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001111 – FALL PROTECTION REQUIREMENTS

Design Standards

A. General Notes/University Requirements

1. Fall protection drawings shall be submitted to the University for design review. The University’s review is for design concept only. The University review does not relieve the contractor of the sole responsibility to review, check and coordinate the shop drawings prior to submission. The contractor remains solely responsible for errors and omissions associated with the preparations of shop drawings as they pertain to member sizes, details, dimensions, etc.

2. All Federal, State, and Local regulations pertaining to fall protection apply in selecting the equipment.

3. The intended design standards are:
   a. Federal and OSHA Fall Protection Standards
   b. 2012 IFC

4. The University requires that:
   a. All areas where serviceable equipment exists within 15’ of an unprotected side or edge and there is a risk for falling of 6’ or more, including, holes, mechanical pits, skylights, etc, shall be provided with adequate fall protection equipment for workers to protect themselves from falling. All fall protection systems and equipment must meet Federal OSHA Fall Protection Standards 29 CFR 1926.502 and ANSI Z359-2007/2009.
   b. Parapets or sufficient railings at least 42” high should be installed where possible. Where parapets or railings cannot be installed, fall arrest anchors are required. All anchors, horizontal lifelines or other fall systems shall be adequately designed so that a person may safely utilize the system to limit fall exposure when working in the area.
   c. All equipment, photovoltaic panels, etc, shall be set back from the roof edge a minimum of 4’ per the 2012 IFC requirements.
   d. All roof hatches shall be equipped with perimeter railings and a self-closing gate.
   e. All railings, horizontal life lines, anchor points, etc. must be designed to meet or exceed the design requirements as specified by the manufacturer and OSHA 1926.

5. Before turning the systems over to the University, Maintenance personnel shall be trained by a “Competent Person” as defined by OSHA, in the proper use of fall protection installations and equipment to be used with those installations.

6. Contractors shall ensure that various manufacturer’s equipment installed and/or purchased is compatible. Contractors shall provide manufacturer’s certifications that each type of equipment is compatible within the system and that fall arrest systems are design and tested as complete systems.

7. The University has established ongoing relationships with several Fall Protection
Consultants. Please contact the University Project Manager to determine if a Fall Protection Consultant is required for the project.

B. Fall Protection System Design Criteria Guidelines

1. Single Anchor Points
   a. Design live loads used in the design of fall protection systems are as follows:
      i. Fall Protection Anchor Points: A minimum of either 5,000 lbs. or a concentrated force of 2 times the maximum intended load for the application and equipment to be attached.

2. Roof Hatches/Guardrail Design
   a. Guardrail System Design
      i. Guardrails must meet all OSHA 29 CFR 1926.502(b) requirements
      ii. All guardrails should be 42” high measured from the top layer of the roof, typically the roofing membrane.
      iii. Concentrated load of 200 pounds applied at any point along the top rail in any direction. The mid-rail must be capable of withstanding 150 pounds of force in any direction.

3. Self-Retracting Lifeline
   a. Self-retracting lifeline devices must limit dynamic fall forces to 900 pounds or less
   b. Self-retracting lifeline devices shall have an internal inertial braking system which is designed to arrest a fall within a maximum distance of 42”
   c. Self-retracting lifelines must employ stainless steel wire rope.
   e. Only self-retracting lifelines that are designed to do so may be used in the horizontal position.

4. Shock Absorbing Lanyards
   a. Shock absorbing lanyards must limit dynamic fall forces to 900 pounds or less.
   b. Shock absorbing lanyards must be designed to arrest a fall within a maximum distance of 42”.

5. Horizontal Life Line Systems
   a. Shall be designed to allow two (2) users to walk uninterrupted the entire length of the line and provide a secure anchorage to arrest an accidental fall.
b. All essential components required for a complete Fall Protection System shall be included.

c. The system shall be designed to comply with the following fall arrest system requirements:

   i. Maximum load at end supports to be limited to manufacturer’s requirement.

   ii. Maximum load at intermediate supports to be limited to manufacturer’s requirement.

   iii. Minimum cable pre-tension: manufacturer’s requirement.

   iv. Limit maximum arresting force on a user to 900 pounds maximum arrest force.

   v. The system shall be rigged such that the users can neither free fall more than six feet (6’0”) or contact any lower level.

   vi. Ultimate design loads to be 2x working loads noted above per OSHA requirements.

   d. The manufacturer specified shall specialize in the design and fabrication of engineered fall protection systems and have a minimum of five (5) years documented experience.

   e. The Installer Company shall be trained and approved by the product manufacturer.

   f. The Horizontal Life Line system “Evolution” as manufactured by DBI/Sala will be the primary Horizontal Life Line system used by the University.

      i. Other manufactured products meeting this specification may be substituted only with prior written approval from the University.

   g. Stainless Steel should be used where at all possible, including:

   h. Stainless Steel Cable for Horizontal Life Line system

   i. DBI Evolution components

6. Corrosion and weather-resistant signage shall be prominently displayed and provided, clearly stating:

   a. Maximum Service Capacity (Number of allowable users)

   b. Manufacturer’s Name

   c. Installer’s Name and Phone

   d. Serial Numbers and Installation Date

7. Additional weather-resistant signage shall be provided at all points used as “tag line anchors” and should clearly state that those anchors are not capable of supporting a potential fall.

8. Cable Shuttle

   a. Must have a bypass feature for continuous hands-free operation along the entire system. Provide two (2) cable shuttle’s.
9. Harnesses

10. Complete a “Certification for Use” form and include with O&M Manual.
11. Training program is to include all sections on all aspects of the fall protection system, including use, care and maintenance.

C. OSHA

1. OSHA 1926 Subpart M- Fall Protection
   a. Refer to OSHA 1926 Subpart M for comprehensive fall protection requirements.

2. OSHA 1926 Subpart X- Ladders
   a. Refer to OSHA 1926 Subpart X for comprehensive Ladder Requirements.

Material Standards

(Not Listed)
003132 – GEOTECHNICAL DATA

Design Standards

A. During Schematic Design, Architect/Engineer to obtain three (3) proposals from geotechnical engineering firms on behalf of University for subsurface investigation reports and recommendations. The recommendations should include alternative foundation options that may prove to be lower cost to the University. In addition, Architect/Engineer to obtain a separate proposal from same firms to perform special inspections and testing for construction activities involving the foundation and earthwork. This proposal shall include unit costs for additional testing services. The University's intent is to award the geotechnical subsurface exploration/recommendations and special inspections/testing for earthwork and foundation to one firm.

B. After completion of Construction Documents, Architect/Engineer to obtain three (3) Proposals for Special Inspection and Testing. Proposal to include the basis of all costs (estimated number of tests, number of trips, number of hours, and hourly rates for personnel), a schedule of guaranteed unit prices for additional work (if required), and a statement of insurance coverage and the anticipated schedule.

C. Architect/Engineer to submit required Special Inspection and Testing letter to Code Officials.

Material Standards

(Not Listed)
**014516 – FIELD QUALITY CONTROL PROCEDURES**

**Design Standards**

A. Architect/Engineer shall require independent field testing of exterior wall assemblies. The tests applicable to each project shall be determined in consultation with the Owner.

B. Exterior Wall Assembly Hose Test

1. Perform field hose tests for resistance to water leakage. Test areas shall be selected by Architect in consultation with the Owner and should cover approximately 10% of the exterior surface. Each test area shall be three glass openings wide by two floors high, or 400 ft² (37 m²), whichever is greater. Operable doors and windows shall be tested in the same manner as fixed wall areas. There shall be no unacceptable water leakage as defined in this Section. Provide powered scaffold, hose, water supply and manpower to perform at least two successful tests, plus any unsuccessful tests. Water testing shall be conducted early in construction schedule. Construction sequence shall include provisions for timely completion of test areas. Remedial measures shall maintain standards of quality and durability and are subject to approval.

2. Conduct test with Monarch Type B-25 #6.030 brass nozzle and 3/4 inch diameter hose. Water pressure to nozzle shall be in the range 30 to 35 psi. Working upward from bottom of test area, direct water at 5 foot long segments of glazing seals, frame joints and perimeter joints, moving slowly back and forth on each segment for minimum of 5 minutes. Where a framing member is between two glass units and its width does not exceed 4 inches, both lines of glazing seal may be tested as one segment by centering the spray on one glazing seal while moving in one direction, and centering the spray on the other glazing seal while moving in the opposite direction. Sustained spraying at one point while the nozzle remains stationary is acceptable. Tip of nozzle shall be 12 inches from specimen exterior surface. Nozzle shall generally be perpendicular to specimen surface, but shall be tilted to any angle that maximizes exposure of a given joint to water flow rate and kinetic energy. Continuously check for leakage on indoor side. If necessary to pinpoint leak sources, perform additional testing. Repeated testing of joints is acceptable. The use of masking to pinpoint leaks is acceptable.

3. Check completed areas below test area, and report any leaks that occur. A test that results in leakage at a completed area below a designated test area is a failure.

4. Submit, for information only, reports that contain dates of tests, elevation drawings of test areas with locations relative to grid lines (including any lower areas where leaks occur), and location of each leak. (The report requirement may be waived if tests are observed and reported by a member of the design team.)

C. Exterior Wall Internal Gutter Test

1. Test internal gutters on each floor by temporarily plugging weep holes and filling with water. After minimum of fifteen minutes, inspect for water leakage.

2. Correct deficiencies and retest until successful tests are achieved. Remove weep hole plugs.
3. Test each type of internal gutter at minimum of 2 widely separated locations on each floor.
4. For any gutter that fails test, perform test on all similar gutters within 20 feet of failed gutter.
5. For floor with 4 or more failures of a given gutter type, perform test on 100 percent of gutters of that type.
6. Submit, for information only, reports that contain dates of tests, elevation drawings of test areas with locations relative to grid lines, and results.

D. Architect/Engineer shall obtain testing proposals on behalf of the Owner.

E. Owner will pay for initial testing only. All additional testing due to failure of the initial tests shall be reimbursed by the Contractor.

Material Standards

(Not Listed)
018113.01 – SUSTAINABLE DESIGN REQUIREMENTS

Design Standards

A. Washington University has adopted a policy that, as a minimum, all new buildings and renovations will be designed and constructed to incorporate green building guidelines based upon the following:

1. Projects under $2 million
   a. Green Building Guidelines shall be practiced. Design and construction practices and all material selections and their installation shall comply in strict accordance with the U.S. Green Building Council (USGBC).

2. Projects $2-$5 million
   a. Green Building Guidelines shall be practiced and documented. Submission to the USGBC for LEED certification shall be optional, on a per project basis. Design and construction practices and all material selections and their installation shall comply in strict accordance with the U.S. Green Building Council (USGBC).

