy to verify elevated pressure availability prior to sizing and installing a 2 psig system.

#### 3.3 System Configuration

Typical standard pressure CSST configurations are shown in Exhibit A. Elevated 2 psig delivery pressure CSST system configurations are shown in Exhibit B. The qualified installer is responsible for designing a system in accordance with building configuration, construction style, appliance loads, code restrictions, and available delivery pressure.

### 4. MATERIAL

#### 4.1 General

Each length of pipe shall be examined prior to installation. Any dirt or obstructions shall be removed. Damaged, kinked, or otherwise defective pipe shall not be installed. Any burrs left by the cutting tool shall be removed.

When defective pipe or fittings are located in a gas piping system, the defective pipe or fittings shall be replaced. CSST splices or couplings may be used for repairs, but are not accepted for new installations.

#### 4.2 Pipe

Steel pipe shall be at least standard weight (schedule 40) and shall comply with ASTM A53 or ASTM A106.

Corrugated stainless steel tubing (CSST) shall be tested and listed in compliance with the construction, installation, and performance requirements of *Interior Fuel Gas Piping Systems Using Corrugated Stainless Steel Tubing*, ANSI/AGA LC 1. Approved manufacturers are listed in Exhibit I.

### 4.3 Fittings

Threaded fittings for steel pipe shall be of steel, brass, bronze, or black malleable iron and shall be of standard weight, banded and beaded type. Bushings, all-thread (close) nipples, saddles, and cast iron connections are not permitted. Unions are permitted only as follows:

1. Between shutoff valve and appliance
2. Between system regulator outlet and manifold inlet
3. For insulating underground house piping

CSST fittings and components are part of the CSST piping system and shall be as specified by the manufacturer. Fittings are not interchangeable between different manufacturers of CSST.

### 4.4 System Regulators

Duke Energy's 2 psig delivery systems are equipped with overpressure protection devices designed to limit customer's pressure to 10 psig. Customer's regulators operating at 2 psig inlet must be capable of sustaining a 10 psig exposure without damage. System regulators listed in Exhibit I are approved for Duke Energy's 2 psig delivery systems.

### 4.5 Valves

All house-piping valves shall be approved for natural gas applications.

## 5. INSTALLATION

### 5.1 Meter Connection

Duke Energy gas meters and meter manifolds shall be partially supported by customer's house piping. CSST shall not be connected directly to the gas meter. Customer's installer shall use 1" or larger size steel piping to connect the gas meter to the CSST system. The steel piping shall be securely attached to the exterior building wall. See exhibit C for typical meter connections.

### 5.2 Support

Tubing shall be supported with metal pipe straps, bands, or hangers suitable for the size and weight of the tubing. Support spacing shall be as specified by the CSST manufacturer. Gas piping shall not be supported by other utilities. Structural integrity of the building shall not be compromised by the installation of gas piping.

### 5.3 Clearances

Where CSST is installed through floors, walls, ceilings, etc. the opening will be at least ½" greater than the tubing outside diameter.

#### 5.4 **Bending Radius**

Changes in direction shall be accomplished with a generous bending radius to avoid over stressing tubing and fittings. Tight bends, kinks, twists, or stretching of CSST is not permitted. CSST manufacturers specify the minimum allowable bending radius.

#### 5.5 **Tubing Beneath Floor Joists**

CSST may be routed beneath, through, or along ceiling or floor joists. Consideration shall be given to future construction such as finished basements. Striker plates shall be installed to protect concealed support points within 3" from edge of stud, joist, floor, or ceiling. See exhibit E for protection methods.

#### 5.6 **Tubing Between Wall Joists**

CSST may be installed between wall studs if it hangs freely to prevent the possibility of being punctured by a 3" long nail. Striker plates shall be used at points of constraint through studs, joists, floors, ceilings or similar restraining type structures. See exhibit E for protection methods.

#### 5.7 **Termination Outlet**

All piping outlets shall be installed to provide sufficient clearance from ceilings, walls and floors to permit use of a pipe wrench of suitable size without straining or bending the pipe. The outlet fitting or piping shall not be placed behind doors.

Termination outlets shall be securely closed and gas-tight with an approved threaded plug, threaded cap, or listed convenience outlet immediately after installation and shall remain closed until an appliance is connected.

A typical CSST termination outlet is shown in exhibit E. A flexible metal conduit or striker plate shall be used to protect tubing where movement is restricted and where tubing is at risk of puncture from a 3" long nail.

#### 5.8 **Appliance Shutoff Valves**

Customer's installer shall install an approved shutoff valve ahead of the appliance controls, union, or approved flexible connector as the particular case may warrant. The valve shall be in an accessible location, and within six (6) feet of the appliance as measured along the piping run. Where local building departments invoke *CABO One and Two Family Dwelling Code*, the valve shall be installed within three (3) feet and in the same room as the appliance.

#### 5.9 **Sediment Traps**

A sediment trap shall be installed where required to catch dirt or other foreign materials. The sediment trap shall be at least ½" size and no smaller than the pipe to which it is attached. The sediment trap should be installed as close as practical to the inlet of the equipment, preferably downstream of the equipment shutoff valve. See typical furnace connection exhibit G for a sediment trap installation.

### 5.10 Manifolds

Manifolds are installed where multiple runs are made from a common location. Several configurations are possible, see exhibit D for typical manifold installations. Manifold installations must be accessible.

An approved shut off valve must be installed upstream of the system regulator for elevated 2 psig systems. Where Duke Energy performs house line inspections and pressure testing, a temporary nipple shall be installed in place of the system regulator. Customer's installer replaces the temporary nipple with system regulator after pressure test approval and gas is turned on. Where local governments have assumed the responsibility for house piping inspections and testing, contact the local building department for installation requirements.

Customer's installer may install approved shutoff valves on manifold outlet appliance runs. If appliance piping is 6 feet or less, a manifold outlet shutoff valve may be used as the required appliance shutoff valve. Permanently engraved metal tags shall identify an appliance for each manifold outlet shut off valve.

### 5.11 Regulator Venting

Regulators equipped with approved vent limiting devices and located in ventilated areas do not require breather vents to be piped to an outside location.

### 5.12 Concealed Fittings

When installing house piping that will be concealed, the number of concealed fittings shall be kept to a minimum. Concealed fittings are not permitted where CSST is installed in conduit.

### 5.13 Tubing Under Concrete

CSST shall not be directly embedded in concrete. CSST shall be routed inside a non-metallic watertight conduit with an inside diameter at least ½" larger than the tubing outside diameter. CSST concealed within conduit must be one piece with no splices or joints. See exhibit F for tubing installed within conduit.

### 5.14 Outdoors

When installed outdoors, CSST shall be protected from mechanical damage. A conduit or chase is required for installations in exposed unprotected areas within 6 feet of grade. Conduit shall be supported with proper size pipe hooks, pipe straps, bands, or hangers.

Protective coating must remain intact outdoors. Mechanical joints and associated exposed metal tubing shall be wrapped or protected by shrink sleeves. Appropriate measures must be taken to shield CSST from corrosive environments such as exposure to acid or chloride based cleaning solutions for brick or masonry.



Where passing through an outside wall, CSST shall be protected. CSST must be sleeved where passing through brick or masonry walls as shown in exhibit C.

### 5.15 Buried Outdoors

Buried CSST shall be routed inside a non-metallic watertight conduit with an inside diameter at least ½" larger than the tubing outside diameter. CSST concealed within conduit must be one piece with no splices or joints. Minimum depth is 18 inches of cover.

The non-metallic watertight conduit shall extend above grade and shall be properly supported to protect CSST from mechanical damage. If a building or structure is not available for support, a 4X4 treated post or equivalent shall be installed for support.

Conduit openings shall be sealed with a compound non-corrosive to stainless steel to prevent entry of water. See exhibit F for tubing installed within conduit.

### 5.16 Prohibited Locations

Except as otherwise provided in this section, gas piping shall not be installed in or pass through any air conditioning, heating or ventilating duct system, clothes chute, chimney, flue, or elevator shaft.

House piping may enter a duct system only when all the following conditions are met:

1. The gas utilization equipment is used to pre-heat outside make-up air.
2. The gas utilization equipment is approved for such use.
3. The use is confined to commercial/industrial occupancies.
4. The installation meets all local, state, or federal code.

## 6. HOUSE PIPING SHUTOFF VALVES

### 6.1 General

Duke Energy will install a shutoff valve on the inlet piping to every meter installation. In some situations, the customer is also required to install a meter outlet valve at the meter set. Where the meter is not located at the building, a shutoff valve shall be installed, by the customer's installer, in the house piping at the building wall and in an accessible location.

### 6.2 Multiple House Piping

In multiple tenant buildings supplied through a master meter or where meters are not readily accessible from the appliance location, an individual shutoff valve for each apartment or for each house piping system shall be provided at a convenient point of

general accessibility. Each valve must be plainly marked with a permanent tag by the installing agency so the individual gas piping systems can be readily identified.

## 7. APPLIANCE

### 7.1 General

CSST gas systems terminate at the shutoff valve or termination outlet. Appliances shall be connected to the CSST gas system with rigid piping or A.G.A. approved flexible metal appliance connectors.

### 7.2 Gas Fireplaces/Log Lighter/Fire Place Piping

The appliance shutoff valve shall not be installed inside a firebox for log lighters, gas wands, or in any firebox, that burns solid fuel. CSST may be used to deliver gas directly to the appliance shutoff valve.

**NOTE:** If the valve is in a finished basement or adjacent room, the valve shall be accessible through a door or open area and must be identified.

Shutoff valves supplied with gas log lighters are considered appliance valves and, therefore, require a separate approved shutoff valve.

### 7.3 Non-Movable Appliances

Central heating, unit heaters, room heaters, water heaters, incinerators and similar non-portable equipment may be connected directly to CSST provided sediment trap and appliance shutoff valve requirements are observed. See exhibit G.

### 7.4 Movable Appliances

A.G.A approved flexible metal appliance connectors may be used to connect domestic gas ranges, room heaters, refrigerators, fireplace heaters, clothes dryers, hot plates and similar portable equipment as shown in exhibit G. When a flexible connector is used, the connection shall be made to an outlet in the same room as the appliance and the connector shall not be in a concealed location.

### 7.5 Outdoor Equipment

Gas appliances mounted on concrete pads or blocks, such as heat pumps, air conditioners, pool heaters and Natural Gas Vehicle refueling systems, shall be connected to the CSST system at a termination fitting using either rigid pipe or an approved outdoor appliance connector.

Remote pad mounted gas appliances served by buried CSST may be connected directly to CSST. The buried portion of CSST must be sealed in watertight non-metallic conduit. Requirements for sediment trap and appliance shutoff valve must be observed.

Gas appliances attached to the building may be connected directly to CSST provided sediment trap and appliance shutoff valve requirements are observed.

Movable outdoor appliances such as barbecue grills shall be connected using an A.G.A. approved outdoor appliance connector. The connector shall be attached to the CSST system using a termination fitting or approved quick disconnect device. Permanently mounted gas grills may be connected directly to the CSST system.

See Exhibit H for typical outdoor installations.

## 8. ELECTRICAL BONDING, GROUNDING AND CIRCUITS

### 8.1 Electrical Bonding

Each above ground portion of a CSST gas piping system upstream from the equipment shutoff valve shall be electrically continuous and bonded to the grounding electrode system at the point where the gas piping enters the building, as required by the *National Fuel Gas Code*, ANSI/NFPA 54, 7.13.2 and the *National Electrical Code*, ANSI/NFPA 70, 250-104 (b). The bonding wire shall not be smaller than 6 AWG copper wire or equivalent. Installation of bonding wire, clamps, and other bonding materials shall be as required by the local authority having jurisdiction for electrical installations.

### 8.2 Electrical Grounding

Gas piping shall not be used as a grounding conductor or electrode.

### 8.3 Electrical Circuits

Electrical circuits shall not utilize gas piping or components as conductors.

*Exception:* Low-voltage (50 volts or less) control circuits, ignition circuits, and electric flame detection device circuits shall be permitted to make use of piping or components for a part of an electrical circuit.

## 9. INSPECTION AND TESTING

### 9.1 General

This section is intended to provide the minimum testing requirements for CSST gas systems installed the Duke Energy service area. All gas piping must be tested in accordance with these specifications. The gas meter must be disconnected prior to testing house lines. The requirements of this section apply where Duke Energy is performing inspection and testing of customer's house piping. Contact the local building department for requirements where the local jurisdiction is responsible for inspection and testing.

All testing shall conform to this section, the National Fuel Gas Code ANSI Z223.1 NFPA 54, local codes and local ordinances. It is the responsibility of customer's

installer to insure that the gas house piping system is installed and tested in accordance with the prevailing local requirements at the time of installation.

Duke Energy shall not be responsible for any defective material or faulty workmanship or for any loss or damage arising from such defective material or faulty workmanship by the customer or their agent.

Many local governments have the responsibility for house piping inspections and testing. Please contact the local building department for installation requirements. In these instances, Duke Energy requires an approved house piping inspection & pressure test performed by the local inspection department before turning on a meter.

## 9.2 Inspection

All customer house piping must pass a visual inspection and pressure test by Duke Energy or the authority having jurisdiction before the meter is set and the line is placed in service. At the time the meter is installed, Duke Energy will perform a meter check to insure the customer house piping is tight.

As much as practical the entire system shall be made visible to the Duke Energy inspector. Transition from steel to CSST must be accessible for visual inspection. If any portion of the piping must be buried prior to completion of work, see 9.3 of this section. The customer must provide access to gas lines and equipment on roofs.

Approved house piping will be marked with a white tag, see exhibit J. House piping not approved will be marked with a red tag, see exhibit K. The tag will be placed on the house piping as near the meter connection as possible. A copy of the inspection form will be left in a weatherproof plastic bag affixed to the house piping meter connection. In most cases, this will be beyond the foundation wall on the outside of the building. See exhibit M for a copy of the inspection form.

## 9.3 Partial House Piping Inspection

Partial house piping inspections must be requested prior to covering buried portions of house piping systems including non-metallic conduit for buried CSST. This may or may not include the pressure test.

Approved partial house piping will be marked with a blue tag, see exhibit L. House piping not approved will be marked with a red tag. The tag will be placed on the house piping as near to the end of house as possible.

There is no charge for this inspection unless the piping fails the inspection and a second call must be made.

## 9.4 Pressure Test Requirements

Gas piping systems containing CSST will be tested at a minimum pressure of 10 psig for at least 15 minutes. This applies to both standard pressure delivery systems and elevated 2 psig delivery systems.

Where system regulators are required, regulator shall not be installed at time of pressure test. Customer's installer shall install a temporary nipple in place of the system regulator. After pressure test approval and gas is turned on, Customer's installer replaces temporary nipple with system regulator. Duke Energy will close and red tag manifold shutoff valve prior to turning gas on. See exhibit N for a copy of the red appliance shutoff tag.

EXHIBIT A

STANDARD PRESSURE SYSTEM CONFIGURATIONS

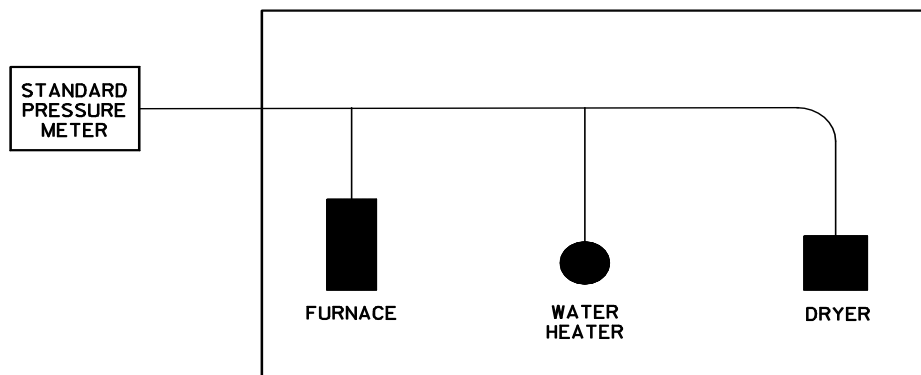
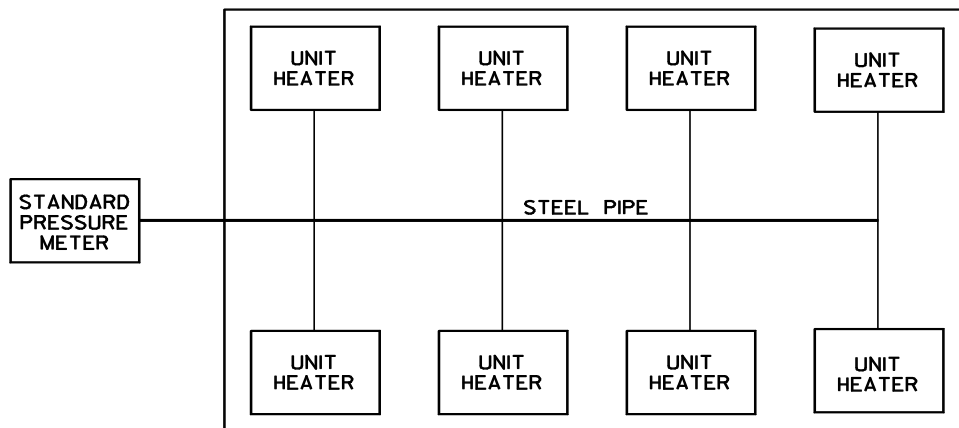
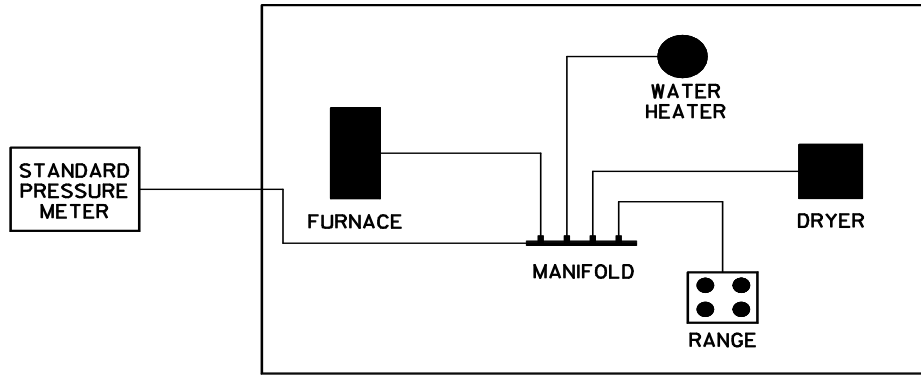


