Design Manual

Facilities Administration
George Mason University
4400 University Drive
Fairfax, VA 22030-4444

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University design and construction standards are contained in the George Mason University Design Manual. These standards are updated periodically to include new systems, equipment and construction methods preferred by the University for new construction, renovations and additions. The following table of contents provides links to the various sections and portions of the Design Manual. A complete copy of the Design Manual can be downloaded here (20130628 Mason Design Manual – Full).

Chapter 1

Introduction and First Principles

1.1 MISSION STATEMENT

OUR MOTTO:
Freedom and Learning

MISSION:
A public, comprehensive, research university established by the Commonwealth of Virginia in the National Capital Region, we are an innovative and inclusive academic community committed to creating a more just, free, and prosperous world.

OUR VALUES:

Our students come first
Our top priority is to provide students with a transformational learning experience that helps them grow as individuals, scholars and professionals
Diversity is our strength
We include and embrace a multitude of people and ideas in everything we do and respect differences
Innovation is our tradition
We strive to find new and better ways to deliver on our mission while honoring time-tested academic values
We honor freedom of thought and expression
We protect the freedom of all members of our community to seek truth and express their views
We are careful stewards
We manage the economic and natural resources entrusted to us responsibly and sustainably
We act with integrity
We hold ourselves to the highest ethical standards as educators, scholars, students and professionals
We thrive together
We nurture a positive and collaborative community that contributes to the well-being and success of every member

1.2 OVERVIEW OF THE DESIGN MANUAL

Each individual, each department, and each facility plays a part in accomplishing Mason's institutional mission. Mason's physical facilities provide a sense of "presence and welcome" and contribute to the overall learning environment of the university. The Design Manual serves as a framework to align Mason’s physical facilities—including capital and non-capital projects on all Mason campuses—with the mission of the university. In addition, it is the intent of the Design Manual to introduce rigorous performance standards, delineate standards for sustainability and accessibility, support administrative procedures for the Facilities department, and provide a system to track the impact of individual projects on the campus as a whole. The Design Manual also incorporates “lessons learned” from previous projects in order to establish a higher standard for future university projects.

The Design Manual is intended to inform and direct the Project Team for any new construction, renovation or alteration of facilities or spaces on a George Mason University Campus. The Design Manual clarifies and defines Mason's procedures and standards, indicates preferences on certain materials used in construction of its facilities, and answers common questions related to construction projects on any campus. The Design Manual supplements the requirements of contracts between the university and its consultants, as well as contractors (including but not limited to the Owner-Architect Agreement, Design-Build Contract, as well as the CM Contract). The Design Manual shall be considered a fundamental part of the Program provided for each project. Whenever the term “Design Team” is used, it shall apply to the architect and/or engineer. The term “Constructor” shall refer to the construction manager, design builder, and/or contractor. “Project Team” refers to the Design Team, Constructor, and George Mason University.

The current version of the Commonwealth of Virginia Construction and Professional Services Manual (hereafter referred to as the CPSM) is the principal authority on policies and procedures that must be followed in the design and construction of any George Mason University project, whether it is a capital outlay or non-capital endeavor. In some instances, Mason may impose more rigorous standards than required by the CPSM. The Design Manual is intended to supplement, not supersede, the CPSM, nor any industry standards or mandatory codes.

It is the university’s intent to maximize the design potential of each campus building, infrastructure element, or other facility project with the multiple goals of accommodating the programs to be served, fostering collegiality on the campus, and contributing to the positive public image of the university campus. Mason expects each project to achieve long-term endurance and sustainable operations. It is the responsibility of the Design Team and Constructor not only to employ the industry's best management practices, but also to recommend innovative technologies–balanced with those that are time honored and proven—subject to the university’s review and approval. New designs must cost-effectively overlay the specific, user-generated objectives for the project with the broader and overarching University objectives of institutional identity, durability, longevity, flexibility, and adaptability.

This manual will be available online at http://facilities.gmu.edu/physicalplant/BldgStandards.htm. Changes are inherent and updates will be made and posted with a date stamp when necessary. The Design Team and Constructor are responsible for confirming use of the most current version of this manual. Pages have been dated for this purpose.

The Design Team is responsible for producing the best possible life cycle cost building within the constraints of the first cost building budget. Mason does not wish to handicap creative efforts by insistence on blind adherence to requirements; team members are encouraged to think creatively about solving problems throughout the process. Variations will be considered and approved if there is an advantage in terms of risk, time, and cost to Mason to do so. However, intended variations must be brought to Mason’s attention for written approval. Otherwise, the Design Team will be held responsible as indicated in section 1.8 of this manual.

An attempt has been made to establish performance rather than specification standards. The Design Manual is not intended to be a “master specification”; therefore, much of the language in the Design Manual will require modification before being included in the Project Specifications.

To achieve the university’s goals, it is incumbent upon the project design team to invest in an understanding not only of immediate program objectives, but also of the history of planning and architecture on the campus, the intent of the current campus master plan, and particularly the immediate context (precinct and site) of the project.

1.3 ORGANIZATION OF THE DESIGN MANUAL

The text of The Design Manual is arranged in five Parts:

Chapter 1 - Introduction and First Principles

This chapter defines the intent of the Design Manual and the general organization of the document, as well as how the Design Manual is to be used. The first principles of George Mason University, including its approach to accessibility, sustainability and energy management, and maintenance and operations, are also defined in this chapter.

Chapter 2 - Design Process and Procedures

This chapter includes information about administrative procedures that the Design Team must follow in working with the university during the design process. This statement of procedures is intended to establish a smooth operating relationship throughout the design process, from pre-design through construction documentation. Information regarding administrative procedures for the construction process, including bidding, can be found in Divisions 00 and 01 of Chapter 4.

Chapter 3 - Design Standards

This chapter defines exterior and interior planning and design, as well as environmental, security and life safety, and accessibility standards.

Chapter 4 - Construction Products and Activities

This chapter discusses technical requirements of materials, systems and methods of construction. It is arranged on the basis of the Construction Specifications Institute (CSI) 48-Division Specification Format to include all areas in which the university requires certain minimal standards in the selection of materials and quality of workmanship. When this manual is silent on a particular material, no standards have been developed by George Mason University. In all cases, the Design Team and Constructor are to use professional judgment and, where such judgment indicates material or methods contrary to information found in this manual, must discuss these areas with Mason's Project Manager.

Chapter 5 – Mason Standard Details

This chapter contains standard details. These details represent typical standards established by the university and are included to assist the Design Team and Constructor in preparing drawings that are acceptable and uniform for all projects.

1.4 PRINCIPLES OF ACCESSIBILITY

It is a key objective of George Mason University to maintain an accessible environment for all people. To achieve this goal, the university is committed to the following principles:

- Mason supports universal design and strives to make all public spaces and facilities on its campuses physically accessible to people of all abilities, including physical, mental, learning or other.
- Creating an accessible campus is inclusive of interior and exterior spaces, both new and renovated. At a minimum, all designs for new construction and renovations shall be in compliance with applicable state and federal mandates. In instances where Mason's standards exceed state and federal regulations, the most stringent requirement (i.e., most beneficial to persons with disabilities) must be followed.
- Accessibility must be considered in the initial phases of design and throughout the entire process. All members of the design, construction and maintenance teams must maintain a seamless integration of design for people of all abilities.

1.5 PRINCIPLES OF SUSTAINABILITY

Mason is committed to providing its students with a transformational learning experience while being a careful steward of its economic and natural resources. In this vein, Mason has two main strategic goals related to sustainability:

- Incorporate sustainability concepts into all learning experiences for students, faculty, and staff to foster a more sustainable culture.
- Aspire to eventual climate neutrality.

These goals are referenced in more detail in Mason's Climate Action Plan (http://rs.acupcc.org/site_media/uploads/cap/84-cap.pdf) and its 2014 Strategic Plan (http://provost.gmu.edu/wp-content/uploads/2012/01/FINAL_Strategic_Goals_for_2014-1.pdf).

The majority of Mason's greenhouse gas emissions are produced from the operations of its buildings. As such, it is essential to improve the design, construction and maintenance of campus facilities, and to create opportunities for awareness-building, education, and research.

It is Mason's expectation that its Design Teams will propose practices, technologies, and designs that are based on life cycle analysis and support efforts to mitigate Mason's current and future impact on the natural environment, with the following goals in mind:

- Create efficient and long-lasting buildings from the design and construction phase through the operations and maintenance phase. This applies especially to energy consumption as the energy consumed in buildings produces the majority of Mason's emissions and is its largest operational expense.
- Support environmentally sustainable site development, especially with regard to storm water management and features that strengthen existing transportation support systems.
- Promote both the understanding and involvement of building occupants of the efforts being pursued within the building, along with their comfort and well-being.
- Apply appropriate design, processes, and tools to minimize waste and increase recycling.

1.6 PRINCIPLES OF MAINTENANCE AND OPERATIONS

It is well established that over 80% of the cost of any facility is attributed to the ongoing cost of maintenance and operations, which is why the ability to easily, efficiently, and effectively maintain and operate a facility is critical to the success of any George Mason University project.

Because the implications of a design on the subsequent operations and maintenance are often overlooked, it is important to be aware of how design decisions will impact maintenance and operations. The following standards apply to all new projects at George Mason University:

- Projects at Mason must be cost effective, not only in terms of their first cost, but also the ongoing energy, maintenance, operations, and staffing costs (to name a few). Therefore, the university views full life cycle cost analysis as the best way to ensure the value and longevity of its investments.

- Design, construction and maintenance personnel must be judicious in their selection of materials, equipment, and products to ensure proven performance, longevity, and durability.

- In the design of any project, it is critical that all systems and devices are made accessible for the full life cycle of that piece of equipment, inclusive of major overhauls, replacement of major components, and segmented full equipment recap.

- All design and construction decisions should consider the ease and practicality of future maintenance and modifications. A greater first cost may be required to achieve the best long-term gain. New systems shall be compatible with existing systems as they are emplaced.

- Finally, Mason supports and encourages sustainable maintenance practices that mitigate or arrest harm to the people and the natural environment.

1.7 PRINCIPLES OF DESIGN FOR OUR CAMPUSES AND BUILDINGS

As a destination and center for educational, business, social and cultural events for divergent interests and populations, each campus of George Mason University has unique and distinctive characteristics. With an assembly of specialized facilities, natural landscapes, public art and other attractive features, George Mason University's campuses comprise significant settings for educational, research and service activities.

Mason's campus settings must be attractive, progressive, and welcoming. The campus environment must also communicate the importance of the university in our society through its unique sense of place and evolving academic traditions. Each design opportunity, be it campus or building, offers a unique opportunity to create an environmentally and socially responsible physical environment which can create an atmosphere conducive to intellectual discovery and interaction as well as relaxation and contemplation.

Used in conjunction with the George Mason University Master Plan, the following design principals and guidelines are intended to convey an understanding of the specific objectives and design intentions that contribute to: the qualities of the physical environment; a unity of visual character; a unique sense of place; and activities that are encompassed at various Mason campuses and locations.

George Mason University's campus and building design should strive to achieve the following goals which generally align with Smart Growth development principals:

- Preserve natural beauty, open space (lawns, fields, plazas, quads etc), and critical environmental areas
- Foster a distinctive, attractive campus with a strong sense of place
- Create a walkable campus
- Mix land uses
- Take advantage of compact building design
- Create a range of housing opportunities and choices
- Strengthen and direct development towards existing academic core and residential neighborhoods
- Provide a variety of transportation choices (emphasizing the reduction of single occupancy vehicle trips)
- Make development decisions predictable, fair, and cost effective
- Encourage university community and stakeholder collaboration in development decisions

1.8 ENFORCEMENT OF THE DESIGN MANUAL

As stated previously, the Design Manual is intended to provide guidance to all parties involved in the design and construction process at Mason. It is critical that efforts be made to ensure the provisions are followed, and that any exceptions are executed in a transparent, open, and explicit manner.

To facilitate this process, during each design submittal and/or modification to the design of a project (new construction, renovation, rehabilitation, maintenance effort, and so forth), the designer of record will provide a listing of any exceptions taken to this manual or certify that there are no such exceptions taken. Any exceptions will be reviewed through an internal Mason procedure that will result in a written approval of exception by the Vice President of Facilities. Once approved, the modification can be used without further recourse. In the event that an exception is not noted by the designer of record, and it is subsequently found that an exception was made, the university will consider cost sharing with the designer for the required change in order to align the project with the Design Manual. It is incumbent upon designers to review and aide in the enforcement of these procedures throughout the process.

Chapter 2

Design Procedures

2.1 PROJECT MANAGEMENT

2.1.1 GENERAL

The Design Team and Constructor will work primarily with the Project Manager from Mason Facilities. All input and coordination shall be conducted through the Project Manager. Input during design will be generated by various elements of the campus community, including Facilities and its allied departments.

At award of the construction contract, a representative from Facilities will oversee the contractor’s work and administer the construction contract. Roles and responsibilities are defined in the CPSM and promulgated by the Bureau of Capital Outlay Management (BCOM).

Terms such as “George Mason University," “Mason,” or “the university" used in the Design Manual refer to George Mason University Facilities (Project Manager), especially when approval permission or consultation is referenced.

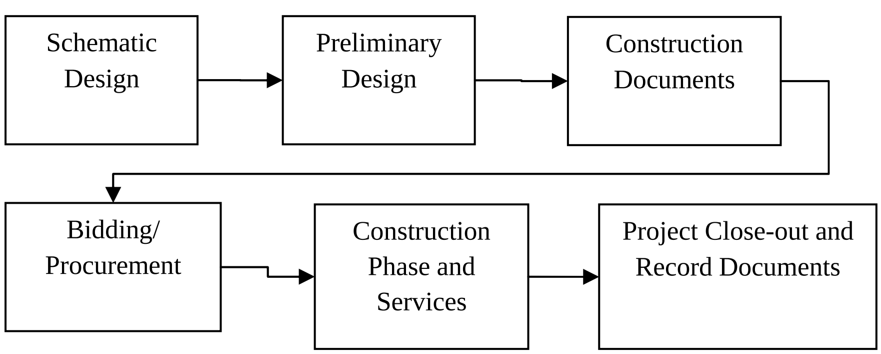
Refer to the chart below for the general flow of the Design Process at George Mason University.

2.1.2 COMMUNICATION PLAN AND PROCEDURES

George Mason University, as an agency of the Commonwealth of Virginia, follows the procedures for design as outlined in the CPSM.

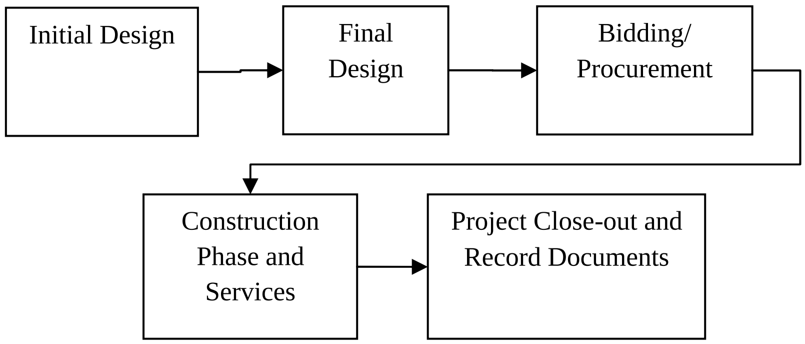
Prior to a project being formulated and assigned a project code by BCOM, often the university will develop a planning level package that develops scope, feasibility, and programming for a proposed effort. This effort is geared to aid in the submission of a project as a part of George Mason University’s capital plan. Normally these efforts are spearheaded by a planner within Facilities. See also Pre-Design below.

For Capital Projects, the process involves 6 basic steps as outlined in the following diagram.

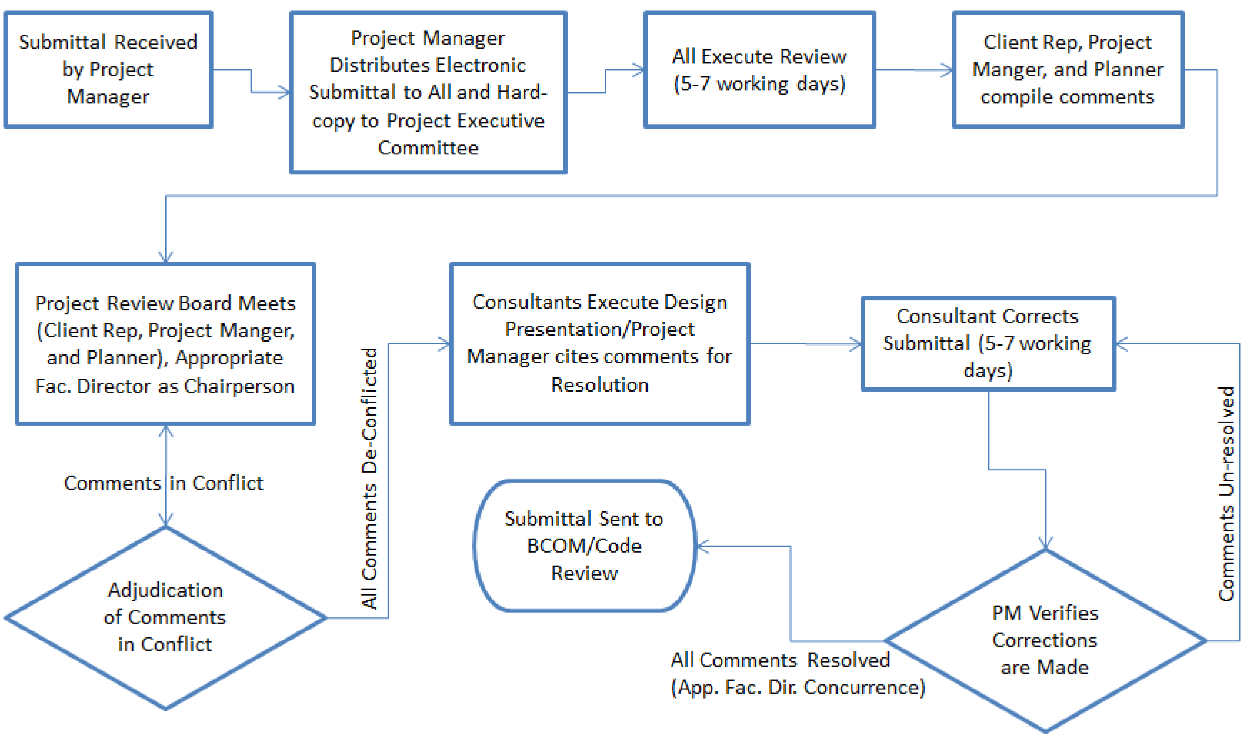


At each stage of the capital project development process, the State Review Agency and Authority Having Jurisdiction, BCOM, executes reviews of the project for code and state compliance requirements, while the university reviews the project for additional project requirements. The Project Manager will be the primary point of contact and shepherd the project thorough all stages of the project.

For all non-capital projects, this process is somewhat abbreviated. Unlike in capital projects, the state review agency, BCOM, does not require interim reviews of design submittals, and in some cases has delegated authority to the local agency for maintenance, minor renovation, and modification projects.



As noted above, at each stage the university will either review design submittals prior to sending them to BCOM or concurrently review design submittals while they are at BCOM. A process similar to the following flow chart will be followed and managed by the Project Manager. Typically, review by the university will take 21-28 days.



2.1.2.1 Meeting Minutes

The Design Team shall provide meeting minutes for all meetings during the design process. Typically, the project will maintain recurring monthly, bi-weekly, or weekly meeting, depending on the design development schedule. Some meetings may target particular topics, while the purpose of others will be general progress updates. Other meetings may take the form of workshops or design charettes. The Design Team shall make a record of meeting participants and the items discussed. Meeting minutes shall be distributed primarily to the Project Manager, but may include others as requested. Minutes shall be provided in an editable electronic format, and saved for record in PDF format following a minimum 2 week commenting period. During the Construction Phase the Design Team must schedule bi-weekly (or semi-monthly) construction progress meetings in consultation with the Project Manager and Owner. The purpose of the meetings is to review progress of the work during the previous week, discuss anticipated progress during the following weeks, and review critical operations and potential issues. The Design Team shall conduct the meeting and is solely responsible for generating the written record or minutes of each progress meeting. The Design Team distributes progress meeting minutes in an electronic editable format to the Owner and the Contractor(s). All objections or corrections are noted as such at the next progress meeting or in writing to the Design Team. The Design Team is to be notified at the next progress meeting or in writing explaining the objection. The minutes of the next Progress Meeting shall reflect any objection or response from the Design Team. The Design Team may transmit the agenda and minutes for each progress meeting using electronic means as directed by Project Manager.

2.1.2.2 Decision-Making

Decision making as a part of the design process shall be facilitated by the Project Manager and the Planner assigned to the project. Ultimate authority for all decisions resides with the Vice President of Facilities, delegated and affirmed by the Directors of the various departments of the Facilities organization.

2.1.2.3 Day-to-Day Management of Project

References:

- Refer to the CPSM, Chapter 2.2 for definition of the Project Manager.

2.1.3 INVOICING

References:

- CPSM, Chapter 3.2.4 – Proportioning of the A/E Fee and Payments

2.1.3.1 Alternates

No deduction shall be made from the Design Team’s fee for any penalty or liquidated damages charged to any contractor, excepting in Design-Build projects. No additional compensation shall be made for preparation of alternates, unless the Owner prior to execution of the work approves such additional compensation in writing.

2.1.3.2 Payments

During Pre-Design Activities (Programmatic Phase), Schematic Design, Design Development, and Contract Documents and Bidding, the university shall make monthly payments to the Design Team based on the progress of the work as outlined in the Commonwealth of Virginia’s Construction and Professional Services Manual (Capital Outlay Manual). Such payments shall in no event exceed the fee limits for phases as set forth in the contract. These payments shall be limited in proportion to the Owner’s estimate of progress and percentage completion of the work in the current phase. During Construction, the payments toward the fixed fee due for that phase shall be made to the Design Team in proportion to progress payments made to the Constructor for construction of the Project, as certified by the Design Team.

The Design Team shall use a format for payments as provided by the DEB.

2.1.3.3 Change Orders

The Design Team cannot proceed on change orders without the written authorization from Mason. Change orders cannot be billed without such authorization. Refer to the CPSM, Chapter 3.2.5.

All change orders shall be sequentially numbered when approved. The revised contract amount shall be shown on the invoice along with the original contract amount and the previous contract amount if more than one change order. Invoices shall follow the same format as previously described.

2.1.4 SCHEDULES

During the design phase (through completion of Working Drawings and permit issuance) the Design Team shall develop a project schedule that details all design deliverables, BCOM review periods, and periods of design effort. A minimum of 4 weeks—and an average of 6 weeks—should be allocated for the review of any design submittal by BCOM. Prior to submittal to BCOM or local code review authorities, the Design Team shall allow sufficient time for Mason's internal review. Annotations shall be made for critical meetings and design charette workshops. The Design Team shall coordinate closely with the Project Manager for the availability of Mason personnel and scheduling of other resources through the design phase of a project.

The following chart of meetings is provided as a reference for the meetings that are anticipated during throughout the project:

Meeting Name (one per phase unless otherwise noted)	**Feasibility**	**Programming**	**Schematic Design**	**Preliminary Design**	**Working Drawings**	**Construction**	**Commissioning**	**Close-out**	**Warranty**
Kick-off Meeting	x	w	w	w	w	x	x	w	x
Core Team Member Periodic Meeting (suggested every 2x weeks)	x	x	x	x	x	x	x	x	x
Core Team and Design Team Meeting (in conjunction with the above)	x	x	x	x	x	x	x	x	
Core Team and CM/DB/GC Pre-Construction Meeting (with the above)		w	w	x	x	o			
Design Meetings (numerous per phase, may be in periodic meetings)	w	x	x	x	x				
Core Team Member Internal Meeting (once monthly or as needed)	x	x	x	x	x	x	x	x	x
Interview with Users (as required)	x	x	x	w	o	o	o	o	o
Value Engineering			x	x	x				
Sustainability	x	x	x	x	w		x	x	o
Project Review (one per month)	x	x	x	x	x	x	x	x	x
Finishes Determination/Selection		o	x	x	x	o			
Architectural Design Review (one initial, until UA approved, per phase)		x	x	x	x	o			
ITU Meeting		o	x	x	x	o	x	w	
Facilities Management Shops Input Meeting - MEP Focus			x	x	x		x	x	x
Facilities Management Shops Input Meeting - Others (e.g. Recycling)			x	x	x		x	x	x
Pre-Survey Meeting			x						
Post-Survey Meeting			x						
Utilities Meeting (one per phase with each utility)			x	x	x				
EHS Meeting		x	x	x	x				

Meeting Name (one per phase unless otherwise noted)	**Feasibility**	**Programming**	**Schematic Design**	**Preliminary Design**	**Working Drawings**	**Construction**	**Commissioning**	**Close-out**	**Warranty**
Parking and Transportation Meeting		**x**	**x**	**x**	**x**				
Public Safety Meeting									
Space Administration Presentation		**x**	**x**		**x**				
ADA Compliance Meeting		**x**	**x**	**x**	**x**				
Auxiliary Enterprises (when not the primary client)			**x**	**w**	**w**				
Town hall Presentations			**x**	**x**	**x**				
Pre-Construction Meeting						**x**			
Construction Progress Meeting (every 2x weeks, with Core Team Meeting)						**x**	**x**	**x**	
Preparatory Meeting						**x**	**x**		
Punch-list Generation (at conclusion of each phase of construction)							**x**	**x**	
Punch-list Resolution (every 2x weeks)								**x**	
Turn-over Meeting (to FM)								**x**	**x**
Warranty Review (NLT 3 months prior to conclusion of gernal warranty)									**x**

Code Key:

x	Must Occur
w	Can be waived (Especially if similar meeting occurs in earlier phase, and no additional team members), but assumed to take place
o	Optional (Discretion of Team Leader, see Project Team Member Checklist)

2.1.4.1 Construction Phase

During the Construction Phase, the Design Team shall review and provide information related to the reasonableness of the Contractor/CM schedule for execution (in D-B this will be done as an independent analysis by the Design Team on behalf of the university). At the Bidding/Proposal/GMP stage, the Design Team is responsible for notifying the university if it feels it does not have adequate Construction Phase services coverage in terms of fee, personnel, or scope of services to cover the project as a part of the construction schedule review. The Design Team shall work with the Project Manager to account for any variations/contract modifications that may be required.

2.1.5 DELIVERABLES

2.1.5.1 General

References:

- CPSM: http://www.dgs.virginia.gov/DivisionofEngineeringandBuildings/BCOM/CPSM/2012CPSMRev1/tabid/1267/Default.aspx
- BCOM forms: http://www.dgs.virginia.gov/DivisionofEngineeringandBuildings/BCOM/Forms/tabid/406/Default.aspx
- Virginia Public Records Management Manual: http://www.lva.virginia.gov/agencies/records/manuals/vprmm.pdf
- VPRRM Retention Schedules: http://www.lva.virginia.gov/agencies/records/sched_state/index.htm
- Construction Operations Building Information Exchange: http://www.wbdg.org/resources/cobie.php

The Commonwealth DEB has strict requirements for reporting, and subsequent approval of updates at each stage of the project, and the CPSM does a thorough job of describing the submittal requirements for each phase of a project. Chapter 5 of the 2012 CPSM covers Project Submittal Standards and Requirements. Specifically:

- The CO-3a, Terms and Conditions of the A/E Contract, Sections 15 and 16, prescribe required documents to be provided to the Owner, at the completion of the Design Team's work.
- Refer to Chapter 5 of the CPSM for general requirements on all project submittals, specifically the requirement for all project documents, (drawings, specifications, contracts, invoices, correspondence, etc.), to be clearly marked with the 11 digit Project Identification Code.
- Refer to CPSM, Chapter 5.11 for Project Submission Requirements, specifically the Table for Required Submittal Copies by Phase for Capital Projects in Chapter 5.11.1 of the CPSM. The Design Team shall provide at a minimum the number indicated as required for review by BCOM and State Fire Marshall. Additional copies, "as appropriate for a particular project" shall be coordinated with the university. Refer to the Table for Required Submittal Copies by Phase for Non-Capital Projects in Chapter 5.11.2 of the CPSM. Coordinate with the university for additional copies that may be required.
- Refer to Chapter 5.2 of the CPSM for General Requirements for Drawings. These requirements generally pertain to a printed drawing, and the CPSM requires hardcopy drawings for submission to BCOM. Further clarification on the required format can be found in Section 2.2 of the Design Manual.

- Refer to Chapter 5.3 (specifically, Section 5.3.3) of the CPSM for information on Specification Standards. Note that submission to BCOM shall be hardcopy 8.5”x11” format. Chapter 7.24.4 of the CPSM states that, “These documents shall be provided to the Owner electronically in PDF format. The Owner may also request additional copies of the record documents in other formats at its discretion.”

Beyond the requirements of the CPSM, the university has submittal requirements in conjunction with the design phase of a project and the Construction Phase. These are detailed in the Design Manual and are partially indicated in the following checklist:

Mason Design Submittal Checklist

Item	Schematic Design	Schematic Re-Submit	Preliminary Design	Preliminary Re-Submit	Working Drawings	WD Re-Submit	Building Permit	Fire Alarm/ Sprinkler	FA/Sprink. Re-Submit
BCOM Required Items (see also CPSM)									
Basis of Design Narrative (with which Agency agrees)	X	X	X	X					
DPB Form S-1, Project Scope Profile (updated to reflect current scope)	X	X	X	X					
Cost Estimate provided by Architect/Engineer	X	X	X	X	X	X			
Soils Report with Boring Logs (provided by Agency)			X	X					
Calculations (1 copy for each discipline)			X	X	X	X	X	X	X
Drawings (WD and BP* Drawings must be sealed)	X	X	X	X	X	X	X		
Boring Logs (posted on drawings)					X	X	X		
Shop Drawings (provided by GC/CM/DB, with sealed review cover sheet)								X	X
Equipment Cut Sheets								X	X
Building Systems and Equipment Checklist			X	X					
Project Manual, including:									
Project-Specific IFB Notice					X	X	X		
Project-Specific Bid Form					X	X	X		
Form CO-7 (General Conditions, unedited)					X	X	X		
Form CO-7a (Instructions to Bidders, unedited)					X	X	X		
Other Standard Forms					X	X	X		
Project-Specific Technical Specification Sections					X	X	X		
Soils Report (copy bound in Project Manual)					X	X	X		

Mason Design Submittal Checklist

Item	Schematic Design	Schematic Re-Submit	Preliminary Design	Preliminary Re-Submit	Working Drawings	WD Re-Submit	Building Permit	Fire Alarm/ Sprinkler	FA/Sprink. Re-Submit
Other Items (list below):									
Stmt. of Struct. & Special Inspections (CO-6a & CO-6b)					X	X	X		
Independent Cost Estimate provided by Agency (CM Est. if CM, DB Contract if DB)			X	X					
V.E. Study & Recommendations (Report & VE-1)			X	X					
Application for Building Permit (CO-17a)							X		
Design Team Responses to BCOM Review		X		X		X			X
GMU Additional Required Items									
Prepped Form DGS-30-380_04-08_Transmittal_for_Review	X	X	X	X	X	X	X	X	X
Departure from the GMU Deisgn Manual Log/Matrix	X	X	X	X	X	X	X	X	X
Request for Code Modification Matrix	X	X	X	X	X	X	X	X	X
LEED or VEES Scorecard Update with Back-up Documentation	X	X	X	X	X	X			
Program Re-Confirmation (with DPB S-1 Form)	X	X	X	X	X	X			
Blocking and Stacking/Linkage-Adjacency Analysis	X		X						
Reference Master Plan Documentation Compliance Check	X		X		X		X		
AARB Approval (SD or PD and WD)	X		X		X				
Updated Building Systems and Equipment Checklist					X	X			
Owners Performance Requirements (OPR) (and revisions)	X	X	X		X	X			
BOD/Actual Equipment Cut Sheets			X		X		X	X	X

Mason Design Submittal Checklist

Item	Schematic Design	Schematic Re-Submit	Preliminary Design	Preliminary Re-Submit	Working Drawings	WD Re-Submit	Building Permit	Fire Alarm/ Sprinkler	FA/Sprink. Re-Submit
Engineering Analysis & Calculations									
Structural	X		X		X	X	X		
Civil	X		X		X	X	X		
Mechanical	X		X		X	X	X		
Plumbing	X		X		X	X	X		
Electrical	X		X		X	X	X		
Fire/Life Safety	X		X		X	X	X	X	X
Accoustics/AV	X		X		X	X	X		
Net/Telecom	X		X		X	X	X		
Load Letters/Utilities									
Electric LL (Per Dominion Power), Revised at PD	X		X						
Water Connection (Per City of Fairfax), Revised at WD			X		X				
Sanitary Fixture Count/DU Count (Per County of Fairfax), Revised at WD			X		X				
Gas (Per Washington Gas), Revised at WD			X		X				
Site Utility Routing Diagram (Revised at PD)	X		X						
Health Department (Food Service only)			X		X				
Detailed List of Owner Provided Items that Impact the Construction/Design (Includes FF&E required)			X	X	X	X			
Consolidated Submittals List			X	X	X	X			
Consolidated Bench/Attic Stock List			X	X	X	X			
Consolidated Warrenty List					X	X			
Consolidated Training Requirements List					X	X			
Consolidated Planned/Designed Outages					X	X			

Mason Design Submittal Checklist

Item	Schematic Design	Schematic Re-Submit	Preliminary Design	Preliminary Re-Submit	Working Drawings	WD Re-Submit	Building Permit	Fire Alarm/ Sprinkler	FA/Sprink. Re-Submit
EIR			X						
SWPPP			X		X				
VSMP/NPDES/E&S Controls Permit Application			X		X				
HAZMAT Survey Disclosure (Survey by Agency)			X		X		X		
DEQ Form 7/AST Back-up			X		X		X		
Life Cycle Cost versus First Cost Analysis (CM/DB or A/E)	X		X		X				
Additive Bid Items List (with Priority and Order)			X		X	X	X		
CxA Issues Log and Status	X		X		X	X		X	X
ICE/CM: Schematic Estimates/DB: Proposal Cost	X								
CM/DB: Risk Analysis Matrix	X		X		X	X			
CM/DB: VE Items List/Log	X		X		X	X			
CM/DB: Design Review Comments/Log	X		X		X	X	X		
GC/CM/DB: Phasing/Logistics Plan (GC after Permit)			X		X	X	X		
CM/DB: Long Lead Item Matrix			X		X	X	X		
CM/DB: Construction Schedule	X		X		X	X	X		
CM/DB: Site Specific Safety Plan			X		X		X		
CM: GMP/ICE: Final Estimate							X		
GC: Notice of Intent to Award Construction Contract							X		

Note: Unless otherwise approved by the Project Manager or a GMU Form is provided, all parties shall utilize standard DGS or DPB Forms for all of the above tasks that pertain. These forms can be found at the following two links:

BCOM Forms Center or DPB Forms Center

2.1.5.2 Pre-Design

Pre-Design has two distinct meanings at Mason. The first refers to studies, efforts, and planning done in order to develop and round out the capital plan for submission to the Commonwealth; referred to Pre-Planning Studies. The second are activities that occur prior to the execution of the design of a particular project that has been approved/authorized by the Commonwealth and George Mason University for execution; Pre-Design Activities.

2.1.5.2.1 Pre-Planning Studies

The Director of Campus Planning leads the effort to construct the university's 6-year capital plan. On a Bi-annual basis this plan is developed and submitted to the Commonwealth for approval. In order to construct this plan, the first step is to refer to Mason's Master Plan Document(s). These can be found at http://facilities.gmu.edu/masterplans/index.htm. Master Plan documents are periodically updated as needed by the university in collaboration with consulting firms, under the direction of the Campus Planning portion of Facilities.

Pre-Planning Studies are executed to define the scope, schedule, and budget for a potential capital project at the university. Design firms are often procured for these studies through term contracts that the university already has established.

Deliverables for Pre-Planning Studies include:

- Project justification narrative
- Conceptual cost estimate
- Massing studies
- Review and validation of deferred maintenance (if applicable)
- Site analysis
- Utility coordination planning
- Phasing/sequencing/schedule plan

A Planner from the Campus Planning portion of Facilities will oversee and direct a pre-planning study. A specific scope, details and requirements will be developed for each study. Planning studies require the use of the Design Manual to ensure that the project developed and submitted into the capital plan accounts for all aspects of its eventual development.

2.1.5.2.2 Pre-Design Activities

References:

- Refer to the CPSM, Chapter 5.5 for details on the required pre-design conference. Agendas and meeting minutes from this conference shall be documented and kept in the permanent project record.

Prior to the start of design, the Design Team must furnish a planned design schedule, a proposed fee allocation and a clear understanding of the scope of services for the project. These are annotated and agreed upon based on a Memorandum of Understanding that becomes a part of the CO-3 A/E services contract.

The Design Team shall fully understand the program and other requirements through a review of the project authorization indicated on the CO-2 and project submission documentation that the university has used to define the project at the outset. These documents can be provided to the Design Team by the university. For the purpose of fee negotiations, Mason's anticipated fee amount may be withheld from the Design Team during this stage of the project.

As a part of the Pre-Design Phase, the Design Team shall provide the university with a report on the existing conditions, as well as any absent investigations that are to occur in subsequent phases. This report, to be delivered prior to the beginning of Schematic Design, shall include applicable narratives, diagrams, photographs, and other descriptive items. This report will require positive concurrence by the university prior to entering into Schematic Design. Refer to Section 2.3 – Existing Conditions in the Design Manual for additional requirements.

It is during this phase that the final design services contract is developed and finalized. The Design Team shall ensure that they have a full understanding of the various responsibilities and typical contract mechanisms used as it relates to specialty consultants. The following annotates some of those requirements:

- CxA Services: Mason typically acquires Commissioning Agent (CxA) services independently from the prime Design Team contract. If there is a CxA hired by Mason, the Design Team shall work closely with them to coordinate and assure responsibilities for design development and construction project commissioning are concluded and scoped correctly in the design documents. The Project Manager will facilitate the process of scope clarification for the various services. If Mason does not hire an independent CxA, they will direct the Design Team to hire such services, or opt to have the Design Team provide certain CxA services as Mason directs.

- Geotechnical Engineering Services: Mason typically acquires Geotechnical Engineering services independently from the prime Design Team contract. If there is a Geotechnical Engineer hired by Mason, the Design Team shall work closely with them to coordinate and develop the subsurface investigation plan during design. Likewise they will coordinate with the Geotechnical Engineer regarding foundation and other related design elements of the project during design development. Should it be necessary, Mason's Geotechnical Engineer may be brought in to aid with field issues as they occur during the construction phase of the project. The Design Team will ensure Boring Plans are adequately presented in the design documents per CPSM requirements. The Project Manager will facilitate the process of scope clarification for the various services. If Mason does not hire an independent Geotechnical Engineer, they will direct the Design Team to hire such services, or opt to have the Design Team provide certain Geotechnical Engineering services as Mason directs.

- Engineering and Materials Testing Services: Per CPSM requirements, Engineering and Materials Testing services must be independently procured by Mason for all capital and non-capital projects permitted through BCOM. The Design Team shall work closely with the Engineering and Materials Testing team to ensure that all quality assurance testing is timely, coordinated, and noted in the construction contract documents. Likewise they will coordinate with the Engineering and Materials Testing service regarding structural and other related design elements of the project during design development. The Engineering and Materials Testing team will be brought in to aid with field issues as they occur during the construction phase of the project. The Design Team will ensure that the testing plans are adequately presented in the design documents per CPSM requirements. The Project Manager will facilitate the process of scope clarification for the various services.

- AV Consultant: It is expected that the project design team will provide a qualified AV consultant (preferably possessing a InfoComm CAVSP Emerald Level or higher organizational certification) to assist with AV infrastructure, Acoustics (a separate acoustical consultant is permissible) and AV drawings to be included in the construction documentation when one of the following scenarios exist: There are classrooms in the project; Specialty Classrooms or Labs (Discipline Specific Spaces); Experimental Classrooms; Classrooms with 150 seats or greater; or when more than 3 Classrooms are a part of the project scope. Outside of these scenarios, and when a project is outside of the ability of Mason's resources to execute the scope of the project (as determined by the university), the shall Design Team provide: a) A qualified AV consultant for AV infrastructure and AV Systems Design for any project where non-classroom spaces are to be equipped with AV equipment and b) Coordination among classroom & non-classroom space designs in order to consolidate purchasing, design, implementation, etc.

- Estimating Services: Mason will hire an independent cost estimator (ICE) on all projects (either independently, or through CM Pre-Construction Services, or by virtue of the Design-Build proposal price). For CM/Traditional General Contractor projects, the Design Team shall provide such assistance as is required to ensure the ICE/CM is able to adequately estimate the project at the various stages of the project. Likewise, the Design Team will work with the ICE/CM to execute estimate reconciliation at the direction of the university at each design phase/estimate.

- Mason Term Consultants: It is noted that Mason has several term consultants that it may opt to use or provide portions of design effort throughout the process. Several of these perform specialty services that enable better synchronization with overall campus systems and themes. The Project Manager will facilitate the process of scope clarification for the various services.

2.1.5.3 Schematic Design

References:

- Refer to CPSM, Chapter 5.6 for requirements for submittal to BCOM at the Schematic Design phase.

Note that this phase is also called "initial design" in non-capital projects.

In addition to these requirements, the Design Team shall provide the following items as a part of the Schematic Submittal (packaged separately from, but at the same time as the items above):

- A listing of any and all deviations from the Design Manual for approval by the university, if applicable. Such deviations require a narrative justification for each deviation provided by the Design Team.

- A listing of any and all deviations from the code for review by the university, if applicable. The Design Team shall prepare a justification in accordance with (IAW) the CPSM and the VUSBC for each deviation. If agreed upon by the university, the Design Team shall prepare a code waiver for submission to BCOM.

- Provide a LEED (or Envision) checklist for the project as it is understood with backup documentation.

- Provide a tabular program reconfirmation based upon the design as it is understood. Deviation from the program as it was established by the university prior to Schematic Design shall require a narrative or other justification on the part of the Design Team.

- Provide blocking/stacking and linkage/adjacency analysis information. The Design Team shall determine the best way to present this information in coordination with the university.

- Provide confirmation and reference information related to the applicable George Mason University Master Plan(s). The Design Team shall provide a narrative and/or depictions on how this project fits within the larger context of the campus in terms of the Master Plan. It must be made clear that the Design Team has carefully analyzed the Master Plan and incorporated the applicable elements into the proposed design.

- Provide materials to support submission to the Art and Architecture Review Board (AARB). Based on direction from the university, the Design Team shall provide boards and other depictions and be prepared to present these to the AARB.
- Provide an annotated copy of the Owners Performance Requirements. This document shall follow a standard template (AASHRAE Guideline 0) and indicate the performance measures for the project. This document will be initially drafted by the independent CxA if there is one as a part of the project; otherwise, drafting of the document shall be done by the Design Team.
- Provide a copy of any and all calculations, by discipline, used in the design to this stage.
- Provide an Electrical Load letter in the format used by the applicable utility for the site/campus.
- Provide an annotated diagram that indicates desired utility routing on the site of construction.
- As directed by the university, provide life-cycle cost analysis for elements of the design. In D-B and CM projects this is to be done in conjunction with the construction execution portion of the team.
- Provide the CxA issues log and status report with annotations from the Design Team, when CxA services are provided for a project.
- Provide a reconciled copy of the estimate as executed by an independent cost estimator or the CM (in addition to the Design Team's reconciled cost estimate), if applicable.
- For CM/D-B projects provide a copy of the risk analysis matrix in coordination with the university at an order of magnitude level.
- Provide a VE Items listing using the applicable DEB form.
- For CM/D-B projects, provide a copy of the updated anticipated construction schedule.

2.1.5.4 Preliminary Design

References:

- Refer to the CPSM, Chapter 5.7 for requirements for submittal to BCOM at the Preliminary Design phase. Specific requirements for drawings are enumerated, and compliance with the NCS is strongly encouraged.

In addition to these requirements, the Design Team shall provide the following items as a part of the Preliminary Design Submittal (packaged separately from, but at the same time as the items above):

- A listing of any and all deviations indicated in the design, from this design manual for approval by the university, if applicable. Such deviations require a narrative justification for each deviation provided by the Design Team, beyond those previously approved.
- A listing of any and all deviations indicated in the design, from the code for review by the university, if applicable. The Design Team shall prepare a justification in accordance with (IAW) the CPSM and the VUSBC for each deviation. If agreed upon by the university, the Design Team shall prepare a code waiver for submission to BCOM, beyond those previously approved.

- Provide an annotated and updated copy of the design issues identified by the university and/or BCOM in prior design submissions, with locations to find resolutions within the design submittal. Comments and resolutions are to be segregated into resolved and unresolved issues in the log/comment sheet, as determined by the university.
- Provide a LEED (or Envision) checklist for the project, as it is understood, with backup documentation.
- Provide a tabular program reconfirmation based upon the design as it is understood. Deviation from the program as it was established by the university prior to Schematic Design shall require a narrative or other justification on the part of the Design Team.
- Provide blocking/stacking and linkage/adjacency analysis information. The Design Team shall determine the best way to present this information in coordination with the University.
- Provide confirmation and reference information related the applicable George Mason University Master Plan(s). The Design Team shall provide a narrative and/or depictions on how this project fits within the larger context of the campus in terms of the Master Plan. It must be made clear that the Design Team has carefully analyzed the Master Plan and incorporated the applicable elements into the proposed design.
- Provide materials to support submission to the Art and Architecture Review Board (AARB). Based on direction from the university, the Design Team shall provide boards and other depictions and be prepared to present these to the AARB, if the project has not previously garnered full approval from the AARB.
- Provide an updated and revised copy of the Owners Performance Requirements. This document shall follow a standard template (AASHRAE Guideline 0) and indicate the performance measures for the project.
- Provide a copy of information as it relates the Basis of Design of any major component. Items such as cut-sheets, standard details and drawings, and operations information shall be provided for review by the university.
- Provide an initial furniture design and layout. Such layouts and designs shall be closely coordinated and approved by the Mason Interior Design staff.
- Provide a copy of any and all calculations, by discipline, used in the design to this stage.
- Provide an Electrical Load letter in the format used by the applicable utility for the site/campus.
- Provide water connection information in the format used by the applicable utility for the site/campus.
- Provide a sanitary fixture count/housing unit count in the format used by the applicable utility for the site/campus.
- Provide a Gas Load letter in the format used by the applicable utility for the site/campus, if applicable.
- Provide a revised annotated diagram that indicates desired utility routing on the site of construction.
- Provide information for the Health Department in the format used by the applicable utility for the site/campus, if applicable.
- Provide a detailed listing, on behalf of the university, of the owner-provided items that affect the project. This includes but is not limited to the furnishing, fixtures and equipment to be provided.

- Provide a consolidated listing of all submittals indicated in the project manual in a format acceptable to the university.
- Provide a listing and indication of the anticipated bench/attic stock (if any) for the project.
- Provide an Environmental Impact Report in accordance with state and federal requirements.
- Provide a stormwater pollution prevention plan (if applicable) in accordance with state and federal requirements.
- Provide a Virginia Stormwater Management Program and Erosion and Sediment Control Permit application for the project.
- Provide a recommendation for the Hazardous Materials disclosure statement based upon the Hazardous Materials survey information provided by the university.
- Provide information to support air permitting by the university for any emitting device in the project and/or information to support storage tank permitting in accordance with state and federal law.
- As directed by the university, provide life-cycle cost analysis for elements of the design. In D-B and CM projects this is to be done in conjunction with the construction execution portion of the team.
- Provide a listing of proposed Additive Bid items in the design, with applicable priorities.
- Provide the CxA issues log and status report with annotations from the Design Team, when CxA services are provided for a project.
- Provide a reconciled copy of the estimate as executed by an independent cost estimator or the CM (in addition to the Design Team's reconciled cost estimate), if applicable.
- For CM/D-B projects provide a copy of the risk analysis matrix in coordination with the university. This risk should allow for an understanding of the impact in terms of weeks of time or in terms of the nearest thousand dollars of expense.
- Provide a VE Items listing using the applicable DEB form.
- For CM/D-B projects, provide a copy of the updated anticipated construction schedule.
- For CM/D-B projects, provide a copy of the phasing/site logistics plan created by the construction executor.
- Provide a listing of any long lead item (in excess of 10% of the anticipated construction duration) for the project. This listing shall include anticipated time for procurement, delivery and installation, as well as the latest date of order to meet the anticipated construction schedule critical path requirements.
- For CM/D-B projects, provide a copy the site specific safety plan for review.

2.1.5.5 Working Drawing Phase Documentation

References:

- Refer to CPSM, Chapter 5.8 for requirements for submittals to BCOM at the Working Drawings Phase (Construction Documents Phase). This phase is also referred to as "Final Design" in non-capital projects.

In addition to these requirements, the Design Team shall provide the following items as a part of the Working Drawing Submittal (packaged separately from, but at the same time as the items above):

- A listing of any and all deviations from the Design Manual for approval by the university, if applicable. Such deviations require a narrative justification for each deviation provided by the Design Team, beyond those previously approved.
- A listing of any and all deviations from the code for review by the university, if applicable. The Design Team shall prepare a justification in accordance with (IAW) the CPSM and the VUSBC for each deviation. If agreed upon by the university, the Design Team shall prepare a code waiver for submission to BCOM, beyond those previously approved.
- Provide an annotated and updated copy of the design issues identified by the university and/or BCOM in prior design submission, with locations to find resolutions within the design submittal. Comments and resolutions are to be segregated into resolved and unresolved issues in this log/comment sheet, as determined by the university.
- Provide a LEED (or Envision) checklist for the project as it is understood with backup documentation. In addition, demonstration of submission of the LEED design submittal credit approvals shall be provided.
- Provide a tabular program reconfirmation based upon the design as it is understood. Deviation from the program as it was established by the university prior to Schematic Design shall require a narrative or other justification on the part of the Design Team.
- Provide confirmation and reference information related to the applicable George Mason University Master Plan(s). The Design Team shall provide a narrative and/or depictions on how this project fits within the larger context of the campus in terms of the Master Plan. It must be made clear that the Design Team has carefully analyzed the Master Plan and incorporated the applicable elements of those plans in the design presented.
- Provide materials to support submission to the Art and Architecture Review Board (AARB). Based on direction from the university, the Design Team shall provide boards and other depictions and be prepared to present these to the AARB, if the project has not previously garnered full approval from the AARB.
- Provide an updated and revised copy of the Owners Performance Requirements. This document shall follow a standard template (AASHRAE Guideline 0) and indicate the performance measures for the project.
- Provide an updated copy of the Building Systems and Equipment Checklist as indicated in Chapter 5.7.2.2 of the CPSM.
- Provide a copy of information as it relates the Basis of Design of any major component. Items such as cut-sheets, standard details and drawings and operations information shall be provided for review by the university if not already provided.
- Provide air-flow drawings and diagrams for all mechanical systems.
- Provide a copy of any and all calculations, by discipline, used in the design to this stage.
- Provide an Electrical Load letter in the format used by the applicable utility for the site/campus, if not already provided at an earlier stage and not in need of revision.

- Provide water connection information in the format used by the applicable utility for the site/campus, if not already provided at an earlier stage and not in need of revision.

- Provide a sanitary fixture count/housing unit count in the format used by the applicable utility for the site/campus, if not already provided at an earlier stage and not in need of revision.

- Provide a Gas Load letter in the format used by the applicable utility for the site/campus, if applicable, if not already provided at an earlier stage and not in need of revision.

- Provide information for the Health Department in the format used by the applicable utility for the site/campus, if applicable.

- Provide a detailed listing, on behalf of the university, of the owner provided items that affect the project. This includes but is not limited to the furnishing, fixtures and equipment to be provided.

- Provide a consolidated listing of all submittals indicated in the project manual in a format acceptable to the university.

- Provide a listing and indication of the anticipated bench/attic stock (if any) for the project.

- Provide a listing of all warranties to be provided as a part of the project to the university.

- Provide a listing of all training to be provided as a part of the project to the university.

- Provide a listing of all required/planned/anticipated outages related to the construction of the project.

- Provide a storm water pollution prevention plan (if applicable) in accordance with state and federal requirements, if not already provided at an earlier stage.

- Provide a Virginia Stormwater Management Program and Erosion and Sediment Control Permit application for the project.

- Provide a recommendation for the Hazardous Materials disclosure statement based upon the Hazardous Materials survey information provided by the university.

- Provide information to support air permitting by the university for any emitting device in the project and/or information to support storage tank permitting in accordance with state and federal law.

- As directed by the university, provide life-cycle cost analysis for elements of the design. In D-B and CM projects this is to be done in conjunction with the construction execution portion of the team.

- Provide a listing of proposed Additive Bid items in the design, with applicable priorities.

- Provide the CxA issues log and status report with annotations from the Design Team, when CxA services are provided for a project.

- For CM/D-B projects provide a copy of the risk analysis matrix in coordination with the university. This risk should allow for an understanding of the impact in terms of days of time or in terms of the nearest hundred dollars of expense.

- Provide a VE Items listing using the applicable DEB form.

- For CM/D-B projects, provide a copy of the updated anticipated construction schedule.

- For CM/D-B projects, provide a copy of the phasing/site logistics plan created by the construction executor.

- Provide a listing of any long lead item (in excess of 10% of the anticipated construction duration) for the project. Such a listing shall include anticipated time for procurement, delivery and install, as well as the latest date of order to meet the anticipated construction schedule critical path requirements.

- For CM/D-B projects, provide a copy the site specific safety plan for review, if not already provided.

2.1.5.6 Permit Phase Documentation

References:

- Refer to Chapter 5.9 of the CPSM for requirements for Bid Forms and Procedures.

In addition to these requirements, the Design Team shall provide the following items as a part of the Permit Submittal (packaged separately from, but at the same time as the items above):

- A listing of any and all deviations from the Design Manual for approval by the university, if applicable. Such deviations require a narrative justification for each deviation provided by the Design Team, beyond those previously approved.

- A listing of any and all deviations from the code for review by the university, if applicable. The Design Team shall prepare a justification in accordance with (IAW) the CPSM and the VUSBC for each deviation. If agreed upon by the university, the Design Team shall prepare a code waiver for submission to BCOM, beyond those previously approved.

- Provide an annotated and updated copy of the design issues identified by the university and/or BCOM in prior design submissions, with locations to find resolutions within the design submittal. Comments and resolutions are to be segregated into resolved and unresolved issues in this log/comment sheet, as determined by the university.

- Provide confirmation and reference information related the applicable George Mason University Master Plan(s). The Design Team shall provide a narrative and or depictions on how this project fits within the larger context of the campus in terms of the Master Plan. It must be made clear that the Design Team team has carefully analyzed the Master Plan and incorporated the applicable elements of those plans in the design presented.

- Provide a copy of information as it relates the Basis of Design of any major component. Items such as cut-sheets, standard details and drawings, and operations information shall be provided for review by the university, if not already provided.

- Provide a copy of any and all calculations, by discipline, used in the design to this stage.

- Provide a recommendation for the Hazardous Materials disclosure statement based upon the Hazardous Materials survey information provided by the university.

- Provide information to support air permitting by the university for any emitting device in the project and/or information to support storage tank permitting in accordance with state and federal law.

- Provide a listing of proposed Additive Bid items in the design, with applicable priorities.

- For CM/D-B projects, provide a copy of the updated anticipated construction schedule.
- For CM/D-B projects, provide a copy of the phasing/site logistics plan created by the construction executor.
- Provide a listing of any long lead item (in excess of 10% of the anticipated construction duration) for the project. Such a listing shall include anticipated time for procurement, delivery and installation, as well as the latest date of order to meet the anticipated construction schedule critical path requirements.
- For CM/D-B projects, provide a copy the site specific safety plan for review, if not already provided.
- For CM Projects, a copy of the Guaranteed Maximum Price Proposal and acceptance by the university.
- For D-B/Design-Bid-Build/General Contracted projects, a copy of the Notice of Intent to Award.

2.1.5.7 Construction Phase Documentation

References:

- Refer to Chapter 2.1.5.8 of the Design Manual for information regarding Project Record Documentation.
- Refer to Chapters 7.10 through 7.17 of the CPSM for Requirements of the A/E during the Construction Phase. The university intends for the Design Team to provide all services both required and optional as indicated in Chapters 7.10.2 and 7.10.3 of the CPSM with the following exceptions:
    - The university does not want the Design Team to conduct the monthly pay meeting.
    - The university may opt to not have the Design Team certify pay requests and approve the CO-12 schedule of values.
    - The university does not want the Design Team to receive the contactors affidavit of claims.

During a project the Design Team shall maintain a record copy of the following items, to be provided to the university:

- Submittals, including shop drawings
- Change orders, Architects Supplemental Instructions, Bulletins, and similar documents.
- Testing records, abatement reports
- Documentation, including approved submittals, of project "piggy-back" contracts for Fixtures, Furnishings, and Equipment (CPSM, Chapter 3.2.2.7)
- All CM RFPs and responses
- Any and all inspection reports
- Meeting Minutes
- Bid process documents, contracts (as per state req.)
- Revisions to Drawings or Specifications and any addendums

- Environmental Impact Statements, Geotechnical Reports, Storm Water Management Plans, and Site utilities survey information

2.1.5.8 Project Record Documentation

References:

- Refer to Chapter 7.24 of the CPSM for the requirements for Record Drawings and Specifications.

Project Record Documentation includes the complete and formal documentation of the project. Of critical concern is the record drawings and specifications, but the documentation includes other items as well. The university requires that the Design Team shepherd this process to conclusion and deliver all Project Record Documentation, as indicated below, in a timely manner.

It is noted that the Design Team may or may not be the originator or primary caretaker of these documents, but it is still the responsibility of the Design Team to ensure that these documents are properly obtained, cataloged, collated, and provided.

Project Record Documentation shall be provided in electronic format in two manners (except as noted below). First, the documents shall be provided in an Adobe Portable Document Format (PDF), replicating the printed record derived directly from the software or source derived. If it is not possible to derive a PDF directly from the editable version, provide a scanned copy in PDF format. Secondly, the documents shall be provided in their original editable format; the original editable format must be compatible with Mason’s software (see below). Editable files shall be “bundled” to include all external references and objects.

The Design Team shall prepare “record drawings” showing the “as-built” conditions, locations and dimensions based on the contractor’s as-built set of drawings and specifications, and other data furnished by the contractor to the Design Team.

2.1.5.9 Record Drawings and Specifications

References:

- Refer to Chapter 7.24.1 of the CPSM. Note that this section of the CPSM does not account fully for current technology and records storage that is utilized by the university. It remains a requirement of the university to provide a hard-copy deliverable, which is stamped “Record Drawings”/”Record Specifications,” and reconciled with the contractor’s field information (see Chapter 7.18 of the CPSM). Additional university requirements for full project Record Drawings and Specifications are included in the Design Manual.

The following outlines the procedure that the university follows for the development of Project Record Drawings and Specifications:

- The Design Team shall obtain a copy of the contractor’s “as-built” drawings from the field at substantial completion. Prior to developing the record drawings, the Design Team shall scan in the contractors “as-builts” into Adobe Portable Document Format (PDF), and catalog the drawings clearly. The A/E shall then provide two DVD/CD media copies of these drawing files to the university.

- Based on all of the project documentation collected in the Construction Phase and the contractor’s “as-builts”, the Design Team shall draft a set of project record drawings and specifications.

- Upon completion of draft record drawings and specifications by the Design Team, the Design Team shall provide two paper copies to the university for review.

- When the completed draft record drawings and specifications are returned to the university, the reviewer will either accept or reject them. If they are rejected, the unaccepted documents will be reported for additional revisions and returned to the Design Team for a second draft record drawings and specifications document release.

- Following university reviews, incorporating comments, and upon final acceptance by the university, provide:

  - Hard Copy: one signed and sealed copy of final Record Drawings on Mylar, one full size signed and sealed copy of final Record Drawings on standard white bond paper, one signed and sealed copy of final Record Specifications on standard white bond paper.

  - Electronic Copy: to CD/DVD media copies of : one set of files in an editable design software format that Mason uses (see below) and one in Adobe Portable Document Format (PDF), replicating the printed record drawings and specifications derived directly from the design software. All editable design files shall be "bundled" to include all external references and objects.

- The specific requirements of the accepted drawings and specifications for Mason's use are as mandated by the CPSM.

2.1.5.9.1 Additional Project Record Documentation

References:

- Virginia Records Management Manual.pdf: http://www.lva.virginia.gov/agencies/records/manuals/vprmm.pdf

- Infrastructure Update Worksheet – Infrastructure Value Worksheet.pdf

The Design Team shall ensure that in addition to the Project Record Drawings and Specifications, the following items are provided to the university:

- Provide the final approved and certified LEED (or Envision) checklist for the project with all backup documentation. Inclusive in this is a copy of any and all certification paperwork, certificates, or acknowledgements from the applicable rating agency.

- Project warranties manuals

- Project Operations and Maintenance (O&M) manuals

- A copy of all other records maintained by the Design Team during the Construction Phase in electronic format

All project submittal documentation shall be provided both electronically and in original format.

2.2 DOCUMENT ORGANIZATION AND FORMAT

2.2.1 GENERAL

References:

- CPSM, Chapter 5.2 – General Requirements for Drawings and CPSM, Chapter 5.3 – Specification Standards.

Project documents come in numerous formats. It is noted that these requirements primarily pertain to printed drawings and specifications. That said, this is the base point from which all project documentation must take its mark. It is also noted that the CPSM requires drawings submitted to BCOM to be submitted in hardcopy format.

2.2.2 DRAWING AND DOCUMENTATION STANDARDS

2.2.2.1 Drawing Format and Organization

References:

- CPSM, Chapter 5.2

It is the policy of George Mason University that the Design Team use Computer Assisted Drawing (CAD) or Building Information Modeling (BIM) software to develop drawings for all capital outlay building and infrastructure projects. For non-capital outlay projects, the primary means of developing drawings shall be CAD, but other methods may also be considered at the direction of the Project Manager.

Although Mason requires the use of CAD, it remains platform neutral, and supports the standards, guidelines, and recommendations found in the National CAD Standard. The current version can be found at http://www.nationalcadstandard.org/.

Furthermore, the university encourages the use of new technologies and collaborative efforts, and requires the use of BIM on all new capital outlay building projects and select renovation or infrastructure projects as determined by Facilities. For projects designed in BIM, Mason requires the use of the National BIM Standard and the use of the Construction Operations Building Information Exchange (COBie) format for the database support of BIM. These standards can be found at http://www.nationalbimstandard.org/ and http://www.wbdg.org/.

Mason strongly encourages and may mandate (as determined by the university) the design team to form a BIM Implementation Team, made of at least one representative from the Design Team, GC/CM/D-B Constructor, and the owner. Through the regular meetings thereof, develop and follow a BIM Execution Plan, in order to address the specific needs of the project and the developing technology and ability of the owner to utilize the data produced with BIM to support both the project, and the entire facility lifecycle.

The following formatting guidelines shall be followed in the preparation and delivery of drawings:

- When placed into a plan set (a bundle more than one sheet; whether electronic (PDF) or printed in hard copy format) all drawings shall be oriented uniformly (preferably landscape orientation). Likewise, plans shall be oriented so that the orientation of geographic north remains consistent throughout the plans (refer to Chapter 5.2.5 of the CPSM).

- Sheet Size: For capital outlay projects and non-capital outlay project submitted to BCOM for permit, 30”x42” (CPSM, Chapter5.2.3). All others shall be 22”x34”, 17”x22”, 11”x17”, or 8½” x 11”.

- Lettering: Refer to Chapter 5.2.4 of the CPSM. Fonts shall be as specified in Mason's Visual Identify Guide found at http://logo.gmu.edu/.

- Title Sheet: Shall conform to Chapter 5.2 of the CPSM. In addition, the title sheet shall include the Mason logo, as provided in Mason's Visual Identify Guide found at http://logo.gmu.edu/. The Logo shall be a maximum 3" high, minimum 2" high. The title sheet shall also contain the name, address, phone number, fax number, and email address of the Design Team and any consultants used on the project.

- Title Block: The Design Team may use their standard title block, provided it contains the following minimum information:

  - Primary Design Team firm name and sub-consultant Design Team, if applicable
  - Project name (shall match the title of the project on the CO-2)
  - Project number: cross-referenced to Project Code on the CO-2.
  - Geographic location (shall be the street address of the site)
  - Campus name (Abbreviations: ARL = Arlington Campus; FFX = Fairfax Campus; PWC = Prince William Campus, LDN = Loudon Campus, SMSC = Smithsonian-Mason School of Conservation, PSC = Potomac Science Center, POV = Point of View)
  - Date drawing was completed/approved/ready for bid (see Chapter 5.2.8 of the CPSM)
  - Revision block (indicate revision issue, revision made by, revision date, revision approved by, and revision description; block shall include at least 6 lines for revisions)
  - Scale of drawing, unless noted under each detail (refer to Chapter 5.2.14 of the CPSM)
  - Sheet number and drawing number (see below)
  - Building number, if provided by the university
  - Area large enough for Design Team's signature and seal
  - Approval block (for the signature of the university to approve the drawing)

2.2.2.2 Drawing Arrangement and Number

References:

- Refer to Chapter 5.2.6 of the CPSM for section/detail identification and section/detail numbering.

- The university's drawing numbering system must be used for all drawings. Details of Mason's drawing numbering system are included below:

- Drawings shall have the following first letter(s) indicator, in the following order (as they are applicable to the type of project): T - Title Sheet and Index, C - Plot and/or Site plans, C - Sanitary and Civil, U – Any Other Utilities, B - Boring logs, L – Landscaping, D – Demolition, A – Architectural, AI – Architectural Interiors (including Furniture Layouts), AL – Laboratory Furniture, Benches, Layouts, Details and Accessories, FS – Food Service Layouts and Details, S – Structural, FP- Fire Protection Information, SP-

Sprinkler Systems, Standpipes, and Accessories, P – Plumbing, M - Mechanical (heating, cooling, ventilation, etc.), E – Electrical, R - Asbestos Abatement.

- Each drawing shall have a unique number of the following format: First Letter Indicator (above) followed by a number in the format of XXX. The following provides further numbering information for drawings which is to be confirmed with the Project Manager for any project:
    - Indexes, reference diagrams, data, standard mountings, common terms, or narratives information shall be in the "zero series" (e.g. C001, M002, T001, etc.)
    - Plan information shall be in the "hundred series" (e.g. P101, E102, AI105, etc.)
    - Building or road cross-sections shall be in the "two hundred series" (e.g. C235, A203, etc.)
    - Details and profiles shall be in the "three hundred series" (e.g. U301, AI305, SP304, etc.)

2.2.2.3 Electronic Drawing Documents

References:

- Refer to Section 2.1.5.8 of the Design Manual for deliverable requirements for electronic documents.
- Design Team firms shall use National CAD Standards and The Uniform Drawing System, which includes the accepted CAD layer guidelines.
- If using BIM, the National BIM Standard must be used.

The university currently uses AutoCAD (current edition) as its editable drawing format. Additionally, ArcGIS is used for utility and boundary related information. The university uses Revit as its BIM software package. Mason requires that electronic drawing files must be in a format no older than two versions before the latest release (e.g. if the current software release date is 2012, the file format must be 2010 or later).

2.2.2.4 Bid Documents

References:

- Design Manual, Section 2.1.5.6 – Permit Phase Documentation

At the time of bid advertisement, provide one electronic copy on CD/DVD Media and 5 paper copies of bid drawings to the university.

2.2.2.5 Drawing Procedures

2.2.2.5.1 Drawing Release Procedure

- All fields in the title block area of the drawing are to be completed. A comprehensive description of the project and drawing title is mandatory for documentation and future reference.
- The university must sign all drawings to be released.

2.2.2.5.2 Drawing Revision Procedure

- Any changes shall be made to the original drawing; include a description of the revision in the revision area of the title block.