3. Projects $5 million and above
   a. Green Building Guidelines shall be adhered to, documented and submitted to the USGBC for certification and achieve a minimum level of LEED certified under one of the following rating systems:
      i. LEED NC for new construction.
      ii. LEED CI for commercial interiors
      iii. LEED CS for Core & Shell.
   b. Projects will be reviewed in detail on an individual basis seeking silver to platinum status. The level of potential achievement will be determined for each project during the conceptual or preliminary design phase after completing a Washington University LEED Scorecard (Appendix A). All material selections and their installation shall comply in strict accordance with the U.S. Green Building Council (USGBC).

Contract Document Guidelines

A. In addition to performing basic scope of services, the architectural firm shall have on staff a LEED Accredited Professional (LEED AP) or employ a LEED AP to serve as a principle participant of the project team to serve as the principle facilitator for LEED compliance, directing the team members in achieving the highest possible rating, using the Owner's basis of design and to coordinate and monitor the documentation of the project. The scope of work includes the documentation and submission process to the USGBC from registration through certification. The principle LEED AP team member shall be familiar with the appropriate LEED NC, CI and CS
.rating system and have completed a minimum of two LEED projects.

B. The selected engineering firm(s) must also have a LEED AP on staff or employ a LEED AP to serve as a principle participant of the engineering project team and the engineering interface facilitator. The LEED AP team member shall also be familiar with the appropriate LEED NC, CI and CS rating system and have completed a minimum of two LEED projects.

Execution

A. At the beginning of each project, the architect/engineer/owner shall review the project scope, confirming the type of building, project estimated cost and the appropriate rating system to apply, followed by review and completion of the Washington University LEED Score Card (Appendix A). Implementation shall strictly adhere to Section 01813 – Sustainable Material Requirements.
018113.02 – SUSTAINABLE CONSTRUCTION REQUIREMENTS

Construction Standards

A. Washington University has adopted a policy that, as a minimum, all new buildings and renovations will be designed and constructed to incorporate green building guidelines based upon the following:

1. Projects under $2 million
   a. Green Building Guidelines shall be practiced. Design and construction practices and all material selections and their installation shall comply in strict accordance with the U.S. Green Building Council (USGBC).

2. Projects $2-$5 million
   a. Green Building Guidelines shall be practiced and documented. Submission to the USGBC for LEED certification shall be optional, on a per project basis. Design and construction practices and all material selections and their installation shall comply in strict accordance with the U.S. Green Building Council (USGBC).

3. Projects $5 million and above
   a. Green Building Guidelines shall be adhered to, documented and submitted to the USGBC for certification and achieve a minimum level of LEED certified under one of the following rating systems:
      i. LEED NC for new construction.
      ii. LEED CI for commercial interiors
      iii. LEED CS for Core & Shell.
   b. Projects will be reviewed in detail on an individual basis seeking silver to platinum status. The level of potential achievement will be determined for each project during the conceptual or preliminary design phase after completing a Washington University LEED Scorecard (Appendix A). All material selections and their installation shall comply in strict accordance with the U.S. Green Building Council (USGBC).

Construction Guidelines

A. In addition to performing construction services, the general contractor shall have on staff a LEED Accredited Professional (LEED AP) or employ a LEED AP to serve as a principle participant of the project team to serve as the facilitator for LEED compliance, directing the construction team members in supporting and achieving the highest possible rating, using the Owner's basis of design and project score card to coordinate and monitor the construction documentation process for the project. The scope of work includes the documentation and submission process to the USGBC from selection as the general contractor through project certification. The LEED
AP team member shall be familiar with the appropriate LEED NC, CI and CS rating system and have completed a minimum of two LEED projects. The construction schedule shall list and include time frames for all LEED activities including, third party building commissioning and building flush out procedures. The Washington University score card (Appendix A), identifying project potential LEED credits will be made available to all bidders to assist the contractor and their potential subcontractors in preparing their bid and establish the construction schedule and completion date. Implementation shall strictly adhere to Section 018113 – Sustainable Design Requirements.

Execution

A. Upon "Notice to Proceed" the general contractor shall make available their comprehensive construction schedule that lists all construction activities, including all LEED requirements for commissioning, building flush out, owner occupancy, etc. The project scope and schedule should identify if the building will be occupied in phases or occupied all at one time. Punch list time frames shall be established and adhered to. All punch list items must be completed prior to owner occupancy of an area or the building. No additional time or associated cost will be accepted from the contractor for project extensions that were not initiated by the owner.
018113.03 – SUSTAINABLE MATERIAL GUIDELINES

Design Standards

A. Incorporating sustainable features beyond LEED requirements is also important to the University. To achieve this, the following minimum level of sustainable materials shall be utilized for all construction and maintenance work on campus.

1. Regional materials shall be utilized for all work unless a waiver is obtained from the University.
2. Low-emitting materials shall be utilized for all work unless a waiver is obtained from the University.
3. Recycled materials are encouraged for use to the extent practical and upon approval by the University.
4. Rapidly Renewable materials are encouraged for use to the extent practical and upon approval by the University.

Material Standards

A. Regional Materials

1. Regional Materials: Materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles of the Project site. If only a fraction of a product or material is extracted/harvested/recovered and manufactured locally, then only a percentage (by weight) shall contribute to the regional value.

2. Regionally Manufactured Materials: Materials that are manufactured within a radius of 500 miles from the Project site. Manufacturing refers to the final assembly of components into the building product that is installed at the Project site.

3. Regionally Extracted and Manufactured Materials: Regionally manufactured materials made from raw materials that are extracted, harvested, or recovered within a radius of 500 miles from Project site.

B. Low-emitting Materials.

1. For field applications that are inside the weatherproofing system, use adhesives and sealants that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):

   a. Wood Glues: 30 g/L.
   b. Metal to Metal Adhesives: 30 g/L.
   c. Adhesives for Porous Materials (Except Wood): 50 g/L.
   d. Subfloor Adhesives: 50 g/L.
   e. Plastic Foam Adhesives: 50 g/L.
   f. Carpet Adhesives: 50 g/L.
   g. Carpet Pad Adhesives: 50 g/L.
   h. VCT and Asphalt Tile Adhesives: 50 g/L.
   i. Cove Base Adhesives: 50 g/L.
j. Gypsum Board and Panel Adhesives: 50 g/L.
k. Rubber Floor Adhesives: 60 g/L.
l. Ceramic Tile Adhesives: 65 g/L.
m. Multipurpose Construction Adhesives: 70 g/L.
n. Fiberglass Adhesives: 80 g/L.
o. Contact Adhesives: 80 g/L.
p. Structural Glazing Adhesives: 100 g/L.
q. Wood Flooring Adhesive: 100 g/L.
r. Structural Wood Member Adhesive: 140 g/L.
s. Special Purpose Contact Adhesive (contact adhesive that is used to bond melamine covered board, metal, unsupported vinyl, Teflon, ultra-high molecular weight polyethylene, rubber or wood veneer 1/16 inch or less in thickness to any surface): 250 g/L.
t. Plastic Cement Welding Compounds: 350 g/L.
u. ABS Welding Compounds: 400 g/L.
v. CPVC Welding Compounds: 490 g/L.
w. PVC Welding Compounds: 510 g/L.
x. Adhesive Primer for Plastic: 650 g/L.
y. Sheet Applied Rubber Lining Adhesive: 850 g/L.
z. Aerosol Adhesive, General Purpose Mist Spray: 65 percent by weight.
aa. Aerosol Adhesive, General Purpose Web Spray: 55 percent by weight.
bb. Special Purpose Aerosol Adhesive (All Types): 70 percent by weight.
cc. Other Adhesives: 250 g/L.
dd. Architectural Sealants: 250 g/L.
ee. Non-membrane Roof Sealants: 300 g/L.
ff. Single-Ply Roof Membrane Sealants: 450 g/L.
gg. Other Sealants: 420 g/L.

2. For field applications that are inside the weatherproofing system, use paints and coatings that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24) and the following chemical restrictions:

a. Flat Interior Topcoat Paints: VOC not more than 50 g/L.
b. Nonflat Interior Topcoat Paints: VOC not more than 150 g/L.
c. Anticorrosive and Antitrust Paints Applied to Ferrous Metals: VOC not more than 250 g/L.
d. Clear Wood Finishes, Varnishes and Sanding Sealers: VOC not more than 350 g/L.
e. Clear Wood Finishes, Lacquers: VOC not more than 550 g/L.
f. Floor Coatings: VOC not more than 100 g/L.
g. Shellacs, Clear: VOC not more than 730 g/L.
h. Shellacs, Pigmented: VOC not more than 550 g/L.
i. Stains: VOC not more than 250 g/L.
j. Primers, sealers, and Undercoaters: VOC not more than 200 g/L.
k. Dry-Fog Coatings: VOC not more than 400 g/L.
l. Zinc-Rich Industrial Maintenance Primers: VOC not more than 340 g/L.
m. Pretreatment Wash Primers: VOC not more than 420 g/L.
n. Aromatic Compounds: Paints and coating shall not contain more than 1.0 percent by weight total aromatic compounds (hydrocarbon compounds containing one or more benzene rings).
o. Restricted Components: Paints and coatings shall not contain any of the following:

i. Acrolein
ii. Acrylonitrile
iii. Antimony
iv. Benzene
v. Butyl Benzul phthalate
vi. Cadmium
vii. Di (2-ethylexyyl) phthalate
viii. Di-n-butyl phthalate
ix. Di-n-octyl phthalate
x. 1,2-dichlorobenzene
xi. Diethyl phthalate
xii. Ethylbenzene
xiii. Formaldehyde
xiv. Hexavalent chromium
xv. Isophorone
xvi. Lead
xvii. Mercury
xviii. Methyl ethyl ketone
xix. Methyl isobutyl ketone
xx. Methylene chloride
xxi. Naphthalene
xxii. Toluene (methylbenzene)
xxiii. 1,1,1-trichloroethane
xxiv. Vinyl chloride

3. Do not use composite wood or agrifiber products or adhesives that contain ureaformaldehyde resin.

C. Recycled Content.

1. “Post-consumer” material is defined as waste material generated by households or by commercial, industrial, and institutional facilities in their role as end users of the product, which can no longer be used for its intended purpose.

2. “Pre-consumer” material is defined as material diverted from the waste stream during manufacturing process. Excluded is reutilization of materials such as rework, regrind, or scrap generated in a process and capable of being reclaimed within the same process that generated it.
D. Rapidly Renewable Materials.