EXHIBIT B

ELEVATED 2 PSIG SYSTEM CONFIGURATIONS

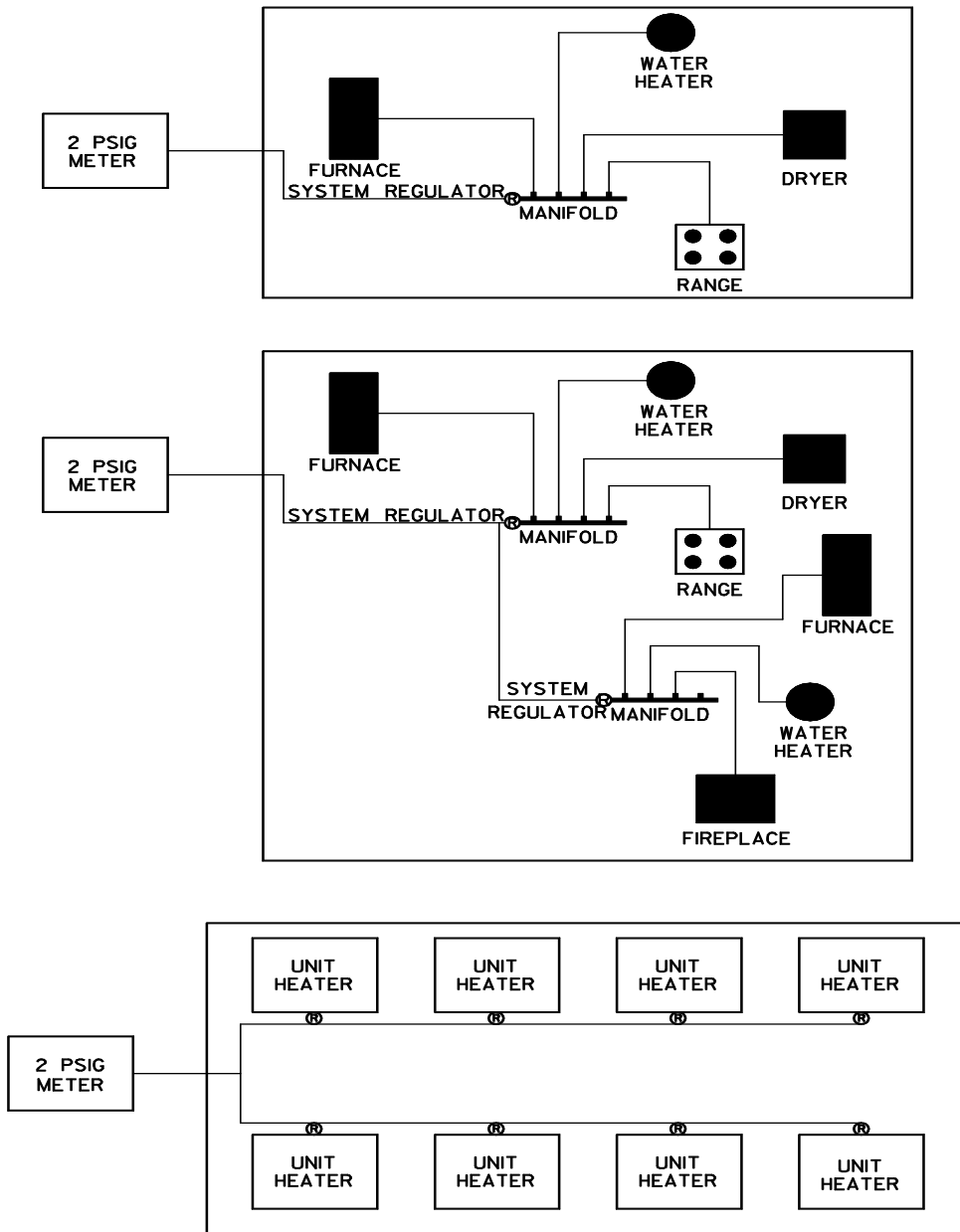


EXHIBIT C

GAS METER CONNECTION

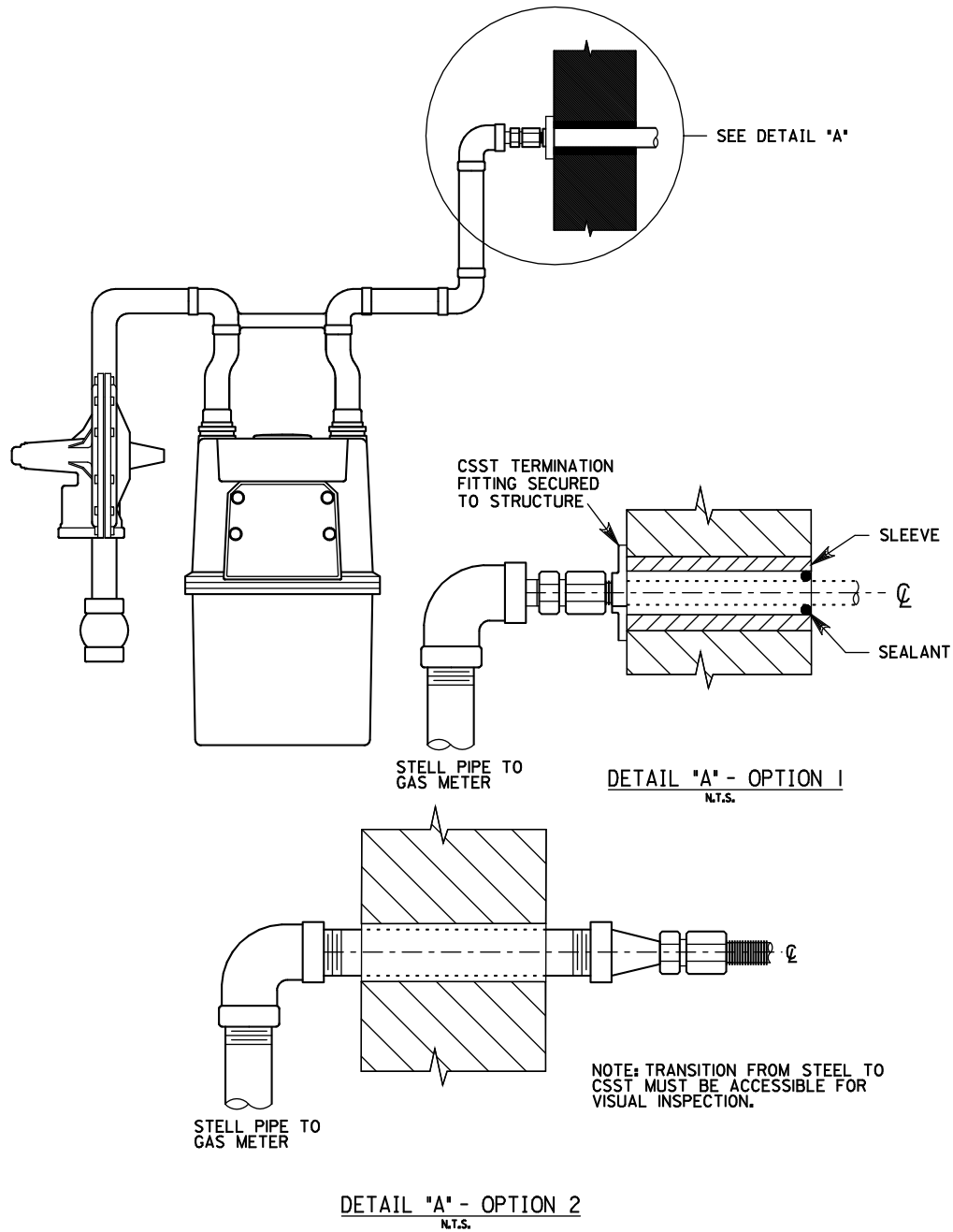
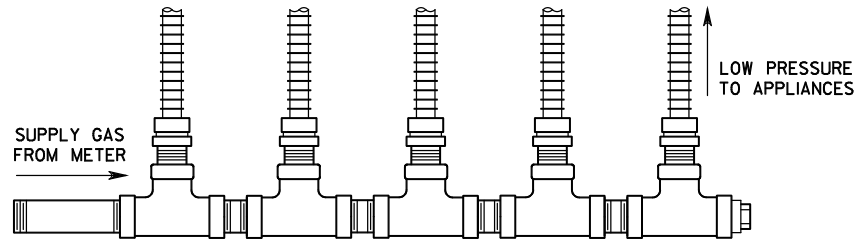




EXHIBIT D

MANIFOLDS



MANIFOLD FABRICATED FROM PIPE NIPPLES AND TEES

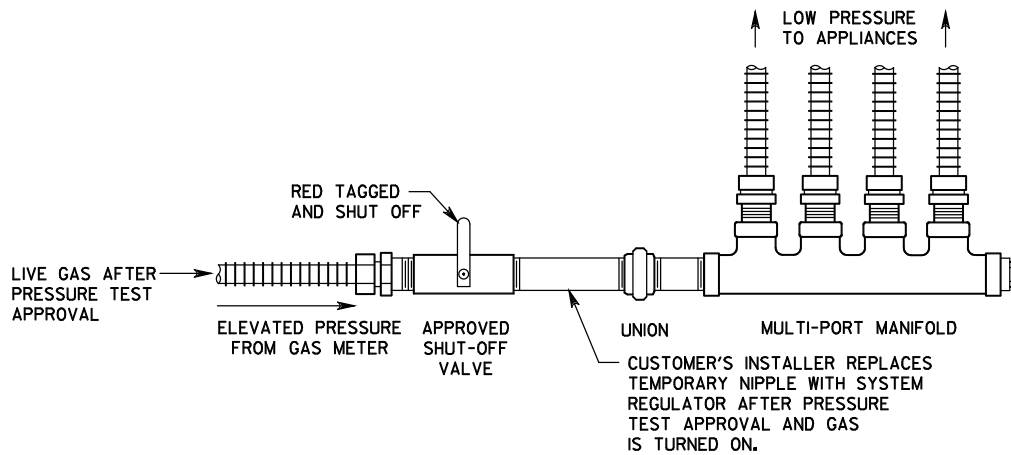
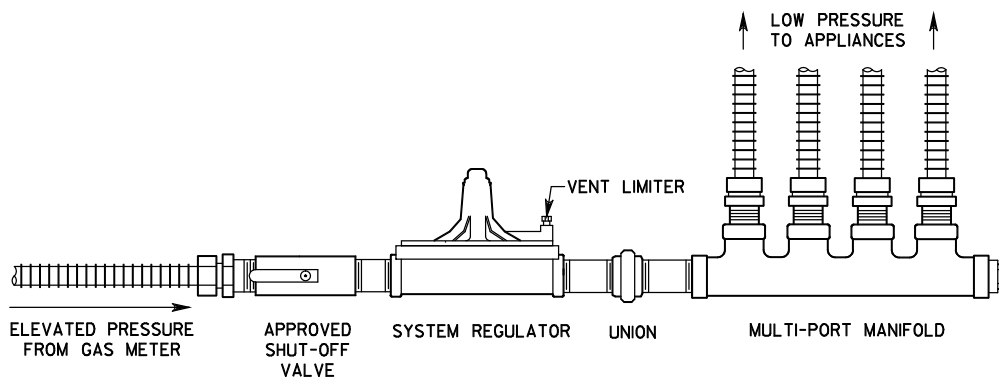


EXHIBIT E

**CSST PROTECTION METHODS**

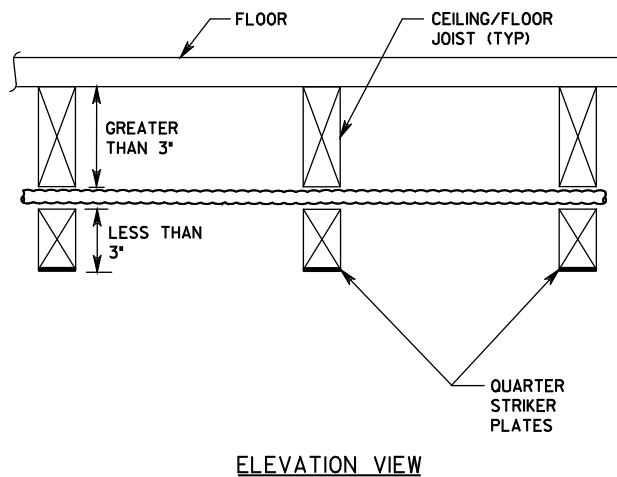
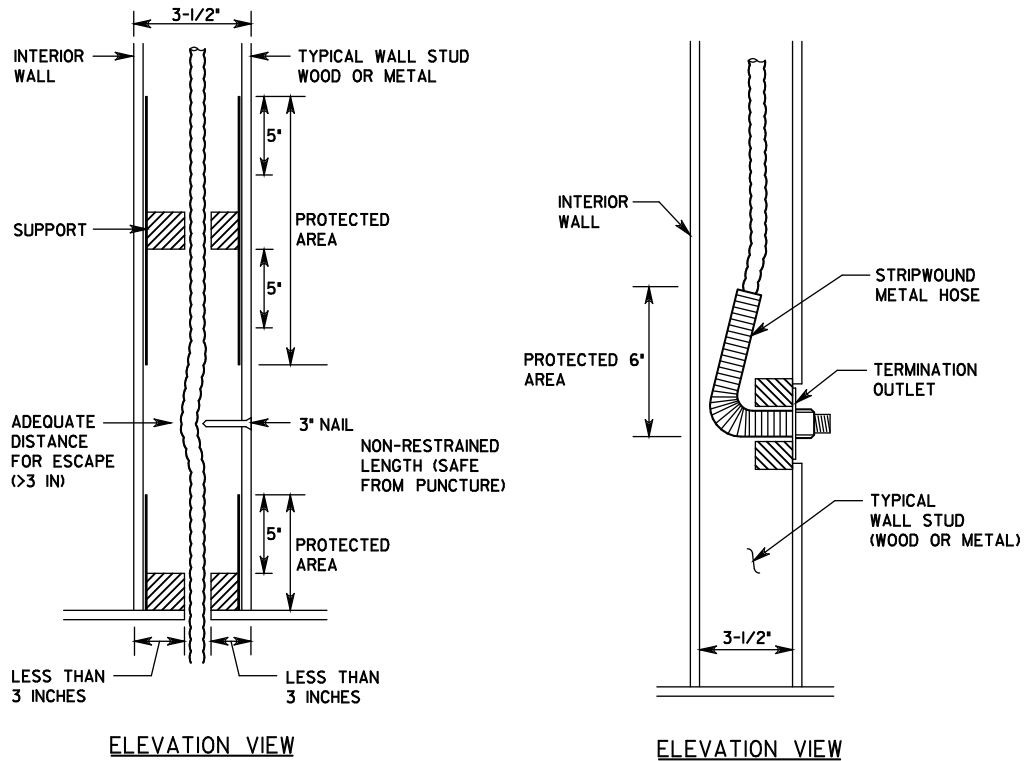


EXHIBIT F

BURIED/EMBEDDED CSST

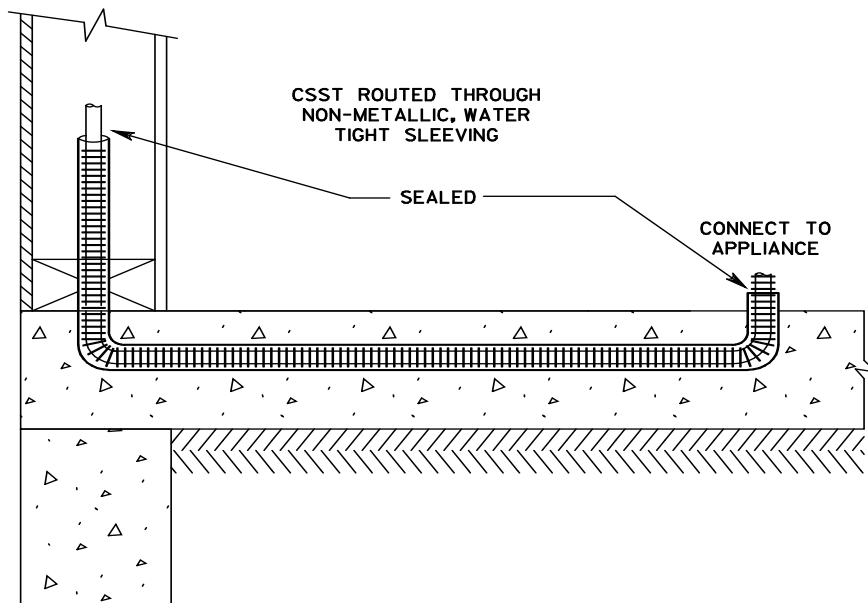
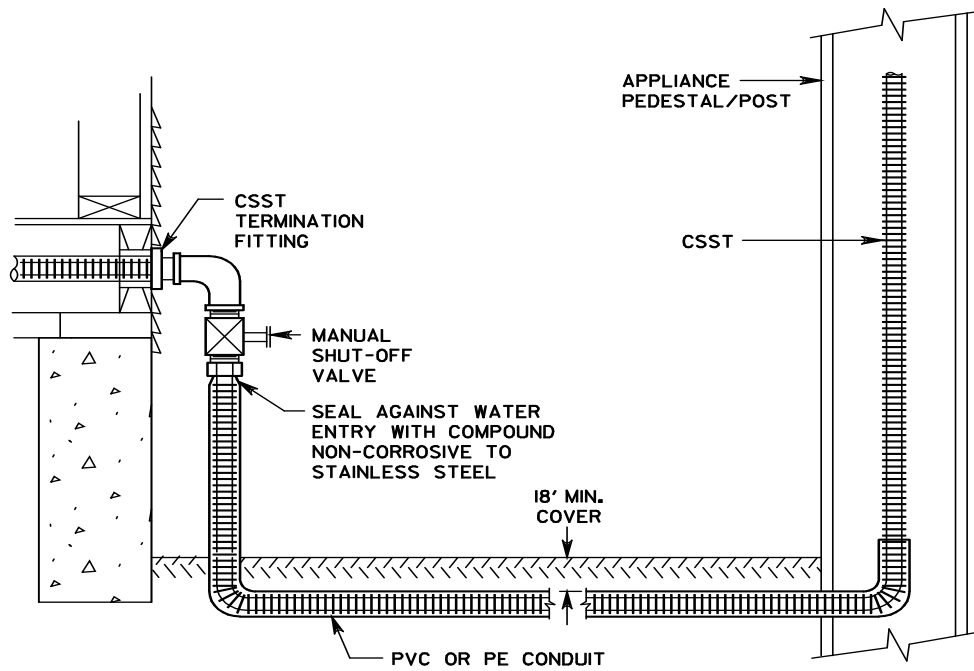