2.2.3 SPECIFICATION STANDARDS

2.2.3.1 Coordination

References:

- CPSM, Chapter 5.3 – Specification Standards

Specifications shall be coordinated so that issues are addressed only once, and conflicts are avoided. For instance, the engineering specifications shall not reiterate the number of shop drawings needed, or mention additions to the Bid Form. These problems often arise when the Designer of Record uses sub-consults. The prime Design Team is responsible for reviewing the other designers' specifications and coordinating such items. Specifications from consultants must be submitted to the prime Design Team with enough time to perform this review.

2.2.3.2 Format and Content

2.2.3.2.1 Format

The following guidelines must be adhered to in the formatting of project specifications:

- Use the Construction Specifications Institute (CSI) MasterFormat™, 2004 Edition, for all specifications. The format shall be consistent throughout the entire specification.
- The university currently uses Microsoft Office (current edition) as its editable specification format. Mason requires that electronic drawing files must be in a format no older than two versions before the latest release (e.g. if the current software release date is 2012, the file format must be 2010 or later).
- Specification documents shall be provided in electronic format in two manners (except as noted below). First, the documents shall be provided in an Adobe Portable Document Format (PDF), replicating the printed record derived directly from the software or source derived. Secondly, the documents shall be provided in their original editable format, in a form that is compatible with Mason's software. Editable files shall be "bundled" to include all external references and objects.
- All articles, paragraphs and subparagraphs shall be numbered or lettered in outline form for easy reference.
- Section Number and Title shall be boldly indicated at top of first page of Section. The first Section of each Division shall also indicate the Division name and title.
- Each Section (each major CSI division shall be a separate section) shall end with "END OF SECTION XX XX XX" to indicate that this is the last page of the Section. Each page of the Section shall have the Section number and page number (sequentially numbered) centered at the bottom of the page. Reason: in the printing process it is possible to misplace a page or get pages in wrong order. The Contractor can easily determine that he has all proper pages by checking the sequential numbers and will know he has the last page with the "END OF SECTION" indication. All pages of the specification are to be sequentially numbered from page 1 to the end of the Division. This must be performed just prior to printing when the entire specification is complete and is most easily accomplished by using one of the large type numbering machines.

2.2.3.2.2 Proof Reading

The Design Team must ensure that all specifications are proofread. The omission of a simple word, such as "not," will completely change the meaning of a sentence.

2.2.3.2.3 Prohibited Language

References:

- CPSM, Chapter 5.3

The following words, phrases, and clauses are expressly prohibited:

- "Plumbing Contractor," "Food Service Contractor, etc. When writing specifications, the Design Team must be cognizant of the method of procurement of construction. For contracts using traditional Design-Bid-Build/prime Lump Sum General Contracts, the General Contractor is responsible for performing all work required. Therefore, it is the General Contractor’s business decision as to how the work will be divided amongst their subcontracts (also refer to Chapter 5.3.13 of the CPSM). If the work is to be performed under Construction Management or Design-Build methodologies, and the Design Team has coordinated with the construction execution element, and upon agreement with the university, the specifications may make such an assignment. Aside from this caveat, **the only exceptions** are for automated building controls, building access systems, and chemical treatment of hydronic piping, where Mason uses specific manufacturers.

- The note "by others" or Not in Contract (NIC), unless agreed upon by the university. If there is work to be performed by others, or outside of the prime contract, name the specific contractor or agent to provide the item. Refer to Chapter 5.3.13 of the CPSM.

- The word~~s~~ "alternate" to indicate an "option". The word "alternate" shall be used only for alternate work which is specified in the technical sections of the specifications and must be included in the bidders' proposals. The word "option" shall be used to indicate items for which the contractor may make a choice without affecting the contract. All options must be approved by the university prior to construction/permit document preparation, in which case either the change will be done at no increase in cost to the project, as a credit or deduct (which the Design Team shall make clear in the appropriate specification).

- "Is," "are," or "will be." Use the word "shall," or put in imperative tense. This is particularly a problem when copying specifications provided by manufacturers which are used as a sales tool. Remove text which indicates the advantages for using this product, or other text unrelated to the nature of the material or its proper installation.

- Avoid abbreviations and symbols without clarification and consistency, such as #, @, &, and w/.

- When referring to George Mason University, use the terms "Owner" or "University". Do not use "Using Agency" or "State."

2.2.4 ROOM NUMBERING

2.2.4.1 General

The numbering of rooms at the inception of a project, through construction, and into commissioning of a building has a lasting effect on the building after construction has concluded. Room numbers are utilized to track the location of furnishings, space control, and the allocation of future program space by the Office of Space Management. Fire protection systems (inclusive of fire alarm layouts and programming), electrical systems (inclusive of panel schedules), and mechanical maintenance work must be coordinated using the appropriate room numbers. Punch-lists are developed based upon the room numbers that are provided in the plan set. Once in operation, general maintenance, energy management systems, housekeeping services, key control, housing room number assignments, telecommunications, and emergency response services depend upon an accurate room numbering system. Likewise, the registrar utilizes these numbers to enable the scheduling of classes and academic activities. Also, student life, recreation, athletic, and other activities depend upon the use of accurate and useful room numbers for the scheduling of the numerous activities that go on at George Mason University.

It is hoped that through this procedure Design Team firms will have enough guidance to anticipate these needs and assign proper room numbers as a matter of course. Note that this procedure is not all encompassing, but is intended to provide guidance in the development of the room numbering and applicable signage for any particular building that may be designed. Design Team firms are responsible for discussing, coordinating, and validating the room numbering of any particular building with the planning project manager through the design process.

2.2.4.2 Procedure

References:

- For signage related to room numbering, refer to Chapter 3.2 – Interior Space Standards in the Design Manual.

During the design phase, the Planning Project Manager will provide guidance to the Design Team regarding the assignment of room numbers. The Design Team shall review this document with the Project Manager and the Offices of Campus Planning and Space Management prior to the establishment of room numbers for the preliminary drawings.

The following are the particular guidelines to be used in numbering rooms in a building at George Mason University:

- Numbering shall be conducted by floor level.
  - The level of the building having the main entrance to the building shall be in the 1XXX series of numbers starting at 1001 and continuing through 1999. If doubt exists concerning what is to be considered as the main entrance of the building, the Planning Project Manager will make this determination in consultation with the Office of Space Management.
  - Floors above the main level shall be numbered in groupings of thousands, increasing sequentially (e.g. the level above the main level shall be 2XXX, the level above that shall be 3XXX, etc.).
  - Non-exposed floors below the main level shall be numbered in sequential hundred groupings starting with B1XX, then B2XX, etc.

  - If there is an exposed level below the main entry level of the building (or between the main level and non-exposed floors below), this level shall be numbered using a thousand number grouping starting with L001 through L999. If there are multiple exposed levels below the main level of a building, coordinate a solution with the Planning Project Manager.

  - In the event that the work involved requires an addition to the building that has an already established numbering system, the numbers shall be assigned by cardinal direction in relation to the existing building, and by the applicable floor level designator (e.g. a two-level east wing addition expanding the main level and the level above and below it would have room numbers for the main floor in the E1XX series, the floor above in the E2XX series, and the floor below with either ELXX or EBXX depending upon whether or not it was exposed).

  - Note that there may be instances where floor levels do not easily fit into the schema indicated above (e.g. performing arts centers, arenas, etc.). In this case, the Design Team shall coordinate with the Planning Project Manager to schedule a meeting with the Offices of Space Management, Facilities Planning, Commissioning, and any other relevant parties to discuss the room numbering plan in detail. The goal, however, is to attempt to follow the guidance in the Design Manual to the maximum extent possible.

- Numbering by floor shall be conducted in a counter-clockwise fashion from the main entrance of the building (or from the entry to that floor closest to the main entrance of the building for floors above and below the main floor) flowing along the corridors to be provided. Rooms shall be numbered sequentially as their entrances are arrived at on either side of the hallway. Rooms do not need to be numbered odd on one side of the hall and even on the opposite side, but shall simply numbered in order of arrival. In the case that two rooms have their entrance doors aligned directly in front of one another, the exterior room shall be numbered ahead of the interior room.

- If a single room, or a pair of rooms, does not have direct access to a hallway/corridor, they shall be numbered following the number of the room immediately connected to the hallway/corridor.

- Multiple rooms not having direct access to hallways/corridors, such as suites or a series of multiply-connected rooms, shall have a 100 number separation from the previous room in the sequence. For instance, if an office suite has a central room off the corridor, the central room shall be assigned a number at the next century mark from the prior number room as indicated above (e.g. if the prior room was 1029 the first/central room would be 1100). The offices, in a manner of flow from one into another, or in a counter-clockwise fashion if no intervening rooms exist, shall be given numbers in singular sequence as designators for each room off the central room (e.g. 1101, 1102, 1103, etc.). Once the suites room numbers are complete, the next room shall be numbered in the next century interval (e.g. 1200 continuing the sequence above).

2.2.5 ADDENDA

References:

- CPSM, Chapter 7.3.2 – Addenda to the Bid Documents

2.3 EXISTING CONDITIONS

2.3.1 GENERAL

Sources of existing conditions documents include Mason Facilities Archives and Records, Mason Land Disturbance, George Mason University Libraries/Fenwick Library, the Facility Manager (if applicable).

The Design Team is responsible for verification and documentation of existing conditions. Any testing or verification of existing conditions beyond visual inspection will require review and approval by the Project Manager.

2.3.2 SITE CONDITIONS

2.3.2.1 Land Disturbance

References:

- CPSM, Chapters 4.17 – Erosion and Sediment Control Requirements and 6.2 – Civil and Sitework Design Standards
- Refer to the Mason Erosion and Sediment Control Standards How-to Manual: http://facilities.gmu.edu/LandDevelopment/erosion1.htm.

2.3.2.2 Site Permitting

References:

- Design Manual, Section 2.3.2.1 – Land Disturbance

2.3.2.3 Natural Features

2.3.2.3.1 Surface Investigation

2.3.2.3.1.1 Historical Concerns

- The Design Team shall ascertain any and all information required in order to determine any historical concerns of the project site or its nearby environs.

2.3.2.3.1.2 Environmental Concerns

- The Design Team shall execute such studies, surveys, assessments, and other discovery techniques to ascertain the environmental sensitivity of the project site and its environs inclusive of any implications of the Chesapeake Bay Protection Act, the provisions of the EPA, the requirements of Virginia DCR, sustainment goals of the university of the Commonwealth of Virginia, and all Environmental Impact Statements or Environmental Assessments that may have been or will be required to be executed for the site.

2.3.2.3.1.3 Survey of Existing Site Conditions

- The Design Team shall ascertain the existing topographic and on-site data as required for the actual pre-existing conditions, including existing storm and run-off structures and systems. If existing as-built data that may be provided by the university or term-contract consultants, does not represent the actual on-site conditions by simple observation, the Design Team is obligated to execute a site survey in order to provide an accurate survey to the required precision for development within the framework of the project that the Design Team is retained for. Such a survey shall include: topographic survey of surface features, existing features mapping, an existing utility survey, a tree survey (both in plan and profile), and a soils survey. The Design Team shall execute digital photography of the site for any project.

2.3.2.3.2 Subsurface Investigation

References:

- CPSM, Chapter 6.2 – Civil and Sitework Design Standards

2.3.2.3.2.1 Geotechnical Data

- The Design Team shall review and provide feedback on provided archived Geotechnical reports. If after such a review, the A/E feels that geotechnical data is lacking, the Design Team shall make such recommendations and develop the required provisions and specifications for GMU to execute further geotechnical investigations as required for the project.
- At least two borings shall be required for parking lot areas and major roadways, in addition to the borings requested for the building itself. The minimum borings for a building shall be six with one boring for every 2,500 sq. ft. of built over area. Borings shall be to depth no less than the expected depth of excavation for the project.
- The Design Team shall show all boring results on the drawings.
- All horizontal structures within 10 feet of any proposed grade shall be investigated and identified on the drawings.
- All vertical structures within 30 feet of propose grade, at a location of refusal (e.g. bedrock) within 30 feet of proposed grades, or to a depth that is acceptable to the university that is less than these requirements, shall be investigated and identified on the drawings.

2.3.2.3.3 Storm Drainage

- During design, consider storm runoff from all areas surrounding the site in addition to storm runoff from the site and adjacent sites. Prepare calculations to support design. Calculations shall be submitted to the university.

2.3.2.4 Utilities Infrastructure

2.3.2.4.1 Utility Services

- The Design Team shall discover and assure knowledge of the locations of the various utilities feeding to or through the project site. This discovery shall require that contact be made with the applicable utility provider (Electrical: Dominion Virginia Power, NOVEC, etc.; Sewer: Fairfax County, Prince William County, etc.; Water: Fairfax City, Arlington County, etc.; Gas: Washington Gas) and be thoroughly familiar with that utility's connection and other requirements.

2.3.3 BUILDING CONDITIONS

2.3.3.1 Substructure

The Design Team shall full review and ascertain the conditions of foundations systems, substructures and nearby foundation system issues inclusive of water infiltration, uplift and differential settlement that may be evident.

2.3.3.2 Envelope

2.3.3.2.1 Existing Building As-built Conditions

- The Design Team shall execute a full review and acquire the fullest corpus possible of the as-built conditions and documents of any buildings adjoining or residing near the project site. To that end, the Design Team has the due diligence requirement to actually execute an on-site assessment of the existing architectural systems and buildings and be thoroughly familiar with the conditions and designs of those spaces. Likewise, it is expected that the Design Team shall execute such investigations as required to include inspection of cavities, hidden features, or access panels throughout the adjoining structures to be able to fully understand the as-built conditions and avoid any conflicts that may evolve pertaining to the connection to or placement near these features of the existing architecture.

2.3.3.3 Interiors

2.3.3.3.1 Hazardous Materials

- The Design Team shall execute such surveys, investigations, and discovery techniques required to ascertain the status of any and all Hazardous Materials that may be on or near the project site that may directly or indirectly effect the development and construction of the project.

2.3.3.4 Services

2.3.3.4.1 First Responder/Emergency Management

- The Design Team shall discover and ensure understanding of any applicable first responder or emergency management issues, concerns, or requirements as they pertain to the project.

2.3.3.4.2 Telecom and Security

- The Design Team shall work to understand and provide for the requirements of the George Mason University telecommunications, information technology and applicable security systems to be employed throughout the university as they pertain to this project.

2.3.3.4.3 Mechanical Systems

- The Design Team shall investigate, survey, assess and determine, as required, the conditions, balance, commissioning, and operation of any and all mechanical systems that may exist as they relate to the project. The Design Team has the obligation to ensure that such discovery enables the design team to provide a fully functioning mechanical system that maintains proper pressure balance, temperature settings, humidity control, energy management controls and other requirements seamlessly between any new and existing elements of the project.

2.3.3.4.4 Specifications

- The Design Team shall review all prior specifications, and such submittals as required, to understand the existing systems and their employment in and around the project site.

2.4 CALCULATION TEMPLATES

2.4.1 ESTIMATING STANDARDS

COMPLY WITH CPSM

2.4.2 AREA AND VOLUME CALCULATIONS

COMPLY WITH CPSM

2.4.3 ENERGY/LIFE CYCLE COSTS

RESERVED

2.5 SUSTAINABILITY QUALIFICATION

2.5.1 GENERAL

References:

- Refer to Chapter 1.5 in the Design Manual for additional information regarding Mason’s approach to sustainability.

In 2007, Mason's Board of Visitors established that all new buildings and renovations must obtain, at minimum, the Leadership in Energy and Environmental Design (LEED) Silver certification level or its equivalent. Mason currently utilizes LEED, Virginia Energy Conservation and Environmental Standards (VEES), and Green Globes. Mason has a preference for LEED since it is a well-established, industry-recognized, third-party certified, progressive standard. It is the standard accepted and measured within STARS which provides Mason its sustainability rating. Thus, Mason requires use of the USGBC LEED Rating system for all building projects. For non-building projects, Mason will accept the use of the Envision rating system as an alternate to LEED.

2.5.2 COMMISSIONING

References:

- CPSM, Chapters 5.16 – Commissioning of HVAC Systems and 7.17.3 – Commissioning Inspection of HVAC Systems

- ASHRAE Guideline –0-2005, The Commissioning Process

- Design Manual, Section 3.4 – Environmental Standards

2.5.3 SUSTAINABILITY CERTIFICATION

References:

- CPSM, Chapter 6.1.3 – Special Construction Design Standards
- Design Manual, Section 3.4 – Environmental Standards

The decision regarding the minimum certification level to be obtained (LEED Silver or higher) and the requirements for certification will be part and parcel to the Preliminary Design approval. The Design Team is obligated to ensure that certification is executed and provided as part of the project record documentation.

2.5.4 LESSONS LEARNED

Following the project closeout, the Architect must lead an informational review with the university and the construction element to discuss "lessons learned" throughout the design and construction process. The purpose of this session is for Mason to gather and record knowledge that can be applied to future projects.

The "Lessons Learned" session shall include:

- Project Team
- Stakeholders/Steering Committee
- Executive Management
- Contractor/CM/D-B Construction Team
- Maintenance and Operations

Questions to address include:

- What worked well in the design and construction process?
- What would you do the same?
- Did the delivered product meet requirements and expectations?
- Were cost budgets met?
- Was the schedule met?
- Was the university's project management effective and successful?
- How could communication be improved?
- What could be done to improve the overall process?
- What obstacles were experienced, and how were they overcome?
- What procedures should be implemented in future projects?

- What changes would help to expedite future projects?

The recordation format for Lessons Learned sessions is described in the table below:

Item to Discuss	How it was handled	Recommendation for future projects	Who is affected	What can be done to improve the outcome
Communication	Example: Regular meetings were/were not held; meeting minutes were distributed to only part of the team, etc.	Example: Meeting minutes should be distributed to the entire project team, stakeholders and executive committee within X amount of time	Example: Project manager, project team	Example: Project manager will establish set dates for meetings; standards for meeting minutes (format, distribution, timeframe) will be established and enforced
Changes				
Schedule				

Chapter 3

Design Standards

3.1.3 CAMPUS SITEWORK

References:

- Refer to Section 3.4.4 – Sustainable Sites in the Design Manual for additional information regarding sustainable site development.
- VDOT Manuals and Guides: http://www.virginiadot.org/business/manuals-default.asp
- MUTCD: http://www.virginiadot.org/business/manuals-default.asp
- Virginia Supplement (2011 or current version): http://www.virginiadot.org/business/virginia_mutcd_supplement.asp

3.1.3.1 Site Improvements

3.1.3.1.1 Roadways

3.1.3.1.1.1 Vehicular

The Design Team shall consult all pertinent Campus Master Plans to determine whether major vehicular travel ways are included within the limits of the project, and which roads are to be improved or constructed. Roadways shall be designed in accordance with all VDOT requirements, unless amended by the Facilities. Where such roads are onsite roadways maintained by Mason, they shall additionally meet the design criteria outlined below.

Except where further supplemented herein, the design of vehicular roadways must meet VDOT standards.

George Mason University aims to achieve several main objectives in its system of vehicular roadways: mobility, compatibility and orientation. The goal of mobility refers to the maintenance of a connected network, with congestion minimized to the greatest extent possible. To achieve compatibility, the over-building of campus roadways should be avoided and vehicular roadways should maintain an appropriate scale for the campus context. This also contributes to orientation, or the visitors' ability to navigate the campus through road design and wayfinding.

Campus roadways are classified as Primary Streets/Drives/Lanes; Secondary Streets/Drives/Lanes and Tertiary Drives/Lanes. The typical sections for these roadways can be found in Chapter 5:

- Primary – refer to detail 3.1-1.
- Secondary – refer to detail 3.1-2.
- Tertiary – refer to detail 3.1-3.

Specific design criteria for vehicular roadways are described below:

- Travel ways must be constructed of flexible pavement meeting VDOT pavement design criteria.
- Drainage shall be designed in accordance with the VDOT Drainage Manual.

- Striping and signage shall be in accordance with the current edition MUTCD and 2011 Virginia Supplement or newer version.
- Street lighting shall utilize campus standards for fixtures, poles, bases and controls.
- Fire lanes shall conform to local (first responders) requirements for size, signage, striping, and surfacing.
- Truck turning movements must be verified at all proposed intersections or entrances to roads. WB-50 trucks must not enter opposing traffic lane on campus roads.
- Reduce the perceived width of roads with granite cobble or concrete paver borders. Highlights for traffic calming are encouraged.
- Refer to the Transportation Master Plan for minimum road cross sections.
- For signage and markings at vehicular intersections, refer to details 3.1-5 and 3.1-6. Refer to detail 3.1-7 for major mid-block and closely spaced mid-block crossings.

3.1.3.1.1.2 Shuttles and Transit

It is the goal of George Mason University to provide a convenient shuttle and transit system that provides service to all desired destinations, with useful stops and a reasonable schedule. In addition to connectivity and availability, it is a priority for Mason's shuttle and transit systems to provide safe and reliable service. Any addition to the existing shuttle and transit system shall be designed to maximize the benefit of the existing locations of transit stops.

3.1.3.1.1.3 Bicycle Routes

It is the goal of George Mason University to provide a network of bicycle paths on the campus, supported by amenities such as secure storage and shower facilities, with connections to surrounding bicycle infrastructure (refer to VDOT for Bike Lanes on Public Roads and to the Fairfax Country Trails Map for county trails). New routes shall be established to meet the demand, providing options for both commuting and recreation. It is important that bicycle routes are designed to minimize conflicts with pedestrians and motorized vehicles.

Off-road bicycle paths are shared with pedestrians, and for this reason they must also meet the design standards for the pedestrian system as described in this manual, as appropriate.

- Separate bicycle paths shall be 8' wide. Refer to detail 3.1-4 – Shared Use Trails.
- Additional paved width for bicycle routes is required for primary roadways in accordance with MUTCD. Lanes must be well-marked and safely separated from vehicular and pedestrian traffic where possible.

3.1.3.1.2 Parking Lots

The following parking design guidelines refer to both surface lots and parking garage facilities. For additional information regarding campus parking systems, refer to the George Mason University Transportation Master Plan. For accessibility guidelines related to parking, refer to Section 3.6 in the Design Manual.

George Mason University follows two main guiding principles in regard to its Campus parking system:

- Design facilities consistent with the Campus Master Plan's safety, ecological, and aesthetic goals.
  - Provide safe and convenient entrance/exit points.
  - Minimize traffic, pedestrian and bicycle conflicts.
  - Respect and preserve aesthetic and ecological resources.
  - Develop facility scale and appearance consistent with campus architectural aesthetic
  - Maximize opportunities to share parking resources among various users (employees, residents, visitors and event attendees).
  - Proposed parking equipment shall be compatible with existing system or replace existing system to make compatible.
- Use innovative parking management and policies to reduce demand and improve operations.
  - Deploy management systems to track facility use.
  - Install modern and innovative signage to manage traffic flow and wayfinding.
  - Use information technology to advise drivers regarding facility use and alternative options.

In addition to these guiding principles, sustainability is a high priority for George Mason University; all new parking areas and facilities shall be designed to minimize their financial and environmental impact. It is also important that parking facilities are both flexible and efficient, serving as many users as possible through aggressive parking management measures. Refer to Section 3.4.4 – Sustainable Sites in the Design Manual for additional information regarding sustainability guidelines.

The following standards apply to the design of new parking areas on any George Mason University Campus:

- The number of parking spaces to be provided within the project is to be determined in consultation with Mason's Facilities Office.
- Typical perpendicular parking space shall be 8.5' x 18'. Any space less than a minimum width of 8'-0" will be considered a compact space. Compact spaces shall represent no more than 20% of any designated parking area. Compact spaces must be marked with signage and have a painted end line. The only allowable encroachment into this space is a light pole base at front corner of space.
- Avoid angled parking spaces; when necessary, angle = 60 degrees.
- Service Vehicles: Provide a parking space of 9'-0"x 18'-0" minimum for service vehicles. Parking for service vehicles must be considered, reviewed, and approved by Mason for all building projects.
- Parking Garage: To create better sightlines, all end spaces in a parking garage must be dedicated compact parking spaces. Provide a minimum 7'-6" overhead garage clearance for non-ADA spaces and routes. Provide a minimum 20'-0" aisle width in parking garages.
- Surface Lots: Construct surface parking lots using flexible pavement. The maximum slope in any direction in a parking lot shall be 5%. Surface parking lots shall have minimum 22'-0" travel isles

- Loading Areas: All projects must review the loading area with Mason's Recycling and Waste Management Team. Delivery truck loading spaces shall be minimum 12'-0" wide. Truck routes to a loading dock must be confirmed using WB-50 truck turning templates or computer software. List types and sizes of waste and recycling receptacles (compactors – with or without sanitizers; co-minglers for recycling; typical trash receptacles – steel fluted 30 gal; typical 48 gal recycling bins).

- Landscaping within the project limits shall consider and avoid conflicts with vehicle overhangs, mirror overhangs and snow plowing and removal requirements.

- Consider medians and parking spaces of concrete pavers to reduce large expanses of asphalt.

- Use granite cobbles or cobble-like concrete pavers in contrasting gray or tan tones for edges of parking spaces and parking space delineators.

- Refer to detail 3.1-18, Parking Bay/Travel Way.

3.1.3.1.3 Pedestrian System

The pedestrian system throughout Mason's campuses is comprised of walkways, trails and foot bridges. It is the goal of George Mason University for its pedestrian system to improve orientation on the campus, improve accessibility, address conflicts with other modes of transportation (cars, service vehicles, and bicycles), and connect campus neighborhoods with transit services and parking facilities. There should be a clear hierarchy within the pedestrian system, helping to create a legible and identifiable means of travel on and around the campus.

Each Mason campus has its own unique character, which is reflected not only in their physical facilities but also in the material and texture of the landscape. Concrete paving on the Fairfax, Prince William and Arlington campuses shall have the following characteristics:

- Fairfax Campus: Specify naturally buff-colored concrete, or include a color admixture, avoiding cool-gray toned concrete.

- Prince William Campus: Intermix concrete and unit pavers, incorporating the same tones as indicated above for pavers on this campus. Avoid strong yellow or brown tones.

- Arlington Campus: Specify concrete with tan or beige tones.

Sustainability is an important priority for George Mason University and the Design Team shall apply sustainable strategies in the development of the landscape. Refer to Section 3.4.4 – Sustainable Sites for additional information regarding permeable surfaces and stormwater management.

For information regarding accessibility for pedestrian walkways, refer to Section 3.6 – Accessibility Standards in the Design Manual. For product and construction information, refer to Chapter 4, Division 32 – Exterior Improvements.

Sidewalk widths (included below) are measured as clear widths.

3.1.3.1.3.1 Pedestrian System Appurtenances

- If benches are provided along walks, refer to detail TBD.

- If trash and/or recycling receptacles are provided along walks, refer to detail TBD.

- Where railings are necessary, they shall be provided and shall meet detail TBD.

- All walkway plans must include a lighting and signage plan. Consult with the Mason Facilities Planning Office for specific requirements of these plans.

3.1.3.1.3.2 Primary Walkways

Primary walks are those that comprise the major corridors of pedestrian movement within a campus at George Mason University. For the location and orientation of the primary walks, refer to the Transportation Master Plan. Primary walks have the following characteristics:

- Primary walkways shall be 12 feet wide. Refer to details 3.1-8, Secondary Walk Section and Plan and 3.1-12, Typical Primary Walk Paver Dimensions. For a detailed section of typical a typical sidewalk, refer to detail 4.3-14.

- At the intersection of primary walks with each other a patterned paver and concrete pattern as shown in detail 3.1-12 shall be used.

- Utilize borders along the outer edges of walkways to reduce the perceived width. Apply border material to special landings, intersections and crossings.

For additional information regarding paving materials and construction, refer to Chapter 4, Division 32 – Exterior Improvements.

3.1.3.1.3.3 Secondary Walkways

Secondary walks fall directly below primary walks in the hierarchy of the campus pedestrian system. For the location and orientation of secondary walks, refer to the Transportation Master Plan.

- Secondary walkways shall be 8 to10 feet wide. Refer to details 3.1-10, Secondary Sidewalk Section and Plan and 3.1-14, Secondary Walk Paver Dimensions.

3.1.3.1.3.4 Tertiary Walkways

Tertiary walkways are any smaller, supplemental walks that fall below primary walkways in the hierarchy of the pedestrian system.

- Tertiary walkways shall be 6 feet wide. Refer to detail 3.1-11, Tertiary Sidewalk Section and Plan.

3.1.3.1.3.5 Crosswalks

- Provide curb cut ramps wherever a walkway intersects a raised curb or enters a vehicular travel way. Refer to details 3.5-3, 3.5-4, 3.5-5 and 3.5-6.

- At street intersections, these ramps will be provided at each curb return.

- Street crossings shall be designed to be perpendicular to the street and the ramps positioned appropriately.

- Crosswalks of streets from 0-10% may be approved by the Office of Campus Planning.

- Pave crosswalks with granite colored brick or cobble-shaped smooth concrete pavers.

- Pave crosswalk borders and areas between crosswalks at intersections with large granite cobbles or cobble-like, granite-colored concrete pavers for traffic calming and to provide a finished look.

- Consider raised crosswalks when pedestrian traffic is high. Refer to details 3.1-15 and 3.1-16.

3.1.3.1.3.6 Trails

For trail cross-section detail, refer to detail 3.1-17.

3.1.3.1.3.7 Foot Bridges

Foot bridges should be designed in a clean, modern style decked with pressure-treated lumber or, if possible, sustainably harvested wood for longevity. The railings should be steel or wood with steel cable slats. The structure of the bridge can be steel or sustainably harvested treated yellow pine stained to match the wood. Piers and decks can be wood with concrete piers.

3.1.3.1.3.8 Plazas and Stairs

- For large areas of paving, provide a mixture of paving colors, textures, patterns and materials to create a lively, attractive space. Granite colored concrete pavers, local granite cobbles, or brick must be used for plazas and terraces. For materials, refer to Chapter 4, Division 32 – Exterior Improvements. Refer to detail 4.3-13 for a typical brick paver detail (plan and sections).

- Use gray cobble pavers to highlight or border brick plazas. Use light gray, granite colored concrete pavers in simple shapes for plaza paving. Important plazas may utilize gray granite paving in bands. Gray concrete pavers in a running bond brick pattern may be used in prominent plazas as a contrast to granite.

- For stairs, use light colored concrete. In special areas, where budget allows, use light gray granite.

3.1.3.1.4 Site Development

3.1.3.1.4.1 Site Furnishings

For specific product information regarding site furnishings, refer to Chapter 4, Division 12 – Site Furnishings.

It is the goal of George Mason University to achieve consistency among all campuses in the materiality and aesthetic of its site furnishings, while at the same time reducing materials cost. Furnishings have been selected based on affordability, low maintenance, sustainable principles and aesthetic appearance. A single palette of site amenities is recommended for all campuses; within each campus, however, furnishings and materials are specific to the corresponding landscape character zone. For a description of landscape character zones, refer to Section 3.1.3.1.5 – Landscaping .

The Mason offices of Campus Planning, Facilities Management and Parking and Transportation will have input in the final selections and location of site furnishings.

- Provide ash urns near designated seating areas and outdoor smoking areas.

- Lighting styles must be consistent within each landscape character zone. For lighting recommendations, refer to Chapter 4, Division 26 – Electrical.

- Install roadway bollards whenever the need exists to prevent non-university vehicles from entering authorized areas or to prevent vehicular traffic onto sidewalks while still maintaining service and emergency access. When roadways need to be separated from normal vehicular traffic, use a collapsible traffic bollard operated by a standard hydrant wrench.

3.1.3.1.4.2 Fences and Gates

- Fencing, where required, shall conform to Mason's standards. Uncoated chain link, wood and PVC shall not be used. Permitted fencing is limited to five general types, to be applied per the chart below.

	Arch. Metal Fence	**Split Rail Fence**	**Coated Chain Link Fence**	**Low Stone Wall**	**Pest Control Fence**
Academic Zone	X			X	X
Athletic Zone			X		X
Campus Entryway				X	
Maintenance Zone			X		
Natural Zone		X			
Parking Zone		X			
Residential Zone				X	X

3.1.3.1.4.3 Exterior Signage

- All transportation-related signage shall conform to the MUTCD and Virginia Supplement: http://www.virginiadot.org/business/manuals-default.asp.

- All signage must comply with the Mason Signage Master Plan. Contact Mason's Environmental Graphics Designer to coordinate signage.

3.1.3.1.4.4 Retaining Walls

- Retaining walls, when constructed as an extension of the building, must use masonry facing to match the building. Other retaining walls shall be modular stacking.

- Design site walls to fit within the context of nearby structures and the environment.

- Timber retaining walls are not permitted unless Mason grants specific authorization.

- Concrete retaining walls require prior Mason approval, especially as it relates to color pattern and overall design. Form liners shall be required at a minimum.

3.1.3.1.5 Landscaping

The following goals and objectives will be considered in the design of open space on any George Mason University campus:

- Use open space to help link the campuses with a consistent visual character

- Enhance the appearance of the campus through the selection of consistent, aesthetically-pleasing, affordable and low-maintenance plantings, hardscape and site furnishings

- Enable planners and facilities management personnel to quickly select from a range of materials known to be compatible with the campus landscape
- Refer to character zones to determine the placement of specific groups of materials
- Apply principles of sustainability to the selection of materials

While elements of the landscape should have aesthetic continuity with regard to the style of paving, materials, street furniture and plantings, the design shall also be tailored to its specific zone of use. The majority of space within the George Mason University campus system falls within one of four landscape character zones, or a combination of character zones, described below. For the location of landscape character zones on Mason's Fairfax campus, refer to the Landscape Character Zones Map, 3.1-18. Specific planting guidelines for each zone are included in 3.1.3.1.5.2 Plantings.

Academic Zone

The academic zones contain all educational buildings, as well as the cultural, recreational, and administration facilities. Landscapes within the academic zone tend to be formal and geometric. Plantings are typically used as accents for the buildings and hardscape as opposed to stand-alone designs. Because these landscapes represent the "face" of the university, it stands to reason that this zone should receive the most maintenance and exhibit a formal character.

Residential Zone

The Residential Zones contain vegetation patterns that are looser in their organization due to the fact that the building geometries and placements are not as rigid. However, the larger-scale and newer dormitories have begun to take on the feel of academic buildings. The Prince William has a very limited residential component and Arlington Campuses do not contain residential zones.

Natural Zone (Mason Pond, RPAs, and Woodland Clusters)

Both the Fairfax and Prince William Campuses have Natural Zones, which are overlays of woodland vegetation on top of the Academic and Residential Zones. They exist as small clumps of trees, riparian corridors, RPA's or woodland edges. The primary defining characteristic of natural areas is that they contain more undisturbed vegetation than built features.

Parking Zone

Parking zones exist solely for the purposes of parking vehicles.

3.1.3.1.5.1 Irrigation Systems

Irrigation is generally avoided on George Mason University campuses. The planting guidelines, which call for hardy and drought-resistant species, are intended to reduce reliance on irrigation. When irrigation is necessary, sustainable practices such as rainwater cisterns or stormwater ponds are preferred. Refer to Section 3.4 – Environmental Standards for additional information regarding irrigation and stormwater management.

For guidelines related to new and replacement irrigation systems, refer to Chapter 4, Division 32 – Exterior Improvements.

3.1.3.1.5.2 Plantings

- New plantings must be selected from the Required Plant Materials Table. Plants on this list meet at least one, if not all, of the following criteria:
  - Aesthetic quality consistent with the delineated campus character zones
  - Native to the Virginia Coastal physiographic region
  - Hardy and drought-resistant
  - Limited fruit litter
  - Available in local or regional nurseries
- The majority of new plants must be native or cultivars of native plants. No more than 10% of new plants may be non-invasive exotics that are hardy, drought-tolerant and suitable for their specific site conditions. If non-native species are installed, ensure that they are non-invasive and hardy to the Fairfax USDA Hardiness Zone and can tolerate dry soil conditions.
- Minimize traditional turf lawn; use only as necessary for public gathering and recreation spaces.
- Consider permeable paving where pedestrians will utilize the area, or converting the area into a planting bed that is self-sustaining or requires minimal maintenance.
- Consider alternatives to traditional turf lawn, such as no-mow or low-growing turf.
- Utilize thick plantings of low shrubs, possibly supplemented with small protective fences, to encourage pedestrians to stay on the sidewalks.
- Ensure variety in plantings (textures, colors and scents). Avoid using the same species of plant in multiple locations to enhance visual interest and limit species-specific diseases.
- Avoid locating highly-scented trees or shrubs near seating areas as they may attract bees and insects.
- When new buildings are designed, retain as much natural vegetation and woodland as possible. Integrate wooded areas in between the buildings.
- Avoid placing plantings that are salt-sensitive adjacent to streets and sidewalks.

Academic Zone Planting Guidelines

- New plantings shall respond to the shape and form of adjacent buildings, retaining the formal geometries present in the zone.
- Accent plantings not associated with buildings shall be formal in arrangement and utilize rectilinear, radial, triangular, or other formal patterns.

Residential Zone Planting Guidelines

- Use plantings to make residential areas welcoming to students. Naturalistic, radial, curvilinear, and “organic” designs tend to be more peaceful and relaxing than geometric patterns. Group plants in threes or fours, but in no particular arrangement.

- Use a hierarchy of vegetation to reduce the scale of larger dormitory buildings. Begin with a tall shade tree, and then layer ornamental trees and shrubs to avoid students feeling as though the buildings were over-powering them. Avoid installing only low shrubs next to multi-story buildings.

- Provide shaded areas for students to utilize as outdoor studying, eating, or relaxing space. In these areas, avoid installing plants that have thorns or high levels of fruit litter (e.g. acorns or large seed pods) that would make sitting on the ground or a blanket uncomfortable.

Natural Zone Planting Guidelines

- Small clumps of woodland vegetation and "leftover" spaces adjacent to wooded areas can serve as seating or outdoor classroom areas. Install a limited number of benches or tables, or leave grassy spaces open for picnicking.

- Retain all existing natural zone plantings unless the stand of vegetation is threatened by disease or a large number of plants are dead or dying.

- Consider creating new natural zones on campus in open spaces that are not regularly used by students, faculty, staff, or visitors. In addition to creating more tree canopy for environmental and aesthetic reasons, new natural areas could present donor opportunities (e.g. named groves, listings of tree donors in University publications, Master Gardener community service hours for installation, etc.).

Parking Zone Planting Guidelines

- Refer to the Parking Lot I/Student Parking for an excellent example of integrating parking into a natural landscape.

- Install trees that are known to work well in urban situations. Refer to the Virginia Cooperative Extension publication Trees for Problem Landscape Sites: Trees for Parking Lots and Paved Areas (http://pubs.ext.vt.edu/430/430-028/430-028.html) for assistance in selecting trees. An additional resources is the Virginia Tech website "Urban Street Tree Selector" found at http://www.cnr.vt.edu/dendro/treeselector/index.cfm.

- Ensure that new tree installations will not interfere with existing lighting.

- Avoid overplanting shrubs on planting islands and medians so that grounds crews will have a place to pile plowed snow. Design parking lot planting so that open ground remains to accept snow piles.

- Use evergreen plantings or densely-planted deciduous trees to screen parking lots from view. Stagger two planting rows for maximum screening.

- Ensure that new parking lots have interior planting islands and medians in which to plant trees. A standard practice is to have no more than ten or twenty spaces in a row without a planted island.

- While it is the goal of the university to achieve visual consistency among all campuses, the landscape design must be sensitive to its unique context. The difference in physical size may be the most obvious distinction, but other qualities set the campuses apart as well.

3.1.3.1.5.3 Fairfax Campus

Because the Fairfax campus is the most developed and largest of the three campuses, it has the most diverse spaces and vegetation. There are greater opportunities for a variety of formal planting arrangements, naturalistic groupings, and simple designs:

- Consider portions of the campus as arboretum-like spaces. Designate the Mason Pond area as a place to receive unique and memorial plantings. The space need not be a strict catalog of plants, but can serve as an attractive collection of interesting vegetation.

- Promote sculpture zones, where pieces of art from the Hirschhorn sculpture program or other collections could be displayed. These could be the arboretum-like spaces with interpretive signage or themed botanic gardens.

3.1.3.1.5.4 Prince William Campus

The most notable landscape feature of the Prince William Campus is the presence of woods and a wetland to the north of the campus, and it is the Mason's intent to preserve and showcase these natural features. To this end, in addition to the general planting guidelines, the following strategies apply:

- Keep plantings around drainages and waterways naturalistic and informal.

- Make use of the wetland and woods as a planting design concept. Have the woodland plants and natural aesthetic flow into the campus and then become more formal around the buildings. An alternate option is to keep plantings in the "front" of the buildings (along George Mason Circle) formal and urban, while the rear of the buildings has a more natural aesthetic that blends with the woods and wetland.

3.1.3.1.5.5 Arlington Campus

The Arlington Campus has a unique urban character compared with the Fairfax and Prince William Campuses, so a somewhat different approach to landscape design is appropriate:

- Native plant selections are not as important on this campus.

- Select plant species that will grow in urban conditions (i.e. compacted, poor-quality soil and small spaces).

- Consider utilizing moveable planters to hold annuals, perennials or shrubs.

3.1.3.1.5.6 Landscape Buffers

The following buffer classifications are to be used to establish or supplement landscape buffers. Buffers are to be established at Mason Fairfax at the perimeters of the campus to screen adjacent uses and roads and within the Academic Zones on campus near university buildings to establish a forest ecosystem (i.e. limited reforestation). Buffers are to be provided at Mason Prince William for both forest establishment and forest supplementation specific for their soil and microclimate. These buffers will provide a range of species composition, growth rate and succession for a typical native Virginia forest aesthetic. All buffers shall require little or no maintenance, and shall not require permanent irrigation (except as needed during initial planting seasons to establish plant material). All existing dead or hazardous trees shall be removed prior to planting in order to preserve the existing vegetation that will remain.

The *Buffer Descriptions* section below defines more specifically each buffer type. The *Minimum Requirements* section succeeds and lists the composition and notes for each buffer type. It is the intent that the buffer compositions shall contain the total amount listed, choosing from the species on the Buffer Plant List; however, the amount or variety may vary depending on site conditions.

Buffer Descriptions

Buffer Type A – Perimeter Woodland Cluster Buffer

This buffer retains existing forest areas (overstory/understory/shrubs/groundcover/organic leaf litter) and is supplemented with vegetation that offers screening with evergreen trees and shrubs for an immediate screening effect. The supplemental plantings shall be a mixture of smaller deciduous and evergreen shrubs, seedlings and groundcovers that will fill in over time. This buffer type will occur most often along property perimeters and adjacent to existing residential properties and roadways.

Buffer Type B – Academic Zone Buffer

This is a reforestation that uses a variety of native species to establish a forest ecosystem where no existing vegetation exists. The landscaping shall be planted with a variety of sizes to offer a natural forest effect, including overstory, understory, shrubs, groundcover and seedlings. This buffer acts predominantly as a reforestation effort rather than a dense evergreen screening effect.

Buffer Type C – Mason Prince William Buffer

This is a general landscape buffer for the soils and microclimate for overall campus wide use at Mason Prince William. This buffer is for the campus perimeters and reforestation efforts in the Academic Zones. This can be either infill, as in Buffer Type A, or re-establishment, as in Buffer Type B, but with a different range of species.

Minimum Requirements

Buffer Type A – Perimeter Woodland Cluster (Refer to detail 3.1-19, Landscape Buffer A)

Composition:

- Evergreen Trees: 5 trees per 100 linear feet, planted 6’ tall minimum.
- Evergreen Shrubs: 5 shrubs per 100 linear feet, planted 18” tall minimum.
- Understory Deciduous Trees: 3 trees per 100 linear feet, planted 1” caliper minimum.
- Deciduous Shrubs: 2 shrubs per 100 linear feet, planted 12” tall minimum.
- Overstory Seedlings Species: 5 seedlings per 100 linear feet, planted in protective tubing.

Notes

- Infill evergreen trees and shrubs along existing forest edges.
- Infill seedlings in center of existing forest for future urban forest succession.
- See Exhibit C: Buffer Plant List for recommended species and spacing.

- Depending on site conditions, the planting scheme may require an adjusted ratio from the composition specified above. Where possible, group evergreen trees and shrubs in groups of 3 or 5.

Buffer Type B – Academic Zone (Refer to 3.1-20, Landscape Buffer B)

For a typical 30’ wide planting area use the following composition:

- Evergreen Trees: 5 trees per 100 linear feet, planted 6’ tall minimum.
- Evergreen Shrubs: 6 shrubs per 100 linear feet, planted 24” tall minimum.
- Overstory Deciduous Trees: 6 trees per 100 linear feet, planted 2” caliper minimum.
- Understory Deciduous Trees: 5 trees per 100 linear feet, planted 1” caliper minimum.
- Deciduous Shrubs: 9 shrubs per 100 linear feet, planted 10” tall minimum.
- Overstory Seedlings Species: 10 seedlings per 100 linear feet, planted in protective tubing.
- Groundcover: woody seed mix, 15 lb. per acre, 300 sf.
- Scarify soil prior to planting trees, shrubs or seedlings, so groundcover can have seed to soil contact.
- After planting trees, shrubs and seedlings, hand seed, broadcast or hydroseed groundcover seed mix. Apply light mulch or hydromulch (±1” thick) over seed bed to protect seeds until germination and to provide moisture and nutrients to newly planted trees, shrubs and seedlings.
- See the Buffer Plant List for recommended species and spacing.
- Use as a guide only; field adjustments may be necessary.

Buffer Type C – Mason Prince William

Composition:

The Type A Perimeter Woodland Cluster Buffer composition shall be used for infill and the Type B Academic Zone Buffer composition shall be used for reforestation, however, the species to be used are those options as specified in the “Buffer Zone” column on the Buffer Plant List.

General Buffer Type Planting Notes

- This document shall be used as a guide only. Field adjustments may be necessary.
- Since sites differ in existing density, composition, slope and aspect, etc., all ratios listed above shall be distributed as necessary in the field and verified by a certified arborist or landscape architect prior to planting.
- If the density of the site allows for more or less plantings that differ from the compositions listed above, the composition can be adjusted as necessary.
- Shrubs should be planted staggered in groups of 3’s or 5’s.

- Planting shall primarily be done during spring (March 15-June 15) or autumn (September 15-November 15). Planting done outside these windows requires extraordinary protective and establishment measures, thus are highly discouraged.

- Irrigation shall be provided 3-4 times per week during the first month and regularly during the first year to establish vegetation and shall be continued well into the second year to maintain growth, but this will vary depending on annual weather conditions.

- During the first year, container grown plants should be watered every other day during summer, weekly in the spring and autumn and as needed during the winter. Balled and burlapped trees should be watered weekly during summer, biweekly in the spring and autumn and as needed during the winter. Watering can be adjusted for the site's aspect: if sunnier, water more frequently, if shadier water less frequently, as needed.

- See detail 4.3-4, Tree, Shrub and Perennial Planting Details.

3.1.3.2 Site Civil/Mechanical Utilities

The Design Team is responsible for coordinating with utility providers. Utility design, unless specifically addressed here, will conform to the design requirements of the utility that will ultimately have maintenance responsibility for that utility.

3.1.3.2.1 Water

3.1.3.2.1.1 Water Services - All Campuses

All domestic water services, including fire hydrants, shall conform to the local water supply agency. Below are the links to appropriate supplier/utility. It is the responsibility of the designer to notify Mason Land Development if the link does not work.

3.1.3.2.1.2 Arlington Campus: www.arlingtonva.us/departments/environmentalservices/projectsandplanning/environmentalservicesspecs.aspx

3.1.3.2.1.3 Fairfax Campus: www.fairfaxva.gov/publicworks/pfm.asp

3.1.3.2.1.4 Loudoun Campus: www.loudounwater.org/developers-and-new-construction/engineering-design-manual

3.1.3.2.1.5 Prince William Campus: http://www.pwcsa.com/index.php?option=com_content&view=category&layout=blog&id=8&Itemid=7

3.1.3.2.2 Sanitary Sewer

3.1.3.2.2.1 Sanitary Sewer - All Campuses

- All Sanitary Sewer mains 8" and larger shall conform to the local sewer collection agency. Below are the links to appropriate agencies. It is the responsibility of the designer to notify Mason Land Development if the link does not work.

- Sanitary Sewer laterals shall be in conformance with local requirements and VUSBC.

- Sewer laterals shall include a detectable marking tape if not laid in a straight line from cleanout at the building to the sewer manhole.
- The building cleanout shall be located outside of the building, approximately 5' from the outside wall, but in conformance with the Plumbing Code.
- Cleanout shall not be located within a sidewalk or within 5' of a building entrance or exit.
- All cleanouts shall be made of brass, set flush with the surface, in a concrete ring. Refer to detail 4.3-8, Downspout Cleanout.

3.1.3.2.2.2 Arlington Campus: www.arlingtonva.us/departments/environmentalservices/projectsandplanning/environmentalservicesspecs.aspx

3.1.3.2.2.3 Fairfax Campus: www.fairfaxcounty.gov/dpwes/publications/pfm/

3.1.3.2.2.4 Loudoun Campus: www.loudounwater.org/developers-and-new-construction/engineering-design-manual

3.1.3.2.2.5 Prince William Campus: http://www.pwcsa.com/index.php?option=com_content&view=category&layout=blog&id=8&Itemid=7

3.1.3.2.3 Storm Sewer

3.1.3.2.3.1 Collection

At a minimum the design shall meet the requirements of the VDOT Drainage Manual (http://www.virginiadot.org/business/locdes/hydra-drainage-manual.asp) and Road and Bridge Standards. VDOT Manuals and Guides (http://www.virginiadot.org/business/manuals-default.asp).

3.1.3.2.3.2 Storm Water Management/Best Management Practices

- All aspects of the Stormwater Management and Best Management Practices (SWM/BMP's) for any project must comply with the Mason MS4 permit and the University Master Plan, current version. At a minimum the SWM/BMP's will meet the requirements of the Virginia Stormwater Management Handbook http://www.dcr.virginia.gov/pub_list.shtml
- The project site outfall (s) must be shown as adequate (by computations) down to already established storm structures (ponds). On the Fairfax campus these include Mason Pond, Rivanna River Land Pond, the Braddock Pond, the Krosnow Pond, and the Mason Vale Pond. On the Prince William Campus, project site outfall(s) must be shown as adequate down to University Blvd or Freedom Center Blvd. For all other outfalls, consult George Mason University.
- Drainage from roofs must:
  - Be connected to storm system (not day-lighted) unless it drains directly into a defined channel/swale.
  - Provide cleanout (per detail 4.3-8) for roof drains at building and at change in direction, vertical or horizontal.

3.1.3.2.4 Heating and Cooling Distribution

Mason's Fairfax Campus utilizes a Central Heating and Cooling Plant (CHCP) to supply High Temperature Hot Water (HTHW) and chilled water (CHW) to campus buildings. All new buildings located on Mason's Fairfax Campus shall be designed to utilize HTHW as the primary heating source and chilled water as the primary cooling source unless specifically determined by Mason. The consultant is not responsible for evaluating the adequacy of these campus systems for individual building projects. Mason is responsible for determining adequacy of these central systems and their associated distribution system. The consultant is responsible for providing building heating and cooling loads to Mason during the preliminary design phase. Where Mason directs the consultant to design standalone heating and/or cooling source for the building shall be determined as part of the overall HVAC System Selection Analysis.

In general, Mason does not utilize underground steam distribution systems. Implementation of underground steam distribution systems is not allowed without written justification by the consultant and approval by Mason.

- Refer also to Chapter 3, Section 3.3.1.4.16 and 3.3.1.4.17 for details on design for the HTHW and CHW distributing systems. Refer to Chapter 4, Sections 23 21 13 and 23 21 14 for additional underground hydronic piping system requirements. Refer to Chapter 4, Section 23 05 16 for HTHW piping system expansion compensation requirements. Refer to Section 23 07 00 for HTHW piping insulation requirements. Refer to Section 23 05 23 for HTHW valve requirements.

- The existing campus HTHW underground distribution piping is installed in a tunnel system. All new underground HTHW piping shall be housed within a tunnel system. Refer to details 4.1-1, HTHW Tunnel Detail, Fairfax Campus, 4.1-2, HTHW Tunnel Top Details, and 4.1-3 HTHW Manhole Detail.

- General: The pathway for the campus wide HTHW distribution system piping shall be a system of tunnels and manholes which are designed to facilitate operations and maintenance. The tunnel system shall be designed by a Virginia registered Professional Engineer. The tunnel and manhole system, including hatch covers, shall be designed for HS-20 loading capable of carrying a minimum of 200 passes per day.

- Tunnel System: At least 90% of the tunnel system must have removable tops. At least 75% of the tunnel system must be designed so that the top is at grade. Tunnel height may vary with site contour but the inside (clear) tunnel height shall not be less than four feet and shall not exceed eight feet. The tunnel and manhole system should be designed to minimize the number of low points. All reinforcing steel used in construction of tunnel and manhole system shall be epoxy coated. Tunnels will have their tops primarily exposed as walkways. Therefore, the routing of tunnels shall be coordinated with the pedestrian system. Where deemed appropriate by Mason, sections of tunnel will be covered.

- Tunnel Section: The minimum inside (clear) tunnel height when the tunnel is not at grade is four feet. Minimum clearances between insulated pipes must be 18 inches; minimum clearance between insulated pipes and sides of tunnel must be 12 inches; minimum clearance between insulated pipe and tunnel top must be 24 inches. For branch building service, where the tunnel is at grade with removable tops, the minimum height of the tunnel may be reduced with written approval of George Mason Facilities. Provide drain channel in floor of tunnel, with low points of tunnel and manhole system discharging to campus storm water drainage system.

- Tunnel Tops: Removable tops shall not exceed 4500 pounds weight. Tops to be constructed with an alternating lip pattern to permit easy removal. Refer to Part V Detail 03310 - 2 Tunnel Top Details. Reinforcing steel to extend into the lip. Where the top of the tunnel is exposed at grade, provide broom finish. Provide neoprene gaskets between the horizontal surfaces at the lips and wherever the top makes contact with walls or an adjoining top section.

- Tunnel Top Lifting Devices: Four epoxy coated reinforcing steel lifting loops will be installed in the sides of each tunnel top section (Refer to Part V Detail 03310 - 2 Tunnel Top Details) unless the top is located adjacent to a paved surface (such as plaza, road, sidewalk, or curb) or other situation that precludes side mounted loops. In which case, four stainless steel lifting lugs will be imbedded in the tunnel top, fitted with a screw in cap. (Refer to Part V Detail 03310 - 3 Tunnel Top Lifting Lug Detail) If lifting lugs are used, a total of ten lifting loops which screw into the lugs will be provided to the Owner; packaged and marked with the project identification.

- Manholes: Manholes shall be provided at all valve and tempering tank locations. Inside height of manhole must be minimum of seven feet. Manholes must be provided with a floor drain, piped to the campus storm drainage system. If a gravity drain is not practical, provide a sump and sump pump for tunnel and manhole system drainage. Sump pump and associated discharge piping, where required, must be rated for minimum design operating temperature of 200 degrees F. Design of manhole shall be such that a person entering the manhole can immediately step-on and access the ladder safely without an under-turn.

- Access Hatches & Hatch Covers: Access hatches and hatch covers shall be provided at all manholes; and at all piping system expansion joints, ball joints, anchors, drain or vent valves, and sump pumps, when these components are not located in a manhole. Access hatches shall provide minimum four foot by three foot clear access and be fitted with a locking cover. A fixed ladder or rungs aligned with hatch opening must be provided at all locations where the depth of the tunnel or manhole is four feet or greater. Hatch lip drains must be piped, using copper or Sched 40 galvanized steel pipe, to within 6 inches of the floor.

- Foundation Drainage: Foundation drainage must be provided around the perimeter of all tunnels and manholes. Drainage pipe must be at least four inches in diameter, perforated ABS pipe. It must be covered by filter fabric and sit a distance equal to its diameter from the tunnel bottom at level with the lower edge of the tunnel bottom. The drainage pipe must be covered in #57 stone to provide drainage to the pipe and the #57 stone must cover the pipe to a height six inches above the bottom slab of the tunnel, and extend to either side at the level in both directions lateral to the pipe a distance equal to the diameter of the pipe. If the tunnel has a bottom lip, the #57 stone has to meet the preceding qualifications and then continue laterally in towards the tunnel to meet the side tunnel water. The #57 stone must be wrapped in an approved filter fabric which must be brought up the side of the tunnel wall and pinned in place against the wall by protection board.

- Waterproofing: Exterior sides of tunnels and manholes must be waterproofed. Wherever the tunnel tops are below grade, the tunnel tops must be waterproofed. Where a tunnel section or manhole extends below the water table, use self-adhered roll-type membrane waterproofing . Provide protection board as required for waterproofing system.

- Design chilled water piping systems with a minimum cover of 36 inches.

- All piping systems shall be designed based on a piping stress analysis and shall be designed to meet the requirements of the latest edition of ASME B31.1. The piping system stress analysis shall include piping system geometry, routing, support locations, specific support types, and expansion compensation information.

- Construction drawings shall include plans and profiles of all piping systems identifying all elevations, fittings, valves, expansion compensation, supports, anchors, vaults, and tunnel structure.

3.1.3.2.5 Fuel Distribution

3.1.3.2.5.1 Fuel Distribution – All Campuses

The designer will verify the availability of gas service to the site. If gas service is available to the site, the designer will verify the university's need for gas service to the facility. If gas service is needed, the designer will work with the utility provider to insure that the site layout will accommodate the extension of gas service lines and appurtenances to the facility. The servicing utility will be provided with all necessary site information to allow them to design their service lines and appurtenances to the site.

3.1.3.2.5.2 Arlington Campus: http://www.washgas.com/

3.1.3.2.5.3 Fairfax Campus: http://www.washgas.com/

3.1.3.2.5.4 Loudoun Campus: TBD

3.1.3.2.5.5 Prince William Campus: http://www.washgas.com/

3.1.3.3 Site Electrical Utilities

3.1.3.3.1 Electrical Distribution

3.1.3.3.1.1 Primary Service – Fairfax East Campus

Mason's primary electrical distribution consists of 15kV - 3 phase underground electrical lines, fed from a 15kV substation and distributed to buildings in the campus via manholes and 15kV underground ductbanks.

- The infrastructure design of the primary electrical distribution shall be comprised of the following:
  - Design of new manholes in the vicinity of new building grounds.
  - Design of new 15kV underground ductbanks (conduits encased in concrete) from manhole to the building.
  - Design of service entrance ductbank and location of main electrical room.
  - Design of main single-ended substation consisting of 15kV loadbreak switch, dry type transformer, and 480/277V or 208/120V secondary switchgear all located in main electrical room.
- To accomplish the above, the Design Team shall submit information of project electrical loads and location of electrical service entrance to Mason's Facilities Management.
- Information related to the specific manhole to be connected to and available fault current shall be provided by Mason's Facilities Management.

3.1.3.3.1.2 Arlington Campus: https://www.dom.com/dominion-virginia-power/

3.1.3.3.1.3 Fairfax Campus: https://www.dom.com/dominion-virginia-power/

3.1.3.3.1.4 Loudon Campus: TBD

3.1.3.3.1.5 Prince William Campus: http://www.novec.com/

3.1.3.3.2 Site Lighting

- Lighting styles shall be consistent within each landscape character zone. For lighting recommendations, refer to Chapter 4, Division 26 – Electrical. The chart below designates the minimum and average recommended lighting levels for various outdoor spaces.

Exterior Space Location	Foot Candle Minimum	Foot Candle Average	Notes
Temporary Site Lighting	1	1.5	For security purposes, and only in areas required for the purpose.
Roadways	1.2	1.5	Where roadways are immediately adjacent to a walkway, the walkway lights can be combined with the roadway lights, so long as the lighting levels of the walkways are maintained at their minimum level as indicated herein.
Walkways			For pedestrian safety.
Crossing Streets	4	4.5	
Adjacent to Parking Lots	2	2.5	
Adjacent to Roads	1.8	2	
Interior of Campus	1.5	1.8	
Interior of Campus in Large Open Areas	1	1.2	
Plazas	5	5.5	
Landscape Areas Adjacent to Walkways	1.5	1.8	
Parking Lots	2	2.5	
Parking Decks	5	5	
Loading Docks	8	10	
Building Entrances	6	6.5	
Underpasses/Contained Areas	10	12	For pedestrian and general campus safety.
Heavily shadowed areas around buildings	3	5	For security purposes.
Sports/Recreation Fields	TBD	TBD	Based on NCAA guidelines, must conform to the above within 5 feet of the field edge.

3.1.3.3.3 Site Communications and Security

3.1.3.3.3.1 Communications

The Mason Campus is provided with communication manholes and handholes throughout the campus from which IT, A/V, and security utility cables are routed to each building's main Telecom room. Refer to Chapter 4, Division 27 and for additional information regarding communications.

- All cables shall run in underground ductbanks (PVC conduits in concrete encasement) from existing or new manholes or handholes to main Telecom room.

- Provide new manholes and handholes with cover locking means for systems security.
- Design service entrance to prevent water infiltration and conflicts with other utilities.
- Provide at least one IDF closet on each floor of the building with 2-4" conduits to main Telecom room. Conduits shall have 2 bends maximum.
- All communication work shall be coordinated with and approved by Mason ITU/NET.

3.1.3.3.3.2 IT

For additional information regarding IT systems, refer to the separate IT Design Guidelines.

- Provide IT drawings and spec Section 27 tailored to all infrastructure work for each project.
- Required shutdown of existing network systems must be scheduled during the Christmas holiday.
- Ensure that security is provided to all telecom rooms.
- Provide all IT equipment and A/C systems with emergency power.
- Provide record drawings to Mason ITU/NET.
- IT rooms must be separate from security rooms.
- The preferred phone system shall be VOIP.
- Show cable trays on all contractor coordinated drawings.
- Establish ADA Standards for phone and data and include in contract documents.
- Extend all conduits from wall jacks to the corridor.
- Include inside and outside wireless systems in the design.
- Provide all IT rooms with sprinklers.
- Design/include temporary IT systems in all renovation projects.

3.1.3.3.3.3 Security

- All doors inside shall have a key pass to meet the Virginia state law.
- Card access system is preferred.
- Omni locks are being phased out on Mason campuses.
- Security closets shall have swipe card access.
- Provide wireless locks for low use spaces.
- Explore EVI contactless card technology for door systems.
- Standardize padlocks to secure outbuildings and athletic equipment.
- Standardize CCTV systems for security systems on campus.

EXHIBIT C: BUFFER PLANT LIST

	BOTANICAL NAME	COMMON NAME	BUFFER ZONE	MINIMUM SPACING**	MINIMUM INSTALLATION SIZE
	OVERSTORY DECIDUOUS TREES				
	ACER FALCATA	SOUTHERN RED OAK	ALL	30'	1" CAL.
*	ACER RUBRUM	RED MAPLE	ALL	20'	1" CAL.
	CARYA GLABRA	PIGNUT HICKORY	ALL	20'	1" CAL.
	CARYA TOMENTOSA	MOCKERNUT HICKORY	ALL	20'	1" CAL.
*	FAGUS GRANDIFOLIA	AMERICAN BEECH	B	30'	1" CAL.
*	FRAXINUS PENNSYLVANICA 'PATMORE'	PATMORE SEEDLESS ASH	B,C	20'	1" CAL.
	GLEDITSIA TRIACANTHOS	HONEY LOCUST	ALL	20'	1" CAL.
*	LIQUIDAMBAR STYRACIFLUA	SWEETGUM	A,B	20'	1" CAL.
*	LIRIODENDRON TULIPIFERA	TULIP POPLAR	B,C	30'	1" CAL.
	NYSSA SYLVATICA	BLACK GUM	ALL	20'	1" CAL.
*	QUERCUS ALBA	WHITE OAK	ALL	30'	1" CAL.
*	QUERCUS PHELLOS	WILLOW OAK	ALL	30'	1" CAL.
	TILIA AMERICANA (AND CULTIVARS)	AMERICAN LINDEN, BASSWOOD	ALL	20'	1" CAL.
*	ULMUS CARPINIFOLIA	LACEBARK ELM	A	20'	1" CAL.
	UNDERSTORY DECIDUOUS TREES				
	AMELANCHIER LAEVIS	ALLEGHENY SERVICEBERRY	ALL	10'	4-5' HT.
*	CERCIS CANADENSIS	EASTERN REDBUD	ALL	20'	4-5' HT.
*	CHIONANTHUS VIRGINICUS	FRINGETREE	ALL	10'	4-5' HT.
*	CORNUS FLORIDA	FLOWERING DOGWOOD	ALL	20'	4-5' HT.
*	CRATAEGUS VIRIDIS 'WINTER KING'	WINTER KING HAWTHORN	B,C	10'	4-5' HT.
*	MAGNOLIA VIRGINIANA	SWEETBAY MAGNOLIA	A,B	15'	4-5' HT.
*	OXYDENDRUM ARBOREUM	SOURWOOD	ALL	20'	1" CAL.
	EVERGREEN TREES				
*	ILEX OPACA	AMERICAN HOLLY	ALL	12'	3-4' HT.
	JUNIPERUS VIRGINIANA	EASTERN RED CEDAR	ALL	10'	3-4' HT.
*	PINUS STROBUS	WHITE PINE	ALL	25'	3-4' HT.
*	THUJA OCCIDENTALIS	EASTERN ARBORVITAE	ALL	10'	3-4' HT.
	TSUGA CAROLINIANA	CAROLINA HEMLOCK	A	15'	3-4' HT.
	DECIDUOUS SHRUBS				
*	ARONIA ARBUTIFOLIA 'BRILLIANTISSIMA'	BRILLIANT RED CHOKEBERRY	ALL	4'	3-4' HT.
*	CALLICARPA AMERICANA	AMERICAN BEAUTYBERRY	ALL	5'	2-3' HT.
*	CEONOTHUS AMERICANUS	NEW JERSEY TEA	ALL	3'	18-24"' HT.
*	CLETHRA ALNIFOLIA	SUMMERSWEET	ALL	6'	2-3' HT.
	CORNUS AMOMUM	SILKY DOGWOOD	ALL	5'	3-4' HT.
	CORNUS SERICEA	REDOSIER DOGWOOD	A,C	3'	3-4' HT.
	CORNUS RACEMOSA	GREY DOGWOOD	ALL	6'	3-4' HT.
	CORYLUS AMERICANA	AMERICAN HAZELNUT	ALL	10'	2-3' HT.
	GAYLUSSACIA BACCATA	BLACK HUCKLEBERRY	ALL	3'	2-3' HT.
	GAYLUSSACIA FRONDOSA	DANGELBERRY	ALL	3'	2-3' HT.
*	HAMAMELIS VIRGINIANA	WITCH HAZEL	ALL	12'	5-6' HT.
*	HYDRANGEA ARBORESCENS	WILD HYDRANGEA	ALL	5'	2-3' HT.
*	ITEA VIRGINICA	SWEETSPIRE	ALL	6'	2-3' HT.
*	LEUCOTHOE AXILLARIS	COAST LEUCOTHOE	ALL	6'	18-24"' HT.
*	LINDERA BENZOIN	SPICEBUSH	A,C	8'	3-4' HT.
	RHODODENDRON PERICLYMENOIDES	PINXTERBLOOM AZALEA	ALL	5'	2-3' HT.
	RHUS COPALLINUM	WINGED SUMAC	ALL	12'	3-4' HT.
*	VIBURNUM DENTATUM	ARROWWOOD VIBURNUM	ALL	8'	3-4' HT.
*	VIBURNUM NUDUM 'WINTERTHUR'	WINTERTHUR VIBURNUM	ALL	5'	2-3' HT.
*	VIBURNUM PRUNIFOLIUM	BLACKHAW VIBURNUM	ALL	12'	2-3' HT.
*	PHYSOCARPUS OPULIFOLIUS	NINEBARK	ALL	5'	2-3' HT.
	EVERGREEN SHRUBS				
*	ILEX GLABRA	INKBERRY	ALL	4'	18-24"' HT.
*	ILEX VERTICILLATA	WINTERBERRY	ALL	8'	2-3' HT.
	ILEX VOMITORIA	YAUPON HOLLY	ALL	4'	18-24"' HT.
*	JUNIPERUS CHINENSIS	CHINESE JUNIPER	A,C	4'	2-3' HT.
*	KALMIA LATIFOLIA	MOUNTAIN LAUREL	A	6'	3-4' HT.
*	MYRICA PENSYLVANICA	NORTHERN BAYBERRY	B,C	6'	18-24"' HT.
	RHODODENRON MAXIMUM	ROSEBAY RHODODENDRON	ALL	8'	2-3' HT.

