March 2023

CONSTRUCTION STANDARDS

INTRODUCTION

INTENT

In place of the previous University of Wyoming (UW) *Instructions to Architects & Engineers*, two new documents were developed—the *UW Design Guidelines* and the *UW Construction Standards*. The *UW Design Guidelines* are intended to serve as a resource for design professionals to facilitate the planning and design of UW facilities. The *UW Construction Standards* are intended to convey technical requirements for the design of new and renovated facilities and contain much of the substance of the previous *Instructions to Architects & Engineers*. These guideline documents were prepared to address problems that UW has experienced during design, construction, and operation of new and renovated facilities. The intent of these documents is to provide the information necessary to avoid these problems in the future and to promote the design and construction of better university facilities. These guideline documents will answer many frequently asked questions and can help consultants avoid redesign and unnecessary construction administration time.

ORGANIZATION

The *UW Construction Standards* are organized based on the Construction Specifications Institute (CSI) specification format. A detailed Table of Contents is provided instead of an index. These standards must be used in conjunction with other UW design and construction documents.

DISCLAIMER

These construction standards are not intended to be a substitute for specifications prepared by design professionals, and do not relieve the consultants from their responsibility to exercise due care in design and documentation of UW projects in a manner consistent with accepted standards of professional practice. The standards are intended to represent minimum requirements.

MODIFICATIONS

This document is intended to be an evolving resource, and UW encourages comments, suggestions, and proposed corrections/modifications from consultants and other interested parties. Please email your comments to UW Operations at hearl@uwyo.edu. Suggestions will be considered, and the Standards and Guidelines updated periodically.

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SECTION 001100 – SUMMARY OF WORK

Existing building air intakes within 500’ of new construction will need protection from excessive fouling due to construction. Contractor shall install or pay UW to install and maintain construction blanket on exterior of intake or sacrificial 2” filters in front of outside air filter banks.

SECTION 03 00 00 - CONCRETE

All exterior slabs that will require snow removal by machines shall be 4,500 lb. fiber-reinforced concrete, 6" minimum thickness, 6' minimum width. Hand-troweled control joints to control cracking are preferred over saw-cut joints.

Select base shall be placed under concrete equal to the thickness of the concrete.

Expansion joints shall be provided at 30 feet O.C. for concrete curbs and sidewalks. Expansion joints shall be continuous at the perimeter of concrete slabs that adjoin buildings and shall be provided at 20 feet O.C. in each direction for patios, plazas, courtyards, etc. Control joints shall be spaced at a maximum of 5’ O.C. for sidewalks.

Curing compounds that incorporate a sealer shall be specified.

Concrete mixes shall be Wyoming Public Works Type A (3,500 psi) or Type B (4,000 psi)
All grating, trench drains, hatch covers, manhole lids, and non-concrete items located within walks shall have a minimum loading capacity of 1,500 pounds per square foot.

Foundation wall designs shall employ water-managed principles, rather than waterproofing. Wall damp-proofing and capillary break shall be provided. Surface water shall be drained away from the building, and a sub-grade perimeter drainage system shall be provided.

SECTION 03 35 00 – CONCRETE FINISHING

Exposed interior concrete floors shall be sealed with Hillyard 341 sealer.

Newly poured concrete shall be kept from freezing for a minimum of 6 days.

SECTION 04 00 00 - MASONRY

Expansion joints shall be incorporated to eliminate cracking and stress whenever possible. Expansion joints shall be indicated on the drawings and detailed.
For masonry or cavity wall insulation, extruded polystyrene shall be specified.

Corrosion-resistant fasteners shall be used to secure masonry ties. For planter liner material, welded stainless steel or copper shall be used.

Stone masonry on the UW Campus originally utilized local sandstone; however, sandstone from the original quarry is no longer available. Alternatives to the local sandstone are as follows:

A. Natural Sandstone: Buff (80%) and Pink (20%); Quality Building Stone, 993 W. 14730 South, Bluffdale, Utah [www.Qualitybuildingstone.com, (801) 255-2911] or approved substitution. Units shall be a combination of nominal 4”, 8” and 12” height cut to lengths of nominal 4”, 8”,

12”, 16”, 20” and 24” laid in a non-coursed random ashlar pattern matching the stonework of other campus buildings. Nominal coursing of natural stone shall match that of standard concrete or modular brick unit masonry. The size of the stones may vary to match existing stone, if approved by the University.

B. Calcium Silicate Masonry Units: Arriscraft International Inc.; Renaissance Masonry Units; Rocked Face Colors – G03-1209A (80%), G03-1209C (20%). Units shall be a combination of nominal 4”, 8” and 12” height cut to lengths of nominal 4’, 8”, 12”, 16”, 20” and 24” laid in a non-coursed random ashlar pattern matching the stonework of other campus buildings. Nominal coursing of calcium silicate masonry units shall match that of standard concrete or modular brick unit masonry.

Stone masonry shall be installed to maintain the standard 4” nominal modules as shown on Figures 040000-1 and 040000-2 following this Section. Vertical bed and horizontal head joints shall be accurately located on standard 4” nominal modules. The layout of stone masonry at non-modular building dimensions shall be pre-planned to maintain standard 4” modularity and minimize cutting.

FBS type brick shall be specified.

Type S Mortar shall be specified unless otherwise approved by the UW Project Manager.

The Contractor shall prepare for tests required by the IBC. Actual testing will be performed by a testing agency hired by the University or by the University.

Joint reinforcement shall have a minimum of 3/16” diameter side and cross rods.

Control joints shall be detailed, and their locations shall be indicated on the construction documents.

If a masonry allowance is used, the allowance shall be noted in the requirements in the special conditions.

Quarry-faced sandstone shall be laid in a random ashlar pattern. As the name implies, the pattern shall be random, and regularity such as overly long horizontal or vertical joints and similar height/ size adjacent units shall be avoided—see the examples below:

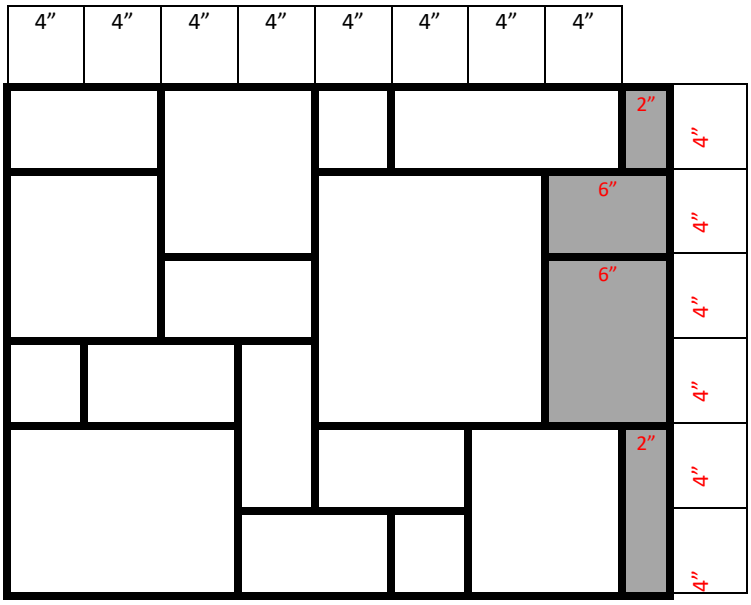


Figure 040000-1: INCORRECT
Vertical stones used and the 4” increment is not maintained.

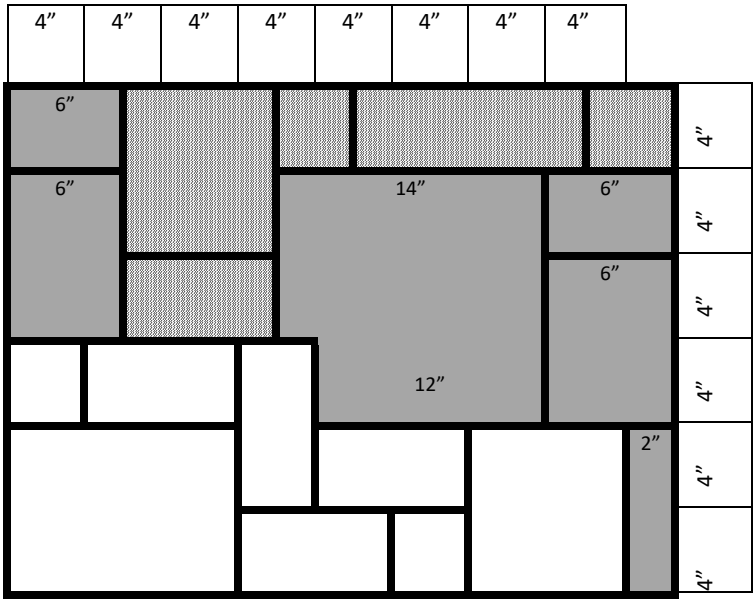


Figure 040000-2: INCORRECT
Notching of stone is not permitted. Vertical stones used and 4” increment is not maintained.

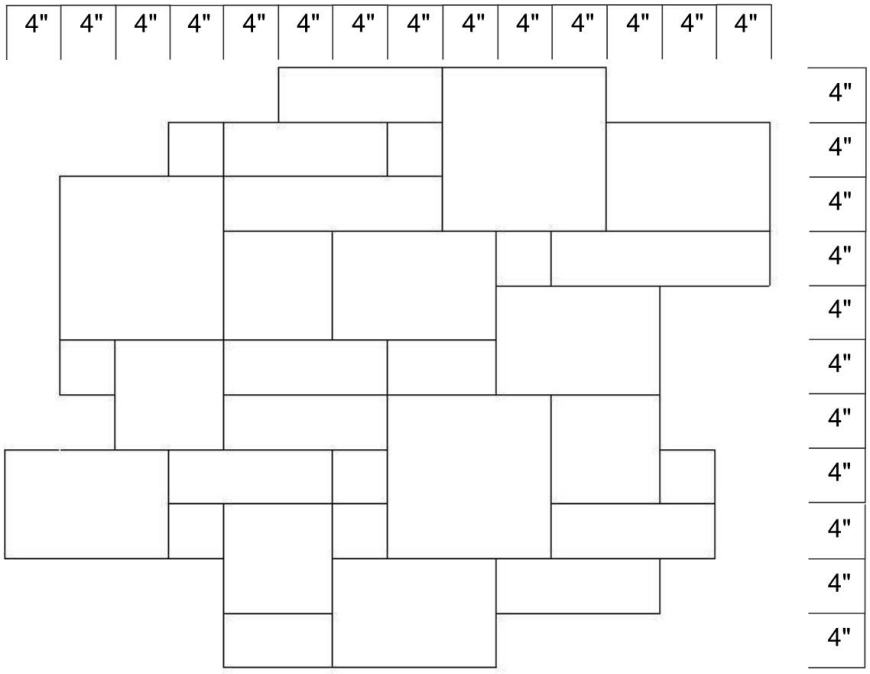
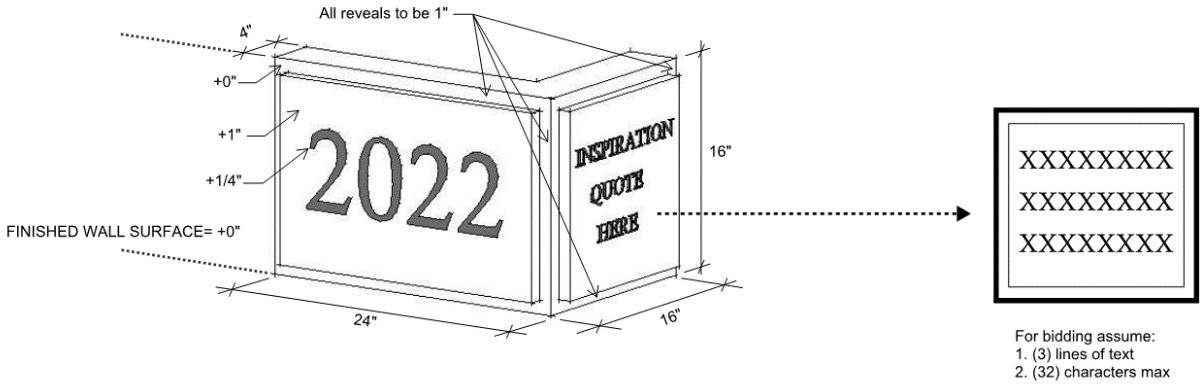


Figure 040000-3: CORRECT
Random ashlar pattern with no vertical stones in 4” increments.

Cornerstones: New buildings and major additions shall include a building corner stone indicating the year the stone was laid. A sample is included below:



Cornerstones shall be placed on the right corner of the main building elevation with the date facing the main elevation.

Bottom of cornerstone to be located approximately 24” above finished grade, coordinated with masonry coursing and detailing. Care should be taken not to obscure the stone with landscaping.

Text: shall be Calisto MT unless matching existing cornerstone text during an addition project.

The year constructed text shall be 6” tall and ¾” deep, painted black.

On the face opposite the year constructed, an inspirational quote or the UW Medallion shall be placed. Text for the inspirational quote shall be ½" deep, painted black.

SECTION 06 00 00 – WOOD, PLASTICS AND COMPOSITES

Pressure-treated wood shall be provided for wood members exposed to moisture or in contact with masonry or concrete.

Specify plastic laminate or melamine interior and semi-exposed surfaces for plastic laminate cabinets

Indicate minimum securing of upper cabinets. Fasteners shall be adequate to resist 40 lbs. per linear foot of shelf.

Require continuous blocking or backing in walls having cabinets mounted to them.

Provide PVC, rubber, or hardwood edging for plastic laminate cabinets.

Require corner units at upper and lower cabinet runs when continuing to adjacent walls.

Provide filler panels at the top and bottom of corners of upper cabinets and where front filler panels are used.

Where upper cabinetry does not terminate at a ceiling, a gypsum board soffit or other enclosure shall be provided to avoid trash and dust from accumulating on top of cabinetry. A minimum 1" overhang shall be provided for terminating casework to drywall.

Consult the UW Operations Paint Department for assistance matching existing casework stains.

Provide blocking or backing in walls for soap dispensers, paper towel dispensers and other toilet accessories.

SECTION 07 20 00 – THERMAL PROTECTION

Unless otherwise specified, thermal performance of facility components shall meet the standards listed in ASHRAE 90.1, Energy Standard for Buildings Except Low-rise Residential Buildings:

A. The "R" value per inch thickness shall be indicated in the specifications. The "R" value for polyurethane insulation used in calculations shall be specified as 6.5 per inch.
B. Rigid insulation for other than roofing applications shall be extruded polystyrene.
C. See roofing insulation comments in Roofing section.
D. A minimum of 2" of high-density extruded polystyrene foundation perimeter insulation or floor edge insulation shall be provided ensuring minimum R-values are met to meet the requirements of the 2021 IECC.
E. Protection board shall be required for below-grade insulation.

Spray foam insulation shall be used to seal the inside stud cavity against the polystyrene cover board (where applicable).

SECTION 07 30 00 TO 07 76 00 - ROOFING

Roof systems shall be by the same manufacturers as, or compatible with, systems at the University of Wyoming. Other systems may be considered based on application and building environment.

Snow guards, dormers or canopies shall be provided at building entrances below sloped roofs and other areas where sliding snow can cause injury.

Single-Ply Low Slope Roof Systems (in order of preference):

A. Sarnafil - PVC 72-mil S-327 reinforced membrane, white SRI of 104>. The installer shall have at least 5 years' installation experience AND provide a separate 5-year Installer's warranty. Provide minimum 20-year no dollar limit, 1½" hail rider manufacturer's warranty. In areas of roof top contamination, overlay membrane with G459 flashing membrane. Membranes shall have the capability to be successfully installed during winter and summer weather conditions.
B. Seaman FiberTite- ASTM D 6754-02 (or latest revision) EIP or KEE sheet roofing having >50% DuPont Elvaloy. 8160 "XT", nominal 50 mil membrane. White or beige SRI of 104>. The installer shall have a minimum of 5 years installation experience AND provide separate 5-year Installer's warranty. Provide 20-year no dollar limit, 1½" hail rider manufacturer's warranty. The membrane manufacturer shall show proof that the waterproofing product has not undergone formulation changes in the last 20 years. Membrane shall be unaffected by contact with contaminants such as oil, asphalt, ethylene and polypropylene glycol. Membranes shall have the capability to be successfully installed during winter and summer weather conditions.

C. Firestone, Versico or Carlisle EPDM, black, standard, 60 mil minimum, reinforced membrane. The installer shall have a minimum of 5 years installation experience AND provide a separate 5-year Installer's warranty. Provide 20-year no dollar limit, 1½" hail rider manufacturer's warranty. Membrane shall be unaffected by contact with contaminants such as oil, asphalt, ethylene and polypropylene glycol. Membranes shall have the capability to be successfully installed during winter and summer weather conditions.

The preferred roofing system is polyisocyanurate insulation, with base layer mechanically attached (assuming a nailable roof deck) and subsequent layers (joints staggered to minimize thermal bridging) adhered with low-rise foam including a top layer of ½" cover board (USG Securock, Dens Deck. or High Density Polyiso), and a fully adhered membrane. As a cost savings measure, all insulation layers and cover board may be mechanically attached or a loose laid assembly with rock ballast may be utilized. If the roof system utilizes rock ballast, HD polyiso cover board is preferred over hard cover board.

Low-Slop Inverted, Protected, and Plaza (in order of preference):

A. Fluid Applied Hot Rubberized Asphalt. Membrane shall not be affected by fertilizer products, salt water or acid rain. The installer shall have a minimum of 5 years installation experience AND provide a separate 5-year Installer's warranty. Provide 20- year full system manufacturer's warranty.
B. Siplast, Inc. SBS Modified Bitumen torch-applied membrane. Surface shall meet minimum SRI of .24 if surface-applied and exposed to the elements. Inverted or Plaza roof system Siplast Spec 2020 PMC-T or the current equivalent system. The installer shall have a minimum of 5 years' installation experience AND provide a separate 5-year Installer's warranty. Provide 20-year full system manufacturer's warranty.

C. Sarnafil thermoplastic waterproofing system, containment grid with accessible below leak indicator bulb. The installer shall have a minimum of 5 years installation experience AND provide a separate 5-year Installer's warranty. Provide 20-year full system manufacturer's warranty.

System surface and components shall be removable for repair and maintenance. Plaza deck rated concrete pavers are preferred. Where applicable, membrane shall be heat-fused directly to structurally sloped concrete roof deck. Roof drains shall be cast into deck 1" lower to allow for clamp ring height.

Steep Slope Roof Systems

A. Malarkey SBS Modified Shingles, "Legacy", Silverwood, Class 4 impact rated, 90 mph wind speed rated and applied over SBS underlayment. The installer shall have minimum 5 years installation experience AND provide separate 5-year Installer's warranty. Provide minimum 10-year non-prorated full system manufacturer's warranty.
B. Metal Sales Image II, Copper Sales Una-Clad UC-4. Architectural metal roof systems shall be concealed fastener type, minimum 26-gauge thickness over solid sheathing with continuous high temperature rated underlayment waterproofing. The underlayment system shall be the waterproofing layer and all penetrations and wall flashings shall be flashed a minimum of 8" in height. Surface caulking the panels and applying strip mastic joints is not an acceptable means of waterproofing. Penetrations greater than vertical rib spacing shall be cricketed to divert drainage around penetration. Smaller penetrations shall be placed between ribs allowing drainage around both sides of penetration.
C. Structural metal roof systems shall be minimum 24-guage thickness standing seam applied with clips to allow for expansion and contraction of the panels. All penetrations shall be cricketed or located so drainage between ribs is not inhibited. Equipment curbs and hatches shall be framed with steel members connected to the purlins and structural frame of the building flush with the underside of the metal roof panels.

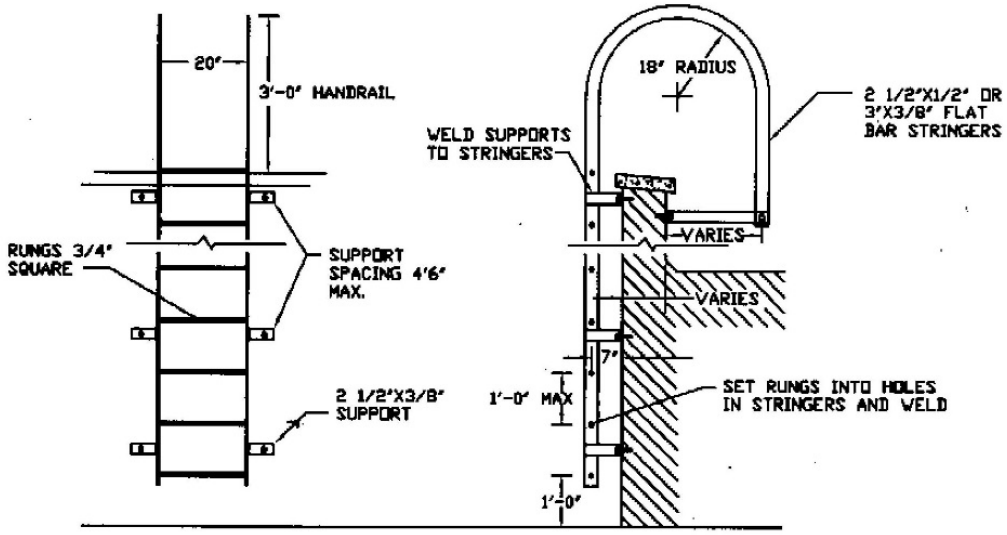
Roof slope: Provide positive slope to roof drains or scuppers. Prefer primary roof deck structure be sloped minimum of ¼" per foot. 4-way taper system is preferred over 2-way taper system with crickets. 4-way taper system may be ¼" or 1/8" per foot slope. 2-way taper system shall be minimum ¼" per foot primary slope with minimum ½" per foot crickets. Ponding water is NOT acceptable due to slip hazard, collection of debris, accelerated deterioration of the membrane, and potential for increased leakage.

Cover Board: ½" minimum thickness, 4'-0" x 4'-0" cover board size shall be scored and mitered to the ridge and valley lines of the taper system with no gaps exceeding 1/8". Gypsum wallboard is NOT an acceptable cover board. ½" high density polyisocyanurate cover board is acceptable for roofs having minimal expected future roof activity.

Insulation: Average overall "R" value shall be aged "R" value. Maximum layered insulation thickness shall not exceed 10". Conventional flat and taper systems shall employ 4'x4' polyisocyanurate boards, 20 psi min. Tapered edge strip shall be specified at drains, scuppers, valleys, and penetrations as required to provide continuous support of cover board substrate. Use of expanded polystyrene roof insulation is discouraged due to its low melting point, compressive strength, and poor moisture penetration resistance. Extruded polystyrene is required for inverted, protected or plaza systems and is acceptable for low slope conventional system if UL rated. Cover board seams shall be taped to prevent solvent adhesive from damaging boards.

Drains: Roof drains shall be cast iron no hub (including dome strainer) set 1” below concrete deck or in receiver pans in metal deck. Aluminum or weldable metal retro or insert type roof drains are also acceptable for overflow drains. PVC, fiberglass, and other plastic roof drains and or parts and accessories (which deteriorate in the sun) are not acceptable. Provide under-deck clamps to resist forces of membrane uplift. “Level-Eze” or other adjusting raised collar roof drains are not acceptable. Drain basins shall be gradually sloped to the primary roof drain. Through-wall scuppers are the preferred overflow system. If a secondary roof drain system is necessary, overflows shall be set upslope of the primary drains, and the overflow basin shall drain to the primary roof drain basin. Roof drainpipe systems shall be routed interior in conditioned space to prevent winter freezing. Insulate horizontal runs of roof drain piping to below the ceiling level and for at least 30’ minimum from the roof drain bowl. Prefer underground piping system that connects to underground storm system. Surface discharge of primary roof drainage is not allowed on north exposures, at entries, onto or across walkways, handicap ramps or sidewalks due to freezing and slip/fall hazards.

Maintenance access: A stair-type roof hatch or roof access door shall be provided to at least one main roof level with then leading to all other roof levels. Slip-resistant walkways shall be provided between all rooftop access doors, access ladders, and rooftop equipment requiring maintenance and/or servicing. Ladders shall be UW standard (see detail below) wall-mounted clear of roof and base/counter flashing.



STANDARD ROOF LADDER DETAIL

NOTE: CAGES SHALL BE PROVIDED FOR ALL LADERS 20' OR MORE AS PER WYO. OPPUPATIONAL HEALTH AND SAFETY RULES AND REGULATIONS.
LADDERS IN EXCESS OF 30' SHALL BE CONSTRUCTED WITH LANDING PLATFORMS AS PER W.O.S.H.A. RULES AND REGULATIONS.

TYPICAL ROOF LADDERS

Roof top walkways or raised access stairs shall be adjustable of bolted assembly, galvanized metal non-penetrating bases; slip resistant walkways complete with hand and guard rails. The photo below illustrates an example of an acceptable product.

ROOF WALKWAY & STAIR WITH NON-PENETRATING BASES

Parapet walls, curb construction: Parapet walls shall be 42” (±3”) in height so fall protection is not required. Where parapet walls are not provided, guardrails shall be utilized. Parapet walls abutting a mechanical penthouse, skylight wall, or curb penetrations shall have a minimum vertical flashing height of no less than 8 inches from the roof surface to the bottom of the counter flashing. Wall and curb bases shall be air sealed, insulated, and constructed of masonry, steel framing, or wood framing covered with treated plywood to resist 200 lbs. / lineal foot force laterally at the base attachment. Provide steel framing to attach curbs to structural steel joists in metal frame construction. Gypsum core boards and sheathing are NOT acceptable substrates for roof base attachment.

Roof utilities, equipment: Plumbing, control, electrical and guy wire penetrations shall be flashed with pre-manufactured roof boots, not pitch pans. Multiple penetrations shall be grouped in a roof curb and services shall be accessible/replaceable without re-flashing. The curb interior shall be insulated and sealed to prevent excessive heat loss or air leakage. The photo below illustrates an acceptable example.

Equipment curbs shall be covered with one piece 24-gauge minimum galvanized metal cap with no penetrations sloped to drain. If curb size requires seams, they shall be a soldered raised hem type. The photo below indicates the preferred method of flashing large roof mounted exhaust fan or similar equipment. Attachment of equipment to curb shall be accomplished by employing an equipment rail complete with vibration isolators securely fastened into the counter flashed sides of the curb. All round duct and/or flue pipe penetrations shall be provided with square curbs to terminate membrane and be flashed with square-to-round transitions and draw band type weather collars. Guy wires shall be in walls or fascia where possible. If not possible, provide a metal plate secured to the deck with welded steel pipe riser minimum 8” above finished roof surface, with threaded pipe cap/eye bolt connector. Provide minimum of one 20-ampere, 120-volt, dedicated outlet on each roof level within 100 feet of all reaches of the roof system for servicing and repair. Provide one freeze-proof domestic water supply sill cock at a central location on the exterior wall of the mechanical penthouse wall for membrane cleaning and flushing roof drains.

LARGE ROOF FAN FLASHING

Roof-to-wall termination: Provide standard membrane termination bar. Cover with redundant inset Reglet type or one-piece surface-mount 24-gauge minimum metal counterflashing attached with removable Tap-cons to facilitate future roof removal and replacement.

Ballasted systems: Provide heavy-weight concrete walkway pavers laid on protection membrane to all roof top equipment, doors, and ladders. Concrete topped “LG” or 8” x 16” concrete interlocking roof pavers yield deficient performance and are not acceptable as roof ballast. Stone ballast shall be evenly graded, round, washed river rock with 100% passing a 1” screen and no particle dimension exceeding 2½”.

Exterior Gutters and Downspouts: Gutters shall be rectangular with deck apron or half-round styles of galvanized or prefinished metal minimum 24-gauge thickness, sloped to drain, and designed to conform to the *SMACNA Architectural Sheet Metal Manual*. Downspouts shall be of the same material and thickness of adequate size to prevent plugging and splitting from freezing during the winter.

Rooftop equipment stands, duct supports, conduit racks, etc.: These items shall be protected with hot dip galvanized coating. On-site fabrication method shall be bolted or riveted connections. Stands, supports and racks shall be constructed with a minimum vertical clearance of 24” from the finished roof surface to facilitate maintenance and future replacement of the roof system. Support legs penetrating the roof system shall be fabricated with round pipe flashed with factory boot or field wrapped and covered with draw band type storm collar.

Roofing protection: The Contractor shall be responsible for protection of roof systems during construction. The roof system shall be in new condition when delivered to UW. The Contractor shall install protection mat at all main roof access points during construction to the satisfaction of UW. The General Contractor shall require all subcontractors to protect roof systems from damage while working on the roof system from ladders, stored/staged material, welding, painting, glass/metal installation, etc. and coordinate penetration flashing with the roofing contractor. The General Contractor shall include roof protection as an agenda item at the start-up meeting and notify UW to have a representative present. UW may provide protection mat materials on loan to help facilitate compliance.

Splash blocks/drainage: If a storm sewer is not available, primary and overflow downspouts shall discharge clear of pedestrian walkways and entrances where discharge may saturate below-grade foundation backfill or create a slip hazard. Finished grade shall slope a minimum of 2% away from the building for at least 10' at downspout discharge. A concrete valley gutter or formed splash block at discharge is preferred. "French drains" are not acceptable. Provide storm sewer inlets to convey downspout discharge to storm sewer system in as short a distance as possible when primary roof drainage is discharged above-ground. Avoid placing primary and overflow downspouts on the north side of a building. Lamb tongues shall extend far enough outward to not drip on the exterior wall.

SECTION 07 42 13 - METAL WALL PANELS

In general, Metal Wall Panels **shall not be used**.

SECTION 07 90 00 - JOINT PROTECTION

Assembly numbers for required fire stopping systems shall be provided, and non-standard applications shall be detailed.