1. Materials made from plants that are typically harvested within a 10-year of shorter cycle. Rapidly renewable materials include products made from bamboo, cotton, flax, jute, straw, sunflower seed hulls, vegetable oils, or wool.
024116 – STRUCTURE DEMOLITION

Design Standards

A. Determine with University items that the University will salvage prior to start of building demolition.

B. Determine with University items that Contractor will salvage and deliver to University.

C. Determine with University items that can reasonably be removed and reused in new project.

D. Determine all utility disconnect locations and requirements with University.

E. Request letter from University and applicable utilities to confirm disconnects prior to demolition.

F. Consult with University on abatement schedule and coordinate utility disconnects with abatement work.

G. Determine local governing authorities requirements for servicing, tree protection, dust control, neighbor notification, fencing, and site filling/grading/sod restoration (if new construction not planned).

Material Standards

(Not Listed)
**033000 – CAST IN PLACE CONCRETE**

**Design Standards**

A. Owner preference for elevated floor slabs in non-residential buildings is flat concrete slabs to provide maximum ceiling space, assuming time, costs and performance are equal with other systems.

B. Utilize carton "void" forms if ground-supported concrete rib slab is constructed over expansive soils. Owner's preference is for rib slab if all other factors are equal. Owner preference for curing is either plastic cover or two coats of water-applied curing compound.

C. The Designer should work with the Owner and Construction Manager to locate and design the foundation of tower cranes on projects that require them. The tower crane foundation should be coordinated with the building design to avoid conflict and/or become a portion of the finished structure. The foundation location shall be shown on the design drawings.

D. Where tiered classrooms and other raised floors are to be used, the Designer should design a flat floor structure and use a foam core encased with concrete to provide raised slabs and risers. This has proven to reduce sound transmission and allow for future flexibility.

**Material Standards**

A. A pre-installation conference shall be conducted before each major segment of concrete work.

B. Mock-ups shall be required for projects with significant architectural concrete. Mock-ups shall include color, finish, joints, ties, etc., for each condition.

C. Each type of concrete shall be provided by the same supplier for the duration of the project.

D. Carton forms shall be biodegradable paper surface, treated for moisture-resistance, structurally sufficient to support weight of plastic concrete and other superimposed loads. Provide one of the following:

1. Econ-O-Voids, Deslauriers, Inc., Bellwood, IL; 708-544-4458; or approved equal.

E. Use low VOC approved membrane curing compound that will not affect surfaces to be covered with finish materials applied directly to concrete.

F. Apply curing compound on exposed concrete with power sprayer as follows:

1. Apply curing compound to concrete slabs as soon as final finishing operations are complete (within 2 hours and after surface water sheen has disappeared). Apply uniformly in continuous operation by power spray according to manufacturer's printed instructions.
2. Apply curing compound to formed surfaces immediately after forms are removed.
3. Recoat areas subject to heavy rainfall (e.g., not under protecting overhangs) within three days after initial coating or as indicated in manufacturer's instructions – whichever is earlier.
4. Use approved membrane curing compound that will not affect surfaces to be covered with finish materials applied directly to concrete.

G. The Owner will employ an independent testing agency to perform sampling and testing and to prepare and submit test reports.

1. In addition to the sampling and testing specified below, the Owner's testing agency shall review all proposed design mixes and supporting documentation, including specifications and analyses of proposed components.

H. Sampling and testing for quality control during concrete placement may include the following, as directed by the Architect:

1. **Sampling Fresh Concrete:** ASTM C 172, except modified for slump to comply with ASTM C 94.
   a. **Slump:** ASTM C 143; one test at point of discharge for each day's pour of each type of concrete; additional tests when concrete consistency seems to have changed.
   b. **Air Content:** ASTM C 173, volumetric method for lightweight concrete; one for each day's pour of each type of air-entrained concrete.
   c. **Concrete Temperature:** ASTM C 1064; one test hourly when air temperature is 40 deg F (4 deg C) and below, when 80 deg F (27 deg C) and above, and one test for each set of compressive-strength specimens.
   d. **Compression Test Specimen:** ASTM C 31; one set of four standard cylinders for each compressive-strength test, unless otherwise directed. Mold and store cylinders for laboratory-cured test specimens except when field-cured test specimens are required.
   e. **Compressive-Strength Tests:** ASTM C 39; one set of each day's pour exceeding 5 cu. yd. plus additional sets for each 50 cu. yd. more than the first 25 cu. yd. of each concrete class placed in any one day; one specimen tested at 7 days, two specimens tested at 28 days, and one specimen retained in reserve for later testing if required.

2. When frequency of testing will provide fewer than five strength tests for a given class of concrete, conduct testing from at least five randomly selected batches or from each batch if fewer than five are used.

I. **Additional Tests:** The testing agency will make additional tests of in-place concrete when test results indicate specified concrete strengths and other characteristics have not been attained in the structure, as directed by the Architect. Testing agency may conduct tests to determine adequacy of concrete cored cylinders complying with ASTM C 42, or by other methods as directed.
SECTION 044313 – STONE MASONRY VENEER

Programming and Design Guidelines

A. Alternates/alternatives

1. The Base Bid shall include AMissouri Red granite as produced by the Ironton, Missouri, quarry in a mixture of colors to closely match the granite field of McDonnell Hall.
2. As an Alternate Bid provide the net difference in cost to use a mixture of Cold Spring Granite and GranicorAcajou to closely match the granite field of the Psychology Building on Forsyth. Ensure that the Bid Form provides for this alternate.

B. Limestone

   a. 7.5 percent water absorption by weight;
   b. Minimum 144 pcf density;
   c. Minimum 4,000 psi compressive strength;
   d. Minimum 500 psi modulus of rupture;
   e. Minimum 500 psi flexural strength.

2. Variety: Oolitic limestone;
4. Indiana Oolitic Limestone Grade and Color: ILI Rustic, Buff.
5. Limestone Sources: Subject to compliance with requirements of the Contract Documents, provide Indiana Limestone as quarried in Lawrence, Monroe and Owens counties of Indiana.

C. Coursing

1. The Architect should ensure that the design of the stone veneer works to stone coursing and that the limestone features work to the coursing without lugging or other modifications.

Bidding and Contract Document Guidelines

A. Mock-ups. The following mock-up requirements are appropriate for larger projects. For small projects with limited exterior stonework, reduce the requirements for mock-ups appropriately. All masonry mock-ups shall be constructed within the construction limits of the project and oriented such that the exterior veneer receives direct sunlight.

1. Preliminary Mock-up: Prior to constructing the final stone mock-up, the installing contractor, using proposed granite and mortar shall construct mock-ups of the granite field for final approval of percentages of proposed material colors.
a. The preliminary mock-ups shall be approximately 5 feet wide by approximately 6 feet high and shall be constructed on a cast-in-place concrete footing at a site designated by the Architect.

b. The preliminary mock-ups shall be laid with the specified coursing, mortar joint width and detail and range of sizes.

c. After the mortar has cured and the wall has been cleaned, the preliminary mock-up shall be reviewed by the Architect, Owner, Contractor, masonry contractor, stone fabricator and supplier. If the initial mock-up is not acceptable in every respect, the Architect and Owner shall provide the Contractor with written direction with respect to required adjustments to the percentages of different granite colors, mortar color and joint detailing.

d. Based on the Architect’s directions, the installing contractor shall construct a second preliminary mock-up adjacent to (and the same size as) the first mock-up for the Architect’s and Owner’s review and approval. If necessary, this process will be repeated until the preliminary mock-up is acceptable to the Architect and Owner.

e. For bidding purposes, assume that two (2) preliminary mock-ups will be required.

f. Maintain the preliminary mock-ups until the completion and approval of the final mock-up.

2. Final Mock-up (if appropriate for project scope).

a. After approval of the preliminary mock-up and after approval of samples of limestone, mortar and sealant, the installing contractor shall construct the Final Mock-up at a site designated by the Architect.

i. [The design of the final mock-up should be a representative portion of the building including (e.g.) a typical window, coping, outside corner with quoins, flashing, weeps, relief angle, etc.]

b. The final mock-up shall be constructed with approved mortar colors, sealant colors and the approved ranges of limestone and granite colors.

c. The final mock-up stone veneer shall be constructed with CMU backup, dampproofed, rigid insulation, fasteners, flashing, weeps, sealant and other typical stonework accessories. The mock-up shall be constructed on a cast-in-place, reinforced concrete foundation; the CMU shall be reinforced and braced to resist maximum wind loading from any direction.

d. After curing and cleaning, the Architect and Owner shall review the final mock-up. Unacceptable and nonconforming work shall be identified and replaced. When the final mock-up is approved it shall become the standard for stone masonry work for the Project.

e. Maintain the final mock-up until the completion of the stone masonry or until directed by the Architect to demolish the mock-up.

3. Building Mock-up
a. The design team should consult with the Owner to determine if there is a requirement to construct a building mock-up. The building mock-up is representative of a portion of the building and includes, but is not limited to, structural concrete and masonry back-up with damproofing, insulation, anchors, fasteners, flashing, mortar net, weeps, relief angles, sealants, windows and roof assembly. The mock-up shall undergo an approval process and components that do not meet the requirements of the specified construction requirements or desired color shall be corrected. Once approved, the mock-up shall be used to establish the quality of construction and approved colors for all components of the building exterior.

B. Preinstallation meetings

1. Conduct a reinstallation meeting. Attendants shall include the Contractor, masonry contractor, Architect and Owner.

C. Coursing: Random Ashlar Rubble [to duplicate the coursing of the Psychology building]; refer to Drawings for additional coursing information. No horizontal joint shall exceed 6 ft.-0 inches in length.

D. Drawings should clearly indicate coursing. To match coursing on (e.g.) the Psychology Building on Forsyth, the basic coursing module is 11-1/16 inch (from bottom of stone bed to bottom of stone bed) including the mortar joint. The three heights of cut granite use to create the Random Ashlar Rubble are nominally 10 inches, 6 inches and 3 inches. The actual stone dimensions are 10-1/16 inches, 6-3/8 inches, and 2-11/16 inches (within a tolerance of 1/8 inch).

1. Based on wall area, the approximate mix of stone sizes (nominal thickness) shall be:
   a. 25 percent of area: 3 inch;
   b. 55 percent of area: 6 inch;
   c. 20 percent of area: 10 inch.

2. The stone color percentages should follow this ratio:
   a. Missouri Red stock 80%
   b. Light Missouri Red stock 20%

3. The stone color percentages shall be maintained for all stone sizes utilized on the project.

4. No granite stone laid in the wall should be longer than 22 inches

E. Integral Water Repellent for limestone and granite mortar: Sonneborn Hydrocide Powder, or approved equal.

F. Weep Holes: cotton sash cord of sufficient length to produce a 2 inch projection at the exterior face of the stone and 18 inch projection within the cavity (laid in through-wall flashing and covered by granular material).
Mortar and Grout Mixes

A. Comply with referenced standards and with manufacturer’s instructions relative to mix proportions, mixing equipment, mixing speeds, mixing containers, mixing times and other procedures needed to produce mortars and grouts of uniform quality and with optimum performance characteristics.