* SOURCE: SPECIES WITH AN ASTERICK ARE FROM THE GMU LANDSCAPE GUIDELINES, APRIL 2008 EDITION.

** MINIMUM SPACING IS FOR SAME SPECIES. OVERSTORY DECIDUOUS TREES CAN BE LAYERED WITH UNDERSTORY DECIDUOUS TREES AND SHRUBS. EVERGREEN TREES AND DECIDUOUS AND EVERGREEN SHRUBS CANNOT BE LAYERED AND SHOULD MAINTAIN MINIMUM SPACING REQUIREMENTS.

George Mason University Landscape Guidelines
Approved Plant Materials and Standards
APPROVED - September 2009

Common Name	Scientific Name	Native1	Drought Tolerant2	Character Zone3	Litter Level4	Potential Mature Size (H x W)	Installation Size	Comments
Deciduous Trees	*Scientific Name*	Native	Drought Tol.	Char. Zone	Litter Level	Pot. Mature Size	Installation Size	Comments
Hedge Maple	*Acer campestre*	N	Y	All	Low	30' x 30'	2 to 2-1/2" cal.	
Red Maple	*Acer rubrum (and cultivars)*	Y	Y	All	Low	50' x 45'	2 to 2-1/2" cal.	May have surface roots
River Birch	*Betula nigra (and cultivars)*	Y	N	A, R, N	Low	50' x 50'	2 to 2-1/2" cal.	
American Beech	*Fagus grandiflora*	Y	N	N	High	60' x 100'	2 to 2-1/2" cal.	Beech nuts
Patmore Seedless Ash	*Fraxinus pensylvanica "Patmore'*	Y	Y	All	Low	50' x 35'	2 to 2-1/2" cal.	Urban and salt tolerant
Tulip Poplar	*Liriodendron tulipifera*	Y	N	R, N	Low	70' - 80' tall	2 to 2-1/2" cal.	Will outgrow small spaces
Planetree	*Platanus x acerifolia*	N	Y	R,N,P	High	50' x 40'	2 to 2-1/2" cal.	Round fruit and exfoliating bark
White Oak	*Quercus alba*	Y	N	N	High	60' x 70'	2 to 2-1/2" cal.	Acorns
Willow Oak	*Quercus phellos*	Y	Y	All	Medium	60' x 40'	2 to 2-1/2" cal.	Small acorns but slender foliage
Lacebark Elm	*Ulmus carpinifolia*	N	Y	All	Low	50' x 50'	2 to 2-1/2" cal.	Urban tolerant w/ attractive bark
Bald Cypress	*Taxodium distichum*	Y					2 to 2-1/2" cal.	
Sweet Gum	*Liquidambar styraciflua*	Y					2 to 2-1/2" cal.	
Evergreen Trees	*Scientific Name*	Native	Drought Tol.	Char. Zone	Litter Level	Pot. Mature Size	Installation Size	Comments
Leyland Cypress	*Cupressocyparis leylandii*	N	Y	All	Low	60' x 12'	#5 cont. (3'-4')	May outgrow small spaces
American Holly	*Ilex opaca (and cultivars)*	Y	N	A,R,N	Low	30' tall	#5 cont. (3'-4')	Male and female plants needed for berries
Eastern White Pine	*Pinus strobus*	Y	N	All	Low	60' x 40'	B&B (5'-6')	Not salt tolerant
Eastern Arborvitae	*Thuja occidentalis*	Y						
Southern Magnolia	*Magnolia grandiflora*	Y						
Ornamental Trees	*Scientific Name*	Native	Drought Tol.	Char. Zone	Litter Level	Pot. Mature Size	Installation Size	Comments
Downy Serviceberry	*Amelanchier arboreaor A. canadensis*	Y	N	All	Low	20' tall	B&B (5'-6')	Can be clump or tree-form
Eastern Redbud	*Cercis canadensis*	Y	Y	All	Medium	25' x 30'	B&B (5'-6')	Small seed pods, can be clump or tree-form
Fringetree	*Chionanthus virginicus*	Y	N	All	Low	15' x 15'	B&B (3'-4')	Urban tolerant
Flowering Dogwood	*Cornus florida*	Y	N	All	Low	25' x 30'	B&B (5'-6')	
Corneliancherry Dogwood	*Cornus mas*	N	N	All	Low	25' x 15'	B&B (5'-6')	Urban tolerant
Winter King Hawthorn	*Crataegus viridis 'Winter King'*	N	Y	All	Low	20' x 20'	1-3/4" - 2" cal.	Some thorns, urban tolerant
Crapemyrtle	*Lagerstroemia x. (and cultivars)*	N	N	All	Low	15' x 15'	B&B (8'-10')	
Sweetbay Magnolia	*Magnolia virginiana*	Y	N	All	Low	25' x 25'	B&B (5'-6')	Fallen leaves may be slippery when wet
Sourwood	*Oxydendrum arboreum*	Y	N	R, N	Low	25'-30' tall	2 to 2-1/2" cal.	
Deciduous Shrubs	*Scientific Name*	Native	Drought Tol.	Char. Zone	Litter Level	Pot. Mature Size	Installation Size	Comments
Brilliant Red Chokeberry	*Aronia arbutifolia 'Brilliantissima*	Y	N	R,N	N/A	7' x 4'	#3 cont. (3'-4')	Tends to spread
American Beautyberry	*Callicarpa americana*	Y	Y	R,N	N/A	6' tall	#3 cont. (2'-3')	
New Jersey Tea	*Ceonothus americanus*	Y	Y	All	N/A	3' tall	#3 cont, (18"-24")	
Summersweet	*Clethra alnifolia*	Y	N	All	N/A	5' x 6'	#3 cont. (2'-3')	Good in groupings/masses or borders
Tatarian Dogwood	*Cornus alba*	N	N	All	N/A	6' x 6'	#3 cont. (2'-3')	Plant in masses
Border Forsythia	*Forsythia x. intermedia*	N	N	All	N/A	8' x 10'	B&B (5'-6')	Needs pruning in tight areas, urban tolerant
Witch Hazel	*Hamamelis virginiana*	Y	Y	All	N/A	12' x 12'	B&B (6'-8')	Somewhat urban tolerant
Wild Hydrangea	*Hydrangea arborescens*	Y	N	All	N/A	5' x 5'	#3 cont. (18"-24")	Grows best in partial shade
Sweetspire	*Itea virginica*	Y	Y	All	N/A	4' x 6'	#3 cont. (18"-24")	Good in groupings/masses or borders
Mountain Laurel	*Kalmia latifolia*	Y	Y	All	N/A	6' x 6'	#3 cont. (2'-3')	Good for part-shade
Coast Leucothoe	*Leucothoe axillaris*	Y	N	All	N/A	3' x 6'	#3 cont. (18"-24")	Best in part-shade
Spicebush	*Lindera benzoin*	Y	Y	A,R,N	N/A	8' x 8'	B&B (5'-6')	May be better in naturalistic settings
Koreanspice Viburnum	*Viburnum carlesii*	N	Y	All	N/A	6' x 6'	#3 cont. (18"-24")	Somewhat urban tolerant
Arrowwood Viburnum	*Viburnum dentatum*	Y	N	All	N/A	8' x 8'	#3 cont. (3'-4')	Very urban tolerant
Winterthur Viburnum	*Viburnum nudum 'Winterthur'*	Y	N	All	N/A	5' x 5'	#3 cont. (2'-3')	Good in wet areas
Blackhaw Viburnum	*Viburnum prunifolium*	Y	N	All	N/A	15' x 12'	B&B (2'-3')	
Rhododendron								
Evergreen Shrubs	*Scientific Name*	Native	Drought Tol.	Char. Zone	Litter Level	Pot. Mature Size	Installation Size	Comments
William Penn Barberry	*Berberis x gladwynensis 'William Penn'*	N	N	All	N/A	4' x 4'	#3 cont. (18"-24")	
Chinese Holly	*Ilex cornuta 'Bufordii Nana'*	N	Y	All	N/A	6' x 6'	#3 cont. (18"-24")	Has several cultivars of varying heights
Inkberry	*Ilex glabra*	Y	N	All	N/A	4' x 4'	#3 cont. (18"-24")	Has several cultivars of varying heights
Winterberry	*Ilex verticillata*	Y	N	All	N/A	8' x 8'	#3 cont. (18"-24")	Wet site tolerant, male/female for berries
Chinese Juniper	*Juniperus chinensis*	N	Y	All	N/A	Varies	Varies	Several cultivars of varying heights (2' to 6')
Nothern Bayberry	*Myrica pensylvanica*	Y	Y	All	N/A	6' x 6'	#3 cont. (18"-24")	Salt tolerant, forms colonies through suckers

Common Name	Scientific Name	Native[1]	Drought Tolerant[2]	Character Zones[3]	Litter Level[4]	Potential Mature Size (H x W)	Installation Size	Comments
Perennial Grasses	*Scientific Name*	Native	Drought Tol.	Char. Zone	Litter Level	Pot. Mature Size	Installation Size	Comments
River Oats	*Chasmanthium latifolium*	Y	N	R,N	N/A	3' tall	#1 cont.	
Elijah Blue Festuca	*Festuca ovina 'Elijah Blue'*	N	Y	A,R,P	N/A	8" tall	#1 cont.	
Soft Rush	*Juncus effusus*	Y	N	N	N/A	1' x 1.5'	#1 cont.	Grows well in standing water
Muhlygrass	*Muhlenbergia capillaris*	Y	Y	A,R,P	N/A	3' x 3'	#1 cont.	Pink/purple flower, very drought tolerant
Switch Grass	*Panicum virgatum*	Y	Y	All	N/A	Varies	#1 cont.	Height varies by cultivar (3' to 7')
Dwarf Fountain Grass	*Pennisetum alopecuroides 'Hameln'*	N	Y	All	N/A	18" x 24"	#1 cont.	Species form grows taller
Little Bluestem	*Schizachyrium scoparium*	Y	Y	All	N/A	3' tall	#1 cont.	Best in groups or masses
Woolgrass bulrush	*Scirpus cyperinus*	Y	N	N	N/A	4'-5' tall	#1 cont.	Prefers wet sites
Indian Grass	*Sorghastrum nutans*	Y	Y	All	N/A	6' tall	#1 cont.	Cultivars can grow shorter
Groundcovers	*Scientific Name*	Native	Drought Tol.	Char. Zone	Litter Level	Pot. Mature Size	Installation Size	Comments
Compact Youngstown Juniper	*Juniperus horizontalis 'Plumosa Compacta Y*	N	Y	All	N/A	2' x 5'	#3 cont. (12" to 15")	Good for masses, slopes, and erosion control
Blue Rug Juniper	*Juniperus horizontalis 'Wiltoni'*	N	Y	All	N/A	6" x 5'	#3 cont. (12" to 15")	Good for masses, slopes, and erosion control
Big Blue Lilyturf	*Liriope muscari 'Big Blue'*	N	N	All	N/A	1' x 2'	#1 cont.	Variegated species available
Japanese Spurge	*Pachysandra terminalis*	N	N	All	N/A	8" tall	2" in flat	Full shade only
Sedum	*Sedum spp.*	N	N	All	N/A	18" x 24"	#1 cont.	Available in lower-growing species
Fragrant Sumac	*Rhus aromatica (gro-low)*	Y						
Woodland Phlox	*Phlox divaricata*	Y						
Creeping Phlox	*Phlox stolonifera or P. sublata*	Y						
Perennial Plants	*Scientific Name*	Native	Drought Tol.	Char. Zone	Litter Level	Pot. Mature Size	Installation Size	Comments
Butterfly Weed	*Asclepias tuberosa*	Y	Y	A,R,N	N/A	2' x 1.5'	#1 cont.	
Heart-leaved Aster	*Aster cordifolius*	Y	Y	N	N/A	3' tall	#1 cont.	Woods or grassy clearings, natural settings
White Wood Aster	*Aster divaricatus*	Y	Y	N	N/A	2' tall	#1 cont.	Woods or grassy clearings, natural settings
Threadleaf Coreopsis	*Coreopsis verticillata*	Y	Y	A,R,N	N/A	2' tall	#1 cont.	Variety of yellow tones
Delphinium	*Delphinium exaltatum (and cultivars)*	Y	N	R,N	N/A	5' x 1.5'	#1 cont.	
Purple coneflower	*Echinacea purpurea*	Y	N	All	N/A	2-3' tall	#1 cont.	
Joe Pye Weed	*Eupatorium fistulosum*	Y	N	N	N/A	5' tall	#1 cont.	
Wild Geranium	*Geranium maculatum*	Y	N	R,N	N/A	2' tall	#1 cont.	Grows better in part shade
Ox-eye Sunflower	*Heliopsis helianthoides*	Y	Y	A,R,N	N/A	4' x 3'	#1 cont.	Border plant or naturalized in open area
Daylily	*Hemerocallis spp.*	N	N	All	N/A	2' x 2'	#1 cont.	Numerous varieties and cultivars available
Hosta	*Hosta spp.*	N	N	All	N/A	Varies	#1 cont.	Numerous varietiesavailable, needs shade
Cardinal Flower	*Lobelia cardinalis*	Y	N	R,N	N/A	2' x 2'	#1 cont.	Border plant or naturalized in open area
Bee Balm	*Monarda didyma (and cultivars)*	Y	N	A,R,N	N/A	3' x 3'	#1 cont.	
Russian Sage	*Perovskia atriplicifolia*	N	Y	All	N/A	3' x 3'	#1 cont.	
Black-eyed Susan	*Rudbeckia fulgida*	Y	Y	All	N/A	3' x 4'	#1 cont.	
Autumn Joy Sedum	*Sedum 'Autumn Joy'*	N	N	All	N/A	1.5'-2' tall	#1 cont.	
Blue-Eyed Grass	*Sisyrinchium angustifolium*	Y	N	N	N/A	1.5' x 1'	#1 cont.	Native plant gardens, borders, natural areas
Tall Meadow Rue	*Thalictrum pubescens*	Y	Y	N	N/A	4' tall	#1 cont.	Background plant in natural settings
Golden Alexanders	*Zizia aurea*	Y	N	N	N/A	2' x 2'	#1 cont.	
False Indigo	*Baptisia australis*	Y					#1 cont.	
Columbine	*Aquilegia Candadensis*	Y					#1 cont.	
Bluestar	*Amsonia tabernaemontana*	Y					#1 cont.	
Ferns	*Scientific Name*	Native	Drought Tol.	Char. Zone	Litter Level	Pot. Mature Size	Installation Size	Comments
Christmas Fern	*Polystichum acrostichoides*	Y						
Hay-scented Fern	*Dennstaedtia punctiloba*	Y						
Interrupted Fern	*Osmunda claytoniana*	Y						
Ostrich Fern	*Matteuccia struthiopteris*	Y						
Royal Fern	*Osmunda regalis*	Y						
Turf Lawn Substitutes	*Supplier Name*							
Native Sun Turfgrass	Native American Seed	N/A	Y	All	N/A	5"-8" tall	Seed	http://www.seedsource.com/
Enviro-Turf	Bluestem Nurseries	N/A	Y	All	N/A	4"-6" tall	Seed	http://www.bluestem.ca/
Original No-Mow Grass	NoMow Grass	N/A	Y	All	N/A	3"-6" tall	Seed	http://nomowgrass.com/index.htm
Improved Lush Blue-Green	NoMow Grass	N/A	Y	All	N/A	4"-7" tall	Seed	http://nomowgrass.com/index.htm

1. The term "native" for this report means that plants are native to the State of Virginia
2. Drought tolerance was based on publications that suggested that these plants were adaptable to dry sites, soils, and conditions and would survive dry conditions.
3. A = Acadmic; R = Residential; N = Natural; P = Parking
4. High = Large number of fruits/nuts/pods dropped; Medium = Some fruits/nuts/pods dropped; Low = Neglible amount of fruits/nuts/pods dropped

3.2 INTERIOR SPACE STANDARDS

3.2.1 GENERAL

3.2.1.1 General

References:

- Mason Master Plans: http://facilities.gmu.edu/masterplans/index.htm
- CPSM, Chapter 6 - Design & Procurement Criteria, Policies & Guidelines
- Virginia Correctional Enterprises (VCE): http://www.govce.net/store/
- Office of Space Management website: http://facilities.gmu.edu/space/index.htm

Space planning for new and renovated university facilities shall generally follow the guidelines in the CPSM 2012 Edition, Revision 1, Section 6.1.1 – Guidelines for Space Planning and Section 6.1.2 – Building Efficiency Ratios. In addition to those outlined in the CPSM, the following space guidelines shall be used. The Design Team shall document specific space allocations based on these guidelines and the requirements of the project in design during the Programming and Schematic Design phases for review and acceptance by Mason. These space allocations will become the basis for the development of the project design. Guidelines for specific space types can be found in Sections 3.2.2 through 3.2.15 of the Design Manual.

This section is organized by space use categories as defined by the Postsecondary Education Facilities Inventory and Classification Manual (FICM): 2006 Edition. For definitions of space use categories, refer to http://nces.ed.gov/pubs2006/2006160.pdf, Chapter 4.

George Mason University contacts for matters related to interior space planning design are listed below:

- Director of Campus Planning
- Associate Director, Space Management
- Assigned Project Planner
- Assigned Interior Design Staff

3.2.1.2 Facility Planning and Design

It is important that all facilities and spaces on all George Mason University Campuses reflect the spirit of the university, as well as the future vision of the institution as defined in Mason's Master Plan. This applies not only to the planning and placement of new facilities, but also to the quality of their interior spaces. When beginning any new project, it is the responsibility of the Design Team to become familiar with the Master Plan and to incorporate these principles and guidelines, as appropriate, into their design.

Interior spaces—just as the exterior and landscaping features of a facility—should reflect the campus context and the desired image of the university. For example, the Design Team should consider how elements such as building entrances, significant interior spaces, and interior circulation may respond to adjacent outdoor spaces and pedestrian walkways.

Many other factors will be considered in the planning of interior spaces. In planning all spaces on campus, it is a priority for George Mason University to create an environment that promotes learning and encourages collaboration. In designing successful interior spaces, the Design Team shall strive for the most efficient and effective use of space. Program adjacencies shall respond to allied uses and avoid conflicts with mechanical rooms or spaces that may generate auditory distractions. In terms of the quality of space, natural daylighting shall be maximized (e.g., locating workstations near the perimeter of the building's floor plate, and offices towards the center). Finish ceiling heights, as well as the level, quality, and durability of finish materials shall be appropriate to the type of activity programmed for the space.

Finally, as noted throughout the Design Manual, George Mason University places a high priority on the sustainability of its facilities and spaces, which shall remain a contributing factor throughout the design process.

3.2.1.3 Windows and Walls

3.2.1.3.1 General

- Design partitions to meet the applicable NC rating and/or the fire rating. All partitions shall extend a minimum of 6" above the ceiling, except where specifically noted otherwise.

3.2.1.3.2 Interior Signage

- The Design Team shall provide room and area identification signage based on Mason sign standards. All interior and exterior assignable rooms shall be based on room numbering standards listed in Section 2.2.4 of the Design Manual for the following space types:
  - Lobby areas, entry areas, or foyer areas incapable of having furniture being placed in them
  - Elevators, elevator mechanical rooms, or adjoining rooms that are used as mechanical or electrical space only.
  - Corridors, hallways, or other walking paths
  - Restrooms of any sort.
  - Any mechanical, electrical, and/or telephone/data rooms.
  - Any open vertical shafts or spaces made for the passing of mechanical, plumbing, or other systems.
  - Janitors or service closets
  - Any classrooms, labs, and studios
  - Administrative office suites
  - Offices and administrative work spaces
  - Stairwells (corridor side)
  - Stairwell levels (inside stairwell)
  - Fire control room
  - Vestibules and exterior cavities

- The Design Team shall provide wayfinding signage for all public spaces based on Mason sign standards. This will include the following sign types:
  - Building identification
  - Building directory at primary and secondary building entrances
  - Building directory at elevators
  - Directional signage (wall mounted or suspended)
  - Projecting identification (stairs, restrooms, elevator, vending, etc)
  - Area identification (theaters, libraries, study nooks, etc.)
  - Regulatory signage
- In addition to those sign types and spaces previously outlined, the Design Team is responsible for coordinating applicable signage for rooms/areas that may require special signs due to outside code regulations. In these cases, the Mason sign standards may be altered to meet those regulations, but must be reviewed and approved by the Project Manager and Office of Facilities Administration.
- The signage standards shall be provided as indicated by Campus Planning.
- Initial signage needs and requirements will be determined in a signage kickoff meeting, which is to be conducted as early as practicable in the architectural design process.
- The Design Team shall provide preliminary sign location plans and message schedule to the Project Manager once room numbers have been assigned. The preliminary sign plan must be reviewed and approved by Campus Planning for adherence to sign standards and wayfinding rationale prior to preliminary drawing submission to BCOM. All such signage shall be included in this submission.
- The Design Team shall refine sign location plans and message schedule and provide finalized location plans and message schedule prior to completion of working/construction drawings. The refined sign plan must be reviewed, and approved, by Campus Planning prior to the completion of working/construction drawing submission to BCOM. All such signage will be included in this submission.

3.2.1.4 Doors

3.2.1.4.1 General

- Vision panels and side lights are encouraged.

3.2.1.5 Accessibility

3.2.1.5.1 General

- Drinking fountains located along a path of travel must be recessed when possible.
- A grab bar must be provided on at least one wall of each elevator cab.

- Interior and exterior signage marking permanent spaces must have both the name and number in raised letters and Braille in compliance with the applicable accessibility codes.

3.2.1.6 Furniture and Equipment

3.2.1.6.1 General

- Each assembly building shall be equipped with at least one Automated External Defibrillator (AED) as part of new construction contracts. The Environmental Health and Safety Office determines the location and type purchased. AED’s must be mounted in a cabinet that is labeled and have a sign above the cabinet indicating the location of the AED. The Design Team shall coordinate with the Environmental Health and Safety Office in the selection of the make and model of the AED.

- Equipment shall be arranged to provide service clearances and maintenance access with a minimum disruption to workspace. The minimum width of an egress way in non-service or maintenance areas is 36 inches.

- Storage shelves shall be located in such a way that they do not permit the storage of items within 24 inches from the ceiling.

- Provide adequate space around equipment and furnishings. In general, 30" of free floor area is required for operations done while standing, and 36" of free floor area is required for seated operations, aisles, passageways, and doorways. These are minimums which should be increased depending on many variables including occupant traffic capacity, size of material used in an operation, and facility use.

3.2.1.7 Materials and Finishes

The Design Team in conjunction with the Mason design staff will select colors of interior finishes early during construction. The Design Team shall obtain submissions from the Contractor on all manufacturers and products that the Contractor intends to use on the project. Using the standard or special colors from these manufacturers, the Design Team shall prepare a color board indicating the various spaces and the color schemes for each space or series of spaces. These color boards shall be submitted to the Mason Project Manager, Interior Designer, and Planner for review and approval at a point early in the construction process and no later than the date that structural elements of the building are 50% complete. Upon approval of the colors, the Design Team shall develop a detailed listing for the Contractor indicating the colors selected for each material and location on the project.

It should be noted that Mason is required to use certain vendors for the purchase of furnishings, furniture, and systems modules.

3.2.1.7.1 General

The following guidelines apply to the selection of interior finishes for all space types throughout Mason’s campuses:

- All paint, mastics, adhesives, sealants, and caulks must pass indoor air quality standards and be low VOC.

- All door frames shall have semi-gloss paint.

- All handrails shall have Direct to Metal (DTM) paint.

- For every paint color used, the Design Team shall provide one additional full can of paint per building for future maintenance purposes.

3.2.1.7.2 Wall Finishes

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3.2.1.7.3 Floor Finishes

- Avoid solid and light colored carpeting. Use flecked colors and shades that do not show dirt and stains as readily.
- All carpet shall be solution-dyed.

3.2.1.7.4 Ceiling Finishes

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3.2.1.8 Building Systems

3.2.1.8.1 General

- Interior direct and structure born vibration from vibrating mechanical equipment and elevators can cause occupant complaints and concern for safety. The structural engineer and mechanical engineer for the project should work together to design the building systems to achieve the minimum vibration from mechanical and elevator equipment as recommended in Chapter 48 "Sound and Vibration Control" from the ASHRAE Applications Handbook as indicated for Human Comfort in Office areas unless otherwise indicated by Mason. Where critical vibration-sensitive laboratory or process equipment requires a more stringent vibration criteria, the design should be coordinated between the users and the Design Team to meet the specification requirements of the specific equipment.
- Vibration sources (mechanical and electrical equipment such as pumps, chillers, fans, emergency generators, and transformers) shall be located away from activities sensitive to vibration, such as laboratory instruments.

3.2.1.8.2 Plumbing

- Refer to Section 3.3.3 – Plumbing Systems.
- Equip all areas, rooms, or spaces where chemicals will be used or mixed with an emergency shower and eyewash unit. Refer to Chapter 3.3.3 of the Design Manual for additional information regarding plumbing systems, including emergency shower requirements.

3.2.1.8.3 Heating, Ventilating and Air Conditioning

- Refer to Section 3.3.1 – HVAC Systems.
- Provide HVAC system in accordance with applicable codes and design guidelines referenced in Chapter 3.3.1 of the Design Manual.

3.2.1.8.4 Electrical

- Refer to Section 3.3.2 – Electrical Design Criteria.

- Provide GFCI circuit protection for electrical outlets on countertops and within 6 feet of a water source. If countertop is used for laboratory equipment, consider a surface-mounted raceway with outlets.

- Electrical outlets shall meet electrical requirements of specific pieces of equipment to include amperage demands and plug configuration for voltage requirements.

3.2.1.8.5 Communications

- Equip each floor with a campus phone that is accessible to all building occupants and provide a sign to identify its location.

3.2.1.9 Acoustics

3.2.1.9.1 General

The acoustical quality of an environment relies on several factors which can be controlled through the design of a building or space. Sound Transmission Class, or “STC,” refers to the amount of sound insulation provided in the construction of a wall, floor or ceiling. A higher STC rating translates into greater sound isolation between spaces.

The Noise Criteria, or “NC,” describes the amount of mechanical background noise that is audible within a space. A higher NC means a greater level of background noise.

A third means of controlling the acoustical quality of a space is using interior finishes—as well as manipulating the shape of the room itself—to absorb sound. It is important that all factors contributing to the acoustical environment are considered throughout the design process. In addition, the following general guidelines shall apply:

- Specific criteria for NC and STC ratings are noted where applicable in subsequent sections. All spaces shall be designed in accordance with ASHRAE, ANSI/ASA, and best practices. Any recommendations in the Design Manual which are more stringent than these requirements shall be applied.

- Interior-source background noise from mechanical systems in the spaces shall be calculated using the sound from all relevant HVAC sources and paths. Where ever possible, the mechanical system design shall comply with all requirements in Chapter 48 “Sound and Vibration Control” from the ASHRAE Applications Handbook and, unless otherwise noted, shall be designed to achieve the Noise Criterion (NC) ratings for the various spaces recommended by the ASHRAE Applications Handbook. The values listed in the ASHRAE Applications Handbook are intended as the system design goal.

3.2.1.10 Security

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3.2.2 CLASSROOMS

3.2.2.1 General

The Design Team must coordinate all classroom designs with the Office of Campus Planning and the Information Technology Unit including, but not limited to, the Division of Instructional Technology (Do IT).

3.2.2.2 Facility Planning and Design

3.2.2.2.1 Classroom Concepts

The following classroom concepts are included for discussion between the Design Team and George Mason University during the planning and design of non-lab teaching spaces. Various furniture configurations show a number of possibilities for classrooms of the same size to support a variety of instructional delivery types.

The diagrams included should be used as a reference when evaluating the space needs for new or renovated classrooms. It should be noted that the allocated square footage per student exceeds the guidelines for space planning in the CPSM. A greater square footage allocation for classrooms provides more flexibility in instructional delivery and the option for collaborative learning. Refer to the CPSM, Chapter 6.1 – General Design Standards for minimum state requirements.

For classroom prototype diagrams, refer to details 3.2-1, 3.2.3, 3.2.4, 3.2.5, 3.2.6 and 3.2-7. The table below includes planning standard suggestions for classroom learning environments.

Type	Seating/Surface	SF/student	Details/Notes
Lecture Hall	Fixed seating; sloped or tiered floor	18sf/stud	Details 3.2-5 and 3.2-7.
Tiered Classroom	Movable seats, fixed tables; two rows per riser	25sf/stud	Modesty panels on table at front of riser; back table has double width to allow student collaboration. Detail 3.2-6.
Case Study	Tiered room, seats in a “U”/”C” shape	35sf/stud	Room has to be laid out to determine actual square footage. Details 3.2-1 and 3.2-2.
Flexible Classroom	Movable tables, movable chairs; flat floor	40sf/stud	Details 3.2-1 and 3.2-2.
MILS (Mason Innovative Learning Space)	Movable chairs; flat floor		Problem based learning/SCALEUP/New Mason Idea. Detail 3.2-4.
High Volume/Density Classroom	Flat floor, tables/chairs or movable tablets	25sf/stud	Detail 3.2-3.
Break-out Rooms			

3.2.2.2.2 Classroom Proportions

- The acceptable classroom proportion is a rectangle between 1:1 and 4:3 (Width : Length) or between 1:1 and 3:4 (Width : Length).

- Ceiling height and ceiling projector mounting height shall be coordinated to provide the desired image size.

- Any space with a ratio greater than 3:4 or 4:3 is unacceptable as a classroom space.

3.2.2.3 Windows and Walls

- Natural light is highly desired in classrooms, however, the placement of windows should be carefully coordinated to avoid distracting from instruction. Classrooms shall have blackout shades supplied on all windows.

3.2.2.4 Doors

- It is unacceptable to place classroom doors on the instructional wall; the ideal place for doors is on the wall opposite the instruction wall.

- It is acceptable to place classroom doors on side walls; however, they should be on the side of the room opposite the lectern.

3.2.2.5 Accessibility

- Classrooms shall be universally accessible for students, staff, and faculty.

- For classrooms—regardless of size—it is preferred that accessible seating be dispersed rather than clustered in a single location. Provide an accessible space for students at the top and bottom of each classroom. Exceptions may be approved by Mason depending on unique circumstances.

- Lectern placement and furniture must be compliant with the current ADA guidelines. In addition, the following guidelines shall apply:

  - A 60” minimum from instructor side of lectern to wall or obstruction behind the lectern is required.

  - If 12” of unobstructed knee clearance is available, then the lectern may be 48” from any obstruction or wall behind the lectern.

  - Lectern must have 36” knee width unobstructed underneath the lectern.

  - Lectern must be between 27”-34” in height. Preference is for 34” height.

  - Where the reach depth exceeds 20 inches (510 mm), the Lectern high forward reach shall be 44 inches (1120 mm) maximum and the reach depth shall be 25 inches

  - An ADA compliant path of travel to the lectern must be provided.

3.2.2.6 Furniture and Equipment

3.2.2.6.1 Classroom Specialties

- Classroom specialties such as whiteboards, projection screens, and seating vary significantly depending upon the ultimate use of the space. The Design Team shall work closely with Mason to identify the needs of each room.

- Projection screens in classrooms shall be coordinated with Campus Planning and the Department of Instructional Technology.

- Provide wall protection in all classrooms to mitigate chair and table impacts.

3.2.2.6.2 Whiteboards

- Mason accepts three types of whiteboards: wall talkers; porcelain-on-steel surface; and white-board paint. The use of each shall be determined by Campus Planning and DoIT in coordination with the Design Team.

- The writing surface shall span the entire teaching wall with a 48” height whiteboard. Additional whiteboard space may be required for a given classroom.

- Other types of whiteboards shall be full wall surface.

- Whiteboard walls shall be free of all devices (thermostats, receptacles, switches, strobes, horns, etc.).

3.2.2.6.3 Classroom Display Size and Placement (Projected and Direct View)

- Avoid locating projection screens near doors due to conflict with exit lights.

- The display shall either be a front screen projection or a direct view monitor for classrooms with technology.

- Rear projection is not preferred, but may be considered in specific projects in coordination with Learning Space Design in Mason’s Division of Instructional Technology.

- The bottom of the displayed image shall be located at a min of 48” AFF and as appropriate for viewing.

- A minimum of a 3” separation shall be provided between the top of the display and the finished ceiling.

- The maximum display size for a classroom is a direct factor of the ceiling height of the classroom. This display size will dictate the nearest viewer (defined as the closest set of viewer eyes in front of the display) and the further viewer (defined as the furthest set of viewer eyes in front of the display).

- Front projection shall not be used in any space with a ceiling height lower than 102”.

Finished Ceiling Ht. (FCH)	FCH – 48" – 3" = **Maximum Display Ht.**	1.6 x Display Ht. = **Maximum Display Width** (16:10)	Width of Screen = **Nearest Viewer**	Screen Ht. x 7 = **Furthest Viewer**
90 in.	39 in.	62.4 in.	62.4 in.	273 in.
96 in.	45 in.	72 in.	72 in.	315 in.
102 in.	51 in.	81.6 in.	81.6 in.	357 in.
108 in.	57 in.	91.2 in.	91.2 in.	399 in.
114 in.	63 in.	100.8 in.	100.8 in.	441 in.
120 in.	69 in.	110.4 in.	110.4 in.	483 in.
126 in.	75 in.	120 in.	120 in.	525 in.
132 in.	81 in..	129.6 in.	129.6 in	567 in.

Table of Display Maximums and Viewer Locations based on Ceiling Height (this chart is not for use to determine floor to floor or desired ceiling heights for new classroom spaces, only to show relative proportionality in selecting projection size).

- All students must be within proper sight lines of the screen. Sight lines are defined as any viewing angle within 45 degrees off the axis of the edge of the display.
- For any classroom with more than 150 seats, multiple displays may be necessary as determined by the Mason for proper viewing. All students should be within the sight lines of both displays and within the nearest and furthest viewer range for both displays.
- When placing single displays it is expected that the display will be placed off center to allow maximum use of whiteboard space and displays simultaneously while preserving sight lines.
- Consider options other than traditional screens (e.g. whiteboards, etc) for projection display surfaces, as approved by the Mason.
- All classroom screens shall be motorized and provided with a low voltage wall switch to be located behind the instructor's lectern and low voltage connectivity to be controlled by a Crestron system via relays,
- Screens shall be ceiling recessed.
- Install screens so that the center of the screen does not fall on a ceiling grid line.
- Screens must be Matte White Material with a Gain of 1.0.
- Do not use tab tensioning for screens.
- Screen roller and other serviceable parts must be accessible from the classroom without making alterations to the ceiling grid (typical of Da-Lite Advantage Electrol).

3.2.2.6.4 Projector Infrastructure Placement

- Coordinate projector infrastructure with with Campus Planning and the Department of Instructional Technology, based on the project, screen size and screen placement.

3.2.2.6.5 Ceiling Type

- Construct ceilings to allow for easy installation and maintenance of audio visual equipment and screens.
- Classrooms, in most cases, shall have drop ceilings with acoustical tile.
  - Gypsum wallboard (sheetrock) is unacceptable for classroom ceilings.

3.2.2.7 Materials and Finishes

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3.2.2.8 Building Systems

3.2.2.8.1 General

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3.2.2.8.2 Plumbing

3.2.2.8.2.1 All Classrooms

- Refer to Section 3.3.3 – Plumbing Systems.

3.2.2.8.3 Heating, Ventilating and Air Conditioning

3.2.2.8.3.1 All Classrooms

- Refer to Section 3.3.1 – HVAC Systems.

3.2.2.8.4 Electrical

- Refer to Section 3.3.2 – Electrical Design Criteria for additional information.
- Single display classrooms (90% of classroom spaces) shall follow a defined lighting pattern. For classrooms larger than 150 seats or having multiple displays, the Design Team shall coordinate lighting design with Campus Planning and the Department of Instructional Technology.
- Single display classrooms shall utilize a four zone lighting scheme. All zones shall have dimmable capacity.
  - Zone 1 is defined as the lighting above the instructor and lectern. The lighting design shall provide for on/off control of all fixtures in this zone on a single circuit.
  - Zone 2 is defined as the lighting above the screen or display location. The lighting design shall provide for on/off control of all fixtures in this zone on a single circuit.
- In rooms with projection, when Zone 2 is in an off state and all other lighting is in an on state, a 15:1 projected image systems contrast ratio will be achievable at screen location as measured by ANSI/INFOCOMM 3M-2011. It should be assumed that the projector output is 3600 lumens for the lighting design purposes. To achieve this ambient light at screen location will be ~5 foot-candles (~50 lux) or lower, however, this should be verified by the lighting designer.

- Zone 3 & Zone 4 are defined as the fixtures above the students. These fixtures should be double ballast fixtures. Zone 3 shall provide on/off control of the first ballast for all fixtures within the area on a single circuit. Zone 4 shall provide on/off control of the second ballast for all fixtures within the area on a single circuit.
- Provide lighting control for all circuits both at the instructor wall adjacent or behind the lectern and on the entry wall behind the door.
- Presets for each zone shall be determined by Campus Planning, the Department of Instructional Technology, and the Provost Office representative.
- If there is an emergency or always-on fixture in the room, it shall be placed above the entry door furthest from the display.
- For an example of a single projection classroom lighting scheme, refer to detail 3.2-9.

3.2.2.8.5 Communications (IT/AV)

3.2.2.8.5.1 Lectern Location

- Requirements for the lectern include:
  - Single 20-amp individual branch circuit on same phase as projector/s
  - Duplex 5–20r receptacles

3.2.2.8.5.2 Projector Location

- Requirements for the projector include:
  - Single 20-amp individual branch circuit on same phase as lectern branch circuit
  - In rooms with 2-4 projectors, the individual branch circuit may be shared amongst projectors only.
  - Projector ceiling box enclosure shall be hard wired only.

3.2.2.8.5.3 Boxes and Conduit

- Requirements for ceiling box enclosures (typical of FSR CB-22p) include:
  - Plenum rated, 2’x2’ in size to fit into a ceiling tile grid
  - Two full rack units of space for low voltage equipment
  - External AC receptacle and a switch/circuit breaker on the ceiling surface
  - Five internal AC outlets ergonomically spaced to allow room for equipment power supply bricks inside the enclosure
  - A white rim access door that you insert a ceiling tile into
  - Projector Pole Mount (1½” NPT fitting to hold up to a 50 lbs)

- 1½” NPT fitting can be located in multiple positions to optimize projector placement
- Requirements for lectern floor box and AV conduit (example: FSR FL-500P-4) include:
  - Minimum 4” depth
  - Floor box cover shall allow for cables to pass through when closed
  - Floor box cover shall have the same finishing as flooring
  - If floor box is not in use, it should blend in with the rest of the floor
  - Single gang separation for duplex electrical outlet
  - Electrical shall have its own conduit
  - Single gang knockout for networking
  - Networking shall have its own conduit
  - At minimum a dual gang knockout for audiovisual cabling
  - With two 1¼” conduit enclosed from floor box to stubbed up above finished ceiling
  - Above the finished ceiling an audiovisual cable tray is to be installed from AV conduit stub out, from floor box, to projector ceiling box enclosure
  - For information regarding AV floor boxes and conduits, refer to details 3.2-8 and 3.2-10

3.2.2.8.6 Network & Telecom

- Provide 3 each: Network connections terminated to a standard wall plate type receptacle in each classroom floor box using dedicated networking conduit
- Provide 2 each: Network connections terminated into a surface mount jack housing placed in each classroom ceiling box (if there is a projector)
- Provide 2 each: Network connections terminated into a wall place behind each wall mounted large screen monitor in a manner coordinated with the AV installation (if there is a large screen monitor)
- Provide 1 each: Wall mounted digital telephone and required networking infrastructure including wall mount style telephone jack in each classroom located on the wall behind or adjacent to the lectern

3.2.2.9 Acoustics

References:

- Acoustical Performance Criteria, Design Requirements, and Guidelines for Schools, Part 1: Permanent Schools
- For classrooms <50 student seats, follow ANSI/ASA S12.60-2010/Part 1

3.2.2.9.1 Videoconferencing or Lecture Capture

Videoconferencing or Lecture Capture (any seat count) and classroom (> 49 seats) require special attention and the services of an acoustical engineer. Initial guidance (needs to be verified by an acoustical engineer) for the following issues:

- High-reflectance materials near the instructor area that project sound.
- Sound-absorbing materials on ceilings and on the upper levels of walls in the rear.
- The following acoustical targets shall apply to any videoconferencing or lecture capture room:
    - Target 0.75 reverberation time (acceptable range, 0.6 to 1.2)
    - 50 STC Walls, ceilings, floors, movable or folding partitions
    - 40 STC Doors and windows near high noise areas
    - 28 STC Doors and windows near low noise areas

3.2.2.10 Security

- Specifications are to be provided by Mason's Physical Security Office.
- All classroom primary doors must have an electronic card swipe reader and strike plate.
- If a classroom has two doors that do not share the same hallway, then the secondary door must have an electronic swipe card reader and strike plate. If the two doors share the same hallway, then the secondary door must have only an electronic strike plate.

3.2.3 LABORATORY FACILITIES

3.2.3.1 General

Unless otherwise noted, the following guidelines apply to instructional science labs (including chemical, biology, animal, and special equipment laboratories), art studios, and scene shops.

3.2.3.2 Facility Planning and Design

The matrix below includes a suggested baseline for laboratory planning standards, and should be tested against actual equipment needs, workflow, and numbers of occupants on a project-by-project basis. The size requirements for laboratories can vary significantly. The matrix below represents guidelines for general classes in the noted areas. For advanced classes in these disciplines, the space requirement shall be developed for the specific used in coordination with Mason. Additional laboratory support and storage spaces may also be required. All spaces shall be in compliance with the CPSM. Where recommendations in the Design Manual differ from the CPSM, the greater space allocation shall apply. Suggested laboratory configurations and equipment lists can be found in Chapter 5, details 3.2-11 through 3.2-27.

	Space Type	SF/Seat
LABORATORY	Biology, General	52
	Chemistry, General	52
	Engineering, General	60
	Physics, General	41
	Geology, General	52
	Art and Architecture	60
	Research, Wet Lab	62
	Research, Dry Lab	40
LAB SUPPOR	Biology	13
	Chemistry	13

3.2.3.2.1 Lab Safety Requirements

3.2.3.2.1.1 All Laboratory Facilities

- All buildings that contain laboratories, art studios, or maintenance buildings where chemicals are used shall have an adequately sized and designed room for chemical storage and waste storage, as well as supplies. Refer to NFPA 30 – Flammable and Combustible Liquids Code.
- Refer to NFPA 45 – Standard on Fire Protection for Laboratories Using Chemicals.
- Design floors to support large pieces of laboratory equipment (i.e., mass spectrophotometers, freezers, etc.). In addition, vibration and stabilization may need to be considered for certain pieces of equipment (i.e., electron microscopes, etc.).

- All labs shall have hard floors, preferably chemical resistant (VCT and sheet vinyl are typically acceptable). For floors that are subject to extensive washing, refer to Animal Laboratories in Section 3.2.3.7 – Materials and Finishes.

- Decontamination stations such as sinks for hand washing and storage of clean clothes shall be designed into each laboratory, shop, studio or other such space. These facilities shall be located near exits leading to less hazardous areas.

- The most hazardous operations areas, such as chemical fume hoods, biological safety cabinets, and chemical storage areas must be located away from doors and exits in an area that is least susceptible to cross drafts, foot traffic, or sources of exhaust from other laboratory equipment. This is to improve safety and to minimize the chance that turbulence is created near the hood or cabinet.

- Sufficient areas convenient to all occupants must be provided to discourage eating and drinking in, and continuous occupancy of, potentially hazardous work areas.

- Typical labs are arranged to allow for a variety of student teams, from 2 to 8 people, depending on the course and discipline.

- For all instructional laboratories, provide sufficient space beneath the bench top to accommodate a person's legs and allow them to sit comfortably and erect while working at the bench top.

- Specific design requirements for microscope rooms depend on the type of microscope and the work to be performed. Vibration, ventilation, lighting, and utilities are important considerations.

- Fume Hoods

    - If fixed fume hoods, sinks, larger equipment and overhead storage can be located around the perimeter, a more flexible lab center will allow for a wider range of pedagogies and sub-disciplines over the life of the building. Coordinate with Mason to select the layout type appropriate for each laboratory.

    - Basic fume hoods for organic chemistry are typically 6'-0" wide; general chemical fume hoods for allow for two students to work in the hood .

    - Write up stations shall not be co-located with chemical storage areas.

3.2.3.2.1.2 Biology Laboratories

- All biological laboratories shall be provided access to a cold room within the same building as the laboratory.

3.2.3.2.1.3 Animal Laboratories

- If the College of Science will use the animal space, the space must be designed to meet AAALAC standards.

- Penetration in floors, walls, and ceilings should be sealed, to include openings around ducts, doors, and door frames, to facilitate pest control and proper cleaning.

3.2.3.3 Windows and Walls

3.2.3.3.1 All Laboratory Facilities

- Presentation areas with sliding marker boards, projector screens, and A/V equipment shall be located on an interior wall to allow for exterior glazing.
- Glass to the corridor is desired to allow for light to penetrate into the building and to allow for views into the dynamic teaching lab environment. Interior glazing also contributes to a safer lab environment.
- Seal all gaps between the room and adjacent construction.

3.2.3.3.2 Biology Laboratories

- Windows in biological laboratories shall be non-operational.

3.2.3.3.3 Animal Laboratories

- External windows are not recommended.

3.2.3.4 Doors

3.2.3.4.1 All Laboratory Facilities

- Hazardous waste storage rooms shall have hard key doors only.
- Doors shall be self-closing and self-locking.
- Doors shall be of sufficient dimensions to accommodate equipment and may not be less than 48 inches wide.
- Vision panels must be provided in the active leaf of all laboratory doors.

3.2.3.4.2 Animal Laboratories

- For laboratories containing research animals, doors shall open inward (doors to cubicles inside an animal room may open outward or slide).
- Vision panels on doors may be tinted to prevent disruption of the animals’ light/dark cycle.

3.2.3.5 Accessibility

3.2.3.5.1 All Laboratory Facilities

- Aisles shall have a minimum dimension of 5’-0” based on American Disabilities Act (ADA). This represents good laboratory practice for safe circulation zones in the lab.
- Each lab shall be designed to have at least one position that is ADA compliant. This will affect the design of at least one fume hood (where applicable) and sink.

3.2.3.6 Furniture and Equipment

3.2.3.6.1 Autoclaves

3.2.3.6.1.1 All Laboratory Facilities

- Autoclaves are industrial appliances that require overhead exhaust and floor drains. The size and model of autoclave should be determined by the specific function for the area and the anticipated frequency of use.

- Install a water softener in locations that have hard water (e.g., Prince William) to prevent calcium buildup from disrupting the function of the autoclave.

- Provide all biological laboratories with access to an autoclave within the same building as the laboratory.

- Provide autoclave rooms with sufficient ventilation to accommodate a high heat load of the equipment in the room.

- Provide autoclaves with a drip pan capable of holding 30% of the autoclaves operating capacity.

- Autoclave effluent shall discharge directly to sanitary sewer, and shall not discharge to a neutralization tank.

3.2.3.6.2 Special Equipment

3.2.3.6.2.1 All Laboratory Facilities

- Locate any labs with vibration-sensitive equipment (that would equal or exceed the vibration resistance needs of a 400X microscope) on the lowest floor where there is a concrete slab on grade, or utilize a vibration table if placed on an upper level.

- Equipment containing high strength magnets has specific design requirements that must be followed to shield the magnetic field, limit radiofrequency disturbance, and provide adequate ventilation for cryogenic liquids used to cool the magnet. Coordinate design of laboratories containing this equipment with EHS, the end user, the vendor, and a project engineer with appropriate knowledge and experience.

- Laboratories containing radioactive materials shall be equipped with appropriate mechanisms to secure radioactive materials inventory (lockable freezer) and waste (lockable waste containers).

- All laboratories, art studios and scene shops using or storing gas cylinders shall have cylinder storage mounts, racks, or floor stands for each cylinder to be used or stored. Mounts shall be located at a height that allows for the cylinder restraint to be placed 3/4 of the way up the cylinder. The design of cylinders shall comply with 29 CFR 1910.101.

3.2.3.6.3 Casework, Benches, and Furniture

3.2.3.6.3.1 All Laboratory Facilities

- Organizing lab casework on a three foot module will allow for easy changes and can be well served by an interchangeable inventory of casework.

- Ideally, labs shall be organized on a two directional grid to add flexibility to casework layouts

- Select easily cleanable materials and finishes for laboratory casework that are compatible with substances used for cleaning and disinfection. All wet lab benches shall be made of epoxy resin.

- Construct all bench tops of materials that are impervious to the chemicals and materials used in the laboratory. Ideally, bench tops should incorporate a lip to prevent runoff onto the floor.

- Provide a biosafety cabinet in any room where infectious materials will be used in a manner than can generate an aerosol, splash or splatter. The type of biosafety cabinet will be determined by an EHS risk assessment.

- Cold and warm rooms shall have stainless steel counters, legs, and sink and wire shelves.

- All chairs shall be constructed of synthetic non-fabric, non-porous materials.

3.2.3.7 Materials and Finishes

3.2.3.7.1 All Laboratory Facilities

3.2.3.7.1.1 Wall Finishes

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3.2.3.7.1.2 Floor Finishes

- All laboratory floors must be made of wipeable materials (no carpeting or rugs). VCT or similar material is acceptable.

- Waste storage rooms shall have recessed floors and be sealed with concrete.

3.2.3.7.1.3 Ceiling Finishes

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3.2.3.7.2 Animal Laboratories

- Walls, floors, and ceilings should be water resistant and designed to facilitate cleaning and housekeeping.

3.2.3.8 Building Systems

3.2.3.8.1 General

- Arrange light fixtures, air ducts, and utility pipes to minimize horizontal surfaces for cleaning.

3.2.3.8.2 Plumbing

3.2.3.8.2.1 All Laboratory Facilities

- Refer to Section 3.3.3 – Plumbing Systems.

- For information regarding compressed air piping, vacuum piping, gas piping, chemical waste systems and processed water systems for laboratories refer to Chapter 4, Sections 22 61 13, 22 62 13, 22 63 13, 22 66 00 and 22 67 00.

- Design plumbing systems to accommodate easy service isolation and maintenance while minimizing disruption to laboratory functions. Adequate fluid temperature, pressure, and volume should be delivered to required laboratory functions. Consider future capacity allowances in building designs.

- Consider building services needed by researchers (centralized bottled gases, compressed air, etc.) in the design. All effluent plumbing from laboratories shall be made of chemical-resistant materials and drain into a neutralization tank before discharge to sanity sewer.

- Provide a sink with pressurized running water near the exit door in all laboratories.

- An ANSI-approved shower and eyewash must be located within a 10 second walk in all spaces where chemicals are used or stored. The pathway to the emergency shower and eyewash shall be unobstructed (i.e. no doors without panic bars, no doors that do not swing open in the direction of travel). The installation of both a shower and eyewash in a mutual location is preferred by Mason.

- An ANSI-approved eyewash must be available in all spaces where eyes may be exposed to small particulates.

- Emergency shower and eyewash locations should be determined by an EHS risk assessment.

- The floor beneath emergency showers and eyewashes must not be carpeted.

- Do not install drains under emergency showers unless sensitive or extensive equipment/electronics exist below that may be adversely affected by the use of the emergency shower.

- Floor drains shall not be located inside laboratories unless required for indirect discharge from equipment.

3.2.3.8.3 Heating, Ventilating and Air Conditioning

3.2.3.8.3.1 All Laboratory Facilities

- Refer to Section 3.3.1 – HVAC Systems.

- Refer to Chapter 4, Section 23 07 00 HVAC Insulation for information regarding duct lining for laboratories and animal use areas.

- Ventilation systems shall comply with NFPA 45, latest edition.

- Design all laboratories to provide the required air changes indicated in Mason's Laboratory Ventilation Management Plan, unless one of the following conditions applies:

    - Space internal loads dictate greater airflows for cooling.

    - The total fume hood and containment device exhaust air requirements exceed 12 air changes per hour.

- The minimum occupied and unoccupied air change rate will be determined by EHS via risk assessment and is dependent on the type of work being performed in the laboratory.

- The minimum occupied and unoccupied fume hood face velocity set-point will be determined by EHS. Maximum fume hood design air flow rates shall be based on sash height and face velocity criteria determined by EHS.

- Where internal loads dictate airflows greater than 12 air changes per hour; use of chilled beams shall be evaluated in collaboration with Mason/EHS.

- Where the total fume hood and containment device exhaust air flow dictate greater than 12 air changes per hour, low flow fume hoods shall be evaluated in collaboration with Mason/EHS.

- All laboratory exhaust, including general exhaust and local exhaust ventilation (e.g., chemical fume hoods, biosafety cabinets, and snorkels) shall be single pass and vented to the outside of the building.

- All laboratory exhaust, including general exhaust and local exhaust ventilation (e.g., chemical fume hoods, ducted biosafety cabinets, and snorkels) should be manifolded if the chemicals used in the laboratories are compatible.

- "Co-Mingling" or mixing of general laboratory exhaust and exhaust directly from fume hoods and other containment devices is allowable as long as it is accomplished in compliance with applicable building and life safety codes and the chemical used are compatible.

- "Co-mingled" or combined fume hood and general room exhaust systems must be considered and designed as "hazardous exhaust systems" in accordance with International Mechanical Code, and other applicable building and life safety codes.

- Where fume hoods and general room exhaust streams are combined, the ductwork shall be fully welded type 316 stainless steel. The stainless steel ductwork shall be run from the point of collection (hood connection or room exhaust grille/inlet) to the main riser for that portion of the building. The main duct riser and associated downstream ductwork shall be constructed of stainless steel or anti-corrosion coated galvanized steel or other suitable materials approved by the Mason and the AHJ.

- Where general exhaust and fume hood exhaust systems are NOT combined, the fume hood exhaust ductwork shall be fully welded type 316 stainless steel and shall be considered a hazardous exhaust system.

- No heat recovery wheels (or any other technology which does not completely separate the exhaust and intake airstreams) will be considered for energy recovery building exhaust which handles fume hood exhaust, whether combined or not.

- Variable air volume control dampers controlling the exhaust flow from fume hoods and general room exhaust shall fail OPEN upon loss of control power or control air.

- Where exhaust is required to be filtered with HEPA filters, bag-in/bag-out containment type filter housings shall be utilized and shall include bubble tight dampers the inlet and outlet of the filter housing. The dampers housing shall be fully welded to the filter containment housing. The housing and damper material shall be stainless steel and shall be fully welded construction.

- For fume hood duct design and construction, see Chapter 4, Section 11 53 00.

- Vacuum pump systems shall have water resistant HEPA filters on the suction side with the exhaust to the outside of the facility. Vent vacuum system exhaust to the outside of the building, not recirculated to the mechanical room. A sampling port may be needed to sample exhaust. Design filter housing for easy replacement of the filter, with maximum protection for maintenance personnel.

- Fume Hoods

- o All chemical fume hoods shall meet all relevant design and testing protocols as required by ASHRAE 110. ASHRAE 110 testing shall be completed after the chemical fume hood is installed, and testing certificates/reports delivered to EHS. ASHREA 110 testing shall be specified as part of the building construction contract.
- o Design all wet laboratories to accommodate at least one chemical fume hood to allow for flexibility and university expansion.
- o All chemical fume hoods shall have the following features: lighting, movable sash, chemical and fire resistant work surface, a raised lip or recessed work area. Provide at least 2 linear feet of work space per user.
- o All chemical fume hoods shall have a face velocity of 80-120 feet per minute when the sash is opened 18".
- o All chemical fume hoods shall have a monitor with a digital display of the average face velocity. The monitor shall be equipped with an audible and visual alarm. The monitor shall have a digital display showing the average face velocity.
- o If volatile radioactive materials are to be used, provide a chemical fume hood capable of trapping volatile radioisotopes to prevent their release into the environment.
- o If perchloric acid is to be used, a chemical fume hood shall be manufactured to meet ANSI/AIHA Z9.5-2003 and NFPA 45.
- o Locate chemical fume hoods and biological safety cabinets in an appropriate location within the laboratory that is least susceptible to cross drafts, foot traffic, or sources of exhaust from other laboratory equipment. They may not be placed near doors or emergency exits. Chemical fume hoods shall not be located close to biological safety cabinets.
- o A 12-14 inch clearance above biosafety cabinets may be required to provide for accurate air velocity measurement across the exhaust filter surface.

- Biological safety cabinet operation, as specified by NSF/ANSI Standard 49-2007, Annex F plus Addendum #1 shall be verified at the time of installation and, as a minimum, annually thereafter. Operational tests include Down flow Velocity Profile Test, Inflow Velocity Test, Airflow Smoke Patterns Test, HEPA Filter Leak Test, Cabinet Integrity Test (A1 cabinets only), Electrical Leakage and Ground Circuit Resistance and Polarity Tests, Lighting Intensity Test, Vibration Test, Noise Level Test, UV Lamp Test (if present).
- Ventilation systems must be designed to handle anticipated heat loads generated by specific pieces of equipment. This is especially critical for biological laboratories as incubators, freezers, and other pieces of equipment generate significant heat loads.
- Ventilation ductwork must be compatible with chemicals exhausted from the space.
- Local exhaust ventilation must be designed to effectively capture anticipated airborne contaminants as close to the generation point as possible. Appropriate testing must be completed after the local exhaust is installed, and testing certificates and reports (when appropriate) must be delivered to EHS. Testing shall be specified as part of the building construction contract. Dust

collection systems are required for dust generating equipment, such as saws, to prevent a fire hazard.

- Prior approval by EHS is required for the use of canopy hoods.
- All exhaust in art studios and scene shops, including general exhaust and local exhaust ventilation (e.g., general ventilation, snorkels, and slot hoods) shall be single pass and vented to the outside of the building.
- All art studio and scene shop exhaust, including general exhaust and local exhaust ventilation, shall be manifolded if the chemicals used are compatible.
- For additional information regarding fume hood exhaust fans, refer to Section 3.3.1.4.20.5.

3.2.3.8.3.2 Animal Laboratories

- Provide ventilation in accordance with the Guide for Care and Use of Laboratory Animals. Heat and humidity shall be adjustable to accommodate a range of animal species.

3.2.3.8.3.3 Darkrooms

- Furnish darkrooms where chemicals are used with local exhaust ventilation to control airborne levels of photographic process chemicals. This shall be in the form of a flanged slotted plenum running the length of and behind the work area where chemicals are used. A capture velocity of 50 linear feet per minute (LFM) must be provided at the front edge of the work area. The required exhaust flow rate to produce this capture velocity shall be calculated by the following formula:
- $Q = 2.6\ LVX$

  Where:

  Q = Volumetric flow rate in cubic feet per minute (CFM)

  L = Length of work area, in feet

  V = Desired capture velocity (in this case, 50 LFM)

  X = Distance from slot to front of work area, in feet

- Once the required flow rate is determined, the slot width shall be sized to provide a slot velocity of approximately 2000 feet per minute. The plenum shall be sized to provide a plenum velocity of approximately half the slot velocity. (Taken from the ACGIH Industrial Ventilation Manual, 22nd Edition.)

3.2.3.8.4 Electrical

3.2.3.8.4.1 All Laboratory Facilities

- Refer to Section 3.3.2 – Electrical Systems.
- Emergency generators shall be sized to provide adequate power for all exhaust fans serving combined fume hood and general room exhaust systems. Supply air handler outside air intake isolation damper actuators shall be served by the emergency power system and power OPEN to

prevent excessive negative building pressurization upon loss of primary power source. Supply air handlers do not have to be included in emergency generator capacity. Where fume hood exhaust is separate from general room exhaust, only the fume hood exhaust fans need to be included in calculating the emergency generator capacity.

- Laboratory research requires high-quality lighting for close work, in terms of both brightness and uniformity. Position fixtures to provide uniform, shadow-free, and glare-free illumination of the laboratory bench top. Lighting shall be at least 70 foot-candles and may be as great as 120 foot-candles depending on the application.
- Post emergency lighting, either electric or photoilluminescent, at each exit in a laboratory. This lighting must provide at least an average of 1 foot candle of light and 0.1 foot-candle at floor level.
- Art studios and scene shops require high-quality lighting for close work, in terms of both brightness and uniformity. Position fixtures to provide uniform, shadow-free, and glare-free illumination of the work bench. Lighting shall be at least 30 (according to OSHA) foot-candles and may be as great as 50 foot-candles depending on the application.

3.2.3.8.5 Communications (IT/AV)

3.2.3.8.5.1 All Laboratory Facilities

- All laboratories shall be equipped with a phone.

3.2.3.9 Acoustics
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3.2.3.10 Security
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3.2.4 OFFICE FACILITIES

3.2.4.1 General

The guidelines in this section address offices and office support spaces.

Office and office support space standards are used to provide the Project Team with design guidelines for offices within new construction and/or renovation projects. Mason's office and office support space standards supersede the guidelines outlined in the CPSM and have been developed to meet Mason-specific standards that are used in planning new and/or renovated offices and office support spaces. Office space standards represent the general guidelines the Project Team should use when planning office spaces and represent maximum allowable assignable square feet for each employee category listed in the chart in section 3.2.4.2. It is understood that variations in space size may be needed to meet project specific programming needs, particularly for renovation projects in which the project program must be housed within an existing building envelope. Variations from these standards must be approved by the Associate Director, Space Management for each capital or non-capital project.

3.2.4.2 Facility Planning and Design

3.2.4.2.1 Faculty Offices

It is George Mason University's objective to use space efficiently, and shared offices are encouraged where it is feasible.

Project Teams shall carefully analyze space plans to account and provide for spaces with shared use such as conference rooms, pantries, etc. A ratio of one shared use space for every 12 private offices is an appropriate assumption for planning.

The chart in this section includes the **maximum** assignable square feet (ASF) for each category of space. The minimum office size for an enclosed individual office is 90 ASF. Minimum cubicle or workstation size is determined by furniture design and layout. The ASF listed in the chart is intended to be a general guideline for these spaces, and it is understood that ASF may vary according to program needs within individual projects. Approval from the Associate Director of Space Management is needed for space that would exceed guideline ASF for each space category.

The diagrams in Chapter 5, 3.2-29 and 3.2-30 illustrate workspace configurations that have been adopted by George Mason University and represent the desired models to be used.

3.2.4.2.1.1 Full-Time Faculty

In most cases, full-time faculty are assigned private offices. In some cases, a department may utilize shared space for tenured, tenure-line, or term full-time faculty. The ASF for offices that will be shared by multiple faculty members will be adjusted to meet the total number of faculty who will be assigned to those spaces.

3.2.4.2.1.2 Part-Time/Adjunct Faculty

In all cases, part-time/adjunct faculty are assigned work space within a shared office or a hoteling workstation (inclusive of shared support space; i.e. conference, copy/print areas, etc.).

3.2.4.2.1.3 Classified Staff

Staff are assigned to workstations in either open common areas or within enclosed shared offices. An approved business use is required for private staff offices within a project program. Trade (shops/maintenance) staff are assigned shared drop-in stations.

3.2.4.2.1.4 Graduate Teaching/Research Assistants

Graduate assistants are provided shared workstations within a suite that includes workstations, a small 2-3 person meeting room, and collaboration areas. The number of workstations for each suite will be determined by the total number of GTA/GRAs assigned for each department and calculated by the percentage of occupancy for those spaces.

3.2.4.2.1.5 Collaboration Areas

Academic and research space programs should include ASF for open collaboration areas for faculty and faculty-student collaboration. These spaces should include whiteboard surfaces, power/data connections and flexible furniture.

	Employee Category	Type	Max ASF
FACULTY AND STAFF OFFICES	President	Private Office	350asf
	Vice President	Private Office	285asf
	Associate/Assistant Vice President	Private Office	180asf
	Provost	Private Office	285asf
	Associate/Assistant Provost	Private Office	180asf
	Dean	Private Office	250asf
	Associate/Assistant Dean	Private Office	150asf
	Chair/Director	Private Office	150asf
	Associate/Assistant Chair/Director	Private Office	140asf
	Instructional Faculty	Private Office	120asf
	Research Faculty*	Private Office	120asf
	Administrative/Professional Faculty	Private Office	120asf
	Graduate Teaching Assistant	Shared	35asf
	Graduate Research Assistant*	Shared	48asf
	Part-time/Adjunct Faculty	Shared	35asf
	Classified Staff	Workstation/Private Office	64 /100asf
	Wages Employee	Workstation/Shared Office	64 / 100asf
	Student Assistant	Workstation	20asf
SUPPORT SPACES	N/A	Waiting/Reception Area	250asf
	N/A	Storage Room	100asf
	N/A	Supply/Mail Room	120asf
	N/A	Pantry (shared – one per floor)	varies by program
	N/A	Copy/Work Room (shared-one per floor)	100asf
MEETING	N/A	Small Conference Room (4-10 seats)	26 asf/seat
	N/A	Medium Conference Room (10-20 seats)	28 asf/seat
	N/A	Large Conference Room (20+ seats)	34 asf/seat

*Additional space assigned for research faculty and graduate research assistant is determined by State Council of Higher Education in Virginia (SCHEV) guidelines for ASF per $100,000 of annual research expenditures.

3.2.4.2.2 Conference Rooms

- For conference room configurations that have been adopted by George Mason University, refer to detail 3.2-28.

- Note that there will be variations for higher level furnishing levels where appropriate and indicated by the Planner.

3.2.4.3 Windows and Walls

3.2.4.3.1 All Office Facilities

- For executive level offices, confirm with the Planner the need for partitions above those indicated in Section 3.2.1.3.
- Partitions shall go to the underside of the deck above for all conference and private meeting rooms.
- Provide roller shades for offices; provide roller shades and blackout shades for conference rooms. All shades shall be manual except as specifically indicated in the project.
- Built-in millwork shall be provided on a case-by-case basis as required by the project.
- All operable windows shall have impervious sills and be fitted with screens.

3.2.4.4 Doors

3.2.4.4.1 All Office Facilities

- All doors for offices and conference rooms shall have a sidelight.
- All doors shall be solid core wood veneer.
- Provide a coat hook on the back of the door for each office.
- Provide a door stop for each door.

3.2.4.5 Accessibility

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3.2.4.6 Furniture and Equipment

3.2.4.6.1 All Office Facilities

The table below includes general information for conference room equipment and furnishings.

Room Size	Floor Power and Data Box	Projection Screen	Projector	Writing Surface	Furniture	Lighting
Small (4-10 seats)	1	Manual	Table Top	White Board*	Moveable Tables and Chairs	Dimmable at screen
Medium (10-20 seats)	2	Manual	Table Top	White Board*	Moveable Tables and Chairs	Dimmable at screen
Large (20+ seats)	2-3	Power	Ceiling Mounted	White Board*	Moveable Tables and Chairs Storage Credenza	On separate switches and dimmable

- For shared copy rooms, provide data and electrical support. Provide a minimum of one shared copy room per floor.
- The State of Virginia mandates furniture for State funded projects is purchased through Virginia Correctional Enterprises (VCE) unless a waiver is received.
- Casegoods furniture is standard for all individual offices. Systems furniture shall be used for staff in open or shared office configurations.

3.2.4.7 Materials and Finishes

3.2.4.7.1 All Office Facilities

3.2.4.7.1.1 Wall Finishes

- Walls shall be painted drywall.
- Consider using an accent paint color in conference rooms.