Paintable sealant shall be used at interior locations unless performance of the joint requires a different type. Flexible (silicone or urethane) sealant shall be used at exterior locations.

SECTION 08 11 13 - HOLLOW METAL FRAMES

1. Preferred Manufacturers: Steelcraft, Ceco, Curries, Rocky Mountain Hollow Metal, Southwestern Hollow Metal, or substitutions approved by the UW Lock Shop.
2. Manufacturers shall provide documentation for UL 10C or other approved testing agency stating that hollow metal applications comply with UBC 7-2. All necessary instructions and documentation shall be supplied to the job site as required for code official approval of the application.
3. All frames shall be set up and arc welded. Knock-down frames will not be accepted.
4. Frames in interior locations shall be 16-gauge cold-rolled, pickled, and annealed steel free from scale, pits of other defects.
5. Frames in exterior and vestibule locations shall be 14-gauge hot dipped galvannealed steel having A60 zinc-iron alloy coating per ASTM924.
6. Frame reinforcements:
    a. Spreader bars shall be 16-gauge channels (2 minimum per door opening). Spreader bars shall be removed prior to plumbing and securing the frame in wall.
    b. Hinge reinforcements shall be 7-gauge.
    c. Provide high frequency hinge reinforcements at top and bottom hinge locations of all exterior frames and high traffic applications such as cafeterias, stair wells, and loading dock areas.
    d. Surface-mounted closes and overhead stops and holder reinforcement shall be 14-gauge steel plate welded inside jamb.
    e. Reinforce for rim-mounted strikes with 14-gauge steel sheet welded on inside of jamb.
    f. Drill and tap for surface-mounted hardware at job site.
    g. Strikes for mortise locks and cylindrical locks shall be 4-7/8" and conform to ANSI A115.1 and A115.2
7. Fully enclosed mortar boxes over all mortise hardware preparations.

8. Frames shall be tenon and butt type construction with face corners mitered. Fully back welded inner jamb including stops.
9. A sample section of welded frame corner shall be submitted for review at the request of the Architect or UW Lock Shop.
10. All mortised hardware shall be prepared by the manufacturer or supplier prior to delivery using the hardware manufacturer's templates. Surface hardware shall be drilled and tapped in the field.
11. Provide a minimum of 3 anchors per standard height or 2'-6" on center. Provide additional anchors per manufacturer's recommendations for frames 7'-6" and taller and fire-rated frames.
12. Provide all necessary sleeves or clips at frame splices and weld all field splices to match frame. Splices shall be welded, ground smooth, and puttied if necessary to conceal the splice.
13. Frames shall have three (3) rubber silencers per strike jamb and two per double door head, applied by the manufacturer.

SECTION 08 11 13 - HOLLOW METAL DOORS

1. Preferred Manufacturers: Steelcraft, Ceco, Curries, Rocky Mountain Hollow Metal, Southwestern Hollow Metal, or substitutions approved by the UW Lock Shop.
2. Manufacturers shall provide documentation for UL 10C or other approved testing agency stating that hollow metal applications comply with UBC 7-2. All necessary instructions and documentation shall be supplied to the job site as required for code official approval of the application.
3. Doors in Interior locations shall be 18-gauge cold rolled.
    a. Interior doors: Face sheets shall be 0.042 in. minimum thickness.
4. Doors in exterior and vestibule locations shall be 16-gauge hot dipped galvannealed steel having A60 zinc-iron alloy coating per ASTM 924.
    a. Exterior doors: Face sheets shall be 0.053 in. minimum thickness.
5. Door Hardware reinforcements:
    a. Reinforce for rim exit devices with 14-gauge steel channels projection welded or bonded to the door edge at lock and hinge side of door. Reinforce at top and bottom of doors for surface-mounted vertical latches.
    b. Reinforcement for mortise locks shall be 14-gauge steel projection-welded to edge of door with stabilizing tabs to keep lock body centered in mortise.
    c. Reinforcement for cylindrical latch/locksets with 16-gauge steel projection-welded to edge of door. The reinforcement shall include tabs to center the latch bolt horizontally and vertically.
    d. Reinforcement for flushbolts shall be 16-gauge steel angle projection-welded to edge of door or 14-gauge steel astragal with tabs drilled and tapped to receive flushbolt.
    e. Reinforcement for surface mounted door closers and overhead stops and holders shall be 14-gauge steel channel 14" deep x 20" long.
    f. Provide high frequency hinge reinforcements at top and bottom hinge of all exterior doors and in high traffic applications such as cafeterias, stair wells, and loading dock areas.
6. Mortised hardware preps including function holes shall be prepared by manufacturer or supplier prior to delivery to job site using hardware manufacturer's templates. Trim holes and mounting holes shall be field drilled and tapped.
7. Surface-mounted hardware shall be drilled and tapped in the field.
8. Doors shall have 1/8" in 2" bevel both hinge and strike edge of door.
9. Reinforce the top and bottom of door with 18-gauge steel channel welded to face skins.

10. Lite kits shall be one-piece 24-gauge formed steel with reinforced and welded corners. Kits shall be flush with face of door and have no exposed fasteners.
11. Finish tops of exterior doors with flush top cap welded or applied with screws to secure top cap into top channel of door. All seams and exposed fasteners shall be completely sealed and watertight.
12. Honeycomb core shall be the standard specified construction. Polystyrene core doors in locations as dictated by insulation value requirements for that location are acceptable. Vertical stiffened doors will not be accepted.
13. Dark color finish shall be avoided on polystyrene doors at exterior applications. Polystyrene doors painted in dark colors may absorb heat from the sun and swell to causing binding in the frame.
14. Manufacturers shall provide documentation illustrating test results of ANSI A250.4 and ANSI A250.5.
15. Doors to rooms such as offices, meeting rooms, classrooms and conference rooms shall have a vision panel or side light.

SECTION 08 14 00 - WOOD DOORS

1. Preferred Manufacturers: VT Industries, Algoma Hardwoods, Marshfield Door Systems, Eggers, or substitutions approved by the UW Lock Shop.
2. Structural Composite Lumber Core, 5-ply, hot-pressed. 7-ply is prohibited.
3. Fire doors shall be mineral core as required.
4. All mineral core doors must have:
    a. Lock blocks for exit device reinforcement.
5. Wood doors shall be used on building interiors only.
6. Door Lites may not extend within 9” of head or below 43” above finished floor.
7. Latch stile must not be less than 6”.
8. Any wood door over 3’-0” wide and 7’-0” tall shall use 5” heavyweight hinges.
9. Wood doors shall not be used in pool areas.
10. All doors shall have pre-drilled pilot holes for the hinge preps.
11. Veneer, finish and cut shall be determined by the University on a project-by-project basis.
12. Doors scheduled for fire rating labels shall be supplied with proper labels attached.
13. Preparation of labeled fire door assemblies for locks, latches, hinges, concealed closures, glass lights, vision panels, louvers, astragals, and laminated overlays shall be performed in conformance with NFPA and UL Standards.
14. All doors shall meet or exceed WDMA I.S.1-A-11 extra heavy-duty performance rating.
15. All doors shall meet or exceed WDMA I.S.1-A-11 quality standards Premium Grade.
16. All doors shall be pre-machined and pre-finished at the factory; the finish shall be equal to WDMA TR-6.
17. For adhesives and composite wood products, documentation indicating that product contains no added urea formaldehyde is required.
18. The top and bottom rails shall be sealed.
    a. Doors shall be stored in accordance with manufacturer’s instructions.
    b. Doors shall be stored in clean, dry areas indoors, protected from damage and direct sunlight.
    c. Doors shall be stored on a flat, level surface.
    d. Doors shall not be stored on concrete.

e. Doors shall be kept completely covered. A covering shall be used which allows air circulation and does not permit light to penetrate.

19. Doors to rooms such as offices, meeting rooms, classrooms and conference rooms shall have a vision panel or side light.

SECTION 08 30 00 - COILING OVERHEAD DOORS AND HORIZONTAL FIRE SHUTTERS

1. Fire-rated coiling doors are highly discouraged and shall be used only when approved by the UW Lock Shop.
2. Coiling fire doors shall not require manual spring re-tensioning following fire alarm activation.
3. Design wind load shall be 70 MPH. minimum.
4. Aluminum or galvanized steel is preferred; fiberglass and wood are prohibited.
5. Furnish drawbar or jackshaft 110V motor operator.
6. Furnish failsafe electric eye bottom safety protection feature.
7. Locking device: Keyed lock to interface with building master.
8. Coiling doors shall be specified with the manufacturer's standard paint finish.
9. A governor shall be required at coiling counter doors.
10. Release mechanisms shall be required to have a time delay feature activated by smoke detectors on all fire doors and shutters. Smoke alarms shall be tied into the new/existing fire alarm system. If coiling overhead doors and horizontal fire shutters are on a smoke detector with release, the system shall have UPS so the door/shutter does not close during momentary electrical fluctuations and short power outages.

SECTION 08 30 00 - OVERHEAD DOORS

Frame and bolt guides and tracks shall be tapped to frame.

3" tracks shall be used on all overhead doors.

For motors less than ¾ HP, use 1-θ; otherwise use 3-θ.

SECTION 08 31 13 - ACCESS PANELS

1. Furnish sizes suited to conditions but not less than 16" x 16" for hand access and 24" x 24" for person access, and 36" x 36" for floor access.
2. Furnish door assemblies manufactured as an integral unit, complete with all parts and ready for installation. Use a minimum of 16-gauge steel.
3. Furnish continuous piano hinges for flush mounting and concealed hinge for recessed mounted units.
4. Provide U.L. listing for fire rating compatible with wall or ceiling assembly.
5. Locking Devices: Furnish flush, screwdriver-operated cam locks for non-rated doors in walls and ceilings and raised knob cam locks for fire-rated units in gypsum board ceilings. Furnish non-keyed, screwdriver-operated cam latch for security or public locations within easy reach.
6. Locking device: Furnish keyed lock to interface with the building master.

SECTION 084000 – ENTRANCES, STOREFRONTS AND CURTAIN WALLS

Specifications for closers and panic hardware shall comply with the criteria for these items in the Finish Hardware and Doors section.

Anodized aluminum finish (color to be selected by Owner from manufacturer's full range of colors) shall be specified. Solar heat gain from the system shall be considered in the selection.

Details shall clearly depict that all horizontal trims, flashing pans, and coping components shall slope to drain a minimum of 3/8" per foot. One-piece seamless, soldered, or welded sill pans with minimum ¾" high back and edges shall extend completely under tubular frame mullions to remove condensation and shall be sealed to the abutting construction. Consideration shall be given to providing insulated tubular frames to reduce heat loss and minimize condensation accumulation. An accurate and complete building mockup shall be constructed by the Contractor and reviewed by the Owner before proceeding with system installation on the building. The system shall be water-tested and designed for long term durability. Air barrier systems, when provided, shall be sealed to storefront and curtain wall system frame at entire perimeter.

All aluminum storefront doors shall have pivot hinges; continuous hinges are not permitted.

SECTION 08 41 13 – ALUMINUM ENTRANCE DOORS

1. Doors: Minimum 5" vertical stile, 5" top rail and 10" bottom rail.
2. Major portions of the door members shall be 0.188" (4.8mm) nominal in thickness and glazing molding to be 0.05" (1.5mm) thick.
3. Frame: 2" x 4-1/2" and includes 3/16" wall thickness at all hardware attachment points.
4. Door thickness 2" minimum.
5. Furnish hardware as specified in Section 087100.
6. Prepare components with internal reinforcement for door hardware.
7. Pivot hinges are preferred.
8. Door corner construction shall consist of mechanical clip fastening, SIGMA deep penetration plug welds and 1-1/8" (29 mm) long fillet welds inside and outside of all four corners. Glazing stops shall be hook-in type with EPDM glazing gaskets reinforced with non-stretchable cord.
9. Accurately fit and secure joints and corners. Make joints hairline in appearance.
10. Provide wind and weather protection.
11. Protect automatic ADA entrance doors from opening greater than 100°.
12. Where doors do not swing to wall for door stop applications, doors are to swing to bollard/door stop.
13. When multiple pairs of doors are in the same area, only one mullion at each bank of doors is to be removable by key, unless directed otherwise by Owner.
14. Prep doors with card access for electric power transfers or electric hinges as specified in Section 087100.
15. Cabling for electric hardware shall be housed in conduit. Cabling is not permitted to be pulled in aluminum storefront. Place doors with electric hardware adjacent to wall construction to facilitate conduit for cabling.
16. Bollards/stops or concealed overhead stop at exterior doors where doors do not swing to wall.
17. Narrow and medium stile design shall be prohibited.

SECTION 08 50 00 - WINDOWS

Sill flashing shall be specified and detailed. Details shall clearly depict that all horizontal trims, flashing pans, and coping components shall slope to drain a minimum of 3/8" per foot. Consideration shall be

given to providing insulated tubular frames to reduce heat loss and minimize condensation accumulation.

Closure angles shall be indicated in the details. All items necessary for a complete installation (including closure angles, sealant, fasteners, backing, shims, etc.) shall be specified.

If a project includes 20 or more standard-sized windows, one extra unit shall be provided to the University.

Additional stop material (sufficient in length to glaze 2 of the standard windows on the job) shall be provided.

Windows shall be designed to prevent sills or “eyebrows” from becoming nesting or perching places for birds.

To aid the replacement of the glazing units, submittals on windows shall state the manufacturer’s name and type of product installed, the glazing values, coatings, solar heat gain factors, shading coefficients, etc.

Window systems shall be water-tested after installation for leak-tightness with a water hose stream over the entire window frame, and visual inspection shall be made inside the framing system for water penetration. Air barrier systems, when provided, shall be sealed to window frame system at perimeter of every unit.

All glazing shall meet or exceed the properties (including shading coefficients) of PPG “SolarBan 70XL”.

Operable windows shall have sensors to notify the building control system that the window is open.

SECTION 08 70 00 - HARDWARE

1. General
    a. Any modifications to the door hardware must be approved by the UW Project Manager and UW Lock Shop.
    b. The University will designate exterior doors to receive security card readers.
    c. The Architect shall include a complete Hardware Schedule in the Contract Documents.
    d. The stated functions, products, operation, and keying shall remain unchanged.
    e. Installer Qualifications: An experienced installer with five (5) years of documented experience who has completed door hardware similar in material, design and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance trained and certified by the lock, closer and panic hardware manufacturer.

2. Finish:
    a. Unless otherwise indicated, finish hardware shall be US26D or US10. Verify finish at time of project with the UW Project Manager and UW Lock Shop.
    b. For door closers and automatic operators: Powder-coated aluminum finish 689/691.
    c. For thresholds and weather stripping: Mill aluminum finish.

d. When matching existing construction, specify finish to match existing except as directed by the UW Project Manager and UW Lock Shop.
e. For remodel and addition projects: Match existing hardware finishes where appropriate.

3. Fasteners
   a. Furnish screws for installation with each hardware item. Provide Phillips flat-head screws unless otherwise indicated. Furnish stainless steel (exposed under any condition) screws to match hardware finish or, if exposed in surfaces of other work, to match finish of this other work as closely as possible including "prepared for paint" surfaces to receive painted finish.

4. Hinges:
   a. Preferred Manufacturers (Exterior): Rixson or equivalent
   b. Preferred Manufacturers (Interior): Ives, Stanley, McKinney, Hager, or substitutions approved by the UW Lock Shop.
   c. Furnish the following hinge quantities for each door leaf:
      i. 3 hinges for doors up to 90" in height.
      ii. 1 additional hinge for every 30" on doors over 90"in height.
      iii. 4 hinges for Dutch door applications
   d. Furnish hinge weight and type as follows:
      i. Standard weight: Ball bearing hinge, 5BB1, for interior openings that are 36" or less in width.
      ii. Heavy weight: 4 ball bearing hinges, 5BB1HW, for interior openings that exceed 36" in width for doors with push/pull hardware, exit devices, swing clear hinges and any other high traffic doors.
   e. Hinges at all exterior out-swinging doors shall have non-removable pins (NRP).
   f. All exterior hinges shall be non-ferrous.
   g. Hinges for doors 3'-0" in width shall be 4.5" x 4.5" minimum. Hinges for doors exceeding 3'0" in width shall be 5" in height.
   h. Furnish all hinges to template standards.
   i. Continuous hinges are not permitted.

5. Pivots:
   a. Preferred Manufacturers: Rixson, or equivalent
   b. Pivots shall be used at all aluminum storefront doors.
   c. Provide pivot sets complete with oil-impregnated top pivot, unless indicated otherwise.
   d. Where offset pivots are specified, provide one intermediate pivot for doors less than 91" (2311 mm) high and one additional intermediate pivot per leaf for each additional 30" (762 mm) in height or fraction thereof. Intermediate pivots spaced equally not less than 25" (635 mm) or not more than 35" (889 mm) on center, for doors over 121" (3,073 mm) high.
   e. ¾" offset at electric openings EPT-10s

6. Keying System:
   a. Preferred Manufacturers: Corbin Russwin Zero Bitted, 6 pin keyway, Medeco. Verify correct keyway with UW Lock Shop at the time of construction.
   b. Provide all tail pieces and components necessary to integrate cylinder with locking device.
   c. Construction Keying: Provide each cylinder with temporary construction keying during the construction period. At Substantial Completion, General Contractor shall accompany the

UW Project Manager/UW Lock Shop while voiding the construction keying. Provide temporary construction keying to comply with the following:

i. Keyed temporary cores: Provide interchangeable core compatible cylinders and levers with keyed construction cores during the construction period. Cores will remain the property of the Contractor and will be returned upon installation of the Owner's permanent key system.

d. UW Lock Shop shall install all permanent cores.

e. Cylinders shall be shipped to UW. On small projects, UW will key the cylinders, on larger projects, it shall be done with the construction contract.

7. Keys:
   a. Furnish key blanks for each lockset and/or cylinder as follows:
      i. Furnish 3 cut keys for each lockset and/or cylinder.
      ii. Furnish 50 additional key blanks for each keyway on projects with five to twenty locks per keyway.
      iii. Furnish 100 additional key blanks for each keyway on projects with 21 to 40 locksets per keyway.
      iv. Furnish 20% minimum additional key blanks for each keyway on projects with more than 40 locksets per keyway.
   b. All keys shall be stamped "UWYO Do Not Duplicate."
   c. All locks and cylinders shall be packed without permanent keys.
   d. Keys shall be provided with special bows.
   e. Construction master keys shall be shipped with the locks to the UW Lock Shop.
   f. The Lock Manufacturer shall ship all permanent keys and key blanks to the Owner via registered mail to:

      UW Operations Lock shop
      1000 E. University Ave., Dept. 3227
      University of Wyoming
      Laramie, WY 82071

8. Cylindrical Locksets:
   a. Required Manufacturer: Best 9K3, 15D lever design, no substitutions.
   b. Provide locks with standard 2-3/4" (70 mm) backset, unless noted otherwise, with ½" latch throw. Provide proper latch throw for UL listing at pairs.
   c. Provide locksets with separate anti-rotation thru-bolts, and no exposed screws.
   d. Provide independently operating levers with two external return spring cassettes mounted under roses to prevent lever sag.
   e. Trim: All locksets shall have cast brass or cast bronze levers and wrought roses.
   f. Latch bolts: All latch bolts shall have ½" throw and shall be three-piece bolts with no plastic parts.
   g. Fire Rating: Lock shall be listed for up to 3 hours.
   h. Strike Plates: Provide ANSI 4-7/8" strike plates. At pairs of doors, provide strike with 7/8" flat lip. At single doors, provide round-lipped strike with lip length as required to minimally clear jamb and trim. Provide dust boxes at each strike location.
   i. Locksets shall be:
      i. Entrance Function: 9K3-O-AB-15D-S3-626-COR (MED for Medeco)
      ii. Storeroom Function: 9K3-O-D-15D-S3-626-COR (MED for Medeco)

iii. Classroom Function: 9K3-O-R-15D-S3-626-COR (MED for Medeco)

j. The use of mortise locks shall be avoided.

9. Panic Devices:
   a. Required Manufacturer: Von Duprin 98 series; no substitutions.
   b. Application Criteria:

i.	Exterior pair – exterior	98NL X KR4954 X 98EO
ii.	Single door – exterior	98NL
iii.	Fire rated – single	98L-F
iv.	Fire rated – pair	98L-F X KR9954 X 98EO-F
v.	Single – interior, non-rated	98L
vi.	Pair – interior, non-rated	98L X KR4954 X 98EO
vii.	Dummy push pad	350
viii.	KR Mullion (non-rated)	KR4954
ix.	KR Mullion (rated)	KR9954
x.	KR Mullion (w/ elect. Strike)	KR4854

   c. The lever handle trim shall have a mechanism to disengage lever from operating should excessive force be applied and allow lever to be re-set to its operating position. Lever design to match lock manufacturer's lever design.
   d. Multiple door entries shall have keyed access on one leaf only.
   e. Where door opening requirements are less than 4'-0", a single leaf door shall be installed.
   f. When multiple pairs of doors are in the same area, only one mullion at each bank shall be removable by key, unless directed otherwise by the UW Lock Shop. All mullions shall have stabilizers (154). All key removable mullions shall have a wall-mounted storage kit (MT54). Storage kits shall be installed as directed by the UW Lock Shop.
   g. Manual hex-key dogging or cylinder dogging shall be furnished with all non-fire-rated exit devices. Dogging type shall be verified with the UW Lock Shop prior to the start of construction.
   h. For electrically operated openings, furnish Quiet Electric Latch (QEL) retraction or Electric Latch (EL) retraction with Electric Power Transfer (EPT) and Von Duprin Power Supply (PS902-2RS-FA-BBK-KL at QEL devices, PS914-2RS-FA-BBK-KL at EL devices). Verify with the UW Lock Shop if QEL or EL should be used prior to the start of construction.
   i. All QEL devices shall be equipped with exit switches (RX).
   j. All QEL devices used with auto operators shall be equipped with request to exit switches (RX) and latch bolt monitoring switches (LX).
   k. Electric power transfers shall be Von Duprin EPT-10. Electric power transfer shall be concealed in the door and frame when the door is closed. Power transfers shall have a steel tube to protect wires from being cut. Power transfers shall be supplied with a grout box to house all terminations.
   l. Where designated by the UW Lock Shop, furnish conduit and EPT prep at door frames for future expansion. Where doors and frames are prepped for future power transfers, furnish Don Jo EPT cover plates over prep.
   m. Equip devices with dead locking latch bolts. Furnish through-bolted fasteners for all devices. Where required, provide projecting glass bead stop kits to provide clearance when used with projecting glass stops. Furnish glass bead stop kits at locations using both exit devices and electric strikes.
   n. Surface vertical rods, concealed vertical rods, and concealed cables are not permitted.
   o. Through-Bolts: All exit devices shall be installed with through-bolts.

10. Door Closers:
    a. Required Manufacturer: LCN Door Closers 4040XP Series, no substitutions.
    b. Closers shall be certified to exceed ten million (10,000,000) full load operating cycles by a recognized independent testing laboratory. For door closers accessible to the physically challenged, provide adjustable units complying with ANSI A117.1 provisions for door opening force and delayed action closing. Except as specifically indicated, comply with the manufacturer's recommendations for size of door control units, depending upon size of door, exposure to weather, and anticipated frequency of use.
    c. Closers shall be cast iron construction with forged lever arms, independent adjusting valves for closing, latching and back check. Hydraulic regulation shall be controlled by tamper-proof, non-critical screw valves. All closer adjustments shall be shielded by full metal cover plate after installation. Pressure relief valves are not acceptable.
    d. All closers shall be installed on the least visible side. Regular arms are acceptable.
    e. Provide special templated arms to allow clearance and applications of overhead stops and holders. Size the units for proper depth and projection to ensure clearance with adjacent hardware. Advance variable backcheck (AVB) shall only be used at exterior openings and high abuse openings as directed by the UW Lock Shop.
    f. All closers at non-fire-rated doors shall be held open.
    g. Through-Bolts: All closers shall be installed using through-bolts.
    h. Closers shall be mounted for maximum door swing.
    i. Exterior doors to roof penthouses shall be installed to prevent them from being damaged from the wind. This may include a roof bollard with an attachment mechanism to the door or similar means to prevent door, frame, or wall damage.

11. Low Energy ADA Operators (Electromechanical):
    a. Preferred Manufacturer: LCN 4600/4800 Series, Horton 7000 Series. Location as directed by the UW Project Manager/UW Lock Shop. Substitutions shall be subject to approval by the UW Lock Shop.
    b. Hardware supplier shall provide point-to-point wiring diagrams for automatic operator(s) to general and electrical contractor prior to electrical rough in. The electrical contractor shall provide 120V AC power to control box and provide and install wiring from control box to actuators.
    c. The system shall be electrically powered and surface-mounted; door-mounted overhead operator shall provide easy access for persons with disabilities. Opening force and time to close standards shall comply with ADA requirements. Full closing force shall be provided when the power cycle ends.
    d. A wireless, surface-mount actuator kit (LCN 8310-3857TW) shall be used at auto operators.
    e. Provide installation complete with drop plates, brackets, or adapters for arms as required to suit details.

12. Overhead Door Stops and Holders:
    a. Acceptable Manufacturers: Glynn Johnson; substitutions are subject to approval by the UW Lock Shop. Acceptable manufacturer and respective catalog numbers:
        i. Heavy Duty Surface-Mount Glynn-Johnson GJ900 Series
        ii. Heavy Duty Concealed Mount Glynn-Johnson GJ100 Series
    b. Provide overhead stops and holders as scheduled, sized per manufacturer's recommendations based on door width.

c. When the overhead holder or stop is installed with a surface closer, template closer according to work with the stop or holder. Provide mounting plates with closer if required. If a conflict occurs between the overhead stop through-bolt and the door closer, provide a drop plate drilled out to provide clearance for the through-bolt head.

13. Electromagnetic Door Holders:
    a. Preferred Manufacturer: LCN Door Closers SEM 7800 Series; substitutions are subject to approval by the UW Lock Shop.
    b. Openings requiring electrically controlled door holding magnets shall be equipped with units which are fail-safe and are tied into the fire alarm. Provide holders with through-bolt attachment for door-mounted armatures. Plastic housings covers are prohibited; use only die-cast housings.
    c. Provide 2 x 4 reinforcement backing for wall-mounted, electromagnetic door holders.
    d. The Architect-Engineer shall coordinate voltages and other device requirements with the fire alarm designer/specifier.
    e. Door armature extensions are prohibited. The maximum distance between door face and wall-mounted electromagnet shall not exceed the distance required for clearance of operating trim.
    f. The Architect-Engineer shall specify magnetic hold-opens to be furnished in this section and installed by the electrical contractor.
    g. Combination door closer/electromagnetic door holder applications are prohibited without prior approval by the UW Lock Shop.
    h. Magnetic holders shall be housed in die cast housing.

14. Thresholds:
    a. Preferred Manufacturers: Zero, Pemko, Reese; or substitutions approved by the UW Lock Shop.
    b. Thresholds shall extend the full width of opening (no splices in width) and shall be made of extruded aluminum.
    c. Coordinate with project conditions, thresholds must comply with ADA accessibility guidelines.
    d. Thresholds must be installed with the braking edge of threshold at outside face of door.
    e. Where thresholds occur at openings with one or more mullions, they shall be cut for the mullions and extended continuously for the entire opening.

15. Smoke/Sound Seals:
    a. Smoke-Labeled Gasketing: Assemblies complying with NFPA 105 that are listed and labeled based on testing according to UL1784.
    b. Fire-Labeled Gasketing: Assemblies complying with NFPA 80 that are listed and labeled based on testing according to UL10C.
    c. Gaskets must comply with UL10C.

16. Weather-stripping:
    a. All exterior doors shall be fully weather-sealed. Provide non-corrosive fasteners.

17. Rain Drip Caps:
    a. Provide full frame width, unless detailed otherwise.

18. Knox Box:
    a. Architect shall include Knox Box in the Hardware Specification for each building where a Knox Box does not already exist, and where building entry (Fire Department Entry) is changing due to addition or remodeling. Consult with the UW Project Manager for requirements at existing buildings. The City of Laramie Fire Department will determine the quantity required.

19. Warranties:
    a. The supplier shall provide assistance during the work and throughout the warranty period regarding work in this section and the following:
    b. Installation & repair training.
    c. Service equipment.
    d. Master Keying.
    e. Key Control.
    f. Replacement/repair parts.
    g. Provide the following special hardware warranty for the following items:
        i. Continuous Hinges: Lifetime
        ii. Locksets: 7 years
        iii. Door Closers: 30 years
        iv. Panic Devices: 3 years
        v. Electrical Security Products and Electrical Closers: 1 year
        vi. All other hardware: 2 years

20. Coordination:
    a. The General Contractor shall coordinate with the supplier for the following items with the related trades.
    b. Coordinate the work of this Section with other directly affected Sections involving manufacture of any internal reinforcement for door hardware. Furnish hardware templates to door fabricators for factory preparation to receive hardware.
    c. Furnish hardware items of proper design for use on doors and frames of thicknesses, profile, swing, security, and other indicated requirements as necessary for proper function.
    d. Coordinate solid blocking between studs of frame construction to support wall-mounted items such as stops.
    e. Electrical System Roughing-in: Coordinate layout and installation of electrified door hardware with connections to power supplies, fire alarm system and detection devices and access control system. Electro-Mechanical Hardware requires coordination among:
        i. Architect
        ii. Electrical engineer
        iii. Hardware supplier/contractor
        iv. Electro-mechanical hardware supplier/contractor.
        v. Frame supplier/contractor
        vi. Electrical Contractor
        vii. Security systems Contractor
        viii. Owner

21. Pre-Installation Meetings:

a. Pre-installation conference shall be conducted prior to installation of hardware at Project site with the Owner, Contractor, Installer, and Manufacturer's Representatives. A separate pre-installation conference shall be conducted prior to the installation of electronic security hardware with the electrical contractor. Review catalogs, brochures, templates, installation instructions, and the approved hardware schedule. Survey installation procedures and workmanship, with special emphasis on unusual conditions, as to ensure correct technique of installation, and coordination with other work. Notify participants at least ten (10) working days before conference.
b. Auto Operator Installation:
    i. Install low energy automatic operators, hard-wired and wireless actuators in accordance with manufacturer's suggested installation instructions. Interface with Division 16, Fire/Life Safety Systems and Security Access Systems.
c. Electronic Security Hardware Installation:
    i. Install electromechanical security exit devices, key switches, power transfers, power supplies, junction boxes, door position switches, and request for exit and motion detectors in accordance with manufacturer's suggested installation instructions and practices. Interface with Division 16, Fire/Life Safety Systems and Security Access Systems.
d. Boxed Power Supplies: Locate power supplies as indicated or, if not indicated, above accessible ceilings. Verify location with Architect-Engineer.
e. Builder's Hardware Installation:
f. Install each hardware item in compliance with the manufacturer's instructions and recommendations. Where cutting and fitting is required to install hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation or application of surface protection with finishing work specified in the Division 9 Sections. Do not install surface-mounted items until finishes have been completed on the substrates involved.
g. Manufacturer's representatives shall Instruct Owner's personnel in the proper adjustment and maintenance of door hardware and hardware finishes. Allow three 4-hour training classes for mechanical locksets, exit devices and door closer. Allow three 4-hour training classes for electronic locksets and electronic security products.