EXHIBIT G

TYPICAL INDOOR APPLIANCE CONNECTIONS

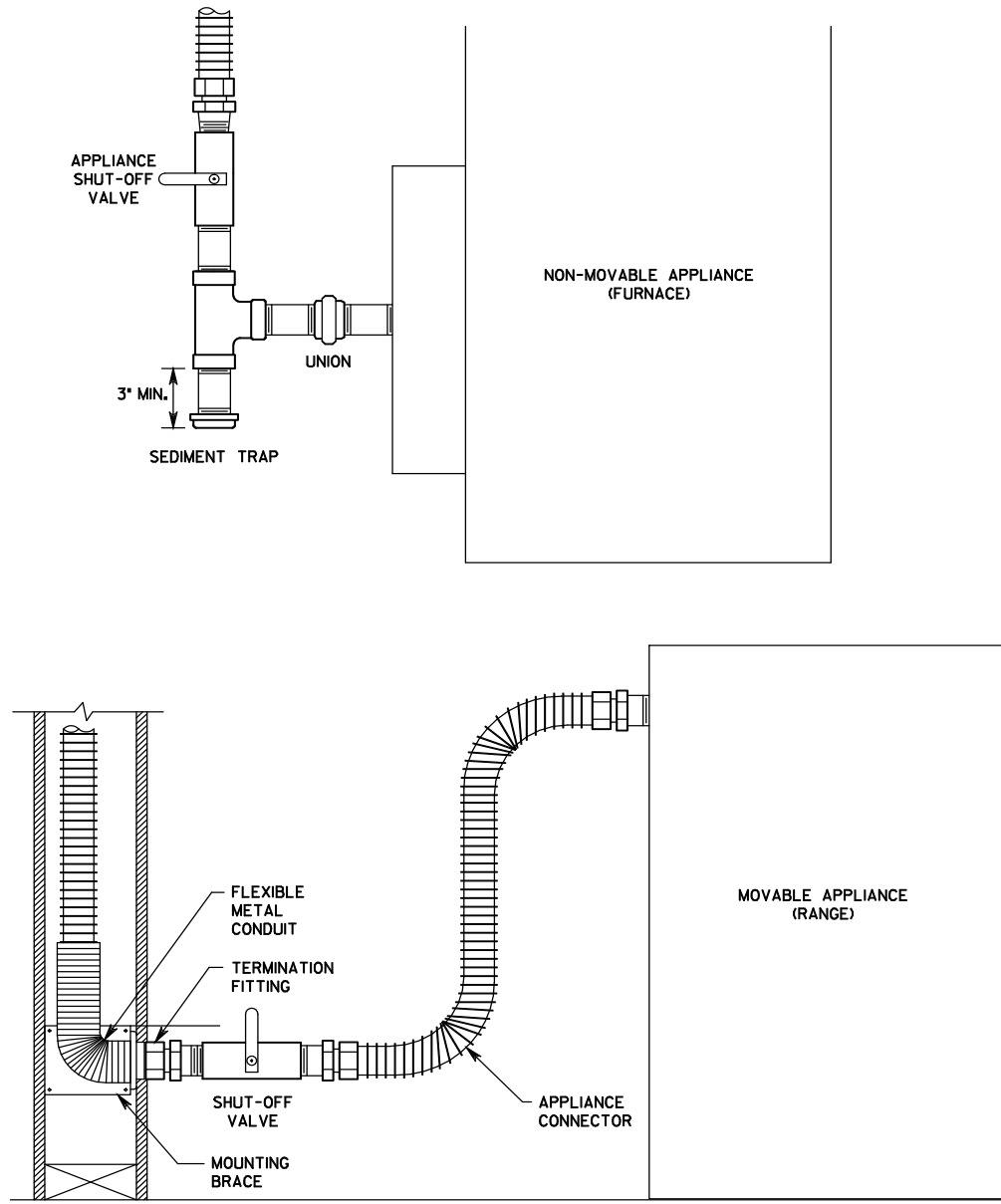
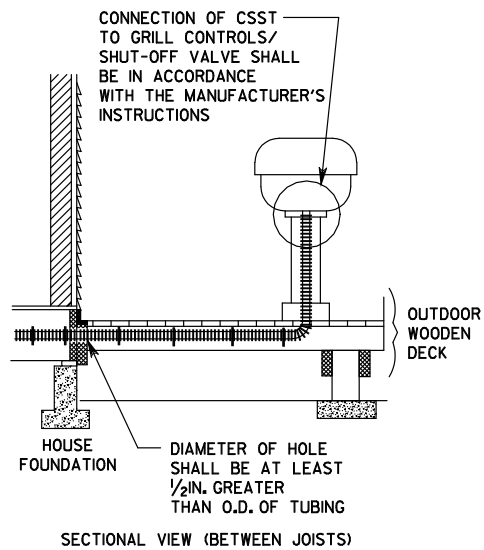
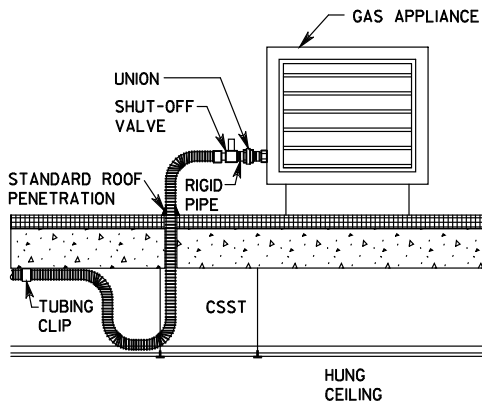
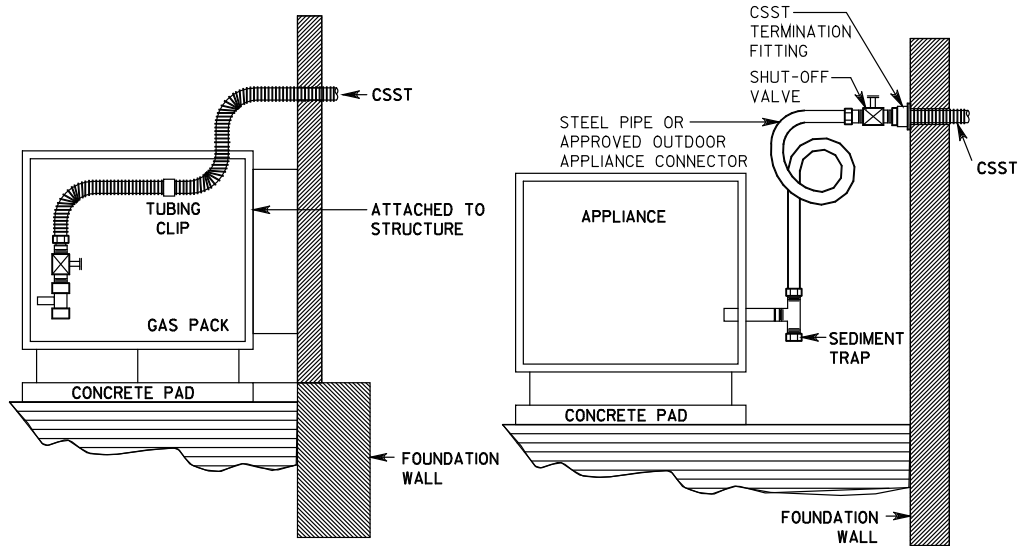


EXHIBIT H

**TYPICAL OUTDOORS APPLIANCE CONNECTIONS**



## EXHIBIT I

DUKE ENERGY APPROVED CSST MANUFACTURERSGastite

Titeflex Corporation  
P.O. Box 90054  
603 Hendee Street  
Springfield, MA 01104-0054

(413) 739-5631  
(800) 662-0208

Wardflex

Ward Manufacturing  
P.O. Box 9  
115 Gulick St.  
Blossburg, PA 16912

(717) 638-2131  
(800) 248-1027

TracPipe

OmegaFlex  
Subsidiary of Mestek, Inc.  
251 Creamery Way  
Exton, PA

(800) 671-8622

Parker PGP

Parker Hannifin Corporation  
Parflex Division  
Ravenna, Ohio 44266

(800) PARAFLEX (727-3539)

Pro-Flex

Tru-Flex Metal Hose Corp.  
Highways 263 & 28  
P.O. Box 247  
West Lebanon, Indiana 47991

(800) 255-6291

DUKE ENERGY APPROVED SYSTEM REGULATORS

Maxitrol 325-3  
Maxitrol 325-5A

OARA Type 300  
OARA Type 600

## EXHIBIT J

This form is used for final house line inspections.

ADDRESS		CITY			
APT./FLR.	TESTED AT	PSIG	FOR	MINUTES	
		FINAL INSP. <input type="checkbox"/>			
<b>APPROVED</b> <input type="checkbox"/>					
LA 128		SIGNATURE		DATE	

## EXHIBIT K

(RED LABEL)

This form is used when house line inspections are not approved.

ADDRESS		CITY			
APT./FLR.	TESTED AT	PSIG	FOR	MINUTES	
PARTIAL INSP. <input type="checkbox"/>	FINAL INSP. <input type="checkbox"/>	VISUAL INSP. <input type="checkbox"/>			
<b>NOT APPROVED</b> <input type="checkbox"/>			<b>CALL 421-9500</b>		
REASON:					
A-116-R-2-GAS		SIGNATURE		DATE	

## EXHIBIT L

(BLUE LABEL)

This form is used for partial inspection approvals.

ADDRESS		CITY			
APT./FLR.	TESTED AT	PSIG	FOR	MINUTES	
PARTIAL INSP. <input type="checkbox"/>	VISUAL INSP. <input type="checkbox"/>				
<b>APPROVED</b> <input type="checkbox"/>					
A-130-GAS		SIGNATURE		DATE	

EXHIBIT M

HOUSE PIPE INSPECTION CHECKLIST

A-893-R-1

DISAPPROVED \_\_\_\_\_

**HOUSE PIPE INSPECTION CHECK-LIST**

ADDRESS \_\_\_\_\_ NAME \_\_\_\_\_ DATE WANTED \_\_\_\_\_

SIZE \_\_\_\_\_ TEST AT \_\_\_\_\_ LBS. FOR \_\_\_\_\_ MIN.

COMPLETE \_\_\_\_\_ PARTIAL \_\_\_\_\_ NUMBER OF CHARGES \_\_\_\_\_

COMPANY: CG&E \_\_\_\_\_ ULH&P \_\_\_\_\_ LWBG \_\_\_\_\_

	YES / NO		YES / NO
Ready for inspection	___ ___	UNDER GROUND HOUSE LINE	___ ___
Holds pressure	___ ___	Proper depth min 18"/max 24"	___ ___
Totally exposed	___ ___	Properly cased	___ ___
Properly sized	___ ___	Properly coated	___ ___
Properly supported	___ ___	Anode connected properly	___ ___
Proper fittings & piping	___ ___	Insulated fittings	___ ___
Dirt Legs	___ ___	Properly controlled	___ ___
Metal tag on multiple	___ ___	House line tied in	___ ___
Valves, Union, Swing Joints Accessible	___ ___	Meter set	___ ___
Gas Is On	___ ___	Refer to Supervisor _____	

REMARKS: \_\_\_\_\_

SIGNATURE \_\_\_\_\_ DATE \_\_\_\_\_ TIME \_\_\_\_\_



**EXHIBIT N**

**APPLIANCE SHUTOFF NOTICE**

**WARNING**

GAS IS ON TO THIS VALVE.

**APPLIANCE SHUTOFF**

**NOTICE**

DO NOT RELIGHT OR USE THIS APPLIANCE UNTIL THE CONDITION(S) NOTED ON THE REVERSE SIDE OF THIS NOTICE ARE CORRECTED. CONTACT YOUR PLUMBER OR HEATING CONTRACTOR FOR NECESSARY REPAIRS OR REPLACEMENTS.

(OVER)

TA-181 R6 GAS

THE GAS TO THIS APPLIANCE HAS BEEN SHUT OFF BECAUSE IT IS UNSAFE AND MAY RESULT IN INJURY TO PERSON OR PROPERTY.

UNSAFE CONDITION: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

ADDRESS: \_\_\_\_\_ DATE: \_\_\_\_\_ TIME \_\_\_\_\_

**CINERGY®**

COMPANY REPRESENTATIVE: \_\_\_\_\_

**SECTION J**  
**UNDERGROUND HOUSE PIPING INSTALLATION REQUIREMENTS**

**1. MATERIAL**

**1.1 General**

All underground house piping installed by customers or their agent must conform to Company specifications. Choice of materials will be subject to Company approval. New underground gas house piping installations shall be plastic or steel.

Each length of pipe shall be examined internally and externally before installation. Any dirt or obstructions found internally shall be removed. Damaged sections shall not be installed.

**1.2 Plastic Underground House Piping**

The Company approves polyethylene plastic pipe that meets the requirements of ASTM Specifications, D 2513. Plastic pipe manufactured two or more years prior to installation will not be accepted. Specification abbreviations, required plastic pipe markings, approved trade names and manufacturers are listed in the back of this section.

The Company uses the following polyethylene pipe sizes, and dimension ratios (wall thickness) and types:

1" CTS SDR 11.5, PE2406/2708  
1 ¼" IPS SDR 10, PE2406/2708  
2" IPS SDR 11, PE2406/2708  
3" IPS SDR 11.5, PE2406/2708  
4" IPS SDR 11.5, PE2406/2708  
6" IPS SDR 13.5, PE2406/2708  
8" IPS SDR 17.0, PE4710

If the customer uses a different polyethylene pipe type or different SDR than is the Company standard, the customer is responsible for verifying the material meets the minimum emergency pressure rating listed in Section F3.4.

**1.3 Steel Underground House Piping**

Buried steel house piping shall have a yield strength of 35,000 PSIG or greater (ASTM A53 grade B or higher). Schedule 40 or greater wall thickness is required. Buried steel piping must be protected against corrosion with a protective coating and the use of Magnesium anodes in accordance with Section K.

Weld fittings shall be in accordance with ANSI B16.9 and ASTM 234 Grade B or equal. Pipe Flanges shall be in accordance with ANSI B16.5 and ASTM A105 or equal. Most installations require Class 150 flanges. Raised or flat face flanges are acceptable.

1.4 Buried CSST house piping is addressed in Section “L”.

## 2. CAUTION BEFORE DIGGING

### 2.1 Locating Utilities

To have gas piping located, along with other underground utility facilities that may be buried in the vicinity of where you plan to dig, you must call the Utilities Protection Service at least two (2) working days in advance. In Ohio, call 1-800-362-2764. In Kentucky, call 1-800-752-6007. You may dial 811 to reach the Utilities Protection Service in Ohio and Kentucky.

### 2.2 Customer Responsibility

The customer is responsible for any local or state permits required to install the customer service pipe.

The customer is also responsible for any damage to utilities that are caused by their activities.

## 3. INSTALLING THE UNDERGROUND HOUSE PIPING

### 3.1 General

The customer's house piping must be installed in a trench that is separate from other utilities except as noted in Section E 6.3. The trench shall be graded uniformly and provide a continuous solid or thoroughly compacted foundation for the customer's house pipe. The trench shall also be of sufficient depth with a minimum of 18”.

Where buried house piping is installed parallel to other utilities, the gas service trench shall be at least three (3) feet away from other utility trenches. If the service piping must cross over, under or be near other utilities, a twelve (12) inch minimum separation must be maintained.

Exception 1: Polyethylene plastic pipe cannot be installed within five (5) feet parallel or crossing an underground steam line.

Exception 2: Gas service piping in joint service trench must not be installed closer than twelve (12) inches to shared trench utilities. See Section E 5.4.

Underground house piping is to be sleeved where it comes out of the ground through hard paving. See Sketch 2, Section L.

Except where directional drilling is necessary, the gas house pipe must be completely visible and exposed from end to end. Each end of the service piping must be temporarily and securely capped to keep dirt and water out. After you have completed the installation, and before you backfill, you must request a visual inspection. See Section C for inspection and meter set telephone numbers.

### 3.2 Plastic Installation

Plastic pipe must be free of kinks, sharp bends, and scratches.

Risers for 2" and smaller house piping include a blind end stab coupling. **Do not attempt to make this connection.** Company will connect the house line to the riser. Customer must provide riser. Pipe must be capped and extend above ground near riser bracket.