1. Do not add admixtures, including air-entraining agents, accelerators, retarders, antifreeze compounds, or calcium chloride unless specifically authorized in advance by the Architect.

2. Mixing: Combine and thoroughly mix approved cementitious materials, water and aggregates in a mechanical batch mixer or silo unless otherwise indicated. Discard mortars and grout when they have reached their initial set.

   a. [For larger projects, require that limestone and granite mortar ingredients be provided to the job site pre-mixed in bags or silos, including all approved components, so that only water needs to be added. Assuming adequate quality control on the part of the supplier, pre-mixed ingredients should provide more consistency than job-mixed mortars.]

Treatment of Limestone Joints

A. The joints at the limestone are to receive mortar except where they will encounter expansion and adverse leakage resulting from weathering. Typically, these joints shall be addressed as follows:

   1. Coping stones – raked and sealant
   2. Water tables – raked and sealant
   3. Profiled stringcourse – raked and sealant
   4. Flat stringcourse, within the plane of the wall – mortar
   5. Window mullions – raked and sealant
   6. Control joints – sealant (one inch plus or minus one-eighth inch wide)
   7. Arches – raked and sealant
   8. All window limestone – raked and sealant
   9. All door surround limestone – raked and sealant
   10. Joint between coping and wall flashing – sealant between coping stone and flashing on both wall faces
   11. Extended projections beyond the face of the wall – rake and sealant
   12. All instances within or recessed behind the plane of the wall – mortar

Hand-dressed Granite

A. Each individual granite stone is to be A hand-pitched (i.e., dressed by hand) around the perimeter to ensure that the exposed edges of the adjacent, exterior head and bed surfaces closely match. Additionally, granite shall be visually examined and placed with the predominately convex surface exposed. The standard for quality with respect to these requirements is a portion of the granite exterior, designated by the Owner, of the Psychology Building on Forsyth, completed in 1996.
B. Grind granite to receive all surface mounted devices, including, but not limited to lights, hose bib boxes, Knox boxes, card readers, etc. Hand pitch the stone around the device mounting surfaces.

Granite/CMU Attachment

A. For attachment of granite to CMU walls, use Dur-O-Wal CRT horizontal joint reinforcement with 1/4" diameter lock bar and 3/16" diameter triangular ties.
B. The lock bar must pass through three courses of CRT horizontal joint reinforcement.
C. Provided there is no deleterious galvanic incompatibility, the CRT and lock bar may be galvanized. All triangular anchors shall be stainless steel. Confirm the compatibility of the materials with manufacturer.

Wall Cavity Drainage System

A. The design of the wall cavity drainage system is to be based on The Mortar Net as manufactured by Mortar Net USA, 1-800-664-6638 and to use Perm-A-Barrier wall flashing as manufactured by Grace Construction Products 1-800-558-7066 or approved equals.
051200 – STRUCTURAL STEEL

Design Standards

A. Owner’s preference for academic and administrative building structures is reinforced, cast-in-place concrete. CMU in-fill is used where concrete shear walls are not required. Structural steel should be limited to those structural elements that cannot be economically constructed of, or are infeasible in, structural concrete (relief angles, dormer framing, etc). Where possible use simply-supported beams and girders. Avoid moment connections and complex connections by keeping connections at right angles whenever possible.

B. Design columns with horizontal base plates and square anchor bolt patterns.

C. Where possible use light gauge metal framing for roof structures. Space sloping members close enough that the sloping steel depth is less than the web depth of the simply supported steel beam. Discuss with the Owner any circumstances that will require the complete roof design to exceed 6.25 pounds per square feet.

D. For interiors, the Owner’s preference is steel-framed stairs with seven inch risers and eleven inch treads.

E. Structural steel penetrations through the roofing are to be designed with round or tube sections to allow the use of prefabricated pipe boots to seal the penetration. Pitch pockets are to be avoided at roof penetrations.

F. Review the design of stone window components and include stainless steel or galvanized steel supports as required to reinforce the stone tracery and at windows.

G. Review the masonry details and include reinforcing for masonry panels. Show all details for miscellaneous iron attachment of stone and masonry to work to the structural frame. Allow for articulation in relief angles by slotting the vertical leg and the use of shims.

Material Standards

A. The Owner will provide an independent testing agency to test steel connections.
062023 – INTERIOR FINISH CARPENTRY

Programming and Design Guidelines

A. Typically, provide wood (or other approved material) chair rails in public and common rooms with moveable furniture.

Bidding and Contract Document Guidelines

A. For stained or clear finished wood, specify plain or quarter-sawn red oak. For painted or concealed hardwood specify other less expensive species.
071326 – SELF-ADHERING SHEET WATERPROOFING

Design Standards

A. Owner preference is rubberized asphalt material with insulation drainage board. Urethane may be considered for damp locations. Obtain Owner’s approval for alternative materials.

B. Provide waterproofing for all subgrade walls with adjacent interior space.

C. Provide bentonite waterproofing for walls and floors at elevator pits and utility pits.

D. Extended three year watertight warranty is required.

Material Standards

A. Comply with low-emitting requirements in Section 01813 – Sustainable Material Guidelines.

B. Rubberized Asphalt Sheet – 60 mil self-adhering sheet consisting of 56 mil rubberized asphalt laminated to 4 mil polyethylene film with release liner on adhesive side.

C. Bentonite – Volclay Voltex bentonite material or equal.

D. Termination Bars – 1/8” thick x 1” wide aluminum bar.

E. Insulating Drainage Board – Extruded polystyrene board with tongue and groove edges and grooved drainage channels, unfaced, minimum 1” thickness.
072100 – THERMAL INSULATION

Design Standards

A. Insulation shall be continuous at all exterior walls. Gaps shall be filled with insulation prior to closing the space.

B. Vapor barriers shall be wrapped at all openings and sealed tight at all penetrations.

C. Insulation exposed to air plenum shall be fire-rated for plenum exposure.

D. Perimeter slab insulation shall be extended 2’-0’’ below finish grade.

Material Standards

(Not Listed)
073215 – SLATE ROOFING

Programming and Design Guidelines

(Not Listed)

Bidding and Contract Document Guidelines

A. Quality Assurance

1. Mock-ups

   a. Prior to commencing installation, construct a 4 foot x 4 foot mock-up. The mock-up shall be constructed on a slope to match the typical building roof slope.
   b. Use specified substrate (e.g., nailable insulation), roofing felt, nails and other required accessories. The mock-up shall exhibit the range of materials and quality of installation proposed for the building roof. The mock-up shall be approved prior to commencement of shingling work.
   c. Construct mock-up at a site designated by the Architect. Protect and maintain the mock-up until its demolition is permitted by the Architect.

B. Slate Manufacturers

1. Subject to compliance with requirements of the Contract Documents, provide specified slate shingles from one of the following manufacturers:
   a. Evergreen Slate Co., Inc., Granville, NY.
   b. Vermont Structural Slate Company, Inc.

2. Slate quarries shall be known to produce slate consistent with slate currently used on the Washington University campus.

C. Materials

1. Slate Shingles: ASTM C 406, Grade S1 slate shingles, machine punched with two nails located for proper head lap. Shingles shall comply with the following:

   a. Type: 20 inch long x random width 10 to 14 inches;
   b. Texture: Rough Texture;
   c. Nominal Thickness: 1/4 inch to 3/8 inch.
   d. Color: Unfading green;

2. Slater’s Nails: 11 gauge hard copper, chisel-point with 3/8 inch diameter head and of sufficient length to penetrate either through or 3/4 inch into sheathing.

3. Snow Guards (not required with parapets): prefabricated, lead-coated bronze, designed for use with slate shingle roofing; complete and pre-drilled with anchoring holes. Subject to compliance with requirements of the Contract Documents, provide one of the
following:

a.  #10-LC Snow Guards, M.J. Mullane Co., 17-19 Mason Street, Hudson, MA 01749.
b.  #4 Snow Guard, Zaleski Snow Guards, Inc.

4. Perimeter Underlayment: polyethylene-sheet-backed rubberized asphalt membrane 40 mils thick, minimum. Provide primer recommended by membrane manufacturer. Subject to compliance with the requirements of the Contract Documents, provide one of the following:

a.  Bituthene Ice & Water Shield, W.R. Grace & Co.;
b.  Polyken 640 Underlayment Membrane, Polyken Technologies;
c.  Polyguard Deck Guard, Polyguard Products, Inc.
075323 – EPDM ROOFING

Programming and Design Guidelines

A. Section includes

1. EPDM membrane roofing;
2. Roof insulation; typically indicate R-30 minimum.
3. Walkway Protection; typically indicate pads for smooth surface roofs and pre-cast concrete for ballasted roof surfaces.

B. Slopes for the purpose of providing roof drainage for membrane roofs should be obtained by the use of tapered roof insulation rather than sloping structural members.

C. Walkway protection shall be provided for foot traffic from roof hatches to all roof-mounted mechanical equipment requiring maintenance.

D. Review with the Owner the relative merits of ballasted and fully-adhered, unballasted membrane roofing systems.

Bidding and Contract Document Guidelines

A. Subject to compliance with design requirements, acceptable manufacturers include:

a. Carlisle
b. Firestone
c. Manville

B. Roof Insulation

a. Typically, specify extruded polystyrene board insulation. Use polyisocyanurate where required to obtain fire-rated assemblies.

C. Field Quality Control

a. Site tests

i. Roof Flood Test: After completion of the roof membrane and related flashing, plug the roof drains and flood the roof with not less than 2 inches of water. Maintain the water level for not less than 48 hours. Repair leaks and other defects in the membrane, flashing and accessories.
076200 – SHEET METAL FLASHING AND TRIM

Programming and Design Guidelines

A. Typically, use copper for exposed sheet metal work (e.g., scuppers, conductor heads, down spouts, flashing, etc.)

B. For concealed flashing (e.g., through wall flashing, use flexible membrane flashing as specified below). In some instances, the flexible membrane must be used in conjunction with metal flashing (e.g., at relief angles). *The metal edge shall be stainless steel with an exposed profile of ¼ inch or less.*

C. *Copper flashing and counter flashing shall be used at step flashing in conjunction with slate roofs and for parapet and other conditions receiving copper gutters and roofs.*

D. *Use flexible membranes in conjunction with membrane roofing systems.*

Bidding and Contract Document Guidelines

A. Materials

1. Copper Sheet for exposed work:
   a. ASTM B 370, cold-rolled except where temper 060 is required for forming;
   b. Typically, for gauges, follow recommendations of CDA and SMACNA.