22. Post-Installation Meetings:
    a. The Architect shall perform inspections and prepare inspection reports.
    b. Post inspection: Consultant and Owner's representative will inspect door hardware installation and state in each report whether installed work complies with or deviates from requirements, including whether door hardware is properly installed and adjusted.

23. Clearances:
    a. Install doors, rated and non-rated, in accordance with NFPA 80 requirements for door clearances as follows:
        i. 1/8" between door and frame head and jambs for wood doors.
        ii. 3/16" between door and frame head and jambs for metal doors.
        iii. 1/8" at meeting stiles of pairs of doors.
        iv. ¾" undercut maximum.

24. Adjusting and Cleaning:

a. Clean, adjust, and lubricate each hardware item in final building environment (air handlers running, smoke seals installed).
b. Check for proper operation.
c. Replace items that cannot be adjusted to operate as intended.
d. Self-closing door devices shall be adjusted to the specifications of appropriate ADA/Building Code and/or Fire Officials.
e. Adjust closer spring tension, closer speed, back check and latch speed for each device.

25. Mounting Heights:
    a. For existing buildings, locate hardware on doors at heights to match existing hardware. The Contractor shall visit the site and verify the location of existing hardware and submit locations to the Owner for approval.
    b. For new buildings, locate hardware on doors at heights specified below, with all hand-operated hardware centered within 34” to 48”, unless otherwise noted:
    c. Hardware heights above finished floor:
        i. Deadlocks centerline of strike: 48”
        ii. Centerline of door pulls: 40”
        iii. Push plates and push/pulls shall be 50” to top of plate. Locate push and pull plates to prevent conflict with other hardware.
        iv. Exit devices: 39-13/16” from finished floor to center of touch pad.
        v. Lever lockets: 38” from finished floor to center of lever.

26. Miscellaneous:
    a. Furnish a complete set of specialized tools and maintenance instructions needed for Owner’s continued adjustment, maintenance, removal, and replacement of finish hardware. Include the following items:
        i. Von Duprin 98/99 Maintenance Kit : Part No. 050046
        ii. Closer Adjustment Wrenches: Part No. GHW12
    b. Extra stock: Furnish extra materials from the same production run as products installed. Package with manufacturer’s standards packaging and identify with descriptive labels.

SECTION 09 20 00 – PLASTER AND GYPSUM BOARD

All gypsum wallboard products used on UW projects shall be made in the United States and be asbestos free.

Gypsum wallboard used for partitions shall be Type X and have a minimum thickness of 5/8".

Gypsum board systems shall be specified with metal edge trim, level 4 finish, and smooth texture.

Require “U.S. Gypsum First Coat” or Owner-approved substitution primer to be applied prior to texturing or priming walls.

3-5/8” deep metal framing shall be used at non-load bearing walls unless structural requirements, design criteria, or concealing utilities requires a deeper member.

Control joints shall be specified, detailed, and located for gypsum board walls/partitions.

The means by which the fire rating will be maintained at recessed items (such as electrical and fire extinguisher cabinets) in fire-rated walls shall be indicated.

Gypsum wallboard (including exterior metal panel backing) shall not be used in showers, steam rooms, or other wet/high humidity areas.

SECTION 09 30 00 - TILING

Ceramic wall tiles shall only be used on walls of masonry construction or on stud walls with cement backer board. Masonry lintels shall be provided in areas receiving tile.

Ceramic and porcelain tile shall not be installed on framed floors, floors incorporating light steel joists, or precast concrete without full waterproof membranes.

Floor tile with abrasive grit shall be specified in showers, drying rooms, steam rooms, and rooms with high humidity.

Non-shrink, high bond mastic and grouts shall be used on all ceramic tile installations.

Grouted tile floors shall be sealed with Hillyard 341 sealer.

Large format wall tile in any material composition shall not be used as an interior wall finish.

Extra Materials: Provide 5% of each size type and color for future use but not less than 2 cartons; except in the case of accent tiles, in which case the design consultant shall recommend the appropriate quantities.

SECTION 09 51 00 - SUSPENDED ACOUSTICAL CEILING SYSTEMS

Acoustical ceiling panels shall be fine fissured or non-directional pattern, 2 x 4 or 2 x 2, Class A square-edged, mineral fiber, and minimum ¾" thick (Armstrong 823A, Armstrong 895A and USG Mars 88185, USG Mars 86185).

A 15/16" (intermediate duty) ceiling grid shall be USG – Donn Dx unless circumstances require heavy duty. If environmental or aesthetic considerations are a factor, other types of ceiling grids may be specified with the approval of the UW Project Manager. The specifications shall require the ceiling grid to be supported to building structure within 3" of each corner of light fixtures and as otherwise required in IBC standard 25-2. The ceiling grid shall permit acoustical ceiling panels to be removed without breakage.

Extra Materials: Provide 2 percent but not more than two unbroken cartons of total acoustical unit areas of each type of acoustical unit for Owner's use in maintenance of project.

For areas requiring elevated levels of privacy and/or sound control are required; High-NCR Acoustical Panels.
Painted mineral fiber, with the following characteristics:

Classification: ASTM E1264 Type III. Class A
Pattern: Fine fissured or non-directional
Size: 24 by 48 inch
Thickness: Minimum 5/8 inches
NRC Range: 0.80 to 0.85, determined in accordance with ASTM E1264.
Panel Edge: Square
Color: white
Suspension System: Exposed grid
Products: a. Armstrong World Industries, Inc; Ultima High NRC, 80: Basis of Design Product. www.armstrongceilings.com/#sle b. USG Corporation; []: www.usg.com/ceilings/#sle

SECTION 09 65 00 - RESILIENT FLOORING

Vinyl composition tile and vinyl/rubber/thermoplastic base shall be 1/8" thick.

The flooring shall be extended beneath casework and other installed items.

At the conclusion of construction, the Contractor shall provide the following information for all flooring materials used on the project:

- Vender name and contact information
- Product brand name
- Product color
- Product type
- Product classification
- Product Material Safety Data Sheet (PDF)

Extra Materials: Provide one (1) carton of each size, type and color of resilient flooring installed; except in the case of accent tiles for which the Architect shall recommend the appropriate quantities.

SECTION 09 68 00 - CARPETING

The University encourages the use of carpet with high recycled content and the ability to recycle both new and existing carpet as opposed to disposing of materials in the landfill.

Entrance Mats: Provide C/S "Peditred" or C/S "Gridline" for the walk-off mats or similar product. Mats are to be removable for cleaning; 60-80 square feet in area, in a recessed area with hard surfaces and/or metal trim picture framing them. Coordinate with LEED requirements.

At the conclusion of construction, the Contractor shall provide the following information for all flooring materials used on the project:

- Vender name and contact information
- Product brand name
- Product color
- Product type
- Product classification
- Product Material Safety Data Sheet (PDF)

Extra Materials: Provide one (1) carton of each size, type and color of carpet tile installed. Provide 10 square yards (about the area of an apartment bedroom) per 2,000 SF in one piece for each type of roll carpeting installed.

SECTION 09 91 00 – PAINTING

UW Operations uses Sherwin-Williams "Navajo White, SW 6126" and "Dover White, SW 6385" for interior paint; these paint colors shall be matched on remodel projects.

Sherwin Williams "Super Paint" shall be used as the level of quality for paint systems. The following are approved colors for use:

Navajo White	SW 6126
Dover White	SW 6385
Essential Gray	SW6002
Versatile Gray	SW6072
Quick Silver	SW6245
Evergreen Fog	SW9130
Gold Coast	SW6376
Favorite Jeans	SW9147
Rustic Red	SW7598
UW Gold	
UW Brown	

At the conclusion of construction, the Contractor shall provide the following information for all paints, coatings and stains used on the project:

- Vender name and contact information
- Product brand name
- Product color name and number
  - For custom colors, the mix codes formula data shall be provided.
- Product type
- Product classification
- Product base material

- Product sheen
- Product Material Safety Data Sheet (PDF)

Excess paint shall be removed from the project site.

Capital construction projects: new construction and renovation owner stock paint will be furnished via store credit at the Laramie Sherwin Williams. The dollar amount shall be sufficient to procure 5 gallons of each color used on the project.

SECTION 10 14 23 - PANEL SIGNAGE

See this section at:
http://www.uwyo.edu/uwops/_files/construction_standards_guidelines/interior_room_space_identification_sign_standard_august_2016.pdf

SECTION 10 21 00 – TOILET COMPARTMENTS

Doors, panels, and pilasters for toilet compartments shall be high density polyethylene (HDPE). The Basis of Design shall be "Hiny Hiders" as manufactured by Scranton Products.

SECTION 10 28 00 – TOILET, BATH, AND LAUNDRY ACCESSORIES

The following Campus Standard toilet accessories shall be specified:

Paper Towel Dispenser: Renown Model REN05173-wb Roll Towel Dispenser; Owner-furnished, Contractor-installed. Confirm dispenser sizes for each installation location with the Deputy Director, Facilities Services of UW Operations. Facilities Services only provides roll paper towel dispensers in restrooms and at hand washing sinks. If there is a need for paper towels at other locations (usually only in laboratory settings), a tri-fold paper towel dispenser shall be provided.

Soap Dispenser: GOJO ADX-12, Black/Black (for use with GOJO ADX 1250 ml (about 42.27 oz) refill/GOJO/Clear & Mild Foam hand wash); Owner-furnished, Contractor-installed. Confirm dispenser sizes for each installation location with the Deputy Director, Facilities Services.

Toilet Tissue Dispenser: Provide the following Renown dispensers as appropriate for the situation:
-Renown model REN05161-wb® Dispenser, three-roll dispenser for most placements.
-Renown model REN05162-wb® Side-by-Side Bath Tissue Dispenser, two-roll horizontal dispenser for placement in ADA stalls to provide clearance from grab bars.
-Renown REN05152 Vertical Bath Tissue Dispensers, two-roll vertical tissue dispenser for applications where horizontal space is a consideration.

Confirm dispenser sizes for each installation location with the Deputy Director, Facilities Services.

Sanitary Napkin Disposal: Bobrick model B-270 surface mount sanitary napkin disposal

Framed Mirror: Bobrick B-290 Series.

Framed Mirror/Shelf Combination: Bobrick B-292 Series.

Grab Bars: Bobrick B-6806 Series.

Electric Hand Dryer: No standard has been determined.

Mop and Broom Holder: Bobrick Model No. B-223 x 24.

SECTION 11 53 00 - FUME HOODS

1. All fume hoods shall meet the requirements of NFPA 45, Standard on Fire Protection for Laboratories Using Chemicals; American National Standard Institute (ANSI) "Laboratory Ventilation, ANSI/AIHA Z9.5 – 2012"; and *Prudent Practices in the Laboratory*, The National Academies Press, 2011.

2. All fume hoods shall be selected to operate with an exhaust system with a remote fan with redundancy. Fume hoods shall not be selected to operate with local motors.

3. Variable air volume (VAV) fume hoods shall be used, unless there are sound reasons not to do so (e.g., if there are only a few hoods and energy savings would not be achieved, or for dedicated single-ducted hoods). In those cases where VAV hoods cannot be used, constant air volume hoods with bypass air openings shall be used. All hoods shall be equipped with sash stops on vertical rising sashes allowing the sash height to be set at 16" during routine use unless there are sound reasons to use another sash height.

4. VAV fume hood labs shall be controlled such that higher air changes per hour are used during occupied times. At unoccupied times, the number of air changes per hour shall be reduced. These rates shall be established per ANSI/AIHA Z9.5 – 2012 standards. An emergency purge button shall be considered for each lab and be placed in the most accessible place to activate an emergency purge if there is an outside of the fume hood spill.

5. Single fume hoods exhaust ducts shall terminate in the offset stack configuration and be complete with a drain and hood mounted on-off control system.

6. Perchloric hoods shall have 316 welded stainless-steel ductworks with a complete, freeze proof, wash down system and hood mounted with on-off control at the hood. Perchloric systems shall operate at a sound level below OSHA's 8-hour threshold sound power level that requires hearing protection. The spray system shall be zoned as required for proper cleaning. Perchloric hoods shall have an on-off switch. Keep the use of these hoods to a minimum and isolate them from principal areas in building.

7. Centralized fume hood exhaust systems shall be incorporated on large lab buildings. Lab design shall meet the requirements of OSHA, ASHRAE, International Institute for Sustainable Laboratories (I2SL), and NFPA; and include the latest practices such as: ANSI Z9.5-2012 and non-bypass air hood exhaust fans. Hoods shall have flow alarms to alarm the users of low face velocities. On-off controls, if used, shall be integrated with the supply air and alarm systems. Consider wind tunnel or other modeling for exhaust stack optimization, rather than high velocity discharge. All supply and exhaust fans shall be on VFDs. Consider a sequence of control that maps the necessary exhaust fan rpm (which equates to discharge velocity and the height of the exhaust plume) for a particular wind speed and direction. The exhaust plume height would be

based on a wind tunnel study that would detail the plume height verses wind speed and direction. Recommended Smart Lab parameters are air speed across filters = 350 fpm max, total system pressure drop (supply + exhaust) <5 in w.g. including dirty filters, no noise attenuators, occupied minimum ACH (Air Changes per Hour) = 4, unoccupied <2 ACH. Laboratory fume hoods shall have the minimum face velocity of 60 fpm with occupant away from hood, low pressure drop lab and inlet pressure supply and exhaust air VAV valves shall have a pressure drop of less than 0.2" w.g. Critical Room Control valves are preferred, with AccuTrol a second choice. Labconco's Extreme8 series hoods have worked well with the 60 fpm velocities. The lab air system shall include heat recovery (chemically resistant for the conditions to be encountered) and an economic analysis. Where feasible, a second, completely redundant, exhaust fan shall be provided to allow system operation while the other fan is being repaired. Konvetka or heat pipes (rather than run-around heat recovery coils) are preferred methods of heat recovery. The preferred orientation of any heat recovery coil is vertical. The heat recovery coil on the exhaust side shall be bypassed unless there are other means to control its output. For lab supply units, there shall be no hard-wired freeze thermostats on the supply air side; instead, a "software freeze stat" shall be used. All lab exhaust air, lab exhaust heat recovery equipment and cooling equipment shall be safely serviceable by maintenance personnel without having them suit up with special personnel protective equipment and breathing equipment. In major building-wide systems, it shall be possible to maintain the air handling units and exhaust systems without shutting down building operations. At least one of the redundant lab exhaust fans shall be on emergency power.

8. Options for fume hood control will be handled case by case, including room pressurization control. Laboratory air valve criteria:

    a. Native BacNet.
        i. Determination if it meets criteria determined individually by the UW Operations Building Automation (BAS) Team and shall incorporate local compatibility testing.
        ii. Points on controller transparent.
        iii. Point names changeable.
        iv. Can have a computer within lab controller network as additional troubleshooting device, but not be the primary. Phoenix Microserver is not permitted.
    b. Utilizes actual measured air flow feedback in real time valve positioning.
        i. Shall read accurate flow versus reading the same simply based on valve position.
        ii. If the supply fan is down, the valve air flow shall indicate this.
    c. Supply air temperature adjusts based on air flow changes prior to cold air reaching room stat.
    d. Valve shall not require a half hour to reset power.
    e. Shall not require a laptop to connect locally to change values or additional software. It is difficult to make an adjustment up in the ceiling while standing on a ladder.
    f. Any exceptions to Lon based programs must not be proprietary adapted to any extent.
    g. Valves shall not be position dependent.
    h. Valves shall be CRC or Acutrol, or Owner-approved substitution. Nominal 0.2" pressure drop across the valve.

SECTION 14 20 00 – ELEVATORS

Installations shall comply with the most stringent applicable provisions of the following codes:

ASME A17.1, A17.3, NEC. ADA. IBC and UFC, latest editions locally in force. The installation shall include receptacles for the car and pit, and hoistway and pit lighting. Car lighting shall be on emergency power per ASME Elevator Code and be LED.

Elevator machine rooms shall be kept between 65-90^{o} F. Radio frequency interference (RF) shall be investigated, and the machine room shall have proper shielding installed if necessary. Access doors shall be self-closing.

The elevator shall be tested per ASME A17.1 Inspector's Manual for Elevators and Escalators in the presence of an authorized representative.

Require 24-month warranty and 24-month service agreement, with elevator rescue by the University's Maintenance Contractor. Provide alternate pricing for 60-month warranty and 60-month service agreement.

Specify elevators furnished by TK Elevator, Schindler or Kone.

Hydraulic or hole less hydraulic elevators shall not be used.

Elevators shall have ADA car phones, connected to the University's elevator phone system. Phones shall be as specified in the Information Technology Section of these instructions.

Elevator Service Keys installed in Knox Box or accessible location for Emergency Responders.

A "service tool" shall be supplied as part of the contract.

Cars shall have infrared door guards and shall be ADA-compliant.

Car lighting shall be as described under the requirements of the Lighting Section.

The elevator system shall have necessary components to easily tie into building fire alarm system. Sequence of control shall be tested during fire alarm operation.

The car floor covering shall be coordinated with the Room Finish Schedule. Elevators shall have heavy duty flooring system with no ceramic floor tile. Johnsonite Roundel Gray floor system is preferred. Concrete is an acceptable flooring system for elevator machine rooms.

Elevator equipment must be maintainable by any licensed elevator mechanic. Controls must include on-board diagnostic and adjustment tools. No periodic coding or pin number required for continuous operation or adjustment. Adjustment and parts manuals shall be provided. Parts shall be available for purchase by any Owner's representative.

Contact building user group/ UW project manager for weight limitations.

SECTION 21 00 00 – FIRE SUPPRESSION

All fire department pump/pump test connections shall be New York Corp threads (3.00 x 8tpi). All fire pump test headers to be piped to outside of building, preferably where discharge is in parking lot or

alleyway. Jockey pumps to have a drain valve with liquid filled pressure gauge to allow testing start/stop pressures. Depending on the system, soft start units shall be considered.

Fire sprinkler piping (threaded and roll groove) shall be schedule 40 throughout for wet. Dry and pre-action systems shall be galvanized Schedule 40. CPVC is an option in locations where it is behind drywall or otherwise concealed (no flame impingement) in light hazard occupancies. All low spots in the piping system shall have a manual drain and noted on as-built drawings. On mains 4" and larger, schedule 20 is permitted.
Fire Suppression Hydraulic Calculations placards shall be installed at all riser locations. Exterior Signage shall be placed to identify the Fire Department Connection (FDC) locations. All placards shall be printed, or laser engraved; no handwritten data is permitted.

Fire pumps shall be wired such that when activated by an alarm, they will not de-energize until manually de-energized (no timers). In systems with larger fire pumps that require emergency power soft start models shall be used.

Heads prone to freezing shall be alarmed by the BAS system.

Underground isolation valves for fire valves and shall be right hand open.

Fire systems shall have liquid filled pressure gauges and a means to flow test the jockey pumps.

Stainless steel flex connectors to the sprinkler heads are permitted.

All rooms/ spaces with 'wet' fire suppression systems shall be insulated and conditioned to prevent freezing of lines.

Dry systems shall have provisions to drain any trap areas.

SECTION 22 00 00 AND 23 00 00 – GENERAL MECHANICAL REQUIREMENTS

See maintainability clause in General requirements.

Before any construction or modifications begin on a heating or cooling system, constructions screens/strainers shall be installed to collect debris from the work. After completion of work, Owner shall remove construction screens and shall replace with contractor furnished standard screens. Temporary filtering on air handling ducts and equipment shall be shown on the plans and verified that they have been removed prior to start-up.

The owner's representative shall witness any system pressure testing and inspection of tracer wire for any systems under pressure before they are covered up or otherwise made difficult to correct any issues. Required testing shall include:

- any exterior buried fluid carrying system (steam, water, oil, air, gas),
- the exterior conduit for the chilled water or steam/condensate direct buried piping system and the piping inside the conduit,
- interior piping systems,
- other.

If an existing heat transfer fluid needs to be drained, the preferred method of disposal of the glycol/ water mixture is by recycling. Contact the City of Laramie Water Treatment Plant if other means are necessary.

Balancing work shall be done with standard screens in place.

Intake air vents shall be placed and sized to minimize snow infiltration and drifting against vents. Snow guards may be required for critical installations. Intakes shall also be positioned not to ingest odors from plumbing vents, combustion gases from any gas or diesel fired equipment including emergency generators. The design engineer/architect shall take measures to ensure that this does not happen.

Heating during building construction or major renovation shall NOT be with existing heating systems. They shall have temporary heat that does not contaminate the duct work or fan systems. Existing HVAC systems shall be protected from contamination due to construction.

Construction strainers shall be used on all hydronic systems during construction and not be removed until all work is done on the system. The system shall be balanced with new filters in place. Any construction air filters shall be removed, including any screening material placed on return air systems. Filters on fan terminal and fan powered VAV units shall be removed after construction is complete with no filter put back in.

Mechanical rooms shall be large enough to allow room to work and change out any piece of equipment. Also, an outside entrance completes with a minimum width of 4' would be preferred. All equipment in the mechanical room shall be removable from the room to the exterior without cutting or major disassembly. Room size and layout must be approved by the Owner. Rooms shall have floor drains or sinks with a minimum drain size of 4” with trap seals and shall be capable of draining water from the largest reduced pressure back flow device in the room. Mechanical room lighting shall be on emergency power. Each mechanical room shall have one domestic water hose bib as a minimum for maintenance and cleaning.

Mechanical rooms shall have ventilation to maintain 80^{o} F maximum room temperature.

Reference Section 27 00 00 – Communications for restrictions on equipment placed in IT closets.

Pipe chases shall have enough room to work in, have proper access and shall have adequate width for maintaining back-to-back restroom and other major chases. They shall be kept above freezing. A temperature sensor tied to the BAS system to monitor chase temperatures may be necessary if chase is cold or even back up heat. Also, ladders and grating installed at various levels of multi-story chases would be preferred.

Equipment installed shall have proper clearances for servicing and replacement. Note IMC 306.5. This includes VAV boxes and other BAS equipment.

Mechanical rooms and tunnels shall have adequate lighting and receptacles (20 foot candles minimum). LED lighting shall be provided. Tunnel lighting shall be on a 2-hour timer to automatically shut the system down if left on.

Clean-outs shall be ample and accessible.

All branch lines for heat transfer fluids shall have flow control devices unless control valve is a Delta-P.

All mechanical equipment shall have a 2-year contractor's warranty from the start date of warranties as per the contract.

No outdated (discontinued or no longer made) equipment shall be used and all mechanical/electrical equipment shall be suitably protected if stored outside.

If loading docks and/or overhead doors are included in the design, a separate zone shall be designed for the area adjacent to the loading dock. Thermostats shall be placed such that they will not be obstructed by stored materials. A low temperature alarm shall be placed near overhead doors (or directly on the fire suppression pipe) tied to the facility BAS.

SECTION 22 00 00 – PLUMBING

Mechanical Equipment shall be of the following manufacturers:

A. Water pumps: Taco, Peerless, Teel, Paco. B&G inline <2HP ok, *B&G or Armstrong are not permitted.*
B. Faucets: Delta Commercial, Chicago, Sloan, Zurn, Kohler or Crane
C. Faucets for restrooms: Delta ADA Metering Faucet or Owner-approved substitution.
D. Flush Valves: Sloan or Zurn. Water closet valves shall be adjustable to increase gallon per flush, if required.
E. Automatic Flush Valves: Sloan, Zurn, consider hard wired and for urinals only
F. Lab Faucets: Kewanee, Labconco or Zurn. For hazardous or combustible gases, single lever handles shall be provided.
G. Lavatories & Water Closets: American Standard, Eljer, Kohler, Zurn
H. Pressure Reducing Valves (steam): Fisher, Sarco, Hoffman, Boylston
I. Water Coolers and Bottle fillers: Elkay or Owner-approved substitution
J. Steam or Condensate, 2" or smaller: Vogt or Bonny forge gate valves #800
K. Steam or Condensate, 2½" and larger: Tyco K-LOK or Owner-approved substitution, NACE-rated with Spiro flex flange ring gaskets, 150# rating minimum.
L. Steam or condensate isolation valves for mains in the steam tunnel: Vanessa Series 30,000, zero leakage butterfly valve with ASTM A216 WCB Carbon Steel Body or Tyco K-LOK.
M. Lab gas, air, vacuum valves shall all be single handle to visually verify if it is closed.
N. Hydronic ball valves for non-potable water shall be sweat or threaded using a stainless-steel ball
O. Ball valves for potable water shall be silicone bronze. On valves ¼"-1", the ball shall be silicone bronze with no plating. On valves 1-1/4"-2-1/2", the ball and stem shall be stainless steel. The valves shall be Apollo (77CLF140 for threaded and 77CLF240 for soldered) or Nibco full port bronze. Domestic water or heating water, chilled water, compressed air, 2½" or larger: Nibco LD-2000 or Owner-approved substitution.
P. Flex connectors at pumps and equipment shall be stainless steel braided flex. Rubber ball flex joints are not permitted.
Q. Non-glycol protected heating and cooling coils: Cooney or approved equal.
R. Water meters, back flow devices and read heads: shall be by the City of Laramie and meet their latest standards.

Dielectric isolation between dissimilar piping materials: On heating and cooling systems isolate steel from copper piping using Clearflow dielectric waterway fittings by Precision Plumbing Products, Inc., or Owner-approved substitution. For a typical coil installation, these nipples need to be installed on the steel piping before the isolation valve. These unions shall be used on domestic and heating/cooling piping systems.

For steam service 75 psi and below, use a high-quality cast steel gate valve with at least 150# rating with 2" and below valves threaded and above 2" welded. For 125 psi steam, use 300# rating with weld in connections.

Hangers shall be of the same material as the piping when in direct contact with the piping material or other methods used to assure electrical isolation.

Do not install any piping where freezing will be an issue in exterior walls.

Plumbing vents shall be located far away from any fresh air inlet. Combine where possible to reduce the number of roof penetrations and run them to the highest roof in the vicinity.

For every floor in a building, there shall be at least one bottle fill/water cooler combination system.

In buildings equipped with emergency generator back-up power, a minimum of one HWS pump including all necessary controls for full operation shall be on back-up power. Controls shall be on a large UPS that serves the main control panel and all equipment controllers. If any refrigeration equipment is chilled water cooled and not a direct connection to the campus chilled water loop (i.e. on a flat plate connected to the loop), the pump shall also be on emergency power.

In general, chilled water and heating hot water piping systems inside buildings shall be welded schedule 40 with flanges only at the equipment connections. Grooved piping systems are allowed for fire and domestic cold water. In certain remodel situations where the building remains occupied, grooved piping may be allowed after consultation with UW Operations. In those cases, only Vitaulic is approved, with all project installers being factory-trained for the particular project and all gaskets glycol rated.

Water circulation lines shall be Type L with all solder lead free. Use only Type K soft copper with brazed or silver soldered fittings for underground piping with no "Ford" couplings for piping above 1¼". Domestic hot water recirculating lines shall be sized for 1.5 to 2 feet/sec. pipe velocity.

Any steam piping inside tunnels shall be at least Schedule 40, welded steel minimum with the exception of fiberglass condensate lines. Non-fiberglass condensate lines shall be welded Schedule 80 steel or other UW Operations approved product.

All potential potable water contamination locations shall be protected with an approved back flow prevention device per IPC and the City of Laramie. Keep outside installations to a minimum. Any room where there is backflow protection device shall have a drainage system that will handle the total discharge from the device without pumping. Pressure gages shall be installed on either side of a booster pump and downstream of the meter and back flow device.

All studs used for piping work shall be a Grade (8) minimum and all bolts shall be a Grade 5 minimum.

The use of base-mounted close coupled pumps that do not have a coupler between the motor and the impeller shall be minimized, with the only application for this type would be in instances when the pump is operating continuously and or of low horsepower (1 HP or less).

Pumps for heating fluids shall have mechanical seals, compatible with the chemical treatment/freeze protection fluid to be used.

Piping systems shall have a single press gauge tap for all pump installations with petcocks to allow for inlet or discharge readings (gauge shall be Owner furnished), a non-mercury thermometer shall be used at the supply and return points, Pressure and Temperature taps at all coils (supply and return) and main runs. “Seaton” style piping identification systems shall be used for all piping (including type and direction of flow), run at 30’ intervals outside of mechanical rooms and 15’ intervals inside mechanical rooms or spaces.

All Process, Industrial and Domestic Hot Water returns shall have return temperature thermometers or DDC sensors for heating control.