Each flexible riser kit assembly includes a foundation bracket that must be securely fastened to the building above the finished grade.

Exception: Mobile home and free standing meter installations. See Sections H and J.

A #12 AWG or heavier (smaller AWG number), insulated, solid copper wire must be installed to the top of the riser.

Plastic to Plastic joints can be made by butt fusion, coupling (electro fusion or mechanical) or flanged using Duke Energy's procedures. Only individuals qualified by the Company are permitted to install fittings or make fusion joints on plastic pipe. Company inspectors will check fusion card of individuals making the fusion joints. 1" CTS service tubing requires a continuous length (no joints).

### 3.3 Joint House Piping

One (1) gas service can be installed in a joint service trench with electric service cable in conduit, telephone cable, and television cable. The pipe must not be installed closer than twelve (12) inches from these cables.

Only electric, telephone, and cable television utilities are permitted in the same trench with gas piping. There are no exceptions. When other utilities parallel gas piping, three (3) feet of separation between trenches shall be maintained with undisturbed native soil between trenches. If the gas piping must cross a facility other than shared trench occupants, a twelve (12) inch minimum separation must be maintained.

All occupants in the trench with gas service piping must enter the building above ground level.

These requirements are for gas piping and electric service cable only. Contact your cable television company and your telephone company for their requirements.

### 3.4 Steel Installation

Steel pipe shall be welded. Locking compression couplings are permitted where welding is not practical. Changes in direction shall be accomplished with welding elbows. Mitered joints beyond 3 degrees are prohibited.

Damaged pipe shall not be installed and any burrs left by the cutting tool shall be reamed. Defects in pipe coating (holidays) must be field coated in accordance with Section K.

Protection of underground metallic piping against corrosion shall be accomplished by coatings, designed specifically for use on underground pipe, and cathodic protection, by the use of magnesium anodes. See Section K for corrosion protection requirements.

### 3.5 Backfilling

The customer's house piping trench shall not be backfilled until the pipe has been "visually inspected" and approved by a Company representative. If the electric service lateral also occupies a joint service trench, it must be inspected by the appropriate electrical code inspection authority before the service trench can be backfilled. The house piping should be continuously supported beneath its entire length by clean, firm backfill material (no rocks). Intermittent blocking shall not be used to support plastic pipe. The first layer of fill material around and 6 inches over the pipe shall be carefully backfilled and must be free of rocks, stones, cinders, slag, concrete blocks, pieces of wood, or other materials that may cause damage to the pipe or pipe coating. If native rock free soil is not available, the first layer of fill material around and 6" over the pipe shall be sand. Lime sand is not permitted.

Extra caution is required when backfilling around the service riser to avoid pulling the plastic pipe out of the fitting on the riser. Riser must remain plumb.

Both ends of the house piping must be capped or taped to prevent water or dirt from entering the pipe.

## SPECIFICATION ABBREVIATIONS

ANSI	- American National Standards Institute
API	- American Petroleum Institute
ASTM	- American Society of Testing Materials
CTS	- Copper Tubing Size
DR	- Thermoplastic Pipe Dimension Ratio as defined by ASTM Specification D 2513
IPS	- Iron Pipe Size
PC	- Protective Coating
PE	- Polyethylene
PE 2406	- Plastic Pipe Institute material designation PE 2406 manufactured under ASTM Specification D 2513
SCH	- Schedule

### Plastic Pipe Markings

IMPORTANT: The Company will only accept approved plastic pipe that is properly marked per ASTM D2513. The following information must appear legibly on the pipe:

1. Nominal Size
2. Dimension Ratio (DR) and/or Wall Thickness
3. Manufacturer's Name
4. "GAS" pipe or tubing
5. Material Designation (PE2406, PE2708, PE3408, PE4710)
6. Certification Basis (ASTM D 2513)
7. A series of letters and/or numbers to indicate the Lot Number, Date of Manufacture, Operator Identification, and Shift Identification.

### ACCEPTABLE PIPE MANUFACTURERS

CP Chem Performance Pipe  
5085 West Park Blvd.  
Plano, Texas 75093  
(800) 527-0662

Oil Creek Plastics, Inc  
45619 State Hwy 27  
P.O. Box 385  
Titusville, PA 16354  
(800) 537-3661

Poly Pipe, Inc.  
P.O. Box 390  
Gainesville, TX 76240  
1-800-433-5632

Charter Plastics, Inc.  
221 S. Perry Street  
P.O. Box 770  
Titusville, PA 16354  
(814) 827-9665

JM Eagle/US Poly, WL Plastics, ENDOT Industries, Flying "W" Plastics, KWH Pipe, Silver-Line Plastics.

### RISER MANUFACTURER INFORMATION

Perfection Corporation  
222 Lake Street  
Madison, OH. 44057-3189  
(440) 428-1171

## **SECTION K**

### **CORROSION PREVENTION**

#### **1. GENERAL**

The Company requires that underground metallic piping be protected against corrosion. Protection is accomplished by coatings, designed specifically for use on underground pipe, and cathodic protection, by the use of magnesium anodes. The coating and anodes complement each other, and adequate protection cannot be achieved when either is used alone.

Effective corrosion prevention also requires that the protected piping be electrically isolated (insulated).

#### **2. INSTALLATION REQUIREMENTS**

##### **2.1 Electrical Isolation**

Electrical isolation is accomplished by use of dielectric fittings, commonly known as insulating fitting. Insulating fittings are required whenever steel pipe leaves or enters the ground. The Company provides electrical isolation at the curb and at the meter.

##### **2.2 Coatings**

Coatings used on house piping shall be of a suitable type, designed for underground use. Paint type coatings are not acceptable. Steel service pipe having an acceptable coating applied at a coating mill is available and is preferred. However, field applied coatings are acceptable, provided a compatible primer is used if necessary and proper installation techniques are followed. Field applied coatings must be installed in accordance with the manufacturer's instructions. In general, these materials should be spiral wrapped and overlapped 1/2 inch minimum.

Acceptable Mill Applied Coatings:

- (1) Reinforced coal tar enamel
- (2) Extruded polyethylene
- (3) Fusion bonded epoxy

Acceptable Field Applied Coatings Manufactured for the Purpose of Cathodic Protection:

- (1) Coal tar/synthetic resin tape with plastic backing.
- (2) Coal tar/synthetic resin tape with glass reinforcement.
- (3) Pressure sensitive polyethylene or polyvinyl chloride tape.
- (4) Wax impregnated tape

Surfaces to be coated must be dry and free of loose rust, scale, and foreign material prior to coating application.

## 2.3 Anodes

Anodes are installed at equal distances along the length of the piping. They are buried a minimum distance of two (2) feet from the pipe and at or below the pipe depth and backfilled with soil. The connecting wire shall be attached to the pipe, using a cadweld, thermite weld or brazed. The point of attachment to the service must be cleaned to bright metal to insure a durable, low resistance connection. After the connection is made, exposed metal shall be coated with Duke Energy approved pipe coating material.

**MAXIMUM SPACING FOR MAGNESIUM (MG) ANODES**

<b>Size Of Service (Inches)</b>	<b>3# Mg ANODE</b>	<b>5# Mg ANODE</b>	<b>9# Mg ANODE</b>	<b>17# Mg ANODE</b>
<b>Up to 3"</b>	<b>100 ft.</b>	<b>200 ft.</b>	<b>400 ft.</b>	<b>800 ft.</b>
<b>3" - 4"</b>	<b>NR</b>	<b>100 ft.</b>	<b>200 ft.</b>	<b>400 ft.</b>
<b>6" - 8"</b>	<b>NR</b>	<b>NR</b>	<b>100 ft.</b>	<b>200 ft.</b>
<b>12"</b>	<b>NR</b>	<b>NR</b>	<b>NR</b>	<b>100 ft.</b>

NR = NOT RECOMMENDED

This table specifies the maximum allowable spacing between anodes. Use half of this spacing to determine maximum distance from an insulating joint to the nearest anode.

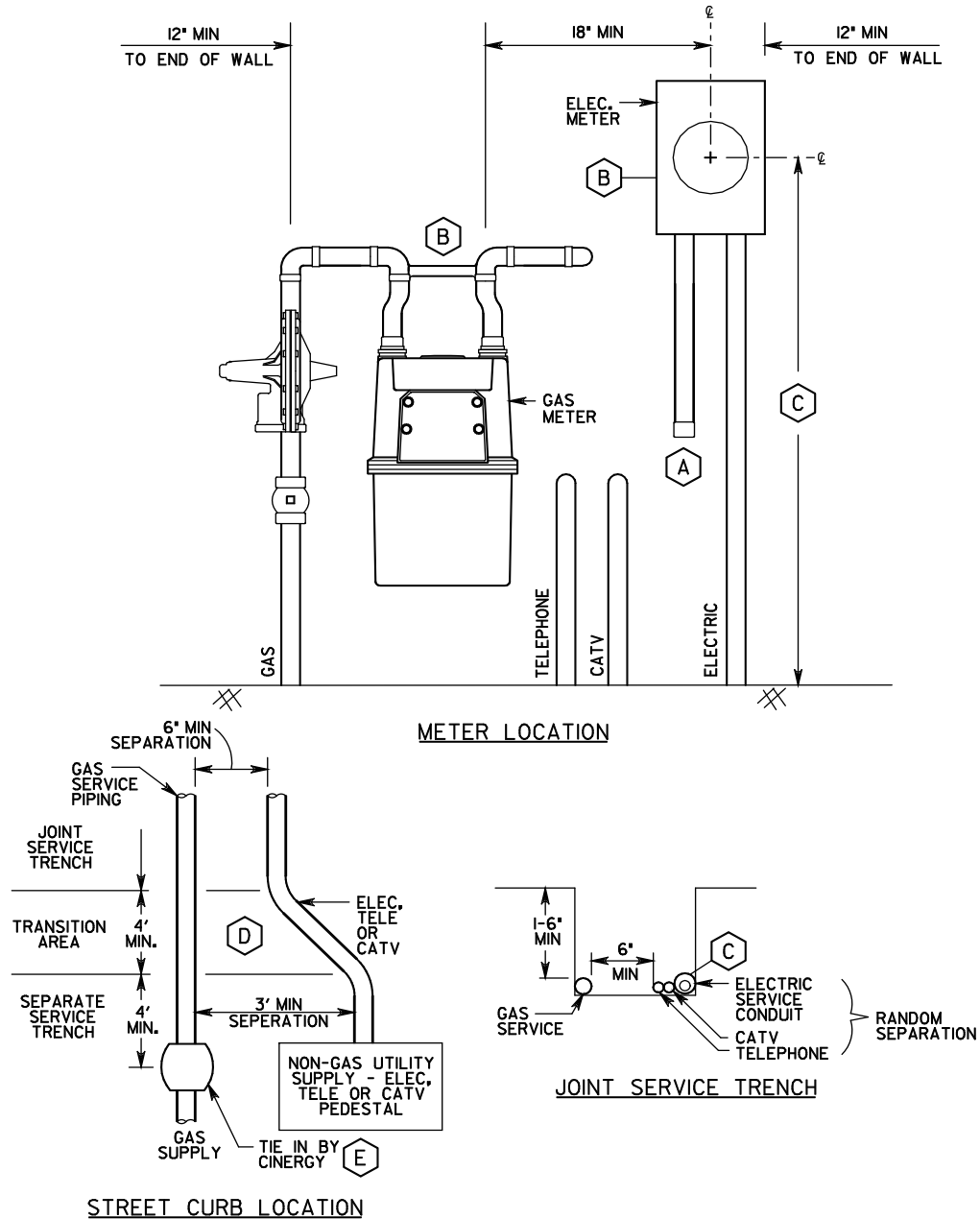
Steel risers for 3" and larger plastic house piping are typically protected with a single 3# or larger magnesium anode.

3. **INSPECTION**

Adequacy of pipe coating and anode installation is checked as part of the visual inspection as noted in Section K of this manual.



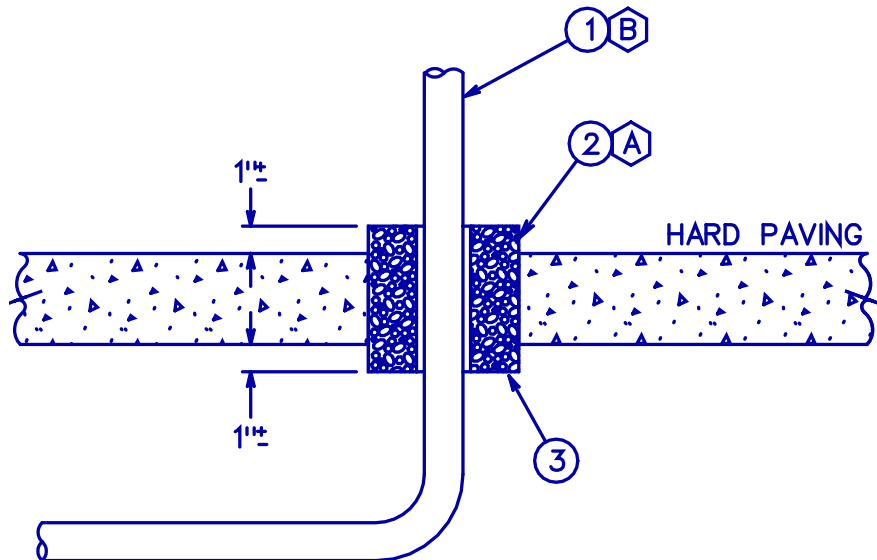
SECTION L  
 SKETCH 1  
 JOINT SERVICE TRENCH



SKETCH 1 NOTES

- A. When telephone, CATV or electric services run in joint trench with gas, all pipe, cable, and conduit entries into building are to be above ground level.
- B. Working clearances for gas and electric meters are 3 feet wide and 4 feet deep. Clear area in front of each meter.
- C. Consult "Information and Requirements for Electric Service" booklet for additional electric details.
- D. Non-Gas utilities are not permitted within 3'-0" of the gas tie-in point. Transition to separate trench must start at least 8'-0" from gas tie-point.
- E. Customer's portion to terminate within 2'-0" feet of gas tie-in point, above ground, capped, with enough pipe to extend beyond tie-in point. Duke Energy to tie-in gas supply.

## SKETCH 2

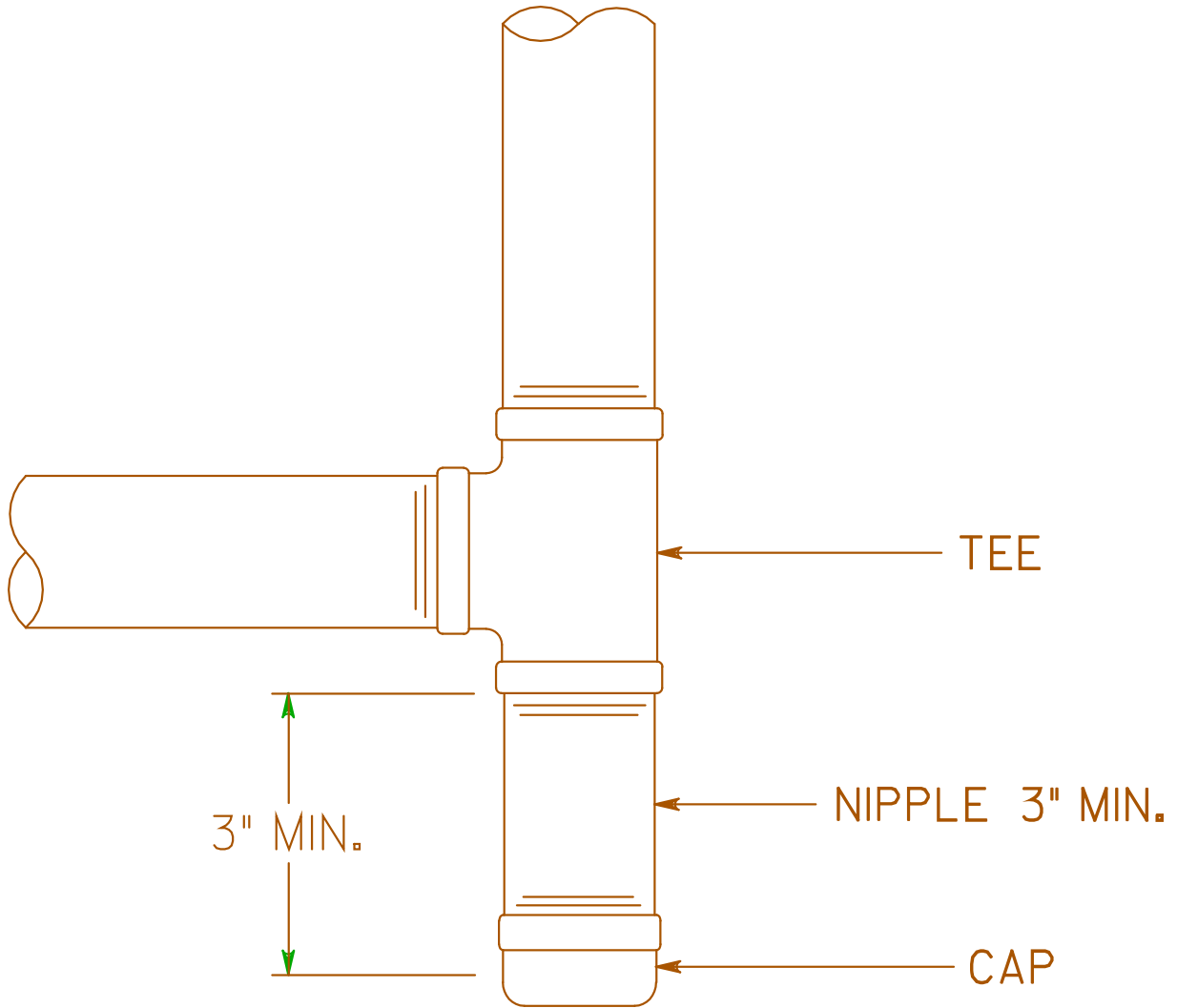
GAS PIPING  
THROUGH HARD PAVING

Material	
1.	Service (All Materials).
2.	Sleeve (Plastic Material Preferred).
3.	Gravel