2. Membrane flashing for concealed work:
   a. APerm-A-Barrier by W. R. Grace & Co., or ADUR-O-BARRIER, or approved equal.
   b. 32 mil thick pliable, highly adhesive rubberized asphalt compound bonded to 8 mil high-density, 4-ply, cross-laminated polyethylene film to produce an overall thickness of 40 mils.
   c. Other manufacturers providing products equivalent to Perm-A-Barrier should also be specified.
078100 – APPLIED FIREPROOFING

Design Standards

A. Utilize cementitious, hardcoat type fireproofing where exposed in service and utility rooms.

B. Topcoat shall be utilized if required to achieve durability.

C. Owner preference is to avoid fireproofing on small steel shapes such as metal joists.

Material Standards

(Not Listed)
The following maintenance items are the responsibility of University employees and contractors who are working in contact with membrane roof surfaces. Joe Kastner (935-4248) is the Hilltop Campus Facilities contact for all roofing issues.

<table>
<thead>
<tr>
<th>MAINTENANCE ITEMS</th>
<th>ACTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drainage</td>
<td>Keep roof surfaces clean at drains and scuppers to prevent clogging. Check to see that all ponding water has drained from roof 48 hours after a rain.</td>
</tr>
<tr>
<td>Petroleum Products</td>
<td>Keep all petroleum products (e.g., solvents, grease, oils, and liquids containing petroleum products) off the membrane to prevent damage.</td>
</tr>
<tr>
<td>Animal Fats</td>
<td>Do not exhaust kitchen wastes (including fumes from vegetable oils) and animal fats onto the roof surface. Depending on the type and concentration, these fumes could degrade the roof membrane.</td>
</tr>
<tr>
<td>Chemicals</td>
<td>Contact roofing contractor if any chemicals come into contact with the roofing membrane. Depending on the type and concentration, some chemicals could degrade the membrane. A chemical or oil spill may be indicated by a puckered membrane.</td>
</tr>
<tr>
<td>Foot Traffic</td>
<td>Keep foot traffic to a minimum. Walkways must be provided if frequent traffic is required or if rooftop equipment has a regular (e.g. 30 day or less) maintenance schedule.</td>
</tr>
<tr>
<td></td>
<td>CAUTION: Slippery when wet. The placement of walkways to and from all areas needing maintenance is recommended. Exercise caution when not walking on walkways. Particular caution should be exercised when walking on white membranes since ice or frost buildup may not be as apparent as on black membranes.</td>
</tr>
<tr>
<td>Roof Alternations</td>
<td>Please refer to Joe Kastner, or, if he is not available, to the zone supervisor.</td>
</tr>
<tr>
<td>Cleaning</td>
<td>Hand prints, footprints, general traffic soil, industrial pollutants, and environmental debris may be cleaned from the membrane surface by scrubbing with a mild dilute detergent. After cleaning, rinse thoroughly with clear water.</td>
</tr>
<tr>
<td>Metal Work</td>
<td>Ensure that metal (e.g., flashing and counter flashing, scuppers, vents, etc.) interfacing with roof membrane is sealed watertight.</td>
</tr>
</tbody>
</table>
| Leaks | Locate the leak and determine if it is a roof membrane leak or a wall, curb, skylight, mental ductwork, or plumbing leak. Deterioration or failure of building components that cause leaks are not covered by roof membrane warranties. A water leak may indicate soft or warped insulation.  

Physical damage to roof membrane is not covered by the membrane warranty.  

Notify roofing membrane contractor through Joe Kastner (or the zone supervisor if Mr. Kastner is not available) if the leak is determined to be membrane related and covered by the warranty.  

The investigation and repair cost must be paid by the building owner if the damage is found to be outside the scope of the membrane warranty. |
<table>
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<tbody>
<tr>
<td>Temporary Repairs</td>
<td>Use sealant and patch material recommended by the roofing manufacturer for temporary repairs to membrane. Notify Joe Kaster in writing of all temporary repairs.</td>
</tr>
<tr>
<td>Hypalon and Acrylic Coatings</td>
<td>Coatings are maintenance items and may be excluded from the roofing warranty. Re-coat when necessary.</td>
</tr>
<tr>
<td>Roof Cement</td>
<td>Do NOT use roof cement to repair or install flexible membrane roofing or flashing. Roof cement contains petroleum products that may degrade the membrane.</td>
</tr>
<tr>
<td>Rooftop Maintenance</td>
<td>When necessary for workers to service roof-mounted equipment and devices (HVAC, antenna, etc.) walkways should be used. Care must be take to protect the membrane from tools, fasteners, and equipment. Objects with sharp edges or objects that may puncture membrane should not be placed on the membrane surface. Protect the membrane from welding or soldering spatter and all hot objects. Use temporary protection (e.g., plywood, hardboard, etc.).</td>
</tr>
<tr>
<td>Construction Activities</td>
<td>Avoid allowing construction debris to fall onto or accumulate on roof membrane surfaces. Promptly remove all fasteners, wire, sheet metal, masonry, mortar, and other materials and debris that are not components of the membrane roofing system.</td>
</tr>
</tbody>
</table>
The above care and maintenance requirements are for membrane roofing systems. Roofing contractors and membrane manufacturers recommend that the roofing surfaces be inspected at least twice each year. The inspection should include high-risk areas including roof hatches, drains, roof-mounted equipment and the entire roof membrane system—including membrane flashing. The inspector should look for membrane damage (e.g., cuts, tears, deterioration, etc.), evidence of oil or freon leaks, chemical spills, and water infiltration.

Compliance with the above guidelines will aid in ensuring a durable, watertight membrane roofing system.
**142400 – HYDRAULIC ELEVATORS**

**Design Standards**

A. Hydraulic elevators shall typically be used unless performance requires use of a higher speed type.

B. Contract Documents must clearly indicate size, capacity, type of door openings, cab interior, finishes, etc. Elevators shall comply with building code, ADA and ANSI requirements along with project seismic loads.

C. The Architect should ensure that, in addition to the required elevator pit, the bottom of the pit shall include a cast-in-place sump. The design should include an electric sump pump and provisions for discharging effluent from the sump or, if a pump is not warranted, provisions (e.g., conduit, sleeves and electrical rough-ins) to provide for the installation of a future sump pump. The pit must have a GFI duplex outlet and a light fixture. The light fixture should be inexpensive, wall-mounted, fluorescent and switched adjacent to the pit ladder.

D. The elevator machine room(s) must be of adequate size and, typically, isolated from surrounding areas with rated assemblies. Where the elevator machine and control equipment are not located at the top of the hoistway, only machinery and equipment required for the operation of the elevator shall be permitted in the elevator machine room. Adequate cooling and ventilation must be provided. The temperature of the machine room must be maintained between 65 and 100 degrees F (18 to 38 degrees C.)

E. The preferred location for elevator machine rooms is the ground floor as close to the elevator shaft as possible. Adequate space must be provided for required clearances between (e.g.) disconnects, panels and adjacent equipment. Refer to ANSI A17.1. Piping should be run above ground. In addition to the required electrical service for the equipment the machine room must have a GFI outlet.

F. If the elevator machine room is adjacent to a public lobby, classrooms, offices or other areas where equipment noise should be limited, provide acoustical treatment for walls, floors (if machine room is above ground level) and doors. Mount rotating and vibrating elevator equipment (e.g., pumps) on vibration-absorption mounts designed to prevent structure-borne vibration.

G. The preferred shaft construction is gypsum board partitions.

H. The plunger-cylinder assembly is required, the casing shall be placed in a capped PVC liner.

I. Verify that the design provides adequate overhead clearance (refuge space) between top of elevator cab and structure above when elevator is at top floor. If a hoistway beam is provided the clear distance must be to the bottom of the beam.

J. Typically, guide rail brackets are attached to the structure below each floor level. When the floor-to-floor elevations exceed certain dimensions, supplemental framing (typical steel) is required to
provide support for intermediate guide rail brackets. If necessary, ensure that this framing is included in the Contract Documents. Typically, this supplemental framing would not be provided by the elevator contractor; however, its location should be coordinated with work specified in this Section.

K. The Architect and his consulting engineers shall verify with the Fire Marshall and the authority having jurisdiction, the current requirements for heat and smoke detectors, sprinklers and shunt-trip breakers.

L. If the elevator serves more than three (3) stories, ANSI A17.1 requires that the shaft be ventilated, prior to construction of the elevator pit.

M. Coordinate the location of the elevator pit ladder with the elevator equipment. The elevator contractor should review and approve the design and location of the ladder prior to construction of the pit.

N. Typical Speed shall be 100 to 150 fpm. The required speed should be specified.

O. Coordinate need for key switches and card access with Owner. Keys shall be similar to keys for other campus elevators as directed by Owner.

P. It is important that the elevator submittal process occur as soon as possible so that sleeves, inserts, pit and shaft dimensions, etc., can be reviewed in a timely manner by the Architect and Contractor. If necessary, consider a two-part submittal process where the basic components including the plunger-cylinder assembly, shaft guide rails and supports, machine room equipment and other work that may affect concrete work (e.g., sleeves, embedded work, etc.) is submitted first. The balance of the submittals that will not affect the work of other trades can be submitted at a later date (e.g. cab interiors, etc.).

Q. Require complete shop drawings and bills of materials for all components and assemblies. Require large-scale, detailed elevations of each wall of the cab interior, reflected ceiling plan (showing provisions for accessing inspection and escape hatch), and hoistway entry and hoistway plan. Require a large-scale detailed plan of the elevator machine room showing locations of all equipment required sleeves, etc. Require a large-scale detail of the proposed method of sealing the joint between the hydraulic plunger-jack assembly [and casing if specified] and the concrete elevator pit floor.

R. Require complete wiring diagrams detailing circuits for power, signal and control systems. Diagrams should clearly indicate elevator manufacturer-installed wiring, field-installed wiring and wiring not included in this Section, including points of connection to work provided by others.

S. Require complete operation and maintenance manuals.

T. Require manufacturer’s standard warranty for materials and workmanship. In addition to the manufacturer’s standard warranty for materials and workmanship, require the General Contractor and elevator manufacturer (and installer if not the manufacturer) to jointly provide a written “special warranty” including the replacement or repair of defective materials, workmanship and systems during the special warranty period. The special warranty period shall
be for a period of twelve (12) months commencing at the date of substantial completion. The special warranty shall include defects, failure, sub-standard performance, excessive vibration and noise, excessive deterioration and aging of materials and finishes, unsafe conditions, leaks, requirements for excessive maintenance and other similar, abnormal and unsatisfactory conditions.

U. Require elevator manufacturer to provide a one-year service and maintenance agreement commencing at the date of substantial completion. The agreement should include normal and regularly-scheduled and as-needed service and maintenance. The maintenance service shall provide 24-hours-per-day, 7-days-per-week, emergency service. Maintenance service required due to the abuse, misuse, neglect or other similar occurrences beyond normal use, wear and tear will be paid for by the Owner.