All piping loops shall be labeled at their tee as to what system or piece of equipment they feed.

Install accessible shutoff valves for branch line piping (specifically for individual laboratory piping systems). Each floor level shall have isolation valves for the floor tap offs.

All hot, domestic, and chilled water building systems shall have floor-by-floor isolation so the entire system does not need draining for repair work.

Every lab shall have isolation valves for all piping systems for that lab. Gas to labs shall have an emergency shut off button/valve located on the exit path from the lab.

Acid waste lines shall be chemical and acid resistant. Products acceptable are polypropylene with mechanical joining system above grade by Zurn or air plenum-rated CPVC with glued joints by Zurn or Orion or Owner-approved substitution.

Emergency eye wash stations shall <u>not</u> have under-counter hoses. Stations shall use tepid water in accordance with the most current version of ANSI Z358.1. Below is a picture of what UW prefers:

Safety showers shall have floor drains adjacent to the shower and be capable of handling 30 gpm water flow.

Mechanical Rooms with evaporative cooler sump drains shall have a floor sink connected to a minimum 4” waste line. For evaporative cooler sump pumps, use Liberty Model 230-2 w/25’ cord and 3-year

warranty. If in critical application, use Tsurumi LB-480A-62's. Dump line on sumps shall have line sized solenoid valves. Diaphragm types of floats shall not be used. Mechanical room floor sinks to which the AHU's drains need to be deep (12" minimum, engineered calculation required).

Clean-outs shall be ample and accessible.

Water softener systems shall be manufactured by Hellenbrand or Owner-approved substitution.

For Reverse Osmosis (RO) systems shall be as manufactured by Evoqus. The units shall be fed with soft water, then carbon filtered and finally to the RO unit. If backflow prevention is required, do it via a double check device. Softener shall be manufactured by Hellenbrand. Mee Fog is an acceptable RO supplier if Hellenbrand softeners are used.

Chemical treatment for piping systems shall be compatible as recommended by the University's current chemical provider (FCT Water Treatment, Inc. through June 2026)

SECTION 22 13 00 – FACILITY SANITARY SEWERAGE

All underground utilities shall be designed and constructed as required by the Wyoming Public Works Standards, the City of Laramie Public Works Standards, and Wyoming Department of Environmental Quality Rules and Regulations, latest additions, as amended by these instructions. Materials specifications shall be in accordance therewith as well.

Sewers shall be laid with uniform slope between manholes. Sewer Size Minimum Slope shall be:

PIPE SIZE		MINIMUM SLOPE					
(in)	(mm)	FOR 2.0 ft/s (0.6 m/s)			FOR 2.5 ft/s (0.75 m/s)		
Manning's n -->		0.010	0.013	0.015	0.010	0.013	0.015
4	100	.01	.01	.01	.01	.01	.01
6	150	.01	.01	.01	.01	.01	.01
8	200	0.0020	0.0034	0.0045	0.0031	0.0052	0.0070
10	250	0.0015	0.0025	0.0033	0.0023	0.0037	0.0052
12	300	0.0011	0.0019	0.0026	0.0018	0.0030	0.0040
15	380	0.00085	0.0014	0.0019	0.0013	0.0022	0.0030
18	450	0.00067	0.0011	0.0015	0.0010	0.0017	0.0023
24	600	0.00045	0.00077	0.0010	0.00071	0.0012	0.0016
30	760	0.0003	0.00056	0.00074	0.00052	0.00088	0.0012

The maximum slopes without the use of concrete anchors shall be 20. Consult with UW Operations on what Manning # is planned for their acceptance.

Exceptions to the above will be dealt with on a case-by-case basis.

For existing facilities that are having their sewer systems modified and the underground sewer piping material is older cast iron, the highest available flow water closets and urinals shall be used. This will require an investigation as to the pipe condition, type, and slope to make a final determination.

Sewage ejector use shall be kept to an absolute minimum and shall be approved by the Deputy Director for Utilities. All major building sump and ejector pumps shall be of the duplex design, tied into the emergency power and BAS for alarming for high water alarm and pump failure. Sewage ejector pumps shall only handle loads too low for gravity (i.e., floors above that shall be gravity.) Pumps shall be sized to handle feminine hygiene products with a nominal discharge of 3" minimum. Install remote light at the building (exact location determined case by case) to alert the occupants, and the system shall be alarmed to the campus wide DDC. Sewage ejector pumps shall be at distinct, separate levels and each alarmed so if one goes offline, it can be repaired before the second pump fails. Situate such that if they fail, overflow can be contained before it spreads. The preferred location for sewage ejector pumps is outside. Sewage ejector pumps shall be Weil Pumps only.

Seals for all pumps and rubber materials in valves, etc. shall be compatible with the heating fluid and chemical treatment products currently in use.

Acid waste lines shall be chemical and acid resistant. Products acceptable are polypropylene with mechanical joining system by Zurn or air plenum rated CPVC with glued joints by Zurn or Spears Labwaste or Owner-approved substitution.

SECTION 22 15 00 – COMPRESSED AIR

Air for temperature control (if required) and general building use can be provided by the Campus Air System. Taps to the Campus Air System shall include a full line size drip leg with drain valve and an in-line 40-micron air filter with bypass line and valve. The tie-in shall include unions, drip legs, tees, and drain and isolation valves. Piping shall be Type K copper or Owner-approved substitution. For most control system motors, electric digital actuators and motors are preferred rather than pneumatic. If threaded piping is used, it shall have "Union Pacific" couplings, not NPT.

If the building is to be provided with an air compressor, the compressor shall not produce any heat gain to the room in which it is housed. This typically requires connecting intake and cooling air to the outside, exhaust air to the exterior and by-pass ducting to the unit. Multiple compressor units shall have valving and removal means installed to completely isolate one compressor unit from the other for servicing. If the air compressor is not a modular unit with multiple compressors that each can be isolated for repair with the remaining running, tunnel air shall be tied into the system for back up. For scroll compressors, Gardner L series is the basis of design.

In general, air compressors shall have storage tanks sized at 10 gallons/CFM (3 gallon/cfm wet tank and 7 gallons/CFM dry tank), with air pressure and dew point sensing devices downstream of the tank to energize the compressor. These sensors shall be installed with a pigtail and filter. On compressor systems > 100 CFM, dew point demand control shall be installed.

For tunnel air to a building, a dual-filtering system with isolation valves and bypass shall be provided. Filters typically used are Gardner Denver 30 housing with an E grade filter for 0.01-micron particulate and 99.99% oil removal.

Air for Lab use can be provided by the Campus Air System if approved by the Deputy Director for Utilities and the user. Specifications for tunnel air are: 105/95 PSI discharge pressure from compressors. The compressor is oil lubricated. A Non-Lube module filters particulate to 0.5 ppm,>3

microns at 100% and 0.1 to 3 microns at 99.98%. It also effectively removes oil <2ppm in = 0.01 ppm out and <10 ppm in = 0.05 ppm out. A desiccant dryer delivers air to a -40° F dew point if required. If desiccant drying is required, the units shall only dehumidify when the air requires dehumidification (Energy Conservation Mode). The system shall not use compressed air for desiccant drying; electric or some other available source shall be used. Heat from this desiccant process shall be removed from the mechanical room, preferably without mechanical cooling.

For a lab using tunnel air, review the specifications for the equipment to be used in the lab and install a filter such as an Ingersoll Rand F35I (grade) or F71I (grade) with the appropriate A, G, H or D filter grade. They have an indicator, which tells when to change the element.

1. Grade A, AC activated carbon: Oil vapor and hydrocarbon odor removal, providing a maximum remaining oil content of <0.003 mg/m^3 (<0.003 ppm) excluding methane) @ 21°C. (Precede with Grade H filter)
2. Grade G, GP - General Purpose Protection. Particle removal down to 1 micron including coalesced liquid, water, and oil, providing a maximum remaining oil aerosol content of 0.5 mg/m^3 @ 21° C.
3. Grade H, HE - High Efficiency Oil Removal Filtration. Particle removal down to 0.01 micron including water and oil aerosols, providing a maximum remaining oil aerosol content of 0.01 mg/m^3 @ 21°C. (Precede with Grade G filter).
4. Grade D, DP - General Purpose Dust Filtration. Dust particle removal down to 1 micron.

SECTION 22 62 00 – VACUUM SYSTEMS FOR LABORATORY FACILITIES

If required, the basis for specification shall be Dekker Vacuum Technologies, V-max model. Duplex units shall be able to be isolated so one can operate with the other offline, including the exhaust piping. Units shall come with oil mist collection filters. Discharge piping from the unit shall be easily removed for access to the unit filters. In general, vent the pump exhaust to the exterior, away from any outside air inlets.

In general, smaller, portable, vacuum units are preferred with their discharge hoses running back into a fume hood, which would be equipment provided by the researcher like a Vacuulan system. Coordinate cabinetry, hoods, electrical and mechanical needs if this method is used.

SECTION 230000 – HEATING, VENTILATING AND AIR CONDITIONING

Balancing shall be performed on a new set of filters. HVAC units shall have a spare set of filters furnished. Supply ductwork shall be vacuumed clean. Standardized filter sizes shall be maintained at 24”x24” or 20”x20” and the filter type shall be extended surface, high capacity, pleated panel with a MERV rating of 8 as a minimum. A filtration system using MERV 13a is the campus standard for most buildings. These 13a systems have no pre-filters. For more complex buildings (labs, computer areas, etc.) or buildings where the siting may pose special problems, filtration efficiency shall be increased after discussion with Owner. Camfil low pressure drop bag filters (HiFlo ES 22” deep) complete with Fast Frames for MERV 13a and 14a installations. Units with Camfil bag filters shall not be pre-filtered.

Fiberglass panel or furnace type filters are not acceptable unless they are for pre-filtering only. Roll filters are not acceptable. All filter banks shall have a differential pressure gauge (Magnehelic as manufactured by Dwyer) with the dirty filter pressure reading at ¾ gauge span. Fan coil units shall have construction filters during construction, and they shall be removed permanently for final balancing. If screening is used for cotton capture, it shall be easily replaceable.

Belt-driven fans shall have some built-in adjustability, both in additional amperage to increase wheel speed and in sheave sizing to allow future increased capacity. Direct-drive units are preferred.

Bearings for HVAC equipment shall be marked at all bearing locations as to type, sealed bearing or a greaseable type with easy, accessible grease nipple for servicing. Bearings shall have 200,000-hour life. Extend grease line to exterior if it is dangerous or difficult to service bearings. A remote grease system such as the Inter Lube AX3 shall be considered and incorporated if access for UW staff will be limited during their maintenance duties and the air handling unit cannot be shut down for scheduled maintenance. Injector sizing along with pump cycle shall be determined to ensure proper lubrication of components not accessible.

Belts for HVAC equipment shall be standardized as much as possible. Chain or toothed belts shall need prior approval for each specific installation.

Limit humidity control to critical areas as defined by the University.

Evaporative cooling systems shall be evaluated case by case. If used, the evaporative cooler systems shall be stainless steel construction, complete with moisture eliminators, chemical feed and drain down systems. The system designer shall establish blow down rates and the sumps shall be drained every three nights during the cooling season. Sump overflows shall discharge into a 4” minimum floor sink. For laboratory supply/exhaust systems with heat recovery, if evaporative cooling is necessary on the exhaust side of the heat recovery coil, it shall be of the RO/fogging staged type with all maintainable equipment out of the air stream with no actuators or automatic valves permitted in the laboratory exhaust air stream. R-22 is not allowed. Evaporative media needs to meet 25/50 flame spread/smoked developed rating. All evaporative-cooled AHUs shall pass a water test in which the floor is flooded to ensure the AHUs do not leak. The floors of the mechanical room with the evaporative cooling equipment shall be epoxy sealed or have a waterproof membrane under the concrete that drains to the building sanitary. Misting shall be in stages on the exhaust air side of the coil, with the control of the valves directly by the BAS system. Carel misting equipment shall not be used. The supply air side shall be served through a staged evaporative pad arrangement. For supply air side evaporative cooling, a traditional cell deck system fed with soft water shall be used. Face and by-pass dampers for discharge temperature modulation shall not be used.

Cooling for miscellaneous mechanical and lab equipment and spot cooling shall utilize the campus chilled water loop. If not possible, cooling shall be either by air-cooled condensers or a closed loop fluid cooler system. City water-cooled equipment is not permitted. The preferred method of heat removal from air compressors, dryers, etc. shall be with outside air supply and exhaust systems.

Roof top mechanical equipment shall all have hinged doors, not requiring removal or screws or nuts for servicing with piping from below inside the unit.

Large air handing units (5’ or greater in height) shall have windows such that all dampers, motors and other operating equipment can be seen while the unit is in operation without opening an access door. These observation windows shall have manual light switches to light the areas in question. No devices such as control cabinets, starters, VFDs etc. shall be installed higher than 6’ above the floor where the equipment is located. Adequate lighting (minimum 20-foot candles) shall be provided for the operation and maintenance of control equipment. Opening the doors shall de-energize the fan in that section. Mechanical plans shall show details of roof attachment of ductwork, fans, etc. Details shall agree with roofing system manufacturer’s recommendations and Owner’s Standards.

For VAV systems, design per the California Energy Commission’s Advanced Variable Air Volume System Design Guide and ASHRAE 90.1 2007. In general, pre-filtering is discouraged, along with return air fans. Duct velocities shall be kept low (below 1500 fpm with pressure drops in the 0.08” to 0.05”/100’ range, with 0.05” preferred) to keep system horsepower minimized. VAV boxes shall be set up to take advantage of the high delta-T cooling coils at minimum air flow (i.e., do not want to re-heat air or increase the discharge air set point to compensate for the cold air). Design ductwork transitions to minimize pressure drop. The use of CO2 sensors for indoor air quality shall only be considered after consulting with UW. Control of the return/exhaust/supply fans shall also be approved by the Owner before issuing design development documents.

All VAV boxes shall have discharge air sensors tied to the VAV controller and trended on the BAS. All VAV controllers shall have auxiliary points for lighting and occupancy control.

Ventilation requirements shall be per the latest version of ASHRAE 62.1.

Systems shall be designed to reduce the spread of Legionella. A set schedule for dry-out and drain sequencing shall be implemented by the control system every three nights during use (coordinate with UW BAS office).

Use louver face diffusers, not perforated face.

Air blenders, or other means to guarantee mixing of the air streams, are required on all major air handling units without heat recovery coils to mix the return air with the outside air. See commentary on freeze stats below concerning air stream mixing.

Damper motors shall be factory mounted or shaft shall extend outside the wall of the AHU at least 6”.

VAV boxes shall be designed and sized to operate at an inlet static requirement of 0.25” maximum, assuming no reheat coil and minimal downstream pressure drop.

Control components of factory-built air handling equipment shall be mounted at the jobsite unless there is prior approval by the Owner. Package controls on air handling equipment are not allowed except to control a refrigeration or gas fired system. See Section 250000 for controller requirements.

The following table is recommended to determine which contractors install what mechanical/electrical HVAC equipment. (MC = mechanical contractor; EC = electrical contractor).

Equipment	Furnished by	Set in place by	Wired by	Power Control

Equipment motors	MC	MC	EC	-
Magnetic motor starters				
Auto Control w/ or w/o HOA	MC	EC	EC	MC
Auto Control w/ or w/o HOA but supplied as a part of factory-wired equipment	MC	MC	MC	MC
Manually controlled	MC	MC	EC	MC
Manually controlled but supplied as a part of factory-wired equipment	MC	MC	MC	MC
Push-button stations/ pilot lights				
Full-load amps	MC	EC	EC	EC
Non full-load amps	MC	MC	-	MC
Disconnect switches/ thermal overload switches	EC	EC	EC	-
Multi-speed/ manual switches	MC	EC	EC	EC
Temperature control relays/ transformers (Note 1)	MC	MC	EC	EC
Electric thermostats @ time clocks (Note 2)				
Full-load amps	MC	EC	EC	EC
Non full-load amps	MC	MC	-	MC
Remote bulb thermostats/ motor valves/ etc. integral to mechanical equipment or directly attached to ducts/ pipes/ etc. (Note 2)	MC	MC	EC	EC
Temperature control panels and time clocks mounted on panels	MC	MC	EC	MC
Motors/ Valves/ Damper motors	MC	MC	EC	MC
Control circuit outlet	EC	EC	EC	-
Fire protection control	MC	MC	EC	EC
Smoke detectors and relays for fan shutdown				
Building w/ fire alarm system	EC	EC	EC	EC
Building w/o fire alarm system	MC	MC	MC	MC
Smoke dampers and relays for damper closure	MC	MC	EC	EC
Boiler and water heater controls/ boiler burner control panels	MC	MC	EC	MC
Temporary heating connections	MC	MC	EC	EC
Low voltage control wire from DDC panel to control device	MC	MC	MC	MC
Power wiring for DDC devices (valves, damper motors, air valves, VAV boxes, actuators, etc.	MC	MC	EC	-

Notes:

1. Control relay and control transformers shall be furnished under the mechanical contract except where furnishing such items is specifically required under the electrical specifications and/or drawings.
2. Immersion thermostats, remote bulb thermostats, motor valves, floor controls, etc. that are an integral part of the mechanical equipment or directly attached to ducts, piping, equipment, etc. shall be set in place under mechanical contract. Motor driven units which are controlled from line voltage manual operating or start-stop switches or automatic controls such as line voltage thermostats, float switches or time switches which conduct full load current of the motor shall be wired for both power and control circuit under the electrical contract. This description shall apply to units not integrated into a centralized temperature control programming system, and in general applies to 120 volts and above control. However, if the control device does not conduct full load current, then the responsibility shall be set forth in the above schedule. (Example: a 208 V, 3□, 3 wire motor

requires 120-volt control. Electrical contractor shall furnish a 120-volt circuit for control and 208-volt circuit for power. The mechanical contractor shall wire all controls).

Freeze stats shall be located downstream of the heating coil and set at 30° F.

Lubrication products required for equipment shall match the current products being used by the University; coordinate with UW Operations.

Note access requirements of UMC 306.5, these shall be enforced

All motors shall be evaluated by the electrical and mechanical engineer based on actual loads encountered and be sized to be the most energy efficient possible. Part of substantial completion shall be power measurements taken after system balance to record KW and power factor for each load. If, after measurements are taken, motor loading is less than 60% of rated load, motor shall be resized to achieve a minimum 60% loading. Power factor shall be corrected to 90% minimum. Premium efficiency motors shall be used. All efficiency measurements shall be by using IEEE Method B.

See Section Motor and VFD specifications in MOTOR AND VFD section.

All new panels shall be designed for a 50% fill and have an additional 50% capacity for future loads. This additional capacity shall be figured in throughout the entire building's electrical system. Control wiring conduit shall follow the same fill rules.

All flush-mounted panels shall have at least four (4) spare ¾" conduits stubbed out from the top or bottom of the panel depending on conduit layout.

Exterior enclosures housing contactors, beakers and other control equipment shall be painted galvanized steel, NEMA 4, not 3R.

All flow measuring systems, valves, expansion joints, pump volutes, steam traps, unions, etc. shall have removable insulation jackets or removable insulation blocks. Jackets shall be rated for the service required, have a K significant enough to keep the surface temperature from condensing for chilled water applications and below 110° F for heat applications. They shall attach via stainless steel wire with adequate attachment points. For hot surfaces, the University has been using blankets and jackets made by Thermal Stitch Mfg., out of Casper (bedskins@webpursuits.com, Advanced Thermal or approved equal. The jacket has the following properties: rated for 500° F., meets Mil-C-20079G, UL-91 flame out 1 second, UL 723 flame spread 0, smoke development index 10, ASTM E84, IBC 42-1, NFPA 255, color silver, type E fiberglass, 4 harness satin weave, 15.5 oz/SY, 0.016" thickness, 60" width and 500 psi tensile strength. Blankets and jackets used on medium and high-pressure steam shall have a Nomex lining. The insulation is fiberglass and has the following properties: composed of 100% select grade type E glass fibers needled together to mat form, non-combustible, asbestos free with no resinous or inorganic binders, conforms to Mil-I-24244, UL listed flame spread - 0, smoke - 0, 1200° F. max temperature, 1/2" and 1" thicknesses, 60" width, 9#/cubic ft., K=0.40 at 300F, 0.50 at 500 F, 0.65 at 600° F. Jackets and blankets are individually fitted to each component. They use stainless steel wires and strapping with D rings with the straps made of the double thickness jacket material to affix the jacket to the component. Fasteners shall be able to withstand 500° F.

Insulation systems for larger sized (4” and greater) piping shall be: Insulation-Type 1, 850º F mineral fiber or fiber glass, 4.5” thick with a thermal conductivity range of 0.29-0.32. Below are the 2018 IECC minimum insulation requirements:

TABLE C403.11.3
MINIMUM PIPE INSULATION THICKNESS (in inches)[a, c]

FLUID OPERATING TEMPERATURE RANGE AND USAGE (°F)	INSULATION CONDUCTIVITY		NOMINAL PIPE OR TUBE SIZE (inches)				
	Conductivity Btu • in./(h • ft² • °F)[b]	Mean Rating Temperature, °F	< 1	1 to < 1 1/2	1 1/2 to < 4	4 to < 8	≥ 8
> 350	0.32 – 0.34	250	4.5	5.0	5.0	5.0	5.0
251 – 350	0.29 – 0.32	200	3.0	4.0	4.5	4.5	4.5
201 – 250	0.27 – 0.30	150	2.5	2.5	2.5	3.0	3.0
141 – 200	0.25 – 0.29	125	1.5	1.5	2.0	2.0	2.0
105 – 140	0.21 – 0.28	100	1.0	1.0	1.5	1.5	1.5
40 – 60	0.21 – 0.27	75	0.5	0.5	1.0	1.0	1.0
< 40	0.20 – 0.26	50	0.5	1.0	1.0	1.0	1.5

For SI: 1 inch = 25.4 mm, °C = [(°F) - 32]/1.8.

a. For piping smaller than 1 1/2 inches and located in partitions within conditioned spaces, reduction of these thicknesses by 1 inch shall be permitted (before thickness adjustment required in footnote b) but not to a thickness less than 1 inch.

b. For insulation outside the stated conductivity range, the minimum thickness (T) shall be determined as follows:

$T = r\left[(1 + t/r)^{K/k} - 1\right]$

where:

T = minimum insulation thickness,
r = actual outside radius of pipe,
t = insulation thickness listed in the table for applicable fluid temperature and pipe size,
K = conductivity of alternate material at mean rating temperature indicated for the applicable fluid temperature (Btu • in/h • ft² • °F) and
k = the upper value of the conductivity range listed in the table for the applicable fluid temperature.

c. For direct-buried heating and hot water system piping, reduction of these thicknesses by 1 1/2 inches (38 mm) shall be permitted (before thickness adjustment required in footnote b but not to thicknesses less than 1 inch.

In applications where space is a constraint, consider a fibrous product by Aspen Aerogels called Pyrogel XTE.
For piping within the utility tunnels and the CEP; the jacketing shall be Canvas, 8 oz/sq-yd wrap with thread count of 36x28 glued with two coats of lagging adhesive and two coats of paint.
For piping within a Plant; piping below 10’ from working service area-0.032” stucco embossed aluminum jacketing.
Every exposed piping component of chilled water systems in contact with the fluid shall be insulated, complete with a vapor barrier. No component of the chilled water system shall “sweat”.

Pipe support saddles shall be made of foam glass insulation at least 12” long, inserted such that the insulation jacketing is not torn or breached, with a 180-degree galvanized iron cover the same length of the foam glass or calcium silicate for the hanger/roller to rest on.

Piping elbows shall be fully insulated.

Label what pipe system carries and in what direction. All piping intersections within the mechanical room should have arrows showing the directions of flow coming and going from that junction.

SECTION 23 25 00 – HVAC WATER TREATMENT

All chilled water and heating water building systems shall have taps with valves installed to accept a portable side stream filtration unit. The system shall be reviewed by UW''s current chemical treatment vendor for their approval.All heating systems exposed to outside air shall have a 30% by weight mixture of water and glycol. Specification recommendations for glycol follow:

"The closed loop piping system shall contain a pre-blended solution of industrially inhibited ethylene glycol or propylene glycol and de-ionized water blended to provide adequate freeze protection for the proposed geographic location. The University of Wyoming uses Interstate Chemical Company ethylene glycol OP-100 for the heat transfer fluid. If propylene glycol is required (for food service and day care facilities), UW uses Interstate Chemical Company P-300.

Product shall be shipped via tanker truck that has been sufficiently cleaned of any foreign material that would alter or contaminate the new product. Makeup water and fill water for heat transfer systems shall be treated per ASTMD-1193, both on initial fill and on-going operation. Approximately 2 drums should be left over for future use—55 gallons for major projects and 5 gallons for smaller projects.
DILUTION WATER QUALITY: The water used for the dilution of the glycol must meet the following water quality criteria: <25ppm Sulfate; <25ppm Chloride; <1ppm Calcium; <1ppm Magnesium <25ppm Silica. Electrical conductivity umho/cm @ 25 C. 1.0 max. Total water hardness shall be less than 60ppm and meet the Type II Reagent Water specification as per ASTM D-1193.

The selected coolant shall meet or exceed the ASTM D-1384 corrosion test for coolants in glassware at 190 ^{o} F for 336 hours. The solution shall contain a fluorescent dye to facilitate easy leak detection. Color to be determined by Owner.

Approved manufacturer and coolant: Interstate Chemical Company, Inc. INTERCOOL® NFE / OP-100 (ethylene glycol) or INTERCOOL® NFP / P-300 (propylene glycol) or Owner-approved equivalent. NOTE: Should the possibility of incidental food contact exist in the application, an inhibited USP GRADE Propylene Glycol fluid such as INTERCOOL® P-323 shall be used.

The coolant manufacturer shall analyze the fluid annually at no cost to the Owner to ensure the glycol water solution continues to provide corrosion protection within industry standards.

No chemical additions shall be made to the glycol water solution until the coolant manufacturer has completed an analysis. Should such a chemical addition be required, it shall be done in accordance with the recommendations in the analytical report as supplied by the manufacturer.

The mechanical contractor shall meter the initial water fill for the purpose of hydrostatic pressure testing and/or system flushing. After completion of this requirement, the water shall be metered out. This will provide the contractor with a precise measure of coolant required to fill the system and the amount of water trapped in it. This process will allow for any adjustments required prior to delivery of the premixed glycol solution and ensure that the solution strength follows the specification.

Should the concentration still require adjustment after the system has been filled and because of trapped water, the required amount of fluid shall be drained from the system and replaced with the

same manufacturer's coolant in its concentrated form. This process shall be repeated until compliance with this specification is achieved.

System Preparation: Any dirt, oil or metal filings that could contaminate the system piping and mechanical components and contaminate the fresh heat transfer fluid shall be removed. The system shall be flushed thoroughly using a mild cleaning solution like INTERCLEAN DG-3 low foam cleaner and high-quality water. (For older systems, special cleaners like INTERCLEAN® MC-1 may be necessary to remove scale or rust.)

The system shall be drained as soon as possible after the required circulation period to prevent settling of foulants. The circulating pumps shall be run and flushed with clean water until the discharge water is clear. All flushed fluids shall be disposed per manufacturer's recommendation and local governances.

When the system water is clear, the system shall be drained; and all strainers shall be removed, cleaned, and replaced.

The system shall be filled with the approved glycol blend, and all air vents shall be opened during the filling process to ensure that all air is purged from the system. Contractor shall provide Owner with job site measured heating and cooling system volumes, including how much glycol was used in each system.

The glycol water mixture shall be circulated for 72 hours (about 3 days) before a sample is taken and tested for the proper fluid concentration."

The system shall include a suitable plastic make-up drum filled with the 30% solution of glycol and water, complete with a makeup water line for manual use with approved air gap and injection pump for makeup. The pump shall be Oberdorfer Pumps model #N991 or Owner-approved substitution, complete with a 1/3rd HP, 115-volt motor or Owner-approved substitution. Drum shall be 30-gallon size for small systems (100 gallon or less) and 55-gallon size for larger, plastic preferred. The drum shall have a removable seal at the manual water makeup and shall have a gooseneck style vent that will not allow contamination into the barrel. The system shall also have a drum low water alarm tied to the building BAS. The mechanical room shall provide easy access for drum changes. Pump shall operate manually via normal maintenance personnel. If there are two or more glycol systems feeding with the same percent solution of glycol, a second pump with separate discharge piping and manual switch shall be installed from the same tank. The tank may have to be upsized for this occurrence.

SECTION 23 57 00 – HEAT EXCHANGERS, HEATING AND COOLING COILS

Heat exchanger tube bundles shall use single wall (unless otherwise noted), ¾" inside diameter copper tubing with the necessary surface area for its rating with Type L wall thickness. Exchangers shall be Bell and Gossett or Owner-approved substitution. Flooded heat exchangers by Maxi-Therm are also approved case by case. No other flooded heat exchanger manufacturers will be considered now.

Flat plate heat exchangers shall have a minimum number of plates specified and shall have a removable insulation system.

Pipe make-up to heat exchangers such that they do not have a direct tap to domestic water. Provide coil drains for heating and chilled water coils. See requirements for freeze stat isolation on chilled water coils. Freeze-proof coils need to be considered for make-up air use.

All cooling coils shall be controlled using Delta-P-Valve pressure independent modulating 2- way flow control valves or Owner-approved substitution. For major cooling coils (above 2000 cfm), install a winter bypass with a manual bypass valve to maintain loop circulation during the non-cooling months. No flow control devices for these coils are required on the Delta-P valved coils. If other pressure independent valves are installed, discuss flow control requirements with the Owner to see if required. Grizwald flow control valves are not permitted for either chilled water or heating water applications.

Cooling coils shall be sized for a 20° F. delta T of the water side (41-61) if pressure drop does not become an issue. Heating coils shall be sized for a 40° F delta. Unless humidity control is required by UW Operations, the cooling coils shall be downstream of a heating coil in AHU's that supply outside air.