3.2.4.7.1.2 Floor Finishes

- Provide a minimum 4” vinyl cove base in a dark color to coordinate with the floor finish. Provide broadloom carpet for office and small and medium conference spaces.
- Provide carpet tile for large conference rooms, open office areas, and circulation corridors in office areas.
- Provide VCT for copy/file/storage and pantry areas. Ceilings shall be 2’x2’ acoustic tile.

3.2.4.7.1.3 Ceiling Finishes

- GWB ceilings shall be used by exemption and as required by the project as an exception

3.2.4.8 Building Systems

3.2.4.8.1 General

3.2.4.8.2 Plumbing

3.2.4.8.2.1 All Office Facilities

- Refer to Section 3.3.3 – Plumbing Systems.
- The only plumbing provided in this space type is for pantry areas. Pantry areas are intended to be provided as a shared function for a floor.
- No dishwasher, disposal, or separate water station for coffee makers shall be provided in pantry areas.
- Refrigerators in pantry areas shall have ice makers.
- Provide a single bowl sink for pantry areas.

3.2.4.8.3 Heating, Ventilating and Air Conditioning

3.2.4.8.3.1 All Office Facilities

- Refer to Section 3.3.1 – HVAC Systems.
- Where possible, provide opportunities for natural ventilation without hampering and/or being in concert with the house ventilation system.
- Based on the economy of the overall system, to the maximum extent possible, provide limited user control of HVAC (minimum of 3 and a maximum of 5 offices), within a range of operation that can be centrally over-ridden IAW commonwealth standards.

3.2.4.8.4 Electrical

3.2.4.8.4.1 All Office Facilities

- Refer to Section 3.3.2 – Electrical Design Criteria for illumination level recommendations and additional information.
- Conference rooms shall have a multi-gang slide dimmer with one control device per zone.
- Lighting in offices shall consist of 2’x4’ recessed fluorescent or LED fixtures.
- George Mason University has a preference for indirect and direct indirect lighting (as opposed to direct lighting) in office spaces.
- Lighting shall be controlled by wall or ceiling mounted occupancy sensors and wall mounted override switch.

- Receptacles (20A - 12SV) with isolated ground and 200% neutral shall be provided at each desk location. An additional outlet shall be provided at each desk location. In conference rooms each wall shall be provided with an electrical outlet adjacent to the lectern.

- Provide a ceiling mounted outlet for projectors and projection screens in large conference rooms.

3.2.4.8.5 Communications

3.2.4.8.5.1 All Office Facilities

- Provide a telephone/data outlet in each office at the desk area. Also provide a telephone/data/AV outlet at the blackboard/lectern area.

- Provide a floor outlet with elec/tel/data/AV capabilities at the center of the table in conference rooms.

- Refer to Chapter 3.3 for wireless requirements

3.2.4.9 Acoustics

Interior-source background noise from mechanical systems shall be calculated using the sound from all relevant HVAC sources and paths. Wherever possible, the mechanical system design shall comply with all requirements in Chapter 48 “Sound and Vibration Control” from the ASHRAE Applications Handbook and shall be designed to achieve the following Noise Criteron (NC) ratings in the spaces. The lower values listed below are intended as the system design goal and the higher values specify the performance of the total system installed and operating under actual field conditions. The higher values shall not be exceeded anywhere in the space.

	Maximum Design NC Rating	Maximum Field NC Measurement
Private Office	30	35
Shared Office	35	40
Open Plan Offices	35	40
Conference Rooms	30	35

3.2.4.10 Security

RESERVED

3.2.5 STUDY FACILITIES

3.2.5.1 General
This space use category includes study rooms, stacks, open-stack reading rooms, and library processing spaces.

3.2.5.2 Facility Planning and Design
RESERVED

3.2.5.3 Windows and Walls
RESERVED

3.2.5.4 Doors
RESERVED

3.2.5.5 Accessibility
RESERVED

3.2.5.6 Furniture and Equipment
RESERVED

3.2.5.7 Materials and Finishes
RESERVED

3.2.5.8 Building Systems
3.2.5.8.1 General

RESERVED

3.2.5.8.2 Plumbing

- Refer to Section 3.3.3 – Plumbing Systems.

3.2.5.8.3 Heating, Ventilating and Air Conditioning

- Refer to Section 3.3.1 – HVAC Systems.

3.2.5.8.4 Electrical

- Refer to Section 3.3.2 – Electrical Design Criteria.
- Lighting in study and library processing spaces shall consist of 2x4 recessed parabolic fixtures with 2-T5 lamps controlled with local wall switches.
- Lighting in stacks and open-stack reading rooms shall be 1x4 recessed with 2-T5 lamps controlled by multiple local switches at room/entrance.
- 20A - 125A electrical duplex outlets shall be provide in study and open-stack reading rooms for portable laptop use by students at each desk location.

- Emergency lighting and exit lighting must be provide in large study and open-stack reading rooms to meet local fire codes.

- See Section 3.3.2 for recommended illumination levels.

3.2.5.8.5 Communications

- Tele/data wall or floor outlets shall be provided at each student desk in study and open-stack reading rooms.

3.2.5.9 Acoustics
RESERVED

3.2.5.10 Security
RESERVED

3.2.6 SPECIAL USE FACILITIES

3.2.6.1 General

This space use category includes military training rooms, athletic and physical education spaces, media production rooms, clinics, demonstration areas, field buildings, animal quarters, greenhouses, and other room categories that are sufficiently specialized in their primary activity or function to merit a unique room code.

3.2.6.1.1 Recreation Facilities

- Recreation facilities should be warm, inviting, and friendly. Colors and large areas of glazing are often used to create an inviting atmosphere.

3.2.6.2 Facility Planning and Design

3.2.6.2.1 Recreation Facilities

- Requirements for gymnasiums and aquatic facilities shall be dictated by the appropriate National Governing Body (NGB).

- Where feasible, locate columns at the perimeter and corridor wall. Design large activity spaces such as rooms for strength training and conditioning, group fitness, martial arts, and gymnasiums to be free of columns for maximum flexibility and functionality.

- For basketball courts, the space between the outside line of the court and perimeter walls may be a minimum of 3’-0”, but a greater distance of between 3’-0” and 10’-0” is preferred. Provide padding on walls less than 10’-0” from courts.

- Provide an uninterrupted ceiling height of 20’-0” for multi-purpose rooms and weight rooms to allow hanging heavy kick bags in multiple locations. A minimum ceiling height of 14’-0” is permitted if a greater ceiling height is not feasible.

- Open ceilings are preferred in gymnasiums and multi-purpose rooms.

- Provide adjacent storage areas in lieu of the outdated “goody box” storage solution for racquetball courts..

- Provide adequate storage rooms that are easily accessible to the spaces they support.

- Locate housekeeping closets in close proximity to service areas to reduce travel and labor time.

- Locate equipment checkout and membership services outside of access control.

- Provide unisex toilets and family changing rooms.

3.2.6.3 Windows and Walls

3.2.6.3.1 Recreation Facilities

- Walls behind basketball backboards and soccer goals must be solid enough to withstand direct hits by balls and other objects.

- Walls used for medicine ball exercises shall be reinforced and covered with an appropriate surface.

- The bottom 18” of weight room walls shall be protected with a hard surface to prevent damage and discoloration. Carpet or the same floor surface in a dark color may be used, preferably with sound absorption properties.

- Racquetball courts are also used for wallyball and must be designed to withstand high impact.

- Select exterior glazing with a maximum UV rating. Exterior glazing on the east and west face of the building shall be fitted with electronic curtains.

3.2.6.4 Doors

3.2.6.4.1 Recreation Facilities

- Areas used for high activity and/or with flying objects must have doors that are not alarmed or have the alarm feature protected.

- Emergency egress doors within access control shall have panic hardware with a minimum 15 second delay before opening once activated.

3.2.6.5 Accessibility

RESERVED

3.2.6.6 Furniture and Equipment

3.2.6.6.1 Recreation Facilities

- Provide space to accommodate large fans in weight, cardio and multi-purpose rooms. In the case that the ceiling height is restrictive, fans may be located on the floor in a corner.

- Provide at least one mirrored wall in weight rooms and multi-purpose rooms, and mirrors on columns where it is feasible.

- Provide a stretch bar mounted to one wall in dance rooms.

- When nets are used to divide a gymnasium, maintain visual access to allow supervision across the space. The weight of the net may be enhanced with vinyl on the bottom portion, however, the height of the vinyl shall be a maximum of 4’-0”. Provide maximum flexibility with sectioned nets. Areas at the corners must remain open.

- Utilize walk-off mats at facility entrances to prevent dirt and water trailing.

3.2.6.7 Materials and Finishes

3.2.6.7.1 Recreation Facilities

3.2.6.7.1.1 Wall Finishes

RESERVED

3.2.6.7.1.2 Floor Finishes

- Use suspended wood floors for gymnasiums, with special consideration for shock absorption. Consider the logistics of future maintenance to allow for the repair of minor damages without replacing the entire floor.

- For wet spaces such as pool decks and locker rooms, use 2” tile or smaller on the floors. Provide maximum slip resistance.

- Mason prefers modular carpet tiles (opposed to broadloom or wall-to-wall carpet) due to ease of repair and replacement.

3.2.6.7.1.3 Ceiling Finishes

RESERVED

3.2.6.8 Building Systems

3.2.6.8.1 Plumbing

3.2.6.8.1.1 All Special Use Facilities

- Refer to Section 3.3.3 – Plumbing Systems.

3.2.6.8.1.2 Recreation Facilities

- Hot, cold water and drains are important. Often they are available in locker rooms and in predesigned athletic training rooms. The ability to adapt other spaces in proximity to activity/ locker room spaces is often a costly adaptation.

- Aquatic systems shall be connected to proper wastewater disposal systems and be provided with appropriate wastewater backwater valves and have appropriate domestic water backflow preventers.

- Hose bibs shall be installed at various locations where they are beneficial.

- Chemical delivery systems shall be adequately protected, yet accessible to qualified staff. Pre-design access to repair and replace these systems.

3.2.6.8.2 Heating, Ventilating and Air Conditioning (HVAC)

3.2.6.8.2.1 All Special Use Facilities

- Refer to Section 3.3.1 – HVAC Systems.

3.2.6.8.2.2 Recreation Facilities

- Indoor aquatic centers produce large quantities of chlorine laden water vapor through the process of surface evaporation. Design the HVAC system to provide adequate dehumidification year round to remove the vapor as liquid waste water. This waste water shall be properly disposed of per the applicable plumbing code or recycled and reused in the aquatics systems. A proper air change rate and air supply/return configuration shall be provided to adequately remove all harmful water vapors that could condense on building surfaces and designed to control the chloramine levels at the water surface.

3.2.6.8.3 Electrical

3.2.6.8.3.1 All Special Use Facilities

- Refer to Section 3.3.2 – Electrical Design Criteria.

- Normal lighting for these areas shall consist of a mixture of 2x4, 2x2 compact fluorescent, sconces, and pendant decorative fixtures to meet the program requirements and as designed and specified by the interior designer and/or lighting consultant of the projects.
- Illumination levels shall be maintained in accordance with associated tables in Section 3.3.2 of this manual.
- Lighting in these areas shall be controlled by lighting relay panels overridden by local switches.
- Audiovisual fire alarm devices shall be provided in all of these areas as required by NFPA and local codes.
- Emergency and exit lighting shall be provided in accordance with national and local fire codes.
- Provide protection for fire alarms, fire suppression devices, clocks, scoreboards, lights and sprinkler heads in high activity areas.

3.2.6.8.3.2 Recreation Facilities

- Provide lights with motion sensors in racquetball courts where it is feasible.
- Additional electrical capacity is needed in gymnasiums as these spaces are often multipurpose and the need for five 20 amp breakers in addition to existing power is costly.
- Weight rooms and cardio spaces often need 220 Volt dedicated circuits to accommodate the equipment, data, televisions etc.
- Provide security cameras at access and egress points, and at locations where financial transactions will occur. Cameras may also be desired for educational purposes.

3.2.6.8.4 Communications

3.2.6.8.4.1 All Special Use Facilities

- Tel/data/AV outlets wall mounted or floor mounted shall be provided as required by the furniture layout in training rooms, physical education spaces, production rooms, clinics, and demonstration areas.

3.2.6.9 Acoustics

3.2.6.9.1 Recreation Facilities

- Acoustical products may be employed to mitigate sound issues.

3.2.6.10 Security

RESERVED

3.3 BUILDING SYSTEMS

3.3.1 HVAC SYSTEMS

3.3.1.1 Overview

The HVAC Design Standards described herein define the minimum design requirements and procedures that the consultant shall adhere to. The HVAC design standards are organized as follows:

- Design Guidelines and Standards
- System Selection Analysis
- Design Criteria
- Commissioning

3.3.1.2 Design Guidelines

Compliance with state and local codes is mandatory by law. It is the consultant's responsibility to provide a design that is in full compliance with the latest applicable codes and the local authority having jurisdiction (AHJ). The design guidelines included herein are intended to supplement all code and AHJ requirements. Where applicable code and the referenced design guidelines are in conflict, the consultant shall submit a written explanation describing the differences between the applicable codes and the referenced guidelines to Mason for review. The Design Guidelines Section is intended to provide guidelines which Mason recognizes and accepts to be applicable to all projects. The Standards and Guidelines listed herein apply to all projects.

Published Standards and Guidelines recognized by Mason to be applicable are listed below.

- American Institute of Architects
  - Guideline for the Design and Construction of Healthcare Facilities - Latest Edition
- ASHRAE Handbooks (All) - Latest Editions
- ASHRAE Standards - Latest Editions
  - Standard 15 - Safety Standard for Refrigeration Systems
  - Standard 55 - Thermal Environmental Conditions for Human Occupancy
  - Std. 62.1 - Ventilation for Acceptable Indoor Air Quality
  - Std. 62.2 - Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings
  - Std. 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings
  - Std. 90.2 - Energy Efficient Design of Low-Rise Residential Buildings
  - Std. 154 - Ventilation for Commercial Cooling Operations
  - Std. 169 - Weather Data for Building Design Standards

  - Std. 170 - Ventilation for Healthcare Facilities
  - Std. 183 - Peak Cooling and Heating Load Calculations in Buildings Except Low-Rise Residential Buildings
  - Std. 189.1 - Standard for the Design of High-Performance, Green Buildings Except Low-Rise Residential Buildings
- ASHRAE Guidelines - Latest Editions
  - Gdl. 0 - The Commissioning Process
  - Gdl. 13 - Specifying Direct Digital Control Systems
- American National Standards Institute - Latest Editions
  - ANSI/AIHA Z9.5 - Laboratory Ventilation Standard
- National Fire Protection Association (Latest Editions)
  - NFPA 45: Standard on Fire Protection for Laboratories Using Chemical
  - NFPA 90A: Standard for the Installation of Air Conditioning and Ventilating Systems
  - NFPA 90B: Standard for the Installation of Warm Air Heating and Air Conditioning Sytems
- SMACNA (Latest Editions)
  - HVAC Duct Construction Standards - Metal and Flexible
  - Rectangular Industrial Duct Construction Standards
  - Round Industrial Duct Construction Standards

3.3.1.3 System Selection Analysis

3.3.1.3.1 Overview

- The consultant will be responsible for an evaluation of applicable HVAC system options. The evaluation shall be based on both a qualitative and quantitative analysis. A minimum of three (3) systems shall be analyzed and the consultant shall provide a written summary of the analysis results including recommendations.

3.3.1.3.2 Qualitative Analysis

- The qualitative analysis shall be a comparison of each applicable HVAC system option based on qualitative evaluation criteria. The evaluation criteria shall include, but shall not be limited to the following:
  - Constructability: Impact on construction schedule, ongoing facilities operations, and overall project phasing requirements shall be considered.
  - Flexibility: The ability of systems to be modified to serve likely future changes in space usage without rework of central systems or main distribution.

- Maintainability: The ease at which system components can be accessed and serviced. As an example, utilization of above ceiling hydronic heat pumps would not rank high in this category because of the multiple compressors, fans, filters, and condensate drain pans located above the ceiling which access for regular maintenance.

- Comfort Control: The ability of the system to satisfy environmental requirements including temperature, humidity and space noise criteria.

3.3.1.3.3 Quantitative Analysis

- The life cycle costs for each HVAC system option shall be determined and used as the basis of quantitative comparison. Life cycle costs shall include the following system costs:
  - First Cost
  - Annual Energy Cost
  - Annual Maintenance Cost
  - Life Cycle Replacement Costs
- All life cycle costs shall be performed in accordance with NIST handbook 135 - "Life Cycle Costing Manual for Energy Management Program."
- First costs and replacement costs shall be determined using R.S. Means Cost Works (latest edition) or third party cost estimate.
- Annual energy costs shall be determined by one of the following energy modeling methods:
  - Modified Bin-Hair Method using preliminary HVAC loads
  - Software simulation using an approved load and energy simulation program
- Utility costs shall be based on the applicable utility rates and shall include all utility charges. Where records of historical energy costs and usage are maintained by the campus or facility; average and all inclusive rates may be used when justified by the historical data.
- Annual maintenance cost shall be estimated using the latest edition of ASHRAE Handbook, HVAC Applications, Chapter 36.

3.3.1.4 Design Criteria

3.3.1.4.1 Overview

- Design criteria described herein are mandatory. The design criteria address minimum system design and performance requirements.

3.3.1.4.1.1 Design Conditions

Outdoor Design Conditions

Location	Winter	Summer
Arlington	7°F DB	91°F DB/77°F WB
Fairfax	7°F DB	91°F DB/77°F WB
Prince William	10°F DB	93°F DB/77°F WB

For evaporative cooling, use 78°F WB.

Indoor Design Conditions

Space Type	Winter	Summer
Classrooms	70°F DB	76°F DB, 50% ORH
Offices	70°F DB	76°F DB, 50% ORH
Laboratories	70°F DB	76°F DB, 50% ORH
Assembly	70°F DB	76°F DB, 55% ORH
Commercial Type Kitchen	68°F DB	78°F DB
Residential	70°F DB	76°F DB, 50% ORH

For space types not listed above, indoor design conditions shall be as directed by Mason.

3.3.1.4.1.2 Sizing Criteria

Hydronic Piping Systems

Location	Maximum Velocity (FPS)	Maximum Friction Rate (FT WC/100FT)	Remarks
Below Grade	12	3.3	
Above Grade - Ultimate Spaces and Mechanical Rooms	12	3.3	
Above Grade - Above Ceilings and in Wall Chases	10	3.3	
Terminal and Coil Run-outs	10	3.3	

Ductwork

System		Building Location	Maximum Friction Rate (In.WC/100 FT)	Maximum Velocity (FPM)	Remarks
Type	Location				
VAV	Primary supply	Above Ceilings and In Wall Chases	0.25	1,500	
VAV	Primary supply	Shafts and Mechanical Rooms	0.25	1,800	
VAV	Secondary supply	All	0.08	1,200	Runouts to terminal boxes/valves less than 10' may e same size as terminal inlet.
`CVSZ	Supply	Above ceilings and In Wall Chases	0.08	1,200	
CVSZ	Supply	Shafts and Mechanical Rooms	0.10	1,400	
All	Return	Above ceilings and In Wall Chases	0.08	1,200	
All	Return	Shafts and Mechanical Rooms	0.10	1,400	
CVSZ	Exhaust	All	0.08	1,200	
VAV	Primary Exhaust	Above ceilings and In Wall Chases	0.25	1,500	
VAV	Primary Exhaust	Shafts and Mechanical Rooms	0.25	1,800	
VAV	Secondary Exhaust	All	0.10	1,200	

- The maximum friction rates and velocities listed above are maximum allowable and are based on the following general assumptions:
  - Typical classroom or office application with noise requirement no less than NC 35-40
  - Rectangular ductwork with aspect rations no greater than 4:1
  - Ductwork design provides adequate straight run between fittings and at fan connections to provide uniform velocity profiles and negligible system affect

  - o Piping design provides adequate straight run between fittings and at pump connection to provide uniform velocity profiles

- The consultant is responsible for the acoustic performance of all systems and shall be responsible for determining appropriate distribution system velocities based on the specific acoustical requirements of each space.

3.3.1.4.2 Heating Systems

- Where central campus heating capacity and associated distribution is of adequate capacity to serve the heating load of the facility, the campus heating utility shall be utilized as the primary heating source. The consultant will not be responsible for evaluating the adequacy of the campus heating capacity or distribution for individual building projects. Mason will be responsible for determining adequacy of the central campus heating and distribution based on the building heating loads determined by the consultant.

- Where central campus heating capacity and associated distribution is not of adequate capacity to serve the heating load of the facility, the primary heating source for the facility shall be determined as part of the System Selection Analysis.

- Where central campus heating is utilized as the primary heating source, it shall be decoupled from the building heating water system as follows:

Primary Heating Medium	Decoupling Method	Remarks
Steam	Heat Exchanger	
High Temp. Hot Water	Heat Exchanger	
Medium Temp. Hot Water	Hydraulic Bridge	
Low Temp. Hot Water	Hydraulic Bridge	

- Where central campus heating is not utilized, the following heating methods shall be analyzed as part of the HVAC System Selection Analysis:

  - o Hot water generation using condensing type boilers.
  - o Hot water generation using fire tube boilers (Scotch Marine Types)
  - o Geothermal heat pump system

- Electric boilers are not acceptable. Use of electric heat for supplemental heat in hydronic heat pump systems is not acceptable.

3.3.1.4.3 Heating, Ventilating, and Air Conditioning (HVAC)

- Refer to the CPSM.

- The Mason Fairfax Campus operates a Central Heating and Cooling Plant (CHCP) to supply High Temperature Hot Water (HTHW) and Chilled Water to campus buildings. New buildings are to be served by these systems, unless specifically directed otherwise by Mason.

- All equipment shall be designed and installed with sufficient clearances to insure proper maintenance access to the equipment and its components. Equipment shall be provided with adequate clearances to allow ease of regular maintenance activities such as filter replacement, removal and replacement of strainers, draining equipment, filter changes, lubrication, belt replacement adjustment, testing, inspection, etc. Adequate clearances and provisions within the facility shall be provided to all replacement of major components such as heat exchanger tubes, coils, fans, compressor and motors without removal of other equipment or system components. It is the Design Team's responsibility to identify access space and service clearance requirements in the contract documents.

- Specifications prepared by the engineer shall include requirements for the Contractor to maintain a marked up set of Contract Drawings ("Red-Lines") which indicate all changes in construction and installation due to field conditions, coordination between trade, concealed conditions or other deviations from the Contract Documents. The engineer shall incorporate all changes indicated in the Contractor's "Red-Lines" and produce the As-Built Drawings for the project incorporating all marked-up information. The engineer shall submit As-Built Drawings in the format and media defined in Chapter 4, Section 01 78 39 of Division 01.

- All equipment, controls, and devices installed behind an inaccessible finished surface shall be provided with a suitable access door. It is the Design Team's responsibility to identify, in the contract documents, the minimum size of all access doors and ensure that access to those doors is not blocked by conduit, wire trays, ductwork, etc.

- The engineer shall field verify HVAC system performance in existing buildings prior to completion of the schematic design phase of all renovation projects. Performance verification shall include the following:

  - Air Handling Units:

    1. Air Flow: Supply, return, outside air, and relief.

    2. Fans: RPM, brake HP, Volts, Amps.

    3. Unit Pressure Map: Measure static pressure at unit discharge and across each unit component.

  - HVAC Risers: Measure total airflow and static pressure at all floor branch take-offs.

  - Floors and Spaces within the Area of Work: Measure airflow of all supply, return, and exhaust air devices.

  - Fans: Measure airflow, inlet static pressure, outlet static pressure, RPM, brake HP, Volts, Amps.

  - Measure airflow and pressure at all necessary locations in order to establish existing system performance.

- All HVAC performance measurements shall be recorded and submitted to Mason prior to completion of the schematic design. The report shall include a deficiency list, identifying all observed performance deficiencies. Performance measurements shall be performed by a qualified TAB Technician using instrumentation which has been calibrated within six months.

3.3.1.4.4 Cooling Systems

- Where central campus chilled water capacity and associated distribution is adequate to serving the cooling load of the facility, the campus chilled water system shall be utilized as the primary cooling source. The consultant will not be responsible for evaluating the adequacy of the campus chilled water generation capacity or distribution for individual building projects. Mason will be responsible for determining adequacy of the campus chilled water generation and distribution based on cooling loads determined by the consultant.

- Where central campus chilled water capacity and associated distribution is not of adequate capacity to serve the cooling load for the facility, the primary cooling source for the facility shall be determined as part of the System Selection Analysis.

- Where campus chilled water is utilized as the primary cooling source, the campus piping system shall be connected to the building chilled water system in accordance with Typical Building Central Cooling System Schematic.

3.3.1.4.5 Humidification Systems

- In general, Mason does not humidify its buildings for comfort. Humidification shall be provided to preserve materials such as wooden musical instruments, library collections, archives, artwork, etc. Humidification shall be provided for spaces and areas defined by Mason and its users as requiring winter humidity control.

- Where humidification is required, one of the following methods shall be employed:
  - Non-fired steam generator using high temperature hot water, medium temperature hot water or steam as primary heating medium.
  - Gas fired steam generator.
  - Gas fired packaged humidifier.
  - Electric steam generator.
  - Electric cartridge type humidifier.

- Electric type humidifiers (cartridge type) exceeding 75 pounds per hour (PPH) capacity or 30 amps shall not be allowed. Electric steam generators exceeding 500 PPH capacity or 200 amps shall not be allowed.

3.3.1.4.6 Dehumidification Systems

- Dehumidification equipment and controls shall be provided for spaces and areas defined by Mason and its users as requiring strict humidity control.

3.3.1.4.7 Airside Heat Recovery

- 100% exhaust air heat recovery shall be utilized with the following systems:
  - Laboratory general exhaust
  - Chilled Beam and DOAS system general exhaust
  - Air handling unit zones with 35% or greater exhaust/relief

- Heat recovery systems shall be in accordance with applicable codes and the AHJ.

3.3.1.4.8 Airside Economizer

- All air handling units shall be provided with economizer and/or enthalpy optimization controls. All air handling unit outdoor air intakes and outdoor air ductwork shall be sized for 100% outdoor air with a velocity no greater than 1200 fpm and a friction rate no greater than 0.08 inches wc/100 feet. Design of systems for minimum outdoor air (i.e. no economizers) is not allowed unless specifically approved or directed by Mason in writing. The consultant shall submit a written variance request to Mason with justification for the variance request.

3.3.1.4.9 Expansion Compensation

- Avoid using expansion compensators on Low Temperature Hot Water Systems. Use expansion loops and z-bends to maintain acceptable piping stress levels. Where there is inadequate space for loops and z-bends, bellows type can be used if approved by Mason.

- Do not use bellows type expansion joints on High Temperature Hot Water piping systems. Flanged, slip type expansion joints are preferred for High Temperature Hot Water piping systems.

3.3.1.4.10 General-Duty Valves for HVAC Piping

- Include sufficient zone isolation/shut off valves in heated water, chilled water, steam and other service piping to allow maintenance of equipment and replacement of terminal equipment without shutting down entire building or floor.

- Install valves on all piping that penetrate the floor from below.

- Install valves on all branch piping take-offs.

- Install valves on all lines at locations such that each floor can be isolated without affecting service to other floors. Example: Install valves at pipe riser horizontal branch take-offs at each floor.

- Chain-wheel operators for valves above 7’-0” shall be located in a place where they will not interfere with normal access and shall be restrained at wall or column if necessary.

- OS&Y gate valves shall be used on all piping 2-1/2” and above, unless Mason provides written direction/acceptance of another valve for a specific application.

- Drain valves shall be installed in accessible locations at all low points in the piping system to permit drainage and servicing.

3.3.1.4.11 Fuel Burning Equipment

- The Design Team shall be responsible for preparation and follow-up correspondence for all permitting required for fuel burning equipment.

3.3.1.4.12 Hangars and Supports for HVAC, Piping, and Equipment

- All High Temperature Hot Water, Medium Temperature Hot Water, High Pressure Steam (>15psig) and High Pressure Condensate piping systems shall be designed based on a piping system stress analysis and shall be designed to meet the requirements of the latest edition of ASME B31. The piping system stress analysis shall include piping system geometry, routing, equipment nozzle loads, hanger locations, support locations, and specific support types (anchors, guides, slides, springs, etc.). Conform to ASME Code for allowable piping stresses. Submit stress analysis to Mason for review.

- Seismic requirements must be considered as required.

3.3.1.4.13 Facility Fuel Piping

- Fuel oil systems shall be designed for No. 2 fuel oil and diesel fuel.
- Gas fuel systems shall be natural gas, connected to the local or campus natural gas utility, unless otherwise approved by Mason in writing. Refer to Section 3.3.3 " Plumbing Systems" for additional requirements.

3.3.1.4.14 HVAC Piping and Pumps

- Definitions:
  - o High Temperature Hot Water - Hot Water Systems operating with a maximum water temperature between 350°F and 400°F, with a maximum system pressure of approximately 300 psi.
  - o Medium Temperature Hot Water - Hot Water Systems operating with a maximum water temperature between 250°F and 350°F, with a maximum system pressure of approximately 160 psi.
  - o Low Temperature Hot water - Hot Water Systems operating with a maximum temperature below 250°F and a maximum system pressure of 160 psi.
  - o Dual Temperature Water - A system which utilizes one piping system to distribute heating and cooling water. These systems operate within the pressure and temperature limits of Low Temperature Hot Water systems. The typical winter design supply temperatures are 100°F to 180°F and the typical summer supply water temperatures are 40°F to 450°F.
  - o Chilled Water - A system which distributes cold water. Typical design supply temperatures are 40°F to 58°F depending on the application. Antifreeze solution may be used in lieu of water to prevent freezing.
- All new hydronic pipings systems shall be specified to be cleaned and flushed by Mason's term water treatment contractor. The current term water treatment contractor is:

  Water Chemistry, Inc.
  3404 Aerial Way Dr.
  Roanoke, VA 24016
  540-343-3618

3.3.1.4.15 Hydronic Piping and Pumps

- Encase all key crocks for chilled water building isolation in a 1′ x 1′ x 6″ concrete pad.
- Do not run piping above telecommunication racks.

3.3.1.4.16 Hydronic Piping

- Below Grade Piping:

- Mason Chilled Water systems are designed at 42°F with a 14°F delta.
- Provide a 2-way flow control valve on the building main, located in the main mechanical room.
- CHW distribution system (campus loop, on the Fairfax, VA Campus):
  - General: The CHW Piping to be pre-insulated Schedule 40 steel pipe (do not use plastic piping). All components, including piping, valves, flanges and fittings must be manufactured in either Canada or the United States. The system must be designed to minimize system low points to the maximum extent possible. Any deviations from the George Mason University Utility Master Plan Update (current edition) in piping system sizes or design must be approved in writing by George Mason Facilities.
  - Clearances & Pipe Bedding: Wherever the chilled water lines are run alongside the HTHW Distribution System tunnel, maintain a minimum clearance between the insulated CHW pipe and HTHW tunnel or manhole wall of two feet. Maintain a minimum depth of 30 inches. All CHW piping to be set in minimum 6 inch bed of washed natural sand or mason sand. Sand to extend to mid-point of pipe section. Refer to Chapter 5, details 4.1-1 – HTHW Tunnel Detail, Fairfax Campus, 4.1-2 – HTHW Tunnel Top Details, and 4.1-3 – HTHW Manhole Detail for information on HTHW tunnel and piping clearances.
  - Under Building Slab: Whenever the CHW distribution system piping is run under a building slab, the piping must be run in a tunnel system which has a minimum clear height of seven feet and minimum three foot clear walkway. Such a tunnel system must be lighted, ventilated and accessible for maintenance. The same tunnel system can be used for HTHW lines.
  - Valves: At each branch line or building takeoff provide a three valve combination on both supply and return lines which allow back feed capability. Valves shall be OS&Y type gate valves with flanged connections. Triple duty valves are not acceptable. Provide two way flow control valves on the building main, located in the main mechanical room of the building(s) being served.
  - Drains and Vents: At CHW system low points, provide drains (on both supply and return lines) to discharge to the sanitary sewer. Drains to be 1" pipe size for 6" CHW lines; 2" pipe size for lines above 6". At CHW system high points, provide 3/4" vents. All drains and vents to be valved with gate or ball valve with valve box. Valve boxes located in other than paved areas shall be encased in a 20"x 20" x 6" thick concrete pad.
  - Insulation. Use manufacturer supplied pre-insulated pipe kit for piping joints and fittings. All raw ends shall be sealed.
- Dual temperature systems shall be designed for 100-190°F., winter and 42°F to 55°F summer.
- 4-pipe systems are preferable.
- Mason prefers diaphragm-type compression tanks.
- Triple duty valves are not acceptable.
- Flexible connection shall be installed at pumps only when directed by Mason or when acoustic consultant recommendations are accepted by Mason.

- Hanger spacing for copper pipe shall be as follows:

Pipe Size	Hanger Spacing
1"	6’-0”
1-1/2"	8’-0”
2"	9’-0”
3"	10’-0”
4"	12’-0”

- Do not use butterfly valves for throttling hydronic systems.

3.3.1.4.17 High Temperature and Medium Temperature Hot Water Piping

- All welding of High Temperature Hot Water and Medium Temperature Hot Water systems shall be performed by welders certified in accordance with ASME B31.1 Power Piping, latest edition.

3.3.1.4.17.1 Fairfax, VA Campus:

- The HTHW tunnel shall be separated from the mechanical space in the building by a removable solid steel or aluminum plate to keep heat, water vapor, etc. from entering the mechanical space and damaging equipment. Ensure the plate can be easily removed from the mechanical room for servicing, and the tunnel side as a means of escape in case of emergency.

- Design tunnel and piping with as little abrupt elevational and lateral direction change as possible to avoid anchorage and expansion joints. Tunnel height can vary with site contour, but height shall not exceed 8’-0”.

- The HTHW Piping system to be designed for an operating temperature of 400° F and operating pressure of 350 psig; with a 100°F delta. Use ANSI Class 300 Rating for valves, flanges and flanged fittings. All HTHW piping must be Schedule 80 or Extra Strong seamless steel. All HTHW distribution system components, including piping, valves, flanges and fittings must be manufactured in either Canada or the United States. Any change in piping direction must be made using standard welded fittings. Mitered fittings are not allowed in the piping system. The piping system should be designed with as little abrupt elevation and lateral direction change as possible to minimize requirements for additional anchorage points and expansion joints. The piping system must be designed to minimize system low points to the maximum extent possible. The pathway for the campus wide HTHW distribution system piping shall be a system of tunnels and manholes which are designed to facilitate operations and maintenance. Any deviations from the George Mason University Utility Master Plan Update (current edition) in piping system sizes or design must be approved in writing by George Mason Facilities.

- Clearances: The minimum clearance between pipe and tunnel or manhole floor is 12 inches. The minimum clearance between pipe and tunnel wall is 16 inches. Refer to Chapter 5, details 4.1-1 – HTHW Tunnel Detail, Fairfax Campus, 4.1-2 – HTHW Tunnel Top Details, and 4.1-3 – HTHW Manhole Detail for information on HTHW tunnel and piping clearances.

- Under Building Slab: Whenever the HTHW distribution system piping is run under a building slab, the piping must be run in a tunnel system which has a minimum clear height of seven feet and minimum three foot clear walkway. Such a tunnel system must be lighted, ventilated and accessible for maintenance. The same tunnel system can be used for chilled water lines.

- Valves: At each branch line or building takeoff provide a three valve combination on both supply and return lines which allow back feed capability. Valves shall be OS&Y type gate valves with flanged connections. Triple duty valves are not acceptable.

- Expansion Joints: Expansion joints shall be the packed slip tube type which allows for additional packing to be injected while the expansion joint is under full line pressure. The ends of slip and body shall be furnished with raised face forged steel flanges. The stuffing box shall have integral internal and external guide surfaces. The guide surfaces shall have low friction, non-metallic inserts. The sliding surface of the slip is to be dual chrome plated with 0.001" of hard chrome applied over 0.001" of crack free hard chrome, permascope inspected in accordance with ASTM STD B-499. Each expansion joint to be provided with a two piece removable, reusable insulation blanket which cover the expansion joint body and slip, and incorporates access to the packing cylinders without removal of the body portion of the blanket. The basis for design is Advanced Thermal Systems, Inc. "TP2 Thermal Pak Expansion Joint".

- Slides, Guides and Anchors: All slides, guides and anchors to be hot dipped galvanized steel. Field modification of manufactured components cannot be made without prior approval of the Engineer of Record.

- Bolts: All bolts and nuts at flanges to be ANSI Class 300 Rating. All bolts, studs or expansion anchors used to affix expansion joints, slides, guides or anchorage points to the concrete tunnel structure to be properly engineered and specified by the Engineer of Record. All bolts, studs, expansion anchors and nuts used to fix components to the concrete tunnel structure to be hot dipped galvanized.

- Drains and Vents: At HTHW system low points, provide drains (on both supply and return lines) piped to a tempering tank to discharge to the sanitary sewer. Drains to be 1" pipe size for 6" HTHW lines and smaller; 2" pipe size for lines above 6". At HTHW system high points, provide 3/4" vent. All drains and vents to be welded Schedule 80 pipe with socket weld fittings. All drains and vents to be double valved, with ANSI Class 300 gate valves only.

- Tempering Tanks: The water supply line to the tempering tank must be 2" copper and valved at both the source and at the tempering tank. Hanger spacing for copper water supply line to be to code.

- Insulation: Insulation to be calcium silicate or cellular glass with aluminum jacket nonflammable moisture barrier. Staples are not to be used. All raw ends shall be sealed. Aluminum jacket to be secured using straps, not screws.

3.3.1.4.18 HVAC Pumps

- Secondary pumping of the HTHW and Chilled water at the building is not required at the Fairfax campus. The Fairfax campus Central Plant is designed to provide these services without additional pumping.

- Consult with Mason about pump selection philosophy. Limit speed to 1750 RPM. Any pumps handling High Temperature Hot Water shall be selected with Mason's input. Industrial pumps may be required.

    - For small flows and low heads, in-line circulators may be used, this application is limited to coil freeze protection pumps, heating zone pumps. Typical limits are 80 GPM at 30 feet TDH.

  - Utilize vertical in-line pumps or close coupled end suction pumps for smaller capacity primary, secondary, tertiary pumping systems. Typical limits are 80 GPM at 70 feet TDH.
  - Utilize base mounted separately-coupled end suction pumps for medium capacity primary, secondary, and tertiary pumping systems. Typical limits are 900 GPM at 120 feet.
  - Utilize double suction horizontal spit case pumps for larger capacity primary, secondary, and tertiary pumping systems.
  - Vertical pumps may be used in lieu of base mounted separately-coupled end suction pumps where space is limited. Mason must approve use of vertical pumps.
  - Vertical split case pumps (Bell & Gassett VSC or equal) may be used in lieu of horizontal split case pumps where space is limited. Mason must approve use of vertical split case pumps.
  - Base-mounted, separately coupled double-suction, horizontal split-case type pumps shall be used for connections 4" and larger. B&G VSC or equal may be used. Consider vertical pumps where space is at a premium.
  - Selection should be made for high efficiency. Consideration of life cycle cost study of variable speed pumping should be made.
  - Use mechanical seals when choice is available. Use cyclone separator type seal waste cleaning device on all pumps that can be equipped with it (generally on all double suction pumps).
  - Piping design provides adequate straight run between fittings and at pump connections to provide uniform velocity profiles.

- Do not use vibration isolators or flexible connectors on pumps located on slabs on grade. Provide vibration isolation, flexible pipe connectors, and inertia base for all pumps located above occupied spaces.
- Pump suction diffuser shall be installed at the inlet side of the pump and shall have flanged outlet with grooved inlet connections. Ductile iron body with removable stainless steel frame and perforated sheet diffuser with 5/32″ or 3/16″ diameter holes, 20 mesh stainless steel start-up pre-filter and base support boss. Victaulic Series 731 and W731.

3.3.1.4.19 Steam and Condensate Piping

- Steam system shall be designed for low pressure (15 psig or less) unless otherwise approved by the university. When steam is obtained from a High Temperature Hot Water steam generator, it is especially important to realize that pressures of 30 psig or greater are difficult to justify because they use an enormous flow of primary High Temperature Hot Water. All kitchen equipment (dishwasher, steam tables, etc.) should be operated at less than this pressure. Autoclaves, sterilizers and cage washers should be capable of operating at less than 30 psig steam. If this is not possible, the use of an electric steam generator that can be separately metered (electrically) shall be considered.
- Steam for user-required humidification shall be generated by unitary humidifiers.
- Use bimetallic element traps only with Mason approval.

- Low Temperature Heating Water for coil and terminal is preferred heating medium. Do not utilize steam heating coils or terminals unless directed in writing by Mason

- Adjust class of safety valves for pressure and temperature used in each system.

- Sizing of reducing valves shall be clearly shown on the Drawings for all equipment.

- Pipe discharge from safety valves shall be terminated at a safe height and location to prevent personnel harm.

3.3.1.4.20 HVAC Fans

3.3.1.4.20.1 Air Handling Unit Fans

- Air foil type or backward inclined fan blades shall be used for all centrifugal fans. Use of forward curved or squirrel cage type fans is not allowed without written approval from Mason.

- Fan bearing shall be grease lubricated with extended lube lines.

- Fans shall be selected based on greatest efficiency.

- Housed centrifugal fans shall be belt drive. Unhoused centrifugal fans (plenum fans, plug fans) shall be direct drive. Where unhoused fans are utilized use of multiple fans in parallel duty is encouraged.

3.3.1.4.20.2 In-Line Fans

- In-line fans for return air duty shall be vaneaxial type. Tubeaxial fans for air handling systems which require fan tracking is not allowed because current fan inlet airflow measurement technology cannot be applied to tubeaxial fans.

- Provide thrust restraints on all axial inline fans to prevent fan movement and excessive compression/tension in fan flex connector.

3.3.1.4.20.3 Exhaust/Relief Fans

- Exhaust/relief fans shall be located at terminus of system such that there is no positively pressurized exhaust ductwork within the building envelope.

- Direct drive fans shall be provided with manually operated factory speed dial to be used for balancing in the field.

- Provide low leakage type two-position control dampers where exhaust duct penetrates the building envelope and interlock with the fan operation to close when the fan is de-energized.

- Exhaust fans shall be located on the roof, or in an adequately ventilated fan loft. Exhaust motors shall be located to allow access for maintenance.

3.3.1.4.20.4 Smoke Evacuation Fans: Shall be listed for smoke evacuation duty.

3.3.1.4.20.5 Fume Hood Exhaust Fans:

- Utilize either single width/single inlet housed centrifugal or strobic type.

- The exhaust stack termination height shall be based on the required effective stack height determined by an air dispersion model.

- Fans and duct systems for hoods are to be sized and designed to provide an average hood face velocity of 80-100 LFM, as measured at the face, with the sash wide open. Deviations in this value shall not be greater than 20% at any point across the hood face. To assure this standard, the designer must work closely with the duct installer to determine the effects of duct routing on motor sizing.

- Do not use dampers on laboratory fume hood fans unless specifically approved by Mason.

- Utilize direct drive fans for applications requiring variable fan speed control. Variable frequency drives shall not be the primary means for initial fan balancing.

- Drains shall be provided in fan scrolls, especially when the fan may receive storm water in its ordinary course of duty. This applies to most of the fume hood exhaust fans that use Mason's preferred vertical discharge stackhead.

3.3.1.4.21 Air Terminal Units

3.3.1.4.21.1 Location

- All terminal units shall be located and oriented in accessible locations for routine and emergency maintenance and meet minimum manufacturer service clearances.

- Terminal units shall be placed in typical unoccupied areas (i.e. corridors) in lieu of directly overhead occupied areas where possible.

- Terminal units shall be located so that they can be accessed from an 8 foot ladder for maintenance.

3.3.1.4.21.2 Application

- Fan powered parallel supply air terminal units shall be used to serve perimeter zones and areas with exterior walls.

- Single duct supply air terminal units shall be used for all other spaces.

- Provide reheat coils on all units serving perimeter zones and areas with exterior walls and/or roofs. All reheat coils must be sized to provide reheat with 100 degree water.

- Provide reheat coils on all units serving conference rooms and other high occupancy spaces.

3.3.1.4.22 Air Cleaning Devices

3.3.1.4.22.1 General

- Every supply air system shall be provided with a filter bank. Every air terminal unit shall have filters if it is fan powered.

- Filters shall be pleated type and shall be designed for a maximum 400 feet per minute face velocity unless directed otherwise by Mason.

- Filters shall meet the requirements of International Mechanical Code, latest edition to provide suitable indoor air quality.

3.3.1.4.22.2 Filter Efficiency Requirements

- Supply air system filters shall be provided in accordance with ASHRAE 52.76 to meet these minimum efficiencies:
  1. Classrooms, lecture halls, and auditoriums: 60% (MERV 11)
  2. General Office Space: 60% (MERV11)
  3. Laboratories: 85% (MERV 13)
  4. Clean rooms: Based on room classification
  5. Healthcare: Based on the latest edition of the AIA Guidelines for the Design and Construction of Healthcare Facilities
- Provide higher efficiencies when directed by Mason.
- All other supply air systems that require specialized air filtration shall meet criteria given by the university.
- All supply air systems shall have 35% efficient (MERV 7) pre -filters.

3.3.1.4.23 Breechings, Chimneys, and Stacks

- Terminations of chimneys and stacks shall be "open" (without weathercap) so that an upward velocity is possible, without sideward flue gas movement. Design so that velocity of gases will clear any surrounding roofs, building and especially outside air openings. A velocity control device may be necessary at the outlet of the stack.
- Mason may require an analysis of effluent flume shape and dispersion by a specialist in air wake analysis. Specialist shall be approved by Mason. Such analysis is typical for all discharge stacks such as laboratory fume hood or other laboratory discharges.

3.3.1.4.24 Heating Boilers

- Boilers shall be operating at pressures 15 psig or less.
- Do not use electric boilers.
- Develop water treatment system specification and design in collaboration with Mason.

3.3.1.4.25 Heating Boiler Feedwater Equipment

- Consult Mason’s engineers concerning feedwater equipment.

3.3.1.4.26 Heat Exchangers for HVAC

- HW for heating shall be 190°F (or 200°F if approved by Mason).

3.3.1.4.27 Packaged Cooling Towers

- Induced draft cooling towers shall be utilized for process and building cooling loads. Type of cooling tower (counter-flow verses cross-flow) shall be evaluated by the engineer based on the following:
  - Noise
  - Building Esthetics (Height)
  - Maintainability
  - Efficiency
- Use of forced draft cooling towers is not permitted without review approval by Mason.
- Winterizing requirements shall be discussed with Mason. The appropriate design shall be reviewed prior to such application.
- Fan motors shall be variable speed, controlled and sequenced to obtain the condenser water temperatures needed.
- Provide automatic control valves on cooling tower inlet and outlet where multiple cooling towers are manifolded to common supply and return piping.
- Provide equalizer pipe connecting all cooling tower basins to maintain equal basin water levels under all potential operating conditions. Equalizer pipe shall be appropriately sized to maintain equal basin levels under all operating conditions.

3.3.1.4.28 Air Handling Units

- Utilize indoor modular air handling units wherever possible. All units hall be double wall construction.
- Modular air handling units shall not exceed 35,000 CFM capacity.
- Air tunnels and fans in custom air handling units shall not exceed 35,000 CFM capacity.
- All fans shall be non-overloading type (backward inclined or airfoil blades).
- Air handling units located on the roof shall be provided with heated pipe enclosures/vestibules which include adequate space for control valves. Locating control valves above the ceiling in occupied spaces shall be avoided.
- Fan wall systems shall be considered. Where applied on variable volume systems, a minimum of two variable frequency drives shall be provided for the fan wall.
- All air handlers feeding common ductwork need isolation dampers on supply and return ducts at the unit.
- Provide return air fans whenever return static pressure at peak design air flow will exceed 0.50 inches water column. Return fans are required for all units utilizing air side economizer/enthalpy optimization controls. Return fans may be integral or external to air handling units.

- Relief Fan configurations are not acceptable. Return Fans shall be utilized in all applications except where approved in writing by Mason.

- Provide fan inlet airflow measuring stations on centrifugal and vaneaxial fans. Where tubeaxial return fans, other in-line return fans are utilized; provide return air flow measuring stations in the ductwork. The engineer shall design the ductwork to allow for the manufacturers recommended inlet and outlet straight run at all airflow measuring stations.

- Provide outdoor air flow measuring stations, specifically design for outdoor air flow measurement.

- Do not use electric heat without specific permission of Mason.

- Properly locate face and bypass dampers on 100% outside air systems so that no coil will receive a low temperature blast of cold air when bypassed, or provide a properly sized pumped water protective system.

- All hot water pre-heat coils shall be provided with freeze protection pumps unless Mason allows the pumps to be deleted.

- Humidifiers should be used only with Mason approval. Use canister type steam generator with proper distributing grid if approval is obtained.

- Condensation drain pans shall be stainless steel. Secondary drain pans are required in suspended applications and will require either overflow safety switch or be piped to floor drain with appropriate signage. Drain piping to include cleanout plug.

- All drains shall be properly trapped. Units shall be elevated to allow for proper trap height.

- Unit utilizing steam coils shall be elevated to allow proper steam trap elevation.

- Access doors on negative pressure casings shall open outward. Access doors on positive pressure casings shall open inward. Where there is inadequate clearance within the unit to allow an inward door swing, the access door shall be removable. Supply side doors to open inward and be removable if space is limited inside the unit.

- Provide differential pressure indicator (manometer) for all serviceable filters and locate the indicator where it can be readily observed. Mark on the indicator the “clean” and “replace filter” points.

- Constant volume AHU's should utilize a VFD for energy cost savings. Since most of the AHU's for this application are over sized, instead of using a pulley size reduction to achieve the required CFM a VFD should be used. A 20% turn down results in a 50% reduction in rated H.P. size of the motor.

- Cooling coils used in constant volume systems shall be sized for no more than 450 feet per minute face velocity. Coiling coils used in variable volume systems shall be sized for no more than 500 feet per minute face velocity.

- Heating coils shall be sized for no more than 650 feet per minute face velocity.

- The maximum airflow for an individual coil shall be 17,500 CFM.

- All coils shall be completely drainable at each row. Drainage of coil shall be accomplished by opening vent valves and opening the drain valve with hose connection; no other means shall be required.

Copper tubes with aluminum fins are satisfactory. CHW temperature delta should be 14°F with an entering temperature of 42°F. For 100% outside air applications, a higher delta T may be used with Mason permission.

3.3.1.4.29 Outdoor Intake Locations

- The lowest elevation of an outdoor air intake shall be no less 2 floor levels above grade. Outdoor air intakes shall not be provided via areaways unless approved by Mason. As a general rule, outdoor air intakes shall be located no less than 25'-0" from building exhaust outlets and plumbing vents. Air dispersion studies shall be performed where there is a potential for entrainment of hazardous exhaust/fumes/emissions into the building outside air intake(s). The results of the air dispersion study will determine acceptable outdoor air intake locations, exhaust locations, vent locations and/or additional filtration requirements to eliminate both gaseous and particulate contaminants from entering the building outside air intake(s).

3.3.1.4.30 Mailrooms

- Refer to Section 3.2.8 – Support Facilities for mailroom ventilation system requirements.

3.3.1.4.31 Laboratory Ventilation Systems

- Refer to Section 3.2.3 – Laboratory Facilities for laboratory ventilation system requirements.
- For fume hood duct design and construction, see Chapter 4, Section 11 53 00.

3.3.1.4.32 Type 1 Kitchen Hoods

- Refer to Section 3.2.7 – General Use Facilities for kitchen ventilation system requirements.

3.3.2 ELECTRICAL DESIGN CRITERIA

3.3.2.1 General Design Criteria

3.3.2.1.1 Installation Design Requirements

- In atriums or other multi-story open areas, accessibility and maintenance shall be a consideration when mounting lights.
- Ensure maintenance and accessibility provisions for servicing and replacement of equipment.
- Provide adequate working area around equipment for service.
- There must be permanent access to the roof if any equipment needing service is mounted on the roof.
- Access doors to crawl spaces shall be located as close as possible to electrical equipment under floor.

3.3.2.1.2 Evaluation or Commissioning

- List of items or systems requiring testing, evaluation, verification, or commissioning:
  - Commissioning report: The entire emergency systems, UPS systems and lighting control systems shall fall under the scope of the Commissioning process and be subject to the protocols listed in the independent Commissioning guidelines.
  - Operations and Maintenance Manuals: shall be provided as required by the independent Close-out Guidelines.

3.3.2.2 Power Distribution System

3.3.2.2.1 Power System Overview

3.3.2.2.1.1 Utilization Voltages

Primary Voltages:	
	13.27kV, 3 Phase, 3 Wire
Secondary Voltages:	
Normal	480Y/277V, 3 Phase, 4 Wire
	208Y/120V, 3 Phase, 4 Wire
Emergency/Standby	480Y/277V, 3 Phase, 4 Wire
	208Y/120V, 3 Phase, 4 Wire
Branch Circuits:	
General Use Receptacles	120V

Special Purpose Receptacles	208V, 1 phase and 208V, 3 phase
Fluorescent Lighting	277V
Special Purpose Incandescent Lighting	120V
Motors 1/3 HP and smaller	120V
Motors 1/2 HP and larger	480V, 3 phase

3.3.2.2.1.2 Primary Service

- Information related to available fault current and feeder information is provided on a project by project basis by Mason Facilities Management Services.
- Required information from the project team includes projected loads as well as the location of service entrance equipment.
- Information related to the specific feeder(s) to be connected to, manhole(s) to be connected to, available fault current(s) and related information will be provided by Mason Facilities Management Services.

3.3.2.2.1.3 Electrical Metering

- Provide digital electric meters for all new buildings.
- Meter Location: Meters shall be located on the substation mains and/or the main service to each facility and/or the distribution main. The addition of meters on branch distribution equipment will be determined on a project basis by Facilities Management Services.
- Meter Installation: All metering devices shall have a minimum ¾" conduit with 2 pair 18 AWG stranded individually and overall shielded cable installed from the new meter location to the main telephone backboard. All devices shall be interconnected in a series (daisy chain) configuration.

3.3.2.2.1.4 Primary Feeder Equipment and Distribution Equipment

- Manholes and Handholes
  - Facilities Management Services will identify connection location(s) and designated manholes(s) or handhole(s) for each project. Facilities Management Services will also provide details and fault current information for each manhole or handhole.

3.3.2.2.1.5 Medium Voltage Feeders

- 33% spare capacity shall be included for each feeder. Conduits shall not be more than two-thirds filled.

- For every conduit provided for the project, an equal number of spare conduits shall be provided from the manhole to the Main Electrical Room. Conduits shall be a minimum of 5”. Wire size shall be a maximum of 500 MCM.

3.3.2.2.1.6 Grounding

- Provide an electrode system consisting of all code required grounding electrodes bonded together including metal underground water pipes, metal frame of building or structure, concrete encased electrodes, and ground rods.
- The grounding shall consist of a three ground rods in a tripose arrangement connected with 4/0 AWG bare copper ground conductor under a minimum of 1 foot of cover. The ground rods shall be copper clad steel rods 3/4” diameter x 10’-0” long with top1’-0” below grade.
- Ground rods shall be located as minimum one at each lightning protection down conductor, three at the service entrance location spaced at least one rod length from each other and at least the same distance from other grounding electrodes and at no more than 60 foot intervals around the perimeter.
- The building main electrical room shall be provided with a connection to the grounding electrode system for bonding the neutral conductor at the transformer secondary overcurrent protective device. The grounding electrode system shall also be extended to ground buses located distributed electrical rooms for supplemental grounding and bonding of separately derived systems.
- A separate connection to the grounding electrode system shall be extended to ground buses located in the main communication and intermediate distributed communication rooms.
- All underground connections and connections to structural steel shall be welded connections. Above ground exposed connections will be bolted connections.
- All feeders and branch circuits shall have an insulated equipment grounding conductor.
- Electrical classified, hazardous, areas shall be provided with a supplemental ground bus to ensure exposed metal surfaces are at an equipotential level.

3.3.2.2.1.7 Medium Voltage Termination

- Conductor terminations may be cold or heat shrink type termination kits rated 15kV, 95kV BIL with current rating same as the cable. Splice kits are not acceptable.

3.3.2.2.1.8 Power Shut Off Notification

- 14-day written notification is required prior to any power shut down. Written approval will be given by Facilities Management services including the approved date and time of shut down. This information is to be included in the General Notes section of the drawings, typically located on sheet E-000.

3.3.2.2.2 Normal Power Distribution Equipment

3.3.2.2.2.1 Substations

- Design engineer will provide the final trip setting for the Main Breakers prior to equipment start-up.

- Buildings and their equipment shall be served by unit substations where applicable as required for the load. Generally, substations shall be single ended type, and the secondary or building distribution system voltage shall be as follows:

  - 480Y/277 volt 3 phase 4 wire 60 HZ for buildings with large power loads utilizing 277 volt for most lighting, and small 480 to 120/208 volt transformer for receptacles, lighting and small equipment loads as required.

  - 208Y/120 volt 3 phase 4 wire 60 HZ for buildings with small power loads that can be readily served by this voltage.

- Substations shall consist of a medium voltage load break primary switch, dry type ventilated power transformer and main secondary low voltage switchboard.

- Substation shall be exterior or interior as directed by Mason Facilities Management Division.

- Secondary switchboard main breaker will be set to trip on its lowest setting during construction and will be adjusted to calculated load required set points during commissioning.

- Due to the increasing use of solid state devices for personal computers, data processing units, electronic ballasts, and variable speed drives in a facility, the building electrical system in a facility must be designed to accommodate these non-linear loads. Where these loads are prevalent, the design must include transformers designed for non-linear load applications and over sizing of distribution panel neutrals by 200% as well as the neutral conductors of the system feeding these panels.

3.3.2.2.2.2 Primary Feeders

- All primary feeders shall consist of conduit and copper wire.

3.3.2.2.2.3 Secondary Distribution Transformers

- Secondary distribution transformers and all downstream transformers shall be of explosion resistant, fire-resistant, air insulated, dry type construction, cooled by the natural circulation of air through the windings. Only copper windings shall be specified.

3.3.2.2.2.4 Distribution and Branch Circuit Panelboards

- Panelboards that are not located in the same room as their distribution breaker shall have a main breaker provided in the panel. Exceptions may be made for panels located on the same floor as their distribution breaker, determined on case by case basis.

3.3.2.2.2.5 Variable Frequency Controllers

- See Chapter 4 of the Design Manual.

3.3.2.2.2.6 Secondary Feeders

- All secondary feeders shall consist of conduit and copper wire.

3.3.2.2.2.7 Branch Circuits

- Ratings and Size: Branch circuits shall be at minimum #12AWG.
- Acceptable Conduit Types:
  - Conduit shall be specified as Electrical Metallic Tubing (EMT) or Intermediate Metal Conduit (IMC).
  - Flexible metal conduit (FMC) is acceptable for up to 6 foot max for final terminations to motor loads and light fixtures.
- Conduit Size and Fill
  - A minimum of ¾" conduit shall be specified. A minimum of ½"conduit is acceptable for distribution to receptacles.
  - No more than 9 conductors (3-phase, 3 neutral and 3 ground) shall be installed in a common conduit.
- Usage
  - Branch circuits shall be comprised of like usage. Branch circuits with computer equipment shall have only computers on the circuit. Printers and computers shall not be placed on the same circuit. In general, motors and computers shall not be placed on the same circuit. Branch circuits with computers on them shall be limited to maximum (4) computers per circuit.
  - Electrical wiring system shall be designed and installed with as much flexibility as practical and reasonable.
  - In demolition associated with renovations all wire shall be removed back to the panelboard and all accessible conduits shall be removed.
  - Other branch circuits shall have a maximum of 6-8 receptacles per circuit to allow for future receptacles.
  - Receptacles (and light fixtures) shall be circuited such that the room or area has a diversity of circuits. For example, all outlets in one office shall not be on the same circuit. The failure of one circuit should not take down an entire area.
  - Corridor outlets shall be on a separate circuit with only other corridor outlets.
- J-boxes for Branch Circuits
  - At least one j-box shall be provided for the receptacle branch circuits feeding each room. Branch circuits shall enter the room, connect to the j-box and then continue to the appropriate receptacles. If the circuit continues to an adjacent room, the connection shall be j-box to j-box.

- Commercial Cooking Systems
  - All electrical shunts and other associated shut off devices shall be labeled.

3.3.2.2.2.8 Wiring Devices

- Plate Colors and Labeling
  - The preferred device plate is plastic. Plate colors typically are specified by the architect. White shall be the default color. For receptacles with special power requirements, plate colors shall match receptacle colors.
  - All device plates shall be labeled with originating panel and circuit numbers. The preferred labeling method is black lettering on clear ½" labeling tape.
- Projects that include pre-wired workstations are also required to have each receptacle labeled with panel and circuit number. A note shall indicate as such on both the electrical drawings as well as the furniture plans.
- Receptacle Colors:
  - The default receptacle color shall be white.
  - For emergency receptacles, receptacle and plate shall be red.
  - For UPS receptacles, receptacle and plate shall be orange.
  - For receptacles with isolated ground, receptacle shall be white with an orange triangle. No preference on plate color.
- Receptacle Orientation
  - All receptacles shall be orientated with the ground up.
  - For receptacles located in wiremold, receptacle orientation shall be specified by the engineer on the documents. All receptacles included in the wiremold shall face the same direction.
- GFCI
  - Along with code required locations, all Janitors Closets shall be provided with GFCI outlets.

3.3.2.2.3 Emergency and Standby Power

3.3.2.2.3.1 Terminology

- At Mason, the term "emergency system" refers to the entire system supported by a generator.
- The Emergency System, as defined by Article 700, is more commonly referred to as the Life Safety System.
- The Legally Required Standby Systems (Article 701) and the Optional Standby Systems (Article 702) are more commonly referred to as the Standby System.

- Regardless of terminology, all code requirements for the generator systems are to be met.

3.3.2.2.3.2 Acceptable Power Sources

- Order of Preference for Sources
  - The preferred method of providing emergency (life safety) power to a building is via generator.
  - In cases where it is not physically feasible to include a generator, a central inverter type battery system is acceptable.
  - In cases where a central inverter type battery system is not feasible, individual local batteries will be permitted.
  - For projects in existing buildings, the method being employed in the building shall be followed unless otherwise directed by Facilities Management Services.
- Generators
  - For existing buildings, where a life safety generator is available, all code required life safety devices shall be fed by the generator.
  - Generators shall be sized with a 20 ~ 30% spare capacity.
  - Generator Distribution Board: In the cases where one generator feeds multiple transfer switches, a distribution board with circuit breakers shall be provided.
  - Emergency generators rated 50KW or less shall be natural gas fuel (where available at the site) with propane backup. Fuel tanks shall not be located underground. Propane tanks shall be furnished by the Owner. Emergency generators rated above 50KW shall be diesel. Provide a minimum 8-hour operation fuel tank built into the base of the unit wherever possible.
  - Provide load bank for generators to use when cycling for maintenance. At a minimum, provide a connection for a portable load bank.
  - Consider emergency generator exhaust path in relation t make-up air and building openings.
  - Provide grounding system for generator per NEC.
  - Generator shall provide operational status to the Fire Alarm Annunciator.
- Generator Fuel Storage Requirements
  - Fuel for all generators shall be diesel fuel located in a belly tank. Buried fuel tanks are unacceptable. Fuel tanks shall be able to sustain full load for a minimum of 8 hours. Lab buildings shall have a minimum of 24 hour fuel capacity at full load.
  - Where a fuel tank is located in-doors or in confined spaces, a remote fill apparatus shall be provided. The remote fill location should be coordinated with Facilities Management

Services. Where the remote fill is located outside, tamper resistant and vandalism resistant devices shall be provided.

- Where fuel storage devices are specified with annunciator panels, annunciator panel shall interface with the University BMS System for status and alarms.

- Generator Communication: All generators, regardless of the usage, shall communicate with the University EMCS System. Provisions shall be made to have monitoring contacts from the generator status panel to communicate with the University BMS System for status updates.

- Automatic Transfer Switch: Automatic transfer switches shall be provided for the connection of generators. At least two ATS shall be provided to support both emergency (life safety) and standby loads. One ATS may be provided if only emergency (life safety) load is to be supported as determined by Facilities Management Services. ATS shall be designed by the engineer.

- Commissioning: Generator and transfer switches shall be commissioned.

- Battery Backup
  - Battery backup for life safety lights and exit signs may be acceptable in instances where a generator is not available or not feasible.
  - Central inverter systems with battery backup shall be provided when a generator system is not feasible. Batteries shall provide a minimum of 90 minutes per code. An automatic battery charging means shall be provided per code.
  - Individual battery systems shall be a last resort.

- UPS Systems
  - UPS Systems used consist of two types. One type is the large scale, multi-module type that requires separate space and large scale battery systems. The second type is the small, local, under the desk type or "shoe box" UPS. This section covers only the large, central type, UPS systems.
  - Acceptable UPS Configurations: UPS systems shall include a UPS module comprised of solid-state electronics consisting of a rectifier, an inverter and associated controls. UPS systems may be either the non-redundant or parallel redundant configurations depending on the application.
  - UPS Batteries: Batteries for the UPS system are typically valve regulated lead acid (VRLA) batteries due to space constraints. Batteries shall provide a minimum of 30 minutes at full UPS load. Each UPS module shall be provided with the necessary battery strings for that module. If more than one module is provided, each shall have its own battery strings to maintain for a minimum of 30 minutes, regardless of the other module(s).
  - Maintenance By-pass Provisions: Each module shall be specified with individual maintenance by-pass provisions to allow for maximum maintainability of the system.
  - Distribution: Distribution for large scale UPS systems are typically provided via power distribution units (PDU) and remote distribution cabinets (RDC). Different manufacturers

have different names for these units. PDUs and RDCs models with branch circuit monitoring is preferred, where available.

- Typical Manufacturers: Large UPS system manufacturers include Emerson Liebert and Powerware.
- UPS, regardless of the usage, shall communicate with the University EMCS System.

3.3.2.2.3.3 Systems on Generator Power

- Required Systems: All buildings shall be provided with a generator. All required systems shall be provided emergency power (whether life safety, legally required standby or optional standby power) to meet code requirements.
- Other Systems: The following systems shall be provided generator power on the proper code branch where available.
  - All access control and/or security devices shall be provided with emergency power.
  - All building management system (BMS) devices shall be provided with emergency power.
  - Elevator(s) shall be provided with generator power in some applications.
  - At least (1) emergency outlet shall be provided in each electrical room, mechanical room, elevator machine room and other machine rooms.
  - At least (1) emergency light fixture shall be provided in each electrical room, mechanical room, elevator machine room and other machine rooms.
  - All domestic eater booster pumps.

3.3.2.2.3.4 Roll Up Generators

- Where the building conditions and the Facilities Management Services require roll up generator provisions, the following shall be met:
  - An adequately sized breaker, meant to accommodate the critical loads in a building, shall be provided within the main switchgear. A separate section with key interlocks can be provided, or a remote disconnect can be provided to allow for the safe and efficient connections of a temporary generator. Options on where the breaker is located and how connections are made will be determined on a project by project basis by Facilities Management Services.
  - For New Buildings - Without a Generator: For a new building, where a permanent generator has not been specified, roll up generator provisions shall be provided, as directed by Mason.
  - For New Buildings - With a Life Safety Generator: For a new building, where a permanent life safety emergency generator has been specified, roll up generator provisions shall be provided, as directed by Mason.
  - For New Buildings - With a Life Safety & Standby Generator: For a new building, where a permanent generator has been provided for both life safety power and standby power, roll up generator provisions are not required.