V. Require the elevator contractor to visit the site at appropriate times to physically measure existing conditions that may affect his work.

W. Require that elevators and related systems be thoroughly tested and found to be in compliance with applicable codes and ordinances prior to Fire Marshall’s inspection and test. The testing shall include all life safety features including alarms, intercommunications, auto-recall, etc. Require that each elevator be loaded to its rated capacity and then run continuously for not less than thirty (30) minutes. After full-load testing, require examination of the elevator machinery and components; a record shall be made of all failures and defects, which shall be promptly corrected.

X. Require the elevator contractor to adjust elevator components, machinery and systems to reduce vibration and noise to an absolute minimum. Adjust travel of cab to limit the difference between the finish floor of the cab and the threshold at each to stop to not more than 1/4 inch in either vertical direction.

Y. Require elevator manufacturer to provide the Owner with an orientation and demonstration to include a) proper use and operation; b) emergency procedures; c) access to components; d) Owner-required maintenance not provided by maintenance agreement; e) diagnostic functions; f) points of interconnection for required communication systems; g) all life safety features, etc.

Material Standards

A. Subject to compliance with the requirements of the Contract Documents, furnish and install hydraulic elevators manufactured by one of the following manufacturer’s:

1. Dover - ThyssenKrupp
2. Kone
3. Long
4. Otis

B. Hydraulic elevators shall have microcomputer-based control system and simplex, selective-collective operation. The microprocessor should provide for on-board, self-diagnostics and the control unit should be of modular design.
C. Control system shall be ‘Universal’ to allow interchangeability with several manufacturers. Acceptable controller is available from Motion Control Engineering, 11380 White Rock Road, Ranch Cordova, CA 95742, 800-444-7442 (www.mceinc.com). The controller must be designed for and have provisions to communicate with the Washington University central, computer-based elevator monitoring system over campus telephone communication lines. Provide to the campus communications services the required number of pairs of conductors to link the building fire alarm and detection system to the Simplex 2120 CPU at the Campus Police Station. Telecommunication conductors are to be run in the traveling cable furnished and installed by the elevator contractor. The elevators must have fire fighters’ service operation, provisions for independent service and automatic return to a level designated by the Fire Marshall.

D. The design shall provide for a vandal resistant, hands free emergency two-way communication system in the elevator cab to communicate with Washington University Campus Police when the system is activated. The system, when activated, will play a pre-recorded message, notify Campus Police, and have a visual indicator for the hearing impaired.

E. The design shall provide for an emergency alarm bell properly located within building and audible outside hoistways, equipped to sound automatically in response to emergency stops and in response to “Alarm” button at each car control station.

F. For elevators capable of being used as service elevators, the design of the cab shall provide for heavy-duty, stainless steel, grooved hanging pins to secure hanging protection pads. The elevator manufacturer shall provide a complete, custom set of protection pads with grommets matching the hanging pins.

G. The preferred source of illumination for the cab interior is multiple, compact fluorescent fixtures spaced to provide a minimum level of illumination. The design of the cab canopy must provide provisions for passengers and others to access the code-mandated inspection/escape hatch.

H. Typically, elevator hoistway doors are 1-1/2 hour UL rated; cab doors are typically not rated. Elevator doors shall be provided with Janus Panaforty (or equal) proximity door edge protection to prevent damage during loading and unloading. Doors shall be provided with nudging feature to prevent closing for a predetermined, adjustable period of time; include an audible buzzer to be activated when doors begin to close at a reduced rate of speed.

I. The preferred finish for cab wall panels is embossed, satin finish, stainless steel. This finish is relatively scuff and vandal resistant.

J. Car Enclosures:
   1. Subfloor: Underlayment grade, exterior plywood, 5/8-inch (16-mm) nominal thickness supported at 16" o.c., minimum. Subfloor to contain no urea formaldehyde.
   2. Floor Finish: Specified in a Division 09 section.
   4. Fabricate car with recesses and cutouts for signal equipment.
   5. Fabricate car door frame integrally with front wall of car.
6. **Front Panel:** Front return panel shall incorporate an integral entrance column, shall be brushed stainless steel (#4 finish), and shall extend from finished floor to underside of fascia. The strike jamb shall also be stainless steel (#4 finish). The front return panel shall be arranged for mounting the car control station panels. A full width fascia of brushed stainless steel (#4 finish) shall be furnished over the return panel and car entrance.

7. **Stainless-Steel Doors:** Flush hollow-metal construction; fabricated by laminating stainless steel sheet to exposed faces and edges of enameled cold-rolled steel doors using adhesives that fully bonds metal to metal without telegraphing or oil-canning.

8. **Sills:** Extruded metal, with grooved surface, 1/4 inch (6.4 mm) thick.

9. **Metallic-Finish Plastic-Laminate Ceiling:** Flush stainless-steel panels, with a minimum of eight (8) recessed, round down light fixtures. Provide 1/8” etched lines painted black. Panels to contain no urea formaldehyde.

10. **Luminous Ceiling:** Fluorescent light fixture and ceiling panels of translucent acrylic or other permanent rigid plastic.

11. **Handrails:** Manufacturer’s standard, stainless steel handrails, of shape, metal, and finish indicated.

K. **Hoistway Entrances:**

1. **Stainless-Steel Frames:** Formed from stainless-steel sheet.

2. **Enameled-Steel Frames:** Formed from cold-rolled or hot-rolled steel sheet. Provide with factory-applied enamel finish; colors as selected by Architect from manufacturer’s full range.

3. **Stainless-Steel Doors:** Flush, hollow-metal construction; fabricated from stainless-steel or by laminating stainless-steel sheet to exposed faces and edges of enameled cold-rolled steel doors using adhesive that fully bonds metal to metal without telegraphing or oil canning.

4. **Enameled-Steel Doors:** Flush hollow-metal construction; fabricated from cold-rolled steel sheet. Provide with factory-applied enamel finish; custom colors to match Architect’s sample.

5. **Sills:** Extruded metal, with grooved surface, 1/4 inch (6.4 mm) thick.

6. **Nonshrink, Nonmetallic Grout:** Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107.

L. **Car Control Stations:** Provide manufacturer’s standard recessed car control stations. Mount in return panel adjacent to car door, unless otherwise indicated.

M. **Swing-Return Car Control Stations:** Provide car control stations mounted on rear of hinged return panel adjacent to car door and with buttons, switches, controls, and indicator lights projecting through return panel but substantially flush with face of return panel.

1. Mark buttons and switches with standard identification for required use or function that complies with ASME A17.1. Use both tactile symbols and Braille.

2. Provide “No Smoking” sign matching car control station, either integral with car control station or mounted adjacent to it, with text and graphics as required by authorities having jurisdiction.

N. **Emergency Communication System:** Provide system that complies with ASME A17.1 and the U.S.
Architectural & Transportation Barriers Compliance Board’s “Americans with Disabilities Act (ADA), Accessibility Guidelines for Buildings and Facilities (ADAAG).” On activation, system dials preprogrammed number of monitoring station and identifies elevator location to monitoring station. System provides two-way voice communication without using a handset and provides visible signals that indicate when system has been activated and when monitoring station has responded. System is contained in flush-mounted cabinet, with identification, instructions for use, and battery backup power supply.

O. **Firefighters' Two-Way Telephone Communication Service:** Provide flush-mounted cabinet telephone jack in each car and required conductors in traveling cable for firefighters' two-way telephone communication service specified in Division 28 Section “Fire Detection and Alarm.”

P. **Car Position Indicator:** Provide illuminated, digital-type car position indicator, located above car door or above car control station. Also provide audible signal to indicate to passengers that car is either stopping at or passing each of the floors served. Include travel direction arrows if not provided in car control station.

Q. **Push-Button Stations:** Provide one hall push-button station at each landing. Provide units with faceplate for mounting with body of unit recessed in wall.

R. **Hall Lanterns:** Units with illuminated arrows; but provide single arrow at terminal landings.

S. **Hall Annunciator:** With each hall lantern, provide audible signals indicating car arrival and direction of travel. Signals sound once for up and twice for down.

T. **Hall Position Indicators:** Provide illuminated, digital-display-type position indicators located above each hoistway entrance at ground floor. Provide units with flat faceplate for mounting and with body of unit recessed in wall.

U. **Corridor Call Station Pictograph Signs:** Provide signs matching hall push-button stations with text and graphics as required by authorities having jurisdiction, indicating that in case of fire elevators are out of service and exits should be used instead. Provide one sign at each hall push-button station, unless otherwise indicated.

V. **Emergency Medical Services Symbol:** Provide international symbol of emergency medical services (star of life.) The symbol shall be at least 3 inches high and shall be placed on both sides of hoistway door frame.
311000 – SITE CLEARING

Design Standards

A. Confirm location of existing work, including grass, plants, trees, shrubs, site appurtenances, and underground utilities and structures that may be affected by proposed new work. Consult with the University's Facilities Department on the location of existing on-campus utilities.

B. The University's preference is to remove existing utilities that are affected by new work rather than abandon in place. Consult with University on utility disconnection points.

C. Horizontal and vertical locations of altered utilities to be documented on Record Documents. Include description of alterations, contractor performing work and date performed.

D. Review existing site work to be salvaged and/or protected. Review disposition of salvaged materials and proposed methods of protection.

E. Review provisions for protecting improvements not intended to be altered.

F. Review the general scope of required site clearing and the specific removal of existing trees and shrubbery. Review with University any proposed tree relocation. Trees may be relocated by University prior to the start of construction.

G. Tree protection fences to be provided for trees to remain. Verify tree protection fence requirements with the Owner. Do not store material in drip line. If new work is required within drip line of trees, the University will cut tree roots.

H. Review vehicular traffic and pedestrian control considerations with Owner.

I. Review proposed schedule. If possible, schedule work during climatic conditions that provide maximum protection to existing property and work not intended to be altered.

J. Indicate provisions for dust and erosion control on civil plans. Minimize particulate emissions through the following measures:

1. Wetting of construction areas.
2. Planting of vegetative ground cover.
3. Maintaining clean construction sites, including prompt removal of dust, trash and debris.
4. Paving or frequent cleaning of roads, driveways, etc.
5. Minimize the size of excavations and the volume of particulate matter than can be disrupted.

K. Prepare and submit Storm Water Pollution Prevention Plan (SWPPP) required by local code authorities.
Material Standards

(Not Listed)
312000 – EARTH MOVING

Design Standards

A. The Geotechnical Consultant shall be retained per Section 02010, Subsurface Investigation.

B. High plastic (HC) soils are common on campus. High plastic soils shall be remediated or replaced with satisfactory fill if located within 3-feet beneath the floor sub-grade and/or within 3’ beneath footing bearing for site walls. All removal, replacement and treatment shall be done under the direction of the Geotechnical Consultant.