Consideration shall be given to using freeze-proof HVAC coils (heating and cooling) as manufactured by Cooney Technologies.

All coils shall be completely drainable. For rooftop units, provide detail on drain such that it will not damage the roof, especially for coils with glycol.

All converters and hot water generators shall have flanged piping connections for serviceability and adequate coil pull space. Verify sizing of control valves and converters with UW Operations.

For new construction, design for low hot water entering temperature, approximately 125 degrees. Designer should look at opportunities to cascade from exiting temperatures from exiting buildings (I.e. use 140 degree water exiting Engineering building to feed Agriculture Building).

SECTION 25 00 00 – INTEGRATED AUTOMATION *(Use this section as a basis for the controls specification.)*

PART 1 – GENERAL

2.1 DESCRIPTION

A. The work described under this division is for all labor, materials, and equipment required for the installation of the Building Automation System (BAS)/Automatic Temperature Control (ATC) system.
B. Lighting controls shall be integrated into the BAS system and be native BacNet that ties into a building NAE from Johnson Controls.
C. The system shall be complete in all respects, tested and ready for operation.
D. All materials, equipment and apparatus shall be new and of first-class quality.
E. Electrical Standards: Provide electrical products which have been tested, listed and labeled by Underwriters' Laboratories and comply with NEMA standards and the National Electric Code.
F. "Operator" is defined as the Owner's representative designated to operate the BAS/ATC system after Owner acceptance.

2.2 GENERAL INSTRUCTIONS

A. Control Contractor shall directly bid their work to the general contractor.
B. **The UW Building Automation group will provide Building Supervisory Controllers and Graphics Generation and Integration.** These can include central heating, cooling, and air handling units but is not limited to these systems. UW BAS Team will coordinate with any commissioning agent for any commissioning needed for these specific systems.
C. The general provisions of the contract (Division 1 and other Division 15 sections) apply to work specified in this section.
D. Preliminary Submittal: Prospective BAS/ATC Contractors shall submit for review by the Owner's authorized representatives a preliminary written description of his proposed BAS/ATC systems, including block diagrams showing all major components and panels, printers and other processing devices and required cabling between each. Include environmental and space requirements for panels, CPU's and other major devices.
    1. Include manufacturer's literature for each type of panel, controller or device that may be shown on the Block Diagram.
    2. Block Diagram shall show, schematically, the entire building system with all major components identified.
    3. Include a points list for all input and output devices which shall be provided by the proposed systems.
    4. Include information about proposed communications bus and data transmission.
    5. Provide a written explanation of any characteristics, items of equipment or control intent, which differs from the requirements of this Division. Explain what, if any, alternative characteristics, items of equipment or control intent will be provided. All language interfaces be BACnet/MSTP or BACnet/IP as approved by the UW Operations BAS Team.
    6. Alternate systems, characteristics, items of equipment or control intent, which do not comply with these specifications may be rejected if not acceptable to the Engineer or UW Operations BAS Team. Any rejected alternate system, characteristics, items of equipment or control intent shall be replaced by the specified system, characteristics, and items of equipment or control intent at no extra cost to the project. All field level controllers shall communicate via BACnet MSTP. The only non-BacNet devices permitted shall be for generators and electrical gear. No Carel controllers shall be permitted.
    7. Install building terminal and NAE in a closet adjacent to the data room. If two separate rooms are not achievable, the data room shall be sized for IT, BAS, and Lighting and Fire Alarm Systems. The IT portion of the closet shall be isolated from the BAS/FAS via galvanized woven wire fencing, with separate locking gates for IT and BAS/FAS.
    8. A Johnson Controls FEC, FAC, FX-PCG or FX-PCA shall be used for all AHU control, heat exchanger control, or other complicated mechanical systems with programming input by Owner. Schneider Electric TAC controllers are not permitted.

The Engineer shall be provided access to the BAS system via Internet VPN and an account shall be set up with the UW Operations BAS Team.

2.3 SCOPE

A. In general, the proposal shall be based on an electronic system. Provide electronic sensors and transmitters with full DDC capabilities.

B. The engineering, installation, calibration, hardware, software programming and checkout necessary for complete and fully operational BAS/ATC systems, as specified hereafter, shall be provided under this division by the BAS/ATC Installer.
C. The BAS Contractor shall guarantee that the installed system can maintain the following comfort goals in conditioned areas served by the BAS.
    1. Space Design Temperature +/- 1° F.
    2. The BAS Contractor is not responsible for improper installation by other Divisions; however, the BAS Contractor is responsible for informing the Construction Manager and Engineer of any requirements of this specification or any installation problem which prevents these goals from being maintained.
D. Seamlessly integrate this control system into the Campus wide Johnson Controls ADX Network for remote monitoring and adjustment.

2.4 ITEMS REQUIRED TO BE COORDINATED WITH OTHER DIVISIONS

A. Be responsible for coordinating the following:
    1. Power requirements (voltage, amps, location) for all BAS equipment requiring power. See Section 230000/260000.
B. Installation and connection of all power wiring. Power wiring shall be defined as follows:
    1. Wiring of power feeds through all disconnect starters and variable speed controllers to electric motors.
    2. 120 VAC Emergency and 120V Normal power feeds to all BAS temperature control panels and equipment.
    3. Wiring of any remote start/stop switches and manual or automatic motor speed control devices not furnished by the BAS/ATC Contractor.
    4. See Division 230000/260000 for responsibilities.
C. Note that 120V to 24V surge-protected transformers for low voltage wiring by this Division shall be furnished, set in place and wired (from designated circuit in electrical panel) by this Division, and all low voltage control wiring shall be installed under this Division.

2.5 WORK BY OTHERS

A. The following work shall be provided under separate divisions of the specifications:
    1. Installation of all line size and non-line size automatic valves and separable wells. However, these devices shall be furnished under this division.
    2. Provision of all necessary piping connections, taps, and direct-contact wells required for flow, pressure or temperature devices specified under other divisions.
    3. Provision of manual balancing dampers as specified under other divisions of Divisions 15.
    4. The installation of all automatic control dampers shall be under Division 15. However, all control dampers shall be furnished under this division.

2.6 AGENCY LISTINGS

A. UL 916 PAZX Energy Management Systems.
B. FCC-Part 15 Subparagraph J. Class A. Emissions requirements.
C. UL-864/UUKL Smoke Removal.

2.7 RELATED SECTIONS

A. 15/16001 - Mechanical and Electrical Coordination.
B. 15010 - Basic Mechanical Requirements.
C. 15050 - Basic Mechanical Materials and Methods.

2.8 BAS/ATC CONTRACTOR

A. The BAS/ACT Contractor shall have a local office within a 65-mile radius of the job site, staffed with factory trained engineers fully capable of providing instruction, routine maintenance and 24-hour emergency maintenance service on all system components. The BAS/ATC Contractor shall have a ten-year experience record in the design and installation of computerized building systems similar in scope and performance to that specified herein and shall be prepared to provide evidence of this history prior to Contract Award should the Owner request it.
B. The BAS/ATC Contractor shall be prepared to make a personal presentation of his systems to the Owner or his designated representatives prior to award of Contract should the Owner request it.
C. The engineering, installation, calibration, hardware, software programming and checkout necessary for complete and fully operational BAS/ACT systems, shall be provided under this division by the BAS/ATC Installer.
D. Control components shall be mounted and wired by the BAS/ACT Contractor except as noted. Controllers may be mounted on terminal units at the factory.

2.9 SUBMITTALS AFTER CONTRACT AWARD

A. The following data/information shall be submitted for approval:
    1. Complete sequence of operation. The UW Operations BAS Team shall approve all sequences of control.
    2. Control system Cad generated drawings including all pertinent data to provide a functional operating system.
    3. Valve and damper schedules showing size, configuration, capacity and location of all equipment.
    4. Data sheets for all hardware and software control components.
    5. A description of the installation materials including conduit, wire, flex, etc.
    6. Building Automation System panel locations.
    7. Proposed bussing plan.
B. The Controls Contractor shall provide submitted drawings for the entire control system for review and approval before work begins. Included in the submittal drawings shall be a diagram depicting the system architecture complete with a communications riser. Drawings shall include point-to-point wiring diagrams and must show all temperature controls, start-stop arrangement for each piece of equipment, equipment interlocks, wiring terminal numbers and any special connection information required for properly controlling the mechanical equipment. The submittal shall include a bill of material reference list and equipment sequences of operation.
C. The submittals shall include a specification compliance analysis for review and approval before work begins. The compliance document shall address each paragraph of this specification by indicating COMPLY, EXCEED, or EXCEPTION. Do not indicate COMPLY unless the proposed system exactly meets the paragraph requirement. If EXCEED or EXCEPTION is indicated, then provide a clear and concise explanation of the variance from the specifications and the net effect this would have on the specified system performance.
D. Wiring diagrams shall include internal wiring of all electrical control devices.

E. The contractor shall document and verify the performance, configuration, and route of each control bus network.

PART 2 – PRODUCTS

2.1 GENERAL

A. The Building Automation System (BAS) shall provide an easy-to-use interface for monitoring and managing the building. The Building Automation System shall provide the necessary Hardware, Software, and Network Communication abilities to provide Scheduling, Monitoring, Trending, Historical Storage, and Alarm Functions for the HVAC equipment and systems as described in this specification. Control capabilities shall include Time of Day scheduling, Direct Digital Control, Custom Control, Boolean Logic, Optimum Start/Stop, Duty Cycling, Electrical Demand Control, Temperature Control, After Hours Override, Reports and Logs, Trend Prints, Remote Communications, Alarm Logging, Run Time and Maintenance, and Expanded Informational Messages.
B. The Building Automation System shall be designed to allow full Operator operation with minimal training. It shall have an on-screen "Help" Operator tutorial.
C. Specified application programs shall be engineered, programmed and pre-tested prior to site installation. This shall be verified by standard format programming worksheets or flow diagrams included with the submittals.
D. All equipment and devices shall be native BACnet (i.e. BTL-Certified) and shall not require any integrators.

2.2 BUILDING AUTOMATION SYSTEM

A. Each panel memory shall be protected for at least 48 hours in case of power failure. The internal clock shall continue to run during a power failure so that the system makes the appropriate adjustment to all connected points when power is restored. UPSs on field controllers are not required unless stated otherwise.

2.3 MANUFACTURERS

A. Acceptable Manufacturers:
   1. Metasys Extended Architecture with NAE's, NCE's and FEC's furnished by Owner but paid through the project.
   2. FEC's shall be used on all main air handling units and major mechanical equipment.
   3. Johnson Controls Facility Explorer line is acceptable. Everything below the FX Supervisory Controllers would be permitted. JCI NAE's or equivalent would be used at the supervisory controller level.

2.4 SYSTEM PERFORMANCE

A. The system shall be integrated with the existing campus control system. The BAS Team will provide the building supervisory controllers (Metasys NAE/NCE) required by the Control Contractor's bid/design. The Controls Contractor will not include pricing for any Metasys NAE/NCE required by the design. The Control Contractors' bid shall include Application Specific

Controllers (ASCs) and Programmable Controllers to control AHU's, Heat Exchangers, VAVs, etc. All elements of the system shall be designed for standalone operation. Control shall always occur at the lowest level of the system. Communication between the building management panels and workstations shall be over the Ethernet. Application Specific Controllers shall be constantly scanned by the building management panels to update point information and alarm information. The building supervisor controller(s) will communicate with the ASCs by BACnet IP or BACnet MSTP. System architecture shall be approved by the UW Building Automation Specialists Team. The use of Data Sharing across multiple controllers to perform control tasks shall be minimized.

B. Contractor shall document and verify performance, configuration, and route of control bus network.

2.5 SYSTEM APPLICATION CONTROLLER SOFTWARE

A. System Security: User access shall be secured using individual security passwords and usernames.
B. Passwords shall restrict the user to only the object, applications and system functions as assigned by the system manager.

2.6 SYSTEM SOFTWARE

A. Furnish the following applications for building and energy management. All software applications shall reside and run in the system controllers. Editing of applications shall occur at the operator workstation.
    1. Scheduling: Provide the capability to schedule each object or group of objects in the system. Each scheduler shall consist of the following:
        a. Weekly Schedule: Provide separate schedules for each day of the week. Each of these schedules shall include the capability for start, stop, optimal start, optimal stop, and night economizer. Each scheduler may consist of up to 10 events. When a group of objects are scheduled together, provide the capability to adjust the start and stop times for each number.
        b. Exception Schedules: Provide the ability for the operator to designate any day of the year as an exception schedule. Exception schedules may be defined up to one year in advance. Once an exception schedule is executed, it will be discarded and replaced by the standard schedule for that day of the week.
        c. Holiday Schedules: Provide the capability for the operator to define up to 30 special or holiday schedules. These schedules may be placed on the scheduling calendar and will be repeated each year. The operator shall be able to define the length of each holiday period.
    2. Optimal Start/Stop: The scheduling application outlined above shall support an optimal start/stop algorithm. This shall calculate the thermal characteristics of a zone and start the equipment prior to occupancy to achieve the desired space temperature at the specified occupancy time. Provide an early start limit in minutes to prevent the system from starting too early.
    3. System Coordination: Provide a standard application for the proper coordination of equipment.
    4. Alarm Reporting.
    5. Trending.

6. Diagnostics.
7. Power Fail Recovery.
8. Reports and Logs.
9. Chiller Sequencing.
10. Rotation for equipment (just use JCI's standard sequence which has the equipment with the lowest hours start up after a restart).

2.7 NETWORK CONTROLLERS

A. General. All controls required shall be Johnson Controls NAEs or NCEs extended architecture system. The UW BAS Team will furnish the NAE/NCE's required by the design. Provide enough Building Management Panels to provide the performance specified above.
B. Communications. Each Operator Workstation shall communicate using 1Gig Ethernet (IEEE802.3). Communication system below the NAE level shall not be part of the responsibility of the building IT system/department.
    1. The control contractor is responsible for installing a busing system that meets the needs of the BAS. When problems arise, they shall correct throughout the warranty period.

2.8 APPLICATION-SPECIFIC CONTROLLERS

A. General. All field controllers shall be BACnet MSTP compatible and fully integratable with Metasys Extended Architecture (BACnet devices shall be BACnet Testing Labs Certified (BTLC)).
B. Application Specific Controllers shall be stand-alone, microprocessor-based Direct Digital Controllers with sufficient memory to handle its operating system, database, and programming requirements. Equipment controlled by these controllers shall be able to operate with the loss of the head in unit or loss of communication to the BAS network.

The controllers shall be clearly labeled as to controller type, where it is to be installed, and software address (if applicable). The controller shall be fully tested upon installation to ensure that it is properly matched to the equipment it is under control.

A. The controller shall communicate with other devices on the communication network and be fully integrated with the other system components.
B. Any global or other shared points shall be approved first by the Owner.
C. The hardware shall be suitable for the anticipated ambient conditions.
    1. Controllers used outdoors and/or in wet ambient shall be mounted within waterproof enclosures and rated for operation at –40^{o} F to 155^{o} F.
    2. The controller used in conditioned ambient shall be mounted in dust-proof enclosures and rated for operation at 32^{o} F to 120^{o} F.
D. Box Controllers
    1. The VAV terminal units shall be individually controlled by a dedicated DDC VAV controller. The DDC VAV controller, damper motor, transducer, and transformer (if required) shall be supplied by the BAS contractor.
    2. The BAS shall perform the following VAV Terminal unit control strategies and provide the points as listed on the DDC/VAV point list and specified monitoring and diagnostics.
        a. Grouping: The BAS shall be able to group VAV boxes via keyboard commands. These groups shall make it possible for the operator to send a common command to all boxes in a group to operate in the same mode. A sample of this group report must be provided

in the submittal package for approval by the Engineer and Owner. BAS shall also compile on a group basis, the following:
   i) Minimum group temperature.
   ii) Maximum group temperature.
   iii) Average group temperature.
   iv) Current airflow through boxes in group (total).
   v) Total ventilation airflow in group (total).

b. Setpoint Control: The BAS shall edit the zone space temperature setpoint of each VAV box. The zone temperature setpoint shall be adjustable. Individual zone setpoint and control logic shall reside at the zone level and not depend on the BAS for control. In the event of communication loss, the box will continue to control the current setpoints.
c. Manual/Automatic Setpoint Control: Where indicated in the contract documents, provide a combination zone temperature sensor/thermostat (S/T) with expert control via the Operator's Workstation. In automatic mode, the S/T shall operate only as a room sensor. In Manual mode, the space occupant can raise or lower space setpoint.
d. Override Button: Where indicated on the contract documents, the VAV box shall be capable of being placed in the "occupied" mode. Operation of the over-ride shall energize the associated air handler.
e. Override Sensor: In smaller spaces such as offices, provide a thermostat that has an integrated occupancy sensor or connect to a secondary output on the lighting control occupancy sensor.
   i) All office areas shall have manual temperature re-set.
   ii) All other areas shall have temperature sensing capability only.
f. Cooling Control: The BAS shall control the cooling air valve to a fully open, fully close, maximum CFM, or minimum CFM position based on operator commands. The operator shall also have the capability to adjust the maximum and minimum airflow limits of the air valve through the BAS.
g. Operating Mode: The BAS shall place the box in either the occupied or unoccupied mode based on an operator adjustable time schedule. Separate heating and cooling setpoints shall be enterable for each mode through the BAS. Other modes available for special applications shall include full open, full closed, maximum flow, heating flow and minimum flow.
h. Control Offset: The BAS shall be capable of offsetting the cooling or heating setpoints of one or more groups of boxes by an operator adjustable amount. This capacity will allow for automatic zone setpoint changes based on system requirements, such as demand limiting.
i. Automatic Recalibration: The system shall automatically recalibrate its air flow sensing and air valve position measurement system at system startup and on a schedule basis.
j. Portable interface terminal: The VAV box shall have a communications port on the space sensor for use with a handheld portable operator's terminal. This portable terminal shall give the operator the capability to interrogate and edit DDC/VAV box parameters. Portable interface terminal shall also have the capability to interrogate and edit DDC/VAV box parameters from a central controller.
k. Terminal Unit Status Reports: For each terminal unit, the BAS shall provide an operating status summary of all unit sensed values (zone temperature, CFM, etc.), setpoint and modes.
l. Terminal Unit Group Report: For each group of VAV terminal units, the BAS shall report the group mode, heating and cooling airflow, average zone temperature, minimum zone

temperature, and maximum zone temperature. The report shall also display for each terminal unit in the group, the present temperature control setpoints and the current zone temperature.

2.9 CUSTOM APPLICATION CONTROLLERS

A. The Custom Application Controllers shall provide stand-alone control and require no additional system components for complete operation. It shall have sufficient EEPROM memory to support its operation system, database, and programming requirements. Custom application controllers shall meet the requirements of 2.06 Master Control Panels except they shall reside on a communications network operating at a minimum of 38,400 KBPS.
B. All programming required for operation shall be memory resident and shall be retained in permanent memory.
C. The Custom Application Controller shall be configured such that the Portable Operators Terminal can be plugged directly into it or within sight for programming, editing, and other operator functions. Custom application controllers shall also be programmable from the operator workstation.
D. Controller hardware shall be suitable for the anticipated ambient conditions.
E. Controllers used outdoors and/or in wet ambient shall be mounted within waterproof enclosures and shall be rated for operation at –40^{o} F. to 155^{o} F.
F. Controller used in conditioned ambient shall be mounted in dust-proof enclosures, and shall be rated for operation at 32^{o} F. to 120^{o} F.
G. All air handlers shall have a hardwired keyed maintenance switch to act as a unit enable in addition to the software unit enable. The key switch shall be Cutler Hammer Part # M22-WRS-MS@-A1.

2.10 INPUT/OUTPUT INTERFACE

A. Hardwired inputs and outputs may tie into the system through Master Control Panel, Custom Application, or Application Specific Controllers. Any critical points (process variables) requiring immediate reaction shall be tied directly into the controller hosting the control software algorithm for the critical function.
B. Binary inputs shall allow the monitoring of on/off signals from remote devices. The binary inputs shall provide a sufficient wetting current to be compatible with commonly available control devices.
C. Any Network Engine (NAE, NCE, SNE, etc.) supervising a field controller, that will have an outside air temperature reset, must have an outside air temperature sensor hardwired to one of its supervised field controllers.

All status points shown on the point list shall be positive proof differential pressure or current sensing binary switches.

A. Analog inputs shall allow the monitoring of low voltage, current, or resistance signals and shall have a minimum resolution of 0.1% of the sensing range. Analog inputs shall be compatible with, and field configurable to commonly available sensing devices.
B. Binary outputs shall provide a continuous low voltage signal for on/off control of remote devices. Where specified in the sequence of operations or indicated on the points list, binary

outputs shall have 3-position (on/off/auto) override switches, status lights, and shall be selectable for either normally open or normally closed position.

C. Analog outputs shall provide a modulating signal for the control of end devices. Outputs shall provide a 0 to 10 VDC or a 4 to 20 milli-ampere signal as required to provide proper control of the output device. Systems that utilize a pulse width modulating output (PWM) shall include a position feedback AI for each output.
D. System architecture shall allow for point expansion in all the following ways:
    1. The addition of input/output cards to an existing System Application Controller.
    2. An additional panel and/or controller may be used to expand point capacity.

2.11 SPECIAL SYSTEMS

A. All VFDs shall prove the ability to restart automatically from loss of power and power fluctuations. The VFD's shall have the communication card necessary to fully integrate with the Building Automation System as a field device. Only one motor per VFD shall be permitted unless otherwise approved by the Owner. VFDs shall be an integrated device communicating on the control bus via BACnet MSTP at 38.4 kbps.
B. Domestic hot water circulation pumping systems – consult with UW Op's on sequence of control.

All peripheral equipment (e.g., Boilers, Chillers, Generators, Lighting Controls, Transfer Switches and UPS's etc.) shall be equipped with BACnet communications and shall be tied into the BAS. The lighting control system is to be integrated with a JCI supervisory device located in the building such that the scheduling features in the JCI device can be used to schedule the lighting system. The integration shall be done by BACnet MSTP (preferred) or BACnet IP (by UW BAS Team approval).

2.12 IDENTIFICATION

A. Engraved Labels
    1. Material: Melamine plastic laminate
    2. Thickness: 1/16"
    3. Color
        a. Surface: White
        b. Core: Black (letter color)
    4. Fastenings: Any of the following:
        a. Screws.
        b. Rivets.
        c. Permanent adhesive.
    5. Lettering: Coordinate with shop drawings.

2.13 DUCT SMOKE DETECTORS

A. Duct smoke detectors shall be provided and wired in accordance with Division 26.
B. All electric fire/smoke control dampers shall be monitored (for both open and closed) and controlled by the fire alarm system. Fire/smoke control damper design and installation shall be coordinated with the fire alarm and mechanical system design and installation. This shall include how the damper operation will interface with the rest of the building (we do not want one damper shutting off the entire building or causing extreme pressure issues within the building).

High static protection will be required on systems with fire/smoke dampers. Every duct/smoke detector shall be accessible by a 275 lb. person working on a maximum of 10' folding ladder.

C. The fire/smoke damper actuator assembly shall be rated to cycle 20,000 times and to operate at elevated temperatures of 350F after 20 minutes of exposure against 2000fpm @ 4 in. w.g. minimum. None of the actuators shall be of the stall type. All electric fire/smoke dampers shall have a remote mounted switch on the damper, if easily accessible, or wall mount and shall be key operated. All dampers need to be ordered with an open and closed indicator. The damper motors shall have a resettable thermal disc with no fuse links so if the power is cut, they close and on power restoration, they open. All methods of resetting shall be done without climbing into the ceiling or shaft. Dampers shall have proof of open and closure tied to BAS.
D. All actuator motors, fire/smoke motors and DDC system shall be on electrical circuits with surge protection (TVSS's preferred at distribution panel serving devices). These devices and circuits shall also be on emergency power.
E. The Fire/Smoke dampers shall report position to the BAS. Integration shall be through to the Fire Alarm control Panel. The contractor shall be responsible for providing BACnet compatible integration card and gateway as necessary and point naming for supporting BAS contractor in the integration.

2.14 PIPING

A. Exposed Air Piping: Hard copper tubing or flame-resistant plenum rated polyethylene tubing in metal conduit or trough.
B. Concealed Air Piping:
   1. Soft copper tubing or flame-resistant plenum rated polyethylene tubing, properly supported.
   2. Do not use polyethylene tubing near sources of heat.

2.15 BAS/ATC CONTROL WIRING

A. General: 3-conductor 18 AWG twisted pair cable shield wire shall be used.
B. Provide for all input and all analog output wiring.
C. Copper conductors
D. Do not run input/output wires together in the same conduit or wire bundle with 120V power wiring.
E. Pneumatic or sensor tubing shall not be installed in conduit with any wiring conductors.
F. All control wiring in mechanical room within 5'-0" of the floor, shall be run in rigid conduit complying with Division 16 requirements.
G. BACnet MSTP bus wire shall be 22 AWG Stranded, 3-Wire Twisted Shielded Cable, blue in color. Belden B6501FE or Owner-approved substitution.
H. Wiring color shall be as follows:
   1. Analog Input - Yellow
   2. Analog Output - Brown
   3. Binary Input - Orange
   4. Binary Output - Purple
   5. Communication - Blue

2.16 AUXILIARY CONTROL DEVICES

A. Dampers:
   1. The Building Automation System supplier shall provide all automatic control dampers not specified to be supplied integral to the HVAC equipment.
   2. Dampers to be opposed blade type.
   3. Provide required actuator torque as specified by manufacturer's recommendations, but not less than 7 in-lbs./ft^2.
   4. Damper frames and blades shall be galvanized steel and a minimum of 16-gauge. Blade width shall not exceed 8 inches. Dampers and seals shall be suitable for temperature ranges of –50° F. to 250° F.
   5. Blades: 14-guage, or 16-guage air foil shaped, double, galvanized steel or extruded aluminum. Thermally broken, insulated blades.
   6. Damper frame shall be insulated with polystyrene.
   7. Bearings: Nylon or oil impregnated.
   8. Axles: Welded, hexagonal or pin lock, or with other approved method to prevent blade rotating on axle.
   9. Hardware: Zinc plated steel or aluminum.
   10. Insulated Low Leakage Dampers:
      a. Insulated low leakage dampers shall be provided to conserve energy. Dampers shall be equipped with neoprene edge seals and compressible metal jamb seals. Leakage shall not exceed 3 CFM/Sq. Ft. at 1" W.G. differential.
      b. Low Leakage dampers shall be Tamco-9000 SC.

2.17 CONTROL VALVES

A. Provide control valves of the type, body material and pressure class as determined by manufacturer, based on operating requirements and maximum pressure and temperature in the piping system.
B. Equip control valves with actuators of proper close-off rating.
C. Modulating control valves shall have equal percentage or linear flow characteristics.
D. Valve bodies shall be 2-way normally open or closed, or 3-way mixing as specified. Valve bodies 2" and smaller shall be bronze, screwed type and 2½" and larger shall be iron, flanged and rated at 240°F 125 psig except where otherwise noted.
E. Valves shall have stainless steel stems and allow for servicing including packing, stem, and disk replacement, and have a 5-year warranty on parts and labor.
F. Size valves for 50% coil pressure drop (minimum 3', maximum 12' pressure drop).
G. Two-position, two-way control valves shall have quick opening characteristics.
H. 3-way valves shown in mixing application shall have a single, double-faced disk.
I. 3-way valves shown in diverting application shall have two separate disks on a common shaft.
J. Provide Delta P pressure independent control valves for chilled water applications on air handling units and chilled water coils.
K. Steam valves shall be installed such that the electric actuator will not be damaged from the high steam temperature. Vertical mounting directly above the valve is not acceptable. If pneumatics is available, consider using pneumatic as the motive of force for valve and actuator operation.

2.18 VALVE ACTUATORS (ELECTRIC)

A. Valve actuators shall be electronic low voltage (24VAC) and selected for the valve body and service. Belimo or Owner-approved substitution.

B. Actuators shall be fully proportioning and be spring return for normally open or normally closed operation as called out in the sequence of operations.
C. Provide a handwheel or manual positioner mounted adjacent to valve to allow manual positioning of valve without power.
D. Actuators that rely on heating a medium are not acceptable.
E. All modulating actuators shall be 0-10V or 2-10V proportional type. Floating style actuators are not allowed.

2.19 BUTTERFLY VALVES

Butterfly valves used for automatic control shall be lug type rated for 125 psi non-shock water service to 180° F.

A. Valve body shall be ductile iron with B-Nitrite (BUNA N) or EPDM molded seat and seals.
B. Disc material shall be cast bronze of aluminum-bronze with ASTM A-492 Type 416SS stainless steel stem and fittings.
C. Valves shall be tight close off suitable for end of the line service.
D. Butterfly valves used for two position control shall be line size. Valves used for modulating control shall be sized for a minimum 5 psig differential pressure at full flow.
E. 3-way valve mixing or diverting configurations shall have factory provided linkage kits specifically manufactured for the piping arrangement and actuator used. Keystone or Owner-approved substitution.

2.20 TEMPERATURE SENSORS

A. Temperature sensors shall be Resistance Temperature Detector (RTD) or Thermistor as dictated by the requirements of this specification.
B. Duct sensors shall be rigid or averaging as specified in the sequence of operations.
C. Immersion sensors shall be provided with a separable stainless steel or brass well to match pipe material.
D. Space sensors shall be equipped with setpoint adjustment and/or override switch as specified on the plans or in the sequence of operations. Space sensor shall have a portable service tool jack.
E. Accuracies shall be +/-1^{o} F. for standard applications. Where high accuracy is required, accuracies shall be +/- .2 ^{o} F.
F. Duct mounted averaging sensors shall utilize a sensing element incorporated in a copper capillary with a minimum length of 20 feet. The sensor shall be installed according to manufacturer's recommendation and looped and fastened at a minimum of every 36 inches.
G. Sunshields shall be provided for outside air sensors, and the sensors shall not be located in direct sunlight.
H. For steam heat applications that use outside air, the temperature of the condensate leaving the coil shall be monitored and integrated into the freeze protection system. For other air handling systems with cooling coils, there shall be a temperature transmitter between the heating and cooling coils that will keep this space at 40^{o} F. minimum.