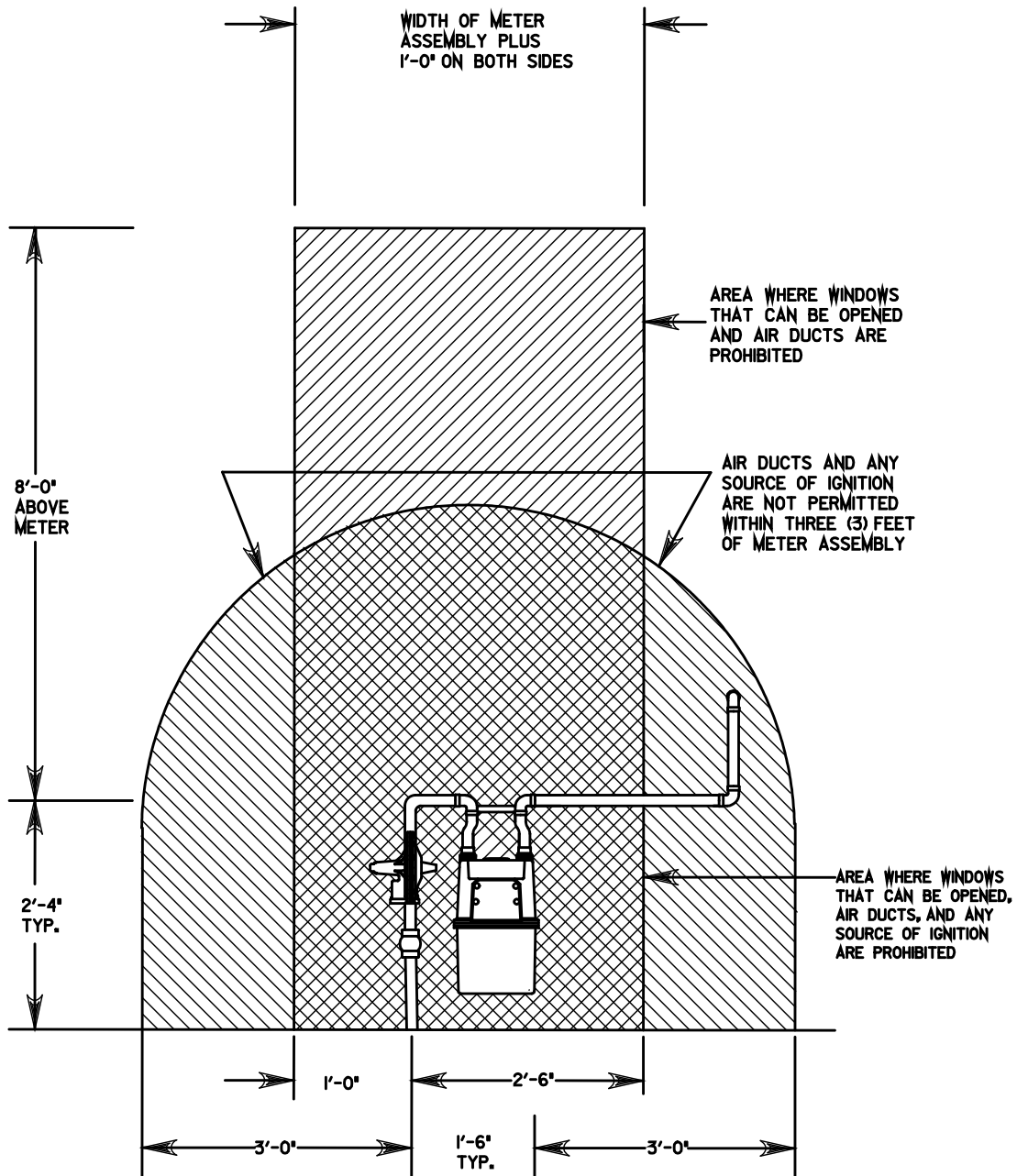
## Sketch 9 Notes

- A. The Sleeve is to be 2 nominal sizes larger than the service riser. Plastic materials are preferred. Formed openings are acceptable.
- B. Center service in sleeve and backfill with gravel.
- C. A Flexible riser is not an acceptable sleeve for hard paving.

**SKETCH 3**  
**SUGGESTED METHOD OF INSTALLING SEDIMENT TRAP**



**SKETCH 4  
RESIDENTIAL METER  
LOCATION RESTRICTIONS**

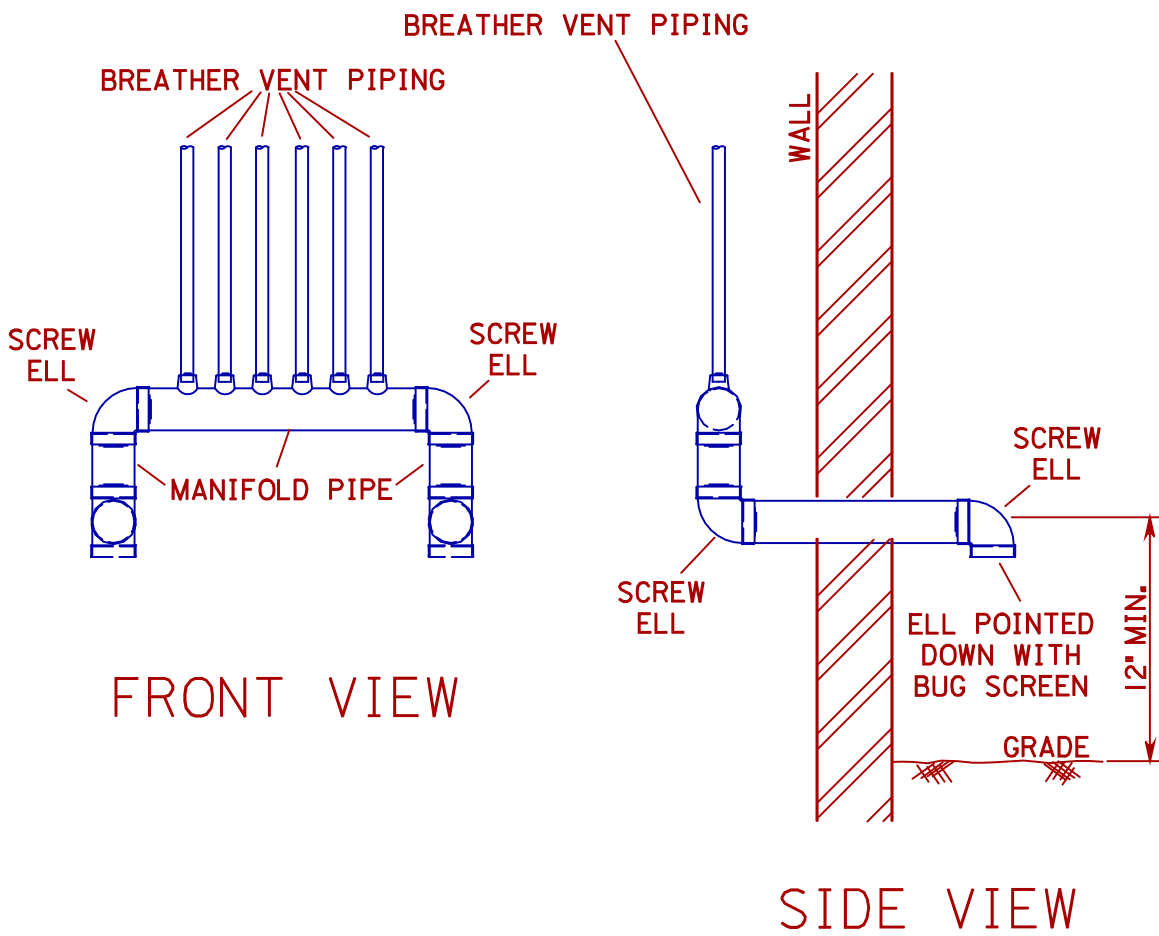


**NOTES FOR SKETCH 4****RESIDENTIAL METER  
LOCATION RESTRICTIONS**

- A. The service piping shall not be terminated nor the meter set:
- (1) Within thirty (30) inches of the left side of a basement window or twelve (12) inches of the right side of the basement window, as you face the window.
  - (2) Within three (3) feet of any source of ignition.
  - (3) Within three (3) feet of an air duct.
  - (4) Below and within eight (8) feet of an air duct.
  - (5) Below and within eight (8) feet of a window that can be opened.
  - (6) Where it will be subject to damage, or
  - (7) In any location that would require the connection to the main to be made under a driveway, tree or other obstruction.
- B. Conditions such as multiple meter installations may require other restrictions or distances. Large meter installations for commercial or industrial application require ten (10) foot separation from sources of ignition, operable windows and air ducts. Large meters shall not be placed under operable windows and air ducts.

**SKETCH 5**  
**MANIFOLD VENTING**

SUGGESTED METHOD OF INSTALLING  
BREATHER VENT MANIFOLD



**NOTES FOR SKETCH 5****MANIFOLD VENTING**

- A. Diaphragm breather vents may be connected to a common manifold for appliance regulators and pressure switches operating with an inlet pressure of 14" W.C. or less. All bleed valves, all pressure relief valves, and any component operating with an inlet pressure greater than 14" W.C. must be vented separately to the outside.
- B. Piping connecting a diaphragm case to the manifold shall be sized as if the vent were routed separately. The sizing procedure shall assume a pipe length measured from the diaphragm case through the manifold to the most distant opening to the outside.
- C. Breather vent piping shall connect to the top or the side of the manifold. Vent piping shall not be connected to the bottom of the manifold.
- D. The manifold pipe size shall be determined by adding the breather vent piping flow areas. The manifold shall have a flow area equal to or larger than the sum. For example: If the six breather vent connections shown in Sketch 12 are  $\frac{3}{4}$ " schedule 40 piping having a flow area of 0.533 square inches each, the manifold shall have at least 3.20 square inches of flow area. A 2" schedule 40 manifold would be acceptable with a flow area of 3.35 square inches.
- E. Both ends of the manifold piping shall be vented to outside locations.
- F. Manifold piping shall slope downward at least 1/4 inch per foot to facilitate drainage to an outside location. Where this method of drainage is not practical, a one (1) inch minimum size drip shall be provided.
- G. Vents shall be designed to prevent the entry of water, insects, or other foreign material that could cause blockage. Vent openings should be inspected regularly for blockage





**Technology Infrastructure, Category 5e, Category 6 Augmented, &  
Fiber to the Desktop Cabling Standard  
Rev.3, 12/5/2014**

**1.0 GENERAL**

**1.0.A**

Northern Kentucky University follows all current ANSI/TIA/EIA 568, 569, 570, 607 and 758 standards, National Electrical Code, National Electrical Safety Code, and all local jurisdiction codes.

**1.1 STANDARDS**

**1.1.A.**

Building structured cabling systems shall meet Northern Kentucky University's (NKU) Office of Information Technology cabling conventions to include adherence to the most currently available BICSI Building Industry Consulting Service International TDM Telecommunications Distribution Methods Manual, TIA/EIA Telecommunications Building cabling Standards, NFPA National Electrical Code manuals (ANSI/TIA/EIA) and also meet a minimum of 25 year warranty standards of the manufacturer. This includes addendums to TIA standards such as 568-B.2 addendums 1, 2, 3, and 4. Contractors shall be fully acquainted with the above referenced standards and be fully qualified, as outlined in the NKU Technology Infrastructure contractor qualifications. Contractors shall have demonstrated qualifications to install and test a 10-Gigabit intra/inter-building backbone. All station and riser cabling shall be tested and certified by the contractor to support 10-Gigabit technology. Additionally, the contractor will be required to meet NKU conventions and standards. The following specified Technology Infrastructure Cabling Standards are to be used as a minimum required guide.

**1.2 COMMUNICATION CABLING SYSTEM CONTRACTOR QUALIFICATIONS**

**1.2.A.**

The NKU Office of Information Technology requires that only qualified and experienced Communication cabling system contractors perform project management and installation services in the construction or remodel of University buildings. Pursuant to this, NKU's Office of Information Technology wants to ensure that successful contractors have the capabilities, qualifications, financial stability, resources, equipment, and experience to complete communication cabling system installations using common industry practices (i.e. Current BICSI TDM, ANSI/TIA/EIA 568, 569, 570, 607 and 758 standards, National Electrical Code, National Electrical Safety Code, and all local jurisdiction codes, etc.), while meeting all NKU Office of Information Technology guidelines.

**1.2.B.**

Contractor (prime and any subs) must meet the requirement of having continuously performed communication cabling system installation work for a period of at least the last five years. Contractor must provide manufacturer technician certification information, customer references, and documentation

supporting this requirement. Contractor shall provide at least 2 references from similar installations, one within the last 6 months and one from at least 2 years ago.

**1.2.C.**

Communication cabling system contractor, at all times during performance and until work is completed and accepted, shall have on the premises a competent supervisor, satisfactory to NKU's Office of Information Technology and with authority to act for the communication cabling system contractor regarding work schedules and any changes to the scope of work. The supervisor must be a BICSI certified Technician and a BICSI member in good standing.

**1.2.D.**

Contractor and their installers must be a local, manufacturer-certified integrator/installer, able to obtain a minimum 25 year warranty.

**1.2.E.**

Communication cabling system contractor must have a current BICSI certified RCDD (Registered Communication Distribution Designer) on staff as a full-time employee. A copy of the RCDD certificate and BICSI member number must be provided with bid documents.

**1.2.F.**

Communication cabling system contractor must provide at least one project manager or lead technician on a project who is a BICSI certified Technician and a BICSI member in good standing. A copy of their certificate and BICSI member number must be provided with bid documents.

**1.2.G.**

Communication cabling system contractor must be skilled and proficient in both inside cable plant (copper and fiber) design, installation, as well as outside cable plant (copper and fiber) design, installation, termination, splicing, and testing. Communication cabling system contractor must provide a list of equipment owned (i.e. fusion splicer, OTDR, excavation equipment, cable testers, etc.)

**1.3 PROGRESS MEETINGS**

**1.3.A.**

The contractor will be required to meet with and coordinate with a representative of the NKU Office of Information Technology prior to work beginning, and weekly during the installation process. Weekly meetings will include a site inspection to ensure compliance with established standards. The successful electrical and Communication cabling system contractor will follow appropriate installation guidelines, as contained in the most currently available BICSI TDM, ANSI/TIA/EIA Wiring Standards, and NFPA National Electrical Code manuals. Additionally, contractor will work with NKU's Office of Information Technology to ensure proper placement, routing, labeling, and documentation of cable and support hardware.

**1.4 DOCUMENTATION**

**1.4.A.**

Prior to system acceptance, the contractor shall submit to the owner fully documented and scaled drawings of the entire fiber optic and copper distribution system. Documentation shall be provided in both a hard copy binder and a soft copy on CD capable of being viewed and edited in Visio Professional.

This will include building and floor layouts with workstation information outlet locations and labeling, MDF (Main Distribution Frame room), IDF (Intermediate Distribution Frame room), cable routes, interconnect locations, intermediate and main distribution frame locations, riser locations, and all other information pertinent to the installation.

**1.4.B.**

The contractor will be responsible for accurately labeling and identifying all relevant components of the cabling system, including, but not limited to: Workstation outlet faceplate labeling; workstation cable labeling; patch panel and port labeling; Telecom block labeling; Riser cable labeling; backbone cable labeling at entrance to MDF or IDF; fiber optic patch panel labeling and strand labeling. The contractor will consult with NKU's Office of Information Technology representative in regards to labeling and identification. The labeling nomenclature is as follows:

All Voice and data cabling for the university will follow one simple labeling plan: room # - Jack# - Outlet #. Data, voice ports will be distinguished in the second Integer where data ports will use a number, voice ports will use a letter, ( A,B,C ).

Other list of possible extensions to be included:

- Security Camera = C
- Crestron Panel = CR
- Elevator = E
- Fire Panel = F
- Projector = P
- Wireless Access = W

EXAMPLE: 208-1-1 ='s room #208, data jack # 1, outlet # 1

EXAMPLE: 549-A-1 ='s room #549, voice jack # 1, outlet # 1

EXAMPLE: 128-3-3 ='s room #128, data jack # 3 and outlet # 3 in that room

EXAMPLE: 745-C-3 ='s room #745, voice jack # 3 and outlet # 3 in that room

EXAMPLE: 609-P-1 ='s room #609, projector jack and outlet # 1 for projector

EXAMPLE 332-W-1 ='s room #332, wireless access jack # 1 for wireless access point

The jack colors below shall be installed for the intended service they will support:

White = Voice, Blue = Data, Orange = Video Conference, Yellow = Switch Port in Student Union, Black = Non NKU network service

Outlets will be numbered from the primary entrance into a room in a clockwise fashion, left to right. Numbering the wall outlets first, floor outlets second and the ceiling outlets last.

This simple nomenclature denotes three integers for all voice and data labeling where, the first integer is the room number, the second integer is either voice, data or projector jack or other (denoted by a number or letter) and the third integer is the outlet in the room.

Northern Kentucky University also requires that each individual cable be labeled at both ends with the same numbering plan explained above, per BICSI standards. All labels must be machine printed and permanent.

Contractor should consult with NKU for proper labeling standards prior to installation.

#### 1.4.C

The contractor will be responsible to affix cable tags on all cables that are installed through the NKU manhole systems. These cable tags will be affixed to each cable in each manhole and clearly state the: To & From locations, pair counts, strand count, cable type and use. Examples:

AST>NC-12ST-MM-D = AST building to Norse Commons, 12 strand, multimode, data.