- For Existing Buildings - Adding a Life Safety Generator: For an existing building, where a project involves the addition of a life safety emergency generator, roll up generator provisions should be considered. In buildings where provisions can be included without major modifications to existing switchgear and excessive cost to the project, roll up provisions shall be provided. All other buildings shall be reviewed on a case by case basis.

- For Existing Buildings - Adding a Standby Generator: For an existing building, where a project involves the addition of a stand by generator in addition to a life safety generator or to replace an existing generator, roll up provisions are not required.

3.3.2.2.3.5 Fire Pumps

- Concrete encased cable or MI cable is acceptable for feeding the fire pump.

- When the fire pump is provided with generator power, a separate ATS shall be specified as per code.

3.3.2.3 Lighting System Criteria

3.3.2.3.1 Lighting System Overview

- New buildings shall have lighting provided at 277V. Light fixtures specified for new buildings shall take into account cost, accessibility, ease of maintenance and availability of replacement parts. Specialty fixtures should be kept to a minimum.

- Existing buildings may have lighting provided at either 120V or 277V depending on the age of the facility. Light fixtures specified for existing buildings shall match the existing look and feel of the building. New fixtures being specified shall also take into account cost, accessibility, ease of maintenance and availability of replacement parts.

3.3.2.3.1.1 Normal Lighting Distribution Equipment

- Branch Circuits:
  - Branch circuits shall be at minimum #12AWG.
  - Conduit shall be specified as Electrical Metallic Tubing (EMT) or Intermediate Metal Conduit (IMC).
  - Flexible metal conduit (FMC) is acceptable for up to 6 foot max for final terminations to light fixtures.

- Conduit Size and Fill:
  - A minimum of 3/4” conduit shall be specified.
  - No more than 7 conductors (3-phase, 3 neutral and 1 ground) shall be installed in a common conduit.
  - 20% spare capacity shall be left on each circuit for future lights.

- Usage: Light fixtures shall be circuited such that the room or area has a diversity of circuits where feasible. It is preferred that all lights in one office not be on the same circuit where multiple circuits exist in the area in order to minimize the failure of one circuit taking down an entire area.

- J-boxes for Branch Circuits: At least one j-box shall be provided for the lighting branch circuits feeding each room. Branch circuits shall enter the room, connect to the j-box and then continue to the appropriate light fixtures. If the circuit continues to an adjacent room, the connection shall be j-box to j-box.

3.3.2.3.1.2 Lighting Fixtures

- Fixtures shall be specified with cost and availability in mind.

- Fixtures shall have standard parts and be easily maintained.

- Cut sheets of all planned fixtures should be submitted with the project plans and specifications.

- Lenses: In general, Classroom, Hall and Corridor fixtures shall have prismatic lenses. In general, Office and Conference room fixtures shall have parabolic lenses.

- Standard light fixtures are 2-3-, or 4-lamp, 2'x4' fluorescent lay-in fixtures with electronic ballasts and T-8 lamps. T-8 lamps shall have low mercury content, a color rendering index of 75 or greater and a color temperature of 4100k in academic and general buildings. High mercury content lamps are unacceptable.

- Light fixtures shall be selected to permit the use of lamps that are on State contract, readily available from multiple manufacturers and are in typical use at the University.

- No lighting fixtures shall be specified for which the manufacturer will require a minimum order for the purchase of replacements. Non-catalog and custom lighting fixtures are to be economically justified and avoided whenever possible.

- Ballasts shall be warranted for 60 months from date of manufacture and shall have harmonic distortion of less than 15%. Ballasts shall be of the parallel lamp connection design such that lamps remain fully lit if any of the companion lamps fail.

- Mason requires the use of light emitting diode (LED) lighted exit signs with diffused lenses. Only red lettered exit signs will be used. Exit lights shall be equal to Lithnia Modular xs/sl series.

- Typical locations for occupancy sensors include small rooms such as individual restrooms, one person offices, and small storage rooms like closets, supply rooms or recycling rooms, areas of rescue assistance and conference room and classrooms. Wall switches also be provided in conference rooms and classrooms such that lights may be controlled by switches when space is occupied.

- Locate light fixture schedule on drawings. Schedule shall contain a description fixture, not simply a model number.

- Use of fluorescent dimming systems is discouraged. When approved, the ballasts shall have a dimming range of 100% to 1%.

- Provide dimming capability for classrooms to allow note taking while viewing a projections screen.

- Specify standard lamps not requiring special order or premium price. The following illumination levels are recommended by Mason. Illumination levels referenced are maintained levels measured at a 30” height from the floor or at an actual work surface and represent an average level for the area.

Lighting Levels

Area/Room Name	Maintained Foot Candles
Offices & Secretarial Areas	30 - 35
Laboratories	30 (Ambient) 75 - 80 (Task + Ambient)
Study Areas & Classrooms	30 - 75
Conference Rooms & Meeting Rooms	30 40
Lecture Hall Auditorium/Multi Purpose	35 - 50
Corridors & Stairwells	5 - 10 (at Floor)
Reception/Lobby, Lounge	25 - 30
Mechanical, Electrical Rooms	20
Telephone & Elevator Machine Rooms	20
Receiving Areas	25
Storage Areas	25
Rest & Locker Rooms	25 ~ 30
Critical work areas such as tissue labs, culture plate areas, instrument room, etc.	90 - 100 (Task/Ambient)

- Fluorescent fixtures are generally preferred. Use of the more efficient H.I.D. fixtures is encouraged only where practical indoors. Incandescent lighting may be used only for special effect architectural lighting or for limited dimming applications.

- Fluorescent fixtures of the static recessed type shall be used for most hung ceiling applications. They shall be 2’ x 4’, 1’ x 4’, or 2’ x 2’ based on ceiling grid, size of room or area, and architectural arrangement. Generally lenses shall be plastic injection molded prismatic type of 100% virgin acrylic. In areas requiring low brightness, numerous CRT’s, or similar equipment, parabolic type louvered fixture shall be used. Commercial fluorescent fixtures shall be used where applicable for surface or stem mounted fixture shall be metal with hinged shielding lens of 100% virgin acrylic prismatic type. Industrial type fluorescent fixtures with bulb protection shall be used in mechanical equipment rooms, storage and receiving areas and similar spaces.

- Stairwells in buildings shall have sufficient fixtures so that loss of one lamp or ballast will not leave the area dark. Please use wall mounted fixtures in stairwells that can be serviced from a 6’ ladder.

- Lighting fixtures in garages shall be sealed and watertight.

3.3.2.3.1.3 Lighting Power Density

- The ASHRAE 90.1 (edition reference in latest energy code) allowable lighting power densities are listed below. At a minimum these values will be met, with the total building lighting power density not exceeding the code allotted densities.

- Below is an example based on 2007 edition of ASHRAE 90.1. Edit the table below to suit the project.

ASHRAE 90.1 2007	
AREAS	**LPD (W/ft^2)**
Office-Enclosed	1.1
Office-Open Plan	1.1
Conference - Meeting - Multipurpose	1.3
Laboratory	1.4
Lobby	1.3
Lounge/Recreation	1.2
Restrooms	0.9
Corridor/Transition	0.5
Stairs - Active	0.6
Storage - Active	0.8
Electrical/Mechanical	1.5
Workshop	1.9

3.3.2.3.1.4 Lighting Control

- Occupancy sensors shall be utilized for interior lighting control for energy conservation that produce a payback in 7 years or less. The designer shall review the application of the required sensors for the various areas throughout a facility. Sensors shall not be used in areas such as corridors, stairwells, laboratories, public areas, lobbies, mechanical and electrical rooms, and any other area where a safety hazard may be created by lights going off automatically. If other means are available to ensure safety in these areas (e.g. there is available windows/glazing that permits lighting both during daylight hours as well as night-time hours via exterior light fixtures that bleed into the building but are not circuited with the building), then sensors may be used once approved by Mason.

- Motion sensors shall not be connected to EMS.

- The use of multiple switching shall be evaluated for each space and condition. Where possible, switching shall be used to effectively reduce artificial lighting near window, permit light reduction for non-critical tasks and during partial occupancy, and reduced lighting for custodial activity.

- All exterior and security lighting shall be powered from one location in the building, namely the main electrical room.

- Where dimming control is required, it shall be normally used to control incandescent lighting only. Dimmable fluorescent or H.I.D. lighting must be approved by Mason's Facilities Management before design of the system. Fluorescent or H.I.D. lighting shall be provided as the primary lighting source with the dimmable incandescent system as secondary.

- Remote switching by means of central control shall be evaluated for special areas.

- Contractor shall provide the initial lighting control setup.
- Daylighting:
  - For daylighting to fully recognize energy savings and become a true sustainability strategy, automatic daylighting controls are needed. These controls switch or dim lighting automatically and maintain a target light level. The more usable daylight falls on the task plane, the less electric light is needed.
  - Daylight harvesting strategies have been demonstrated to produce 35-40 percent energy savings in office spaces according to the New Buildings Institute. For this reason, the ASHRAE Advanced Energy Design Guides and Advanced Buildings Benchmark encourage daylight harvesting controls.
  - For continuous occupied space automatic controls that constantly adjust the electric lighting in response to the available daylight shall be used. The best type makes use of dimmable ballasts controlled by photo-sensors operating fluorescent lamps. Past studies have shown that on/off controls tend to annoy those working in the space and occupants may not bother to use manual lighting controls to turn off lights when enough daylight is available.
  - Fluorescent dimming ballasts allow energy savings of nearly 85 percent at 10 percent lighting. Energy consumed and light level change is a linear and nearly directly proportional relationship as lights are dimmed. Energy consumption decreases continuously as the lights are dimmed with maximum energy savings at minimum illumination.
  - Fluorescent dimming ballasts with 0-10V control will be used to dim the lights to within 10 percent.

3.3.2.3.1.5 Emergency Lighting

- Emergency and exit lighting shall be provided in each building to meet IBC and NFPA codes. These lights shall be connected to buildings emergency power source.
- Emergency lighting, either electric or photoilluminescent, must be posted at each stairwell door and building exit. SFPC 1011.1.
- Emergency lighting shall be provided as required by code; including toilet areas, outdoors at all egress doors, mechanical/main electrical room and in laboratory areas.
- Emergency system wiring shall be in separate conduits, and its distribution through separate panelboards and motor control centers, etc. as required for a complete system to serve exit lights, safety lighting in corridors and stairwells, in general assembly areas, and mechanical equipment rooms and electrical rooms for essential loads, for security systems, fire alarm, and as required.

3.3.2.3.1.6 Switching and Dimming

- Switching Requirements
  - All switching shall be bi-level (a, b).

  - Location: Switches shall be located on the wall opposite the side of the door swing. Switch leg "a" shall be the closest switch to the door.

- Dimming
  - The dimming standard for classrooms is Lutron Radio Touch. Lecture hall and auditorium standard is the Lutron Grafik system.

- Back of House Locations
  - Back of house locations, including electrical rooms, mechanical rooms, elevator machine rooms, storage rooms and the like, shall be provided with a digital time switch. As permitted by Mason.
  - The preferred digital time switch is The Watt Stopper model TS-400. Equals may be submitted for approval.

- Exceptions: Certain exceptions and substitutions may be made on a case by case basis by Facilities Management Services. For example, color temperature of a bulb may be adjusted to match existing fixtures in an area. All exceptions will be made at the discretion of Mason. Cut sheets or documentation shall be provided where necessary in order to approve substitutions and exceptions.

- General Requirements
  - The preferred dimming manufacturer is Lutron.
  - The preferred manufacturer for occupancy sensors is WattStopper.
  - Incandescent bulbs, even in limited quantity are not energy efficient and should not be specified.
  - Bulbs longer than 4' are not acceptable.
  - U lamps are not acceptable.
  - Biax lamps above 42 watts are not acceptable.

3.3.2.4 Documentation

3.3.2.4.1 Standards and Code Requirements

- All equipment shall be UL listed, shall be provided with proper identification related to the UL listing, as well as appropriate listing documentation.
- All equipment and electrical spaces shall meet the minimum code requirements including all Fairfax City codes and amendments.

3.3.2.4.2 Code References

- All drawing sets shall include code references to the specific code being applied including International Building Code (IBC), International Energy Conservation Code (IECC) the Virginia

Statewide Code, National Electrical Code (NEC) and Fairfax City Code Amendments. This reference shall be made on the E-000 sheet.

3.3.2.4.3 Single Line (One-Line) Diagram Requirements:

- Single line diagrams shall be of the most accurate and descriptive nature allowed by the available information. Site surveys and earlier drawings shall be used as references to ensure that the single line being depicted is as up-to-date as possible.
- Projects that include multiple story buildings, regardless if the project scope includes only one floor*, shall have a "riser" style single line diagram. The single line shall be broken up into floors and the equipment, both existing and new, shall be shown on the appropriate floor.
- The basement (or lowest level of the building) shall be shown on the bottom of the sheet. The roof (or highest level of the building) shall be shown on the top of the sheet. Floor delineations shall be in the form of horizontal lines labeled with Mason's recognized floor name.
- Projects that include single story buildings or areas may have a "flow" type single line diagram.
- Projects including multiple electrical rooms on one floor shall have single line diagrams that indicate the room number of each electrical room the gear is located in for quick reference.
  - Exceptions may be made by Facilities Management Services in the case of smaller TI projects that do not require the installation of major pieces of equipment. In these cases, determined on a project by project basis, the existing single line may be used and amended as necessary.

- All Single Line Diagram sheets shall include the following information:
  - All connected building equipment, including panels, generators, switchboards, utility equipment, mechanical gear, etc.
  - Names, locations and ratings of all gear
  - Feeder schedule for equipment included in scope of work
  - Feeder schedules that do not fit on the single line, due to the amount of equipment being shown, shall be located on an adjacent sheet. The single line sheet shall make reference to the adjacent sheet with the feeder schedule. Sheet notes shall be provided as necessary.
- Single Line Diagram sheet numbering:
  - Single line diagrams shall be located in the 700 series sheet numbers, regardless of how many sheets are in the set.
  - Normal single line diagrams shall be first in the series. Emergency single line diagrams shall come next in the series.
  - For smaller projects, single line diagrams may be combined with panel schedules to minimize the page usage. In such cases, the combined single line / panel schedule sheet shall still be located in the 700 series sheet numbers.

3.3.2.4.4 Load Summary

- The load summary can be in the form of panel schedules or a table. The load summary shall include all equipment loads being fed into the main switchgear. Existing equipment may require metering to determine connected load.

3.3.2.4.5 Scope of work

- The equipment related to the scope of work of the project shall be highlighted or some other way indicated as included in the project. All building equipment shall be shown as reference and may be indicated as such.

3.3.2.4.6 Equipment Support

- Support and anchorage of all equipment and conduit.
- Provide fittings for seismic expansion and deflection.
- Provide vibration isolation and seismic anchorage.

3.3.2.4.7 Schedule Requirements

3.3.2.4.7.1 Panel Schedules

- All electrical drawing sets shall include panel schedules. These sheets shall include any and all panels affected by the project scope, regardless of whether the gear is directly or indirectly affected.
- Any panel being referenced by a home run in the floor plans shall have an individual panel schedule and a load summary.
- Panel schedules shall indicate where the panel is located, especially in the cases of large projects with several Electrical Rooms.
- Reference boxes should be included on each sheet in the drawing set that includes panel schedules. The reference box should indicate where on the page each panel schedule is located for quick reference.

3.3.2.4.7.2 Light Fixture Schedule

- A light fixture schedule shall be provided for all projects and shall be included in the electrical drawing set. The light fixture schedule shall be in table form including all of the pertinent information necessary for the sub-contractor. Information should include length, ballast type, wattage, manufacturer and location. See below example light fixture schedule:

Type	Description	Manufacturer and Catalog No.	Lamps		Input Watts	Volts	Comments
			Qty.	Description			

3.3.2.4.8 Circuiting and Identification Requirements

- Each home run shall indicate the corresponding panel name and the circuit number(s).
- Lighting plans and/or reflected ceiling plans shall show the respective lighting panel in its proper location in each electrical room to provide clear indication of home run destination.

3.3.2.4.9 Special criteria/requirements

3.3.2.4.9.1 Equipment Naming

Naming Categories

Emergency	
EL	Emergency-Life Safety (as defined by NEC Article 700)
ER	Legally Required Stand by (as defined by NEC Article 701)
E	Optional Stand by (as defined by NEC Article 702)

Type	
U	Unit Substation
DB	Distribution Board
G	Generator

Voltage	
H	480 or 480/277
L	208/120V

Area	
N	North
S	South
E	East
W	West
	*Segments A, B, C, D are also acceptable

Floor	
B	Basement
1	First
2	Second
3	Third
R	Roof
M	Mezzanine

Alpha	
A	Panel
AA	Sub panel to A
*Alpha category is sequential. The second panel follows with B and so on.	

- Conventions: See Naming Categories above for the selection options in each category.
  - Switchboards/Distribution Boards/Panels Naming Convention

    Panels shall be named based on the following criteria –

    (Emergency) Type Voltage (Area) Floor Alpha

    Example 1: a standard 120/208V, panel located on the south side of the second floor

    LS2A

    Example 2: a 480V emergency standby distribution board located on the north side of the second floor

    EDBHN2
  - ATS Naming Convention

    ATS shall be named based on the following criteria –

    (Emergency) A Voltage (Area) Floor (Alpha)

    Example 1: an emergency stand by 480V ATS in the second floor

    EAH2

    Example 2: the first of two normal 480V ATS on the roof

AHBA

- Transformer Naming Convention

  Transformers shall be named based on the following criteria–

  (Emergency) T (Area) Floor (Alpha)

  Example 1: a life safety transformer in the south area of the third floor

  ELTS3

  Example 2: the first of two normal transformers on the fourth floor

  T4A

- New or Renovated Buildings: For new buildings and completely renovated buildings, panels shall be named in relation to the floor the panel is located on and the type of power the panel is providing. See Conventions section above for additional information.

- Existing Buildings: For existing buildings, panels shall be named in coordination with existing panels. If no pattern is evident in the existing building for panel naming. See Conventions section above for additional information. Verify there is no existing panel with the same name as the new panel in existing buildings.

- Specialty Areas: For buildings with specialty areas, such as a kitchen that includes dedicated equipment for that specialty area separate than the base building, naming of the dedicated equipment shall correspond to the specialty area.

  For example, a server room added to an existing building will add a dedicated ATS, generator, distribution board, transformer and panel. The naming convention for this equipment will include an S. Coordinate with Facilities Management Services for naming convention for specialty areas.

3.3.2.4.10 Lighting Floor Plan Fixture Labeling

- On the electrical lighting floor plans and/or reflected ceiling plans, each light fixture shall have the following information:
  - Fixture type – in capital letters
  - Circuit Number – including panel and circuit
  - Switch leg (where applicable) – in lowercase letters

3.3.2.4.11 Coordination

- Light fixtures shall be coordinated with location of equipment, especially in back of house spaces. Coordination of light locations shall not be left to the contractor or “with field conditions.”

3.3.2.4.12 Field Verifications

- Expectations: Where existing building is involved, the engineer is expected to visit the project site once initiated to confirm the existing conditions, including but not limited to project space, electrical rooms, existing panels, etc. Drawings shall accurately reflect current existing conditions.

- Requests

  - Requests for access to the facility and equipment shall be made through the university Project Manager. Requests shall include areas for access and a brief overview of the plan for the visit.

  - Requests for meter data or to meter equipment shall also be made through the university Project Manager.

3.3.2.4.13 Electrical Coordination Study

- The electrical design will include a short circuit and coordination study to identify overcurrent protection devices which will provide a selectively coordinated system for the emergency systems in the building. The design will also include a preliminary arch flash hazard analysis to identify potential arc flash hazards and to develop strategies to mitigate the hazards. The study shall be submitted to Mason for review.

- In order to provide a baseline database for operation and maintenance of the building, the project specifications will require the following studies to be performed by the installing contractor. All electrical studies will be performed by a registered professional engineer and submitted for review and approval by the electrical engineer and Owner prior to releasing any equipment and shall include the following:

  - Short circuit: Study shall be conducted at tall busses in the system. Study shall be performed for both utility, generator and transition mode. Study shall assume full contribution from all motor loads. A full report shall be provided showing fault currents in all configurations and associated X/R ration.

  - Coordination: Study circuit: Study shall provide all settings for programmable trip units and adjustable breakers. Study shall include copies of all TC curves used and graphic and test data indicating proper coordination.

  - Arc Flash: Study shall indicate working distance for all panels. Study shall include all labeling required per NFPA 70E. Labels will be required in electronic format and installation of labels will be included as a requirement of the specification.

3.3.2.4.14 Estimated Load Summary

- Use tables below to calculate the normal and standby building loads:

Building Electrical Load Summary					
Loads	**KW**	**KVA**	**Load Growth**	**SUB-TOTAL @ Demand**	
				KW	**KVA**
Lighting					
General Power					
Manuf.					
Mechanical					
Elevator					
Other					
TOTALS					
BLDG SF =					
Expansion=				**W/sf**	**kVA/sf**
Total SF =					

Standby Power Load Summary					
Loads	**KW**	**KVA**	**Load Growth**	**SUB-TOTAL @ Demand**	
				KW	**KVA**
Emergency					
Legally Required					
Optional Standby					
Fire Pump					
Elevators					
TOTALS					
BLDG SF =					
				W/sf	**kVA/sf**
TI Total SF =					

3.3.2.5 Fire Alarm System

- A non-coded digital addressable fire alarm system shall be designed for each existing and new building to meet the NFPA and local codes. The fire alarm system shall be connected to building's emergency power source.

- The preferred system is NOTIFIER.

- Per 2009 Virginia Statewide Fire Prevention Code 908.1 for H-use buildings, install a digital voice fire alarm system that uses standard smoke detectors and manual pull stations.

- All new construction shall be equipped with fire alarm system that includes a building wide Public Announcement system. The microphone shall be placed in a locked cabinet in the lobby, fire control room, or other space accessible to building management and first responders. When an emergency occurs, building management must have access to the system microphone to make announcements.

- The digital voice fire alarm public announcement system shall be capable of interconnecting with a remote receiver. The receiver would be used to make building or campus-wide announcements from a central transmitter. SFPC 907.6

- Fire alarm smoke detectors provide in dorm rooms should be supervisory only.

- All fire alarm devices shall be provided with copper stranded wire, maximum size #12AWG. All wiring for fire alarm devices shall be in conduit.
- All system wiring and cable must be in conduit.
- The design documents shall include requirements for demolition and remove the old/un-used system and system components. Abandoning old, un-used and inactive systems and system components is not allowed.
- Fire detection equipment that is located on a pitched roof must have the appropriate tie-offs and guide rails to facilitate a safe ascent to and descent from the equipment.
- Mason inspectors will perform system testing prior to performance of specified third party inspection and testing.

3.3.2.5.1 Fire Alarm Plans:

- A full Fire Alarm System design is required as part of the design documents.
- Plans shall be complete and in accordance with BCOM requirements for submittal/approval.
- Devices powered with 120V (or greater) shall be shown on electrical power floor plans with circuit designations for coordination.
- Fire alarm devices shall be shown on dedicated Fire Alarm plan and shall not be mixed with power plans.
- Provide a fire alarm operations matrix; Mason will provide an example matrix upon request.

3.3.2.6 Lightning Protection

- Each building shall be considered individually to determine the necessity for lightning protection. The building location, height, proximity and height of surrounding facilities, etc. shall be analyzed in determining the need for this protection. If lightning protection is to be provided, it shall be designed and specified to comply with NFPA #780 “Lightning Protection Code” and the completed system and its installation must have U.L. master label.

3.3.3 PLUMBING SYSTEMS

3.3.3.1 Plumbing General Requirements

- Any requirements specified in this design manual that may exceed the minimum requirements of the governing code shall be adhered to unless prior approval is granted by Mason.
- Coordinate all plumbing service entrances including water, storm, sewer and natural gas with the corresponding site utility plans. Verify all sizes and inverts are coordinated.
- All equipment shall be installed with sufficient walk-around room to insure proper maintenance of equipment. Equipment shall be installed such that tube pull, filter replacement, ease of removal and replacement of strainers, ease of draining equipment, filter changes, convenience for service of parts, etc. can be achieved.

3.3.3.2 Meters and Gages

- Water meters shall be included in the contract and installed in accordance with the local water authority.
- Install an approved water meter on the city water make-up supply to evaporative cooling towers.
- Retail Space Utility Metering: Install an Onicon F-4200 Series clamp-on ultrasonic flow meter for the domestic water supply of each retail tenant. Install an Onicon F-5000 Series gas meter if natural gas is provided. For campus standardization purposes, substitutions to the Onicon models will not be accepted. Each flow meter shall be connected to the campus EMS system.

3.3.3.3 General-Duty Valves for Plumbing Piping

- Shut off (isolation) valves shall be provided on the inlet to each piece of plumbing equipment and on supply to each plumbing fixture not having stops on supplies.
- Sectional valves shall be provided close to the main on each branch and riser serving two (2) or more plumbing fixtures or equipment connections.
- Install valves on all lines that penetrate the floor from below.
- Drain valves shall be provided on each plumbing equipment and distribution riser located so as to allow drainage of equipment or riser for service and repair.
- Install valves on all lines at locations such that each floor can be isolated independent of main building.
- Provide automatic air relief valves at the tops of water risers.
- Any equipment such as showers, darkrooms, etc., requiring mixing of hot and cold water shall utilize a solid brass pressure compensated mixing valve rather than a temperature compensated mixing valve.
- Install control valves where they can be reached from the floor, where possible.

3.3.3.4 Hangers and Supports for Plumbing Piping and Equipment

- Provide calculations for pipeline flexibility. Anchor as needed. Conform to ASME Code for allowable stresses. Furnish calculations for spring hangers. For ductile iron/glass piping for sterilizer/autoclave uses ensure pipe hanger supports prevent any lateral movement.

- All piping with insulation shall be supplied with saddles and rigid insulation at pipe hanger locations.
- Seismic requirements must be considered as required.

3.3.3.5 Domestic Water Piping

- Provide di-electric couplings or unions between dissimilar pipe materials.
- Install flexible connectors between piping and connections to rotating or vibrating equipment.
- Provide unions at connections to equipment.

3.3.3.6 Domestic Water Piping Specialties

3.3.3.6.1 Backflow Prevention

- Each water service shall be provided with a service entrance backflow preventer sized for 100% demand load, ASSE 1013 type for domestic water. Where there is only a single water service to the building, backflow preventers on the service shall be arranged in parallel, sized to provide N+1 redundancy to allow for continuous water supply.
- In some cases, a bypass arrangement shall be permitted around a backflow preventer if the equivalent level of cross connection protection is installed in the bypass line.
- Backflow preventers shall have ready access for maintenance, replacement and testing. Backflow preventers shall not be installed where platforms, ladders or lifts are required for access. Backflow preventers shall be installed inside buildings in an area capable of maintaining a minimum temperature of 50 degrees Fahrenheit, except those approved for seasonal removal or replacement.
- Backflow preventers shall be installed in an area exclusively reserved for such assemblies or devices. Related appurtenances including valves, water meters, and fire pumps and sprinkler standpipes shall be permitted to share the same area, provided respective dimensional requirements can be maintained.
- Adequate sized floor drains are recommended for assemblies and devices with relief opening installed inside buildings. The relief port opening shall be installed with a manufacturer's air gap fitting and piped to a floor drain or receptor.
- A minimum of 30 inches of unobstructed space shall be provided in front of backflow assemblies or devices for maintenance and testing. A minimum of 12" of unobstructed space shall also be provided behind 3-inch and larger backflow assemblies or devices. A minimum of 6" of unobstructed space shall be provided behind 2" and smaller assemblies or devices. A minimum of 6'-0" of headroom shall be provided. An assembly or device may be installed in an alcove or under a counter provided it is within 12" of the opening and positioned in a serviceable manner.
- Backflow preventers designed to vent to atmosphere and potable system drainage valves (such as stop and waste or boiler drain type), shall not be installed in pits, vaults or similar submerged areas and shall not be installed in chemical or fume hood.
- In locations that have hard water (e.g. Prince William), a water softener shall be provided to protect specific pieces of equipment, such as water heaters, boilers, and autoclaves).
- Hose Bibs and Wall Hydrants: Hose bibs shall be provided within mechanical equipment rooms, kitchens, loading dock areas, and within planters for watering. Wall or yard hydrants shall be provided

outside the building to accommodate landscape watering, pavement/ sidewalk cleaning, and loading dock cleanup. All exterior hydrants shall be freeze-proof design. All hose bibs/hydrants shall be provided with integral hose bib vacuum breakers (see above), and shall be self-draining type where subject to freezing. Provide a hose bib with hot water on the same level as the exhaust fans serving kitchen hood exhaust system.

- Water Hammer Arrestors: Provide water hammer arresters in accordance with the recommendations in the American Society of Sanitary Engineers Standard 1010 “Water Hammer Arrestors.” Size and locate arrestors in accordance with the Plumbing Drainage Institute (PDI) Standard PDI-WH 201, Water Hammer Arrestors. Show water hammer arrestors on riser diagrams and/or on plans. Water hammer arrestors shall be installed with and inlet isolation valve.

- Provide frost proof wall hydrants every 50'-0” on exteriors of new buildings, with not less than one on each wall. Provide roof hydrants with 25’-0” of roof-mounted air handling equipment requiring periodic wash down maintenance.

- Roof Hydrants: Non-freeze post type hydrant. 1” (25mm) NPT inlet. Roof deck mounting system with cast iron underdeck flange and hydrant support with stainless steel fasteners. Galvanized steel pipe extension. EPDM flashing boot. Mounting shim for pitched roofs. 1/8” (3.2 mm) NPT drain hole. ASSE 1052 backflow preventer.

3.3.3.7 Domestic Hot Water Piping

This section applies to both domestic hot water piping and first aid flushing water piping (i.e. tempered water, emergency water systems).

- Potable hot water systems are a known potential source of bacterial contamination including Legionella strains. Potential for legionella in potable water systems shall be considered and appropriately addressed based on facility risks and system application. Copper-silver ionization shall be considered for potable hot water systems in applications serving residence halls as these buildings may undergo extended periods of non-use and the risk of aspiration of bacteria in water systems via shower heads is greater. Copper-silver systems shall not serve food service areas, and redundancy need not be provided for such treatment equipment, and monitoring protocol shall be developed.

- Distribute domestic hot water to building fixtures at 124°F and incorporate required anti-scalding devices at points of use. Maintain distribution temperature through automatic pumped circulation back to the water heater(s) and master mixing valve(s).

- Do not install plastic hoses for domestic hot water and hot water return lines. Such material is known to harbor and encourage bacteria growth.

- Avoid the use of natural rubber washers, o-rings and gaskets.

- Mix hot and cold water as close to showerheads as possible.

- Minimize distribution piping dead legs. A dead-leg is any length of pipe with one open end connected to the distribution system and the other end terminating at a cap, closed valve, or fixture that is not ordinarily used at least once per day. Dead legs shall be limited to less than 10 feet.

- With the use of ultra-low flow, sensor operated lavatory faucets, hot water circulation to within 3’-0” of the faucet supply is necessary. This means that individual lavatories or a bank of lavatories must have a supply and return circuit extended to the wet wall or chase. Uncirculated branch feeds should not be used as the carrying distance (i.e. displacement) in the supply piping is too short to reach the sensor faucet during its on cycle, resulting in complaints of “no hot water” at the fixture(s).

- Indicate required flow rates for each circuit on the design drawings (plans and/or riser diagrams) and calculate the estimated heat loss on the basis of the system operating temperature, ambient temperature, and insulation value. The minimum flow rate for any one circuit shall be not less than 0.5 gpm with a 1/2” pipe size.

- Hot water return piping shall not be run at the top floor ceiling above the level of the fixtures. This configuration can cause air pockets to form within the return header preventing circulation flow. Instead, always install hot water return headers at the ceiling of the floor below to allow the fixtures above to allow any entrained air to exit the piping system during normal use.

- Indicate the design temperature differential for the circulation system. Hot water return systems serving kitchens shall be sized for a 5°F temperature differential. General building areas shall be sized for a 7°F maximum differential, except that higher differentials (up to 15°F) may be used where justified by the specific application.

- Flushing water to safety showers and eyewash equipment will sit stagnant in the distribution piping if measures to purge the water are not employed. Legionellae, heterotrophic bacteria, and amoebae have been cultured from these piping systems. When these devices are used, aerosolization is expected.

- Regardless of the frequency of testing and flushing of the emergency shower and eyewash fixture, additional means of more frequent flushing shall be incorporated into the distribution system. The connection of the end run of the tempered water distribution system to one or more flushing fixtures (e.g. urinals and/or toilets) is a recommended option. The daily use of these fixtures will displace water through the system at least as much as would be expected from the domestic water system.

- Multiple sinks or similar fixtures may also be used, so long as they ensure sufficient turnover of the water supply.

- In cases where there is no suitable normally used cold water plumbing fixture on the floor served, provide a time clock-actuated line purge at the end of the supply main for the floor, which shall discharge to an indirect waste receptor at a rate of at least 15 gal/min or as necessary to provide a 2 fps velocity in the main for sufficient duration to turn over all contents in the water line on a bi-weekly basis.

- Piping serving emergency fixtures shall be of adequate size to supply the maximum quantity of emergency fixtures to be in simultaneous use, but not less than the flow rate of the single most demanding emergency fixture plus the total simultaneous flow of the flushing purge fixture. In most cases, this will require the distribution main to be 1-1/2 to 2 inch diameter, based on an emergency shower fixture of 20-30 gal/min and a flush-o-meter purge fixture flow rate of (20 to 35 gal/min).

- The minimum size branch line to a single emergency shower is 1-1/4”, and a 1/2” branch shall be provided to serve each eyewash. Flow velocity under conditions of maximum design simultaneous use may be up to 6 ft/min in the main. However residual pressure at the outlet shall not be less than 30 psi. The maximum simultaneous use demand shall be considered in sizing of piping, equipment, and simultaneous pump capacity.

3.3.3.8 Domestic Water Pumps

- Booster pumps for the domestic water system of a building shall be provided when the minimum residual pressure requirements at the most hydraulically demanding fixture cannot be met.
- The Design Team shall substantiate the requirement of a booster pump by hydraulic calculations.
- Building water booster pump systems shall incorporate the following features:
  - Connected to building standby power.
  - Sized and quantity with capacity split for efficient operation under peak demands and minimum design flow.
  - N+1 redundancy of total demand, including simultaneous design load of emergency fixtures (if applicable; typically an allowance of 2 to 4 shower fixtures per building).
  - Sufficient capacity for at least one emergency shower (if applicable) plus peak load with any pump out of service.
  - Lead/Lag/Automatic Alternate with failure logic to maintain operation.
  - Arranged to permit service of single pump or controller with all remaining pumps in service.
  - A constant pressure bypass (with PRV control) shall be provided to ensure continuous service with the VFD or control panel out of service.
  - Where VFD’s are used, separate VFD for each pump.
  - Local control, alarms, and remote general fault alarm to building automation system shall be provided.
  - The use of a pressure accumulator tank should be avoided as the interior EPDM bladder becomes a source of bacteria growth.
- Hot water circulation pumps shall be all-bronze construction, duplexed for N+1 redundancy and controlled by an alternating duplex controller tied to an in-line aqua-stat to maintain distribution temperature. Distribution systems using master thermostatic mixing stations shall always incorporate an aqua stat controller as continuous circulation will result in thermal creep in the system during periods of non-use (i.e. overnight).

3.3.3.9 Sanitary Waste Piping Specialties

3.3.3.9.1 Floor Drains

- Floor drains are required where water may likely accumulate and create a hazard, and also where intensive wet cleaning operations are required, including the following areas:
  - Food preparation kitchen areas, including serving lines
  - Mechanical equipment rooms
  - Toilet rooms with two or more flushometer operated fixtures or water closets
  - Shower or tub room, including area outside ADA shower stalls

- Laundry rooms

- With the exception of toilet rooms, showers, and kitchens, floor drains shall include sediment buckets. Floor drain grates shall be sized and traffic rated for the application, with grates that are fixed or set so as not to slip or deform with anticipated traffic, including consideration of cages, carts, etc. The entire drain shall be corrosion-resistant, smooth, and contiguous with the floor.

- Floor drains shall have minimum 3" diameter outlets, except that drains in loading dock, and kitchens shall have 4" outlets.

- Floor drains in kitchens and other areas where sanitation is paramount shall be constructed of stainless steel.

- Floor drains, floor sinks, and similar penetrations through wet areas above grade shall be protected with a water-proofing membrane and clamping collar, except where floors are otherwise protected with a membrane or approved water proofing system.

- Trap seal primers: Provide automatic solenoid trap seal primers for unattended drain traps where the water trap seal may evaporate over time and allow sewer gases to enter the building. Trap seal primers shall comply with ASSE 1018 or ASSE 1044. Flapper style trap guards such as Proset "Trap Guard" shall not be specified as a substitute for an automatic trap primer. Typical floor drain locations requiring trap guards include:

    - Residential units (to prevent evaporative losses during extended breaks).
    - Mechanical room general drains.
    - Laundry room drains.
    - Floor drains in public restrooms.

- For toilet, locker and shower rooms, general service floor drains shall be cast iron body with flashing collar and adjustable strainer head. Nickel bronze strainer. Round top. For slab on grade, provide gasketed outlet. For above grade, provide no-hub outlet. Provide optional trap primer connection or field connected trap primer to drain tailpiece.

- General service mechanical room floor drains shall be cast iron body with flashing collar. Cast iron ADA grate and slotted cast iron sediment bucket. For slab on grade, provide gasketed outlet. For above grade, provide no-hub outlet. Provide optional trap primer connection or field connected trap primer to drain tailpiece.

- The use of pumping systems shall be avoided. Drainage systems shall be designed to flow by gravity wherever possible.

- Building areas that are sufficiently elevated above the sewer to not require discharge through a pumping system shall be routed independently to discharge by gravity.

- Arrange plumbing systems to prevent sewage backflow into the building due to a stoppage in the exterior sewer by providing relief outside the building through sewer manhole covers.

- Backwater valves shall be provided outside the building for any drainage main that serves fixtures or equipment whose flood level rim is not at least 9" above the elevation of the exterior manhole cover serving the system, or above the next upstream manhole.

- Drains with flood level rim elevations higher than the above reference point shall not be combined with lower level mains upstream of the backwater valve.

- The backwater valve shall be located at the connection with the manhole, or with similar accessible means, to permit access for sewer rodding, or other service.

- Sufficient venting shall be provided to serve the building sewer either through stacks that do not discharge through the backwater valve or by provision of a relief vent.

- The use of individual backwater valves at fixtures is not permitted.

- Where possible, the use of backwater valves that are full-way, normally open type (or devices located at the manhole) are preferred as they are less susceptible to damage or problems related to cable drain cleaning operations.

3.3.3.10 Sanitary Waste Interceptors

- Grease abatement systems shall be provided to prevent the discharge of Fats, Oil, Grease (FOG), and other substances harmful or hazardous to the building drainage system, the public sewer, the private sewage disposal system or the sewage treatment plant or processes.

- Grease abatement systems shall apply to Food Service Establishments (FSE) where food is served to or provided for the public, with or without charge, including, but not limited to restaurants, cafeterias, school kitchens, bars, or any other commercial operation that has the potential to discharge grease laden wastewater.

- Fixtures and equipment shall include, but not be limited to pot sinks; pre-rinse sinks; soup kettles or similar devices; fresh meat cutting and prepping; wok stations; floor drains; floor sinks; automatic hood wash units; and dishwashers.

- Food Waste Disposers shall not be installed on any fixture that requires grease abatement.

- Provide solids interceptors upstream of grease interceptors at fixtures that may discharge solid food waste.

- All grease abatement systems shall receive only stabilized flow from gravity-flow grease waste collection systems and shall not receive pressurized discharge such as from sewage pumps or lift stations. Where pumping is required, grease must be separated prior to the lift station.

- Waste from bathrooms or similar fixtures conveying human waste shall connect directly to the building sanitary drain, and shall not connect through any grease abatement system.

- In general, volume-based grease interceptors shall be located below grade outdoors; or above grade indoors where listed for such applications and within a conditioned space.

- Grease interceptors shall be sized and selected in accordance with the regulations of the Authority Having Jurisdiction.

- Laundries: Laundry facilities not installed within an individual dwelling unit or intended for individual family use shall be equipped with an interceptor with a wire basket or similar device, removable for cleaning, that prevents passage into the drainage system of solids 0.5 in (12.7 mm) or larger in size, string, rags, buttons or other materials detrimental to the public sewage system.

3.3.3.11 Indirect Waste

- Indirect waste connections shall be provided for all plumbing fixtures/equipment that is of public health concern, as well as for equipment drainage as required.
- Food preparation, dishwashing, and ware-washing equipment, autoclaves, ice machines, and similar equipment shall discharge with an appropriate air gap to an approved indirect waste receptor.
- Indirect receptors for food preparation areas and equipment shall be stainless steel floor sinks with appropriate capacity, and with the proper part grate design to eliminate splashing. An internal dome strainer or sediment bucket shall be provided.
- Effluent from autoclaves shall discharge indirectly to a floor drain or floor sink connected to sanitary sewer. Autoclave effluent does not go to waste neutralization treatment.
- Cast-iron floor sinks may be provided in mechanical rooms and similar unfinished areas.
- Floor drains with funnel tops may be used for limited flow applications, such as from ice machines.
- Stainless steel wall outlet boxes connected to a 2” minimum diameter concealed standpipe may be used for various equipment drainage, provided the box is not concealed or inside casework.
- Floor drains and floor sinks shall be installed with their top grate flush to 1/8” below the finished floor, with the finished floor slightly tapered to drain toward the receptor. The installation of floor sinks with rims installed above the floor is not permitted. The only time waste receptors shall be installed with rims above the floor is where specifically necessary to preclude floor drainage from entering the system, such as where a receptor is installed to direct clear water waste to the storm system, or in limited cases where a standpipe receptor/ hub drain is permitted.
- Indirect waste shall not terminate at other plumbing fixtures, including janitor mop sinks, but rather to the appropriate waste receptor.
- Indirect waste shall never terminate over culinary plumbing fixtures or similar applications where use or sanitation is impinged in any manner.
- The use of hub drains and standpipe receptors is not allowed in finished areas because of the potential for trash and debris to enter the drainage system, as well as their unsanitary nature. The interior of these devices is not readily cleanable, and projections above the floor present both sanitation and safety hazards. Such devices, however, may be appropriate in certain mechanical room applications receiving clean wastes, as well as when connected to wall waste outlet boxes.
- Indirect waste receptors shall be installed in readily accessible, normally occupied spaces and shall not be located in toilet rooms, crawl spaces, casework, closets, or any concealed spaces. The one exception is that floor sinks may be located in dedicated walk-in utility connection areas adjacent to sterilizers and similar equipment where such configuration is consistent with the normal equipment installation.

- In locating floor sinks and other indirect waste receptors, the Design Team considers the potential for a waste line stoppage to result in overflow, and ensures the location permits cleanup, constant visual monitoring, and is not likely to cause damage to the building, sanitation issues, or hazard to occupants.

- The placement of indirect waste receptors shall permit removal and cleaning of the sediment bucket or dome strainer and cleaning and mechanical rodding of the device in the event of a stoppage.

- Special care should be applied in locating floors sinks and drains in pits serving lab equipment to ensure accessibility.

- Indirect waste receptors shall be located in the same room as the fixture served, and to minimize the length of indirect waste piping.

- Waste receptors shall be of sufficient depth, and shall be selected to prevent splashing and accommodate peak discharge conditions.

- Undercounter glasswashers and similar equipment shall terminate to adjacent sink wye-branch tailpieces where possible, or may terminate to an accessible unconcealed wall outlet box, or if necessary a funnel top drain or if needed a floor sink.

- Food waste disposers and similar equipment shall not be permitted to discharge through indirect waste receptors, but rather shall be directly connected to the sanitary drainage system.

- As with other drainage systems, the Design Team shall be careful to specify floor sink and floor drain outlet connections that are compatible with the selected waste piping material.

- Floor sinks and floor drains shall be installed to be readily visible, with at least ½ of the grate exposed and removable.

- Floor sinks and floor drains may be fully concealed below equipment only where equipment is readily mobile and elevated over the drain top at least 4”.

- The use of gravity indirect waste lines (including food service and air handling condensate piping) less than 1” diameter shall be avoided, as smaller lines have proven difficult to maintain due to stoppages.

- Plumbing connections to laboratory, vendor designed, and food service equipment shall be included in plumbing documents after coordination with the respective vendor/ consultant.

3.3.3.12 Sanitary Sewerage Pumps

- Only fixtures located below the crown level of the exterior sewer shall be pumped. Where pumped systems are required, equipment is of the duplex type, each capable of discharging 100% of the incoming peak flow in the event of a pump failure.

- Sewage ejectors shall be fed from stand-by power.

- Sewage ejector control panels shall include a dry contact for remote alarm connection to the EMS.

- Pumps shall be commercial grade, submersible type, and provided with lift rail, lead-lag-alternate controls, and designed to preclude single point failure.

- Pumps shall be capable of passing not less than 2 inch diameter solids.

- Basins shall be industrial grade plastic sump of either high density polypropylene or fiberglass construction.

3.3.3.13 Storm Drainage Piping Specialties

- The building storm drain shall extend outside the building and connect to the campus storm sewer system.

- The number and sizes of drains shall be adequate to convey storm water from areas being drained at the same rate as water is collected in those areas. At least two drainage points shall be established for each roof or areaway drainage area, and no roof drain shall have a drain outlet smaller than 3 inches in diameter.

- Roof and deck areas 500 square feet and smaller may be provided with a single drain, provided overflow or other approved relief provisions are incorporated to prevent build-up of water in the event of failure of the primary drain.

- A dedicated secondary emergency roof drainage overflow system shall be provided to serve flat roof areas, except where such roof areas are provided with appropriately sized overflow scuppers. The overflow drain system shall consist of overflow drains installed alongside each roof drain, with a weir 2" to 3" above the roof low point. The system shall be piped independently to discharge through downspout nozzles spilling to the exterior, approximately 12" to 18" above grade. A stainless steel rain cap shall be specified over the top of the overflow roof drain dome grate to prevent intrusion of rainfall during normal conditions.

- Storm drainage leaders (including overflow drains) shall be located in permanent shafts or at building columns. Vertical piping shall be routed as straight as practical, with minimal offsets. An expansion joint or acceptable horizontal offset (swing joint) shall be provided at connections to each roof and overflow drain.

- Drain leaders shall not be located in interior partitions.

- The system design shall avoid placement of horizontal piping above conference spaces, offices, electrical rooms, or other critical areas.

- Where drains are located less than 9" above the elevation of the exterior storm water relief point (e.g. manhole or catch basin grate), automatic backwater valves shall be provided.

- General purpose roof drains shall be cast iron body with nominal 15" outer diameter, combination flashing ring with gravel stop, bottom outlet, extension collar as roof conditions require, under-deck clamp, sump receiver plate and polyethylene leaf guard dome.

3.3.3.14 Rainwater Harvesting Systems

- Rainwater harvesting is permitted for the purposes of flushing water closets and urinals; landscape irrigation systems, and other water handling systems to the extent such rainwater harvesting systems are feasible, reasonable and consistent with the agency mission, program, functionality, and project budget.

- The capturing, harvesting, collection, storage, and filtering of rainwater for the purpose of flushing water closets and urinals shall be designed in accordance with the guidelines of 2007 Virginia Rainwater Harvesting Manual presented by the Cabell Brand Center, Salem, VA; the ASPE/ARCSA Design Handbook or a similar nationally recognized standard. The minimum design standards include the following:

    - The rainwater collected is classified as non-potable and is limited to supplying water closets and urinals only;

- The installation of the harvesting and reclamation system shall comply with all applicable sections of the VUSBC;
- The rainwater shall be collected solely from hard surfaced roofs; collection from green or vegetated roofs is not acceptable due to long term water quality problems;
- Connection to exterior hose bibbs or faucets is prohibited;
- The collection storage system shall be covered, and preferably underground;
- The rainwater shall be filtered through a minimum 6 micron filter before supplying to the water closets and urinals;
- The effluent and first flush from these systems shall be discharged to a storm sewer system;
- Overflow from tanks shall be connected to the storm water system;
- The piping systems conveying the rainwater from the system shall be separated from all other piping systems and clearly identified; and
- The supply rainwater itself shall be colored blue or green with a non-toxic biodegradable dye.

- Rainwater delivered to indoor plumbing fixtures shall meet the minimum water quality standard of limiting fecal coliform to a number less than 2 of a most probable number (MPN) per 100ml and pH levels between 6.5 SU and 7.9 SU.

- Treatment may be required to ensure the quality of the rainwater meets the standards herein. The Design Team shall make the determination as to the required treatment equipment and methods at the onset of the project, but any system shall include the provision for a residual content of a dissolved disinfectant by either chlorination, brominating, hydrogen peroxide solutions or some other accepted disinfectant

- Signage shall be posted in a conspicuous location in each room where rainwater is used. Signage shall be as follows:

NON-POTABLE WATER
RAINWATER USED TO FLUSH
WATER CLOSETS AND URINALS

- The harvesting of rainwater for the sole use in landscape irrigation systems or cooling tower make-up is permitted. Each supplemental potable water supply connection to the irrigation system or cooling tower system shall be protected from backflow in accord with the VUSBC. Any connection to exterior hose bibbs or faucets is prohibited. When rainwater is used for irrigation or cooling tower make-up, the then no dye-marking coloration is required.

3.3.3.15 Emergency Plumbing Fixtures

- Emergency fixture equipment, location and application shall comply with the George Mason University Environmental Health and Safety Office (Mason's EHS) Laboratory Safety Manual.

- Emergency eyewash and shower fixtures shall be provided in pH treatment rooms, hazardous material and chemical storage areas, and other areas where hazardous chemicals are utilized or otherwise deemed necessary through consultation with Mason's EHS.

- In spaces where a significant hazard exists and it is likely a user may be present without supervision, a flow alarm shall be provided to indicate emergency shower operation. Locations where this may be necessary shall be determined through Mason's EHS, and may include areas such as chemical storage and pH treatment system rooms.
- Emergency shower and eyewash equipment shall be fed potable water tempered to a range of 70°F to 90°F, with a recommended setpoint of 85°F which is a few comfortable degrees below average human skin temperature.
- The use of tempered water shall be assessed by Mason's EHS in applications where the chemical exposure my react either chemically or open skin pores and increase the risk of injury. In such cases, cold potable water may be used.
- Tempered water should be generated through semi-instantaneous heat exchangers for the potable hot water supply. When emergency showers are connected, the domestic water heaters shall have a minimum capacity of 2 to 4 showers running (i.e. 40 to 80 gpm tempered, approximately 25 to 50 gpm from the heaters).
- Tempered water supply temperature shall be maintained by an ANSI Z358.1 thermostatic mixing valve. Mixing valves may be centrally located for multiple fixtures, or located at each fixture, whichever suits the building design. Allowable thermostatic mixing valve manufacturers are Lawler, Watts, Bradley or Apollo.
- Where point of use mixing valves are used and supplied by the building potable hot and cold water system, the risers and mains feeding the emergency equipment shall be sized to include the operation of the equipment (20 to 30 gpm).

3.3.3.16 Facility Natural Gas Piping

- Natural gas systems shall be designed per NFPA Standard 54/ANSI Z-223.1, National Fuel Gas Code and 2009 Virginia Fuel Gas Code (2009 IFGC).
- Fuel gas piping distribution systems that serve laboratories shall be low-pressure systems, operating at 7 inches w.c.
- Welded medium pressure natural gas distribution systems of 2 to 5 psi may be used to serve the inlet pressure regulator in food service and mechanical equipment, where justified by the gas load, equipment gas train requirements, and installed in full compliance with 2009 IFGC and serving gas supplier requirements, including proper over-pressure protection.
- Gas services to kitchen appliances shall not exceed 2 psi unless specifically required by individual equipment.
- Commercial kitchen automatic gas shut-off valves shall be interlocked in accordance with applicable codes with Type 1 kitchen hood fire suppression system and shall be labeled.
- Gas distribution systems to food service areas and mechanical equipment shall be separated from the laboratory gas distribution piping starting at the service entrance.
- For laboratories, the volume flow rate required shall be determined from the manufacturer's input ratings.
- Laboratory turret outlets shall be 5 cubic feet per hour and standard diversity factors may be used, but equipment shall be considered at 100% use factor.

- Food service equipment loads shall not be diversified.
- Primary equipment loads shall not be diversified.
- The design pressure loss in the gas piping system shall be such that the supply pressure at any piece of equipment is greater than the minimum pressure required for proper equipment operation.
- A pressure drop of 0.3 inches of water column during periods of maximum design flow is to be used for sizing low-pressure gas installations.
- Pressure drop in medium pressure systems should not exceed 10% of the design distribution pressure.
- Natural gas piping entering laboratories shall first drop down to a local emergency shut-off valve located at the laboratory entrance. This emergency shut-off valve should include the following features:
  - NEMA 1 rated enclosure.
  - A UL listed solenoid valve designed to fail closed on the loss of electrical power.
  - Enable/disable key switch to shut off natural gas to the lab(s) when not occupied.
  - Resettable panic button mounted on panel front.
  - Remote signal to the building fire alarm system upon activation of the panic button.
  - Fire alarm activation signal to the controller to shut down the natural gas to the lab(s) upon activation of the fire alarm.
- Whenever equipment is on wheels or intended to be movable for regular cleaning or usage, the gas connection shall be made with a UL/ AGA listed epoxy-coated stainless steel commercial type gas connectors that is especially designed for movable equipment applications and includes a quick disconnect with integral shut-off and a properly assembled restraining device.
- All connectors shall be properly sized for the required flow rate based on equipment input requirements and maximum allowable pressure drop.
- Gas connections to laboratory equipment and fixed equipment shall be hard-piped, and unions shall not be permitted in concealed, unventilated spaces, including above ceilings.
- The final gas connection below the ceiling to laboratory fume hoods may be made with ASTM A539 welded steel tubing specifically designed for fuel gas lines; however, compression fittings shall not be utilized at any point in a fuel gas system, and joints shall be permitted only at each end.

3.3.3.17 Compressed Air Piping

- Risers for compressed air systems shall be provided as high pressure nominal 100 psi pressure systems, so that laboratories may utilize either high-pressure or low pressure distribution via local pressure-reducing valves at the riser take-offs for each floor to deliver the necessary local or zone low pressure condition.
- Even where high pressure air is not initially required, valved and capped provisions shall be provided at the distribution space or riser take off for each floor, with forethought in system sizing to permit future connections.

- An adequate number of valves shall be provided so as to facilitate maintenance; and to isolate systems for renovations and unexpected emergencies without affecting operation of adjacent spaces. Valves shall be provided as follows:
    - At the source equipment (master shut-off),
    - At the base of each riser,
    - At each riser connection on each floor,
    - At branch piping to each laboratory (generally outside and above the entry door to the lab),
    - At equipment requiring maintenance.
- Compressed air distribution piping shall be OXY/MED copper tubing, ASTM B-819, Type L with BCuP series brazed joints and shall meet the quality requirements established in NFPA 99 for medical oxygen. ACR copper tubing is not allowed due to incompatibilities in pipe and fitting dimensions.
- High-pressure distribution piping systems shall be sized to limit pressure drop to 10% of the system operating pressure. Downstream of local pressure reducing valves, 40 psig laboratory air is distributed to turrets and is sized to limit pressure drop to 3 psi at design demands to the farthest outlet.
- Velocities shall not exceed 4000 ft/min.
- Conventional lab turrets shall provide a flow of 1 cfm at every outlet station. Use standard diversity charts to determine peak loads.
- High pressure air is sized based on projected demand requirements, and detailed programming.
- Special attention should be applied to sizing of systems with regards to quantity and type of high purity gas generators, air tables, and similar equipment which may have high consumption rates and not allow significant application of diversity.

3.3.3.18 Compressed Air Equipment

- A central laboratory compressed air system is typically required for laboratory teaching and research facilities.
- Air compressors shall be of the oil-less or oil-free design with no lubricating oil in contact with the air end of the compressor element.
- Equipment redundancy shall be N+1 and the capacity splits shall be selected to appropriately match the profile demand for maximum energy efficiency. This may include the selection of triplex or quadruplex arrangements of smaller compressors, rather than a duplex set of large compressors at 100% capacity each.
- All compressors shall include an automatic exerciser built into the on-board controller to start and stop the compressor not less than once a week to prevent equipment from sitting idle.
- Compressed air equipment shall tie to the EMS to indicate general/summary fault alarm status.
- In general, air compressors may draw inlet air from the space they are located. Air compressors shall include inlet filters as supplied by the manufacturer.

- The requirement for optional standby power shall be evaluated on an individual program basis, but is typically not required for teaching laboratory systems.

- Provide condensate drainage for intercoolers and aftercoolers over to an adjacent floor drain.

- The discharges from the air compressors shall header together and connect to an ASME rated air receiver sized for 4 to 5 gallons per peak scfm load. For example, an air compressor set sized to provide 150 scfm shall tie to a receiver of 600 to 750 gallons nominal.

- Air receivers shall be provided with a factory applied corrosion resistant coating.

- Air receivers shall be equipped with an ASME pressure relief valve, a pressure indicator, and an automatic drain valve piped over to an adjacent floor drain. In addition, a pressure transducer shall be provided either within the master compressor control panel, a sequencing control panel or on the receiver itself to provide start/stop control to the compressors to maintain system pressure on demand.

- Provide a three valve bypass around the air receiver.

- Provide 3.0 micron pre-filters, 98% efficiency after the receiver. The filters shall be duplexed in parallel for N+1 redundancy. Filter shall be sized for full flow rate at a maximum pressure drop not to exceed 3 psi.

- Provide refrigerated dryers, duplexed in parallel for N+1 redundancy to reduce the pressure dewpoint to a maximum of +40°F.

  - If a lower dewpoint for the central compressed air system is required, provide heat-less desiccant dryer towers duplexed in parallel for N+1 redundancy to achieve a pressure dewpoint of -40°F.

  - In lieu of refrigerated dryers, heat of compression dryers may be considered to reduce purge losses and maximize energy efficiency.

  - When desiccant dryers are used, add 15% of the calculated peak load to the compressor capacity to account for purge losses.

- Provide 1.0 micron final-filters, 98% efficiency after the dryers. The filters shall be duplexed in parallel for N+1 redundancy. Filter shall be sized for full flow rate at a maximum pressure drop not to exceed 3 psi.

- Coordinate heat rejection loads of air cooled equipment with HVAC to ensure adequate ventilation rates. Where water cooled compressors are used, coordinate heat rejection loads as well as required flow rates, temperature rise and operating temperatures with HVAC central chilled water.

- Optional: A final “dry” receiver may be placed after the final filters to serve as a volume of stored energy as well as to moderate the flow through the dryer and filter equipment.

- Final system pressure to the building distribution shall be a nominal 100 psig.

3.3.3.19 Vacuum Piping

- A central laboratory vacuum system is typically required for laboratory teaching and research facilities.

- An adequate number of valves shall be provided so as to facilitate maintenance; and to isolate systems for renovations and unexpected emergencies without affecting operation of adjacent spaces. Valves shall be provided as follows:

  - At the source equipment (master shut-off),
  - At the base of each riser,
  - At each riser connection on each floor,
  - At branch piping to each laboratory (generally outside and above the entry door to the lab),
  - At equipment requiring maintenance.

- Where valves are located above ceilings, thorough coordination of piping services shall be required to ensure proper access for valve operation.
- Run-outs from horizontal piping serving drops to inlets shall be taken off above the centerline of the main or branch pipe and rise vertically at an angle of not less than 45° from vertical.
- Vacuum piping shall be sized based on an inlet flow of 0.5 scfm using standard diversity factors and an overall system pressure drop not to exceed 3 inches Hg from the furthest inlet to the vacuum source equipment.
- Vacuum distribution piping shall be ASTM B 88 copper water tube, Type L with lead free solder joints.

3.3.3.20 Vacuum Equipment

- Prior to selection of vacuum pumps, evaluate the substance being evacuated and compatibility of the system with any potential chemicals.
- Pumps, whenever possible, shall be of the single-stage, fully recirculating, liquid ring type, designed for use in chemical laboratory or chemical processing, constructed of stainless steel with corrosion resistant mechanical seals and elastomers compatible with laboratory chemical process vapors.
- Oil recirculation vacuum pumps may be used in lieu of liquid ring pumps if the expected ingestion of chemical vapors or liquids is compatible with the seal oil without causing oil viscosity break-down or polymerization.
- The vacuum system should be insensitive to occasional ingestion of liquid slugs as may occur from improper trapping and use at vacuum inlets.
- The system design criteria shall be for 100% of the system peak load to remain upon failure of any one pump. All pumps shall alternate in the appropriate lead-lag sequence and include a pump exerciser function.
- Pump sizing shall be based on an inlet flow of 0.5 scfm using standard laboratory inlet diversity factors.
- Vacuum receivers shall be corrosion resistant and have automatic drain traps to remove moisture from the system.
- The determination to provide standby power shall be made on a per project basis. Local control systems with system operating status and alarm condition readout shall be provided at the equipment, and lead-lag-alternate-minimum run functions shall be included.
- A remote signal-to-building automation system shall be limited to a general fault alarm for each system source.

- The laboratory vacuum system shall be capable of maintaining a vacuum of 19 inches Hg at the inlet terminal farthest from the central vacuum source under peak demand. If deeper vacuums are required, they shall be generated locally with special vacuum pumps in the laboratory or laboratory support area. The system or pumps shall be selected for an operational range of 22 inches to 24 inches Hg.

- Vacuum pumps shall include water resistant HEPA filters at the suction side of the vacuum receiver. The exhaust from vacuum pumps shall be discharged outdoors above the roof and at a minimum distance of 25 feet from air intakes, operable windows or other openings and areas where people may congregate. Exhausts shall be protected from entry of insects, debris or water, typically by turning down the exhaust 180 degrees and installing a bird and insect screen.

3.3.3.21 Pressurized Gas Systems

- Pressurized gas systems for laboratories include nitrogen, carbon dioxide, argon, helium, oxygen and other species of gas required for a particular laboratory program. These systems may fall within one of the three following categories:
  - Point-of-use local cylinder(s) with single stem mounted regulator or panel mounted manifold.
  - Central cylinder bank with automatic switchover manifold assembly.
  - Central cryogenic bulk supply with vaporizer(s) and reserve and switchover manifold assembly.

- The primary supply of central system should typically provide not less than two weeks consumption and at least 3 weeks consumption for bulk systems.

- The reserve supply of bulk systems should be sized for a minimum three days' average consumption or for the period of time required for the gas supply vendor to respond to an unscheduled delivery.

- Point of use cylinders are sized according to the specific program requirements as determined by the user or use group.

- Pressurized gas system shall be distributed at 100 psig and regulated down to local required outlet pressures within the labs or at equipment.

- In general and unless noted otherwise, maximum velocity in distribution systems shall not exceed 4000 feet per minute (fpm), and pressure drop shall not exceed 10% for systems operating above 55 psi, and shall not exceed 3 psi for systems operating below 55 psi.

- An adequate number of valves shall be provided so as to facilitate maintenance; and to isolate systems for renovations and unexpected emergencies without affecting operation of adjacent spaces. Valves shall be provided as follows:
  - At the source equipment (master shut-off),
  - At the base of each riser,
  - At each riser connection on each floor,
  - At branch piping to each laboratory (generally outside and above the entry door to the lab),
  - At equipment requiring maintenance.

- Where valves are located above ceilings, thorough coordination of piping services shall be required to ensure proper access for valve operation.

- All laboratories, art studios and scene shops using or storing gas cylinders must have cylinder storage mounts, racks or floor stands for each cylinder. Mounts must be located at a height that allows for the restraining chain to be placed 3/4 of the way up the cylinder. Cylinders shall comply with 29 CFR 1910.101.

- Cylinders containing oxidizers shall be placed an adequate distance away from flammable gases (a minimum of 25 feet) unless one or both is stored in an approved ventilated cylinder cabinet(s).

- Gas distribution piping shall be OXY/MED copper tubing, ASTM B-819, Type L with BCuP series brazed joints and shall meet the quality requirements established in NFPA 99 for medical oxygen. ACR copper tubing is not allowed due to incompatibilities in pipe and fitting dimensions.

- Cylinder and liquefied gas (e.g. Dewar) interior storage areas shall be monitored by an oxygen depletion sensor(s) if determined to be necessary by Mason's EHS.

3.3.3.22 Chemical Waste Systems

- Laboratory waste or other special waste and vent systems shall be separate from the general use sanitary system and shall be designed in accordance with the general drainage design considerations (i.e. sizing and venting) for sanitary waste systems.

- This section provides additional system specific requirements. The Design Team shall carefully evaluate sizing of laboratory waste systems. Many items of equipment do not directly correspond to flow rates and values of common Hunter's Curve fixture unit tables, as the tables are based around flow discharge characteristics of domestic plumbing fixtures and water closets.

- The Design Team shall specify mechanical joint traps under laboratory sinks and fume hoods.

- Borosilicate glass piping is not permitted for direct connections to darkrooms or for vent penetrations through the roof.

- Laboratory waste drainage and vent pipe and fittings, above grade shall be Schedule 40 fire retardant polypropylene (PPFR), ASTM D 4101. Molded fittings per manufacturer system, ASTM D F1412. Heat fusion socket assembly. DWV pattern. Heat fusion method in accordance with ASTM D 2657 and manufacturer's written instructions.

- Laboratory waste drainage and vent pipe and fittings, below grade shall be either Schedule 40 fire retardant polypropylene (PPFR) or non-fire retardant, ASTM D 4101. Molded fittings per manufacturer system, ASTM D F1412. Heat fusion socket assembly. DWV pattern. Heat fusion method in accordance with ASTM D 2657 and manufacturer's written instructions.

- In areas requiring plenum rated materials, laboratory waste and vent pipe and fittings shall be either borosilicate glass, ASTM C 1053 or Schedule 40 PVDF, ASTM F 1673.

- Floor drains shall not be located inside laboratories, unless required for the indirect discharge from equipment.

- Floor drains shall not be located at emergency showers.

- All laboratory waste shall be treated through an approved pH adjustment system designed by a licensed professional engineer.

3.3.3.23 Processed Water Systems

- The water quality parameters for central purified systems (i.e. DI, RODI, etc.) shall be established by the users, use group, Design Team consultant and Facilities Management.

- At a minimum, central pure water systems to labs shall be generated at a quality equal to ASTM D 1193 "Standard Specification for Reagent Water," Type III.

- The use of reverse osmosis bulk treatment followed by either electro-deionization or mixed bed deionization will typically achieve ASTM Type III water minimum resistivity of 4.0 megOhm-cm (maximum conductivity of 0.25 µS/cm). However, when this purified water comes into equilibrium with air (most significantly atmospheric carbon dioxide) it typically assumes a conductivity of around 1.0 to 0.7µS/cm without further polishing. Therefore, distribution of purified water at this conductivity range is acceptable as dissolve carbon dioxide is not considered a contaminant of concern.

- Point of use polishing equipment is typically used in individual laboratories to achieve the required grade of high purity water for specific needs.

- In general when central purified water systems are provided they shall consist of the following basic components:

    - Inlet reduced pressure backflow preventer connected to the building potable water system.

    - Pretreatment particulate filtration, regenerative softeners and service carbon filters.

    - 1 micron RO pre-filter.

    - Two-pass reject staged reverse osmosis (RO) skid with a minimum recovery rate of 75% and a rejection rate of 95% to 99%.

    - Post-RO mixed bed deionization or electro-deionization (CEDI).

    - Storage tank with sub-micron hydrophobic vent filter and return spray ball.

    - Distribution pump(s).

    - 245 nm ultraviolet light for microbial control.

    - Sub-micron final filter(s).

    - Return line conductivity cell.

    - Main PLC controller with compatible communication protocol connectivity to the building EMS.

- In general it is not necessary or desired to feed tempered water to the RO system. Elevated temperature promotes formation of biofilm and encourages microbial growth in the system.

- The extent of equipment redundancy shall be determined on a case-by-case basis to meet laboratory user needs.