2.21 HUMIDITY SENSORS

A. Humidity sensors shall be capacitance or bulk polymer resistance type.

B. Duct and room sensors shall have a sensing range of 20 to 80% with accuracy of +/-3% R.H. Duct sensors shall be provided with a sampling chamber.
C. Outdoor air humidity sensors shall have a sensing range of 20 to 95% RH. They shall be suitable for ambient conditions of –40° F. to 170° F.
D. Vaisala is the preferred manufacturer or Owner-approved substitution.
E. For critical measurements (i.e., outdoor air humidity, lab space humidity), Vaisala HMT330 shall be used.

2.22 DIFFERENTIAL PRESSURE

A. Differential Pressure sensors shall be furnished as indicated for status purposes in air and water applications. Provide single pole double throw switch with fully adjustable differential pressure settings.
B. Sensing range shall be suitable for the application with accuracy of +/-2% of range and repeatability of +/-.5 % of range. The sensor shall be capable of withstanding up to 150% of rate pressure without damage.

2.23 CARBON DIOXIDE DETECTION SENSOR

A. CO^2 sensors are only used with UW's permission. However, if used carbon dioxide detection sensors shall meet, at minimum, the following requirements:
    1. Negligible temperature and humidity affect accuracy.
    2. 4-20 mA transducer interface with the BAS proportional to 0 to 2,000 ppm of carbon dioxide concentration.
    3. 24 VAC or VDC @ 400 mA max voltage.
    4. No maintenance or period sensor replacement is needed.
    5. Accuracy- 5% of reading or 100 ppm, whichever is great.
    6. Operating temperature of 32° F. to 122° F.
    7. Aspirating box.
    8. Outside air sensor shall be environmentally protected.
B. Provide Vaisala, Air Test (NDIR Technology) CO^2 sensors or Owner-approved substitution.

2.24 STATIC PRESSURE SENSORS

A. Static pressure sensors shall be differential pressure type. The sensor range shall be closely matched to the system static pressure, - .5 to .5 inches, -1 to 1 inches, 0 to 2.5 inches.
B. Sensor accuracy shall be plus or minus 5% of the sensing range, and repeatability of 2% of sensor range.
C. Setra is the preferred manufacturer.

2.25 AIR FLOW MEASUREMENT

A. Air flow measurement shall be done using Accutrol AFM transmitters

PART 3 – EXECUTION

3.1 FUNCTION

A. Provide all components necessary to achieve the Sequences of Operation listed in Part IV and any additional industry standard functions normally required of a first-class BAS/ATC installation.
B. This division shall provide a project manager who shall, as a part of their duties, be responsible for the following activities:
    1. Coordination between this Contractor and all other trades, Owner, local authorities, and the design team. See installation responsibility matrix in Section 230000.
    2. Scheduling of workforce, material delivery, equipment installation and checkout.
    3. Maintenance of construction records such as project scheduling, workforce planning, and as-built drawings for project coordination and as-built drawings.

3.2 INSTALLATION METHODS

A. Install systems and materials in accordance with manufacturer's instructions, rough-in drawings, and equipment details. Install electrical components and use electrical products complying with requirements of applicable Division-16 sections of these specifications.
B. Plans shall specify the extent of electrical contractors work for their portion of the temperature control system installation. This includes who provides power to the DDC equipment.
C. Control panels shall have capacity for future expansion, including hardware for at least 10% additional Digital input and output points on each custom application controller.
D. The term "control wiring" is defined to include providing wire, conduit, and miscellaneous materials as required for mounting and connecting electric or electronic control devices.
E. Control Wiring:
    1. Number-code or color-code conductors appropriately for future identification and servicing of control system.
    2. All line voltage power wiring required because of substitution of low voltage power wiring equipment specified in this division, shall be provided by this division.
    3. Comply with the applicable requirements of Division 16 for the installation of electrical wiring incidental to the temperature control system.
    4. Comply with the applicable requirements of National Electrical Code and Standard Building Code for the installation of electrical wiring incidental to the temperature control system.
    5. Conduit shall be run parallel to building lines properly supported and sized at a maximum of 40% fill. In no cases shall field installed conduit smaller than ½" trade size be allowed. Control wiring inside mechanical rooms shall be in conduit.
    6. Where conductors are not in conduit (as allowed through an Owner-accepted substation request) cable rated for use in return air plenums shall be used in all locations.
    7. BAS/ATC division shall provide all control transformers and all control wiring (including low voltage actuator power wiring). This division shall also provide power wiring from the control circuits to the transformer locations and all other temperature control devices requiring power wiring. Division 16 shall furnish appropriate control circuits (normal and emergency) in suitable panelboards throughout the project.
    8. In general, provide a separate wireway for the control wiring and tubing. All wiring and tubing shall be the Teflon coated flame retarded type. Tubing and low voltage wiring within mechanical room can be installed without conduit if protected from damage.
    9. BAS/ATC division shall provide UL listed surge protectors for all control circuits upstream of control transformers.
    10. Each VAV or DDC device needing low voltage power shall have its own control transformer. UW does not allow multiple boxes fed from one transformer.

11. The use of “repeaters” on the communication bus is not allowed. Bus length and capacity shall be professionally designed to eliminate the need for repeaters. The number of devices connected to an individual communication bus shall be limited to less than 50.
12. Wiring color shall be as follows:
    a. Analog Input - Yellow
    b. Analog Output - Brown
    c. Binary Input - Orange
    d. Binary Output - Purple
    e. Communication - Blue

F. Piping System:
1. Provide a complete air piping system for pneumatic actuator controls (if selected by Contractor).
2. Conceal piping except in:
    a. Mechanical rooms.
    b. Areas where other piping is exposed.
3. Secure exposed copper tubing regularly and run parallel to the building's lines.
4. Install only tool-make pipe bends.
5. Where exposed in mechanical rooms and occupied spaces, support non-metallic tubing in:
    a. Adequately supported, rigid, metallic raceways.
    b. EMT pipe
    c. Duct
6. Support non-metallic tubing properly where installed in concealed locations, including:
    a. Pipe chases
    b. Ceiling plenums
    c. Within walls
7. Install in a neat and workman-like manner.
8. Fasten flexible connections bridging cabinets and doors, neatly along hinge side.
    a. Protect against abrasion.
9. Tie and support the tubing neatly.
10. Number-code or color-code tubing, except local individual room control tubing, for future identification and servicing of control system.
11. Do not install pneumatic devices or tubing where there is a danger of freezing.

G. Equipment installed under other divisions of the specifications:
1. Furnish dampers, valves, thermostat wells, flow switches and other equipment to Installers at proper time.
2. Provide installation instructions.

H. Adjust low-leakage dampers so all gaskets and seals are properly compressed.

I. Provide outside air and relative humidity sensors at each outside air intake louvers for air handlers.

J. Install BAS head-end separate closet or dedicated space within the main electrical room. The Last choice is a mechanical room without steam to hot water conversion (i.e. just AHU’s). All BAS NAE’s shall be UPS protected and be on building emergency generator power (if used). UPS shall have the capacity to keep NAE online for 30 minutes minimum.

3.3 IDENTIFICATION

A. Devices Inside Panels: Either of the following:
1. Engraved labels

2. Laser engraved metal placards.

B. Exposed Devices: Engraved labels.
C. Location: On the body of the device or on the surface to which it is mounted.
   1. Do not put identification on removable covers.
D. Label each remotely mounted control panel as to the device it controls.
E. Label all connections in control panels. On MSTP buses, give indication of the last device or Mechanical Room they came from or first device or Mechanical room the bus is going to.

3.4 OPERATING AMBIENT CONDITIONS

A. Electronic controls mounted in unconditioned space shall be rated for ambient operating conditions from -40° F. to 155° F. Controls not meeting these limits shall be mounted in an accessible location within conditioned space. If plant compressed air is available, consider using pneumatic operators for any steam valve.

3.5 OWNER TRAINING

A. The BAS/ATC contractor shall provide 4 copies of an operator's manual describing all operating and routine maintenance service procedures to be used with the temperature control and Building Automation System supplied. This contractor shall instruct the Owner's designated representatives in these procedures during the startup and test period. The Owner training shall consist of at least three 4-hour instruction periods scheduled by the Owner over the first 12 months of system operation. The training shall be scheduled during normal working hours.
B. Follow-up training shall be provided under this Division. It shall include a basic 4 hours at final acceptance, followed by bi-monthly, 2-hour sessions for the remainder for the warranty period. Also, 4-hour seasonal tuning/recommissioning sessions shall be given that shall go through at least one heating and one cooling season.
C. The contractor shall video record all training sessions and provide DVD.

3.6 CALIBRATION AND ADJUSTMENTS

A. After completion of the installation, perform final calibrations and adjustments of the equipment provided under this contract and supply services incidental to the proper performance of the ATC and BAS system under warranty below.

3.7 OPERATION BY OWNER

A. The owner may require operation of part of the system prior to final acceptance. Operation is not to be construed as acceptance of work.

3.8 ACCEPTANCE PROCEDURE

A. General: Calibration and Pre-functional Testing shall be completed. This includes testing each device in the system for proper wiring, control, rotation and installation. All point to point and control loops are working. Graphics completed.
B. Upon completion of the calibration and pre-function testing, Contractor shall start-up the system and perform all necessary testing and run diagnostic tests to ensure proper operation.

The installer shall be responsible for generating all software and entering all databases necessary to perform the sequence of control and specified software routines. Once the Design Team and Commissioning Agent recommend system is substantially complete, an Integrated Systems Test (IST) of the BAS and its mechanical and electrical components shall be conducted.

1. Failing a test is when more than two of the first 10 devices tested, or more than 10% of the first 20 or more devices tested, fail to operate properly within the 14-day period of the IST. The test shall be discontinued, liquidated damages shall begin and repairs made to the system. Testing shall include:
    a. Give each element of the system an operating test to demonstrate to the satisfaction of the Architect/Owner that the control system and sequences of control are functioning properly and that the system is capable of producing the required environmental conditions and optimal operating costs. During this test, operate the system entirely on automatic control and take periodic readings of the inside and outside wet and dry bulb temperatures. Obtain wet and dry bulb temperatures with a recording thermometer-hygrometer. Conduct tests with outside temperature and humidity conditions as near design conditions as practical.
    b. De-energizing all major system motors (fans/pump/etc.) to insure proper back up,
    c. Fail system components (dampers, differential pressure sensors, static pressure sensors, thermostats, mixed air sensors, control valves, flow switches, freeze stats, fire/smoke dampers, etc.) to verify correct control system response.
    d. Field Equipment Test Procedures: DDC Zone and Local Controllers shall be demonstrated via a functional end-to-end test as follows:
        iii) All output channels shall be commanded (on/off, stop/start, adjust, etc.) and their operations verified.
        iv) All analog input channels shall be verified for proper operation.
        v) All digital input channels shall be verified by changing the state of the field device and observing the appropriate change of displayed value.
        vi) If a point should fail testing, perform necessary repair action and retest failed point and all interlocked points.
        vii) Automatic control operation shall be verified by introducing an error into the system and observing the proper corrective system response.
        viii) Selected time and setpoint schedules shall be verified by changing the schedule and observing the correct response on the controlled outputs.
    e. Workstation Test Procedures: The System Workstation test procedures shall be as follows:
        i) Communication with each DDC Zone and Local Controller shall be demonstrated.
        ii) Operator commands will be explained and demonstrated.
        iii) Control sequences shall be demonstrated for proper operation.
        iv) All available system reports and logs shall be demonstrated at the System Workstation.
        v) Correct system start-up and shutdown procedures shall be demonstrated.
            a) All controllers shall be demonstrated to operate in standalone mode. Additional items per the contract documents.
            b) Owner acceptance of IST.
        vi) Once repairs are made, the IST shall begin again for a 14-day test. If successful, liquidated damages shall be stopped.

C. Upon successful completion of IST final project acceptance shall be granted, which starts the warranty period.

1. Perform two (2) seasonal operational tests of the entire mechanical system and correct any issues through the system warranty to the satisfaction of the Owner/Architect. One test shall be with winter conditions and one test shall be with summer conditions.
2. The winter acceptance test shall be conducted when outside temperatures are at or near 100° F. The summer acceptance test shall be conducted when outside temperatures are at or near 90° F. db.
3. Conduct tests during summer and winter outdoor temperature extremes as specified above. Notify the Owner seven (7) days in advance of proposed tests.
4. Record temperature and humidity at an exterior and interior location for each system as designated by the Engineer at least once every hour for 48 hours during tests.
5. Submit a report detailing the following:
    a. Instrument used:
        i) Most recent calibration date.
    b. Date of tests.
    c. Description of test apparatus locations and methods.
    d. Results of tests.
    e. Any abnormal usage of the building or abnormal system characteristics observed during the course of the test.

3.9 RECORD DOCUMENTS

A. Electronic Media As-Built Documentation: After a successful acceptance demonstration, the Contractor shall submit as-built drawings of the completed project for final approval. After receiving final approval, supply complete 11”X17” hard copy as-built drawing sets, together with diskettes to the Owner. The number of hard copies shall be electronic media equal to the number of O&M manuals (Re: Division 1).
    1. Electronic data shall be in .PDF, .DWG or .RVT formats, and GIS.
B. Operation and Maintenance Manuals: Shall be a searchable .PDF format with an index. Submit Operation and Maintenance manuals (Re: Division 1). Include the following in each manual:
    2. BAS/ATC information for insertion into the Manufacturer’s catalog data and specifications on all sensors, transmitters, controllers, control valves, damper actuators, gauges, indicators, terminals, and any miscellaneous components used in the system.
    3. An Operator’s Manual which shall include detailed instructions for all operations of the system.
    4. An Operator’s Reference Table listing the addresses of all connected input points and output points. Settings shall be shown where applicable.
    5. A Programmer’s Manual which will include all information necessary to perform programming functions.
    6. A language manual which will include a detailed description of the language used and all routines used by the system.
    7. Flow charts of the control software programs utilized in the Temperature Control System.
    8. Flow charts of the custom software programs utilized in the Temperature Control System.
    9. Complete program listing file and parameter listing file for all programs.
    10. A copy of the warranty.
    11. Operating and maintenance cautions and instructions.
    12. Recommended spare parts list.
    13. Twelve (12) hour service phone number and point of contact.
    14. Bus Configuration map detailing wiring order of communication bus with hardware address.

15. A chart documenting the terminal devices served by each AH.

3.10 WARRANTY

A. All BAS/ATC devices and installation shall be warranted to be free from defects in workmanship and material for a period of one year from the date of job acceptance by the Owner. Any equipment, software, or labor found to be defective during this period shall be repaired or replaced without expense to the Owner. Factory-authorized warranty service shall be available within 50 miles of jobsite.

PART 4 – SEQUENCE OF OPERATION

4.1 GENERAL

A. BAS/ATC Contractor shall design, install, program, test, commission and demonstrate a complete and fully functional system capable of meeting the Sequences of Operation detailed below. Provide additional control points and functions as required, even if not specifically called for, if normally considered necessary for a BAS/ATC installation of the size and complexity of this project.
B. Listed items of equipment shall be individually controlled by standalone controller. Each controller shall serve only one individual unit. The unit controller shall be supplied by the BAS Contractor and may be furnished to the equipment supplier for factory mounting. The cost to mount, calibrate, program and test the controller and actuator shall be coordinated prior to bid day and included in the BAS price.
    1. VAV Box.
    2. Air Handling Units.
    3. Fume Hood/Lab Controller.
    4. Terminal Reheat Coil.
    5. Constant Volume Box.
C. Multiple units may be controlled by individual standalone controllers for all other control points.
D. Sensor and transducer installation, control power and wiring and communications wiring shall be provided under this division by BAS/ATC Contractor.
E. General UW temperature standards are: 70° F. to 76° F. for interior temperature-controlled areas such as academic, administrative and residence halls. The following heating set point of 70° F. and cooling set point of 76° F. with alarm thresholds set at 68° F. and 78° F. will help maintain this target. Corridor set points are 68° F. for heating and 78° F. for cooling. Humidification systems are discouraged.
F. Refer to the Systems Points List and equipment schedules on the drawings for required control
G. Inputs and outputs for each item of equipment listed in the Sequence of Operation.
H. Programming shall contain necessary comment statements to identify what device the following lines of code operate. Programming shall follow a logical order and have no open statements. On graphic displays, lines connecting the various devices shall not cross. This program must be easily readable by service personnel who did not write the code. Sequence of control shall be approved by the Owner. Coordinate sequence of control for VAV systems with the California Energy Commission's Advanced Variable Air Volume System Design Guide. This link to this file is at: http://www.energy.ca.gov/2003publications/CEC-500-2003-082/CEC-500-2003-082-A-11.PDF

PART 5 – HEAD END PROGRAMMING STANDARDS

5.1 GENERAL

A. Any new DDC system shall be tied and mapped into the UW Operations ADX Server.
B. BAS/ATC Contractor shall contact the Owner's BAS Team located at UW Operations prior to installation of any product to review head end programming standards criteria.
C. Point Labeling: Units – Points shall be labeled with the correct units, i.e., "in wc", "deg F.", etc. For points that refer to a percent of value, label the point as "% closed" or "% open" for dampers and valves and use "% command" for other variable points such as VFD output.
D. Point Naming: The following is a list of point names. Any non-standard points shall have their descriptor approved by the UW BAS Team.
E. General "any ADS server downloads and synchronizations will be scheduled with the UW BAS office."
F.

University of Wyoming Common DDC Point Names

Item Name	Description	Units	Precision
DA-T	Discharge Air Temp	F	0.1
RA-T	Return Air Temp	F	0.1
MA-T	Mixed Air Temp	F	0.1
HWS-T	Hot Water Supply Temp	F	0.1
HWR-T	Hot Water Return Temp	F	0.1
CHWS-T	Chilled Water Supply Temp	F	0.1
CHWR-T	Chilled Water Return Temp	F	0.1
EA-T	Exhaust Air Temp	F	0.1
ZN-T	Zone Temp	F	0.1
BLDG-P	Building Pressure	in wc	0.01
DA1-P	Discharge Duct Pressure	in wc	0.01
OA-T	Outside Air Temp	F	0.1
HR-T	Heat Recovery Temp	F	0.1
LABEA-T	Lab Exhaust Air Temp	F	0.1
??-H	Humidities	%	0.1
??-F	Flows	CFM or gpm	1 or .1
SF-C	Supply Fan Command	on/off	
RF-C	Return Fan Command	on/off	
RLF-C	Relief Fan Command	on/off	
EF-C	Exhaust Fan Command	on/off	

HR-C	Heat Recovery Command	on/off	
HWP-C	Hot Water Pump Command	on/off	
??-S	Status	on/off	
CLG-EN	Cooling Enabled	true/false	
HTG-EN	Heating Enabled	true/false	
??-O	Analog Outputs	%	0.1
OAD-O	Outside Air Damper Output	% open	0.1
RAD-O	Return Air Damper Output	% open	0.1
EAD-O	Exhaust Air Damper Output	% open	0.1
FBD-O	Face Bypass Damper	% open	0.1
OCC-SCHEDULE	Occupied Schedule	OCC/UNOCC	
EFFDAT-SP	Effective DA-T Setpoint	F	0.1
OCCHTG-SP	Occupied Heating Setpoint	F	0.1
OCCCLG-SP	Occupied Cooling Setpoint	F	0.1
UNOCCHTG-SP	Unoccupied Heating Setpoint	F	0.1
UNOCCGLG-SP	Unoccupied Cooling Setpoint	F	0.1
??-SP	Setpoint	same as PV	same as PV
LT-A	Low Temp Alarm	normal/alarm	
DAPHI-A	Discharge Pressure High Alarm	normal/alarm	
EVAP-??	Evaporative Cooling Commands		

Notes:

1. If there is more than one of each, add a number (i.e., DA1-T and DA2-T).
2. Underscores shall not be use; dashes shall be used instead.
3. Alarms that are dependent on -C and -S shall be an extension of the -S point
4. DO/DI shall be trended at a zero time interval, only catching state changes for 50 samples minimum.
5. AO/AI trends shall use default time interval (600 seconds for 144 samples) and only specific trends sent to repository.

5.2 TRENDS

A. Install trends on all air handler inputs and outputs as the norm. Install trends on VAV room temp and discharge air. Install trends on other system inputs and outputs as needed.
B. Use the appropriate sampling rates for the point being trended.

5.3 ALARMS

A. Install alarms on all Air handler analog and digital inputs as the norm. Install alarms on VAV room temps and discharge air points. Install alarms on other system input and outputs as needed.
B. Most alarms shall be tied to an interlock or trigger if possible.
C. Do not program alarm warning thresholds unless specified.
D. Network Application Engines offline timing parameters set for high tolerance.
E. All alarms will be categorized as General and Critical. Check with BAS Team for alarm protocol details.
F. Critical Alarm List.
G. Alarm Message will include location of device (i.e., “SE Mech Room”).
H. Alarm Protocol

ALARMS CATEGORY	Priority Default	PRIORITY	DEFINITION
CRITICAL 1	15	0-24	LIFE SAFETY (CALL-OUT)
CRITICAL 2	35	25-49	PROPERTY SAFETY (CALL-OUT)
CRITICAL 3	65	50-74	WARNING CONDITIONS (SEASONAL CALL-OUT)
CRITICAL 4	85	75-99	WARNING CONDITIONS (NORMAL WORK SHIFT)
FOLLOW-UP 1	115	100-124	NEEDS ATTENTION DURING WEEK
FOLLOW-UP 2	135	125-149	NEEDS ATTENTION DURING MONTH
SUPERVISORY TROUBLE	165	150-174	DEVICES OFFLINE
SUPERVISORY NORMAL	185	175-199	DEVICES ONLINE
DIAGNOSTIC	215	200-224	SYSTEM CHECKS
NORMAL	235	225-255	NORMAL OPERATIONS
ALARMS GROUPS			
HVAC			AIR HANDLERS EXHAUST FANS
FIRE			FIRE ALARM SYSTEMS
SECURITY			SECURITY SYSTEMS
SERVICES			
ADMINISTRATION			
GENERAL			
LIGHTING			
REFRIGERATION			CHILLERS
CRITICAL EQUIPMENT			
AIR QUALITY			
POWER			

ENERGY			METERS
SYSTEM			FIELD DEVICES
MECHANICAL EQUIPMENT			
ZONE CONTROLLERS			
EMERGENCY EQUIPMENT			
CEP		CUSTOM 4	CEP Equipment

5.4 GRAPHICS

A. Provide Graphics for all major systems: AHU's, VAV's, Boilers, Chillers, Hot Water Convertors etc.
B. Provide floor plans for VAV graphics.
C. Provide site plan graphic that list different buildings if applicable.
D. Keep graphics simple and concise. Graphics shall not have lots of text that is not included in the main graphic picture.
E. Submit graphics to BAS Team for approval prior to installation of graphics.
F. Graphics shall be created using JCI Graphics Generation Tool (GGT).

5.5 ALL ITEMS VIEW

A. System or Controller names shall be in all capitals. The names shall be short and concise. Example: AHU-1, RTU-2, HWS-1. VAV controller's names shall be named with room numbers.
B. Example: RM-101. Use the room number of the room in which the thermostat is located.
C. All building or site names shall have the first letter capitalized and the rest lower case.
D. Objects shall have the building name in all capitalized letters from the approved Owner abbreviation list. For example, College of Business will be COB.
E. An object string will have 3 parts: Part 1 – The name of the building. Part 2 - The name of the controller. Part 3 - The name of the point. For example, COB.AHU-1.OA-T
F. Every object shall come with a description. The first letter in every word shall be capitalized. For example, Outside Air Temp.
G. All self-discovered points shall follow the format listed in item D and E.
H. All points shall have the proper COV rates to reduce engine traffic problems.

5.6 MUI (Metasys UI) Implementation

A. Spaces and Systems will be done in-house by the UW BAS office as reimbursable work paid for by the project.
B. MUI Graphics will be done in-house by the UW BAS office as reimbursable work paid for by the project.

A. User views shall be built by the Owner for every building with reimbursement by the project.
B. Separate out AHU's, RTU's and give description as location. For Example, AHU-4 Basement.
C. Separate out heating and cooling systems.
D. Separate out VAV's by floors. Label VAV by room location.

5.7 BACnet STANDARD

A. BAS Contractor shall consult with BAS Team for BACnet addressing for NAE's.

BUILDING METERING

All new facilities connected to the campus utility systems shall be metered for the water and energy they consume. Meters shall have pulse output capability for transmission to the future UW Operations BAS computer-meter system. Meter readings shall be verified for accuracy. In general the meters shall have the following:

A. Meter installation and readings shall be verified by a factory representative.
B. Meter installation shall be accordance with the manufacturer's printed instructions.

ELECTRIC

Shall be digital with KVA, KW, KWH minimum with the multiplier marked on the meter. Electric meters shall be GE Multilin EPM 6010 with display, SHARK 100B BACnet/IP communications and energy measurement or Owner-approved substitution (see: http://www.gedigitalenergy.com/products/brochures/EPM6010.pdf).

A. Preferred installation is with the main distribution gear using easily removable CT's.
B. CT's shall be sized according to UW Operations Specifications, not to main gear bus size.
C. If CT's are installed on spades of transformer inside the secondary compartment they shall l be supported from the transformer structure, not by the spade.
D. If CT cabinet is used, for a typical 3ph4W service of 400A or less, CT mounting bases shall be rated at 10,000AIC, cabinets shall be NEMA 3R with hinged cover.
E. Bypass switches shall be installed to allow meter removal without an outage.
F. Meter installation shall be commissioned.

CHILLED WATER

A. Shall be System 10 BTU magnetic meters (Bac/IP), as manufactured by Onicon, Inc., and including F-3500 electro-magnetic insertion type flow meter and temperature sensors. As an alternate, the two-way Delta-P chilled water valves may be used via the DDC system measuring chilled water supply and return temperatures and valve position. These values shall be translated to BTU's, tons, BTU/hr and Ton-Hour.
B. Temperature and flow rate readouts shall be via the existing DDC system points.
C. Meter shall be commissioned and performance verified.

HOT WATER

D. Shall be System 10 BTU magnetic meters (Bac/IP), as manufactured by Onicon, Inc., and including F-3500 electro-magnetic insertion type flow meter and temperature sensors. As an alternate, the two-way Delta-P chilled water valves may be used via the DDC system measuring hot water supply and return temperatures and valve position. These values shall be translated to BTU's and BTU/hr.
E. Temperature and flow rate readouts shall be via the existing DDC system points.
F. Meter shall be commissioned, and performance verified.

STEAM

All new facilities with a steam supply equal to or greater than 2.5" line size, shall have a steam meter installed. The meter shall be a line sized Armstrong VERIS Accelabar® , complete with a 500°F rated RTD, transmitter head (either direct or remote mount depending on install) and Flow Computer that will output in ModBus or BacNet. Facilities with smaller steam piping shall be metered via a condensate meter described below.

WATER

All buildings shall be metered for water use. Potable and non-potable water meters shall be as required by the City of Laramie. The City of Laramie will install a remote reading head and provide consumption readout via the Waterscope system. Install isolation valves on each side of the meter. If a bypass line is used, it shall have a City approved Back Flow device and isolation valves.

METERING GENERAL

A. Data acquisition and integration shall allow access to real time and logged data.
B. Provide security for data transfer to the main energy monitoring computer
C. Integrate with building automation systems via BACnet/IP or MSTP protocol.
D. Provide real time monitoring and trend analysis.
E. Allow report generation through Microsoft Excel, either manually, on schedule or event driven.
F. Allows custom report generation.
G. Receives alerts and sends alarms if necessary.
H. All meters shall be commissioned.

SECTION 26 00 00 – ELECTRICAL

See the maintainability clauses in the General Requirements section.

Reference Section 270000 – Communications for restrictions on equipment placed in IT closets.

All Building services shall be protected with a TVSS. Critical downstream loads shall also be protected with a TVSS. This includes VFD's 10 HP and greater.

All conductors shall be copper, no aluminum. All building wire shall have 90°C insulation minimum.

For motors greater than 40HP, cabling from VFD to motor shall be shielded by using conduit. The use of harmonic filters will be on a case-by-case basis.

Minimum conductor size shall be #12. Lighting whips shall be a minimum of #16.

Connections at devices shall be via mechanical screw. Conductor splices shall be pre-twisted and nutted. No stab-in type connectors permitted. For wire sizes greater than #8, Polaris connectors shall be used. All j-boxes, conduits supports or electrical equipment that are fastened to walls or ceilings, shall be done with reversing fasteners. Drive pins, ram set nails, or any non-reversing fasteners are not permitted.

Labeling: All junction boxes to identify circuits contained within. Panelboard directories shall be complete.

Color code cover plates for fire alarm systems, branch circuit home runs, high voltage, etc. Controls shall be blue, and fire alarm shall be red (including the conduit runs).

Conductors shall be color coded as follows:

Conductor	120/208 Volt	277/480 Volt
A Phase	Black	Brown
B Phase	Red	Orange
C Phase	Blue	Yellow
Neutral	White	Grey
Ground	Green	Green

Emergency lighting units, inverters and battery packs shall be used as little as possible with emergency generator sets being preferred. In installations without gensets, all emergency lighting fixtures shall be kept on dedicated circuits with no normal AC loads on the circuit.