NCS>LA-400PR-CP-V = Natural Science Center to Landrum, 400 pair, Copper, Voice.

#### 1.5 MATERIALS LIST

**Items are not substitutable. Contractors should present quotes based on the following materials list:**

##### 1.5.A.

**Workstation Outlet - New work:**

**NKU prefers to utilize modular faceplates that allow for a variety of modules such as fiber, copper, USB, and audio/visual connections in both flat and sloped configuration. NKU would also like to flexibility to use keyed modules for both copper and fiber to enhance physical security in certain areas.**

Single Gang Angled Wall Plate, Fog White. Ortronics PN: OR-40300664 plus (1) OR-40300749 plus (1) OR-40300191(2-port); OR-40300664 plus(2) OR-40300749 (4-port) -or- Panduit PN CFPSL2IWY (2-port), CFPSL4IWY (4-port), CFPSL6IWY (6-port)

RJ45 Jack, 10 Gigabit, RJ45, T568A/B, Snap-In Module, Fog White. Ortronics PN OR-TJ6A used for voice outlets -or- Panduit PN CJ6X88TGIW

RJ45 Jack, 10 Gigabit, RJ45, T568A/B, Snap-In Module, Blue. Ortronics PN OR-TJ6A-36 -or- Panduit PN CJ6X88TGBU used for data outlets

RJ45 Jack, 10 Gigabit, RJ45, T568A/B, Snap-In Module, Orange. Ortronics PN OR-TJ6A-42 -or- Panduit PN CJ6X88TGOR used for video conferencing outlets

RJ45 Jack, 10 Gigabit, RJ45, T568A/B, Snap-In Module, Black. Ortronics PN OR-TJ6A-00 -or- Panduit PN CJ6X88TGBL used for non-NKU services outlets

Blank Module, Fog White. Ortronics PN OR-42100002 -or- Panduit PN CMBIW-X

Cat5e

Ortronics TracJack Single Gang/4-Port Wall Plate, PN: OR-40300546 fog white.

Ortronics TracJack, Category 5e, RJ45, T568A, Snap-In Module, PN OR-TJ5E00 fog white used for voice outlets  
 Ortronics TracJack, Category 5e, RJ45, T568A, Snap-In Module, PN OR-TJ5E00-36 blue used for data outlets  
 Ortronics TracJack, Category 5e, RJ45, T568A, Snap-In Module, PN OR-TJ5E00-42 orange used for video conferencing outlets  
 Ortronics TracJack, Category 5e, RJ45, T568A, Snap-In Module, PN OR-TJ5E00-00 black used for non-NKU networks services outlets  
 Ortronics TracJack, Blank Module, PN OR-42100002 fog white

**Workstation Outlet - Renovation Work:**

Wiremold WallSource Box Series - Specification sheet ED864R5  
 Wiremold WSB42-2 two gang box  
 Wiremold WSB07-2A device mounting bracket  
 Wiremold DR20A-V duplex receptacle  
 Wiremold 5507D faceplate

In areas where fiber to the desktop will be deployed:

Keystone Fiber Optic Adapter, Single Mode, Duplex, SC. Ortronics PN OR-63700067  
 -or- Panduit PN CMDBUSCZBU  
 Keystone Fiber Optic Adapter, Single Mode, Duplex, LC. Ortronics PN OR-63700076  
 -or- Panduit PN CMDJLCZBU

**1.5.A.1.**

**Patch Cordage - Copper:**

**Maximum length of Cat6a patch cords is 15 feet. As such, design and implementations shall consider same by ensuring outlet locations are no more than 15 ft from devices to be network connected.**

Ortronics Cat6A Patch Cord, PN: OR-MC610LL-CC where "LL" equals length in feet and "CC" denotes the color. Standard lengths are 3, 5, 7, 9, 15, 20 and 25 feet. Standard colors are white, red, orange, yellow, green, blue and gray.  
 Panduit Cat6A Patch Cord, PN: UTP6ALLCC where "LL" equals length in feet and "CC" denotes the color. Standard lengths are 3, 5, 7, 10, 14, 20 and 25 feet. Standard colors are gray, black, blue, green, red, yellow, orange and violet.

Cat6A Patch Cord, 50ft, blue. Ortronics PN OR-MC61050-06 -or- Panduit PN UTP6A50BU

Cat6A Patch Cord, 75ft, yellow. Ortronics PN OR-MC61075-04 -or- Panduit PN UTP6A75YL/N

Cat6A Patch Cord, 100ft, yellow. Ortronics PN OR-MC610100-04 -or- Panduit PN UTP6A100YL/N

**CAT5e**

Ortronics Clarity Patch Cord, White PN: OR-MC5EXX-YY, where "XX" equals length in feet, and YY denotes the color. Standard lengths are 3,5,7,9,15 & 25 feet.

Ortronics Clarity Patch Cord, 3,5,7,9,15,25ft White PN: OR-MC5EXX-09

Available colors are -00 Black, -02 Red, -03 Orange, -04 yellow, -05 Green, -06 Blue, -07 Violet, -08 gray, -09 white

Ortronics Clarity Patch Cord, 25ft Green PN: OR-MC5E25-05

Ortronics Clarity Patch Cord, 50ft Blue PN: OR-SC5ER50DB-06

Available colors 50 ft: -03,-05,-06,-09

Ortronics Clarity Patch Cord, 75ft Yellow PN: OR-SC5ER75DB-04 (only color available)

Ortronics Clarity Patch Cord, 100ft Yellow PN: OR-SC5ER100DB-04 (-09 also available)

**Patch Cordage - Fiber:**

**Single Mode: Utilized in backbone & workstation applications**

Single mode Fiber Optic Jumpers SC-SC (Ortronics PN: OR-P1DC2IRRZRZXXXXM where "XXX" equals length in meters) -or- Panduit PN: F9D3-3MXY (where "X" equals length in meters)

Single mode Fiber Optic Jumpers SC-LC (Ortronics PN: OR-P1DC2IRRZSZXXXXM where "XXX" equals length in meters) -or- Panduit PN: F9E3-10MXY (where "X" equals length in meters)

Single mode Fiber Optic Jumpers LC-LC (Ortronics PN: OR-P1DC2IRSZSZXXXXM where "XXX" equals length in meters) -or- Panduit PN: F9E10-10MXY (where "X" equals length in meters)

**1.5.B.**

**Station Cable- (Horizontal)**

Augmented Category 6, 4 twisted pair, 24 AWG, CMP Plenum, Blue Station Wire for Data. Superior Essex PN: 6A-272-2B -or- General Cable PN: 7131819 -or- Panduit PN: PUP6A04BU-UG

Augmented Category 6, 4 twisted pair, 24 AWG, CMP Plenum, White Station Wire for Voice. Superior Essex PN: 6A-272-4B -or- General Cable PN: 7131820 -or- Panduit PN: PUP6A04WH-UG

Augmented Category 6, 4 twisted pair, 23 AWG, non-continuous metallic tape, CMP Plenum, Blue Station Wire for Data. Superior Essex 10GainXP PN: 6H-272-2B -or- General Cable PN: 7131849

Augmented Category 6, 4 twisted pair, 23 AWG, non-continuous metallic tape, CMP Plenum, White Station Wire for Voice. Superior Essex 10GainXP PN: 6H-272-4B -or- General Cable PN: 7131850

Fiber to the desk cable, 6 strand armored plenum indoor single mode. (Superior Essex PN: L4006K401 -or- General Cable PN: AP0061PNU-ILPA -or- Panduit PN: FSPP906Y -or- Corning PN: 006E88-31131-A3A

CAT5e

Superior Essex, Category 5E, 4 twisted pair, 24 AWG, CMP Plenum, Blue Station Wire for DATA, PN: 52-241-2B

Superior Essex, Category 5E, 4 twisted pair, 24 AWG, CMP Plenum, White Station Wire for Voice, PN: 52-241-4B

**1.5.C.**

**Riser Cable-**

Category 3 copper cable, 25 twisted pair, 24 AWG, PVC, CMR non-plenum Riser Cable. (Superior Essex PN: 18-475-33 -or- General Cable PN: 2133033)

Category 3 copper cable, 25 twisted pair, 24 AWG, CMP Plenum Cable. (Superior Essex PN: 18-475-36 -or- General Cable PN: 2131505)

Indoor only fiber optic installations will utilize plenum-rated single mode 12 strand premise distribution cable (Superior Essex PN: 44012KG01 - or- General Cable PN: AP0121PNU -or- Panduit PN: FSDP912Y -or- Corning PN: 012E88-33131-29

Outdoor or indoor/outdoor fiber optic installations will utilize plenum-rated single mode 12 strand armored indoor/outdoor plenum-rated cable (Superior Essex PN: L4012K201 -or- General Cable PN: AP0121ANU-ILPA 3 -or- Panduit PN: FSGP912Y -or- Corning PN: 012E8P-31131-A3)

Fiber optic cable construction, glass type and manufacturer shall remain constant through any variation of fiber optic strand count.

**1.5.D. MDF/IDF Data station cable termination and equipment:**

By default, all data cabling media shall be terminated in equipment racks with adequately sized cable management. Minimum 6" wire management is required but will utilize higher capacity (12" and 15") managers in high density situations. The goal is to not exceed a 40% fill rate at installation. The Contractor should review all racks and bring any that will exceed this rate to the attention of the University project manager.

NKU prefers to utilize 110 punch down style panels for most situations, but will require modular panels for high density applications. All panels shall be offered in both flat and angled versions. The high density panels shall be angled to eliminate the need for horizontal cable managers and shall support up to 48 ports in 1RU. Each patch panel port shall be 100% tested to ensure NEXT and RL performance.

Patch Panel, 48-port, 10 Gigabit, T568A/B Wired, Category 6 Augmented.  
 Ortronics PN: OR-PHD610U48 -or- Panduit PN: DP486X88TGY  
 Patch Panel, Angled, 48-port, 10 Gigabit, T568A/B Wired, Category 6 Augmented.  
 Ortronics PN: OR-PHA610U48 -or- Panduit PN: DPA486X88TGY  
 Patch Panel, 24-port, 10 Gigabit, T568A/B Wired, Category 6 Augmented.  
 Ortronics PN: OR-PHD610U24 -or- Panduit PN: DP246X88TGY  
 Patch Panel, Angled, 24-port, 10 Gigabit, T568A/B Wired, Category 6 Augmented.  
 Ortronics PN: OR-PHA610U24 -or- Panduit PN: DPA246X88TGY

Rack, 7ft, 19" mounting, 16.25" channel depth. Ortronics PN: OR-MM6716  
 Rack, EIA, 7ft, 19" mounting, aluminum. Ortronics PN: OR-10-84-T2SDB -or- Panduit PN: CMR19X84

Wire Management as specified in section 1.5.H.

**1.5.E.  
 MDF/IDF Voice station cable & Voice riser cable termination and equipment:**

By default, all voice cabling media shall be terminated on wall mounted backboards.  
 Category 6 96-pair 110 IDC type punch down blocks with mounting legs. Panduit GPKBW24Y -or- Ortronics PN: OR-110ABC6100

CAT5e

Ortronics, T568A Wired, Category 5E, 48-Port High Density Patch Panel, PN: OR-PHD5E6U48  
 Ortronics, T568A Wired, Category 5E, 24-port High Density Patch Panel, PN: OR-PHD5E6U24

Ortronics Mighty Mo 6 7ft Cable Management Rack w/16.25in deep channels, PN: OR-MM6716  
 Ortronics Mighty Mo Wall-Mount Cable Management Cabinet, PN or-40500131  
 Ortronics Wall-Mount Relay Rack, PN: OR-604045450

**1.5.F.**

**MDF/IDF, Fiber Optic entrance cable, Copper entrance cable termination and equipment:**

Indoor only fiber optic installations will utilize plenum-rated armored single mode 12 strand premise distribution cable (Superior Essex PN: L4012K401 -or- General Cable PN: AP0121PNU-ILPA -or- Panduit PN: FSPP912Y -or- Corning PN: 012E88-33131-A3

Outdoor or indoor/outdoor fiber optic installations will utilize plenum-rated single mode 12 strand armored indoor/outdoor plenum-rated cable (Superior Essex PN: L4012K201 -OR- General Cable PN: AP0121ANU-ILPA -or- Panduit PN: FSGP912Y -or- Corning PN: 012E8P-31131-A3)

Fiber optic cable construction, glass type, and manufacturer shall remain constant through any variation of fiber optic strand count.

Fiber Distribution Center termination cabinet, 4 rack units with capacity of 12 adapter panels (Ortronics PN: OR-FC04U-P -or- Panduit PN: FRME4)  
 Fiber Distribution Center termination cabinet, 3 rack units with capacity of 9 adapter panels (Ortronics PN: OR-FC03U-P -or- Panduit PN: FRME3)  
 Fiber Distribution Center termination cabinet, 2 rack units with capacity of 6 adapter panels (Ortronics PN: OR-FC02U-P -or- Panduit PN: FRME2U)  
 Fiber Distribution Center termination cabinet, 1 rack unit with capacity of 3 adapter panels (Ortronics PN: OR-FC01U-P -or- Panduit PN: FRME1U)

Single mode SC connector 6 strand (3 duplex) pre-loaded panel (Ortronics PN: OR-OFP-SCD06AC -or- Panduit PN: FAP3WBUDSCZ)  
 Single mode SC connector 12 strand (6 duplex) pre-loaded panel (Ortronics PN: OR-OFP-SCD12AC -or- Panduit PN: FAP6WBUDSCZ)  
 Single mode LC connector 12 strand (6 duplex) pre-loaded panel (Ortronics PN: OR-OFP-LCD12AC -or- Panduit FAP6WBUDLCZ)

Single mode Fiber Connectors shall be Anaerobic SC or LC:

SC individual - Ortronics PN: OR-205KAN9FA-SM -or- Panduit PN: FSCSBUY -or- Corning PN: 95-201-41-SP  
 LC individual -Ortronics PN: OR-205KAN9GA-SM -or- Panduit PN: FLCSSBUY -or- Corning PN: 95-201-98-SP

Fan Out Kit (6 fiber) -Ortronics PN: OR-61500858 -or- Panduit PN: FO6CB -or- Corning PN: FAN-BT25-06  
 Fan Out Kit (12 fiber) -Ortronics PN: OR-61500868 -or- Panduit FO12CB -or- Corning PN: FAN-BT25-12

24AWG, PE-89 Type REA, direct bury cable with foam skin/filled core, gopher proof sheath, polyethylene jacket, outside plant copper cable - numerous manufacturers.  
 Circa BET Building Entrance terminal - (110 type) 100 pair increments. Circa PN: 1880ECA1-100 or equivalent.



Circa 5-pin plug in protector units, Digital/Solid State. Circa PN: 4B1FS-240 or equivalent.

**1.5.G.**

**Grounding and Bonding:**

All grounding must be on an independent, standalone system ground.

Telecommunications Main Grounding Busbars (TMGB) Ortronics PN: OR-GB4X12TMGB - or- Panduit PN: GB4B0612TPI-1

Telecommunications Grounding Busbars (TGB) Ortronics PN: OR-GB2X12TGB -or- Panduit PN: GB2B0306TPI-1

**1.5.H.**

**Wire management:**

For use with Ortronics OR-MM6716 rack:

For end racks, Vertical Cable Management 84"H x 6"W x 8"D w/Door. Ortronics PN: OR-MM6VMD706

For adjoining racks, Vertical Cable Management 84"H x 10"W x 13"D w/Door. Ortronics PN: OR-MM6VMD710

For use with Panduit CMR19X84 rack:

For end racks, Vertical Cable Management 83.9"H x 6"W x 16.4"D. Panduit PN: PRV6

Door for Panduit PRV6 above. Panduit PN: PRD6

For adjoining racks, Vertical Cable Management 83.9"H x 10"W x 16.4"D. Panduit PN: PRV10

Door for Panduit PRV10 above. Panduit PN: PRD10

**Other:**

Underground duct application: MaxCell, 3 inch, 3 cell, inner duct. Maxcell PN: MXC3456XX5001 (last four characters vary based on needed length) or equivalent

Indoor application: FEP orange Eastern corrugated inner duct. Eastern PN: PDPUI1000 or equivalent (plenum rated as required by code).

Ortronics Tubular Runway 12"W Black. Ortronics PN: OR-TRT10-12B or equivalent

Ortronics Cable Runway to rack mounting brackets. Ortronics PN: OR-MM6CRB16 or equivalent

Ortronics overhead cable pathway rack kit. Ortronics PN: OR-604010010 or equivalent

Ortronics overhead runway cable drop out. Ortronics PN: TRP11-CM or equivalent

Ortronics Transition Pan for 12" runway. Ortronics PN: OR-TRP11-CM or equivalent

Panduit Hook & Loop Cable Ties-continuous roll. Panduit PN: HLS15R0 or HLS75R0  
Cable Tray (basket style) shall be Cablofil or equivalent

**1.5.I.**

**Summary:**

The spreadsheet below summarizes the entire list of NKU approved materials:

## 2.0 CABLE PLANT

### 2.1 TELECOMMUNICATIONS ROOM REQUIREMENTS

#### 2.1.A.

Each MDF/IDF shall be a (stand-alone wiring room) located such that no single UTP (Unshielded Twisted Pair) horizontal cable run shall exceed **90 meters** in total length including service loops. MCRs must be located on the lowest floor of the building. Every floor must have a IDF or MDF to serve outlets on that same floor. All such rooms must be vertically stacked. Telecommunication Rooms shall not be co-located in custodial, mechanical or other shared space where damage to critical electronics may occur. Each room shall be sized according to use, and meet the below listed criteria. Coordinate with a representative of NKU's Office of Information Technology prior to the installation of backboards, grounding systems, bonding systems, and electrical service.

Floor Size: MDF Rooms 12' x 15' minimum or ANSI/TIA/EIA 569 specification.