1. Removal work shall extend 5-feet beyond the building line, including docks, area wells, retaining walls, and site walls, or as otherwise directed by Geotechnical Consultant.
2. Structural ribbed slab with void forms should be considered as an alternative solution.
3. Documents should include a requirement for unit costs for removal/replacement, and remedial treatment.

C. Prior to earthwork starting, a number of steps must be completed to protect site features and utilities.

1. Notify utility locator to identify and mark all underground utilities.
2. Protect items to be saved with fencing or other substantial barriers.
3. Install all needed temporary and sedimentation controls.
4. Trees and other plants should have roots protected. Hand excavate in the vicinity of plant soil/root areas. Do not cut roots; if roots are exposed in the excavation area, notify Owner who will have roots cut and treated.
5. Prevent surface water and groundwater from entering excavations, from ponding on preparing subgrades and from flooding project site and surrounding area. Protect subgrades from softening, undermining, washout, and damage from water accumulation. This is extremely critical in the vicinity of highly plastic soils.
6. Protect subgrades from freezing temperatures, frost, rain, accumulated water, or construction activities. If damaged, reconstruct as directed by Architect and Geotechnical Consultant, without additional compensation.

D. Owner will engage an agency to perform testing of subgrades and fills.

1. Preference is to retain same firm that provided preconstruction site investigations and design recommendations.
2. If initial fill tests fail to meet requirements, the cost for subsequent retests until compliance is achieved shall be the responsibility of the Contractor.

Material Standards

A. For purposes of determining rock quantities encountered during earthwork, rock is defined as follows:

1. General Site Rock: Any subsurface material (except abandoned concrete foundations
and pavements) encountered during mass site excavation and grading operations which cannot be excavated by a crawler type tractor capable of producing 50,000 lb. of draw bar pull with a single shank ripper attachment and loaded out by a 3-1/4 cubic yard capacity front end loader.

2. Pit and/or Footing Rock: Any subsurface material (except abandoned concrete foundations and pavements) encountered during pit and/or footing excavation operations that cannot be excavated and loaded out by a 2-cubic yard capacity hydraulic backhoe.

3. Utility Trench Rock: Any subsurface material encountered during trench excavation operations that cannot be excavated and loaded out by a 1 cubic yard capacity hydraulic backhoe.

B. Detectable Warning Tapes for buried utilities shall be acid and alkali-resistant polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored as follows:

<table>
<thead>
<tr>
<th>Service</th>
<th>Color</th>
<th>Legend</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sewer</td>
<td>Green</td>
<td>Caution Buried Sewer</td>
</tr>
<tr>
<td>Potable Water</td>
<td>Blue</td>
<td>Caution Buried Sewer</td>
</tr>
<tr>
<td>Non-potable Fire (S.40)</td>
<td>Purple</td>
<td>Caution Buried Reclaimed Water</td>
</tr>
<tr>
<td>Natural Gas</td>
<td>Yellow</td>
<td>Caution Buried Gas</td>
</tr>
<tr>
<td>Fuel Oil</td>
<td>Yellow</td>
<td>Caution Buried Fuel</td>
</tr>
<tr>
<td>Chilled Water</td>
<td>Purple</td>
<td>Caution Buried Reclaimed Water</td>
</tr>
<tr>
<td>Heating Water</td>
<td>Purple</td>
<td>Caution Buried Reclaimed Water</td>
</tr>
<tr>
<td>Irrigation Water</td>
<td>Purple</td>
<td>Caution Buried Reclaimed Water</td>
</tr>
<tr>
<td>Steam</td>
<td>Yellow</td>
<td>Caution Buried Utility Line</td>
</tr>
<tr>
<td>Condenser Water</td>
<td>Purple</td>
<td>Caution Buried Reclaimed Water</td>
</tr>
<tr>
<td>Condensate</td>
<td>Purple</td>
<td>Caution Buried Reclaimed Water</td>
</tr>
</tbody>
</table>

C. Satisfactory borrow and fill materials shall be limited to Soil Classification Group CL (liquid limit less than 45) and well-graded 1” minus crushed limestone or limestone screenings with at least 15 percent passing the #200 sieve, or a combination of these groups; free of organic waste, frozen materials, vegetation or other deleterious materials, having a maximum particle size less than 3 inches in any dimension. Where approved by Geotechnical Consultant, satisfactory soils also include CH soils placed below the upper 3 feet of final floor Subgrade elevation.

D. Subbase Material: Crushed limestone, 3/4-inch minus.

E. Base Course: Crushed limestone, 1-inch minus.

F. Engineered Fill: Compacted satisfactory soils approved by Geotechnical Consultant.

G. Bedding Course:

1. For Site Utilities: Sand.
2. See Division 15 Plumbing and Fire Protection Excavation and Backfilling for pipe bedding.
312000 – EARTH MOVING Revised 11/2009

for plumbing and fire protection systems.

3. For Sewer Pipe: For pipe up to 27-inch diameter, use MSD 1 Bedding; for pipes with
diameter greater than 27-inch diameter, use MSD 2 Bedding.

H. Drainage Course: Narrowly graded mixture of crushed stone, or crushed or uncrushed gravel;
ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch (37.5-mm)
sieve and 0 to 5 percent passing a No. 8 (2.36-mm) sieve.

I. Filter Material: Permeable granular limestone (1” clean limestone), as approved by Geotechnical
Consultant.

J. Sand: STMC C 33; fine aggregate.

K. Impervious Fill: Compacted cohesive soil, as approved by Geotechnical Consultant.

L. Subsurface Drainage Geotextile shall be Mirafi 140 N or approved equal.
316329 – DRILLED CONCRETE PIERS AND SHAFTS

Design Standards

A. The decision to utilize drilled piers will be based on the recommendations of the Geotechnical Consultant after discussion and approval of the Owner. Owner preference is to avoid rock sockets.

B. The Geotechnical Consultant shall be retained per Section 02010, Subsurface Investigation.

C. Bid Form shall include Unit Price line items for a per linear foot price for each diameter of pier.
   1. Ensure that the Bid Form includes Unit Prices for each pier materials and pier rock excavation that may be required.
   2. Ensure that the Bid form includes Unit Prices for permanent and temporary casing that may be required.
   3. Unit prices include labor, materials, tools, equipment, and incidentals required for excavation, trimming, shoring, casings, dewatering, reinforcement, concrete fill, and other items for a complete drilled-pier installation.
   4. Bids shall be based on number of piers, design length from top elevation to bottom of shaft, diameter of shaft and bells as shown on drawings and as specified.
   5. Bids shall include all required work, including but not necessarily limited to drilling, concrete, reinforcing, dowels, temporary casing, permanent casing (where indicated) inspections (not performed by the Owner) dewatering, removal of spoil and all other necessary work.
   6. In addition to the theoretical volume of concrete, include in the bid an additional volume of concrete to compensate for allowable auger wobble, expansion of the shaft side walls, densification of concrete, spillage, etc. Include similar language in the Bidding Documents.

D. Periodic payments for pier work shall be based on the total percentage of work completed and approved less the percentage of work completed, approved and included in prior applications for payment.
   1. Percentages shall be based on linear footage of piers completed and approved divided by the total linear footage included in the bid.
   2. No payment will be made for extra length when pier shafts are excavated to depth greater than that required or authorized by the Owner's geotechnical representative.

E. It is anticipated that the total length of piers finally installed and approved will differ from the linear footage included in the bid. Established and agreed to unit prices for piers (one unit price for each diameter of pier indicated) shall be used to calculate the difference between the actual lengths installed and approved, and the total linear footage bid.
   1. Actual length of drilled piers at the unit price applicable to each design shaft diameter. No payment will be made for portions of shaft outside the design diameter.
   2. Actual volume of Special Excavation at the applicable unit price, distance from top of
special excavation to bottom of special excavation multiplied by design shaft diameter.

3. Actual volume of Obstruction Removal at the applicable unit price, distance from top of obstruction to bottom of obstruction multiplied by design shaft diameter.

4. Volume of design bell diameter (includes only the volume outside the design shaft diameter) at the applicable unit rate, based on the bell geometry indicated on the structural drawings, Section S3.101. No payment will be made for portions of bell outside the design bell volume, unless approved by Architect and Owner’s Representative.

5. Actual quantity of Reinforcement at the applicable unit price.

6. Actual length of temporary steel casing left permanently in place at the applicable unit price.

7. No payment will be made for rejected work.

F. The Owner will retain and pay for an independent testing laboratory to provide the following services as required:

1. Batch Plant Inspections;
2. On-site slump tests;
3. On-site casting of concrete test cylinders;
4. Handling, storage, curing, and compression tests of concrete cylinders;
5. On-site measurement of ready-mix concrete temperatures;
6. Air content tests;
7. Other tests and inspections that the Owner may deem necessary;
8. Reports of test results and inspections.

G. The Owner will retain an independent geotechnical specialist who shall be at the site during all pier operations.

1. The Owner’s geotechnical representative will monitor the drilling operation, the spoil material (rock sockets if required), and shall determine when the auger has reached an acceptable depth. The drilling operation shall continue until an acceptable bottom elevation has been achieved.
2. The Owner’s geotechnical representative shall determine the acceptability of each pier hole and completed pier.
3. Based on his examination and measurement of each pier, the Owner’s geotechnical representative shall complete the required pier report for each pier.

H. Require a pre-construction meeting to review requirements included in Contract Documents, scheduling of work, safety, protection of existing facilities, etc.

Material Standards

(Not Listed)
321216 – ASPHALT PAVING

Design Standards

A. Provide minimum 7” base and 2” wearing surface for automobile parking areas. Provide minimum 12” base and 3” wearing surface for roads, drives and parking areas. Verify if additional thickness is required by soils consultant.

B. Indicate locations of each thickness.

C. Provide traffic control bumps per standard detail at end of section. Review locations with Owner.

D. Mark all parking lanes, directional arrows, stop lines, etc. Review locations with Owner.

E. Provide concrete wheel stops at locations to prevent entry onto adjacent walks and planted areas or prevent damage to adjacent walls, utilities, light fixtures, etc.

F. Slope surface to promote drainage.

Material Standards

A. Wearing surface shall be Type AC mix.

B. Wheel stops shall be pre-cast, air-entrained concrete with a minimum compressive strength of 3000 psi at 28 days. Chamfer corners and provide bottom drainage slots. Anchors shall be 3/4 inch diameter by 24 inches long, hot-dipped galvanized or epoxy-coated steel dowels at third points.