Generators shall have a full load resistor bank test with results given to Owner. The gear shall have a circuit breaker-protected test connection point for the load bank. An application for the installation of a genset shall be submitted to and approved by the Wyoming Department of Environmental Quality, Air Quality Division (WDEQ-AQD) per Chapter 6, Section 2. UW will prepare and submit NSR permit applications—not the consultant. Permit applications for generators and incinerators must be submitted and approved prior to equipment ordering. This process can take 1-3 months, so it is critical that all information concerning the equipment being proposed be provided to the Owner as soon as possible. In general, natural gas and diesel generators shall be:

- < 75 HP Tier 4
- >= 75 HP to <750 HP Tier 3 or more strict
- 750 HP Tier 4

Engine driven emergency and standby systems shall comply with standards set forth in NFPA 110. Diesel generator sets shall be loaded no less than 30% of nameplate capacity during a typical power outage. The anticipated load may not be calculated from article 220 of the National Electric Code. It is anticipated that the electrical design engineer will use experience and judgement to create a reliable generator backed power system that also conforms to state and local codes. An overflow prevention valve and alarm system shall be installed on all generator sets. Overflow valve shall be operated by the generator's battery voltage. Leak detection on the floor shall be provided for diesel fueled units. Generators shall be equipped with crank case ventilation systems that capture engine blow-by oil and gases (normally discharged into your engine room, or the environment), and deliver them back into the oil sump. Provisions for load bank testing shall be addressed to the owner during the design phase. Load bank provisions may be required per owner’s discretion.

Generators shall be 1,800 rpm, nominal and not have any transmissions or other gear reduction systems and shall have BACnet conversion to the BAS. Kaytolite and Generac generators are not permitted.

Generator exhausts shall not contaminate any intake air supply to a building or stain the exterior. See the Wind Tunnel Testing requirements in the Design Guidelines to minimize this issue.

Either a separate hard point or auxiliary contact in the automatic transfer switch shall be installed and communicate with the Building Automation System for generator run status.

The generator warranty shall be 2 years from substantial completion.

Mechanical and electrical room lighting shall be via wall switch with a pilot light and no occupancy sensors. Lighting must have uniform intensity of 50 foot candles when measured 3 feet from the finished floor. Indirect lighting is not permitted. Lighting fixtures must be on separate electrical circuits from the electrical outlets feeds for the room. Do not place the light fixture above equipment racks, cabinets, frames or other freestanding equipment to avoid blocking of light.

Receptacles shall be 20 Amp minimum and shall not be fed with stranded wire. No 15A branch breakers permitted. No modular type like the Leviton LEV-LOK shall be permitted.

Receptacle circuits shall have a maximum of 8/circuit with each circuit having its own neutral conductor.

Home runs shall contain a maximum of 3-phase conductors and be ¾" minimum size conduit.

Power circuits shall not share neutrals.

Deviation from conduit runs shown on plans shall not be permitted unless written permission from the Owner's Representative is first obtained.

Conduit size shall be ¾" minimum for home runs. ½" is allowed for final runs to light fixtures. MC cable shall be allowed for lengths up to 8' for branch circuits only. Conduit is required from the branch circuit panelboard to each room.

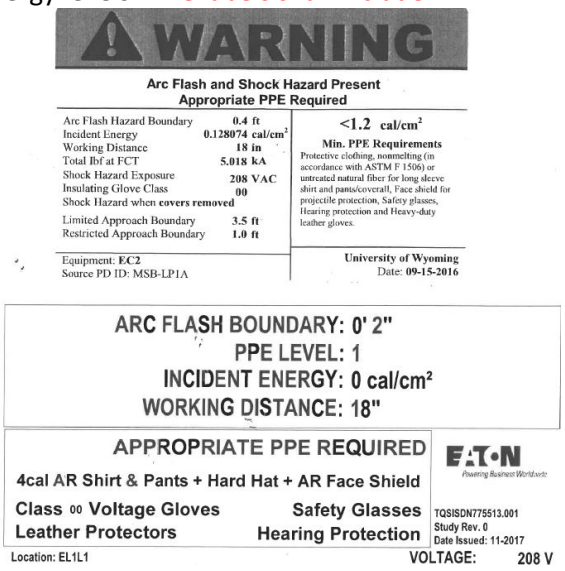
Panels, distribution gear and breakers shall be of one manufacturer, either Square D or ITE/Siemens or Cutler-Hammer equivalent approved by the University. ITE/Siemens panel covers shall open without binding and covers shall not warp when installed. Use of the Fuse based panelboards is prohibited. Main distribution gear (MDG) shall have full sized, continuous bussing. Spaces within the panel shall have mounting fingers installed. Metering can be done at the MDP or the transformer, as detailed in the metering section meters tied to the building DDC system so remote meter reads can be done. If at the transformer, it shall meet the requirements of Rocky Mountain Power and still tie to the building DDC system. Approved manufacturers for MDG gear are Siemens, Square D, Eaton, GE, or Owner-approved substitution.

Any MDP with a main breaker (GFCI or regular) shall be tested by a factory representative after installation.

Breaker trip settings shall be per a fuse coordination study and verification/final adjustment by a factory representative.

MDPs and distribution panels shall be TVSS protected.

All panels shall be labeled to meet the requirements of OSHA 29 CFR 1910.132(d)(1) and NFPA 70E-2018 concerning arc flash protection, Personnel Protective Equipment required and safety work zones. Also referenced is OSH 1910.269 pertaining to the University 13.2 KV electrical distribution system. This includes an arc-flash study (including incident energy analysis), risk assessment and provide site specific labeling on the panels with PPE Category and Incident Energy levels. The labels shall include: Arc flash Hazard Boundary (ft), Incident Energy (cal/cm^3), Working distance (in), Total lbf at FCT (KA), Shock Hazard Exposure (VAC), Insulating Glove Class, Shock Hazard when covers removed in both Limited Approach Boundary and Restricted Approach Boundary (ft), Equipment ID, Source Protective Device ID and Minimum PPE Requirements with Incident Energy level statement (i.e. <1.2 cal/cm^3 for example). Modeling shall be done in E-Tap or approved equal software with all modeling files turned over to Owner. See example at right.



All panelboards, main distribution gear and fused and non-fused switch enclosures shall have hinged doors for service. Fusible branch circuit panel boards shall not be permitted, including emergency power circuits. This includes Bussmann Quik-Speck Coordination Panelboards.

All new panels shall be designed for a 50% fill and have an additional 50% capacity for future loads. This additional capacity shall be figured in throughout the entire building's electrical system. Control wiring conduit shall follow the same fill rules.

All flush-mounted panels shall have at least four (4) spare ¾" conduits stubbed out from the top or bottom of the panel depending on conduit layout.

Exterior enclosures housing contactors, beakers and other control equipment shall be painted galvanized steel, NEMA 4; not 3R.

TRANSFORMERS

A. Exterior pad mount transformers are preferred to interior vaults with pole type units. Locate away from irrigated areas and provide adequate service space. Pad-mounted are preferred. On pad-mounted transformers, provide either concrete vault below that separates the primary from the secondary compartments or install on a concrete pad with PVC coated GRC long radius 4" minimum sized ells into the primary compartment. Color shall be green. Transformer shall have a suitable non-PCB marking on the nameplate and a visible blue and white non-PCB label that certifies the transformer is non-PCB. The label shall be located in either the high or low voltage compartments and shall be readable when the cables are in place.

1. There shall be high voltage warning signs on the exterior of the transformer.
2. Temperature rise shall be 65° C. above a 30° C. average ambient with a maximum ambient temperature of 40° C.
3. Noise levels shall be considered for each installation.
4. Tanks shall withstand a pressure of 7 psi without distortion and shall remain effectively sealed from a top oil temperature range of -5° C. to 105° C.
5. Units with fusing specified shall come complete with fuses plus three (3) spare for each machine.
6. Winding material shall be copper, including all step-down transformers.
7. Oil type shall be FR3.

B. Electrical Construction – 3-Phase Pad-Mounted
   1. The high-voltage and low-voltage compartments shall be separated by a steel barrier.
   2. The high-voltage and low-voltage cable terminating compartments shall have the specified dimensions shown in figure 7 of ANSI C57.12.26.
   3. Hinges and hinge pins shall be type 304-L stainless steel.
   4. Connectors and terminals
      a. The high-voltage connectors are to be externally bolted universal bushing wells. Internal primary leads are to be arranged so the wells may be replaced from the front. The low voltage neutral shall be a fully insulated terminal (bushing).
      b. Provide secondary spade connectors for transformer.
      c. Bushing wells shall be externally clamped.
      d. Units shall have copper windings.
   5. Tank Accessories
      a. Unit shall be equipped with a pressure-vacuum gauge, complete with regulator for pressure relief, complete with a weather cap type indicator, which shall remain attached to the valve and provide positive indication to an observer that the valve has operated.
      b. An oil level indicator shall be provided in the secondary compartment.
      c. A dial type liquid temperature gauge shall be provided in the secondary compartment.
      d. The front sill shall be removable so that the transformer can be lifted, skidded or slid into place on the pad without disturbing the high or low voltage cables.
      e. The area within 4 inches of the center of the primary bushing wells shall be free of obstructions that would interfere with the installation of a feed-through bushing inserts.
      f. A captive and recessed penta-head bolt shall be provided for additional security of the low-voltage compartment door.
      g. An external tap changer switch shall be provided. The switch shall be designed for external, de-energized operation. The operating handle shall give permanent visual indication of the voltage position and have a provision for securing it at the desired position.
      h. An oil testing drain shall be provided for oil sampling in the secondary compartment that will allow oil sampling **with** the transformer energized. Recommend SD Meyers Sample Safe or equal. https://www.sdmyers.com/transformer-services/maintenance/equipment/samplesafe/.
   6. The need for transformer switching or fusing shall be case by case.

C. Tests

The following tests will be done on the transformer, although not necessarily in the order shown. All tests will be made according to the latest revision of ANSI and/or NEMA TR1. Submit certified test ports to the Owner prior to installation of transformer.

1. Resistance measurements of all windings at the rated voltage on tap extremes.
2. Ratio tests at the rated voltage connection and on all taps.
3. Polarity and phase-relation tests on the rate voltage connections.
4. No-load loss at rated voltage on the rated voltage connection.
5. Exciting current at rated voltage on the rated voltage connection.
6. Impedance and load loss at rated current at the voltage connection on tap extremes.
7. Applied potential tests.
8. Induced potential tests.

For exterior pad-mount installations, building ground grid shall terminate at the main distribution gear, with the main bonding jumper installed at this location. Transformer shall be grounded at its location with at least four 10'x ¾" cu ground rods, looped around the transformer with inspection covers where the bonding jumper bonds to the rods. For inside building transformer locations, ground grid shall be at the transformer with the main bonding jumper tied in at the transformer.

D. New Medium Voltage Transformer Efficiencies shall be per DOE 2016 standards summarized below:

kVA	Liquid-Filled	Dry-Type		
		BIL*		
		20 – 45 kV	46 – 95 kV	≥ 96 kV
10	98.70	—	—	—
15	98.82	98.10	97.86	—
25	98.95	98.33	98.12	—
37.5	99.05	98.49	98.30	—
50	99.11	98.60	98.42	—
75	99.19	98.73	98.57	98.53
100	99.25	98.82	98.67	98.63
167	99.33	98.96	98.83	98.80
250	99.39	99.07	98.95	98.91
333	99.43	99.14	99.03	98.99
500	99.49	99.22	99.12	99.09
667	99.52	99.27	99.18	99.15
833	99.55	99.31	99.23	99.20
kVA	Liquid-Filled	Dry-Type		
		BIL*		
		20 – 45 kV	46 – 95 kV	≥ 96 kV
45	98.92	98.10	97.86	—
75	99.03	98.33	98.13	—

112.5	99.11	98.52	98.36	—
150	99.16	98.65	98.51	—
225	99.23	98.82	98.69	98.57
300	99.27	98.93	98.81	98.69
500	99.35	99.09	98.99	98.89
750	99.40	99.21	99.12	99.02
1,000	99.43	99.28	99.20	99.11
1,500	99.48	99.37	99.30	99.21
2,000	99.51	99.43	99.36	99.28
2,500	99.53	99.47	99.41	99.33

E. Interior step-down transformers shall be floor mounted, not hanging.

MOTORS AND VFD

In general, all motors greater than ¾ horsepower and larger shall be 3-phase. Get Owner's approval if otherwise.

In general, all motors less than ¾ horsepower shall be ECM

Fractional motors used for walk in coolers, unit heaters, fan coil units, etc. shall be high efficiency DC types or ECM, provided by the fan or cooler coil manufacturer.

All motors shall be evaluated by the electrical and mechanical engineer based on actual loads encountered and be sized to be the most energy efficient possible. Part of substantial completion shall be power measurements taken after system balance to record KW and power factor for each load. If, after measurements are taken, motor loading is less than 60% of rated load, the motor shall be resized to achieve a minimum 60% loading. Power factor shall be corrected to 90% minimum. Premium efficiency motors shall be used. All efficiency measurements shall be by using IEEE Method B.

Motor Specifications:

A. If the facility has 3 Φ service, all motors ¾ horsepower and above shall be 3 Φ, 60 Hz, squirrel-cage induction type.
B. Motor type: Variable torque, NEMA Design B, normal starting torque, continuous rated duty at 40° C. ambient.
C. The minimum power factor shall be 85%.
D. Duty and Capacity: The temperature rise of the motor insulation shall not be exceeded under continuous operation of the motor at full horse-power output at 7,200' elevation, within voltage variations permitted in NEMA Standard MG-1, nor shall it be exceeded under these conditions if the motor is started up to 4 times per hour. Service factor shall be 1.15 minimum.
E. Bearings shall be ball-type, selected for an L-10 life of 100,000 hours per AFBMA Standard 9.
F. All motors for frequency drive applications shall be inverter duty rated and motors shall have a rotor grounding system (without mercury) and meet the IEEE 841 and be rated for frequency drive use.
G. All AC motors shall be NEMA Premium Efficiency as a minimum efficiency. IEEE Method B shall determine efficiency. Motor name plate shall state efficiency.

H. Acceptable manufacturers: ABB, Danfoss, Reliance, Century, Siemens-Allis, General Electric, Louis Allis, US Electric Motors, Baldor, and Westinghouse. No Toshiba.
I. All motors used for VFD applications shall be VFD-rated and have a shaft grounding system (AEGIS bearing protecting ring or equal).
J. Fans immediately downstream of any evaporative cooling equipment shall be TEAO. In general, any mechanical room motors shall be TEFC or for AHU's fan motors can be TEFO if will cool the motor.

Frequency Drives, if used, shall be ABB ACH-580-PCR which has a built-in circuit breaker disconnect. VFDs shall not have maintenance bypass switches. All drives shall be installed with the manufacturer-specified/ provided input overcurrent protection devices. This may be integrated with the drive enclosure. All VFDs need factory start-up with programming documented to the Owner. Fractional horsepower VFDs shall be evaluated for power quality to the unit and may need a time delay relay setup to prevent nuisance tripping. Drives greater than 5 HP shall be protected with quick-acting fusing as close to the drive as practical. The system shall also be analyzed for harmonic issues and the necessary filtering shall be installed in the system. The maximum drive speed shall be 66 Hz.

All drives shall automatically restart once the fault condition has been corrected. All safety features (fire alarm integration, over pressurization, low or high temp., etc.) shall work in either hand or auto position.

The VFDs shall have the necessary communication module to directly communicate with the building DDC system without any additional integration device via BACnet MSTP. (i.e., install chip for JCI NAE/FEC integration and shall be BACnet MS/TP compatible).

Cooling for VFDs shall be on a case-by-case basis. In general, unit-mounted AC is discouraged. Install drives in proper space conditions and as close as possible to the loads they serve. Elevation of 7,200' needs to be taken in consideration with regards to cooling effectiveness.

VFDs shall be installed such that the drive will be within sight of the motor disconnect. If this is not possible, the disconnect at the motor shall de-energized the drive before opening the circuit conductors by use of a fourth blade on the local disconnect.

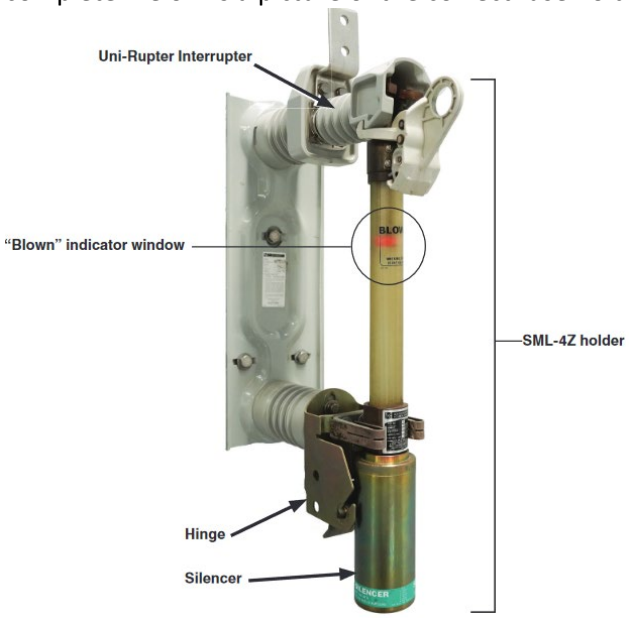
15 KV ELECTRICAL SYSTEMS

Ductbanks shall be concrete encased with a utility warning flagging installed 12" above the ductbank and also 12" below grade. In general, ductbank shall use 4" PVC conduit, installed with plastic chairs with spacing nominally 7.5" center to center. Depth below grade to top of ductbank shall be 30". Centerline distance from the top conduit to the top of the ductbank shall be 6". This same 6" dimension shall be used for the bottom and side conduits (C-L to edge of concrete). Use Schedule 40 PVC conduit with PVC coated GRC large radius for any bends or ells. Ductbank shall penetrate electrical vault walls with rebar reinforcement so shearing of the PVC conduit will not occur.

Furnish and install a minimum of 2, #4 rebar parallel to the conduit for bends, ells, and tie-ins to a vault or manhole. Rebar shall extend 6' beyond any bend, ells, or vault tie-in. Where a ductbank passes into a concrete vault, dowel rebar a minimum of 4" into vault wall.

For new power ductbank installation, provide 30% spare ducts, rounding up to the next whole number. A minimum of 1 spare 4" conduit will be required.

15KV distribution gear and fuses shall be S & C PMH series, with SML 4-Z fuses holders and 80e slow fusing the maximum size. All new loads on the 13.2KV system shall be coordinated with the protection system currently in place. Furnish an extra set of fuses (if applicable) to the Owner when installation is complete. Below is a picture of the correct fuse holder:



Load breaks shall be used on all medium voltage transformer connections as manufactured by Elastimold or Owner-approved substitution.

15KV conductors shall be MV105, EPR copper, 133% neutral, concentric, stranded phase conductor and runs shall include a #2 600V THWN insulated ground to tie the grounding systems together at each switch, transformer, or manhole.

Pad mount transformers shall have a vault below them with access panels in front of the unit. Vaults shall separate the primary voltage compartment from the secondary voltage compartment.

SECTION 26 50 00 - LIGHTING

In General, keep spaces under local switch control

DIMMING
0-10V lighting control conductors shall be installed in all interior spaces from luminaires to point of control. The dimming control wire shall be 14AWG THHN purple and grey and be contained within the raceway throughout the installation. Grey dimming conductors shall be identified by a band of purple tape in 277V installations to differentiate between the grounded conductors (neutral). Rooms designed with no dimming functionality shall be "roughed-in" for the future addition of dimming.

OCCUPANCY
All spaces served by Variable-Air-Volume supply air valves or similar shall contain occupancy sensors with an auxiliary contact and integrate into the building controls. Occupancy control shall be provided in

all common and multi-use spaces. Occupancy controlled spaces include corridors, shared office space, classrooms, conference rooms, and storage areas.

Occupancy controls are discouraged in laboratory space in which the sudden loss of lighting may create safety concerns. Such spaces shall include occupancy sensors for HVAC controls only.

Occupancy sensors within rooms shall be manually controlled “on” and sensor-controlled “off"

LIGHTING CONTROLS
“Advanced Network Lighting Controls” and Lighting Control panels are discouraged from use. It is the university's design intent to promote the long-term maintenance ability and simplicity of lighting controls. Lighting control systems may be used for the following exceptions;

1. In remodeled space in which the existing construction does not permit the easy addition of additional lighting zones or 0-10V dimming
2. In spaces that would traditionally be controlled by a lighting contactor.
3. In large spaces and corridors in which single lighting zones include multiple circuits to be controlled by a single point of control or grouping of occupancy sensors.
4. Atriums in which the addition of daylight harvesting would generate energy savings to offset the additional cost of controls over the lifetime of such controls system.
5. Theatrical and studio spaces.

All lighting designs shall conform to the IECC 2012 requirements and be kept as simple as possible. Typical spaces shall use less than 0.5 w/sf (classrooms, offices, corridors, etc.) to minimize the use of lighting control systems and lighting reduction controls.

The use of LED light sources is required, and all fixtures shall be DesignLights Consortium (DLC®) qualified.

Fixtures in ceiling grids shall be supported to the building structure with two wires for fixtures less than 56 pounds and four wires for fixtures over 56 pounds and as required by IBC Standard 25-2.

Exit signs shall have LED lamps.

Exterior pole lighting:

A. Typical 4” or 5” width square poles, steel or aluminum shall be used. Pole by same manufacturer as luminaire. Typical heights of 15’ and 25’ for pole mount horizontal (PMH), depending on application. Need to verify with design and local codes (if used).
B. Campus standard area and site luminaire is McGraw Edison “Galleon” LED fixture (Cooper Lighting by Eaton) or Owner-approved substitution by other manufacturers. This is a rectangular, fully cut-off, extruded aluminum driver enclosure thermally isolated from Light Squares. Light Squares are IP66-rated.
C. Finish is Bronze.
D. LED systems are required for all exterior applications.
E. 4,000^{o} K. (+/- 275^{o} K) CCT and minimum CRI of 70.
F. Suitable for operation in -40^{o} C. to 40^{o} C. ambient environments.

G. Use Illuminating Engineering Society (IES) recommended lighting levels and distribution classes to suit the project.
H. Wall thickness of lighting poles shall be designed to accommodate banner brackets per City of Laramie wind load requirements.
I. Minimum 5-year warranty by Manufacturer.
J. Poles shall be tied into UW's BAS system.
K. Design shall integrate with irrigation system such that poles and bases are not directly impacted by irrigation spray.

All lamps with a life expectancy over 2,000 hours shall be covered by the Contractor/CMAR's one-year building warranty.

All areas shall be evaluated for occupancy sensor use. It is strongly recommended that classrooms and corridors should have some type of occupancy sensor to shut off the lighting when not in use with the emergency lighting within the corridors staying on. For rooms that have occupancy control, no Automatic Time Switch Control Devices shall be used in accordance with IECC 2012 C405.2.2.1 Exception #2. All room switches shall have a manual on, with a timed off if vacancy is noted by sensor. If dimming is required, dual level switching is preferred. Dimming via dimmable ballasts is not permitted. Wall mounted occupancy sensors shall be mounted in boxes at least 2¼" deep with 2½" preferred. Dimming with LED fixtures is permitted.

Daylight harvesting, if used, shall be done in accordance with IECC 2012 C405.2.2.3.1 Manual Daylighting Controls.

SECTION 27 00 00 - COMMUNICATIONS

The scope of this narrative includes concealed infrastructure (cabling and pathways) for low voltage systems supporting both telephone/voice and data, as well as the design and construction of telecommunications rooms. The specification, purchase and installation of network equipment, outside plant (OSP) trunk/backbone cabling, CATV trunk/backbone, and wireless design will be performed by UW personnel and are outside the scope of this narrative. Fire alarm and security systems will be designed by others and are likewise outside the scope of this narrative.

The telecommunications low voltage systems to be constructed shall be state-of-the-art, and to the greatest extent possible, ubiquitous yet concealed. A common TIA/EIA standards-based Category 6 telecommunications cabling system shall be used as the basic cabling infrastructure for as many of the "low voltage" systems as possible. The use of plenum-rated cabling shall be as required by code and if requested by the University. The final Structured Cabling System design shall be stamped by a Registered Communications Distribution Designer (RCDD).

All new buildings and major renovation projects on the campus will utilize a Cisco VOIP phone network at completion. The RCDD shall be aware of the requirements for Cisco VOIP and Power Over Ethernet for this phone network. In addition, the structured cable system will be required to support security systems such as door card scanners and cameras.

Room Sizing

At least one Telecommunications Room (TR) shall be provided on each floor of the building unless the University determines that the building is small enough to allow for fewer TRs. The TRs on most floors will require less floor space (recommended minimum of 8’ x 10’) than that of the main TR in the building. Two (2) equipment racks will reside within most TRs (one for station cabling, one for backbone cabling and Owner-provided equipment). The main TR (recommended size of 8’ x 15’) will also serve as the Entrance Facility (EF) where outside plant cabling will be terminated by UW. The TRs on the floors shall be stacked and shall not be collocated in or share space with mechanical, electrical, custodial or storage spaces. Doors shall swing out of the room (rather than into the room). The walls of the TRs shall be covered with 8’ tall ¾” plywood backboards. An industry standard telecommunications grounding system shall be installed between the main TR, the building ground, and all other TRs.

Depending on the specific function of the building, the exact TR size will be a decision made by the University Network staff and the RCDD based on total amounts of station runs in the building.

Lighting

Lighting must have uniform intensity of 50 foot candles when measured 3 feet from the finished floor. Indirect lighting is not permitted. Lighting fixtures must be on separate electrical circuits from the electrical outlets feeds for the room. Do not place the light fixture above equipment racks, cabinets, frames or other freestanding equipment to avoid blocking of light.

No Other Systems

No other trade shall be allowed to place equipment, wiring, connections or panels inside a TR without approval of the UW Project Manager. This includes but is not limited to: electrical panels, lighting control, fire alarm, HVAC (environmental control systems), and audio-visual.

Care in MEP Routing

Wet utilities shall not be routed through or over a TR with the exception of fire protection systems.

Room Cooling

All TRs shall be provided with cooling to meet the space needs for the network electronics to be installed in the room. Generally, newer low power network hardware will operate acceptably on room temperature air. The heat generated can be removed by standard room cooling; no special HVAC is needed for most TRs. However, in larger buildings it may be necessary to supply a higher cooling rate for the main TR as the total amount of electronics in that room can be large. A specialized cooling unit may be required if cooling loads cannot be handled via the normal building supply and return air system.

Once an estimate is made of the total number of station runs into a specific TR, the University Network staff will supply a heating load estimate for each room based on the expected amount of network gear required to support the station runs in each TR.

Room Power

Each TR shall be provided with power for the network electronics to be placed in the room. In general, this will consist of two (2) Owner-provided UPS systems and the network switching hardware. The UPS(s) shall be connected to an outlet fed by a separate power circuit and separate breaker connected to the building emergency power system and generator. As with cooling, once an estimate of the

number of station runs for a floor is complete, the University Network staff will supply an estimate for the power loading per TR.

The outlets for the UPS(s), type L5-30 120V, shall be located on the ladder rack above the rack(s) designated for network switching equipment. In general, an outlet for the UPS shall be provided above at least two (2) racks (to be designated) for future expansion of equipment in the room.

Rack Configuration

Racks in TRs shall be designed to make cross-connect cabling within the rack space as easy and clean as possible. In TRs with two racks, one shall be used for station cabling and one will contain building riser cable patch panels at the top, with the remainder of the space reserved for Owner-provided equipment. In the station cable rack, patch panels may extend from the top of the rack to no lower than 2' above the floor level. If the station cabling patch panels will overflow one rack unit, three racks can be used; in this case, the room size shall increase to assure easy access to the racks. Also in this case, the racks shall be laid out with the riser/equipment rack in the center of the three racks so that cross-connect cables to switches can be made as short as possible and to keep the front of the racks as organized as possible. Final layout of the racks shall be made after consultation with the University network staff and may vary from the above depending on the total station cable count in a given TR.

Room Completion

As more and more systems in a modern building require a telecommunications network infrastructure to perform startup and testing, it is now necessary to accomplish network startup far in advance of the building being occupied. The architect and general contractor shall take note that TRs will need to be completed as far in advance of the rest of the building as possible so that the University can install the actual hardware and electronics that power the telecommunications network. All heavy construction work in a TR shall end before the University will install electronics into that space. The room shall be cleaned and have a door installed that can be locked to protect the equipment from dust, dirt and theft. Access to the room shall be limited to University-approved staff and the general contractor's superintendent at that point.

The BAS needs network connectivity to begin start-up of building systems. The contractor shall take TR completion into account when scheduling MEP startup tasks.

The building construction timeline shall provide clear dates for the start/end of telecommunications cable installation, completion of TRs, and the date that building startup will require network support.

Pathways

A cable tray system shall be installed to serve all spaces in the facility. Each floor shall have a cable tray system to provide a pathway for cables to the TRs. The cable tray system preferred by UW is Snake Tray. The stacked TRs shall have four (4) 4-inch sleeves connecting them for voice/data and future cabling. In addition, the main TR/EF shall have two (2) 4-inch conduits coming in from the University tunnel system. EZ-Path devices will provide a code-compliant path through fire-rated walls from corridors into TRs, while EMT conduit sleeves shall be installed through fire-rated walls from corridors into rooms with outlets. The cable pathway serving the outlets within the facility shall consist primarily of 1" (minimum) conduit from the device box to above the ceiling, with J-hooks continuing the pathway from the end of the conduit to the cable tray.

The use of floor boxes shall be avoided.

SECTION 27 10 00 - STRUCTURED CABLING

Overview

The structured cabling system shall be manufactured by an end-to-end manufacturer (i.e., the same manufacturer's warranty shall cover both the cabling and the connectors). The contractor installing the system shall be required to be a manufacturer-backed and -approved installer, able to provide the manufacturer's extended (20-year, 25-year, etc.) application, installation and product assurance warranties. The UW-preferred manufacturer is Commscope (Ex AMP)/ Netconnect.