Floor Size: IDF Rooms 12' x 12' minimum or ANSI/TIA/EIA 569 specification.

Floor Surface: Treated / sealed concrete.

Floor loading: 50 lbf/ft<sup>2</sup> minimum or as required by applicable codes.

Riser sleeves/conduits between floors shall be a minimum of 6 inches and provide pulls strings.

Prefer no false / drop ceiling be installed. If drop ceiling must be installed, Ceiling Height: Minimum of 8.5 ft clear height above finished floor.

Door Size: 3' wide and 6.7' tall w/180 swing out.

Wall Lining (backboard): AC-grade 3/4" x 4' x 8' sheets plywood, with no voids, covered on all sides, with two coats white fire retardant paint, cut outs to allow access to any wall boxes for communications or power.

Lighting: Minimum 500 lux measured at 3' above finished floor throughout the room.

Overhead fluorescent light fixtures must be installed at minimum nine (9) feet above finished floor or at least two (2) feet away from copper cable pathways, rack tops, and overhead cable runways.

Power: Provide dedicated, isolated, non-switched, 4-way, 120Vac 20Amp, circuits, installed every four (4) feet around room walls. On the bay of data racks provide two (2) each 220Vac, 20 AMP, twist lock, dedicated circuits on standard building electrical power. Also, provide two (2) each 220Vac, 20 AMP, twist lock, dedicated circuits on UPS power.

UPS Power : UPS power should be provided by a single UPS, located in the maintenance area , near the building electrical switching gear and backup generator. UPS power is to be provided for all network equipment in the MDF/IDF's.

Overhead runway: Provide overhead cable runway to ring the room and, at minimum, cross the room over data racks. Drop out devices (water falls) shall

be installed at locations where cables drop down out of runway or horizontal conduit or sleeves.

**Grounding and Bonding:** Install a contiguous Intra-building grounding and bonding system in compliance with NEC Article 250 and TIA/EIA-607 using a minimum conductor size of 6 AWG to be located on each plywood backboard with Ground Bus Bar as directed.

**Service slack:** All MDF / IDF closet cables must have industry standard amount of service slack, at each end, within the wiring room. No service loop is required in the racks when CAT 6a is used.

**Security:** Unique telecom key compatible University standard for data closets.

**Location:** Room shall be located such that no single horizontal workstation cable shall exceed 90 meters in total length including service loops.

**HVAC and Humidity :** Separate HVAC units need to be designed and strategically placed to serve all data/communications rooms with year-round temperature and humidity control and maintain a constant temperature of 64 - 75 F with one air change per hour.

**Fire Protection:** As required by applicable codes.

**Equipment Rack:** 7' x 19" x 16.25 cable management rack (**see 1.5.D**) with wire management (**see 1.5.H**) shall be provided and installed as directed. All other specifications of ANSI/TIA/EIA 569 apply.

**Other Network devices:** All equipment housed in the MDF/IDF will be required to have separate data outlets installed to the patch panel and labeled. No equipment will be permitted to plug directly into a network switch.

**Network Equipment Installation:** No network equipment is to be installed before the MDF/IDF rooms are inspected for electrical power and UPS, HVAC, security (NKU locks installed) and free of dust and debris.

#### **2.1.B.**

No copper communication cabling shall be run adjacent and parallel to power cabling. A minimum of 18" distance is required from any fluorescent lighting fixture or 6" from power lines up to 2kVA and 24" from any power line over 5kVA. Similarly, cable should be routed and terminated as far as possible from sources of EMI or RFI, such as ballasts, generators, fans, motor control units, motors, etc.

#### **2.1.C.**

The MDF/IDF shall be constructed using 110 wiring distribution systems for voice. Use patch panels, equipment racks and distribution systems for fiber optics as specified in the materials list. Cable terminations, order of terminations, groupings, numbering plans and labeling shall be performed in accordance with NKU's Office of Information Technology conventions (per paragraph P.1.4.b.). See sections pertaining to Horizontal and Vertical Cable. Coordinate with a representative of the NKU Office of Information Technology prior to installation of MDF/IDF distribution and termination hardware.

### **2.2 ENTRANCE FACILITIES**

#### **2.2.A**

Outside plant facility requirements shall be coordinated with the NKU Office of Information Technology. A minimum of (4) 4" inside diameter schedule 40 PVC conduits shall be run from the MDF to the designated vault or tunnel system. Conduits shall be buried a minimum of 24" from the surface on a foundation of 10" wet sand fill. A metallic locator ribbon shall be installed above and parallel to the conduits. There shall be a minimum horizontal separation of 24" from co-located buried electrical service. One pull string shall be installed in every conduit.

**2.2.B.**

Outside copper cable pair count shall be a minimum of 100 pair. (Building specific, to be determined in conjunction with building occupancy and purpose) Use only 24AWG, PE-89 Type REA, direct bury cable with foam skin/filled core, 8-mil aluminum shield, polyethylene jacket, where applicable. See material list. Copper cable shall be terminated in a minimum of (100) pair increments in its entirety for the count of the specific cable at the MDF in a Building Entrance Termination (BET) system.

**2.2.C.**

The other end of the copper cable shall be terminated in a minimum of (100) pair increments in its entirety at the MDF of its origin as determined by the NKU Office of Information Technology. See materials list.

**2.2.D.**

Copper inter and intra connection cable facilities shall be tested and documented at 100ohm with maximum 0% failure allowed.

**2.2.E.**

Outside fiber optic cable strand count shall be determined by the NKU Office of Information Technology. Fiber optic cables shall be terminated in their entirety at the MDF in a Fiber Patch Cabinet. See materials list in 1.5.F. Cable shall be manufactured by Superior Essex, General Cable, Panduit or Corning. See materials list. Fiber optic fan-out and terminations shall be performed using fan out kits with LC style connectors.

**2.2.F.**

Fiber optic cable shall be terminated in its entirety at the TR/ICR/MCR of both its origin and final destination in a Fiber Patch Cabinet. See materials list. Fiber optic fan-out and terminations shall be done using LC or SC style connectors.

**2.2.G.**

Single Mode Fiber optic facilities shall be OTDR and bi-directional insertion loss tested and documented at 1310nm/1550nm with maximum 0% failure allowed. Max cable attenuation is .4/.3 for loose tube and .7/.7 for tight buffer.

Test results for single fiber shall not exceed maximum attenuation allowed based on EIA/TIA loss calculation formulas. Test results must be provided to NKU in .pdf format.

**2.2.H.**

Grounding and Bonding shall conform to NEC Article 250 and ANSI/TIA/EIA-607 using a minimum conductor size of 6 AWG. See material list.

**2.3 HORIZONTAL WORKSTATION CABLES AND POWER REQUIREMENTS PER LOCATION.**

### 2.3.A

If IP phones are in use , covert Voice outlet for a Data outlet in all spaces.

#### Single Occupant Office

Minimum 2, Duplex (Data & Voice) Outlets (1 each on opposing walls)  
Duplex Power Outlet adjacent to each Data & Voice Outlet.

#### Cubicle Space

Minimum 2, Duplex (Data & Voice) Outlets  
Duplex Power Outlet adjacent to each Data & Voice Outlet.

#### Shared Offices

Minimum 1, Duplex (Data & Voice) Outlet per Occupant  
1 Duplex (Data & Voice) Outlet for Shared Printer and  
Duplex Power Outlet adjacent to each Data & Voice Outlet.

#### Reception/Support Areas

Minimum 1, Duplex (Data & Voice) Outlet per Occupant  
Minimum 1, Duplex (Data & Voice) Outlet for Shared Printer  
And Duplex Power Outlet adjacent to each Data & Voice Outlet.

#### Copy Room/Storage Rooms

Minimum 2, (Data & Voice) Duplex Outlets and  
Duplex Power Outlet adjacent to each Data & Voice Outlet.

#### Lounge Space, Café, Study Areas

Layout and quantity depends on design.  
Data Duplex Outlets for Laptop Access and  
Duplex Power Outlet adjacent to each Data Outlet.

#### Non-Classroom Instructional Spaces/ Seminar Rooms/ Conference Rooms

Minimum 4 Data & 2 Voice Faceplates (opposing walls) and  
Duplex Power Outlet adjacent to each Data & Voice Outlet  
Preferred: Level 2 Smart Classroom Technology (scaled to room size and use). See below.

#### Classrooms and Labs

Minimum 6 Data at instructor station and 2 data at the ceiling mounted projector.  
Duplex Power Outlet adjacent to each Data and/or Voice Outlet.  
Preferred: Level 2 Smart Classroom Technology. See below.

#### Computer Labs

Minimum 4 Data and 2 voice Outlets. Three (3) Data & one (1) Voice at instructor station (1 at the ceiling mounted projector and 1 voice location to be determined by NKU).  
Duplex Power Outlet adjacent to each (Data & Voice) Outlet.  
Level 2 Smart Classroom Technology, See below  
Remainder of layout depends on design.

#### Level 2 Smart Classroom

Minimum 4 data outlets to be located at the podium location  
2 Projector outlets to be located in the ceiling  
Regular room layout depending on the room classification and

Duplex Power Outlet adjacent to each Data & Voice Outlet.

**Vending Areas**

- 1 Data outlet per vending machine
- 2 data outlets (minimum) per vending area

**MultiMedia Outlets** (Fiber To the Desktop) Location TBD by NKU

- 4 Data & 2 Voice outlets per location
- 2 Fiber outlets

**2.3.B.**

Provide (1) Black Category 6 Augmented 4-Pair UTP cable for every voice outlet and (1) Black Category 6 Augmented 4-Pair UTP cable for every data outlet as specified in materials list. Cables shall be distributed in a horizontal star topology to the MDF/IDF. Total length of cable from workstation information outlet jack to the MDF/IDF shall not exceed 90 meters total length including service loops. This length includes a 12" service loop at the outlet and a 10' service loop in the telecommunications room. Each horizontal cable shall be installed in a "home-run" configuration. No "daisy chained" conduit or cables shall be allowed. All workstation cables are to be terminated using the T568A wiring standard.

**2.3.C.**

All cables shall be installed in conduit, cable tray, or "J" hooks. Minimum size of conduit should be no less than a 1" conduit. Fill ratios not to exceed the ANSI/TIA/EIA 569 specification. Where cables are not installed in conduit or cable tray, the cable shall not be pulled or installed directly across suspended ceiling tiles or fluorescent lights without proper suspension and consideration of possible electrical interference. If "J" hooks are used, avoid placing any pressure or creating stress points on the cable. Maximum spacing between "J" hooks shall not exceed five feet.

**2.3.D.**

At no time shall pulling tension exceed 25 lbs. on horizontal cables. Exceeding the maximum recommended pulling tension during installation of cables will compromise the wire integrity. If wire integrity is compromised, the wire may not pass testing and certification standards required for a 10-Gigabit infrastructure. The installing contractor will be responsible for replacement of any cable system that does not pass required certification standards. A representative from the NKU Office of Information Technology may randomly test cable installations during weekly coordination meetings.

**2.3.E.**

Traditional nylon synch style Tie Wraps shall not be used to bundle cables in a MDF/IDF. Only Velcro Tie Wraps are acceptable to bundle cables within these rooms. See material list. Traditional nylon synch style tie wraps are acceptable in all other areas. The tie wraps must be installed as directed in the ANSI/TIA/EIA 568 specification.

**2.3.F.**

No Intra-building telecommunications cable shall be run adjacent and parallel to power cabling. A minimum of 6" distance is required from any fluorescent lighting fixture or power line up to 2kVA and 24" from any power line over 5kVA. Similarly, cable should be routed and terminated as far as possible from sources of EMF, such as ballasts, generators, fans, motor control units, motors, etc.

**2.3.G.**

Horizontal UTP station cable shall be terminated at the MDF/IDF in a manner such that each workstation location will be numbered and terminated in sequential order (see 1.4.b.). Voice (white) cable shall be terminated in 96 pair IDC blocks as specified in materials list. Each 96 pair IDC block will support (24) 4-pair cables. Designator strips shall be blue in color. Data (Blue) cable shall be terminated in patch panels as specified in materials list and shall be located in 19" stand alone rack as specified in materials list. Horizontal and vertical fiber optic cable shall be terminated at MDF/IDF in fiber optic distribution cabinets as specified in materials list. Coordinate with a representative of the NKU Office of Information Technology prior to installation of MDF/IDF distribution and termination cable hardware.

**2.3.H.**

Each workstation information outlet location shall use hardware as specified in materials list. The white Category 6 Augmented cable shall be terminated T568A in a Fog White Category 6 Augmented RJ45 jack. The Blue Category 6 Augmented cable shall be terminated ANSI/TIA/EIA T568A in a Blue Category 6 Augmented RJ45 jack. Striping of cable jacket, untwisting of conductor pairs and termination shall be done using ANSI/TIA/EIA conventions. 12" of excess, jacketed, cable shall be coiled in ceiling above the drop location or as near as possible to accommodate future re-termination. Maintain UTP cable pair twists up to the point of termination (maximum of up to 1/4" jacket removal allowed) at both the station/outlet end as well as patch panel/ block end for each horizontal cable. Take caution as to refrain from physically changing or damaging the shape or geometry of the cable during installation, i.e., do not cinch cable ties too tightly; no kinks are allowed and avoid bends of cable. Do not place bundles in such a way that the weight of large bundles is damaging the cables on the bottom of the bundle. Each workstation information outlet jack wall plate shall be numbered sequentially, consistent with the MDF/IDF numbering layout plan. See section 1.4.B for description of cable labeling requirements.

**2.3.I**

Cables shall be dressed in to patch panels directly from vertical wire managers and not run through any horizontal cable managers in order to limit small bend radius.

**2.3.J.**

Contractor shall test and certify, in writing, building wiring meets or exceeds all applicable ANSI/TIA/EIA 568, 569, 607, 758 or others as applicable conventions and standards for Cat6a. Contractor shall test and certify, in writing, building wiring shall support 10 Gigabit Ethernet technologies. Contractor shall warrant Communication cabling system wiring for a period of not less than 25 years, upon acceptance.

**2.4 VERTICAL RISER CABLE****2.4.A.**

A minimum of (4) 4" conduit paths shall be provided between the MDF/IDF's & B IDF.

**2.4.B.**

For each (12) workstation locations there shall be a (25) pair copper riser from the MDF/IDF to the MDF/IDF as applicable. Copper riser cable shall be of a

25 Pair Category 3 riser rated FEP construction as specified in materials list. All riser cable shall be terminated using 110 IDC wiring distribution systems as specified in materials list. Riser cable shall be terminated on a separate 100 pair block from horizontal station cable. Labeling of all riser and workstation cables shall be labeled in accordance with the NKU Technology Infrastructure labeling documentation. Coordinate with a representative of the NKU Office of Information Technology prior to installation and termination of riser cable and hardware.

#### **2.4.C.**

Each MDF/IDF shall have a 12 or 24 strand count single mode Fiber optic cable

Indoor only fiber optic installations will utilize plenum-rated armored single mode 12 strand premise distribution cable

Outdoor or indoor/outdoor fiber optic installations will utilize plenum-rated single mode 12 strand armored indoor/outdoor plenum-rated cable.

See materials list. Coordinate with a representative of the NKU Office of Information technology prior to installation of fiber optic riser cable.

### **2.5 PATHWAY SUPPORT SYSTEM**

#### **2.5.A.**

All horizontal cable shall be installed using a home-run configuration. Conduit and cable tray are acceptable in any combination to support the cable system and not violate Cat6a rules.

#### **2.5.B.**

Conduits shall be dedicated, using no smaller than a 1 1/2" inside diameter per workstation outlet. There shall be no daisy-chain conduit runs. Each workstation location shall require one 1 1/2" conduit, which is a home run back to the appropriate MDF/IDF or cable tray. Provide pull boxes in communications conduit runs spaced not greater than 100 feet apart, and also provide a pull box located at half the distance of the length on any conduit with more than two right angle bends. If more than two bends are in any 100-foot section, increase the conduit by one trade size. See ANSI/TIA/EIA-569-A Section 4.4 Place **TELECOMMUNICATIONS** label on all pull and junction boxes. If a cable tray system is installed, the conduit shall be a home run from the workstation outlet jack to the tray. Conduit runs shall comply with cable fill capacity and bend design as specified in ANSI/TIA/EIA-569-A documents.

#### **2.5.C.**

Traditional nylon synch style Tie Wraps shall not be used in MDF/IDF's to bundle cables. Velcro style Tie Wraps are the only acceptable method to secure cable bundles in TR/ICR/MCR's. See materials list. At no time shall pulling tension exceed 25 lbs. on horizontal cables. Exceeding the maximum recommended pulling tension on Category 6 Augmented cables will compromise cable integrity. If wire integrity is compromised, the wire may not pass testing and certification standards required for a 1000BaseTX infrastructure. The installing contractor will be responsible for replacement of any cable system that does not meet required standards.

#### **2.5.D.**

No intra/inter-building telecommunications cable shall be run adjacent and parallel to power cabling. A minimum of 6" distance is required from any fluorescent lighting fixture or power line up to 2kVA and 24" from any power



line over 5kVA. Similarly, cable should be routed and terminated as far as possible from sources of EMF, such as generators, motors etc.

### 3.0 Warranty

**3.1.A** All work is to be covered by minimum of a twenty-five year warranty supplied by the manufacturer.

#### **3.2.B Ortronics/Superior Essex nCompass™ Structured Cabling System Warranty**

Superior Essex Communications LP and Ortronics, Inc. (a/k/a Legrand Data Communications, a division of Legrand North America, Inc., hereinafter "LDC") (collectively, the "Supplier") warrant to the end-user ("Buyer") that (i) the nCompass CAT 5e+ U/UTP, CAT 6+ U/UTP, CAT 6e+ U/UTP, CAT 6A+ U/UTP, CAT 6+ F/UTP, CAT6A+ F/UTP Copper and OM3/OM4 and OS1/OS2 Fiber Optic certified network cabling system installations will exceed the defined TIA-568 series industry specifications in effect at the time of product purchase and (ii) the products that comprise the certified nCompass Cabling System will meet or exceed the applicable performance specifications in effect at the time of manufacture (the "Limited Lifetime Warranty").