- Storage tanks should be sized to hold an average 24 hours' supply.

- RO system should be sized to produce the average 24 hours' supply with 8 hours, but shall not have a capacity of less than 1.0 gpm (480 gallons per 8 hour production window).

- Purified water systems shall be of the constantly circulating type, designed such that a minimum velocity corresponding with a turbulence Reynolds Number (Re) of not less than 10,000 is achieved under all conditions, including peak design demand. Higher scouring velocities may be required in some applications, but typically 10,000 to 20,000 Re is adequate.

- The system shall be designed to provide a minimum use pressure of 25 psig at outlets (after polishers), and maximum system pressure shall not exceed 80 psi. Pressure requirements at polisher inlets shall be verified and is typically at least 35 psig.

- For segments of distribution loops where system pressure exceeds 55 psig, a flow control valve prior to the outlet(s) is recommended. A Plast-O-Matic Series FC flow control valve with 1/2" port size set for a flow of 1.0 gpm is a recommended basis of design.

- Dead legs in distribution and return piping shall be minimized to 6 pipe diameters when possible.

- A rotameter and sanitary diaphragm-type valve shall be provided in the return line from each laboratory floor to permit proper balancing and visual indication of flow.

- The piping system distribution on each floor shall be independent of other floors to the connection with the main supply and return riser. Appropriate sampling and sanitation ports shall be provided.

- Distribution pipe material shall be pigmented polypropylene, ASTM D 4101, Type II co-polymer, SDR 11 wall thickness. Socket fusion joints using heat fusion procedures in ASTM D 2657.

- The entire system shall be designed to be chemically cleaned and sanitized.

3.3.4 FIRE SUPPRESSION SYSTEMS

- All fire suppression systems shall be designed and installed in accordance with the building code, referenced NFPA standards and FM Global criteria. Refer to Part 4 for specific design criteria.

- No glycol or antifreeze based fire suppression systems should be used in any part of the building. Due to the issues that the National Fire Protection Association has noted in their safety alert dated April 5, 2011, the use of antifreeze systems are found not to be reliable, and can exacerbate a fire. A dry pipe sprinkler system can take the place of an antifreeze system and be much more reliable.

- External drains that are fitted with a hose connection shall be 2-1/2 in national standard thread.

- No BlazeMaster CPVC piping should be used due to the historical failure of the pipe and fittings in buildings on campus. The exposed conditions of the construction site, and the detailed installation standards from the manufacturer do not allow for the piping to be properly installed. This leads to leaks and building damage throughout the life of the building.

- When installed the Post Indicator Valve (PIV) should be at least ten feet from any drivable surface or protected by reinforced bollards. The building name/address numbers must posted on the PIV.

- All Type I hoods should be protected by a wet-chemical suppression system.

- Fire suppression equipment that is located on a pitched roof must have the appropriate tie-offs and guide rails to facilitate a safe ascent to and descent from the equipment.

3.4 ENVIRONMENTAL STANDARDS

3.4.1 GENERAL

As mentioned in Chapter 1, Mason expects its Design Teams to employ the industry's best management practices and recommend innovative technologies, balanced with those that are time honored and proven. This is especially true in the highly dynamic environmental field.

In July 2007, George Mason University signed the American College and University Presidents' Climate Commitment, an initiative to promote sustainable development among institutions of higher education. As Mason takes steps towards its target of climate neutrality by 2050, it aims to educate its community in the process by integrating sustainability into its curricular and co-curricular activities. This includes showcasing innovative practices for the education of its students, as well as incorporating cutting edge research into its built environment.

Mason measures its progress in this area by the Association for the Advancement of Sustainability in Higher Education's (AASHE) Sustainability Tracking, Assessment, and Rating System (STARS). These commitments, in addition to others and regulatory issues, determine Mason's minimum environmental performance requirements.

In 2007, Mason's Board of Visitors established that all new buildings and renovations shall be built to, at minimum, the Leadership in Energy and Environmental Design (LEED) Silver certification level or its equivalent. Mason currently utilizes LEED, Virginia Energy Conservation and Environmental Standards (VEES), and Green Globes for its buildings, but has a preference for LEED since it is a well-established, industry-recognized, third-party certified, progressive standard. It is also the standard that is accepted and measured within STARS and other rating mechanisms which provide Mason its sustainability ratings. Once the project is completed, Mason expects its Design Teams to supply the built or renovated facilities' certification scorecard along with supporting documentation for Mason's records.

As stated in Mason's principles of sustainability, the university strives to manage its economic and natural resources responsibly and sustainably. This is reflected in Mason's goal to ensure that its programs utilize space in the most efficient and effective way. Mason expects its Design Teams to adhere to the spirit of these commitments and priorities in their design of Mason's buildings and renovations.

3.4.2 REGULATORY ISSUES

- CPSM: http://dgs.virginia.gov/DivisionofEngineeringandBuildings/BCOM/CPSM/tabid/402/Default.aspx
- Corps of Engineers Wetlands Delineation Manual - 1987
- EPA Wetland Regulatory Authority – Regulatory Requirements: http://water.epa.gov/lawsregs/lawsguidance/cwa/wetlands/regs_index.cfm
- Guide for EPA's Evaluation of Phase I Watershed Implementation Plans
- DEB Notice 121510 – Virginia Energy Conservation & Environmental Standards – December 15, 2010
- Common Wealth of Virginia Office of the Governor – Number Nineteen (2010) – Conservation and Efficiency in the Operation of State Government
- VA Stormwater Act: www.dcr.virginia.gov/stormwater_management/documents/vaswmlaw.pdf

3.4.3 EFFICIENT AND LONG LASTING BUILDINGS

References:

- Mason Climate Action Plan 2010-2011: http://rs.acupcc.org/site_media/uploads/cap/84-cap.pdf

3.4.3.1 Goals and Objectives

The majority of greenhouse gas emissions on Mason's campuses are produced by its buildings. As the university's buildings are constructed for a minimum fifty year lifespan, it is important that they are constructed for endurance and designed to be as efficient as possible. Mason expects its Design Teams to integrate passive and active resource reduction strategies into the building design for optimal operations. In addition, the Design Team shall provide life cycle costs analysis in accordance with Building Owners and Managers Association (BOMA) standards when communicating various design and build options.

3.4.3.2 Direct Energy Consumption

In its 2010 Climate Action Plan, Mason committed to reducing its use of non-renewable electricity and natural gas per square foot of built space, and per full-time equivalent student, by 10% below 2006 levels by 2014—a major milestone on the path to climate neutrality.

3.4.3.2.1 Construction

- Goal: Mason seeks contractors that share our commitment to sustainability. It is the expectation that contractors operate according to that shared commitment, to continually improve, and to minimize their energy consumption during construction.

- Minimum Requirement: The contractor shall have mechanisms in place to measure and report their metered utilities use during construction.

3.4.3.2.2 Design

- Goal: New buildings will aim to be net zero buildings and explore the feasibility of renewable energy production.

- Minimum Requirement: New buildings and existing building renovations shall achieve at least a 20% energy reduction from the current, applicable ASHRAE 90.1.

- Note that trees planted on the south side of structures help to reduce the building's energy needs.

3.4.3.2.3 Final Measurement and Verification: How Buildings Perform

- Minimum Requirement: The building shall be commissioned before occupied and a schedule for re-commissioning set in place for within one to three years of commissioning, and within every five years thereafter, to ensure the building operates as efficiently as intended in the long-run.

3.4.3.2.4 Creating User Awareness of Energy Use

- Goal: Mason's brand promise is to provide an exceptional educational experience that inspires innovation, fosters thought leadership, and cultivates success. This includes providing opportunities for building occupants to understand the ways in which their behavior may positively or negatively impact the campus's energy use.

- Minimum Requirement: Provide signage, mechanisms, educational tools, and/or ambient devices to engage and educate building stakeholders about their building and their impact within the building. The Design Team shall ensure that these reporting systems are installed and compatible with the existing technology infrastructure and building systems.

3.4.3.2.5 Renewable Energy

- Goal: The Commonwealth of Virginia has a voluntary renewable energy standard goal of 15% of power generated from renewable sources by 2025, from a 2007 baseline. As an institution of higher learning and one of the largest public institutions in Virginia, Mason has the responsibility to be a leader in the community. Within Mason's 2010 Climate Action Plan, Mason strives to have 10% of its electricity generated by renewable sources by 2014 as a milestone towards being climate neutral.

3.4.3.2.6 Controls Systems

Building utilities must be measurable so that they can be managed and controlled. Mason encourages collaborative decision-making processes that seek win-win solutions, as opposed to pitting one criteria against another. Technical elements of the Design Manual are not intended to limit opportunities to emplace proven energy saving measures.

- Goal: Measure and report utilities at the unit, system, or floor level (such as lighting, HVAC, plug-load, chilled/hot water, potable water, wastewater, irrigation). The Design Team shall ensure that these reporting systems are installed and compatible with the existing technology infrastructure and building systems.

- Minimum Requirement: In order to conserve and measure progress, campus utilities and energy use must be tracked at the level of individual buildings—at the minimum, for metered utilities such as electricity, chilled/hot water, natural gas, potable water, and wastewater. The Design Team shall ensure that these reporting systems are installed and compatible with the existing technology infrastructure and building systems.

3.4.3.3 Energy Efficiency Standards

As part of Mason’s overall energy plan, energy efficiency standards have been adopted for the purchase of new equipment. Generally, the standards meet or exceed federal ENERGY STAR guidelines and specifications for energy efficiency. The Constructor is encouraged to visit www.energystar.gov for complete product specifications and updated lists of qualifying products. Due diligence must be completed by the Constructor to ensure that energy efficient products are used where feasible. The following equipment has been identified to have readily available inventory of its high energy efficiency product line: Energy Efficient Products List.

3.4.3.3.1 Energy Saving Performance Contract (ESPC)

Mason is currently replacing existing plumbing and lighting fixtures under an ESPC. The Design Team shall specify products that meet or exceed the efficiencies of these fixtures.

The ESPC specs are located on Mason’s docushare site. Open either Internet Explorer, Firefox or Netscape and type the following url into the address window: https://docushare.Mason.edu, or simply click on the link. This will bring up the 'Xerox Docushare' website. Then navigate through the following steps:

1. Click on the 'Finance and Administration' folder
2. Click on the 'Facilities' folder

3. Click on the 'General Campus Information' folder
4. Click on the 'Energy Savings Performance Contract (ESPC)
5. Double click on the 'ESPC Specs.pdf' file to download to the HDD and use as necessary.

3.4.3.3.2 Water Efficiency

As water scarcity and rate pressures increase, Mason strives to be a responsible steward of its water resources and to lower its consumption.

- Goal: Mason appreciates the assistance of its Design Teams to evaluate and integrate innovative technologies to address the challenges of harvesting, storing, reclaiming, and reusing its water resources. Design Teams may need to collaborate with and address concerns of local governing authorities in certain locations and situations.
- Minimum Requirement: Water use in new buildings and existing building renovations shall be 30% below the Energy Policy Act of 1992 standards. Therefore, all new construction and existing building renovations shall have water efficient fixtures and products installed, such as low-flow faucets, showerheads, toilets, and appliances.

3.4.4 SUSTAINABLE SITES

References:

- Current University Master Plan: http://facilities.gmu.edu/masterplans/universitymasterplan.pdf
- Current Master Transportation Plan: http://facilities.gmu.edu/masterplans/GMU_FairfaxCampus_TransMgmtPlan_Final.pdf
- North Sector Plan: http://facilities.gmu.edu/masterplans/NorthSectorPlan.pdf
- Sustainable Sites Initiative (SITES)
- Current University Stormwater Master Plan

Mason recognizes the significant and long-term impact that site development has on the surrounding landscape–especially considering that each facility is expected to operate for fifty years or more. The Design Team shall utilize passive design strategies to create resource efficient buildings and to address important issues such as site impact, connectivity, water quality, and habitat protection.

3.4.4.1 Goals and Objectives

3.4.4.1.1 Site Development

Mason strives to be efficient with its resources, including physical facilities, financial assets, and natural resources. The university also understands that once development occurs, it may be challenging to restore that habitat to its natural and original state. Therefore, Mason wants to honor its land use plans by showcasing—and restoring, where possible—the innate and historical features of the landscape. Consequently, before new buildings are constructed on campus, Mason asks its Design Teams to assist in determining whether the program utilizes space in the most effective way.

- Goal: Reuse or regenerate developed sites and/or underutilized land assets over green field sites. Consider the redevelopment of poorly used sites, including creating new open spaces, or reviving existing open spaces, to promote a sense of community with people and nature.
- Goal: Build close to existing infrastructure to minimize the need for tertiary development. For example, minimize utility runs. If infrastructure is not present, consider other sites.
- Goal: Choose building renovations over new construction. Consider solutions other than new construction to meet organizational and operational needs.
- Goal: Preserve special, protected, endangered, and critical habitats.

3.4.4.1.1.1 Siting to Encourage Energy Savings

The location of a building, including its orientation, may affect the operation and comfort of the building occupants. Therefore, Mason asks its Design Teams to design its facilities to maximize the benefits of the building's location and orientation. Some examples include:

- Minimize energy use by using solar gain or shading to the maximum extent possible.
- Utilize natural ventilation techniques.
- Evaluate the feasibility of geothermal capability.
- Maximize views and spaces for peaceful contemplation by capitalizing on the surrounding natural beauty.

The exterior of the building also affects the environmental impact of the overall building footprint. This includes the hardscape, exterior light poles, and exterior furnishings.

3.4.4.1.1.2 Hardscape (permeable pavements, high-albedo (reflective) paving materials)

- Goal: Reduce the heat island effect.
- Minimum Requirement: Where possible, use generous shade tree plantings on streets and paved areas. The use of light-colored reflective materials will also contribute to cooler summertime temperatures, potentially saving on air conditioning costs and countering the effects of climate change. Within LEED certification, solar PV can also be considered to reduce heat island effects.

3.4.4.1.1.3 Lighting (energy efficient fixtures; reduced light pollution)

- Goal: Minimize light pollution and increase lighting efficiency.
- Minimum Requirement: Street and site lighting shall be designed to minimize light pollution while providing a safe and attractive civic environment.
    - Use glare shields and light angles to reduce potential glare into the nighttime sky.
    - Specify energy efficient and solar powered exterior lights to reduce energy consumption.
    - Consider using streetlights with 100% cutoff range and LED lights in pedestrian areas.

- Consider directing exterior lights at items that will not reflect that light back up to the sky. For example, direct lights towards greenscape rather than towards light-colored exterior surfaces that will reflect the light back up to the sky.

- Consider using lighting that is self-powering, using solar panels and battery backup.

3.4.4.1.1.4 Site Furnishings and Materials (benches with recycled content, bike racks to support bicycle commuting)

- Goal: Use locally produced materials for paving, street furniture and site walls thereby supporting the local economy, local environmental oversight of production and reducing energy needs for transport. Mason favors materials that are recycled or produced or harvested in a sustainable manner.

- Minimum Requirement: Utilize inert and low toxicity in site building materials and piping. Reuse construction and demolition debris such as masonry and paving materials as bedding for roads and paths.

3.4.4.1.1.5 Transportation Support Systems

With new construction comes an increase in mobility demands from the building occupants. Within its 2011 Transportation Master Plan and 2010 Climate Action Plan, Mason pledged to reduce its single occupancy vehicle (SOV) use by 5% by 2014, 10% by 2020, and to provide more sustainable transportation options for the Mason community. This has numerous benefits, including emissions reductions and better stormwater management. It also minimizes the heat island effect; promotes a walkable campus; and provides access to affordable transportation options. Mason is working on transportation infrastructure improvements as well as educational outreach and expects the Design Team to design and plan Mason's facilities in support of these efforts. This includes the provision of:

- A sufficient pedestrian network around campus and connecting to surrounding communities. This concept also includes other non-motorized modes of transportation, if applicable.

- Adequate biking facilities such as bike racks, bike shelters, bike signage, lockers, and showers for bicyclists. At a minimum, compliance with Fairfax County's Bicycle Parking Guidelines is required.

- Connections to existing or planned bicycle and mass transit plans from area transportation providers such as the Washington Metropolitan Area Transit Authority, Virginia Railway Express, city and county transit providers, and the like.

- Linkage with Mason's shuttle system.

- Opportunities to utilize carpool, vanpool, and/or alternative fueled vehicles.

- Access and education about virtual interaction and technology opportunities, such as video conferencing, within or close to the building to minimize need for additional travel.

3.4.4.1.1.6 Stormwater Management

Mason's campuses are located within the Chesapeake Bay watershed, so our actions have a direct impact on the health of the Bay. Mason's Fairfax campus is situated at a nexus point where three locally significant watersheds of the Potomac come together, including the upper watersheds of the Accontink Creek, Popes

Head Creek, and the Pohick Creek. In addition, the core of campus is almost entirely encompassed by two sub-watersheds of the Rabbit Branch Creek which feeds into the Pohick watershed. Consequently, Mason aspires to be a good steward of its water resources and aims to use low-impact design and construction, responsible stormwater management principles, best management practices, and innovative rain capture and harvesting techniques to protect and restore the watersheds. Many of the rules and regulations to maintain the health of the Chesapeake Bay will likely be above and beyond most standards. Please refer to those rules and regulations for compliance as well as Mason's Stormwater Management Master Plan.

- Goal: Mason appreciates the assistance of its Design Teams to evaluate and integrate innovative technologies to address the challenges of harvesting, storing, reclaiming, and reusing its water resources. Design Teams may need to collaborate with and address concerns of local governing authorities in certain locations and situations.

- Goal: Engage in reforestation as a part of overall stormwater management strategies. Practice good forest management practices to balance habitat and ground recharge. Provide reforestation for areas that are disturbed but not part of the active use area on the project.

- Minimum Requirement: Use life-cycle cost and life-cycle quantity/quality control modeling to determine the best application of particular best management practices (traditional or low impact development).

- Goal: Use bio-retention cells to absorb and filter runoff, retain stormwater, and replenish the aquifer. Best management practices should be implemented for erosion and sedimentation control during and after construction to preserve top soil and prevent sedimentation of existing streams.

- Goal: It is Mason’s preference to have more pervious surfaces on campus than impervious surfaces. Currently, 49% of Mason’s campuses are covered with impervious surfaces. Porous pavement for parking, pathways, and plazas increase stormwater runoff time of concentration. Where possible, Mason encourages aquifer replenishment by allowing water to filter slowly into the groundwater table. Where it is feasible, use open channel storm drainage and vegetated swales for stormwater conveyance instead of pipes. Refer to detail 3.4-1 for examples of porous paving, rain gardens and streetside bioswales.

- Goal: The university has publically committed to being a leader in the field of SWM. Where practical, the university strives to achieve a level of treatment that exceeds State and Federal minimum requirement.

- Goal: Areas where stream channels are currently deeply incised and eroded. The stream bed should be raised to meet the floodplain thereby minimizing the impact of the restoration and returning the stream to its pre-development elevation.

- Minimum Requirement: Similar to buildings, stormwater features will degrade over time and so operational costs and a schedule for updating those assets will be set in place for every five years thereafter to ensure the features operates as efficiently as intended in the long-run.

3.4.4.1.2 Habitat and Wildlife Protection

In its 2002 Master Plan, George Mason University outlined its commitment to employ strategies to efficiently use its land resources for development; promote a pedestrian and bicycle friendly campus; and strategically preserve its woodlands, wetlands, and waterways to maintain the campus image and provide for ecological diversity. It also established 'ecological corridors’ following drainage ways, streams, and topography, that buffered development, preserved essential natural features and provided for a connective network of walking trails and bikeways. In addition, Mason's 2009 North Sector Master Plan and Design Guidelines encourages a park concept and retention of natural species and habitat. The Design Teams shall help Mason to honor the spirit of its Master Plans by emphasizing the natural beauty of its woodlands, wetlands, and waterways. In addition, educational signage shall be posted to describe the purpose of the natural areas and community space areas and how they should be respected

- Minimum Requirement: Mason will designate conservation areas so that when university-owned forested land is developed, new trees, of the same character and quality as those being removed and in a ratio of two planted to one removed, will be replanted in compliance with reforestation guidelines within Mason's landscaping standards.

3.4.4.1.2.1 Open Space (grassy areas, lawns, Mason Pond landscape)

- Goal: Encourage the reforestation of George Mason University property.
- Minimum Requirement: Lawns are often treated with pesticides and chemicals and require irrigation for proper maintenance. These areas provide minimal wildlife habitat and minimal stormwater infiltration. For these reasons, lawn shall be used only as necessary for public gathering spaces and recreation, not as a general ground cover. The university has a strict Nutrient Management Plan based on the Maximum Nutrients Loading a turf area can sustain. Any maintenance plan shall comply with Mason’s Nutrient Management Plan.

3.4.4.1.2.2 Woodlands (campus buffer woodlands, clumps of trees, Mason Pond woods, riparian buffers)

- Goal: Retain the highest possible number of healthy existing trees and preserve natural areas.
- Goal: Establish protected wildlife corridors and provide passages (tunnels) under roads suitable for wildlife movement. This will also provide educational opportunities for students.

3.4.4.1.2.3 Planted Vegetation (planting beds, wildflower areas, native plants)

- Goal: Cultivate Mason's available natural resources to further understanding of environmental benefits and engagement of Mason's community. This includes concepts such as community gardens, edible gardens, apiculture, etc.
- Minimum Requirement: All plantings shall be native, cultivars of native plants, and noninvasive exotics. Native plantings are adapted to the local environment and are used to provide wildlife habitat, minimize or eliminate chemical fertilizers and pesticides and affirm a sense of place.

3.4.5 OCCUPANT ENGAGEMENT AND WELL-BEING

Mason's top priority is to provide students with a transformational learning experience that supports their growth as individuals, scholars, and professionals. In addition, Mason's brand promise is to provide an exceptional educational experience that inspires innovation, fosters thought leadership, and cultivates success. For these reasons, it is Mason’s intent to educate its community on the challenges and opportunities for fostering a sustainable world.

- Goal: Since buildings have a significant impact on the environment, Mason would like to raise awareness of its institutional commitments and activities as well as inform students on how they can participate in reducing their own and Mason's environmental footprint.

- Minimum Requirement: Design Teams shall provide interactive signage, mechanisms, tools, and/or ambient devices to engage the Mason community in the sustainability dialogue and help them to understand the impacts of their individual and collective actions. Most areas in the Design Manual Include an educational outreach and engagement component.

- Goal: In addition to the building occupants being informed and engaged in the impacts of their behavior, all spaces shall support occupant comfort and wellbeing, as well as a healthy, enjoyable environment in which its occupants thrive.

3.4.5.1 Indoor Environmental Quality

- Goal: Mason seeks to minimize the energy consumption of its systems while maintaining comfort and wellness for building occupants. Mason wants to ensure that the appropriate amount of outdoor air is brought into its building systems to maintain a comfortable and healthy environment.

- Minimum Requirement: For indoor air quality, comply with ANSI's ventilation standards. Refer to Section 3.3.1 – HVAC Systems for the appropriate ventilation standards for each type of room. Refer to ASHRAE 55 for thermal comfort.

- Minimum Requirement: Construction cleanup and pre-occupancy cleaning must be coordinated with Mason's project manager to ensure the use of low toxicity products, equipment and techniques.

- Goal: Building occupants benefit from being able to control their environment.

- Goal: Mason welcomes ideas from the Design Team to promote wellness activities for building occupants. This may include the design of certain elements such as clearly identified, aesthetically pleasing, easily accessible staircases for occupants to use instead of elevators; walking trails or connections; or areas for quiet contemplation and meditation

3.4.6 MATERIALS AND RESOURCES

Mason is committed to minimizing its environmental footprint, which includes reducing, reusing, and recycling. Mason values innovative solutions from its Design Teams to help lessen the impact throughout a building's life cycle—from construction, to purchasing, to disposal, and remediation. As technology advances in this dynamic field, Mason's ultimate goal is to be a zero waste institution. Current research has shown institutions of higher education can maintain a 70% or higher diversion rate. At the minimum, Mason aims to recycle at least 25% of its waste.

3.4.6.1 Renovation over new build

- Goal: Mason wants its Design Teams to evaluate and consider creative reuse and/or recycling of existing building materials. This may include, but is not limited to, salvaging materials and repurposing existing products.

- Minimum Requirement: For new construction and existing building renovations, Mason strives for a minimum 50% construction diversion rate. Contractors must provide proof of their construction diversion.

3.4.6.2 Recycling Infrastructure

- Minimum Standards: That each building occupant has easy, convenient access to a recycling collection site and that each common area, trash room, or lobby has enough designated space for a recycling center that accommodates all the streams of recycling collected at Mason.

- Minimum Requirement: For every trash receptacle, a recycling receptacle shall be co-located with it.

3.4.6.3 Purchasing

- Goal: As stated in the Virginia Public Procurement Act in 2010, preferences may be given to goods produced in Virginia, goods or services or construction provided by Virginia person, firms, or corporations. Preference may also be given to businesses that are small, women-owned, and minority-owned businesses. Mason wants to support the local economy and local businesses.

- Minimum Standards: Within Virginia's Executive Order 19 (2010), it states that state institutions need to follow the waste hierarchy to reduce, reuse, or recycle whenever possible. It also states that as much as possible, materials and supplies purchased by the state, including paper, should be made from recycled and or renewable materials, and be provided with a minimum of packaging. Durable products, rather than disposable, should be used whenever practical. If disposables must be used, they should be biodegradable or recyclable. The use of remanufactured components should be maximized. If disposable plastics must be used, they should, when practicable, be recyclable plastics only. Paper and other office supplies should be reused and only when beyond viable reuse, recycled. Vendors offering take-back programs for packaging or spent products should also be favored. Buy products that:
    - Minimize packaging.
    - Use recycled content.
    - Use materials that minimize or have no off gassing (with a strong preference for those that do not off-gas at all)
    - Minimize use of toxic chemicals throughout their lifecycle. Use lighter Materials to minimize energy/transportation costs.
    - Use local materials, local vendors.
    - Are organically derived or have biodegradable waste streams.
    - Minimize water use.
    - Minimize energy use.
    - Minimize energy and paper use in procurement/contract management measures.
    - Minimize deliveries, minimize removal from campus.

3.5 SECURITY AND LIFE SAFETY STANDARDS

3.5.1 DESIGN FOR SECURITY

3.5.1.1 General

References:

- Crime Prevention through Environmental Design (CPTED) Guidebook: http://www.ncpc.gov.sg/pdf/CPTED%20Guidebook.pdf

It is a priority for George Mason University to create a safe and secure environment for its users. The guidelines below shall be followed:

- Adhere to the Crime Prevention through Environmental Design (CPTED) principles in all designs in accordance with the Crime Prevention through Environmental Design Guidebook, October 2003 edition.

- Increase security and crime prevention through the use of environmental controls. These controls include natural surveillance, natural access control, territorial reinforcement and maintenance as outlined below:

  - Natural Surveillance: Maximize visibility with strategic placement of architecture and physical elements.

  - Natural Access Control: Place entrances, exits, fencing, landscaping and lighting to control movement of people and vehicles.

  - Maintenance: Maintain landscaping, buildings, lighting, etc. in order to maintain visibility, preserve pride in ownership and continue declaration of ownership.

- In planning for security and crime prevention, the following design principles must be addressed (see the CPTED Guidebook for more information):

  - Natural Surveillance

  - Natural Access Control

  - Territorial Reinforcement

  - Maintenance and Management

- Within these principles, the following strategies must be evaluated and employed:

  - Sight Lines: Provide clear sightlines that allow unobstructed views to the maximum degree possible. Minimize dead space and blind spots. Carefully consider camera angles to maximize the coverage area for each camera.

  - Lighting: Lighting shall support a safe and secure campus environment. Address areas of deep shadowing, but avoid over-lighting and consider energy use.

  - Concealed or Isolated Routes: These are to be minimized. If they are required for specific design reasons, provide these areas with appropriate lighting and camera coverage.
  - Entrapment Areas: All designs shall avoid these areas.
  - Isolation: Areas that are isolated from the rest of the campus environment shall be carefully designed to provide an adequate secure environment within and from/to these spaces. Isolated spaces should otherwise be avoided.
  - Land Use Mix: Planning of the campus shall evaluate the location of various functions and encourage mixed land uses.
  - Activity Generators: Entrances to buildings and areas that encourage people to gather should be spaced and adjoin other outdoor spaces in order to create active pathways and avoid unintended isolated areas.
  - Ownership, Maintenance and Management: It must be clear who has oversight and responsibility for all spaces and security measures in any facility or area of the campus.
  - Signs and Information: Signage and wayfinding must indicate safe zones and locations to get help when needed.
- Other factors to be considered include:
  - Vehicular barriers to prevent easy access to areas not intended for vehicles.
  - The impact of landscape design on the security of spaces in and around buildings.
  - The location and security of parking areas. Underground parking is to be designed carefully and should include best practices for perimeter control and structural considerations. Parking near a building is subject to scrutiny.

3.5.1.2 Building Access

- Refer to Part 4, Division 08 70 00 – Hardware.
- All lockable doors on campus are required to have a key bypass
- The Architect is responsible for specifying the lock core (per University system); the University is responsible for keying
- The card key system must be coordinated with the University Security Systems Manager.
- Best Cores are employed University-wide, Access control Access IT Universal are employed University-wide for card access.
- Electronic card access is generally preferred
- All buildings that contain laboratories, scene shops or art studios, or maintenance buildings where chemicals are used, must be equipped with electronic access.
- All hazardous waste and hazardous substance bulk/stock storage rooms must be keyed to the Environmental Health and Safety (EHS) Hazardous Waste Key.

- Security closets and telecom (inclusive of server spaces) rooms should have electronic card access
- Low use spaces, that are normally locked, are good candidates for wireless locking systems; conversely, high volume spaces are not well suited for wireless locks
- Access card closet must comply with UL Listings, and accommodate a 4x8 plywood area for install.
- All access systems need to have backup power and battery available.
- All doors must allow unrestricted egress at all times. Requirements for specific access points include:
    - Primary Entrances
        - Allows egress at all times
        - Card access reader
        - Electronic locking hardware
        - Door position switch
        - Request-to-exit detector
    - Secondary Entrances
        - Electronic locking hardware
        - Door position switch
        - Request-to-exit detector
        - Local alarm sounder, only as designated by University
    - "Exit only" doors
        - Door position switch
        - Local alarm sounder, only as designated by the university
        - Integrated Request-to-exit detector
- Magnetic locks are not permitted
- Padlocks a must be able to accept a George Mason University standard core.
- Building entrances shall be numbered. A street address shall be provided on the building in a visible location.

3.5.1.3 Surveillance Camera Systems

- Within building interiors, provide a camera every 2,700 square feet, as determined by George Mason University for precise locations.

- For exterior space, provide camera surveillance at every entrance, every lot (as determined by Mason), and all garages.

3.5.1.4 Building Systems Security

RESERVED

3.5.1.5 Emergency Notification System

- Electronic message boards
- Emergency telephones

3.5.1.6 Parking

- Parking has separate gate security requirements

3.5.2 DESIGN FOR LIFE SAFETY

3.5.2.1 General

References:

- CPSM: http://dgs.virginia.gov/DivisionofEngineeringandBuildings/BCOM/CPSM/tabid/402/Default.aspx

3.5.2.2 Fire Safety and Emergency Preparedness

3.5.2.2.1 Mass Notification Sign Infrastructure

- The lobby entrance should have at least one Ethernet port supplied with power (power over Ethernet) and at least one 120 Volt electrical outlet installed for future mass notification signage. The Ethernet and electrical boxes should be installed at least eight feet high in the building lobby where users can see the sign. The associated wall system should be reinforced with wood blocking that will be capable of supporting mass notification sign and/or a large screen 52 inch LCD television set.

3.5.2.2.2 Commercial Cooking Hood Systems

- There should be a hose bib with hot water, and power connection on the same level as the exhaust fans for the hood exhaust system.
- All electrical shunts, gas shutoff valves, and other associated shut off devices should be labeled.
- All Type I hoods should be protected by a wet-chemical suppression system.

3.5.2.2.3 Pitched Roofs

- Fire detection or suppression equipment that is located on a pitched roof must have the appropriate tie-offs and guide rails to facilitate a safe ascent to and descent from the equipment. Fall protection such as tie-offs and guide rails shall be in accordance with OSHA standards.

3.6 ACCESSIBILITY STANDARDS

3.6.1 BARRIER FREE DESIGN

3.6.1.1 General

References:

- CPSM: http://dgs.virginia.gov/DivisionofEngineeringandBuildings/BCOM/CPSM/tabid/402/Default.aspx
- Virginia Uniform Statewide Building Code (VUSBC), Chapter 11
- Rehabilitation Act of 1973, Section 504, and supporting Regulations
- Proposed Accessibility Guidelines for Pedestrian Facilities in the Public Right-of-Way, July 26, 2011, US Access Board: http://www.access-board.gov/prowac/nprm.htm
- 2010 ADA Standards for Accessible Design: http://www.ada.gov/regs2010/2010ADAStandards/2010ADAstandards.htm

The following section includes guidelines for accessibility throughout all Mason campuses.

- New construction and renovations shall be in compliance with the current version of the CPSM. In addition to the referenced standards within the CPSM, compliance is required with the following codes, regulations and standards listed above. In addition, any standard in 3.5.1 of the Design Manual that is more stringent (i.e., more favorable to persons with a disability) than a mandate in the code shall be followed.
- Facilities must be accessible at the completion of construction. Adaptable facilities do not meet the Mason's requirements for accessibility unless they are proven to the Mason Office of Equity and Diversity Services to be made immediately accessible on demand.
- Accessibility must be integrated into the design of new and renovated facilities, rather than applied as an afterthought. Where possible, accessibility features should be architecturally inconspicuous. For example, rather than providing stairs at the main entrance and a ramp at a secondary entrance, the main entrance should be fully accessible.
- For accessibility guidelines related to specific space types (classrooms, toilet rooms, etc.), refer to Sections 3.2.1 through 3.2.15 in the Design Manual.

3.6.1.2 Circulation

3.6.1.2.1 Walkways

Pedestrian networks throughout the campus must be capable of conveying persons of all ability levels between desired destinations. While every segment of every path need not be accessible, each corridor must provide a continuously accessible route. All accessible routes must meet ADA standards. A map of accessible routes on the Fairfax Campus can be obtained from the university.

The guidelines in this section must be followed in the design of accessible pedestrian pathways:

- A maximum 2% cross slope shall be designed on all walkways. All walkway designs must include sufficient spot elevations to ensure positive drainage away from walkways, paths and curb ramps.
- A chain barrier is required where any walkway ends at a roadway where a crosswalk is not provided. Chain barriers may be in combination with railings and should guide pedestrians to a safe crossing area of that roadway.
- Provide edge protection on accessible paths when downward slope of adjacent grade exceeds 4:1. Refer to Part 5 – Standard Details. Mason to review on a case-by-case basis.
- Path barriers must be 42” high.

3.6.1.2.2 Stairs

- Contrasted nosing is required for stairs.
- All stairs shall have handrails on both sides.
- The Architect is responsible for designing accessible connections between new and existing buildings; stairs should be avoided when possible.
- Steps with a single riser are prohibited.

3.6.1.2.3 Ramps

- Exterior walkways shall not have a slope greater than 1:20 in the direction of travel. If this is not possible due to site topography, a ramp may be provided.
- Use ramps only when necessary. Refer to detail 3.5-1 for ADA handrail and ramp details.
- Refer to details 3.5-3 Ramps at Mid-Block Crossing, 3.5-4 Ramps at Corner Crossing, 3.5-5 Ramps with Flared Sides, and 3.5-6 Ramps at Grade Breaks.

3.6.1.2.4 Crosswalks

- Locate curb cuts at the end of each curb return, rather than in the middle of the return.
- Diagonal curb cuts at intersections are prohibited.
- Curb cuts shall be painted red and shall have detectable warnings covering the lower 2’-0” of the ramp measuring from the street, extending the entire width of the transition. Detectable warning strips shall be perpendicular to the path of travel.
- If a curb cut is present on one side of the street, there shall be a responding curb cut on the opposite side of the street.
- Where feasible, orthogonal pedestrian crossings are preferred.
- Alternate style for curbless transitions/areas that are not crosswalks (i.e. circulator shuttle stop near Starbucks, front of Research Hall).

3.6.1.2.5 Parking

- Provide required accessible parking within 250’ of the primary entrance. The number of accessible parking spaces to be provided for various facility types is listed below:
    - Residential Facilities
    - Assembly Building
    - Academic and Office Buildings
- With regard to special events, the following requirements apply:
    - Provide signage to designate additional ADA parking (beyond the required number of reserved ADA spaces) when it is needed for special events.
    - Need to provide for cross slope and stall width. This will be clarified by the university during the initial design phase.

3.6.1.3 Doors and Hardware

- All lever hardware shall have an end return.
- Power operated doors shall be hardwired. Include the location and dimensions of activators (push plates) and stub outs for power operated doors on the architectural drawings. Mount activators 36” above the grade or floor and a minimum of 48” from any portion of the door in the open position. The push plate shall be a minimum of 4-1/2” diameter and located within an appropriate proximity to the door (as approved by Mason).
- Where vestibules are provided, the power operated door must activate the doors on both sides of the vestibule. A push plate shall also be located inside the vestibule.
- Provide at least one power operated door per building at the primary entrance. If the entrance closest to accessible parking is not the primary entrance, provide an additional power operated door at that entrance.
- Provide one power operated entrance along any ADA path located near a building. Need to address the vestibule air break to accommodate those that need to be accessible.
- Provide a power operator or magnetic hold open on fire doors heavier than five pounds that are on the accessible path of travel.

Chapter 4

Construction Products and Activities

Division 01 – General Requirements

01 10 00 Summary

1. The Summary section shall provide the following general items (as well as those listed below) that are pertinent to the project: General Project Information, a general description of the Work covered by the contract documents, type of contract, any phasing or critical dates, Work by Owner (if any), Work under separate contracts (i.e. furniture), Purchase contracts (if any), Owner-furnished, Contractor installed products (i.e. toilet accessories), Contractor-furnished, Owner-installed products (if any), Access to site (outline a detailed route, restrictions, and requirements for marking/signage, based on a discussion with the Mason PM).
2. All project materials, emails, correspondence, and submittals shall indicate the project title, project location, and project identification number (247-XXXXX-XXX) prominently on the front page, cover, subject line, or sheet as well as throughout.
3. The contractor shall inspect the job site and be aware of the conditions under which it must accomplish the work. The university will not consider or be responsible for claims as a result of failure to inspect the job site. The contractor will waive any claim based on conditions that would have been discovered from a site inspection.

01 14 00 Work Restrictions

1. Regular Working Hours. The University's regular (normal) working hours are from 7:00 am to 5:00 pm, Mondays through Fridays, except (a) federal holidays and (b) other days specifically designated by the Project Manager.
2. This university is the largest university in Northern Virginia. As such there are times, as a result of heightened security measures (as result of threats, visiting dignitaries, and other reasons); the contractor may not have access to the campus or portions thereof. Many of these events can and will be coordinated with the contractor prior to the event by the Mason Project Manager; however, this may or may not be the case. In the event that it is determined that the contractor cannot work, the university shall furnish a time extension on a day for day basis for such interruptions as approved and agreed upon by the Mason Project Manager, however, the contractor will not be entitled to any additional compensation for such delays as may result.
3. There are particular times during the year as a result of the academic nature of the University, that work is restricted or strictly forbidden. The University academic schedule is available on-line at www.gmu.edu; dates for years not yet included will follow the same pattern as those for the years shown. Make special note of those periods that the University is closed for holidays, which may or may not follow federal or Commonwealth holiday calendars.
4. Construction activity noise levels for a period extending from the reading days before exams until the final day of exams (ten days) shall not exceed 50 dBA. This generally precludes the use of heavy equipment, truck movements and impact type tools. See also the University sound policy and its restrictions which are to be incorporated into the contract documents.
5. There will be no Construction work the day of Commencement and Degree conferral.

01 21 00 Allowances and Unit Prices

1. This section must include the types of allowances (lump sum, unit price, etc.) that will be in the contract and how they will be utilized. Typically will have allowances for the Energy Management Controls portion of the contract as well as for soils.
2. Some Example allowance language for soils follows: "A unit price allowance for excavation, disposal off site, and replacement with suitable material for an estimated XXX CY of unsuitable material encountered at locations where reasonable interpretation of the Geotechnical Engineering Report (soils

report) would have indicated that the material should be suitable. This allowance would not be applicable to any replacement of unsuitable soils when reasonable interpretation of the soils report would lead one to conclude that the material present is unsuitable. This allowance is not applicable to the removal and/or replacement of any fill material (Stratum A) when reasonable interpretation of the soils report would lead one to conclude that the material present is Stratum A material. "Reasonable interpretation" is defined as linear interpolation between bore holes."

3. The Energy Management Controls Allowance shall be determined through coordination with the Mason PM and the sole source vendor prior to bid. The A/E must send set of plans and specifications to the vendor for review at each stage of design, before presentation to BCOM or the University. At the construction documents stage, the vendor will provide pricing and that value shall be incorporated price into documents.
4. For Construction Management (CM) Projects: The Guaranteed Maximum Price (GMP) proposal may include allowances as accepted by the owner and stated in the RFP Response. The CM shall provide a detailed cost breakdown of each allowance including quantities, labor, and material as directed by the Owner. The CM shall include unit pricing, as applicable, to be used to help determine the fair and equitable value of any savings and/or overages to the allowance. At the Owner's discretion, a standard unit price publication may be used for this purpose. CM overhead & profit related to an allowance is accounted for separately within the GMP.
5. The A/E shall evaluate the requirement to have the contractor formulate an allowance within the contract, in conjunction with the University, for the anticipated amount of costs associated with potential changes to the documents that relate to reviews and revisions required based upon comments from BCOM subsequent to the signing of an agreement. Such a provision for an allowance of this sort shall be clearly provided in the contract documents.
6. Any and all cost savings from an allowance item shall be credited to the Owner in the form of a deductive change order. Likewise, any cost overrun from an allowance item shall be paid by the owner in the form of an additive change order. The Contractor must provide a complete, written account and explanation, in sufficient detail for the owner, of any allowance cost overrun as a condition of approval of an additive change order.

01 25 00 Substitution Procedures

1. The Contractor shall be responsible for reviewing all substitution requests to ensure that they are complete, and if not, return them to the Sub-contractor/Trade Contractor for proper submission. The Contractor shall be responsible to review all substitution requests with the A/E and Owner. The Contractor shall be responsible for tracking and monitoring all substitution requests until all such requests are processed by the A/E and Owner. The Contractor shall ensure that all substitution requests are submitted in a timely manner. The Contractor shall include substitution requests, if any, as an agenda item in the Progress Meetings and advise the Owner immediately of any delays in the substitution request process.

01 26 00 Contract Modification Procedures

1. Change orders will be processed in accordance with the provisions of the CO-7/CO-7CM/CO7-DB and these procedures.
2. The Contractor is to provide sufficient back-up justification for the proposed (PCO) or directed change or claim. Such supporting documentation shall include supplier estimates, delivery estimates, storage estimates, labor and equipment estimates, and so forth. The Contractor is free to use what-ever format seems applicable for this back-up documentation. This said, the Contractor shall provide a GC-1 at a minimum (it is preferred that the Contractor also provide SC-1 forms for each sub-contractors and SS-1 forms for sub-sub-contractors) for each proposed or directed change or claim. Each GC-1 shall be sequentially ordered based on the date of first preparation of the GC-1 for that change.

3. Each change order that is proposed, or directed, or each claim, shall be clear to indicate the value in terms of dollars and cents as well as any claim for time. Failure of the Contractor to make the appropriate claim for time and/or monetary compensation at once formally submitting a change request to Mason is a forfeiture of future claims for compensation or time related to that change.
4. The contractor will most often receive, after negotiation, review by the designer of record, and processing a Field Change Order (FCO). This FCO will provide either authorization to proceed or give a directive to be followed as it pertains to the applicable change. The Contractor is to proceed with performance with the task/requirement as indicated in the FCO. The Contractor, however, must have a signed Change Order (CO-11) in order to be compensated for this change. Thus an FCO will give direction and the subsequent Change Order (CO).

01 29 00 Contract Payment Procedures

1. Failure to follow these procedures may result in the delay or partial withholding of payments in accordance with (IAW) the procedures provided in the Commonwealth of Virginia State Bureau of Capital Outlay Management procedures and applicable state law. Questions for the following should be addressed to either the Project Manager responsible for this project or the Director of Project Management & Construction at Mason.
2. Schedule of Values: Prior to the execution of the work, the contractor shall present for approval a schedule of values for approval by the Mason Project Manager. Contractor will be paid through the use of the CO-12 format, unless otherwise indicated by the Director of Project Management & Construction. For select capital projects as directed by Mason this format will be executed using GC Pay online service.
3. A Contractor is eligible to bill for all expenses incurred during a project from the first day of a given month to the last day of the given month. Such expenses must be recorded on an agreed upon initial schedule of values prior to the beginning of work execution. Immediately following the last progress meeting of a given month, a pay application meeting will proceed if the following has occurred: The contractor has provided both Mason and the designer of record a draft copy of their pay application no later than 2 full working days prior to the last progress meeting of the month. This draft can be provided in electronic and/or paper format.
4. Any and all expenses projected to occur between the pay application meeting and the end of a given month; are understood to require validation by a Mason project inspector prior to final approval.
5. Any and all approved change orders have been included in the schedule of values as agreed upon by Mason and the contractor, and payment application of said change orders is only for work completed on or before the end of the month for which the application is being processed. Change orders that are not approved will not be paid nor shall they appear on the schedule of values.
6. The designer of record and/or the Project Manager will review the pay application and prepare comments for the pay application meeting. Likewise the Mason project inspector will review the application, verify the applicable quantities, and review progress reports prior to the pay meeting.
7. The Mason Project Inspector will conduct the pay application meeting with the contractor and the designer of record. Upon conclusion of this meeting, a marked up copy of the pay application as agreed upon by the parties will be provided to the Mason Project Manager and Director of Project Management & Construction. The contractor will then provide an updated and clean copy for final application by no later than the first working day of the month following the month being applied for.
8. In the event that the parties cannot agree to the value of a particular schedule line during the pay application meeting, the Mason Project Manager will investigate and determine the appropriate value to be paid within that month's application. Once this determination is made the contractor will indicate this value in his final application that is to be provided as indicated above.
9. Once the final monthly pay application is provided, and any projected values are verified by the Mason Project Inspector, the pay application will be processed by Mason for payment IAW the contract terms.

10. It is noted that retainage will be deducted, IAW the CPSM and the CO-7/CO-7CM/CO-7DB from each monthly payment. Release of this retainage, in part or in full, will only be considered upon substantial completion.

01 31 00 Project Management and Coordination

1. The following terms are defined beyond those defined in the CPSM:
    a. RESERVED
2. For all project documentation purposes, and in accordance with the CPSM, the contractor, A/E, and any other participant in the project shall use Department of General Services, Division of Engineering and Buildings forms as found at http://www.dgs.state.va.us/FormsCenter/DEBForms/tabid/826/Default.aspx. If a form is not found there, all parties are to obtain guidance from the Mason Project Manager as to the appropriate form or format to be used.
3. The Contractor shall participate in the following meetings as required by the Contract Documents to ensure successful completion of the project: The Preconstruction Conference(s); Weekly Coordination/Subcontractor Meetings, as needed; Preinstallation Conferences; Semi-monthly Progress Meetings (2x per month) or Bi-Weekly Progress Meetings (every other week) as determined by the GMU Project Manager; Monthly Pay Meetings (may coincide with Progress Meeting); Other meetings that the Owner's PM deems necessary; and Any meetings required by the Contract Documents not listed above.
4. Progress meetings are to have an agenda issued and minutes prepared by the A/E of record. If the Contract Documents do not identify the roles and responsibilities for a particular meeting, inclusive of regular progress meetings, then the A/E shall assume responsibility to schedule, coordinate, prepare/issue agenda, conduct, and prepare/issue meeting minutes as directed by the Owner's PM. Meeting minutes prepared by the A/E shall be processed and distributed to meeting participants within seven (7) days of the meeting.
5. Requests for Information: The Contractor shall be responsible for developing and implementing a RFI form for use on the Work. The Contractor shall be responsible for reviewing all RFIs prior to submission to the University. The Contractor shall be responsible for tracking and monitoring all RFIs including an RFI aging report. The Contractor shall include RFIs as an agenda topic at all Contractor regular Bi-Weekly (or Semi-Monthly) Progress Meetings and advise the University immediately of any delays in the processing of RFIs. The Contractor is responsible for facilitating information requests to keep response times to a minimum. The Contractor will maintain copies of the final answers to information requests as part of the Project records.

01 32 00 Construction Schedule and Progress Documentation

1. Construction Schedule: Without taking exception to any provision of the CO-7/CO-7CM/CO-7DB (the General Conditions of the Construction Contract), the Contractor shall additionally follow the following procedures with regards to generating and maintaining the schedule for the work.
    a. The Contractor is wholly responsible for the accuracy, correctness, and feasibility of the schedule presented to the University. The Contractor is permitted to use commercially available software for the development of their project schedule. The University, however, does not warrant, approve or otherwise recommend the use of any particular product nor does the University retain any responsibility for the accuracy, correctness or lack of flaws in any schedule it is presented using such software as may be used by the Contractor.
    b. In presenting its schedule at any time, as provided in the general conditions, the Contractor shall provide a hard copy, a soft copy in the form of an adobe (.pdf) document, and the data file produced by the software utilized. Unless the University indicates otherwise, the Contractor shall be responsible for providing the University one copy (or license) of the

software used to produce the schedule, and read the prior mentioned schedule data file, at its expense.

c. It is the expectation of the University that any schedule presented by the Contractor presents a reasonable plan for performing the work. Additionally in presenting the schedule, or updates thereof, to the University, the Contractor warrants that this plan is presented such that the activity durations are reasonable, the logic ties are accurate between the various activities, and the aggregate remaining duration estimate is reasonable. As such the University makes no agreement nor does it take responsibility for any of the preceding.

d. The following scheduling procedures offered in various software products and otherwise are strictly forbidden for use in the development and maintenance of the schedule: the use of multiple calendars, the use of retained logic, the use of "user assigned constraints", and the use of interruptible activity durations.

e. While generally discouraged and found unacceptable, the following scheduling procedures offered in various software products and otherwise may be used only as exceptions that are specifically approved for each activity or logic tie that it is felt by the Contractor that it is warranted: activity leads, activity lags, untied activities, start to start logic ties, start to finish logic ties, and finish to finish logic ties.

f. In general activity durations should be formulated such that activities last no longer than the update period specified. The Contractor may opt to break apart portions of the work in phases, locations or other easily identifiable and discrete items in order to attain this requirement.

g. The Contractor shall use a 7 day per week (or calendar day), 8 hour per day (or regular work day) calendar in the development of the schedule.

h. Regardless of the software or method used, those activities that are on the critical path must be clearly identifiable both graphically and in a tabular format.

2. The eventuality that weather will negatively affect the progress of the work is highly likely over the period of the contract. For that reason the Contractor will anticipate, plan for, and put sufficient time in his construction schedule to account for the likelihood of weather, as defined in the general conditions. This provision supersedes and waives any additional compensation in the form of time or monetary compensation as provided in the general conditions. The Contractor shall provide the following number of work days(based upon the months that the work is to be executed) as float in their schedule as pre-determined quantity of allowable weather days to those activities that are 1) affected by adverse weather as defined in section 6 of the general conditions, and 2) on the critical path:

GMU	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual**
Weather Day Allowance	6	5	6	6	6	6	6	5	5	4	5	5	65

3. The Contractor shall provide an internet-based or web-based Project Management Information System (PMIS), hosted by the Contractor, for use in scheduling and tracking of the Projects activities and documentation. The PMIS shall have multiple levels of secure access to allow Contractor, Owner, A/E, CA, consultants and Construction Trade Contractor personnel appropriate access to the Projects information. The Contractor shall provide user training to the AE’s PM and Owner’s PM on the system. If an internet-based system is provided, the Contractor shall provide software licenses, appropriate hardware if needed based on software requirements, and install the software on the AE’s PM and Owner PM’s computers. The Contractor will post and maintain Project schedules, reports, records, minutes, tracking documents, and other items of interest to team members and other project constituents.

4. The University, Contractor and/or A/E Firm may dictate certain milestones that need to be tracked during the course of the project. The following are a non-all-inclusive list of example milestones (those listed will be provided at a minimum): Break Ground/Start Construction; Complete footings/foundations; Complete building structure (concrete or steel frame topped out); Building Skin completed (precast/brick/metal panels/windows/curtain wall substantially complete); Roof complete; Permanent power energized; HVAC, Electrical, and fire protection systems complete and ready for pre-testing and commissioning; Commissioning Ready Date; Final Inspections; Certificate of Occupancy/Substantial Completion; and Complete Punch list/Final Completion. These items must be provided on any published schedule and updated as agreed upon by the project team. None of these items shall be a linked event to any other activity in the schedule so as to differentiate them and mark them distinctly from the logic in the schedule.
5. Progress Reports: During the administration of the contract, the Contractor shall prepare monthly reports for the Owner to document Project actions and to keep the Owner's managers apprised of progress. The reports shall cover all relevant topics, including schedule, budget, submittals, RFI's, RFP's, change orders, quality control, meetings, safety and other topics conducive to the success of the Project. The Contractor shall maintain frequent contact by telephone, site visits, meetings, etc., with all parties involved with the Project. The Contractor shall submit prepared monthly progress reports to the Owner's PM by the 10th of the following month. The Owner's PM will provide or approve formats for periodic status reports, including daily diaries, weekly reports, monthly status reports, etc. The Contractor will maintain a detailed daily log of all events that occur at the job site or elsewhere, which affect, or may be expected to affect Project(s) quality, scope, or progress. The Contractor's daily log shall contain at a minimum a record of the weather, each Sub-contractor/Trade Contractor's work on the site, number of workers, identification of equipment and deliveries, work accomplished, problems encountered, and other similar relevant data as the Owner's PM may require. The Contractor will submit bi-weekly reports to the Owner's PM and A/E on the status of construction, including updated copies of all logs maintained at the site for change orders, claims, submittals, etc. Bi-weekly (or semi-monthly) reports shall be submitted prior to Bi-Weekly (or Semi-Monthly) Progress Meetings.

01 33 00 Submittals and Submittal Procedures

1. The A/E shall prepare, as a part of the project manual, a consolidated listing of all submittals included therein. This listing is to provide the kind of submittal to be provided (e.g. certificate of compliance, shop drawing, sample, schematic, cut sheets, product data, etc.), the number of copies to be provided for that submittal, the deadline for submittal (relative to the beginning of the project, the point of execution where that product is to be used, the commissioning start date, and/or substantial completion), and what specification section that submittal is applicable to and/or referenced from. The Mason Project Manager can provide a format for this consolidated listing upon request.
2. The base review period for all submittals shall be 21 calendar days for capital projects and 14 days for non-capital projects, noting key exceptions elsewhere in this section. Submittals shall be distributed to both the A/E and the University simultaneously.
3. Submittals for materials that require approval prior to being installed in a project, or for those submittals used to certify a level of completion prior to the advancement to another milestone in the project, are to be processed as follows: 1) the Contractor shall prepare the submittals and ensure they are full and complete, signifying such through a stamp or other method that is acceptable to the Mason PM, 2) the Contractor shall distribute the submittal to the Mason PM and the A/E, as well as others as indicated in the project manual; 3) the A/E and the University shall review the submittal simultaneously for compliance with the contract documents and other related standards and requirements; 4) prior to issuance back to the contractor the A/E shall confirm with the Mason PM what, if any, comments the University has on the submittal as well as the A/E's recommendation as to the level of approval the submittal should garner; 5) the A/E shall return the submittal to the Contractor with its comments and level of approval.

4. For those submittals that are rejected or are required to be resubmitted the contractor shall be responsible for any and all time delay that results from that point until such time as an approved submittal is returned to them.
5. For those submittals relating to special inspections, submittals shall be provided IAW the applicable standard cited and referenced in the approved drawings from BCOM.
6. In addition to the time allowed for standard submittal review, as indicated elsewhere in the contract documents, the Contractor will allow for up to 45 days for the review and approval of the fire alarm and sprinkler submittals. The Contractor acknowledges and understands that this project is being executed under the jurisdiction of the Bureau of Capital Outlay Management (BCOM), and not any other local, regional, county or other sub-element of the Commonwealth of Virginia for code compliance. As a result the Contractor recognizes that BCOM has the right to fully review the shop drawings for fire safety and provide approval. This requires that the Contractor provide these shop drawings as early as possible, and that the Contractor assumes all risk involved with any delay resulting from failure to provide this submittal that complies with the contract documents within the first 60 days of the construction phase contract.
7. Generally, submittals that can be put into some form of printed format are to be provided as follows: During construction execution: 2x paper printed copies and 1x electronic (.pdf) format; Record document submittals: See section 01 78 00 and Chapter 2 of this manual.
8. Submittals can be processed and managed through electronic means as directed by Mason's Project Manager. The Contractor and the A/E will process electronic submittals in the same general process as indicated herein.

01 35 00 Special Procedures

1. The Contractor shall ensure they coordinate closely with Mason staff in regards to any kind of abatement work that may be a part of the project. The contractor must take care during construction, to not create conditions for such things as mold growth, legionnaire's disease, or sick building syndrome. Guidance will be provided to the Contractor by the A/E in accordance with the CPSM in regards to lead based paint, asbestos, and/or mold remediation.
2. Mason has a no tolerance policy with regards to fraternizing with students. Catcalls, whistles, shouts, etc. are not acceptable. Personnel observed or reported to be participating in these activities will be removed from the project.
3. During construction the Contractor is responsible for adequate signage and way-finding for any and all campus routes that are disrupted by construction activities, unless specifically approved to be close by Mason. The contractor shall propose pedestrian and other routes prior to installation of fencing or other barricades for approval to the University. All routes provided must perform in a similar manner to those that are disrupted (e.g. a vehicular path disruption shall provide the same traffic conditions as the non-disrupted state inclusive of MOT, or accessible pathways must have an alternate and equally accessible pathway provided). The contractor shall consult the accessible path routes information available on the Mason website in developing such plans. Mason's office of equity will validate that alternate pathway plans are in conformance with these requirements during construction.
4. Disruptions to parking and transportation systems must be fully coordinated with Mason Parking and Transportation. Contractors are responsible for paying for parking permits for any and all vehicles that park outside of the designated construction area.

01 40 00 Quality Requirements

1. The Contractor shall have the overall responsibility for scheduling, coordinating, and inspecting all the Construction Trade Contractors' workmanship, materials, and equipment to ensure conformity with requirements of the Construction Documents (including the contract drawings and specifications, subsequent contract change orders, and approved submittals). The Contractor will be required to develop a formal proactive Quality Control Plan using project staff and subcontractors' inspections

prior to start of construction. The Contractor shall coordinate with the owner for the procurement of any specialized inspections to be paid for directly by the Owner as required by the Contract Documents.

2. The Contractor shall make quality determinations based on the records and inspections to protect the University against defects, deficiencies, omissions, and delays. The Contractor will promptly notify individual Sub-contractor/Trade Contractor(s), in writing, observed variances from the Contract requirements and send a copy to the Mason's PM/Mason's PM and A/E. The Contractor will advise the Mason's PM and A/E if the Sub-contractor/Trade Contractor(s) fail(s) to promptly remove, correct, or replace construction work the Contractor and/or A/E have rejected, and the Contractor will recommend subsequent courses of action. As appropriate, the Contractor shall make recommendations to the Mason, to require additional inspection or testing of the work according to the provisions of the Contract Documents, whether or not the work is fabricated, installed, or completed. Throughout construction, the Contractor will maintain an up-to-date list of defects, deficiencies, delays, and omissions as well as corrective actions taken. The Contractor will prepare and maintain inspection reports according to the CPSM's inspection and acceptance requirements.

3. Special Tests and Inspections: The Owner will engage a qualified testing agency to conduct special tests and inspections required by in accordance with the requirements of the VUSBC, IBC and the Commonwealth of Virginia Construction and Professional Services Manual (CPSM), VUSBC Special Inspections requirements. Other inspections are the responsibility of the contractor.

4. Mockups: Before installing portions of the Work requiring mockups, the Contractor/CM/Design-Builder will build mockups for each form of construction and finish required to comply with the following requirements, using materials indicated for the completed Work:

   a. Build mockups in locations and of sizes indicated or, if not indicated, as directed by the Architect.

   b. Build mockup of a portion of the exterior of the building that includes a corner, at least one bay in one direction and at least one bay on the other side of the corner, and one floor high (unless it is appropriate to do more than one floor as determined by Mason) by full thickness, including face and backup wythes and accessories. The mock-up shall include each type of exposed unit masonry construction, precast concrete panel, stone trim, metal wall panel, window, glazed aluminum curtain wall, and glazing (as are appropriate for the project), with sealants, closures and other items that will be installed in the final construction.

      i. Include a sealant-filled joint at least 16 inches (406 mm) long in each mockup.

      ii. Include through-wall flashing installed for a 24-inch (610-mm) length in corner of exterior wall mockup approximately 16 inches (406 mm) down from top of mockup, with a 12-inch (305-mm) length of flashing left exposed to view (omit masonry above half of flashing).

      iii. Include metal or wood studs as indicated in the construction drawings, sheathing, veneer anchors, flashing, and weep holes in exterior masonry-veneer wall mockup.

      iv. Where masonry is to match existing, erect mockups adjacent and parallel to existing surface.

      v. Clean one-half of exposed faces of mockups with masonry cleaner as indicated.

   c. Build mockup of an exam/training support/medical support/treatment room (if present in the project). The mock-up shall include floor, wall, and ceiling finishes, doors, frames, window treatment, cabinetwork, and other items that will be installed in the final construction.

   d. Build mockup of a residential unit (if present in the project). The mock-up shall include floor, wall, and ceiling finishes, doors, frames, window treatment, cabinetwork, and other items that will be installed in the final construction.

e. Provide mock-ups of other products and systems as required in specification sections in Divisions 03 through 14. Provide each mockup using the exact materials to be used in the Work, including adjacent materials and substrates.

f. Notify the Architect at least seven (7) days in advance of dates and times when mockups will be constructed.

g. Demonstrate the proposed range of aesthetic effects and workmanship.

h. Approval of mockups is for material and construction qualities specifically approved by the Architect in writing.

i. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups, unless such deviations are specifically approved by Architect in writing.

j. Obtain the Architect's approval of mockups, in writing, before starting work, fabrication or construction.

    i. Allow seven (7) days for initial review and each re-review of each mockup.

k. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.

l. Protect accepted mockups from the elements with weather-resistant membrane.

m. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion at the discretion of Mason.

n. Demolish and remove mockups when directed, unless otherwise indicated.

5. Laboratory Mockups: Comply with requirements of preconstruction testing and those specified in individual Sections in Divisions 02 through 49.

01 51 00 Temporary Utilities

1. Install temporary service or connect to existing service. Arrange with utility company, Owner, and existing users for time when service can be interrupted, if necessary, to make connections for temporary services. Provide temporary meters and pay all utility charges during construction. The contractor is responsible for closing any and all utility accounts it may open and transfer then to George Mason, if they are to be maintained for permanent service. The contractor shall pay all utility charges until such time as George Mason acknowledges in writing that it has fully transferred all utility charges into its account with the various individual utility providers.

2. Utility Meters (using existing Mason service). Provide a digital electric meter or a stand-alone sub-meter for the building and/or project site during construction. Meter Chilled Water (CW) and High Temperature Hot Water (HTHW) energy usage through the use of ultrasound flow meters on the supply side of both CW and HTHW and temperature transmitters on the supply and return sides of both the CW and HTHW. These flow meters and temperature transmitters shall be connected to communicate with the Siemens Building Automation System. Provide a water meter for domestic water for the building in accordance with the servicing utility requirements. Provide a separate deduction water meter for irrigation water.

3. Sanitary Facilities: Provide temporary toilets, wash facilities, and drinking water for use of construction personnel. Comply with requirements of authorities having jurisdiction for type, number, location, operation, and maintenance of fixtures and facilities.

4. Heating and Cooling: Provide temporary heating and cooling required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of low temperatures or high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed.

5. Ventilation and Humidity Control: Provide temporary ventilation required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed. Coordinate ventilation requirements to produce ambient condition required and minimize energy consumption.
6. Electric Power Service: Connect to Owner's existing electric power service. Maintain equipment in a condition acceptable to Owner.
7. Electric Power Service Distribution: Provide electric power service and distribution system of sufficient size, capacity, and power characteristics required for construction operations. Install electric power service overhead, unless otherwise indicated.
8. Lighting: Provide temporary lighting with local switching that provides adequate illumination for construction operations, observations, inspections, and traffic conditions.
    a. Install and operate temporary lighting that fulfills security and protection requirements without operating entire system.
9. Telephone Service: Provide temporary telephone service in common-use facilities for use by all construction personnel. Install four telephone line(s) for each field office.
    a. Provide additional telephone lines for the following:
        i. Provide a dedicated telephone line for each facsimile machine in each field office.
        ii. Provide four line(s) for Owner's use.
        iii. At each telephone, post a list of important telephone numbers.
            1. Police and fire departments.
            2. Ambulance service.
            3. Contractor's home office.
            4. Architect's office.
            5. Engineers' offices.
            6. Owner's office.
            7. Work Control 703-993-2525.
            8. Principal subcontractors' field and home offices.
    b. Provide superintendent with cellular telephone or portable two-way radio for use when away from field office.
10. Electronic Communication Service: Provide a desktop computer in the primary field office adequate for use by Architect and Owner to access project electronic documents and maintain electronic communications. Equip computer with not less than the following: Provide DSL in primary field office.

01 52 00 Construction Facilities

1. For all capital projects the following facilities must be provided, at a minimum:
    a. Common-Use Field Office: Of sufficient size to accommodate needs of Owner, Architect, and construction personnel office activities and to accommodate project meetings specified in other Division 01 Sections. Keep office clean and orderly. Furnish and equip offices as follows:
        i. Furniture required for Project-site documents including file cabinets, plan tables, plan racks, and bookcases.

ii. Conference room of sufficient size to accommodate meetings of 10 individuals. Provide electrical power service and 120-V ac duplex receptacles, with not less than 1 receptacle on each wall. Furnish room with conference table, chairs, and 4-foot- (1.2-m-) square tack and marker boards.

iii. Drinking water and private toilet.

iv. Coffee machine and supplies.

v. Heating and cooling equipment necessary to maintain a uniform indoor temperature of 68 to 72 deg F (20 to 22 deg C).

vi. Lighting fixtures capable of maintaining average illumination of 20 fc (215 lx) at desk height.

b. Owner's Representative's Field Offices: Prefabricated mobile unit for two staff persons with lockable entrances, operable windows with blinds and serviceable finishes; heated and air conditioned; on foundations adequate for normal loading. The office shall have a minimum of 250 square feet office space, air conditioned/heated and illuminated for office use. The locksets shall include deadbolt combination with minimum three keys. Furnish the office as follows:

i. Provide 2 office desks, 2 desk chairs, 2 side chairs, 1-eight foot bookshelf, 1 drafting table with adjustable lamp and stool, 1 plan rack, 1 plan table or counter top space, 3-four drawer lockable filing cabinets, 1 storage cabinet and 1 coat tree or wall hooks.

ii. Provide minimum two 120V outlet at each desk, an additional outlet spaced at not more than 10 foot intervals on one wall in each room.

iii. Provide six telephone/data lines.

iv. Provide water cooler/heater unit and private toilet.

v. Provide portable, UL rated, fully functional Fire Extinguisher.

2. For non-capital projects a common use field office shall be provided as directed by the Mason Project Manager. The A/E shall specify the size and accommodations to be provided in the contract documents.

3. Janitorial Services: Provide janitorial services on daily basis for temporary offices, first-aid stations, toilets, wash facilities, lunchrooms and similar areas.