Backbone Cabling System

Riser cabling between the main and other TRs shall be single-mode-fiber-optic-cable. The exact countsr shall be based on the final TR room count, station cables terminated in a TR, and Owner estimate of future growth for the building.

While the Outside Plant (OSP) backbone cabling (fiber, copper and CATV)) from the new facility to the campus will be installed by UW and is therefore outside the scope of this narrative, the design/ construction of the pathways from the main TR to a UW-designated connection point outside the building shall be included in the project.

Space for equipment to terminate these OSP customer-installed cables shall be allocated in the EF/TR.

Station Cabling System

The station cabling, (“horizontal cabling”) shall consist of a Category 6 system from each outlet to the first floor TR. There shall be no differentiation between voice and data cabling (i.e., a “universal” cabling system shall be designed). All Category 6 cabling shall be terminated on patch panels in an equipment rack in the TR. Station cabling shall utilize the cable tray/ J-hook system described above.

A typical office shall typically be served with two (2) 2-port faceplates located on the walls to the right and left of the door.

Cabling within Lab spaces shall be based on the usage of the lab and the final layout of the lab equipment and should be designed in consultation with the University network team and the users of the final lab space.

In classrooms student access to networking will be based on a University designed WiFI system. The audio/visual system in the room will require network access and the cabling for that should be designed in close coordination with the AV designer.

Outside Cabling System

The outside plant cable system access paths shall be designed part of the building design but all outside plant cable including pulling copper, fiber, coax cable and all termination of al such within the main TR shall be preformed by the University. The consultant should design a pathway, in general 2-4inch

conduits, from the main TR/entrance facility to a point on the existing University network as designated by the University network staff.

Wireless Communication System (WiFi)

The facility wireless communications system will be designed by UW staff once a final floor plate design has been reached during the Design Development stage. UW will provide to the communications designer the required locations for wireless access points (WAPs) throughout the building based on the current wireless technology in use by UW. The designer then shall be responsible for the routing of cable to those locations from the nearest TR.

During the initial building design phase the Architect/Designer should keep in mind that the WiFi system will be mounting Wireless Access Points (WAP) on the ceiling of many of the spaces. If a unique ceiling system, beyond the standard grid/acoustic tile system, is chosen then the Architect should consult with the ceiling system manufacturer about the appropriate way to mount WAPs on that ceiling and keep in mind how such mounting may change the appearance of the ceiling in the same way smoke sensors and sprinkler heads do.

Bi-directional Amplifier
A building may require the installation of a bi-directional amplifier system/ antennas to meet Emergency Responder Radio Coverage code requirements. The design of such a system is outside the scope of this document.

Contractor
The following information shall be included in the construction documents to aid in the selection of the low voltage subcontractor who will install the network cable plant:

“The low voltage contractor shall be a Commscope (AMP) Netconnect ND&I Company. The successful contractor shall have at least one (1) BICSI RCDD on staff who can sign off on the design of the cabling system. The low voltage contractor shall have at least half of the total number of technicians needed for the project certified as Commscope NETCONNECT ACT I Installers. The Lead Technician/Test Tech shall be certified in Commscope (NETCONNECT ACT 2, Certification and Troubleshooting of LAN Cabling Systems, in accordance with the manufacturer's requirements to support the 25-Year Performance and Applications Assurance Warranty required by the Owner. Proof of this training shall be provided as part of the submittals process prior to beginning the work. Additional BICSI-Certified Technicians will be taken into consideration in addition to meeting the other criteria mentioned. Past performance with the Owner will be taken into consideration, as well as proof of five (5) projects similar in size and scope in the CO/WY region using the Commscope (AMP) Netconnect structured cabling system.”

SECTION 27 30 00 - ELEVATOR AND EMERGENCY PHONES

The configuration/specification of the actual phone inside an elevator is not part of this section. The specification and design of the wiring that connect that phone to the campus phone system shall be undertaken by the telecommunications designer along with the elevator design team.

In general, the University mounts a 2-jack box just outside of the elevator equipment control cabinet, with one of the jack connections to the nearest TR via a standard cable run. The other jack is connected

to the elevator phone system inside the control cabinet. In this way telecommunications staff do not have to access the elevator control cabinet in order to troubleshoot the phone.

Emergency (Blue Light) Phones

Locations for Blue Light emergency phones (if used) shall be chosen by University Security staff and may or not be required for any given project.

Installation of Blue Light phones shall be the responsibility of the general contractor and subcontractors. A cable path shall be determined to allow wiring of the phone to the nearest TR of the building. All installation of the phone except for installation of wire shall be the responsibility of the contractor, including any OSP conduit. The University will install cable from the University OSP termination point in the building to the phone through the pre-installed conduit.

SECTION 28 30 00 – ELECTRONIC DETECTION AND ALARM

Fire Alarm Systems shall be as manufactured by EST, with the systems being either an EST 1, 2 or 3. EST types 2 or 3 are preferred. No printer shall be required. Fire Alarm Contractor shall be EST approved to install and service the systems in Laramie, WY.

Fire alarm systems located on the Main Campus shall tie into the central reporting system and shall monitor both trouble and alarm. FA system shall include the raceway and wiring to tie into this system.

Remote annunciators and exterior horn/strobes shall be installed in a location approved by the Fire Marshal. Consideration shall be given to the location of the annunciator and fire alarm panel so that the sound produced by the panel will not unduly antagonize the building occupants. Programming shall be done to prevent the annunciator from going into drill mode by someone not authorized. All action codes shall be uniform and be the same as with other systems on campus.

Horn power shall be kept separate from strobe power.

Each system shall be tested for audibility in every area of coverage to comply with the IFC. Testing shall cover Emergency Responder Radio Coverage requirements per IFC 2012 Section 510.

The minimum voltage on a 24V DC notification appliance circuit shall be 20VDC. #14 twisted copper shall be the minimum size.

Remote power packs shall be kept to a minimum. If required, remote power packs shall be installed close to the fire alarm panel, and their location shall be marked on the ceiling panel.

Fire alarm panels shall be installed in rooms in which the temperature is maintained between 65^{o} F. and 85^{o} F. A single 120V receptacle shall be provided at each panel location.

Fire alarm systems shall have alarm switches to shut down zone horns and dampers for testing located at the fire alarm panel.

The fire alarm system shall be completely tested by the contractor prior to acceptance with Owner/State Fire Marshal and City Fire Marshal present. If the system fails after one test, the Owner and Fire Marshal shall be compensated for time used on subsequent testing until system finally passes.

On renovation or remodel projects, the existing fire alarm system shall be reviewed. The manufacturer of the system shall be identified in the Contract Documents. If the system requires the manufacturer or their authorized representative to modify the system (including programming) to accommodate additional devices, the Contractor shall be made responsible for the required work and coordinating the changes to the system with the manufacture or their authorized representative.

All devices shall be labeled with the corresponding number from the fire alarm riser diagram.

SECTION 31 13 00 – TREE PROTECTION

Plant materials to remain, removed and/or be moved will be tagged by the Contractor for review and approval by the University and Landscape Architect prior to the start of Work.

Existing trees to remain are to be fenced/ protected to the drip line.

Contractor to water existing trees and plants as determined by Landscape Architect to promote healthy, thriving plant material during construction.

Construction activities, including stockpiling, in tree protection areas are prohibited.

Prune branches of trees to be preserved which interfere with construction only at the direction of the Landscape Architect. Approval of proposed pruning is required prior to start of work.

Provide mitigation from moisture and temperature fluctuations where excavation occurs adjacent to existing trees and is exposed for more than 24 hours.

Cutting grades in root areas is prohibited.

SECTION 32 00 00 – EXTERIOR IMPROVEMENTS

The bicycle racks shall be Triton Commercial Bicycle racks or equivalent as approved by the University Project Manager and shall be bronze in color.

Trash and Recycling receptacles shall be Ironsites (Victor Stanley) model SD-42 with rain bonnet lid or equivalent as approved by the University Project Manager and shall be bronze in color.

Recycling receptacles shall have VSI standard S-2 Dome Lid Decal and Band Decal.

Benches and Café Tables shall be Modular SteelSite Series (Victor Stanley) with or without back. Equivalent as approved by the University Project Manager and shall be bronze in color.

SECTION 32 10 00 – BASES, BALLASTS, AND PAVING

Parking lots and areas shall be designed to support the weight of heavy use vehicle parking and the occasional large bus or over the highway truck. Parking areas shall accommodate 9 feet wide by 19 feet deep parking spaces with a minimum 25 feet of traffic lane. ADA parking shall include both vehicle and van-accessible spaces. Constant heavy vehicle turning areas shall utilize concrete pavement to eliminate

the rutting of asphalt pavements. The following guidelines shall be used for the design of parking lots or areas:

	General Traffic and Parking Areas - Thickness (in Inches)		Access Lanes and Heavy Traffic Areas – Thickness (in Inches)		
Asphalt Concrete Surfacing	1.5	1.5	1.5	1.5	
Asphalt Concrete Base (PMP)	1.5	3.0	2.5	5.0	
¾ inch Crushed Aggregate Base Course	4.0		5.0		
Portland Cement Concrete					6.0
Total Pavement Thickness	7.0	4.5	9.0	6.5	6.0

All asphalt parking areas or roadways edges shall be terminated at concrete improvement such as a sidewalk with integral gutter, curb, curb and gutter, valley gutter or equivalent.

Manhole covers and valve stem covers shall have a concrete collar.

SECTION 32 80 00 - IRRIGATION DESIGN

Most of the core campus is well irrigated with groundwater from the Forelle and lower Chugwater formations. Discharge pressure from the pump house is 80 psig. The water is described as suitable, with limitations, for irrigation purposes. The groundwater is highly saline with total dissolved solids concentrations approaching 1,000 parts per million which results in spotting and staining of cars, windows, signs, and walls. Two limitations reported by the U.S. Salinity Laboratory's for this high salinity water are as follows:

A. Considerable excess water should be applied to provide leaching.
B. Irrigation must be more frequent than normal, and soil should be maintained relatively wet. If possible, all facilities shall have an automatic lawn sprinkler system with a landscaping design.
C. Irrigation system shall be manufactured by Hunter, Rain-Bird or Owner-approved substitution with 50% overlap. The controllers shall be a Toro Sentinel. Communication via radio frequency Hz (TBD).
D. Landscape design shall consider low water, low maintenance landscaping wherever possible.
E. Consideration shall be given to mowing strips near buildings.
F. Inclusion of boulders, stone paving, textured/colored concrete paving, retaining walls, seating walls, appropriate lighting and other non-plant materials is permitted. Paving shall be sandstone or flagstone. Boulders shall be granite and not placed on top of utilities. Retaining walls are preferred to be masonry with concrete caps designed to eliminate use by skateboards and in-line skates.
G. Consideration shall be given to the creation of outdoor activity areas such as learning, presenting, relaxing, meeting, and greeting areas.
H. Ponding shall be kept to a minimum, or the ponding shall be controlled.
I. Final grades shall be designed to control water from snow melt/roof drainage to prevent the buildup of ice on pedestrian walkways.

J. Sprinkler heads shall be located such that their spray will not damage light pole bases or building signage. Over-spray onto buildings, walls, windows, etc. shall be minimized. A drip irrigation system should be considered for areas where vehicles or structures will get over-spray.
K. Irrigation controllers shall be Toro sentinel and have the master control option, allowing it to be controlled from a centralized computer. Irrigation controllers shall be in consultation with University Landscape personnel.
L. Branch piping shall be at 18" minimum depth, mains at 24". Mains shall have locating tracing wires.
M. Every part of the system shall be drainable.
N. Main piping shall be PVC Schedule 40, branches can be the same or polyethylene mainline piping rated at 100#. SDR has to be equivalent to Schedule 40 or DR 11.
O. Programming shall be done in conjunction with Owner's representative.
P. The system shall have a two-year warranty.
Q. Areas that cannot be maintained by tractor-operated equipment shall be minimized. Mow strips, parkways, offset walks, and thoroughfares shall be incorporated whenever possible to reduce manual labor in grounds maintenance.
R. The edges of landscaped areas shall terminate at sidewalks, concrete curbs, or metal edging anchored in place.
S. Strong considerations should be given for tractor-operated snow removal operations and space for depositing snow, as well as prevailing winds, drift factors, location of benches, planters, bike racks, etc.
T. Irrigation system components, trees, bushes, planters, and decorative areas shall be located to minimize damage by snow removal and landscaping operations.
U. 6" minimum of topsoil shall be provided in areas receiving landscaping unless over undisturbed topsoil. Existing topsoil (top 4" unless otherwise directed) shall be stripped and hauled to a location on campus unless otherwise directed by the Owner.
V. Irrigation zones shall be rebuilt in existing areas affected by construction. The Contractor shall restore existing system back to original working condition.
W. Landscaping material shall be maintained (watered, mowed, etc.) under contract until the Certificate of Substantial Completion is issued.
X. Drip irrigation systems shall not be used. Bubbler systems shall be used instead.
Y. Light pole bases, transformers, and other electrical and mechanical equipment shall not be sprayed by irrigation systems.
Z. All irrigation piping shall be adequately flushed and cleaned prior to running the system.
    z.1. All sleeves will be stamped in concrete on each side of slab.

SECTION 32 90 00 - PLANTING

Trees shall not be planted over underground utilities.

The following trees and shrubs are found on the University of Wyoming Campus. The landscape architect shall work directly with the Owner's representative for specifics on their usage:

Deciduous Trees		**Coniferous (Evergreen) Trees**	
Sensation Boxelder	*Acer negundo 'Sensation'*	Douglas Fir	*Pseudotsuga menziesii*
Burr Oak	*Quercus macrocarpa*	Norway Spruce	*Picea abies*
Mayday Tree	*Prunus padus commutata*	White Spruce	*Picea glauca*
Amur Chokecherry	*Prunus maackii*	Blue Spruce	*Picea pungens*
Rocky Mountain Maple	*Acer glabrum*	Englemann Spruce	*Picea engelmannii*
Ohio Buckeye	*Aesculus glabra*	Bristlecome Pine	*Pinus aristata*
Hackberry	*Celtis accidentalis*	Pinyon Pine	*Pinus edulus*
Douglas Hawthorn	*Crataegus douglasii*	Lodgepole Pine	*Pinus contorta*
Crabapple	*Malus pumila*	Limber Pine	*Pinus flexilis*
Lanceleaf Cottonwood	*Populus x acuminata*	Austrian Pine	*Pinus nigra*
Narrowleaf Cottonwood	*Populus augustifolia*	Ponderosa Pine	*Pinus ponderosa*
Quaking Aspen	*Populus tremuloides*	Scotch Pine	*Pinus sylvestris*
American Plum	*Prunus americana*		
Gambel Oak	*Quercus gambelii*		
European Mountain Ash	*Sorbus aucuparia*		
Chestnut			
Plains Cottonwood	*Populus sargentii*		

Decidous and Coniferous (evergreen) Shrubs			
Serviceberry	*Amelanchier sp.*	Cistena Plum	*Prunus cistena*
Black Chokeberry	*Aronia melanocarpa*	Green chokecherry	*Prunus virginiana*
Mugo Pine	*Pinus mugo*	Redtwig Dogwood	*Cornus sericea*
Siberian Peashrub	*Caragana arborescens*	Adams Elderberry	*Sambucus canadensis*
Flowering Currant	*Ribes sanguinem*	Mountain Privet	*Foresteria neomexicana*
Peking Cotoneaster	*Cotoneaster acuitifolius*	Nannyberry	*Viburnum lentago*
Mesa Verde Spruce	*Picea pungens*	Common Juniper	*Juniperus communis*
Cotoneaster	*Cotoneaster multiflora*	Broadmoor Juniper	*Juniperus sabina 'Broadmoor'*
American Cranberrybush	*Viburnum trilobum 'Bailey Compact'*	Buffalo Juniper	*Juniperus sabina 'Buffalo'*
Flowering Almond	*Prunus glandulosa 'Rosea Plena'*	Creeping Oregon Grape	*Mahonia repens*
Common Lilac	*Syringa vulgaris*		
Mountain Ninebark	*Physocarpus monogynus*		
Gold Drop Potentilla	*Potentilla fruticosa "Gold Drop'*		
Western Sand Cherry	*Prunus besseyi*		
Nanking Cherry	*Prumus tomentosa*		
Snowball	*Viburnum*		

Bulbs, ground covers, and perennials: Selected to provide color at appropriate times of the year and appropriate to the area.

Sod shall be machine cut, strongly rooted, certified, turf grass sod, not less than 1 year old and free of weeds and undesirable native grasses. Sod shall be mowed uniformly a height of 1½". Provide sod capable of vigorous growth and development when planted. Sod shall be an equal blend of the following bluegrass varieties or equivalent: Merrit, Midnight, A-34, Challenger. Mats of fescues or other low water grasses appropriate to the area may be considered.

The contractor shall submit with bid the grass variety intended for project along with the location of the sod farm to be used.

The contractor shall submit a 15" x 15" sample of sod for approval prior to the installation of the sod. The accepted sample shall be used as a basis for accepting the remaining sod.

Sod pad size shall be uniform and thickness of 5/8", ± ¼", measured at time of cutting and excluding top growth and thatch. Provide the supplier's standard size of uniform length and width with maximum allowable deviation of ± 1/2" in width and ± 5% in length. Broken or torn pads with uneven ends are not acceptable.

Provide sod pads capable of supporting their own weight and retaining size and shape when supplier's standard size pad is suspended vertically from a firm grasp on upper 10% of pad.

Flower boxes or landscaping beds against building with irrigation systems shall be held back from building to avoid water infiltration/ mold issues.

SECTION 33 10 00 - UTILITIES

All site work improvements shall be designed and constructed as required by the Wyoming Public Works Standards and the City of Laramie Public Works Standards (latest editions) as amended by these instructions. Materials specifications shall be in accordance therewith as well.

All existing underground utilities shall be located by issuing a request to Wyoming One Call.

All newly installed utilities are to be accurately recorded in as-built drawings and submitted to Utilities Management for review **within one month of installation**. See the UW Design Guidelines - Documentation - Section 4: Standards for Geographic Information System (GIS) Deliverables, for acceptable data collection methods and formats for deliverables. **For Capital Construction Projects, new utilities placed by the contractor are the responsibility of the contractor for locating until the utilities are turned over to the owner at Substantial Completion.**

All new underground utilities fabricated from non-metallic piping, except for sewers and irrigation branch lines, shall have locate tracing wires. Terminals shall be placed at logical end points, accessible to maintenance personnel, per industry best practices. A product such as Cobra Access Point is preferred for tracer wire access.

In accordance with Section 1417 of the Safe Drinking Water Act, no person may use any pipe, any pipe or plumbing fitting or fixture, any solder, or any flux, in the installation or repair of any public water system or any plumbing in a residential or nonresidential facility providing water for human consumption that is not lead free. “Lead free” means that solders and flux may not contain more than 0.2 percent lead; pipes, pipe fittings, and well pumps may not contain more than 0.25 percent lead; and plumbing fittings and fixtures must meet standards established under section 1417(e).

All underground utilities shall be designed and constructed as required by the Wyoming Public Works Standards and the City of Laramie Public Works Standards latest additions as amended by these instructions. Materials specifications shall be in accordance therewith as well. Systems shall be flushed per Wyoming Public Works Standard Specifications and DEQ requirements.

A. Underground Potable Water Mains and Fittings: Underground potable water main design and installation shall comply with Chapter 12 of the Wyoming Department of Environmental Quality (WDEQ) Water Quality Rules and Regulations, City of Laramie standard details and municipal code, and the Wyoming Public Works Standard Specifications. Additional University of Wyoming requirements for PVC and ductile iron pipe are listed below.
B. Fittings (bends, tees, wyes, crosses, caps, etc.) shall be domestically made, Tyler/Union or Owner-approved substitution, cement-lined, ductile iron (DI) mechanical joint (MJ) fittings with DI gland, rubber gasket, and 304 stainless steel (SS) T-bolts and nuts (AWWA C110 or C-153 / ANSI 21.10). Wrap fittings with polyethylene sheeting. Use anti-seize lubricant when threading nuts into t-bolts, torque nuts per manufacturer’s specifications.
C. Thrust blocks shall be poured in place for all bends, tees, crosses, caps and bear against undisturbed soil as shown in COL Standard Detail No. 31. Restrained MJ fittings with 304 SS T-bolts, anti-seize and nuts may be used in addition to thrust blocks.
D. Fire hydrants: All T-bolts and nuts for MJ fittings shall be SS (COL Standard Detail No. 35).
E. Valves: Restrained MJ fittings with 304 SS T-bolts, anti-seize and nuts are required for all buried valves (COL Standard Detail No. 24).
F. Restrained MJ fittings shall be Megalug EBBA 1100 series, or Owner-approved substitution.
G. Fasteners for tapping sleeves and couplings shall be 304 SS.
H. All materials shall be new and comply with and be labeled as approved by the National Sanitation Foundation (NSF) 14, 61, or NSF-pw. Additional University of Wyoming requirements for High Density Polyethylene (HDPE) pipe are listed below:
    1. Compression type connections are not acceptable.
    2. Pipe joints shall be butt fusion or electro-fusion.
    3. Flange or mechanical joint adapters with 304 SS fasteners shall be used for pipe and fitting transitions.
    4. PE 3408 high density polyethylene meeting ASTM D 3350 shall be used.
    5. All materials shall be new and comply with and be labeled as approved by the National Sanitation Foundation (NSF) 14, 61, or NSF-pw, AWWA C906.
    6. Pipe shall be ductile iron O.D. pipe size complying with AWWA C906.
    7. Dimension ratios shall be DR-9 or DR-11.
I. Underground HDPE Chilled Water Mains and Fittings. Underground chilled water mains shall meet the following requirements.
    1. Compression type connections are not acceptable. All HDPE materials and fittings shall be new.
    2. PE 3408 high density polyethylene meeting ASTM D 3350 shall be used.

3. Pipe joints shall be butt fusion or electro-fusion flange or mechanical joint adapters with ductile iron glands, gaskets, and 304 SS fasteners shall be used for transitions to valves, ductile iron fittings, and different pipe material.
4. Pipe shall be ductile iron O.D./C900 pipe size.
5. Heat-welded joints shall be Iron Pipe Size (IPS) SDR 11 or SDR 13.5 (let the market conditions determine which pipe). Outside diameters shall be ductile iron/C-900 pipe sizes. The 13.5 is thinner wall, but is considered an odd size, so SDR 11 is often cheaper even though it is a thicker wall and higher-pressure rated. The pipe needs to be joined above grade with a heat fusion "butt" weld. In places where joints must be made below grade, a stainless-steel flange connection or electric fusion couplings are required. The use of couplings shall be limited as much as possible. When tapping to a main, main line isolation valves shall be installed along with the isolation valves for the tee. An underground insulated system will also be considered case-by-case.

When water piping leaves a building, (chilled, domestic or irrigation), have two mechanical joints with sleeve couplings installed on pipe within 5’ of the foundation wall.

Piping under buildings shall be watertight.

Direction for opening underground valves shall be:

Domestic Water - Left Hand open
Chilled Water - Left hand open
Fire Protection - Right Hand open
Irrigation – Left Hand Open

See Section 26 00 00 for electrical ductbank details.

SECTION 33 60 00 – HYDRONIC AND STEAM ENERGY UTILITIES

Condensate pumps shall be electric driven or steam powered case by case. Electric driven units will have duplex pumps and cast-iron receivers as a minimum. If steam powered units are used, they shall be Spirax Sarco and shall be of the spring assisted/float mechanism type. Check valves for these systems shall be a stainless steel, spring loaded “Pump Valve” as manufactured by Durabla. All systems shall terminate in a receiver which gives the pump a minimum of 36” fill height. Have vent system run to a flash tank and then to the exterior. These pumps shall have removable jackets, sight glasses with drain valves on the bottom of the tanks (or sight glass) and be duplex if building wide. Vent such that condensation will not be a problem (i.e. freezing on walks, building surfaces, etc.).

Steam Specialties:

A. Traps, Generally, Armstrong, Sarco, Watson-McDaniel with Armstrong preferred
    1. End of Mains - ¾” Armstrong inverted bucket
    2. Convertors and Heat Exchangers - (2) traps in parallel in lieu of one large trap with bucket traps preferred vs a F&T
    3. Flash Tanks – F&T
B. Strainers: Armstrong, Sarco, Watson-McDaniel
C. Air Vents: Spirovent, Spirotop, Armstrong, Sarco, Watson-McDaniel
D. Pressure Reducing Valves: Fisher 92B’s for most building applications.
E. Safety relief valves: Kunkel, Watson-McDaniel

F. Temperature Regulators: Armstrong, Sarco, Watson-McDaniel
G. Other Specialties: Armstrong, Sarco, Watson-McDaniel

Piping systems for condensate shall be schedule 80, black iron or Owner-approved substitution. For the main pumped condensate systems in the tunnel, the preferred material is steel, with condensate rated fiberglass being a second option. Coordinate installation with Owner and manufacturer. This includes expansion loops, expansion joints, anchors and guides. UW presently uses Smith Fiberglass Green Thread piping for these applications. Gravity or condensate returns where steam might flash shall be Schedule 80 steel. All anchor points and changes in direction for fiberglass systems shall use Schedule 80 steel.

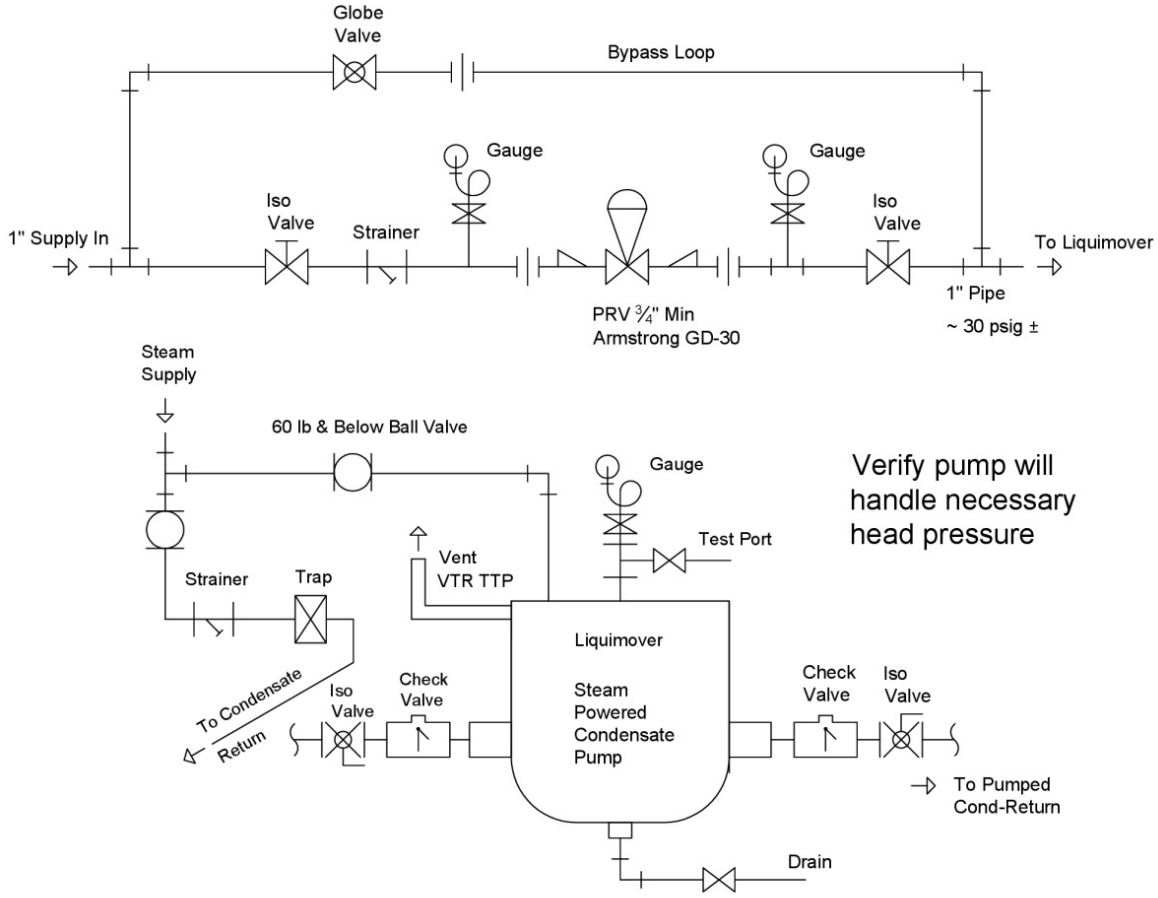
Any piping inside tunnels shall be at least Schedule 40, welded steel minimum, except for condensate lines. Condensate lines shall be Schedule 80 minimum.

Install condensate sample points after any building condensate pump and after any steam to water heat exchanger.

For 60# and below trap lines, install a condensate rated braided stainless-steel hose on the outlet side of the steam trap for differential pipe movement. One source for these is Egglehoff, Inc. These trap lines shall have a removable insulation jacket.

Refer to Section 250000 for steam and condensate system valves specifications.

Below is a typical steam powered condensate pump hood up detail used at UW:



Hot Water:

1. Rated for 150 psig at 200 deg. F.
2. Perma-pipe or Owner approved substitute. All pre-insulated systems with fluid temperature up to 200 F shall utilize polyurethane foam with 2lb/ft2 minimum density pipe insulation, steel carrier piping, with 0125" HDPE jacketing. Internal piping on hot water shall be ASTM A-53, Grade B, ERW Carbon steel. Schedule 40 for sizes through 10 inch, 0.374-inch wall thickness for sizes 12 inches and over (standard). Coated pipe is not acceptable.
3. Pexgol. Installation must minimize connections and utilize experienced spray-foam insulation contractors.