The Limited Lifetime Warranty will be extended to include the entire channel provided that the applicable LDC patch cords and LDC equipment cords are utilized, and all products are installed within areas protected from outside elements. Channel warranties will support current or future applications that are approved by industry recognized organizations (IEEE, ANSI/TIA) for transmission over structured cabling systems defined by the TIA-568 standard in effect at the time of the installation. Channel warranties will perform to the specifications listed in the nCompass system data sheets in effect at the start of the installation. Supplier will honor claims on the Lifetime Warranty for the expected usable life of the building which shall not exceed forty years from the installation of the nCompass Cabling System (the "Limited Lifetime Warranty Period").

#### QUALIFICATIONS AND REQUIREMENTS

To qualify for the Limited Lifetime Warranty, all of the following conditions must be met:

1. Products used in the network cabling system for which warranty support is requested must be qualifying Supplier products. System components must be new (never used before).
2. The network cabling infrastructure must be designed in accordance with TIA-568 and other relevant premises series standards in effect at the start of the time of purchase.
3. The network cabling infrastructure must be installed by Supplier approved designers and Certified Contractors at the Certified Installer Plus-Enterprise Solutions Partner (CIP-ESP) tier or Certified Installer Plus (CIP) tier in accordance with manufacturer's installation instructions and specifications. Supplier is not liable for third party design errors or improper construction.

4. Each permanent link or channel in the network must be field tested in accordance with the TIA-568 series industry standard AND nCompass testing requirements in force at the time of purchase (nCompass testing requirements take precedence over TIA when differences exist). The installed permanent links and channels must have passed all applicable TIA and nCompass performance requirements. Minimum testing for copper systems includes Wire Map, Length, Attenuation, Near End Crosstalk, Far End Crosstalk, Return Loss, PS NEXT, ELFEXT, and PS ELFEXT. Minimum testing for Fiber Optic links includes horizontal and backbone, Bi-Directional Dual Wavelength, Insertion Loss and Length.
5. Special consideration for Category 6A+ Solutions: Designed specifically to mitigate the effects of Alien Crosstalk (ANEXT) between cable segments, Alien Crosstalk field testing is not required for certification of Category 6A+ systems. Alien Crosstalk testing requirements are only waived if the installed system is comprised entirely of nCompass approved Category 6A+ cabling and components including horizontal cabling, patch cords, equipment cords, and associated connectivity. This exception is exclusive to Category 6A+ Alien Crosstalk testing parameters. All Category 6A testing requirements must be performed to certify the installation.
6. Appropriate Warranty Applications should be properly completed online through the Ortronics ConCert certified contractor website prior to initiating the installation.
7. The Warranty Submittal must be completed online within 10 days of installation completion. Copies of all certification test reports must be submitted as part of the Warranty Submittal, and be kept on file by the registrant to be re-submitted when requested by Supplier. Data must be saved and submitted in raw data and summary formats. Test data must be submitted via online upload to the Ortronics ConCert Certified Contractor website. E-mail or disc may be used if the online upload is unsuccessful (please contact the Warranty Administrator for detailed instructions).
8. The Limited Lifetime Warranty will be void if (i) the system is not maintained in accordance with industry standards (ii) a third party has changed, modified or attempted maintenance or repair on otherwise qualifying Supplier products, or (iii) changes are made after warranty issuance and acceptance date, unless Supplier grants written consent for such changes and installation records are updated and forwarded to the Supplier reflecting these approved changes. All changes must be submitted for approval following the original warranty application process.
9. Supplier has issued a registered warranty certificate to Buyer for the Limited Lifetime Warranty. Buyer may not sell, assign or transfer the Limited Lifetime Warranty.

#### ADMINISTRATION

Limited Lifetime Warranty applications will be approved or disapproved by Supplier with a response sent to the applicant. Access to the Limited Lifetime Warranty application information can be obtained by contacting the Warranty Administrator at +1-860-405-2988, or by e-mailing your request to contractor.cert@legrand.us. All warranty applications must be completed on Certified Contractor website.

CLAIMS AND EXCLUSIVE REMEDIES

The validity of any warranty claim under this Limited Lifetime Warranty shall be determined by the Supplier in its sole discretion. A claim will be reviewed by Supplier only if all of the following are satisfied:

1. Reported within ten (10) days of date of defect discovery;
2. ALL system design and installation records are readily available to be provided when requested (original network installation design prints, test results, maintenance records, warranty submittal documentation);
3. Copies of all original receipts for materials and labor from the date of initial installation; and
4. Supplier has full and open access to inspect and evaluate the installation site.

If system performance or material fails to meet the Limited Lifetime Warranty, the Buyer must notify Supplier, in writing, within ten (10) days of the discovery of any non-conformity. Notification shall be made/sent to the Warranty Administrator (above). If a warranty claim is determined by Supplier in its sole discretion to be valid, as Buyer's sole and exclusive remedy, Supplier will, at its option and using Certified Contractor(s) of its choosing, replace or repair the non-compliant qualifying components of the permanent link or channel and cover reasonable cost of labor to affect necessary work. If the Buyer provides a quote from a Certified Contractor of its choosing, the Warranty Administrator, in its sole discretion, may alternatively elect to allow such Certified Contractor to affect the warranty repair and reimburse the Buyer for reasonable labor costs, provided prior written approval is obtained from the Warranty Administrator for proposed materials and labor. If the cause of any error is determined to be improper installation, maintenance or third party repair, the Buyer may be referred back to the appropriate contractor or third party for support.

WARRANTY EXCLUSIONS

1. The Limited Lifetime Warranty does not cover:
2. The installation and maintenance of any other non-performing portions of the Buyer's System;
3. Products not specifically designated as being eligible for the Limited Lifetime Warranty coverage;
4. Products not supplied directly by the Supplier or through channels not approved by Supplier;
5. Products used in the cabling system, which were falsely represented as being in compliance with the Limited Lifetime Warranty registration requirements and procedures;
6. Products that are exposed to moisture, liquids (such as paint), or water;

7. Defects resulting from environmental or third party materials, including but not limited to work areas, patching or equipment cords, or from moves, additions and changes by parties other than a Certified Contractor; and
8. Defects resulting from a noncompliant or improper system design, installation, use, repair, or any system alterations, misuse, neglect, accident or abuse.

THE FOREGOING LIMITED LIFETIME WARRANTY IS EXCLUSIVE AND IS GIVEN AND ACCEPTED IN LIEU OF A) ANY AND ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING WITHOUT LIMITATION ANY WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR ARISING OUT OF THE CONDUCT OR THE PARTIES, AND (B) ANY OBLIGATION, LIABILITY, RIGHT, CLAIM OR REMEDY FOR SUPPLIER'S NEGLIGENCE, ACTUAL OR IMPUTED.

The remedies of the Buyer for breach of the Limited Lifetime Warranty arising hereby, expressed or implied, or by operation of law, or for breach of any duty of Supplier, expressed or implied or arising out of any conduct of the parties, shall be strictly limited to those provided herein to the exclusion of any and all other remedies including, without limitation, claims for incidental or consequential damages. No agreement varying or extending the foregoing Limited Lifetime Warranty, remedies or these limitations will be binding upon Supplier unless in writing, signed by an authorized officer of Supplier.

Ortronics  
125 Eugene O'Neill Drive  
New London, CT 06320  
Tel: 800-934-5432, 860-445-3900  
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www.ortronics.com

### **3.2.A Panduit Certification Plus™ System Warranty**

The Certification Plus™ System Warranty is a 25-year standards-based performance warranty covering cable, components and labor to repair or replace cable and/or components on any registered link and/or channel failing to meet minimum performance requirements as specified in the Commercial Building Telecommunications Cabling Standards. This warranty provides a single point-of-contact for registrations and system issues. All cable and components must be installed only by skilled PCI's (Panduit Certified Installers) who have a RCDD or Panduit-approved equivalent on staff and the required amount of trained technicians.

Eligible installations are warranted as follows:

1. That each registered link and/or channel will meet or exceed the performance requirements of the designated link and/or channel classification defined in the Commercial Building Telecommunications Cabling Standards listed on the warranty certificate.
2. That each registered link and/or channel will support all current and all future network applications designed to run on the designated link and/or channel classification defined in the Commercial Building Telecommunications Cabling Standards listed on the certificate.
3. That all connectivity hardware and cable used in the structured cabling system will be free of defects in material and workmanship under normal handling and use.

In the event that any of Panduit's connectivity hardware and/or cable used in the structured cabling system fails to perform as specified above in #'s 1 - 3, Panduit will repair and/or replace the defective connectivity hardware and/or cable ourselves or will contract a Panduit Certified Installer to complete this work in accordance with the limitations set forth in this Certification Plus™ System Warranty.

The Certification Plus™ System Warranty registration requirements are as follows:

1. A signed SCS Installer Agreement at Panduit (required prior to registration).
2. A RCDD or Panduit recognized equivalent on staff of the installing agent.
3. A completed application for warranty.
4. Standards based test results, taken with an approved field tester and test leads.
5. As-built floor plans indicating work-area outlets and telecommunication closet(s).

For this warranty to be valid:

1. The customer must verify that the structured cabling system has been designed, installed and maintained throughout the warranty period per the following standards:
  - a) TIA/EIA-568-B.1, Commercial Building Telecommunications Cabling Standard Part 1: General Requirements, May 2001.
  - b) TIA/EIA 568-B.2, Commercial Building Telecommunications Cabling Standard Part 2: Balanced Twisted Pair Cabling Components, May 2001.
  - c) TIA/EIA568-B.2-1, Commercial Building Telecommunications Cabling Standard Part 2: Balanced Twisted Pair Cabling Components. Addendum 1 - Transmission Performance Specifications for 4-pair 100  $\Omega$  Category 6 Cabling, June 2002.
  - d) SP-3-4426-AD10-B, draft 5.0, 07/28/06 (to be published as ANSI/TIA/EIA-568-B.2-10) Commercial Building Telecommunications Cabling Standard. Part 2: Balanced Twisted Pair Cabling Components. Addendum 10 - Transmission Performance Specifications for 4-pair 100  $\Omega$  Augmented Category 6 Cabling.
  - e) TIA/EIA 568-B.3, Optical Fiber Cabling Components Standard, April, 2000.
  - f) TIA/EIA-569-B, Commercial Building Standard for Telecommunications Pathways and Spaces, October, 2004.
  - g) TIA/EIA-606, Administration Standard for Commercial Telecommunications Infrastructure, May, 2006.
  - h) IEEE Std 802.3(tm)-2002 Part 3: Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications.
  - i) IEEE 802.3an-2006, Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications. Amendment 1: Physical Layer and Management Parameters for 10 Gb/s Operation, Type 10GBASE-T.
2. Each registered cable link and/or channel must be 100% constructed of Panduit connectivity hardware and cable approved for the designated link and/or channel classification defined in the Commercial Building Telecommunications Cabling Standards listed on this certificate.
3. The PCI (Panduit Certified Installer) must submit to Panduit a certified passing test report for each link and/or channel.

**In the event of a warranty claim:**

In the event of a performance problem the customer must resolve all non-connectivity hardware and non-cable related causes and contact the original Panduit Certified Installer to verify that the system has been designed, installed and maintained per the applicable Commercial Building

Telecommunications Cabling Standards except where the Certification Plus™ System Warranty Program Manager has previously authorized exceptions to these standards in writing. If the performance problem persists, the customer should contact the Certification Plus™ System Warranty Program Manager for corrective action within 10 days of the original performance problem.

**Warranty Exclusions and Limitations:**

1. This warranty does not cover defects where the structured cabling system has been subjected to misuse, abuse, neglect, accidental damage, fire, flood, water submersion, explosion, acts of God, war or terrorism, improper repair, alteration, installation or design, or any other events outside of Panduit's control.
2. This warranty does not cover the installation or maintenance of the system or products not specifically designated for use under the terms of the Certification Plus™ System Warranty. This warranty is void if the defective link and/or channel is comprised of counterfeit products.
3. Under no circumstance shall Panduit be obligated to pay for repairs which exceed the original amount paid by the customer for the Panduit connectivity hardware and/or cable in the structured cabling system. Subject to the foregoing and to the other terms and limitations of this warranty, repair and/or replacement of the connectivity and/or cable used in the defective link and/or channel is Panduit's sole and exclusive obligation and customer's sole and exclusive remedy.
4. This warranty is made in lieu of and excludes all other warranties, expressed or implied, arising by law or custom, including without limitation, implied warranties of merchantability, fitness for particular use, non-infringement or any other matter. Panduit shall not be liable for any other injury, loss or damage, whether direct or consequential, arising out of the use of, or the inability to use, the system. In no event will Panduit be liable for any incidental, exemplary or consequential damages, including, but not limited to damages for lost data, time, profits, revenues or any other economic damages arising out of the use of or the failure of a system.
5. This Agreement shall be governed by and construed in accordance with the laws of the State of Illinois, USA and any disputes hereunder or relating hereto shall be subject to the jurisdiction of the courts of the State of Illinois, USA.

Panduit  
18900 Panduit Drive  
Tinley Park, IL 60487  
Tel: 800-777-3300  
Fax: 708-532-1811  
www.panduit.com

### **Audio Visual Systems:**

Crestron control system components to include the specified control processor, connectivity and the ability to provide integrated control of at least one multimedia projector, one pair of specified stereo speakers, one specified Blu-ray DVD unit, two computer outputs for main computer and laptop, and two additional source devices (e.g. digital document camera, composite video camera). Vendor must provide all required manufacturer power supplies, cables, rack kits, expansion and wall plates (metal expansion and/or wall plates require the use of insulated plenum cabling), sensors and controls. A pre-terminate (25') Twenty-five feet umbilical cord wrapped in braided TechFlex should be installed to connect equipment rack to wall plate. Cabling in walls and ceiling must be plenum rated.

Vendors may submit proposals only for equal or better quality items specified with make and model if the specified item is no longer available from the manufacturer. Specified items not available from the manufacturer will require the vendor to quote the direct replacement item from the specified manufacture and will require approval from Northern Kentucky University's Office of Information Technology. On those items not specified, please supply catalogue pages with all specifications and indicate the make and model of any suggested items.

Programming of Crestron Control System should also include the Crestron Fusion and X-Panel modules. Programming Code (compiled and uncompiled) for Crestron Control Systems must be submitted to the Northern Kentucky University's Office of Information Technology upon project completion. All programming will become property of Northern Kentucky University.

### **Preferred Product Specifications:**

The following list specifies acceptable models of equipment, which at this date are preferred by the Northern Kentucky University's Office of Information Technology for the consistency and ease of support. Substitutions for discontinued items must be of the same manufacturer and be the current replacement for that model.

Spectrum Link Lectern 36" w/4" casters	model # 55123 IDHD
Spectrum document camera/task shelf	model# 55140 IDHD
Middle Atlantic PB-XS	Rackmount for PD815SC
Middle Atlantic PD815SC	8-outlet power distro w/surge
Middle Atlantic PD-915R	9-outlet power Distro
Middle Atlantic U1	1RU utility rack shelf
Middle Atlantic U2	2RU utility rack shelf
Crestron Control System	Crestron DMPS-300-C
Crestron AirMedia	AM-100
Crestron 4.3" Isys touchpanel user interface, gloss black	TPMC-4SMB-B-S
Crestron DM 8G+ receiver/room controller	RMC-Scaler-C
Crestron PoE injector	PWE-4803RU
Chief Universal Projector Mount	RPMAU
Chief Suspended Ceiling Kit	CMS-440
QSC Acoustic Design Speakers (Pair)	AD-S52
Sony Blu-Ray DVD Player	BDP-S5200
Da-Lite 16:10 109" Matte White Manual Screen	Model B
Da-Lite Mounting Brackets (Pair)	Model 6
Panel Crafters –2-gang wall plate, engraved, brushed black 1 VGA (engraved LAPTOP), 1 3.5mm audio, 1 power outlet, 1 HDMI, (engraved AUX HDMI), 1 cat5e (engraved LAN), 1 Composite Video RCA with L/R Audio (engraved AUX VIDEO)	

Panel Crafters – custom 2-gang, engraved, brushed aluminum – 1-speakon (engraved SPKRS), 1 cat5e (engraved DM), 2 male XLR (engraved Mic 1 & Mic 2)

PowerLite 99W WXGA 3LCD Projector  
Epson DC-12 Document Camera

V11H578020  
V12H594020

Note: All HDMI cables should be Crestron® Certified HDMI® Interface Cables

- The vendor is expected to be pro-active in advising Northern Kentucky University's Office of Information Technology representatives of improvements in relevant AV technology and pricing in a timely manner, and to provide demonstration samples for testing and evaluation in actual use.
- Equipment shall be of current design and consist of standard products established manufacturers, carrying valid manufacturer's standard USA warranties.
- All items must be new. Used, including demonstrator equipment is unacceptable.
- The smart controls shall be designed to provide optimum usability for all controllable equipment. They shall imitate the design and functionality type user interface for the University's existing systems.

**ADDITIONAL HARDWARE REQUIREMENTS:** Additional requirements include extension cables from podium interior (equipment location) to podium surface to allow convenient plug-in of additional equipment; cable-pack to include HDMI connections for desktop PC and laptop, composite video, audio (for desktop PC and laptop).

Connector plates, plugs, 20' cables, other required hardware, and installation to allow podium to be moved around the front of the room (i.e. "umbilical cord" with plugs at both ends, to connect podium equipment to wall for power, network, projector, and speakers. Cabling, connectors, programming, installation, and all required components and labor necessary for complete installation.