4. Storage and Fabrication Sheds: Provide sheds sized, furnished, and equipped to accommodate materials and equipment for construction operations. Such temporary offices, shops, and sheds are to be located within limits of the construction area or outside of 30 feet (9 m) of building lines. Such sheds must be constructed of noncombustible according to ASTM E 136. Comply with NFPA 241. Store combustible materials apart from the object of the work, building or project.

5. Traffic Controls: Comply with requirements of authorities having jurisdiction. Contractor will provide Movement of Traffic (MOT) and applicable Traffic control measures as required. Coordination of these measures shall be with the Mason Police Department as well as Mason Parking and Transportation. Protect existing site improvements to remain including curbs, pavement, and utilities. Maintain access for fire-fighting equipment and access to fire hydrants. Coordinate fire access with University Environmental Health and Safety Office

7. Dewatering Facilities and Drains: George Mason University maintains delegated authority for VSMP requirements and maintains its own MS4 permit, thus is the AHJ for this system. Maintain Project site, excavations, and construction generally free of ground water. Dispose of rainwater in accordance with the approved land disturbance and Erosion and Sediment Control Permit. Remove snow and ice as required to minimize accumulations.

8. Waste Disposal Facilities: Provide waste-collection containers in sizes adequate to handle waste from construction operations. See elsewhere in the design manual regarding recycling, waste management, and waste diversion.

9. Lifts and Hoists: Provide facilities necessary for hoisting materials and personnel. Truck cranes and similar devices used for hoisting materials are considered "tools and equipment" and not temporary facilities.
10. Temporary Stairs: Until permanent stairs are available, provide temporary stairs where ladders are not adequate.
11. Maintain support facilities until Architect schedules Substantial Completion inspection. Remove before Substantial Completion. Personnel remaining after Substantial Completion will be permitted to use permanent facilities, under conditions acceptable to Owner.

01 55 00 Temporary Parking and Access

1. The Contractor is required to purchase a parking permit for all his personnel and vehicles that will be parked or operate in the campus. See the Mason Parking and Transportation website for more information on parking regulations and requirements.
2. The Contractor shall provide at least one parking space within the construction site for University use, near to the temporary office facilities.
3. The Contractor is permitted to use for parking any portion of the construction site that is available after all other uses (including, but not limited to, deliveries, loading, staging, and so forth) and required protection, for parking. Such space, if available, is not to be expected as a part of site logistics planning and limited to a small (less than 5 vehicles) on site.

01 57 00 Temporary and Environmental Controls

1. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction as required to comply with environmental regulations and that minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects.
2. Temporary Erosion and Sedimentation Control: Comply with requirements of University's Municipal Separate Stormwater Sewer System (MS4) EPA Construction General Permit and annual permit manual, whichever is more stringent and requirements specified in Division 31 Section "Site Clearing."
3. Temporary Erosion and Sedimentation Control: Provide an erosion and sediment controls plan set that complies with the University annual permit. Provide measures to prevent soil erosion and discharge of soil-bearing water runoff and airborne dust to undisturbed areas and to adjacent properties and walkways, whichever is more stringent.
4. Stormwater Control: Comply with requirements of the University annual permit requirements. Provide barriers in and around excavations and subgrade construction to prevent flooding by runoff of stormwater from heavy rains.
5. Tree and Plant Protection: Install temporary fencing located as indicated or outside the drip line of trees to protect vegetation from damage from construction operations. Protect tree root systems from damage, flooding, and erosion.
6. Pest Control: Engage pest-control service to recommend practices to minimize attraction and harboring of rodents, roaches, and other pests and to perform extermination and control procedures at regular intervals so Project will be free of pests and their residues at Substantial Completion. Obtain extended warranty for Owner. Perform control operations lawfully, using environmentally safe materials.
7. Site Enclosure Fence: Before construction operations begin, furnish and install a minimum of a six foot high, chain link, site enclosure fence, completely surrounding construction area, in a manner that will prevent people and animals from easily entering site except by entrance gates. Six foot high.
    a. Extent of Fence: As required to enclose entire Project site or portion determined sufficient to accommodate construction operations and protect students, faculty or visitors to the campus.

b. Maintain security by limiting number of keys and restricting distribution to authorized personnel. Furnish six set of keys to Owner.

c. Entrance gate(s): As required to maintain access to the site. Gates shall be roller type, shall be installed level and maintained in good working order at all times.

8. Barricades, Warning Signs, and Lights: Comply with requirements of authorities having jurisdiction for erecting structurally adequate barricades, including warning signs and lighting. Coordinate emplacement and maintenance with University Environmental Health and Safety as well as the University Equity Office.

9. Temporary Enclosures: Provide temporary enclosures for protection of construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities. Provide temporary weather tight enclosure for building exterior.

10. Where heating or cooling is needed and permanent enclosure is not complete, insulate temporary enclosures.

11. Temporary Fire Protection: Install and maintain temporary fire-protection facilities of types needed to protect against reasonably predictable and controllable fire losses. Comply with NFPA 241.

    a. Prohibit smoking in construction areas.

    b. Supervise welding operations, combustion-type temporary heating units, and similar sources of fire ignition according to requirements of authorities having jurisdiction.

    c. Develop and supervise an overall fire-prevention and -protection program for personnel at Project site. Review needs with local fire department and establish procedures to be followed. Instruct personnel in methods and procedures. Post warnings and information.

    d. Provide temporary standpipes and hoses for fire protection. Hang hoses with a warning sign stating that hoses are for fire-protection purposes only and are not to be removed. Match hose size with outlet size and equip with suitable nozzles.

    e. Obtain necessary work permits from University Safety Office.

12. The Contractor is wholly responsible for the execution, maintenance and removal of any and all environmental, storm water pollution prevention, and erosion & sediment control measures as described in the contract documents and/or as required by federal and state law and regulations. In the event that the University is found to have not been in full compliance with any law or regulation with regards to these areas on the project as indicated by an inspector from the appropriate state agency or the George Mason project inspector, the Contractor will rectify the deficiency within 48 hours of notice (or earlier as provided by law). If the University is cited for a violation, the Contractor will assume full liability for any and all fines associated with the citation and will fully assist the university in resolving the violation that is cited within 24 hours of being cited.

13. The Contractor will provide a distinct line item in its schedule of values for storm water pollution prevention and erosion & sediment control. Likewise the contractor will provide a line for clean-up in the schedule of values. The values assigned by the Contractor for these distinct item, as well as all other items on the schedule of values, must be approved by the Owner's project manager prior to the first application for payment. Upon initial installation of these control measures, the contractor may apply for up to 50% of the values assigned to these lines during the applicable pay application. The remaining balance will be released to the Contractor on a pro-rated monthly basis, so long as the contractor is maintaining the controls and clean-up to the satisfaction of the GMU project inspector and/or not accumulating multiple and/or repeat violations from DCR. In the event that the Contractor does not maintain controls and execute clean-up, the remaining balance may be maintained until substantial completion to ensure that the contractor maintains these controls throughout the project. Should the contractor opt to modify the planned phasing of the project for his convenience, then any additional measures, approvals, and requirements required for those additional phases shall be provided at no additional cost to Mason.

14. Indoor Air Quality Controls: RESERVED.
15. Project stake-out: The Contractor shall provide utility stake out for any utilities that are to be emplaced by local utility providers as a consequence of the work described in the contract documents. The Contractor shall coordinate with the local utility provider and provide such stake-out in the manner that is preferred or required by that utility (e.g. whether the utility wants offsets or not).

01 58 00 Project Identification

1. The Contractor shall leave space on the site for the University to install a project sign or signs as it determines necessary. The A/E and Contractor shall provide graphic logos suitable for enlargement for placement on the standard University project sign. The Contractor shall make all efforts to not damage, deface, and protect the sign(s) on the site.

01 74 00 Construction Waste Management and Cleaning

RESERVED.

01 77 00 Closeout Procedures

1. Closeout of a project is a deliberate process that Mason considers a critical element. Closeout starts at the point that the contractor indicates that they are prepared for commissioning activities to start and concludes once final completion is certified.
2. Attic Stock: Mason generally does not desire attic/bench stock from projects (see also chapter 2 of this design manual on A/E determinations for Attic stock). The A/E shall discuss with Mason its needs for attic stock. If this is to be provided the A/E shall provide, in the space program room for this attic stock to be stored within the building or designated in another facility, as determined by Mason. The space shall be located adjoining to a mechanical area (see 3.2.14) or a Building Service Area (3.2.13). In the event that Attic stock is specified or required, the following procedures apply.
    a. Attic stock shall be passed to Mason as a distinct submittal as a part of closeout activities. The Contractor shall collect and protect all Attic stock in a designated location agreed upon mutually by Mason and the Contractor. The required attic stock shall be only in proportions as indicated in the design documents. Likewise, all of the attic stock shall be provided to Mason at one time.
    b. The Contractor shall prepare a transmittal document, similar to that of a submittal for the attic stock items, including a full inventory.
    c. Once received, Mason will be responsible for transporting and locating the attic stock in its final destination, if the designated storage area during construction mentioned here-in is not the one and same location as the attic stock final destination.
3. Other Closeout Documentation and Requirements: RESERVED

01 78 00 Closeout Information and Record Documents

1. The Contractor shall compile and provide a warranty manual to Mason in a format as directed by Mason.
2. See also Chapter 2 of this Manual.

01 79 00 Demonstrations and Training

RESERVED

01 80 00 Sustainability Documentation/Certification Requirements

RESERVED

01 90 00 Commissioning Requirements

RESERVED

Division 02 – Existing Conditions

02 41 00 Demolition

1. When a building/facility is to be demolished without new construction in its place, all foundation walls shall be removed to a point 36 inches below grade. All basement slabs below the 36-inch level need not be demolished, but must be broken into approximate 48-inch square areas or smaller, allowing drainage through slabs. Require the Contractor to hire the services of a Virginia licensed surveyor to document the location of all foundations left in place below 36 inches, as well as abandoned utilities and utilities relocated as required by the demolition work. Specify that the survey shall become part of the Contractor's record drawing requirements at completion of the work.
2. Specify that all demolition debris shall be removed from George Mason University property and disposed of by lawful means. Backfill basement cavities and depressions with clean fill, compacted to minimum density of 95 percent for cohesive material and 95 percent relative density for cohesionless material. Specify that the area shall be covered with topsoil and seeded.
3. Obtain George Mason University approval prior to demolition of basement floors or before making connections into existing waste systems.
4. Specify that all utilities are to be cut and capped. Locations of capped utilities shall be included on the record survey provided by the Contractor.
5. Specify that the Contractor shall recycle non-hazardous materials that are removed.

Division 03 - Concrete

03 30 00 Cast-In-Place Concrete

1. Testing: Specify that the Contractor is to retain and pay for the services of a George Mason University approved laboratory to perform concrete testing and inspections. For floors, use ASTM E1155 "Standard Test Methods for Determining Floor Flatness and Levelness Using the F Number System."
2. Specify air-entrained concrete where concrete is exposed to the weather. With the exception of air-entrained agents, no antifreeze or other admixtures are permitted. Concrete additives containing more than 0.1 percent chloride ions are not permitted.
3. Specify that the Contractor protect newly placed concrete exposed to the public to insure that concrete is not defaced prior to complete setting up. This includes concrete floors intended to be left exposed to the public. Replacement of defaced concrete and concrete floors that are stained or otherwise damaged is included in the Contract Sum.
4. Specify clear sealer at all concrete floors which will be exposed within the finished building and which are not scheduled to receive an applied finish.
5. Specify a hardener where floor surfaces are subject to heavy loads, impact loads, or rolling loads.
6. Specify the finish of exposed concrete floors to meet a slip resistance requirement acceptable to the authorities having jurisdiction.
7. If using color in concrete floors, specify integral color additive. Surface-applied color may be used only with written approval from George Mason University.
8. Architectural (exposed) concrete shall be included in mock-up requirements as specified in Division 01. Specify the specific requirements and criteria for review of architectural concrete in Division 03.
9. Sandblasted finishes for interior or exterior structural concrete are not permitted unless specifically approved by the George Mason University.
10. Rubbed finishes for interior concrete to be painted is not permitted. Interior concrete may instead be specified with veneer plaster.
11. Detail concrete structural frames exposed to the exterior with insulation and finish systems minimizing thermal loss and gain.
12. Additional requirements for exterior concrete paving are included in Division 32.

03 40 00 Precast Concrete

1. Provide protection from rust stains and damage during construction of exposed pre-cast concrete.
2. Design precast concrete so that no portion of it touches grade or is below-grade.

Division 04 - Masonry

04 01 20 Masonry Restoration and Cleaning

1. Specify cleaning of brick or stone masonry using procedures and cleaning methods recommended by the original brick and stone manufacturers, except that no acid-based cleansers may be used.
2. Sandblasting of masonry is prohibited.
3. Obtain approval from the George Mason University for mortar joint profiles and mortar colors.
4. Specify waterproof covering of masonry work during nonworking hours and for masonry work during inclement weather.
5. Experience Clause: A 5-year experience record of the subcontractor performing the restoration work is required.

04 20 00 Unit Masonry Assemblies

1. Specify submittals of brick masonry that show the full range of colors and textures that will be provided in the finished work.
2. Specify lightweight concrete block where CMU is used.
3. CMU less than 8 inches thick is not permitted unless approved in writing by the University.
4. Specify that mortar additives must be certified by the manufacturer to contain no more than 0.1 percent chloride ions.
5. Specify flexible through-wall flashing at cavity walls, minimum 20 mils thick.

   Acceptable Products: Nervastral, Inc., 600 or Seal-Pruf HD, or approved equal.
6. Lead-coated flashing is not permitted.
7. Specify plastic weep holes at cavity walls, spaced not more than 24 inches on center at interruptions in the cavity caused by through-wall flashing, openings, and ledgers. Do not specify aluminum weep hole vents or weep holes with sash cord.
8. Specify that masonry coursing is to be coordinated with window and door heads and sills to minimize fractions of courses and cutting of full masonry units.
9. Include masonry in mock-up requirements as specified in Division 01. Specify the specific requirements and criteria for review of masonry in Division 04.

04 72 00 Cast Stone Masonry

1. Specify that samples of materials indicating each shape and color specified are required for approval before proceeding with the work. Submit samples of anchors and relieving angles.
2. Testing Laboratory: Require that the Contractor submit name and credentials of proposed testing laboratory for approval.
3. Inspection: Require that the Testing Laboratory inspect all material, equipment, fabrication, curing and storing of cast stone work at the plant. Mark and record each unit for identification with the day of casting.
4. Tests: Test representative pieces of cast stone randomly selected from those delivered to the jobsite. Costs for tests and replacement pieces of cast stone taken for testing are included in the Contract. A minimum of one unit per 50 units may be selected from delivered cast stone for testing. Samples shall be tested to destruction in accordance with ASTM C 116 and test reports shall be submitted to the A/E and University.

Division 05 - Metals

05 12 00 Structural Steel

1. For erection of structural steel, require that the Contractor provide an affidavit at the completion of the job, that the structural steel frame is plumb and level within the normal tolerances specified by code, or the more stringent tolerances if specified.
2. Require that the Contractor provide a certified survey indicating the exact location of the centers of the columns at their topmost level, exactly as installed. Require that this information be incorporated in the record drawings.

05 30 00 Metal Decking

1. Specify galvanized metal decking conforming to ASTM A 525, G 60 for metal decks, floor slabs, and roof decks. Prime-painted decks are not permitted. Require adhesion testing of sprayed on fireproofing on metal decking.

05 50 00 Metal Fabrications

1. Ventilation shafts penetrating the roof shall be equipped with welded anti-personnel grates to prevent unauthorized access to the building.
2. Specify all exterior miscellaneous steel to be galvanized and prime painted, ready for field finishing.
3. Specify structural support steel for equipment and for miscellaneous uses not specified elsewhere.
4. Specify manufactured removable collapsible steel bollard Maxiforce MCSP SS1-S with lockable base.
5. Bollards: In ground mount: MaxiForce Model MC-SW-SS1-S; Surface mount: MaxiForce Model MC-SW-SS1- U.

05 52 00 Metal Railings

1. Exterior Railings associated with Building: Specify powder-coated galvanized steel handrails. Specify railings to be non-removable and installed using non-shrink grout.
2. Exterior Railings elsewhere: Specify field-painted galvanized steel handrails. Specify railings to be non-removable and installed using non-shrink grout.

Division 06 – Wood, Plastics, and Composites

06 05 00 Common Work Results for Wood, Plastics, and Composites

1. Specify that all lumber be properly seasoned or kiln-dried.
2. Include carpentry elements in the mock-up requirements for exterior wood and plastic framed structures and exterior wood finish work with the mock-up requirements specified in Division 01. Specify specific carpentry requirements for the mock-up in Division 06

06 05 73 Wood Treatment

1. Where fire-retardant treatment or preservation treatment for wood is used, specify that treatment be accomplished by means of pressurization. Preservation treatment is required for all wood in damp areas or in contact with earth, concrete, masonry, plaster, or roofing. Do not provide treated wood in contact with steel.

06 10 00 Structural Carpentry

1. Specify that lumber must be inspected, marked according to grade and certified by the appropriate bureau governing that product.

06 13 00 Heavy Timber Construction

1. Require that the Contractor provide a complete design analysis of structural components along with shop drawings. Data shall bear the seal and signature of a Virginia registered professional Architect or Engineer, attesting that design of trusses and other structural components meets requirements of the specifications and complies with requirements of all codes and ordinances applicable to the particular project.

06 20 00 Finish Carpentry

1. Conform to Architectural Woodwork Institute specifications for custom grade quality work as a minimum.

06 40 00 Interior Architectural Woodwork

1. Specify solid wood cabinet doors and drawer fronts for residential work.
2. Specify veneer plywood cabinetwork elsewhere except for laboratory casework, which is specified in Division 12. Plastic laminate may only be used after obtaining written approval of George Mason University.
3. Specify that materials may not be delivered to the site until the building is completely closed in, weatherproofed, and climate-controlled. These controls shall be maintained until Substantial Completion.
4. Specify that the fabricator of cabinets shall also be the installer, and that the fabricator shall provide the cabinet hardware.

Division 07 – Thermal and Moisture Protection

07 10 00 Dampproofing and Waterproofing

1. Provide waterproofing membranes at floors and walls of below-grade spaces.
2. Specify dampproofing at exterior of below-grade walls that are not enclosing below-grade space.
3. Protect vertical waterproofing and dampproofing against damage during backfill with minimum 1-inch thick extruded polystyrene sheet with drainage grooves. Provide drainage at the bottom of below-grade walls, slabs, and foundation, sloped away from the building. See Division 33 for underslab drainage.

   Acceptable Systems: Self-adhering HPDE sheet waterproofing and bentonite waterproofing are preferred.

07 19 00 Water Repellents

1. Generally, do not specify water repellents for exterior brick or masonry walls. Where required on existing buildings, use silane based water repellents such as one of the following:

   Acceptable Products:

   - Chem-Trete BSM 40 as manufactured by Huls Inc., Edison, New Jersey.
   - SIL-ACT ATS-42 as manufactured by Advanced Chemical Technologies Co., Oklahoma City, OK.
   - Stifel as manufactured by Nox-Crete Chemicals, Inc., Omaha, Nebraska.
   - Klereseal 940-S as manufactured by Pecora Corporation, Harleysville, PA.

07 21 00 Thermal Insulation

1. When using fiberglass batt insulation in areas needing access for inspection and maintenance, specify foil-faced or paper-faced batts to facilitate removal.

07 24 00 Exterior Insulation and Finish Systems (EIFS)

1. EIFS may only be specified with the written approval of the University. Where used, specify only Class PM, Type A, heavy fiberglass mesh-reinforced high-abuse-resistant systems as defined by the Exterior Insulation Manufacturers Association (EIMA). Specify mechanical fastening of extruded polystyrene insulation and reinforcing mesh, and rigid acrylic modified cement plaster finish.
2. Locate control joints and detail the flashing and sealing at penetrations to ensure a properly designed and watertight installation. Provide weepholes at bottom of each panel. Specify the color of sealants to be used.

07 27 00 Air Barriers

1. Assure that a continuous moisture and air barrier is provided, including walls, slabs-on-grade, and roofs, with compatible joints between materials.

07 31 00 Steep Slope Roofing

1. See the Construction and Professional Services Manual (CPSM) Appendix A.
2. Specify minimum 2 layers of #30 asphalt-impregnated building paper underlayment at roof shingles. Specify factory-coated aluminum valleys extending a minimum of 10-inches up each slope. Specify

self-adhering sheet membrane waterproofing at eaves extending an additional 24-inches up the roof beyond the face of the exterior wall below.

3. Slate shingles shall be a minimum of 1/4-inch thick, weighing not less than 900 pounds per square and installed with no fewer than 2 nails per shingle.

07 40 00 Roofing and Siding Panels

1. Provide roof parapets on buildings greater than one story in height for safety purposes.
2. For metal panel exterior walls, specify construction of a mock-up panel. See Division 04 Masonry for details on extent of mock-up panel.

07 50 00 Membrane (Low Slope) Roofing

1. See the Construction and Professional Services Manual (CPSM) Appendix A.
2. Only 4-ply SBS-modified bitumen roofing or single-ply EPDM roofs are acceptable for low-slope roofing, except at vegetated roofs. Provide cold- or hot-fluid-applied roof membranes at vegetated roofs, and use modular planting trays where possible. Fully adhered systems are preferred. Ballasted systems must be approved in advance by the University. Mechanically fastened systems are not acceptable. Specify ballast (if approved) using clean, river-washed gravel meeting ASTM-C-136.
3. Specify a flood test for new roof installations prior to final acceptance. Test must be witnessed by the University's representative.
4. Require a full materials and labor warranty of roof systems for a minimum of 2 years.

07 62 00 Sheet Metal Flashing and Trim

1. Specify thin wall (0.05-inch) copper flashing between parapet walls and capstone.
2. Specify gutters and downspouts formed of minimum (0.05-inch) copper.
3. Downspouts shall drain directly into underground storm drainage system.
4. Do not specify lead or lead-coated flashing.

07 72 00 Roof Accessories

1. Specify walkway pads no less than 24-inches wide to and around all roof-mounted equipment and appurtenances requiring maintenance.
2. Specify snow guards on all roofs with a slope of 6 in 12 or greater over entrances and adjacent to walkways. Specify that snow guards are to be screwed **and** adhered to roof.
3. Smoke relief vents shall be accessible for maintenance using a maximum height 10-foot portable ladder.

07 81 00 Applied Fireproofing

1. Specify fireproofing materials and application methods that are compatible with factory-applied steel finishes.

07 90 00 Joint Protection

1. Specify 2-part polysulfide, 2-part polyurethane or silicone-synthetic rubber type sealants wherever possible and appropriate. Specify pourable urethane base sealants for construction joints in traffic-

bearing locations such as concrete walks, patios, and exterior stairs. Specify sealant for each individual application, and specify installation of sealants in accordance with manufacturers' recommendations.

07 95 00 Expansion Control

1. Specify manufactured interior and exterior covers for expansion joints. Specify interior joint covers that incorporate the finish material in public areas such that they are not apparent.

Division 08 - Openings

08 10 00 Doors and Frames

1. Doors to rooms storing high value items such as computers, scientific equipment, etc. shall have solid doors without vision panels and without adjacent sidelights.
2. The A/E must submit the door manufacturer list early in the design process for review and approval by George Mason University.

08 11 00 Metal Doors and Frames

1. Specify exterior door faces with minimum 0.0635-inch (16 gauge) galvanized steel, and flush edges, including door tops. Specify exterior door frames with minimum 0.0785-inch (14 gauge) galvanized steel and with fully-welded drainage channel at head of each door.
2. Specify interior door faces with minimum 0.0478-inch (18 gauge) steel. Specify interior door frames with minimum 0.0598-inch (16 gauge) steel.
3. Acceptable Products: Curries Series 707, or CECO Legion, or Steelcraft L Series.
4. Knock-down frames are not permitted unless specifically approved in writing by George Mason University.

08 14 00 Wood Doors

1. Do not specify exterior wood doors unless approval is obtained from George Mason University.
2. Specify interior wood doors with solid core, using mineral core where a fire rating is required, or high density particle board core or wood stave core on non-rated doors.

   Acceptable Products: As manufactured by Marshfield, or approved equivalents manufactured by VT Industries or Eggers.
3. Specify clear or stained finished wood doors with factory finishing and pre-machining for hardware. Specify door edges with solid wood matching wood face veneer.

08 33 00 Coiling Doors and Grilles

1. Specify steel slats for exterior coiling doors, unless insulated, in which case aluminum slats are acceptable.
2. Specify only fusible links for automatic closing rolling steel fire doors. Specifying both detectors and fusible links together is not permitted.
3. Fire shutters are not permitted; provide water curtains instead.

08 40 00 Entrances, Storefronts, and Curtain Walls

1. Specify wide-stile aluminum doors with minimum 5-inch stiles, 5-inch top rail and 10-inch bottom rail.
2. Specify that all hardware, with the exception of cylinders, shall be furnished and installed by the aluminum door manufacturer. Specify cylinders for these doors with the rest of finish hardware and matching the building system.
3. Specify only the following hardware for aluminum doors. No other manufacturers or products will be accepted:

ITEM	MANUFACTURER	MODEL NO.
Hinge	Roton Continuous or Stanley	FBB-199 US32D
Closer	LCN	4040 x CUSH x Alum.
Exit Device	Von Duprin	99 rim x 990NL (RHRB Door)
Mullion	Reed	8000 Series (Steel)
Threshold	Reese, or Approved Equal	
Weather-strip	Door manufacturer	

4. Specify finish hardware with US26D finish, with the exception of sprayed aluminum finish on door closers.
5. Typical door hardware schedule for aluminum entry doors:

   Each Leaf;

   1 - Hinge Roton 780-053HD X Alum.

   1 - Exit Device Von Duprin 99 X 99ONL X US26D

   1 - Door Closer LCN 4040 X CUSH X Alum.

   Silencers GJ-64

   Per Pair;

   1 - Removable Mullion Yale M-100

   1 - Threshold Zero or Approved Equal.

08 42 00 Automatic Entrance Doors

1. Specify that hinges and exit devices are to be installed with through-bolts. Specify spanner heads at exposed screws and bolts.
2. Specify frame reinforcement for overhead surface-mounted door operators.
3. Specify 120VAC power supply directly to each door operator.
4. Specify self-contained solid state circuit controller for operating and switching the swing power operator. The electronic control shall provide low voltage power supply for all means of actuation. External or auxiliary low voltage power source are not permitted. Specify adjustable time delay of 1 to 60 seconds, for normal cycle, as well as the following built-in features:
   - Torque limiting for controlled forces on opening,
   - Acceleration control for smooth starts and recycle,
   - Special circuitry for reducing power to the motor when door is in “Hold-Open” mode, extending longevity and assuring reliability.
5. Safety Sensors: VISONPULSE: The swing door presence sensor shall be mounted to each side of the swing door approach and swing path and shall be complete in all respects consisting of the following:
   - Extruded Aluminum housing of 6063-T52 alloy sized to run full width of door, integral high impact, tinted acrylic lenses and injection molded end caps.

- Solid state electronics interfaced to alternating rows of light emitting diodes and receivers contained within the extruded aluminum housing.
- Long/short range switch and flexible cable.
- Sensor shall be capable of operation within temperature ranges of -20F and 160F. Vision pulse shall detect presence not motion and shall not be restricted in application due to door design, construction, material or glass type. Ambient light and radio frequencies shall not interfere with the sensors performance.

ITEM	MANUFACTURER	MODEL NO.
Hinge	Roton or Select Products Limited. No Substitution	
Automatic Operator	NABCO Entrances, Inc. (Low Energy Type). No Substitutions	Gyrotech 500
(*) Electric Strike	Von Duprin 6000 Series 24VDC Fail secure	Model to suit application. No Substitution
(*) Exit Device	Von Duprin	99NL-F x US26D No Substitutions
Threshold	Zero (or) Approved Equal.	
Weather Strip	Zero (or) Approved Equal	

NOTE: (*) May not be required depending on application.

08 50 00 Windows (Exterior & Interior)

1. Where divided lites are required, specify muntins installed in insulating glass units, between the panes of glass.
2. At residential windows specify insect screens in aluminum frames, flat black. At ground floor residential windows specify security mesh in steel sash, flat black.

08 60 00 Roof Windows and Skylights

1. Skylights are not permitted unless special permission has been obtained from George Mason University. Such permission will not be granted without extremely strong reasons. If skylights are accepted by George Mason University, specify continuous inspection of skylight flashing during installation.

08 71 00 Hardware

1. The following hardware for the types of buildings indicated shall be provided.

ITEM	MANUFACTURER	MODEL NO. ACADEMIC BUILDINGS	MODEL NO. HOUSING FACILITIES
Butt Hinges, Interior	Stanley	FBB-179 4-1/2 USP or approved equal	FBB-179 4-1/2 USP

Butt Hinges, Exterior	Stanley	FBB-199 4-1/2 US32D or Approved Equal	FBB-199 4-1/2 US32D
Continuous Hinges	Roton or Zero	Continuous (to suit application)	
Locksets & Latch Sets	Best	93K Series	
Key Cylinders	Best	7 pin	
Flush Bolts	Ives	457-B26D or Approved Equal	457-B26D
Exit Devices	Von Duprin	99x990NL x US26D 1103 x 17	99 Series 1100 Series
Removable Mullions	Yale	M100 Series	M100 Series
Door Closers	LCN	4040 x Sprayed Alum.	4040 Series
Door Stops / Holders	Glynn - Johnson	500 Series Non H. O.	500 Series Non H. O.
Wall Bumpers	Ives	407 - 1/2 x B26D or Approved Equal	407 - 1/2 x B26D
Push Plates	Rockwood	70 3-1/2 x 15 US26D	70 3-1/2 x 15 USD26D
Pull Plates	Rockwood	123 x 73 3-1/2 x 15	123 x 73 3-12 x 15
Mop Plates	Rockwood	18-8-inches	18-8-inches
Kick Plates	Rockwood or Approved Equal	18-12-inches	18-12-inches
Silencers	Glynn-Johnson or Approved Equal	No. 64	No. 64

2. Specify and schedule a hardware set for each door opening in the building. Specifying hardware by allowance is prohibited.
3. Specify finish hardware with 626, Satin Chrome (US26D) finish, with the exception of sprayed aluminum finish on door closers. Specify Protection Plates, Push, and Pulls with 630, Stainless Steel (US32) finish. Specify aluminum items to be finished to match predominant adjacent material, and seals to coordinate with frame color.
4. Obtain George Mason University approval to use hardware not listed below.
5. In addition to these hardware requirements, see those for automatic door openers.
6. Require written guarantee from hardware manufacturers as follows:

    Locksets: Five (5) years

    Exit Devices: Five (5) years

    Closers: Ten (10) years

Electronic closers: Two (2) years.

All other hardware: Two (2) years.

7. Locksets and latches shall be Best 9K extra-heavy-duty cylindrical with Best 7-pin interchangeable core to match existing product throughout the Campus. Lockset and Cores to be of the same manufacturer to maintain complete lockset warranty. Locks to have solid shank with no opening for access to keyed lever keeper. Lock chassis must be through-bolted outside of the lock chassis prep to prevent rotation of chassis after installation. Lock manufacturer shall provide a five (5) year warranty, in writing, to the Owner, along with three copies of the lock service manual. Strikes shall be 16 gauge curved brass, bronze or stainless steel with a 1-inches deep box construction, and have sufficient length to clear trim and protect clothing. Specify lever handles on all doors.

   Product: Best 93K7 15D x 626

   Cores / Cylinders: Best 7-Pin with "Premium" Keyway to match existing system.

8. Hinges: Outswinging exterior doors shall have non-removable pin hinges (NRP). Exterior hinges to be brass, bronze or stainless steel material. Hinges shall be extra heavy weight for high frequency openings or doors over 36-inches in width. All hinge open widths shall be 4.5-inches minimum, but of sufficient size to permit door to swing 180. Furnish hinges with three knuckles and concealed bearing. Plain bearing shall not be permitted.

9. Furnish 3 hinges per leaf to 7 foot 6 inch height. Add one for each additional 30 inches in height or fraction thereof.

10. Exit Devices: Furnish all sets at wood doors with sex bolts unless otherwise specified in Wood Door Section/ Hardware blocking. Trim of exit devices to match trim of locksets. Provide rim devices at single doors. At pairs of doors with low visibility provide two rim devices with key removable mullion. At doors with high visibility, provide concealed vertical rod devices. Depending on location, at exterior openings provide two surface vertical rod devices or two rim devices with key removable mullions.

    Product: Exit Device Series: Von Duprin 99 series rim with cylinder dogging (CD) at standard non rated hollow metal and wood doors openings. Omit CD at fire rated doors.

    Product: Exit Device Series: Von Duprin 99 series rim with cylinder dogging (CD) at narrow stile aluminum door openings. Omit CD at fire rated doors.

    Product: Heavy Duty Lever Trim: Von Duprin 99 series rim. Vandal Resistant Lever Trim.

11. Specify exit-only devices at exterior doors which are not the main access point to the building. Indicate that these doors are to be connected to the fire alarm system. Indicate that such doors shall be clearly marked on the inside that opening the door will sound an alarm.

12. Concealed vertical rod exit devices are not permitted. Specify only those exit devices and manufacturers listed below.

13. At pairs of doors specify rim-type exit devices latching into removable mullion or into strike on second leaf. When no removable mullion is provided, specify a door coordinator.

14. Specify removable mullions at pairs of entry doors.

    Product: Keyed Removable Mullions: Von Duprin 99 series rim. Mullion shall be furnished with a cylinder keyed into the existing GMU keying system.

15. Surface Door Closers: Full rack and pinion type with removable non-ferrous cover. Provide sex bolts at all wood doors unless otherwise specified in Wood Door Section/Hardware blocking. Place closers inside building, stairs, and rooms. Closers shall be non-handed, non-sized and adjustable. All closers shall be R14 die cast aluminum alloy material.

    Product: Closer Series: Ryobi D-4550 / D-4551 Forged Heavy Duty Arm (HDA). Provide multi-size 1 through 6 at all doors rated or not.

Product: Exterior and high frequency openings to receive D-4550 Series with HDA.

Product: Interior and low frequency openings to receive D-3551 Series with HDA.

Flush transom offset brackets shall be used where parallel arm closers are listed for doors with fixed panels over.

Drop brackets are required at narrow head rails.

Set exterior doors closers to have 8.5 lbs maximum pressure to open, interior non-rated at 5 lbs , rated openings at 12 lbs. and meet all ADA requirements.

All closers shall come standard with barrier free feature and all weather fluid.

16. Floor type or overhead concealed door closers are not permitted.
17. Kickplates: Provide with four beveled edges, 10 inches high by width less 2 inches on single doors and 1 inch on pairs of doors unless otherwise specified.. Furnish Type "A" screws to match finish.
18. Seals: All seals shall be finished to match adjacent frame color. Seals shall be furnished as listed in schedule. Material shall be UL listed for labeled openings.
19. Wall stops or floor stops are not permitted.
20. Screws: All exposed screws shall be Phillips head.
21. Silencers: Furnish silencers on all interior frames, 3 for single doors, 2 for pairs. Omit where any type of seals occur.
22. Specify keyed locksets and cylinders to be provided with Best brass construction cores and keys during the construction period. Plastic construction cores will not be permitted. Construction control and operating keys and core shall not be part of Mason’s permanent Best keying system or furnished on the same keyway (or key section) as Mason’s permanent Best keying system. Permanent Best cores and keys shall be prepared according to the approved keying schedule and will be furnished to George Mason University by the local Best factory representative prior to occupancy.
23. Specify cylinders to be Best 7-pin, interchangeable core “Premium” Keyway to match existing key system. (Note, “WC” keyway at Fairfax and Arlington Campus and “WH” keyway at Prince William Campus.)
24. Specify that permanent Best keys and cores shall be stamped with the applicable key mark for identification. These visual key control marks or codes will not include the actual key cuts. All permanent keys and key blanks shall be stamped "GMU - Unlawful to Duplicate."
25. Furnish keys in the following quantities:

    Grand Masterkeys: Zero (0) each

    Masterkeys per set: Zero (0) each

    Change Keys each keyed core: Four (4) each

    Permanent Control key: Zero (0) each

    Construction Keys: Nine (9) each

    Construction Control key: One (1) each

    Key blanks: Two hundred (200)
26. Special Note: All Grand Masterkeys, Masterkeys, and other security keys shall be “cut” by George Mason University Security Department. Furnish one hundred (100) extra key blanks in the appropriate GMK & MK keyway for Owners use.
27. George Mason University will install permanent cores and return the construction cores to the Hardware Distributor. All Construction cores and keys remain the property of the Hardware Distributor.

28. Require that the Contractor submit three copies of the detailed schedule indicating clearly how the University's final instructions on keying of locks has been fulfilled.

29. Typical Door Schedules are as follows:

    Non-Public Toilet:

    1-1/2 pr. Butts
    1 - Stanley FBB179 X US26D
    1 - Privacy Set Best 93K Series w/ privacy lock
    1 - Door Closer LCN 4041 X Alum.
    Silencers GJ-64

    Storage Room, Custodial Closets

    Note: Same set shall apply to Mechanical and Electrical Rooms. However, lever trim shall not be used (knurled knob trim required).
    1-1/2 pr. Butts Stanley FBB179 X US26D
    1 Lockset Best 93K Series
    Silencers GJ-64

    Office Doors

    1-1/2 pr. Butts Stanley FBB179 X US26D
    1 Lockset Best 93K Series
    1 Door Closer LCN 4041 X Alum. (optional)
    Silencers GJ-64

    Public Toilet

    1-1/2 pr. Butts Stanley FBB179 X US26D
    1 Pull Plate
    1 Push Plate
    I Kickplate
    1 Mop Plate
    I Closer LCN 4041
    Silencers GJ-64

    Classrooms, Laboratories

    1-1/2PR. Butts Stanley FBB179 X US26D
    1 - Lockset Best 93K Series
    1 - Closer LCN 4041 (optional)
    Silencers GJ-64

30. Elevator and Fire Alarm Panel Keys

    Specify locking hardware for elevators and fire alarm panels such that it can be operated with existing keys.

31. Furnish one (1) Key Cabinet similar to Lund 1205A , with capacity of one (1) hook per cylinder, plus an additional one hundred (100) percent expansion.

32. Hardware installation locations:

    Bottom Hinge: 10 inches from door bottom to bottom of hinge.

    Top Hinge: 5 inches from door top to top of hinge.

    Center Hinge: Center between top and bottom hinge.

    Extra Hinge: 6 inches from bottom of top hinge to top of extra hinge.

    Lockset/Latchset: 38 inches from finished floor to center of lever or knob.

    Push Bar: 44 inches from bottom of door to center of bar.

    Push Plate: 44 inches from bottom of door to center of plate.

    Pull Plate: 42 inches from bottom of door to center of pull.

    Exit Device: 39-13/16 inches from finished floor to center of pad.

Deadlock Strike: 44 inches from floor, centered.

08 80 00 Glazing

1. Specify exterior glazing to be insulating glass units consisting of clear glass with low-e coating, unless otherwise approved by the University.

08 90 00 Louvers and Vents

1. Specify fixed-drainable blade aluminum louvers unless specifically approved by the University.
2. Specify bird screen at interior of all louvers.

Division 09 - Finishes

1. Interior finishes that are extravagant or costly, or that require a high degree of maintenance, are not permitted. Likewise, finishes that require extremely high levels of workmanship or extremely close tolerances during construction are not permitted.
2. Obtain George Mason University approval of the colors of all finish materials
3. Specify the flame spread and smoke-developed requirements for each interior finish material. Require submittals to indicate the actual flame spread and smoke-developed ratings for each material.
4. Do not specify maintenance materials for finish materials.

09 30 00 Tiling

1. Quarry Tile Cleaning: Where quarry tile is specified, require the Contractor to clean the floor with Hillyard Seal 341 or approved equal. Select colors to minimize showing of dust and footprints.

09 51 00 Acoustical Ceilings

1. Specify and schedule suspended acoustical panel ceilings in lieu of gypsum board wherever possible.
2. Specify minimum 15/16-inch wide exposed runners for suspended ceiling systems.

   Product: Intermediate duty, double web, exposed grid system, equal to DX system by Donn Corporation; main tee equal to DX-24, cross tee equal to DX-422.
3. Specify standard ceiling panels not requiring special order or premium price.

   Product, General Locations: Acoustical Panel: 24 x 24 x 5/8-inch, non-directional mineral board square-edge panels, equal to Armstrong 770 or Celotex 157 Safetone. Specify moisture resistance for all panels.

   Product, Restrooms, Laboratories, Kitchens, and other Damp Locations: Ceramic-faced panels, 24 x 24 x 5/8-inch high density, resistant to moisture, steam, and chemicals, equal to Armstrong Ceramaguard 601A.
4. Do not specify concealed spline ceiling tile systems unless acoustical tiles are directly adhered to ceiling substrate, and only with George Mason University approval.
5. Detail expansion and movement control joints. Specify joint assemblies and soffit covers to minimize visual impact.

09 60 00 Flooring

1. The following are suggested floor finishes for certain space types. Except for materials noted as prohibited, actual finishes are to be selected by the A/E based on design judgment and the specific building requirements:
   - Offices: Carpet.
   - Seminar and conference rooms: Carpet.
   - Library and reading rooms: Carpet.
   - Restrooms: Ceramic tile with dark colored grout. Dark grout and ceramic tile covered base should extend up walls at least 4 inches.
   - Classrooms: Vinyl composition tile (VCT).
   - Corridors: Terrazzo or VCT. Carpet may be scheduled for upper floors in buildings where spills are not anticipated.

- Lounges: VCT unless no vending area nearby, in which case carpeting may be considered.
- Stairs: Terrazzo or rubber tile. Provide contrasting color warning stripe on first tread and at landing, either integral with stair tread material, or inset into tread material.
- Laboratories: Fluid-applied epoxy or seamless sheet vinyl. Do not specify vinyl tile.
- Entrances and Vestibules: Pedigrid/pedimat for recessed and on-surface areas (recessed preferred).
- Lobbies: Terrazzo, Ceramic Tile or VCT.
- Multi-Purpose Rooms: Wood flooring.
- Janitor's Closets: Ceramic tile with 4-inch base and dark colored grout,
- IT Closets: Static dissipative VCT,
- Food Preparation Areas: To be determined by George Mason University.
- Dining Rooms: Specify carpet tiles in lieu of broadloom carpet.

2. Detail expansion and movement control joints. Specify joint assemblies and covers to minimize visual impact and to withstand high traffic.
3. Floor treatment for exit stairways, corridors, common areas, assembly rooms, resident hall rooms and apartments shall be constructed of not less than Class I materials as tested to ASTM E648. Testing must be performed by an approved agency and each lot of carpeting procured shall be accompanied with a certified test report identifying the carpet by manufacturer and style name, and shall be representative of the current construction of the carpet. The carpet must also pass the DOC FF-1 "pill test" (CPSC 16 CFR, part 1630).
4. Floor treatment for offices and other areas not specified above shall be classified not less than Class II in accordance with ASTM E648. Testing must be performed by an approved agency and each lot of carpeting procured shall be accompanied with a certified test report identifying the carpet by manufacturer and style name, and shall be representative of the current construction of the carpet. The carpet must also pass the DOC FF-1 "pill test" (CPSC 16 CFR, Part 1630).
5. Provide details where floor coverings meet building expansion joints to ensure smooth transitions that will not present trip hazards or maintenance problems. Floor coverings shall not cover expansion joints without a transition. Pay special attention to providing a smooth, functional and attractive transition detail.

09 65 00 Resilient Flooring

1. Avoid use of fissured, ribbed or otherwise textured vinyl composition or rubber tile, except in locations where high slip resistance is required.
2. Select color and finish to make imperfections less noticeable.
3. Floor Tile: Vinyl composition, 1/8" x 12" x 12", as manufactured by Kentile, Armstrong or equal, meeting or exceeding Federal Specification #SF-T-321 B, Type 4. Colors selected shall minimize the showing of dust and/or footprints.
4. Base: Vinyl cove base, 4" or 6", as manufactured by Roppee Rubber, Johnsonite Rubber Company, Flexco, or equal, meeting or exceeding Federal Specification #SF-W-40A, Type 1.
5. Specify the type of floor sealer and wax to be used by the contractor prior to building turnover.
6. Linoleum is not permitted.

09 68 00 Carpeting

1. Specify that the Contractor is to provide a Notarized Statement from Manufacturer to the effect that all carpeting and associate materials (including padding) shall be certified to have a minimum flame spread and smoke developed rating meeting the requirements of the VUSBC.
2. Specify impervious carpet backing, such as vinyl.
3. Specify carpet to be solution-dyed.

09 70 00 Wall Finishes

1. Detail expansion and movement control joints. Specify joint assemblies and wall covers to minimize visual impact.

09 90 00 Painting and Coating

1. Specify eggshell paint in lieu of flat paint.
2. Specify a single brand of paint – e.g. Sherwin Williams (paint shop uses a Sherwin Williams paint mixing machine)
3. Specify paint colors and sheens using Sherwin Williams numbers as the basis-of-design, even if other brands are specified as permissible.
4. Specify paint and coating products with zero VOCs, including exterior paints and coatings.
5. Special paint is required for video-conferencing spaces, as determined by Campus Planning and ITU.
6. Specify paint for each use:
    - Office walls: flat
    - Corridor walls: eggshell
    - Toilet room walls and ceilings: semi-gloss
    - Kitchen walls and ceilings: semi-gloss
    - Doors and Door Frames: semi-gloss
    - Railings: gloss (currently) – will transition to DTM (Direct to Metal) paint
7. Maintenance Stock: One full can of each paint type and color per building, plus records.
8. See Division 22 for painting pipes for identification.

Division 10 - Specialties

10 11 00 Visual Display Boards

1. Specify chalkboards only when specifically requested by the University.

   Product: Vitrasite, standard black with clear anodized aluminum trim, chalk rails and track for map hooks. Provide sliding boards where space allows.

2. Typically specify dry marker boards in classrooms and conference rooms.
3. Specify tack boards in conjunction with chalk boards and marker boards.

10 14 00 Signage

1. Refer to the George Mason University Environmental Graphics Standards (TBP).
2. Provide an interior signage schedule to George Mason University for review.
3. Signage Manufacturer: New Hermes, all components: Frame: 6 x 6 inches #743-536; Braille Panel: Gray #271-226 2.220 inches x 5.930 inches; Braille: Routed 1/2-inch tall strip, Dots: 0.239-inch tall; White Gravotac Numerals 0.8-inch tall, 1/32-inch thick, Helvetica Medium; Name Panel: Red # 248-226 3.711 inches x 5.930 inches Name: 0.4-inch tall.

10 21 13 Toilet Partitions

1. Specify toilet partitions as ceiling hung or wall hung. Provide adequate structure to support partitions without sagging or warping. Specify vandal-resistant attachments.

10 26 00 Wall Protection

1. Provide stainless steel corner protection in kitchens and in back-of-house areas where carts will be used.

10 28 00 Toilet and Bath Accessories

1. Sanitary Dispensing Vendors: Rochester Midland Model J2 White Enamel Metal 14 3/4-inches w 6 1/2-inches d x 20-inches h, or approved equal.
2. Provide baby changing stations in Men's and Women's toilet rooms on the entry level of most buildings.
3. Electric Hand Dryers: N/A.
4. The following toilet and bath accessories will be provided by George Mason University, and are to be specified to be installed by the Contractor.

   Toilet Tissue Dispensers.

   Roll-Towel Dispensers.

   Soap Dispensers.

10 44 00 Fire Protection Specialties

1. Specify solid cabinet doors with a small window made of polycarbonate or other plastic glazing to verify the presence of fire extinguisher. Specify cabinet sizes to accommodate the extinguisher sizes specified. Break-glass faced fire extinguisher cabinets are not permitted.

2. Specify 5 pound ABC type extinguishers allowing for 75 feet travel distance for Class A light hazards.
3. Bottom of cabinet shall be mounted a minimum of 16” and no higher than 48” above floor.
4. Fire extinguishers cabinets shall be incorporated into all projects as required by code.
5. Fire extinguishers shall be incorporated into all projects as required by code.

Division 11 - Equipment

11 40 00 Food Service Equipment

1. Prepare specifications for food service equipment in close coordination with University food service personnel.
2. Specify that the Contractor is responsible for coordinating foodservice equipment with utility installation and with structural backing in walls and ceilings.

11 53 13 Fume Hoods

1. General

All new hoods shall meet testing criteria established by the American Society of Heating, Refrigerating, and Air Conditioning Engineers, Inc. (ASHRAE) in ANSI/ASHRAE 110-1995, "Method of Testing Performance of Laboratory Fume Hoods". All hoods, bench, distillation, or walk-in types, shall have proper aerodynamic design to minimize eddy currents and assure against air movement from the hood into the laboratory. This is accomplished by airfoil sides and an aerodynamically designed sill with a one-inch air gap between it and the hood floor. An "air by-pass" shall be present on all hoods to control the range of the face velocity as the hood sash is raised and lowered. The face velocity at any sash position should never exceed three times the "open face" velocity. It is necessary to keep the air velocities within this range to reduce eddy currents around the edges of the hood face.

2. Location
   A. All new fume hoods shall be an integral part of the laboratory design and all laboratory renovations shall also rectify improper hood locations.

   B. Fume hoods shall be located in a room so that air currents generated in the room will not interfere with the hood's ability to capture and eliminate vapors, mists, and airborne particles. Therefore, hoods shall be located as far away as possible from:

      - Doors
      - Supply air diffusers
      - Windows which can be opened
      - Heavy traffic areas
      - Other local exhaust ventilation devices

   C. Room air current velocities at the face of the hood should not exceed twenty linear feet per minute (LFM) from any source and should be as close to zero as practicable.

3. Hood Design and Construction

   A. General: In general, all fume hoods should be constructed and contain materials that will permit their planned use to be carried out safely; therefore, their intended use must be known.

   B. Ducts

      1) Ducts should be constructed of materials compatible with the chemicals being used in the hood. Circular ductwork shall be used.

      2) Ducts are to be constructed of a non-reactive stainless steel, unplasticized PVC, or have an inorganic ceramic coating. Questions about duct composition should be referred to George Mason University.

      3) Fume hoods shall not be manifolded.

4) Ductwork shall take the straightest route to the roof, minimizing bends and horizontal runs. Increased distances and bends create resistance to air flow and require larger exhaust motors. When elbows are necessary, they shall have proper center-line radius (one-and-one-half times the diameter of the ducts) to minimize eddying and resistance to air flow. All elbows shall have removable wear plates when operations will involve heavy dust concentrations. Ductwork shall not enter the blower motor on an elbow. Exhaust blower motors shall be located on the roof so that a negative pressure will be maintained in the ductwork and prevent escape of toxic material through holes and cracks in the duct.

C. Filter Housing

1) HEPA or charcoal filters are not required for most routine uses of fume hoods. Install a filter or filter housing only if specified by George Mason University. Where filters are required, the housing shall be located in the fan room or roof before the blower. The filter housing shall be located to allow for easy filter changing by the bag-in bag out technique. Exhaust fans shall be sized accordingly to handle the increased pressure drop across the filter.

D. Discharge

1) The discharge point must be at a proper height above the highest point of the roof or parapet (10-15 ft.) to reduce air streaming effects of the building. Air shall be discharged vertically with at least 3500 feet per minute stack discharge velocity. The discharge stack should be located in the prevailing downwind direction of air intake point.

2) The discharge stack shall be uncapped, straight, and cylindrical. The discharge duct shall overlap the fan ductwork 6" and have a 1" greater diameter, to provide for rain drip discharge. Deflecting weather caps are prohibited on discharge stacks, as they reduce the effective stack height, reduce air velocity, are not effective rain shields, and increase final cost.

E. Sides: Hood sidewalls shall be 3 1/2 - 6 1/2 inches wide, and shall be properly formed to present a smooth airfoil to the inflowing air. The hood interior lining shall be flush with the sides. These features shall, over the range of the hood's designed air face velocity, prevent significant eddy currents from circulating air from inside the hood through the plane of the face of the hood.

F. Sill: A radiused stainless steel sill is required. It shall be installed at the bottom of the hood opening and extend back under the sash. An open area of approximately one inch shall be present under the sill to direct air across the work surface at all sash positions.

G. Sash: The sash may be vertically or horizontally tracked. Horizontal sash hoods shall have a device to lock the sash in its tracks. Removal of the sash only is possible with special tools or keys. Glass used in the sash shall be at least 7/32" thick combination sheet. The sash shall be securely enclosed in a complete frame, welded and ground smooth at the corners. Stainless steel or a baked on epoxy coat is to be used for the sash frame. Vertical sashes shall be counter-balanced with sash weights, suspended from each side of the sash and shall be easily operated. The sash frame must be held in a stainless steel track and have plastic guides. Sashes shall be anti-guillotine.

H. Interior:

1) The interior lining of the hood must be resistant to the materials and chemicals to which it will be exposed. Stainless steel is acceptable; suitable compositions, including composition board, must be painted or coated with an impervious sealer such as epoxy paint. The selection of

resistant materials must be made through consultation with the George Mason University Environmental Health and Safety Department.

2) Use of perchloric acid, hydrofluoric acid, and radioisotopes require special consideration as detailed in those sections.

I. Exterior: Cold rolled steel shall be used for the hood exterior. All parts shall be joined together with screws to allow for dismantling and access for service. After fabrication and before final assembly, all component parts shall be given an acid, alkali and solvent resistant finish on both exterior and interior surfaces.

J. Frame: The exterior and interior walls of the hood shall be rigidly supported by a full frame.

K. Working Surface: The hood working surface shall be molded epoxy or stainless steel. It shall be recessed not less than 1/4" deep and have a raised area on all sides. The raised area across the front of the hood shall be at least three inches wide.

L. Hood Fixtures and Services: All hood services shall be specified by the user. All electric service shall be located on the exterior of the hood. Plumbing services shall be brass, chrome-plated, or acid and organic vapor resistant plastic. All fixtures shall have color coded end caps. All controls for plumbing services shall be located on the hood exterior.

M. Lighting: Sufficient lighting shall be provided by either fluorescent, halogen, LED, or incandescent light fixtures at the top exterior of the hoods. The light fixture shall be easily accessible from the outside of the hood, shall be shielded from the hood interior by a laminated or tempered glass panel, and shall be vapor sealed.

N. Air By-Pass Mechanism: All hoods shall be equipped with an air by-pass mechanism located above the hood face opening. It shall provide an effective sight-tight barrier between the user and the hood interior. By-pass louvers shall be directed upward away from the front of the hood and provide an effective barrier and deflector for flying debris from inside the hood. The by-pass shall control the face velocity as the sash is lowered. The velocity of the air at any sash position shall never exceed three times the open face velocity. The air by-pass shall begin to operate when the sash is one-third to one-half closed.

O. Plenum and Slot Arrangement: A plenum shall be located in the rear of all fume hoods. It must have at least two but no more than three slots. The lower slot shall be furnished at the working surface level and be locked at 2 to 2 1/2 inches or have the baffle removed entirely. The upper slot shall be located in the upper section of the hood. The opening shall be set at 3/8 to 1/2 inch maximum. A middle slot, if furnished, shall be fixed and have an opening no greater than 2 inches.

4. Exhaust Fans and Ductwork: See Division 15

5. Face Velocity Control System

The fume hood shall be equipped with a device to measure and monitor air flow. At a minimum, the system shall have a visual indicator of the hood face velocity. Additionally, adjustable low flow/caution alarm points with audible buzzer or alarm are recommended. The system chosen shall be approved by REHS.

6. Special Hoods

A. Perchloric Acid Hood

1) To safely contain perchloric acid, work requirements in addition to the standard design for fume hoods are specified under this section.

2) Materials of construction for the hood and ductwork shall be nonreactive, acid resistant and relatively impervious. Type 316 stainless steel, with welded joints, is preferred. Unplasticized polyvinyl chloride or inorganic ceramic coatings, such as porcelain, are acceptable.

3) All interior surfaces of the hood and ductwork shall be smooth and seamless, and constructed for easy cleaning. The work surface shall be smooth and watertight with a minimum of 1/2" dished front and sides and an integral trough at the rear to collect wash-down water. The hood shall be designed to allow easy visual inspection of all interior surfaces.

4) Ductwork and Exhaust Fans: Each perchloric acid hood shall have an individual exhaust system (i.e., individual duct to individual fan). The ductwork shall go straight from the hood to the roof with no horizontal runs or sharp turns. "Wash-down" facilities shall be built into the hood and ductwork. An air ejector system or an exhaust fan may be used. An air ejector exhaust system eliminates the possibility of acid reaction with fan components and allows for ease of cleaning. If a fan is used, the blades shall be made of acid resistant metal or a metal protected by an inorganic coating. The fan shall be lubricated with fluorocarbon type grease.

B. Hydrofluoric Acid Hoods

1) Hydrofluoric acid is a highly corrosive agent. Consequently, materials resistant to hydrofluoric acid attack shall be substituted for standard laboratory fume hood construction materials. For hydrofluoric acid, use the standard design specified for fume hoods, supplemented by the following specifications on construction and materials.

2) The hood and ductwork shall be constructed of nonreactive materials that are resistant to hydrofluoric acid attack and are relatively impervious. A Portland cement hood interior or other suitable material is recommended. The hood shall be constructed to allow easy visual inspection of all interior surfaces. A transparent plastic sash and PVC ductwork are required.

3) Ductwork and Exhaust Fans: Horizontal runs and bends in ductwork must be kept to a minimum. The motor and blower housing shall not have exposed metallic parts.

C. Radioisotope Hoods

In addition to meeting the standard design specifications for fume hoods, the interior of all radioisotope hoods shall be stainless steel or molded epoxy resin and must form a smooth integral unit. All interior screws shall be countersunk and joints sealed and smooth for ease of decontamination.

11 53 19 Sterilizers (Autoclaves)

1. Install a floor drain capable of handling discharge under all autoclaves.
2. Install a stainless steel drip pan under every autoclave with an opening for the floor drain. This opening is to be sealed around the edges to prevent liquids from getting between the pan and the floor.
3. Provide a fused electrical disconnect within 3' of autoclave.

11 53 33 Emergency Safety Appliances

Eyewash Units:

1. Install eyewash units at or near sinks within the hazardous operations space. Such spaces include wet laboratories, areas where dust is generated, darkrooms and other areas where liquid chemicals are used or handled. Handheld hose type units providing a soft spray of 3-7 gpm at a pressure of 30 pounds per square inch are recommended. These may be mounted bench or on the side of the bench or wall, and should be readily accessible and located in a high area or near the main door. Wall mounted units, pedestal-mounted units; eye/face wash units combination safety shower/eyewash units must provide a soft spray of 3-7 gpm at 30 pounds per square inch of pressure.

2. All eyewash units must flush both eyes simultaneously, the flow must remain on without the use of the operator's hands, the unit must remain activated until intentionally cut off and the nozzles must be protected from airborne contaminants.

3. A sign must be posted to identify the location of the eyewash unit and the area behind or around the eyewash unit must be painted with a bright color. Eyewash units for non-ADA compliant units should be installed between 2'-9" and 3'-9" from the floor. For ADA compliant stations, for dimension references CABO ANSI A117.1 standards for drinking fountains shall be followed. However, the appliance shall be eyewash units.

Safety Showers:

1. Install safety showers in a conspicuous location within the room or space they serve. Safety showers in corridors should be recessed into the corridor wall as much as possible to avoid pedestrian traffic interference and can serve several laboratories or rooms. Install safety showers in locations that are clearly marked and accessible at all times.

2. Install safety showers so that the center of the shower head is at least 25" from the nearest wall, bench or furnishing and at a safe distance away from electrical equipment or outlets. The base of the shower must be between 6'-10" and 8' above the floor. The shower head should be a deluge-type head, and should be made of plated brass or plastic. The safety shower unit be capable of providing a flow of 30-50 gallons of water per minute at 30 pounds per square inch of pressure. Provide a floor drain at the shower location capable of handling the same amount of water as the shower head and piped to the applicable drainage system.

3. Safety shower activating valves are to be operated by pulling a chain, a cord attached to die valve lever, an 8 inch minimum diameter ring or a triangle connected by a chain or cord to the lever. The lowest point of the ring, triangle or cord should be located no more than 48" from the floor for frontal approach and no more than 54" from the floor for a side approach, and should run within 1-2 inches of a wall or bench. Safety shower activating valves are to be quick-opening, self-closing globe valves. A shut off valve accessible via a 6 foot ladder is to be installed for each shower head.

4. A sign must be posted to identify the location of the safety shower, and the area behind or around the safety shower must be painted with a bright color. Exterior safety showers and water supply lines must be protected from freezing.

5. Installation and operation of safety showers and eyewash units must comply with ANSI Z358.1-1990.

Division 12 - Furnishings

12 20 00 Window Treatments

1. Specify manually-operated shades unless written approval is obtained from the University.

12 35 53 Laboratory Casework

1. Specify doors and drawer fronts of laboratory casework to be solid wood, clear of defects and discoloration. Specify that casework bodies are to be constructed of steel with powder-coat or baked enamel finish.
2. Specify that a full-scale mock-up of laboratory casework is required prior to fabrication of casework to be delivered to the site.
3. There is a Commonwealth contract for lab casework.

12 48 13 Entrance Floor Mats and Frames

1. Specify recessed entrance walk off mats that can be easily picked up and moved for cleaning. Do not specify entrance grids with carpet inserts.

   Product: Construction Specialties, Inc., Pedigrid.

12 50 00 Furniture

1. Specify that the Contractor shall coordinate the installation of furniture and furnishings with the installation of utilities.

12 61 00 Fixed Audience Seating

1. Fixed seating shall be included in the contract documents.

12 92 00 Site Furnishings

1. Benches for Academic and Residential Zones: Victor Stanley (Dunkirk, MD) Steelsites RB Series 72-inches or 96-inches in “VS Green” (lengths can vary depending on location).
2. Benches for Natural and Residential Zones: Victor Stanley Production Series Model PRSNA-10 in 72-inches in “VS Green” with “Maple” Recycled Plastic Slats.
3. Fairfax Campus Bench: Custom Structures, Inc., P18S (Pullman Series w/o back)
4. Arlington Campus Bench: Victor Stanley, Inc., “Dunkirk”.
5. Prince William Campus Bench: Custom Structures, Inc., P18S (Pullman Series w/o back)
6. Benches: Steelsites RB Series: Back with arms, RB-26; Back without arms, PRNSNA – 127; Backless, RB-12.
7. Trash Receptacles and Recycling Bins for Academic and Residential Zones: Victor Stanley Steelsites RB Series RB-36 in “VS Green” with Standard Tapered Formed Lid.
8. Trash Receptacles: Victor Stanley S-42, Ironsites Bethesda Series or equal 36 gallon litter receptacle with 3/8-inch solid steel bars, standard tapered spun-steel lid, 36 gal high density plastic liner, VS Green color. See Part V, Standard Details.
9. Trash Receptacles and Recycling Bins for Natural and Residential Zones:

- Victor Stanley GreenSites Series RTH-36 in “VS Green” with “Maple” Recycled Plastic Slats
- Wausau Tile (Rothschild, WI) MF3211 in “MF Green” or “MF Yellow”
- Fibrex (Suffolk, VA) Beveled Flat Top receptacle F9132 32-gallon with recycled plastic slats in “Cedar” and lid in “Yellow”
- Fibrex Sloped Top Receptacle S9232 32-gallon capacity with recycled plastic slats in “Cedar” and lid in “Yellow”

10. Trash Receptacles at Parking Lots: Parkside Receptacles Landscape series, WR-34 with security chain, green.
11. Litter Receptacles: Steelsites RB Series 36 Gallon Capacity, RB-36.
12. Bike Racks: Victor Stanley Prairie Series BK-6 in “VS Green” (to be replaced by: Secure Site by Victor Stanley, Cycle Sentry Series, model BRWS-101, in “VS Green”), size based on capacity required.
13. Ash Urns located near designated seating areas and outdoor smoking areas: Creative Pipe (Rancho Mirage, CA) SmokeSnuffer SS-8-PC-SS-C 8-inch Ash Urn with Cigarette Graphic. Color should be RAL 6001 or RAL 6002, based on a sample viewed before color selection is made.
14. Ash Urns: Provided by University.
15. Kiosks:
    - Classic Recreation Systems (Arizona) Triangle Kiosk
    - The Table and Ticket Company (West Chicago, IL) Non-illuminated Kiosks
    - Poligon Three-Column Kiosk (Holland, MI)
16. Picnic Tables (umbrella hole and guide (no less than 2” in diameter with plastic ring) to be provided in all tables):
    - Standard Picnic Tables: Victor Stanley, Steelsites Series: Round, RND-363; Square, IPR-48; Rectangular, FRST-6 in “VS Green”.
    - Accessible Picnic Tables (at least one in every grouping, number to be determined by specific situation as approved by Mason): Victor Stanley, Steelsites Series: Round, RND-ACS-2 in “VS Green” – with post mounted in concrete.
17. Bollards: See Division 03 for concrete bollards and Division 05 for metal bollards.

Division 13 – Special Construction

13 34 00 Fabricated Engineered Structures

1. Specifications for pre-engineered building shall include complete structural requirements including:

   Wind load both horizontal and uplift

   Snow load

   Floor loading

   Mechanical equipment loads

2. Require that the Contractor submit written certification prepared and signed by a Professional Engineer, registered to practice in the Commonwealth of Virginia, verifying that building design meets specified loading requirements and codes of authorities having jurisdiction.

3. Trailer structures must meet applicable codes for industrial facilities.

4. Bike Shelters: MSSMedia will furnish and install bike shelters with bikeracks. Specify that the Contractor provide the required electric service to to the shelter location and provide the hardscape surface.

13 40 00 Storage Tanks

1. All Installations, Modifications and Upgrades of Underground Storage Tank (UST) Systems shall be done in accordance with the UST regulations.

2. Obtain University approval for using steel or fiberglass tanks in a project. Specify anchors, cathodic protection, and leak detection in accordance with tank manufacturer’s written instructions. Obtain University approval for anchor system and tank beds.

Division 14 – Conveying Equipment

14 24 00 Hydraulic Elevators

1. See the Construction and Professional Services Manual (CPSM) section 6.14.
2. Manufacturers providing equipment to George Mason University shall permit maintenance by the University's conveying equipment service contractor. The following are George Mason University approved elevator manufacturers:

   Thyssen/Krupp

   Schindler

   Kone
3. All key switches used in the hallway or inside the elevator should be on Mason's master key system. An exception is the emergency fire key which shall be Chicago Key Way H2389. Twelve copies of the key shall be provided to the GMU Physical Plant for distribution to the appropriate department(s).

14 42 00 Platform Lifts

1. Chairlifts shall require keys for operation.

DIVISION 21 - FIRE SUPPRESSION

21 00 00 Fire Suppression General Requirements

1. At a minimum, follow the requirements set forth in the governing plumbing codes and their referenced standards and regulations.
    - 2009 Virginia Uniform Statewide Building Code (IBC),
    - ASME A17.1, Safety Code for Elevators and Escalators,
    - 2008 International Electrical Code,
    - 2009 Virginia Fire Prevention Code (IFC),
    - National Fire Protection Association (NFPA),
        - NFPA 13, Standard for the Installation of Sprinkler Systems,
        - NFPA 13R, Standard for the Installation of Sprinkler Systems in Low-Rise Residential Occupancies,
        - NFPA 14, Standard for the Installation of Standpipe and Hose Systems
        - NFPA 20, Standard for the Installation of Stationary Pumps for Fire Protection,
        - NFPA 25,Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems,
        - NFPA 45, Standard for Fire Protection for Laboratories Using Chemicals,
        - NFPA 2001, Standard on Clean Agent Fire Extinguishing Systems,
    - Factory Mutual Global
        - Property Loss Prevention Data Sheet 3-26 “Fire Protection Water Demand for Nonstorage Sprinklered Properties,”
    - Bureau of Capital Outlay Management (BCOM) Construction and Professional Services Manual.
2. Design fire protection systems in accordance with governing codes and approved by the authority having jurisdiction. Factory Mutual Global Standards specified herein shall be met beyond the applicable code. These requirements will be reviewed case by case for each project and the Consultant will be instructed as required by GMU Facilities.
3. All fire protection system components shall be FM Approved, including but not limited to sprinkler heads, valves, pipe, fittings, hangers, pumps, controllers, tamper switches and related specialties.
4. Any requirements specified in this design manual that may exceed the minimum requirements of the governing code shall be adhered to unless prior approval is granted by GMU.
5. Coordinate fire sprinkler/standpipe service entrance with the corresponding site utility plans. Verify all sizes and depths are coordinated.
6. Coordinate fire department connection (FDC), fire pump test header and fire hydrant locations with the corresponding site plans. Ensure any FDC is within 50 feet of a fire hydrant.
7. This Section must be coordinated with the General Conditions. Do not address items such as handling of shop drawings, maintenance manuals and other information contained in the General Conditions or written in Division 1.
8. All equipment shall be installed with sufficient walk-around room to insure proper maintenance of equipment.
9. Products and materials manufactured in the United States are preferred.