C. Lane marking paint shall be Alkyd-resin type, Type 1, white complying with AASIT TOM24B.

D. Subgrade shall be suitable for sub-base as recommended by soils consultant and confirmed by proofrolling. Unsuitable materials shall be replaced and compacted to specified densities. Provide geofabric in areas where subgrade is suitable but exceeds optimal moisture content.

E. A pre-installation meeting shall be conducted by Contractor with Owner, and Architect/Engineer in attendance.

F. First installation shall be approved by Owner before proceeding with full installation.

G. The Owner will employ an independent testing agency to test materials and installation. Surface smoothness shall be tested with a 10-foot straight edge applied parallel to and at right angles to centerline of paved areas. Variation shall not exceed plus or minus 1/4” for base course and 3/16” for wearing surface. Contractor shall have clean paved surface. Ponding shall not exceed 3/4” in depth at any location. The Contractor shall pay for all remedial work, additional testing, and related expenses.

H. Valve boxes and other covers shall be flush with finish pavement.
321216 – ASPHALT PAVING

Section @ Double Bump

Traffic Control Bumps

Section @ Single Bump

Vertically Exaggerated - Not To Scale
321313 – CONCRETE PAVING

Design Standards

A. All walks at Danforth Campus, including South 40, shall be exposed aggregate concrete to match adjacent walks designated by Owner. Other campus locations can be plain concrete.

B. Exterior walks and pavement shall be placed such that the elevation of the pavement is 2 inches above the designed finish grades. Back fill the edges of the pavement with topsoil tapering the 2 inch elevation to a point 2 feet out from the walk. See Drainage Detail at Walks at end of this section.

C. Designated fire lanes on Danforth Campus shall be edged with granite. See Fire Lane Pavement Section detail at end of this section.

D. Fully detail concrete thicknesses, expansion and control joints, reinforcing and construction joints. Locate control joints at 10 foot o.c. maximum. Control joints shall be 25% of the pavement depth.

E. Minimum clear sidewalk width shall be 5’-0”.

F. Minimum radius at intersections shall be 2 feet. Preferred radius is 5 feet or larger. Verify radius of fire lane with fire marshal.

G. Provide galvanized steel plate insert at handrail/guardrail locations. See Steel Plate Detail at end of section.

H. Do not ‘crown’ walks to facilitate snow plowing. Pitch in one direction to promote drainage.

I. Joint pattern must be submitted to Owner for approval. Pattern shall match adjacent and nearby patterns as designated by Owner.

Material Standards

A. Exposed aggregate concrete shall match the appearance of the exposed aggregate pavement at the southwest corner of the Millbrook Parking Garage. Vertical curbs shall be broom finished concrete on the vertical and horizontal surface. Use 6 x 6- W1.4xw1.4 WWF reinforcing for walks and pavement:

1. The following mix has produced satisfactory exposed aggregate concrete on the Washington University Campus:

<table>
<thead>
<tr>
<th>Material</th>
<th>Weights per Cubic Yard</th>
<th>Saturated</th>
<th>Surface Dry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Portland Cement Type 1</td>
<td>564.0 lbs.</td>
<td>2.87 (cu. ft.)</td>
<td></td>
</tr>
<tr>
<td>Meramec River Sand</td>
<td>1012.0 lbs.</td>
<td>6.29 (cu. ft.)</td>
<td></td>
</tr>
<tr>
<td>#67 Meramec C Gravel</td>
<td>2000.0 lbs.</td>
<td>12.52 (cu. ft.)</td>
<td></td>
</tr>
</tbody>
</table>
Water     260.0 lbs.  4.17 (cu. ft.)
Air Entrainment 5.0 %  1.36 (cu. ft.)

TOTAL 27.20 (cu. ft.)

AEA WR Grace DARVAIR 1000 2.3 oz.
Water/Cement Ratio 0.46 lbs/lb
Slump 4.00 inches
Concrete Unit Weight 141.0 pcf

2. Sieve analysis of the gravel shall match the following:

<table>
<thead>
<tr>
<th>U.S. Standard Sieve Size</th>
<th>Percent Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 inch</td>
<td>99</td>
</tr>
<tr>
<td>3/4 inch</td>
<td>88</td>
</tr>
<tr>
<td>1/2 inch</td>
<td>52</td>
</tr>
<tr>
<td>3/8 inch</td>
<td>25</td>
</tr>
<tr>
<td>No. 4</td>
<td>3</td>
</tr>
</tbody>
</table>

B. Owner approval of 2’ x 4’ mock-up is required before proceeding with full installation. Include tooled joint for approval.

C. Exterior Concrete Stairs

1. Use epoxy coated reinforcing steel at exterior concrete stairs.
2. Broom finish treads and risers of stairways. Exposed aggregate walk surface shall run to the riser at the top and bottom of the stair.
3. Use 7 inch risers and 11 inch treads at stairs.

D. Use #4 dowels at 12 inch centers at pavement joints and joints between old and new pavements.

E. Tool expansion and control joints. Saw cuts not permitted.

F. Expansion joints shall be sealed.

G. Owner may retain independent testing agent to review proposed mix and base specifications; test sub-base material (prior to installing base material), base material, concrete slump, compression and temperature.

H. Moist curing is required per ACI recommendations

1. Cure Type 1 cement for not less than 5 days; Type 2 cement for not less than 7 days; and Type 3 cement for not less than 3 days.

J. Pavement that does not match approved samples shall be replaced.
NOTE:
TO PROVIDE POSITIVE DRAINAGE, EXTERIOR WALKS AND PAVEMENT SHALL BE PLACED SUCH THAT THE ELEVATION OF THE PAVEMENT IS 2 INCHES ABOVE THE DESIGNED FINISH GRADES. BACKFILL THE EDGES OF THE PAVEMENT WITH TOPSOIL TAPERING THE 2 INCH ELEVATION TO A POINT 2 FEET OUT FROM THE WALK.

Drainage Detail @ Walks

Scale: 3/4" = 1'-0"
ALL STEEL TO BE GALVANIZED. NOTE:

- 6"x6"x1/4" STL PLATE
- POST CONTINUOUS WELDED TO STL PLATE
- 2" GAP

Steel Plate Insert
For Guardrail / Handrail

Scale: 1" = 1'-0"
323112 – PICKET FENCING

Design Standards

A. Fencing shall slope to match finish grade; do not "step" the fencing.

B. Fencing with masonry corners shall be used for trash enclosures. See typical details at end of section.

Material Standards

A. Manufacturer:

1. Westmoreland Tubular Products Manufacturing Company, Inc., 6500 Beaver Dam Road, Levittown, PA 19057; Phone 215-949-3100; Fax 215-949-3103.
2. Ameristar Fence Products, 1555 North Mingo, Tulsa, OK 74116; Phone 800-321-8724; Fax 877-926-3747.
3. Other manufacturers providing equivalent products, approved in advance of the bid by the Architect.

B. Materials:

1. Posts: 2-1/2 inch square x 14 gage steel tubing conforming to ASTM A 513. Hot-dipped galvanized in accordance with ASTM G 90.
3. Pickets: 1 inch square x 16 gage steel tubing conforming to ASTM A 513. Hot-dipped galvanized in accordance with ASTM G 90. Use 'smashed' arrowhead tip.
4. Gate Posts:
   a. Use 2-1/2 inch square and 14 gage wall thickness for gates up to 4 feet wide; 3 inch square and 1/8 inch wall thickness for gates up to 10 feet wide; 4 inch square and 3/16 inch wall thickness for gates over 10 feet wide.
   b. 2-1/2 inch steel tubing shall conform to ASTM A 513; hot-dipped galvanized in accordance with ASTM G 90.
   c. Steel tubing 3 inches and larger shall conform to ASTM A 501 and shall be galvanized per ASTM A 53.
5. Finish: All components shall receive a thermosetting polyester powder applied by electrostatic spray and baked at 500 deg F. Galvanized surface shall be pre-treated with zinc phosphate coating. Black color to match Owner's sample
6. Fasteners:
   a. Post-to-Rail: 1/4 inch aluminum oval head drive rivets.
   b. Grade Fittings: Cast aluminum brackets.

C. Installation:

1. All posts shall be set in concrete.
2. After installation, touch up all finish defects with paint provided by manufacturer to match factory finish.
Typical Dumpster Enclosure Detail

Scale: 1/8" = 1'-0"
Alternate Dumpster Enclosure Layouts

Scale: 1/8" = 1'-0"
**334100 – STORM UTILITY DRAINAGE PIPING**

**Design Standards**

A. Owner will provide to designer a survey and, if available, archival documents to assist in determining buried existing conditions.

B. Before excavating, Contractor shall request public utility companies to locate buried public utilities and request Owner to locate buried private utilities.

C. Designer shall review and confirm storm water detention and water quality requirements with MSD very early in the design process, especially if the project increases the amount of hard surface area. MSD considers all current and previous projects on campus to determine if detention is required for each individual project, so the impact of an individual project, regardless of the size, may require detention.

D. Owner preference is to use Best Management Practices including pervious pavement to minimize impact of storm water.

E. Owner preference is to avoid trench drains. If trench drains are used, provide a minimum of 2 outlet pipes and maximum of 1 per 10 lineal feet of drain.

**Material Standards**

A. Manufacturers:

1. **Cleanouts:**
   a. Anco, Inc.
   b. Josam Co.
   d. Wade Div., Tyler Pipe.
   e. Zurn Industries, Inc.

2. **Trench Drain System:**
   a. ACO Polymer Products, Inc.
   b. Innovative Plastic Products, Inc.
   c. PolyDrain, Inc.

3. **Underground Warning Tape:**
   b. Brady Co.; Signmark Div.
   c. Calpico, Inc.
   d. Carlton Industries, Inc.
   e. EMED Co., Inc.
   f. Seton Name Plate Co.
4. Note: Use "duck bill" backflow preventers.

5. Metallic-Lined Plastic Underground Warning Tape: Polyethylene plastic tape with metallic core, 6 inches wide by 4 mils thick; solid green in color with continuously printed caption in black letters "CAUTION – SEWER LINE BELOW."

B. Owner may retain testing agency to inspect and test excavation sub-grades, backfill materials and backfill compaction densities.
334600 – SUBDRAINAGE

Design Standards

A. Provide perimeter drainage system (i.e., French drain) for all buildings with full or partial floors below grade. Locate drain below the elevation of granular fill of the lowest floor slab.

B. Provide under-slab foundation drainage system if recommended by soils consultant or if water table elevation is near or above lowest floor elevation.

C. All drainage pipe shall be sloped 0.5% minimum to provide positive drainage.

D. Pipe shall be wrapped in geofabric material.

Material Standards

A. Piping shall be PVC Schedule 40, plain or perforated as determined by the designer.
Typical Foundation Drain Detail

Scale: 1/4" = 1'-0"