10. The A/E may specify a single manufacturer and model number to establish a basis of design, however, all specifications shall be open to equal manufacturers or vendors. Where a basis of design specification is indicated, provide at least three other qualified manufacturers or vendors.
11. Refer to Section 10 44 00 “Fire Protection Specialties” for information on fire extinguishers and fire extinguisher cabinets.
12. For all new construction, renovations and alterations, the Contractor shall mark-up the contract documents to indicate any changes in construction and installation due to field conditions or other deviations from the plans and specifications. The A/E shall take the record drawings and produce the As-Builts with a CAD file.

22 05 29 Hangers and Supports for Fire Protection Piping and Equipment

1. Provide calculations for pipeline flexibility. Anchor as needed. Conform to ASME Code for allowable stresses.
2. Hanger installation shall be in accordance with FM LPDS 2-8N and NFPA 13 requirements.
3. Seismic requirements must be considered as required.

21 05 23 General Fire Suppression Valves

1. Control Valves:
    - In all buildings with fire alarm systems, all control valves, including post indicator and wall indicator valves, shall be electrically supervised by the fire alarm panel.
    - At all locations that control valves are concealed above ceilings or behind access doors, a sign shall be provided on the ceiling below the valve or the access door indicating the location of the control valve.
    - In residential buildings, all control valves that are located in spaces accessible by the occupants of the building shall be provided with lockable tamper prevention devices and locks (that shall be specified by the University).
    - Control valves shall only be installed in corridors, stairwells, mechanical rooms, fire pump rooms and sprinkler valve rooms and shall be easily accessible. The control valves shall be accessible with the use of no more than a six foot stepladder. Provide 24” x 24” access door for valves located above inaccessible ceiling types.
    - Control valves shall not be installed, above or below ceilings in classrooms, offices, conference rooms or any dormitory living quarters.
    - Each control valve shall be supplied with a sign indicating the area of the building that is served by the valve.
2. Inspector Test Valves:
    - At all locations that inspector test valves (ITV) are concealed above ceilings or behind access doors, a sign shall be provided on the ceiling below the valve or on the access door indicating the location of the ITV.
    - Inspector test valves shall only be installed in mechanical rooms, corridors, stairwells, fire pump rooms, sprinkler valve rooms and custodial closets and shall be easily accessible. The ITV’s shall be accessible with the use of no more than a six foot stepladder.
    - Inspector test valves shall not be installed, above or below ceilings, in classrooms, offices, conference rooms or in dormitory living quarters or in any area requiring entry through a classroom, office, conference room or any dormitory living quarters.

- Inspector test valves discharge shall be piped to a drain capable of handling the discharge at full flow or to the exterior of the building.

3. Drain Valves:
    - Drain valves shall only be installed in corridors, stairwells, mechanical rooms, fire pump rooms and sprinkler valve rooms and shall be easily accessible. The drain valves shall be accessible with the use of no more than a six foot stepladder.
    - Drain valves shall not be installed, above or below ceilings, in classrooms, offices, conference rooms or in dormitory living quarters, or in any area requiring entry through a classroom, office, conference room or any dormitory living.
4. Main drains discharge shall be piped to the exterior of the building.
5. Auxiliary drain valves discharge shall be piped to a drain capable of handling the discharge at full flow or to the exterior of the building.

21 05 53 Identification for Fire Suppression Piping and Equipment

1. Utilize standard tag or placard to mark all major equipment. Tag all valves and provide valve chart for each floor.
2. Utilize standard Commonwealth of Virginia color coding for various building service piping and equipment. Mark each with name of service, direction of flow, and associated unit served where appropriate.
3. Equipment requiring electrical power shall be provided with a label indicating the electrical panel and/or motor controller feeding the equipment.
4. Plastic labels for equipment shall be multi-layer, multi-color phenolic with contact-type permanent adhesive compatible with attached substrate. Labels shall be 1/16” thick with black lettering over red background.
5. Equipment labels shall include the equipment’s name and unique drawing designation or schedule tag number.
6. Provide pre-coiled, semi-rigid labels to cover full circumference of pipe. Pressure-sensitive type markers are not acceptable.
7. Valves shall be tagged with stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers. 1 ½” diameter disk with smooth edges.
8. Valve tag material shall be brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware. Brass wire-link or beaded chain or S-hook.
9. Unless specified otherwise, comply with ASME A13.1, "Scheme for the Identification of Piping Systems," for letter size, length of color field, colors, and viewing angles of identification devices for piping.

21 11 00 Facility Fire Suppression Water Service Piping

1. A separate water service shall be provided to buildings with fire protection standpipes and sprinkler systems. Fire suppression water shall not be supplied to a building through a combined domestic water service.
2. Unless specified otherwise, fire protection water services shall not be metered.
3. Fire department connections to sprinkler and or standpipe systems shall not be flush mounted or wall mounted. Fire department connections shall be located a minimum of 25 feet from the building. This requirement is often cited by BCOM under the rationale that fire response personnel are at risk of a wall collapsing if they approach a burning building.

4. Fire department connections shall be labeled with a permanently fixed, weather resistant information placard describing the type of system served and the area of coverage.
5. Fire protection water service, below grade, 4 inch and larger:
   - Cement lined ductile iron, Class 52, AWWA C 151.
   - Mechanical joint, ductile iron fittings, AWWA C 110, ductile or gray iron standard pattern or AWWA C 153 ductile iron compact pattern.
   - AWWA C 111 rubber gaskets. ANSI Class 150 flanges.
6. Water service flexible joints: Compound, ductile-iron fitting with combination of flanged and mechanical-joint ends complying with AWWA C110 or AWWA C153. Include two gasketed ball-joint sections and one or more gasketed sleeve sections. Assemble components for offset and expansion indicated. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts. 250 psig pressure rating. Pressure containing parts shall be lined with a minimum of 15 mils of fusion bonded epoxy conforming to the applicable requirements of ANSI/AWWA C213 and shall be factory holiday tested with a 1500 volt spark test. Flexible expansion joint shall have flanged connections conforming to ANSI/AWWA A21.11/C110. Bolts and nuts shall be 316 stainless steel and gaskets shall be neoprene. Equal to EBAA Iron, Inc
7. Flanges shall be ANSI Class 150 flange adapter equal to Victaulic Style 641 for connections to flanged equipment. ANSI B16.1 dimensions.
8. Provide di-electric couplings or unions between dissimilar pipe materials.
9. Provide unions at connections to equipment.
10. Any improperly installed piping, joints or fittings or any piping that does not pass pressure testing requirements shall be removed and replaced.

21 12 00 Fire Suppression Standpipes

1. Where required by the IBC, standpipe systems shall be of the automatic wet type, Class III with 2 1/2” x 1 1/2” removable cap connection.
2. Hose cabinets may be used only for required supplemental hose valves outside of the main egress stairwells.
3. Fire department hose valves shall not be provided with hoses.

21 13 13 Wet Pipe Sprinkler Systems

1. Automatic sprinkler system calculations shall include a 10 psi safety factor to accommodate for any future deterioration or fluctuations in the water supply system.
2. A two-color plastic engraved identification card shall be provided for each sprinkler system zone indicating the hydraulic design information and secured to the respective floor control valve, zone valve or sprinkler riser.
3. All sprinkler heads should be installed using the appropriate wrench as specified by the sprinkler manufacturer. This will help to insure that the heads are installed properly without damage.
4. All steel piping shall be not less than Schedule 40 wall thickness for any pipe size.
5. The use of CPVC sprinkler pipe and fittings (e.g Blazemaster®) for any application is not acceptable and shall not be specified.
6. All sprinkler piping should be hydrostatically tested at 200 psi and should maintain that pressure without loss for 2 hours. Pressure loss should be determined by drop in gauge pressure or visual leakage.
7. Sprinkler system Hazard Category criteria shall be determined by Table 1 in FM Global Property Loss Prevention Data Sheet, 3-26.

8. For any occupancy that does not exactly match that in Table 1 or for guidance on determining what design to use from the tables, contact the FM Global Plan Review Department or GMU's FM Global servicing engineer. The densities in the table are presented only as guidelines; other factors may affect the recommended design criteria.
9. The design criteria for water density and area of coverage shall be determined by Table 2 of the FM LPDS 3-26.
10. The interior and exterior hose demand allowance and duration shall be determined by Table 3 of the FM LPDS 3-26. Interior hose stream demand shall be not less than 150 gpm and shall be taken from the hose valve nearest to the sprinkler riser supplying the system feeding the area covered. In buildings without an interior standpipe system, the interior hose stream demand may be eliminated, but included in the total hose stream demand as exterior.
11. The minimum sprinkler K-factors shall be determined by Table 4 of the FM LPDS 3-36 for the Hazard Classification.
12. The minimum end head pressure for sprinklers shall be determined by Table 5 of the FM LPDS 3-36.
13. The maximum flow velocity in any part of an automatic sprinkler system shall be 20 feet per second.
14. Test Connections - Each water flow indicator shall be provided with an Inspector's Test Connection, consisting of a test pipe of not less than 1" diameter terminating in a smooth bore corrosion resistant orifice giving a flow equivalent to one sprinkler head of the type installed on the system. Test connection shall discharge to the building exterior. The 1" control valve for the Inspector's Test Connection shall be located not more that 7' above finished floor. An alternative arrangement for the Inspector's Test Connection is the "Testmaster", manufactured by the Victaulic Corporation.
15. Final acceptance will be upon completion of the Contractor's Material and Test Certificate (Form 85A) and field examination by an FM Global representative.
16. The A/E shall provide a full head layout on the plans as required by BCOM. Also, the A/E shall include the sprinkler main and branch piping layout for the most hydraulically remote/demanding area. Pipe sizes shall be shown. Provide hydraulic summary indicating design criteria, area covered, required flow rate, end head pressure, required pressure at the riser and pressure available at the riser for each area calculated.
17. Hydraulic calculations shall be based on approved flow tests which will be performed by GMU. All hydraulic calculations shall be reviewed by Owner and Factory Mutual.
18. Hydraulic Design Submittal: In addition to the distribution of drawings specified in General Conditions, the University shall be provided with one set of shop drawings depicting the complete automatic sprinkler system. Shop drawings shall clearly identify the hydraulically remote area, and all reference nodes shall be included from the supply to and including the remote area. In addition, one complete set of hydraulic calculations, including detail and summary sheets, shall also be submitted for retention by the University.
19. Automatic Sprinkler System Submittals shall include:
    - Piping layout and sizes,
    - Location and number of sprinklers (with sprinkler identification numbers (SIN) clearly indicated on the drawing),
    - Fire department inlet connection location and configuration,
    - Location of remote area used in hydraulic calculations,
    - Hydraulic Calculations,
    - Sprinkler head types,
    - Sprinkler pipe and fittings,
    - Sprinkler control valves,
    - Any peripheral equipment - including tamper alarms, waterflow alarms, etc.
    - Occupancy Details - In order to review submitted plans to ensure adequate protection, accurate occupancy details must be provided. This would include a general description of the

area being protected and, in the case of dedicated storage areas details of the materials being stored, storage height, storage arrangement, etc. should be provided.

21 13 16 Dry Pipe Sprinkler Systems

1. Specify only galvanized pipe and fittings for dry pipe and preaction sprinkler systems.
2. Coordinate the requirements for preaction or preaction type interlocks for sprinklers in elevator machine rooms and at the tops of elevator hoist ways with GMU Fire Marshall, FM and BCOM.
   - A "preaction" sprinkler system or equivalent solenoid valve assembly is required to supply sprinklers located in the elevator machine room and at the top of hoist ways.
   - The sprinkler(s) located in the hoist way pit may be wet pipe.
   - All sprinklers must have a minimum operating temperature of 250°F.
   - All control valves shall be located outside the protected area and each machine room, top of hoist way and bottom of hoist way (pit) shall have its own control valve.
   - The elevator machine room preaction valve or solenoid valve shall be activated by a fixed temperature or rate compensated heat detector with a temperature rating of 200°F.
   - These same detectors shall also initiate the automatic recall and then shutdown of main power to all elevators served by the machine room.
   - Each separate elevator hoist way shall have "preaction" valve activated by a 200°F heat detector that also initiates the shutdown of main power to all elevators in the hoist way.
   - Sprinklers located in the elevator pit shall have a separate control valve and water flow alarm switch. This flow switch, in addition to providing an alarm signal, causes shutdown of elevator power to all elevators in the hoist way.
   - In lieu of a solenoid valve, a packaged, modular preaction pre-action valve package provided by major sprinkler manufacturers may be used.

21 22 00 Clean Agent Fire Extinguishing Systems

1. Design and install clean agent fire extinguishing systems in accordance with NFPA 2001.
2. Coordinate fire alarm, HVAC controls and dampers, and interface with preaction systems (if used in conjunction) with the clean agent system monitoring and activation sequences.
3. Clean agent systems shall be used only as a first response extinguishing system to preserve vital or costly equipment in the hazard zone. They shall not be used as a substitution to a required automatic wet sprinkler system (or pre-action system) designed and installed in accordance with NFPA 13.

21 13 13 Electric Drive Centrifugal Fire Pumps

1. Buildings less than three stories (i.e. low rise) should not require fire pumps.
2. The installation of a fire pump is prohibited to reduce interior sprinkler piping sizing is prohibited when street pressure alone with appropriately sized mains and branches will provide specified water density over the coverage area.
3. Fire pumps shall be installed on the discharge side of water service entry backflow preventor(s).

21 34 00 Pressure Maintenance Pumps

1. Fire pumps shall be provided with a properly sized pressure maintenance (jockey) pump. The jockey pump stop setpoint shall be equal to the fire pump churn pressure plus the minimum static supply pressure.
2. The jockey pump start set point shall be at least 10 psi less than the jockey pump stop setpoint.
3. The fire pump start setpoint shall be 5 psi less than the jockey pump start point.

21 39 00 Controllers for Fire Pump Drivers

1. The power supply for electric fire pumps shall be connected before the building's main electrical disconnect. Power supply protection devises (fuses or circuit breakers) shall not be installed in the power supply circuits ahead of the fire pump feeder circuits. The power supply to the controller shall be run in such a way as to ensure that it would not be exposed to fire in the building.
2. Electric fire pumps shall be fed from emergency power through an automatic transfer switch.

Division 22 – Plumbing

22 00 00 Plumbing General Requirements

1. Products and materials manufactured in the United States are preferred.
2. The A/E may specify a single manufacturer and model number to establish a basis of design, however, all specifications shall be open to equal manufacturers or vendors. Where a basis of design specification is indicated, provide at least three other qualified manufacturers or vendors.

22 05 16 Expansion Fittings and Loops for Plumbing Piping

1. Copper Tube Applications: Telescoping housing and guides with fully enclosed stainless steel bellows for compensation of axial expansion of copper tubing for hot water systems and similar system subject to differential temperatures.
    - Bellows: Laminated ASTM A 240 Type 321 stainless steel.
    - End connections: ASTM B 88 copper tube male or female tube ends for sweat solder connection.
    - Housing and Guides: ASTM A 240 Type 304 stainless steel. Rated for 3 inches axial compression and 0.5 inch extension.
2. Install Victaulic in-line expansion joints in water piping systems that are installed in enclosures where pipe bends or loops cannot be applied:
    - 2" through 6" sizes: Packless, gasketed, slip-type expansion joint with grooved end telescoping body, for installation with Style 07 rigid couplings, providing up to 3" axial end movement with pressure rating up to 350 psi. Victaulic Style 150 Mover®.
    - 3/4" and larger sizes: Combination of grooved end short nipples and Style 75 or 77 flexible couplings joined in tandem to provide increased expansion. Joint movement and expansion capabilities determined by number of couplings/nipples used in the joint. Pressure rating dependent on size and style of flexible couplings used. Victaulic Style 155.

22 05 17 Sleeves and Sleeve Seals for Plumbing Piping

1. Do not use sheet metal sleeves through outside walls. Sleeves shall be pipe conforming to ASTM A 120. At outside walls provide "leak plate" and install "Linkseal".

22 05 19 Meters and Gages

1. Pressure Gauges: Direct-Mounted, Metal-Case, Dial-Type Pressure Gages: ASME B40.100. Liquid-filled case, cast aluminum, 4-1/2-inch nominal diameter. Bourdon tube pressure element. Pressure Connection: Brass, with NPS 1/4, ASME B1.20.1 pipe threads and bottom-outlet type or back-outlet type. Movement: Mechanical, with link to pressure element and connection to pointer. Dial: Non-reflective aluminum with permanently etched scale markings graduated in psi and kPa. Pointer: Dark-colored metal. Window: Plastic. Ring: Stainless steel. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range. Scale Range for Water Service Piping: 0 to 100 psi.

    Snubbers: ASME B40.100, brass; with NPS 1/4 ASME B1.20.1 pipe threads and piston-type surge-dampening device. Include extension for use on insulated piping.

    Isolation Valves: Brass ball with NPS 1/4 (DN 8) ASME B1.20.1 pipe threads.
2. Thermometers: Cast aluminum, liquid-in-glass: ASME B40.200, 7-inch nominal size aluminum case with adjustable angle mount. Glass tube with magnifying lens and blue or red organic liquid. Non-

reflective aluminum background with etched scale markings graduated in ºF and ºC. Plastic window. Aluminum, brass or stainless steel stem. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range. Connector: 1-1/4 inches, with ASME B1.1 screw threads. Scale Range for Domestic Hot-Water Piping: 0 to 250 ºF.

3. Direct-Mounted, Light-Activated Thermometers: ASME B40.200. Metal case, 7-inch nominal size with adjustable angle mount. Glass passivated thermistor. Digital LCD display in ºF and ºC (selectable). Aluminum stem. Accuracy: Plus or minus 2 ºF (1 ºC). Connector: 1-1/4 inches, with ASME B1.1 screw threads.
4. Thermowells: Standard: ASME B40.200. Pressure-tight, socket-type fitting made for insertion into piping tee fitting. Brass construction. Stepped shank. External Threads: NPS 1/2, NPS 3/4, or NPS 1,) ASME B1.20.1 pipe threads. Internal Threads: 1-1/4 inches, with ASME B1.1 screw threads. Bore: Diameter required to match thermometer bulb or stem. Insertion Length: Length required to match thermometer bulb or stem. Lagging Extension: Include on thermowells for insulated piping and tubing. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

22 05 53 Identification for Plumbing Piping and Equipment

1. Utilize standard tag or placard to mark all major equipment. Tag all valves and provide valve chart for each floor.
2. Utilize standard Commonwealth of Virginia color coding for various building service piping and equipment. Mark each with name of service, direction of flow, and associated unit served where appropriate.
3. Equipment requiring electrical power shall be provided with a label indicating the electrical panel and/or motor controller feeding the equipment.
4. Plastic labels for equipment shall be multi-layer, multi-color phenolic with contact-type permanent adhesive compatible with attached substrate. Labels shall be 1/16” thick with white lettering over black background.
5. Equipment labels shall include the equipment’s name and unique drawing designation or schedule tag number.
6. Provide pre-coiled, semi-rigid labels to cover full circumference of pipe. Pressure-sensitive type markers are not acceptable.
7. Valves shall be tagged with stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers. 1 ½” diameter disk with smooth edges.
8. Valve tag material shall be brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware. Brass wire-link or beaded chain or S-hook.
9. Unless specified otherwise, comply with ASME A13.1, "Scheme for the Identification of Piping Systems," for letter size, length of color field, colors, and viewing angles of identification devices for piping.

22 07 00 Plumbing Insulation

1. All insulation shall conform to Energy Code requirements.
2. Staples are not acceptable for insulation installation.
3. All "raw" ends of insulation shall be sealed.
4. Insulation specification shall describe what systems and services are to be insulated.
5. Condensate drains shall have 1" of insulation.

22 11 16 Domestic Water Piping

1. Domestic water service, below grade, 3 inch and smaller:
   - Seamless copper water tube, Type K, ASTM B 88 with ASME B16.18 cast-copper alloy or ASME B16.22 wrought copper solder joint fittings.
   - Copper brazed joints, AWS A5.8 BCuP series.
   - Cast copper alloy unions, hexagonal stock with ball and socket solder ends, ASME B16.18.
2. Domestic water service, below grade, 4 inch and larger:
   - Cement lined ductile iron, Class 52, AWWA C 151.
   - Mechanical joint, ductile iron fittings, AWWA C 110, ductile or gray iron standard pattern or AWWA C 153 ductile iron compact pattern.
   - AWWA C 111 rubber gaskets. ANSI Class 150 flanges.
3. Water service flexible joints: Compound, ductile-iron fitting with combination of flanged and mechanical-joint ends complying with AWWA C110 or AWWA C153. Include two gasketed ball-joint sections and one or more gasketed sleeve sections. Assemble components for offset and expansion indicated. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts. 250 psig pressure rating. Pressure containing parts shall be lined with a minimum of 15 mils of fusion bonded epoxy conforming to the applicable requirements of ANSI/AWWA C213 and shall be factory holiday tested with a 1500 volt spark test. Flexible expansion joint shall have flanged connections conforming to ANSI/AWWA A21.11/C110. Bolts and nuts shall be 316 stainless steel and gaskets shall be neoprene. Equal to EBAA Iron, Inc
4. Domestic water, above grade:
   - Seamless copper water tube, drawn temper, Type L, ASTM B 88.
   - Fittings and joints for 2 1/2” and smaller shall be solder joint wrought copper, ASME B16.22
   - Viega ProPress system with EPDM seal may be used in lieu of solder joints 2 1/2” and smaller.
   - Fittings and joints for 3” and larger shall be ductile iron coupling with copper alkyd enamel paint coating, ASTM A-536. Grade “E” EPDM elastomer gasket, ASTM D-2000. Equal to Victaulic Style 606 coupling. ASTM B-75 copper alloy fittings.
   - ASTM B-584 grooved end cast bronze fittings for 6” pipe size.
5. Soldered joints shall be ASTM B-32 solder filler material, Alloy Sb5 “95/5.” Use ASTM B-813 liquid or paste flux. Soldering procedures shall comply with ASTM B-828.
6. Unions shall be cast copper alloy, hexagonal stock with ball-and-socket joint, solder joint ends. ASME B16.18.
7. Flanges shall be ANSI Class 150 flange adapter equal to Victaulic Style 641 for connections to flanged equipment. ANSI B16.1 dimensions.
8. All domestic hot water recirculating systems shall be provided with balancing valves for each zone. Specifications shall require testing, adjusting and balancing of each domestic hot water recirculating zone by a certified TAB contractor. Coordinate with Division 23 specifications.
9. Domestic water systems shall be cleaned and disinfected in accordance with the authority having jurisdiction (AHJ). A water treatment specialist shall be utilized to prepare a cleaning and disinfection plan which shall include detailed procedures; to supervise all cleaning and disinfection activities on site; and furnish all required cleaning and disinfecting chemicals. A written report for each system shall be provided by the water treatment specialist, certifying that each system has been cleaned and

disinfected in accordance with the AHJ and the written cleaning and flushing plan. The water treatment specialist shall be responsible for testing the water quality of each system during the cleaning and disinfection process. The reports shall include all water sample test reports.

22 13 16 Sanitary Waste and Vent Piping

1. Do not use plastic pipe materials above ground.
2. Sanitary Waste and Vent, Below Grade: Hub-and-spigot, cast-iron soil pipe and fittings.
   - Pipe: ASTM A 74, Service weight.
   - Fittings: ASTM A 74, Service weight, DWV pattern.
   - Gaskets: ASTM C 564, rubber.
3. Sanitary Waste and Vent, Above Grade: Hubless cast iron soil pipe and fittings.
   - Pipe: ASTM A888 (CISPI 301), Service weight
   - Fittings: ASTM A888 (CISPI 301), Service weight, DWV pattern.
   - Couplings: ASTM C1540 Heavy duty shielded no-hub coupling. ASTM C564 gasket. Bearing FM 1680 Approval Mark.
4. Galvanized Steel Pipe and Fittings (Sanitary Vent only)
   - Pipe: ASTM A 53/A 53M, Type E or S, Grade A or B, Standard Weight or Schedule 40, galvanized. Include ends matching joining method.
   - Fittings: ASME B16.12, galvanized, threaded, cast-iron drainage pattern.
5. Copper Tube and Fittings (Sanitary Waste and Vent)
   - Tube: ASTM B 88, Type L, copper water tube, drawn temper.
   - Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.
6. Sanitary Waste and Storm Drainage, Force Main: Galvanized Steel Pipe and Fittings
   - Pipe: ASTM A 53/A 53M, Type E or S, Grade A or B, Standard Weight or Schedule 40, galvanized. Include ends matching joining method.
   - Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106, Schedule 40, galvanized, seamless steel pipe. Include ends matching joining method.
   - Unions: ASME B16.39; Class 150; hexagonal-stock body with ball-and-socket, metal-to-metal, bronze seating surface; and female threaded ends.
   - Threaded Fittings: ASME B16.4, Class 125, galvanized, standard pattern.
   - Flanges: ASME B16.1, Class 125.
   - Flanged Fittings: ASME B16.1, Class 125 galvanized.
   - Grooved-End, Steel-Piping Fittings: ASTM A 47/A 47M, galvanized, malleable-iron casting; ASTM A 106, galvanized-steel pipe; or ASTM A 536, galvanized, ductile-iron casting; with dimensions matching steel pipe.
   - Grooved-End, Steel-Piping Couplings: AWWA C606, for steel-pipe dimensions. Include ferrous housing sections, gasket suitable for water, and bolts and nuts.
   - Gate Valves: Iron gate valve, Class 125, NRS.
   - Check Valves: Iron swing check valve, Class 125, non-slam design.
7. Encase all cleanouts and valve boxes located in lawn areas in a 1’ x 1’ x 6” concrete pad.

22 14 13 Storm Drainage Piping

1. Do not use plastic pipe materials above ground.
2. Storm Drainage, Below Grade: Hub-and-spigot, cast-iron soil pipe and fittings.
   - Pipe: ASTM A 74, Service weight.
   - Fittings: ASTM A 74, Service weight, DWV pattern.
   - Gaskets: ASTM C 564, rubber.
3. Storm Drainage, Above Grade: Hubless cast iron soil pipe and fittings.
   - Pipe: ASTM A888 (CISPI 301), Service weight
   - Fittings: ASTM A888 (CISPI 301), Service weight, DWV pattern.
   - Couplings: ASTM C1540 Heavy duty shielded no-hub coupling. ASTM C564 gasket. Bearing FM 1680 Approval Mark.
4. Storm Drainage, Force Main: Galvanized Steel Pipe and Fittings
   - Pipe: ASTM A 53/A 53M, Type E or S, Grade A or B, Standard Weight or Schedule 40, galvanized. Include ends matching joining method.
   - Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106, Schedule 40, galvanized, seamless steel pipe. Include ends matching joining method.
   - Unions: ASME B16.39; Class 150; hexagonal-stock body with ball-and-socket, metal-to-metal, bronze seating surface; and female threaded ends.
   - Threaded Fittings: ASME B16.4, Class 125, galvanized, standard pattern.
   - Flanges: ASME B16.1, Class 125.
   - Flanged Fittings: ASME B16.1, Class 125 galvanized.
   - Grooved-End, Steel-Piping Fittings: ASTM A 47/A 47M, galvanized, malleable-iron casting; ASTM A 106, galvanized-steel pipe; or ASTM A 536, galvanized, ductile-iron casting; with dimensions matching steel pipe.
   - Grooved-End, Steel-Piping Couplings: AWWA C606, for steel-pipe dimensions. Include ferrous housing sections, gasket suitable for water, and bolts and nuts.
   - Gate Valves: Iron gate valve, Class 125, NRS.
   - Check Valves: Iron swing check valve, Class 125, non-slam design.
5. Encase all cleanouts located in lawn areas in a 1’ x 1’ x 6” concrete pad.

22 14 29 Sump Pumps

1. Drain openings with flood level rims that are located below the crown level of the exterior storm sewer shall be pumped. Pump systems serving subsoil/underslab drainage, critical applications, or any application serving more than one drain or multiple areas shall be provided with not less than two pumps for N+1 redundancy, and shall be on building standby power.
2. Sump pumps shall be commercial grade, submersible type, and provided with lift rail, lead-lag-alternate controls, and designed to preclude single point failure.
3. Sump pumps shall be capable of passing not less than 1/2 inch diameter solids.
4. Basins shall be industrial grade plastic sump of either high density polypropylene or fiberglass construction.

5. Elevator pit sump pumps shall be of an oil-preclusion type except that standard sump pumps may be used for electric traction elevators with no hydraulic oil lines.
6. Elevator pit sump pumps shall have a discharge capacity of 3000 gallons per hour (50 gpm) minimum.
7. The pump shall include a high water/general fault alarm to the monitored building automation system.
8. The discharge from elevator pit drains and elevator sump pumps shall spill indirectly to the sanitary drainage system though an air break into a hub drain or floor sink that is located in a mechanical room or similar approved location.

22 35 00 Domestic Water Heat Exchangers

1. Water heaters generally should be heated with HTHW when central heating systems are available. Check with GMU for specific requirements. Use 2-way, cast steel control valves as approved by GMU.
2. Preferred manufacturers include AERCO, Ace Boiler, Chemline, and Patterson-Kelly. GMU will not accept PVI as a manufacturer.
3. All water heaters shall comply with ASME Boiler and Pressure Vessel Code and shall be stamped with appropriate code symbols.
4. Oil fired water heaters shall be used only with GMU's approval.
5. HTHW - Control valve should be on the supply side for better temperature control.
6. Water heaters shall be semi-instantaneous type with pneumatically actuated control valves, with temperature control accurate over entire flow range within plus or minus 4°F.
7. Electric, oil, or gas-fired low volume storage tank type heaters may be employed only for special applications as approved by GMU, such as where HTHW is not otherwise available for the facility.
8. Double wall heat exchangers shall be provided for potable systems, single wall is acceptable for non-potable systems.
9. Heaters shall be sized and arranged to provide N+1 redundancy for the total design load.
10. HTHW supply to heaters shall be sized for full demand plus 20% allowable for future growth.
11. Hot water shall be heated to 144°F and tempered down to 124°F or general distribution by an ASSE 1017 master thermostatic mixing valve.
12. Distribution shall provide 140°F hot water for food preparation kitchens, utility fixtures, and where otherwise required.
13. Point-of use booster heaters at commercial kitchen dishwashers shall be used where water temperature above 140°F is required.
14. Point of use instantaneous water heaters is not an acceptable substitution for connection to the hot water supply and return system.
15. Hot water systems shall not use gaskets, seals or components constructed of natural rubber, which often serves as nutrient to bacteria.
16. Hot water system shall be provided with mechanical pumped circulation to maintain distribution temperatures.
17. Dead-legs shall be kept to a minimum.
18. Large water storage tanks shall be avoided in potable systems.
19. Valves and components shall be suitable for normal working temperature of 176°F to allow for systems sanitization.

20. Hot water outlet temperature shall be controlled by properly adjusted limit stops at point of use control faucets/mixing valves as required by the plumbing code.

22 40 00 Plumbing Fixtures

1. Provide fixtures that comply with the requirements of our Energy Savings Performance Contract (ESPC).
2. All plumbing fixtures must be tight fitting to walls and be neatly sealed at joint with silicone sealant.
3. Specify flushometer valve repair kits equal to 10 percent of the quantity of each type of flushometer valve installed, but no fewer than 6 of each type.
4. Specify faucet washers, cartridges and o-rings equal to 10 percent of the amount of each type and model installed, but no fewer than 6 of each type.
5. Repair parts and materials shall be factory packaged and sealed with protective covering for storage and labeled to describe the contents to cross reference to parts lists in operation and maintenance manuals.
6. Vitreous china fixtures shall be manufacturers' standard white color unless approved otherwise.
7. Faucets, flush valves, exposed fixture stops and supplies shall be polished chrome plated finish.
8. Toilets in all applications shall be 1.28 gallon per flush fixtures.
9. Urinals in all applications shall be 0.125 gallon per flush fixtures. Waterless urinals are prohibited.
10. Lavatory faucets in residential applications shall be 2.2 gallon per minute.
11. Lavatory faucets in non-residential applications shall be 0.25 gallon per minute.
12. Showers in all applications shall be 1.5 gallons per minute.
13. Supplies, Traps and Accessories
14. Supplies and Shut-Offs: Chrome plated brass stops with full turn brass stem and loose-key handle. Chrome plated escutcheon. Sweat by compression connections. Chrome plated copper supplies. Flexible elastomeric supplies are prohibited.
15. Tailpieces, Traps and Waste Arms:

    Exposed: Chromium plated cast brass with nipple and set screw escutcheons.

    Concealed: Rough cast brass or same material as pipe connected.

    Slip joints not permitted on sewer side of trap.

    Traps shall correspond to fittings on cast iron soil pipe or steel pipe respectively, and size shall be as required by connected service or fixture. Minimum trap seal shall be 2 inches.

    Provide offset tailpieces for ADA configured sinks.

16. Strainers

    Public Lavatories: Cast brass chrome plated flat grid strainer with 1 ½" x 4" 17 gauge seamless brass tailpiece, cast brass lock and coupling nut.

    Residential Lavatories: Cast brass pop up drain plug with cast brass follower. 1 1/4" x 4" 17 gauge seamless brass tailpiece, cast brass lock and coupling nut.

    Sinks: Heavy duty forged stainless steel basket strainer with 1 ½" x 4" seamless brass tailpiece, die cast clip and lock nuts.

17. Toilet Seats
18. In general, install toilet seats of the same manufacturer as the water closet fixture. An approved alternate manufacturer may be installed.

19. Description: Toilet seat for water-closet-type fixture.

    Material: Molded, solid plastic with antimicrobial agent.

    Configuration: Open front without cover for public applications. Open front with cover for residential applications.

    Size: Elongated.

    Hinge Type: SC, self-sustaining, check.

    Class: Standard commercial.

    Color: White.

20. Protective Shielding Pipe Covers: Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

21. Water-Closet Supports: Combination adjustable carrier designed for accessible or standard mounting height of wall-mounting, water-closet-type fixture. Include single or double, vertical or horizontal, hub-and-spigot or hubless waste fitting as required for piping arrangement; faceplates; couplings with gaskets; feet; and fixture bolts and hardware matching fixture. Include additional extension coupling, faceplate, and feet for installation in wide pipe space.

22. Urinal Supports: Urinal carrier with fixture support plates and coupling with seal and fixture bolts and hardware matching fixture for wall-mounting, urinal-type fixture. Include steel uprights with feet.

23. Lavatory Supports: Lavatory carrier with concealed arms and tie rod for wall-mounting, lavatory-type fixture. Include steel uprights with feet. For accessible-fixture support, include rectangular steel uprights.

24. Water closets in public applications shall be wall mounted, vitreous china, 1.28 gallon per flush, siphon jet type, with electronic hands-free flushometer, battery powered. The use of manual flushometers for public fixtures is generally discouraged, but may be approved on a case-by-case basis for non-public, non-food service areas. Configuration shall include elongated bowl and top spud flushometer connection.

25. The use of flushometers that provide dual flush volume on water closets that are designed for 1.6 GPF is NOT acceptable due to potential compromise of the trap seal under varying flush conditions, and also due to increased stoppage potential due to the reduced water volume and hydraulic depth for waste transport in the downstream piping system.

26. Water closets in private residential applications may be wall mounted or floor mounted, 1.28 gallon per flush, siphon jet type, with manual flushometer. Residential tank style toilets are generally discouraged, but may be approved on a case-by-case basis. Configuration shall include elongated bowl and top spud flushometer connection.

27. Urinals shall be wall mounted, 0.125 gpf, and of the siphon jet or blowout action type, with electronic hands free flush, battery power. Washout urinals and waterless fixtures are not permitted. The use of manual flushometers is discouraged, and may be approved only on a case-by-case basis for non-public, non-food service areas.

28. Lavatory faucets in public applications shall be cast brass construction with polished chrome finish, touch less automatic sensor operation, 0.5 gpm maximum flow rate. The sensor shall allow for automatic shut-off after 10-15 seconds of continuous discharge. The sensor shall stop discharge within one second of detecting user has moved away. Manufacturer’s warranted battery life shall be a minimum of three years. The faucet shall include am adjustable ASSE 1070-listed thermostatic mixing device set to a maximum of 110°F.

29. Specify Sloan ETF-600 electronic hand washing faucet with EL-154 transformer and ASSE 1070 thermostatic mixing valve. Substitutions shall be made only with approval of Mason.

30. Lavatory faucets in private residence units shall be cast brass construction with polished chrome finish, single lever manual operation and 2.2 gpm maximum flow rate.
31. Shower control valves shall be of the ASSE 1069 thermostatic or combination thermostatic and pressure balance type, except that shower controls that are of the pressure-balance only type will be permitted for applications where the upstream hot water supply includes an ASSE 1017 master thermostatic mixing valve assembly with continuous thermostatic protection throughout the flow range, and where there are no supplemental energy sources that could otherwise negate master thermostatic protection (e.g. heat maintenance cable).
32. Showers shall be rated for a water flow of 1.5 gpm. Maximum outlet temperature at showers shall be limited to 115°F at the individual fixture limit stop. Shower valves shall be institutional cycling type, rotating through cold to hot with an ADA compliant lever handle. Faucet trim, levers, and escutcheons shall be constructed of stainless steel or chrome plated brass, and all shower valves shall include check stops. Where hand showers are provided trim shall be substantially durable for institutional use and all hangers and slide bars shall be securely anchored to the building structure. The inlet hose serving hand-showers shall include an ASSE 1014 backflow preventer or vacuum breaker, mounted to the wall.
33. Kitchen style sinks for residential and non-residential, non-food service applications shall be commercial grade construction of 304 stainless steel, 18 gauge. Satin finish. Fully undercoated to dampen sound. Sink depth shall be 7.5” to 9” for non-ADA configuration and 6” to 6.5” for ADA configured fixtures. Comply with ANSI/ASME A112.19.3M. Coordinate sink hole quantity, spacing and configuration with specified faucet requirements. Faucets shall be cast brass construction with polished chrome finish, single lever operation with swing nozzle. 2.2 gpm maximum flow rate, include 1.5 gpm aerator, vandal resistant.
34. Kitchen sink disposal: Provide a 3/4 horsepower commercial grade disposal unit at every kitchen sink, unless directed otherwise.
35. Plumbing fixtures and fittings for laboratory furniture shall be provided by the laboratory furniture manufacturer.
36. Service sinks shall be floor mounted rectangular precast terrazzo or cast polymer mop basin with rim guard, minimum 24” x 24” dimensions. Minimum 10 inches (254 mm) high rim. Include tiling flange on sides adjacent to walls. Two handle wall mounted service sink faucet with integral vacuum breaker, hose thread outlet, pail hook and wall bracket. Grid strainer and 3 inch (DN 80) drain as provided by basin manufacturer.
37. Food service recycling spaces: Provide a hot/cold water hose station with hose rack in recycling spaces for general washdown. A cold water hose bib is not adequate. Provide a floor drain in the recycling space connected to the sanitary sewer system.

22 45 00 Emergency Plumbing Fixtures

1. Standard: ANSI Z358.1, “Emergency Eyewash and Shower Equipment.”
2. Plumbed, deck mounted eyewash unit.

   Capacity: Deliver potable water at rate not less than 0.4 gpm (1.5 L/min.) for at least 15 minutes.

   Supply Piping: NPS 1/2 (DN 15) with flow regulator and stay-open control valve.

   Control-Valve Actuator: Paddle, stay open design.

   Receptor: Not required, mount to swing over sink basin for operation.

   Drain Piping: Not required.
3. Plumbed, freestanding or wall mounted eyewash unit.

Capacity: Deliver potable water at rate not less than 0.4 gpm (1.5 L/min.) for at least 15 minutes.

Supply Piping, Exposed: NPS 1/2 (DN 15) chrome-plated brass or stainless steel with flow regulator and stay-open control valve.

Control-Valve Actuator: Paddle, stay open design.

Receptor: ABS plastic bowl.

Drain Piping: NPS 1-1/2 (DN 38) minimum, chrome-plated brass, receptor drain, P-trap, waste to wall, and wall flange complying with ASME A112.18.2.

4. Plumbed, single-shower-head horizontal, wall-mounted, vertical, ceiling-mounted, or freestanding emergency shower unit.

   Capacity: Deliver potable water at rate not less than 20 gpm for at least 15 minutes.

   Supply Piping: NPS 1 (DN 25) chrome-plated brass or stainless steel with flow regulator and stay-open control valve.

   Control-Valve Actuator: Pull rod.

   Shower Head: 8-inch (200 mm) minimum diameter, ABS plastic.

5. Plumbed, free-standing or wall mounted eye/face wash unit.

   Capacity: Deliver potable water at rate not less than 3.0 gpm (11.4 L/min.) for at least 15 minutes.

   Supply Piping, Exposed: NPS 1/2 (DN 15) chrome-plated brass or stainless steel with flow regulator and stay-open control valve.

   Control-Valve Actuator: Paddle.

   Receptor: Plastic bowl.

   Drain Piping: NPS 1-1/2 (DN 38) minimum, chrome-plated brass, receptor drain, P-trap, waste to wall, and wall flange complying with ASME A112.18.2.

6. Plumbed, deck-mounted, hand-held drench hose

   Hand held drench hoses are supplemental safety equipment only. They shall not be used as substitutes for fixed, hands-free eyewash or eye/face wash units.

   Capacity: Deliver potable water at rate not less than 3.0 gpm (11.4 L/min.) for at least 15 minutes.

   Supply Fitting: NPS 1/2 (DN 15) brass with flow regulator.

   Hose: Rubber or plastic.

   Control-Valve Actuator: Hand-held squeeze valve.

   Spray Heads: Single or twin.

7. Plumbed, freestanding or wall mounted combination emergency shower and eyewash or eye/face wash unit.

   Piping, Exposed: Chrome-plated brass or stainless steel.

   Unit Supply: NPS 1-1/4 (DN 32) minimum.

   Unit Drain: Outlet at side near bottom.

   Shower Supply: NPS 1 (DN 25) with flow regulator and stay-open control valve.

Eyewash, Eye/Face Wash Supply: NPS 1/2 (DN 15) with flow regulator and stay-open control valve.

Shower Capacity: Deliver potable water at rate not less than 20 gpm (76 L/min.) for at least 15 minutes.

Control-Valve Actuator: Pull rod.

Shower Head: 8-inch (200 mm) minimum diameter, plastic.

Eyewash Equipment: With capacity to deliver potable water at rate not less than 0.4 gpm (1.5 L/min.) or 3.0 gpm (11.4 L/min) for eye/face wash units for at least 15 minutes.

Control-Valve Actuator: Paddle or pull down lever.

Receptor: Plastic bowl.

8. Signage: Provide highly visible signage in close proximity to emergency equipment, as approved by ANSI Z358.1.
9. Emergency shower monitoring kit:
    - For use in areas not normally occupied where an individual may be isolated from other occupants and a remote signal of operation is required to alert others that first aid is necessary.
    - Micro flow switch with time delay relay installed in emergency shower supply to monitor activation of shower. Wall mounted utility controller with normally open dry contact in junction box and mounting hardware.

22 61 13 Compressed Air Piping for Laboratories

1. Compressed air distribution piping shall be OXY/MED copper tubing, ASTM B-819, Type L with BCuP series brazed joints and shall meet the quality requirements established in NFPA 99 for medical oxygen. ACR copper tubing is not allowed due to incompatibilities in pipe and fitting dimensions.

22 62 13 Vacuum Piping for Laboratories

1. Vacuum distribution piping shall be ASTM B 88 copper water tube, Type L with lead free solder joints.

22 63 13 Gas Piping for Laboratories

1. Gas distribution piping shall be OXY/MED copper tubing, ASTM B-819, Type L with BCuP series brazed joints and shall meet the quality requirements established in NFPA 99 for medical oxygen. ACR copper tubing is not allowed due to incompatibilities in pipe and fitting dimensions.

22 66 00 Chemical Waste Systems for Laboratories

1. Laboratory waste drainage and vent pipe and fittings, above grade shall be Schedule 40 fire retardant polypropylene (PPFR), ASTM D 4101. Molded fittings per manufacturer system, ASTM D F1412. Heat fusion socket assembly. DWV pattern. Heat fusion method in accordance with ASTM D 2657 and manufacturer’s written instructions.
2. Laboratory waste drainage and vent pipe and fittings, below grade shall be either Schedule 40 fire retardant polypropylene (PPFR) or non-fire retardant, ASTM D 4101. Molded fittings per manufacturer system, ASTM D F1412. Heat fusion socket assembly. DWV pattern. Heat fusion method in accordance with ASTM D 2657 and manufacturer’s written instructions.

3. In areas requiring plenum rated materials, laboratory waste and vent pipe and fittings shall be either borosilicate glass, ASTM C 1053 or Schedule 40 PVDF, ASTM F 1673.

22 67 00 Processed Water Systems for Laboratories

1. Distribution pipe material shall be pigmented polypropylene, ASTM D 4101, Type II co-polymer, SDR 11 wall thickness. Socket fusion joints using heat fusion procedures in ASTM D 2657.

Division 23 - Heating Ventilating and Air Conditioning

23 00 00 Heating, Ventilating, and Air Conditioning (HVAC)

23 05 00 Common Work Results for HVAC

1. Sleeves and Penetrations
    - Pipe penetrations through exterior walls - use schedule 40 galvanized pipe sleeve with leak plate and premanufactured “linkseal” with stainless steel hardware. Do not use sheet metal sleeves through outside walls. Sleeves shall be pipe conforming to ASTM A 120.
    - Pipe penetrations through interior masonry walls - use schedule 40 steel pipe sleeve.
    - Pipe penetrations through Floors - use schedule 40 steel pipe sleeve. Provide galvanized schedule 40 pipe or cast iron pipe, extended 2 inches above the floor and seal water tight between floor and sleeve.
    - Pipe penetrations through interior (dry-wall) partition walls - use schedule 40 steel pipe sleeve for diameters 6 inch and below; use galvanized steel sheet sleeves for diameters greater than 6 inch.
    - Duct penetrations through non-fire rated interior walls - cover opening between the wall and duct or duct insulation with sheet metal flanges of the same material and thickness as duct. Overlap openings on all four sides by at least 1-1/2 inches.
    - Protect and fire stop all penetrations in accordance with the applicable codes.
    - Coordinate fire stopping requirements with Section 078000.
2. Demolition
    - Remove all utilities, piping, ductwork, wiring, cabling, pneumatic tubing back to the active portion of the distribution system. Portions of distribution systems no longer required for service shall be removed back to the active portion of the distribution system and capped off.
    - All hangers, supports, and controls devices connected to demolished materials shall also be removed.
    - No in-active systems or system components are allowed to be abandoned in place.

23 05 16 Expansion Compensation

1. Welded piping systems:
    - Expansion compensators and expansion joints on concealed piping are not allowed. Provide expansion loops and z-bends on concealed piping.
    - Bellows type expansion joints on HTHW and MTHW piping systems are not allowed. Provide flanged slip type expansion joints on HTHW piping systems. Preferred manufacturer of slip type expansion joints is Advanced Thermal Systems, Inc.
    - Provide expansion loops and z-bends on LTHW piping systems. Bellows type expansion joints are allowed on LTHW piping systems, where approved by Mason.
2. Threaded and soldered piping systems (Piping 2 inches diameter and below):
    - Provide expansion loops, z-bends and swing joints.
    - Bellows type expansion joints are allowed on LTHW piping systems, where approved by Mason.

3. Grooved piping systems (2 1/2 diameter and greater):

   - Expansion and contraction of grooved IPS steel piping systems shall be provided with loops or bends consisting of (8) Victaulic Style 75 or 77 flexible couplings, (4) grooved end 90 degree elbows, and grooved end pipe spools provided in water systems to 230°F in accordance with Victaulic recommendations for expansion compensation.
   - Provide packless, gasketed, slip-type expansion joint with grooved end telescoping body, for installation with Style 07 rigid couplings, providing up to 3" axial end movement with pressure rating up to 350 psi. Victaulic Style 150 Mover® where pipe bends or expansion loops cannot be applied.

23 05 19 Meters and Gages

1. Specify pressure/temperature test stations, combination (PIT) plug on supply and return piping of all water coil connections not otherwise provide with pressure and temperature gages. The basis of design shall be Peterson Equipment Company (Pete's Plug).
2. Water and steam pressure gages shall be liquid filled.
3. Provide water totalizing meter with contact head for make-up water lines on hot water boilers, closed loop hydronic sytems, evaporative cooling systems and steam generating systems.
4. Refer to Section 23 09 00 "Instrumentation and Control for HVAC" for flow meters and BTU meters.
5. Use bimetallic temperature indicators in 5" diameter case. Orient gage so that special flexible joint is not needed.
6. Use materials compatible with service for pressure indicators, temperature indicators and flow meters. Use diaphragm where needed.
7. Use solar powered meters and gages.
8. HTHW – Use 316 Stainless Steel Bimetal Thermowell for all temperature indicators and Pigtail Siphon for all pressure indicators.

23 05 23 General-Duty Valves for HVAC Piping

1. Butterfly valves are not allowed.
2. Valves for High Temperature Hot Water (HTHW) and Medium Temperature Hot Water (MTHW):

   - 2″ and Larger: Shall be OS&Y type of the ASA 300 pound class, cast steel body, 13% Cr. stainless steel trim, flanged at connections to equipment, flanged at other than equipment connections, bored to match inside diameter of pipe.
   - 1-1/2″ and Smaller: Shall be full-port ball valves of ASA 600 pound class, cast steel or forged carbon steel, socket weld pattern, 13% Cr. stainless steel trim, bored to match inside diameter of pipe.
   - Gate Valves: Shall be solid wedge with stainless steel wedge or wedge faces, stainless steel seat rings. Stainless steel bonnet bushings and beveled collar on valve stem for back seating. Provide braided, teflon impregnated backing rings in a large, deep stuffing box suitable for high temperature water service. Insert at bottom of stuffing box, to serve as base for packing. Packing glands shall be non corrosive and shall have bolted gland flange with minimum of 2 eye bolts. Valves with their bypasses, need to be installed for proper operating access.

     1) Gate Valves 1-1/2″ and Smaller: Provide with a minimum of 4 packing rings.
     2) Gate Valves 2″ and Larger: Provide with a minimum of 6 packing rings.

3) Gate valves 6” and Larger: Provide with a minimum of 6 packing rings. Provide forged steel, globe valves bypass, minimum 3/4". Provide with tapered roller or ball bearing yokes and button type grease gun fittings and adapters to allow charging a reservoir with valve lubricant.

4) Gate Valves 8″ and Larger: Provide a minimum of 6 packing rings. Provide forged steel, globe valve bypass, minimum 3/4". Provide with tapered roller or ball bearing yokes, bevel gear operators, clockwise rotation to close, laminated lubricating fittings and approved grease seals.

5) Acceptable manufacturers: Crane, Jenkins, Vogt.

- Globe and Angle Valves: Shall be of the cast plug disc with bevel seat, separately screwed or pressed in disc and seat rings, long disc locknut, port opening full pipe diameter. Provide stainless steel seat ring and disc: stainless steel bonnet bushing and beveled collar for backseating. Provide braided, teflon impregnated packing rings in a larger, deep stuffing box to service as base for packing. Packing glands shall be non-corrosive and shall have bolted gland flange with minimum of 2 eye bolts. Valves with their bypasses shall be installed for proper operating access.

1) Globe & Angel Valves 1-1/2″ and Smaller: Shall have mini um of 4 packing rings.

2) Globe & Angle Valves 2″ and Larger: Shall have a minimum of 6 packing rings.

3) Globe & Angle Valves 6″ and Larger: Shall have minimum of 6 packing rings. Valves shall have forged steel, glove valve bypass; button-type grease gun fittings and adapters to allow charging a reservoir with valve lubricant tapered roll or ball bearing yokes.

4) Globe & Angle Valves 8″ and Larger: Shall have minimum of 6 packing rings. Valves shall have forged steel, globe valve bypass; button-type grease gun fittings and adapters to allow charging a reservoir with valve lubricant; and tampered roller or ball bearings yokes. Shall be equipped with impactor or hammer-blow hand wheel.

5) Acceptable manufacturers: Crane, Jenkins, Powell, Vogt.

- Check Valves: Shall be horizontal swing check, 300 lb. cast steel, with 13% Cr. stainless steel disc, disc face and barrel type seat rings. Provide full port opening. Disc and seat shall be removable without removing valve from line. Acceptable manufacturers: Crane, Jenkins, Powell, Vogt.
- Gage and Instrument Valves: Shut-off valves for pressure gages and instrument isolating valves shall be of the “barstock” construction, with stainless steel body and stainless steel plug type disc integral with stem. Ends shall be I.P.S. screwed. Rating shall be 600 psig at 750°F. Valves shall be 1/2" size, Crane Co. or approved equal.
- Blowdown Valves: Blowdown valves for cascades, expansion drums, hot water generators shall be unit-tandem type valves, consisting of none hardseat and one seatless valve in one common steel body to conform to the ASTM Boiler Code. Valves shall be rated at 400 psig and suitable for pressures to 665 psig. Valves shall be welding ends and alloy steel trim.
- Needle Valves: For high temperature water convectors shall be of “barstock” construction with stainless steel body and stainless steel plug type disc integral with stem. Ends shall be I.P.S. screwed. Rating shall be 600 psig at 750°F. Crane Co. or approved equal.
- Drain and Vent Valves: Drain and vent valves shall be ASA 600-pound class 1 forged steel globe or angle valves, as specified above. Drain valves need to be sized and shown on the Drawings. Unless otherwise required, vent valves shall be 1/2" size.
- Control Valves

1) HTHW – 2-way Flanged 300 lb. cast steel, 316 stainless steel trim, Fisher Type ES body, high pressure pneumatic actuator with positioner, if required.

2) HTHW – For equipment requiring a valve over 2-1/2″ please use 2 valves designed at 1/3, 2/3 arrangement to achieve tighter control and improved energy savings.

3) HTHW – Control valve should be on Supply side for better temperature control and should have a bypass valve installed.

4) Use equal percentage contour plug. Preliminary sizing shall be based on 20 psi. pressure differential (verify with Project Manager).

5) Valves shall be capable of closing off against a 100 psi pressure difference.

3. Valves for Low Temperature Hot Water

- Ball Valves (preferred): Use for isolation and shut-off duty, size 2-inch and below, Class 150 (150 psig SWP) screwed connection, two-piece, bronze body, PTFE seat, stainless steel ball, lever operated with insulation extension.

- Gate Valves (not to be used unless specifically approved by Mason): Use for isolation and shut-off.

  1) Size 2-inch and below: Class 150 (150 psig SWP), screwed connection, bronze body, bronze seat, bronze disk, inside screw rising stem operator.

  2) Size 2-1/2 inch and greater: Class 125, flanged connection, cast iron body, bronze seat, cast iron disc, OS&Y operator.

- Globe Valves (not to be used unless specifically approved by Mason): Use for by-pass and throttling duty.

  1) Size 2-inch and below: Class 150 (150 psig SWP), bronze body with union-ring bonnet integral seat, PTFE disc, inside screw rising stem operator.

  2) Size 2-1/2 inch and above: Class 125 (200 psig CWP), cast iron with bolted bonnet, flanged ends, cast iron seat, cast iron disc, OS&Y operator.

4. Valves for Dual Temperature Water

- Ball Valves (preferred): Use for isolation and shut-off duty, size 2-inch and below, Class 150 (150 psig SWP) screwed connection, two-piece, bronze body, PTFE seat, stainless steel ball, lever operated with insulation extension.

- Gate Valves (not to be used unless specifically approved by Mason): Use for isolation and shut-off.

  1) Size 2-inch and below: Class 150 (150 psig SWP), screwed connection, bronze body, bronze seat, bronze disk, inside screw rising stem operator.

  2) Size 2-1/2 inch and greater: Class 125, flanged connection, cast iron body, bronze seat, cast iron disc, OS&Y operator.

- Globe Valves (not to be used unless specifically approved by Mason): Use for by-pass and throttling duty.

  1) Size 2-inch and below: Class 150 (150 psig SWP), bronze body with union-ring bonnet integral seat, PTFE disc, inside screw rising stem operator.

  2) Size 2-1/2 inch and above: Class 125 (200 psig CWP), cast iron with bolted bonnet, flanged ends, cast iron seat, cast iron disc, OS&Y operator.

5. Valves for Chilled Water

- Ball Valves (preferred): Use for isolation and shut-off duty, size 2-inch and below, Class 150 (150 psig SWP) screwed connection, two-piece, bronze body, PTFE seat, stainless steel ball, lever operated with insulation extension.
- Gate Valves (not to be used unless specifically approved by Mason): Use for isolation and shut-off.
    1) Size 2-inch and below: Class 150 (150 psig SWP), screwed connection, bronze body, bronze seat, bronze disk, inside screw rising stem operator.
    2) Size 2-1/2 inch and greater: Class 125, flanged connection, cast iron body, bronze seat, cast iron disc, OS&Y operator.
- Globe Valves (not to be used unless specifically approved by Mason): Use for by-pass and throttling duty.
    1) Size 2-inch and below: Class 150 (150 psig SWP), bronze body with union-ring bonnet integral seat, PTFE disc, inside screw rising stem operator.
    2) Size 2-1/2 inch and above: Class 125 (200 psig CWP), cast iron with bolted bonnet, flanged ends, cast iron seat, cast iron disc, OS&Y operator.

6. Valves for Low Pressure Steam, Low Pressure Steam Condensate Return and Pumped Condensate:

- Ball Valves (preferred): Use for isolation and shut-off duty, size 2-inch and below, Class 150 (150 psig SWP) screwed connection, two-piece, bronze body, PTFE seat, stainless steel ball, lever operated with insulation extension.
- Gate Valves (not to be used unless specifically approved by Mason): Use for isolation and shut-off.
    1) Size 2-inch and below: Class 150 (150 psig SWP), screwed connection, bronze body, bronze seat, bronze disk, inside screw rising stem operator.
    2) Size 2-1/2 inch and greater: Class 125, flanged connection, cast iron body, bronze seat, cast iron disc, OS&Y operator.
- Globe Valves (not to be used unless specifically approved by Mason): Use for by-pass and throttling duty.
    1) Size 2-inch and below: Class 150 (150 psig SWP), bronze body with union-ring bonnet integral seat, PTFE disc, inside screw rising stem operator.
    2) Size 2-1/2 inch and above: Class 125 (200 psig CWP), cast iron with bolted bonnet, flanged ends, cast iron seat, cast iron disc, OS&Y operator.

7. Valves for Condenser Water:

- Ball Valves (preferred): Use for isolation and shut-off duty, size 2-inch and below, Class 150 (150 psig SWP) screwed connection, two-piece, bronze body, PTFE seat, stainless steel ball, lever operated with insulation extension.
- Gate Valves (not to be used unless specifically approved by Mason): Use for isolation and shut-off.
    1) Size 2-inch and below: Class 150 (150 psig SWP), screwed connection, bronze body, bronze seat, bronze disk, inside screw rising stem operator.
    2) Size 2-1/2 inch and greater: Class 125, flanged connection, cast iron body, bronze seat, cast iron disc, OS&Y operator.
- Globe Valves (not to be used unless specifically approved by Mason): Use for by-pass and throttling duty.

1) Size 2-inch and below: Class 150 (150 psig SWP), bronze body with union-ring bonnet integral seat, PTFE disc, inside screw rising stem operator.

2) Size 2-1/2 inch and above: Class 125 (200 psig CWP), cast iron with bolted bonnet, flanged ends, cast iron seat, cast iron disc, OS&Y operator.

8. Balancing Valves:

- 2″ and Smaller: Y-pattern, globe type manual balancing valves with Ametal® brass copper alloy body, EPDM o-ring seals, 4-turn digital readout handwheel for balancing and concealed memory feature with locking, tamper-proof setting, soldered or threaded end connections and provisions for connecting a portable differential pressure meter. Victaulic/Tour & Andersson Series 786 and 787.
- 2-1/2″ and Larger: Y-pattern, globe type manual balancing valves with ductile iron body and Ametal® parts, EPDM o-ring seals, 8, 12, or 16-turn digital readout handwheel for balancing and concealed memory feature with locking, tamper-proof setting, flanged or grooved end connections and provisions for connecting a portable differential pressure meter. Victaulic/Tour & Andersson Series 788 and 789.
- Install a Series 78U union port fitting and Series 78Y strainer/ball valve combination to complete terminal hookup at coil outlet.

23 05 29 Hangars and Supports for HVAC, Piping, and Equipment

1. All piping with insulation shall be supplied with properly fitted sheet metal saddles and high density insulation inserts at all pipe support locations.
2. Victaulic Style 107, 07, and W07 rigid couplings may be used on IPS steel piping systems, which meet the support and hanging requirements of ASME B31.1 and B31.9. An adequate number of Victaulic Style 75, 77, or W77 flexible couplings shall also be used to compensate for thermal expansion/contraction of the pipe.

23 05 53 Identification for HVAC Piping and Equipment

1. Mark location of air handlers, fan coil units, air terminal units, etc., above ceilings with identifying "buttons" to facilitate maintenance through ceiling.
2. Tag roof top exhaust fans and associated fume hood to facilitate maintenance and identification.
3. Utilize standard tag or placard to mark all major equipment. Tag all valves and provide valve chart for each floor.
4. Utilize standard Commonwealth of Virginia color coding for various building service piping and ductwork. Mark each with name of service, direction of flow, and associated unit served where appropriate.
5. All systems handling hazardous materials must have appropriate marking and visual or audible alarms to protect building occupants and maintenance personnel. Mark exhaust fans on roof which handle hazardous fumes with appropriate color code.
6. Mark air handling units with large letters and numbers.
7. Provide strap-on markers for pipe. Pressure-sensitive type markers are not acceptable.
8. Conform with ANSI 13.1

23 07 00 HVAC Insulation

1. All insulation shall conform to the latest Energy Code requirements.

2. Staples are not acceptable for insulation installation.
3. All “raw” ends of insulation shall be sealed.
4. For High Temperature Hot Water, Medium Temperature Hot Water, and Steam/Condensate piping insulation, provide the following:
   - For interior piping: canvas jacket, coated with Fosters 81-42w or equal and painted.
   - For tunnel piping: wrap with an approved non-flammable moisture barrier and cover with an aluminum jacket.
   - Calcium silicate insulation, 4″ minimum thickness for operating temperatures greater than 400°F.
   - Removable insulation jackets shall be provided on all valves and expansion joints.
5. All indoor exposed chilled water and low temperature hot water piping located in the following areas shall be provided with a field installed protective canvas jacket.
   - Existing central heating and cooling plant at the main Fairfax, VA campus.
   - Mechanical rooms which also contain High Temperature Hot Water or Steam piping systems.
6. All indoor exposed chilled water and low temperature hot water piping located in all other areas (except areas identified in paragraph 5 above): 20 mil (minimum) PVC protected jacket shall be provided.
7. For condensation control on interior Chilled Water piping use the minimum thicknesses: Pipe sizes 1-1/2" and smaller use 1-1/2" insulation, pipe sizes greater than 1-1/2" use 2" insulation.
8. Condensate drains shall have 1" of insulation.
9. Internal insulation or lining of ductwork is prohibited unless approved by Mason.
10. Insulation specification shall describe what systems and services are to be insulated. Refer to the insulation schedule below.

INSULATION SCHEDULE					
Insulation Description	**Service**	**Maximum Thermal Conductivity**	**Minimum Density (lb./c.ft.)**	**Pipe Size**	**Thickness**
Closed Cell Foam	Chilled Water	0.23	3	1½″ and smaller 2″ to 5″	1” 1”
Fiberglass Pipe Insulation	Low Temperature Hot Water, Medium Temperature Hot Water, and Dual Temperature Service	0.23	3	2″ and smaller 2½″ and larger	1½″ 2″
Fiberglass Pipe Insulation	Chilled Water	0.23	3	1½″ and smaller 2″ to 5″ 6″and larger	1½” 1½″ 2″
Fiberglass Pipe Insulation	Low Pressure Steam (15 psig and below)	0.23	3	1″ and smaller 1½″ to 2½″ 3″ to 6″ 8″ and larger	1½″ 2″ 3″ 3½″
Fiberglass Pipe Insulation	Medium Pressure Steam (15 to 70 psig)	0.23	3	1″ and smaller 1½″ to 3″ 4″ and larger	2″ 3″ 4″

INSULATION SCHEDULE					
Insulation Description	**Service**	**Maximum Thermal Conductivity**	**Minimum Density (lb./c.ft.)**	**Pipe Size**	**Thickness**
Fiberglass Pipe Insulation	High Pressure Steam (70 psig and greater)	0.23	3	1″ and smaller 1″ to 3″ 4″ and larger	2″ 3″ 4″
Fiberglass Pipe Insulation	Steam Condensate Return and Pumped Condensate	0.23	3	2″ and smaller 2″ and larger	1½″ 2″
Fiberglass Pipe Insulation	Hot Water Air Separators	0.23	3	All sizes	1″
Fiberglass Pipe Insulation	Steam Vent and Relief Valve Piping	0.23	3	All sizes	1″
Fiberglass Pipe Insulation	Coil Condensate Drain and City Water	0.23	3	All sizes	1″
Fiberglass Pipe Insulation	Refrigerant Suction and Hot Gas	0.23	3	All sizes	1″
Fiberglass Pipe Insulation	Indoor Free Cooling and Outdoor Condenser Water Piping	0.23	3	5″ and smaller 6″ and larger	1½″ 2″
Fiberglass Pipe Insulation	Hot Water Valves	0.23	3	2½″ and larger	2″
Fiberglass Pipe Insulation	Valves for Steam and Steam Condensate Return	0.23	3	2½″ and larger	3″
Calcium Silicate Pipe Insulation and Ceramic Cloth	Engine Exhaust	0.42		All sizes	4″
Foamed Plastic Pipe Insulation	Coil Condensate Drain and City Water	0.26	6	All sizes	½″
Flexible Unicellular Pipe Insulation	Refrigerant Suction and Hot Gas	0.26	6	All sizes	½″
Calcium Silicate Equipment Insulation	Boiler Breeching, Induced Draft Fans, Converter Shell, Condensate Receivers, Flash Tanks, Deaerator Heaters, Hot Water Generator Shell, Boiler Feed Water Heaters, Boiler Feed Water Pumps, and Fuel Oil Heaters	0.42		All sizes	4″
Calcium Silicate Equipment Insulation	Boilers	0.42		All sizes	4″
Calcium Silicate Equipment	Condensate Storage Tanks	0.42		All sizes	2½″

INSULATION SCHEDULE					
Insulation Description	**Service**	**Maximum Thermal Conductivity**	**Minimum Density (lb./c.ft.)**	**Pipe Size**	**Thickness**
Insulation					
Flexible Unicellular Equipment Insulation	Chilled Water Pumps, Plate and Frame Heat Exchangers, Air Handling Unit Coil Headers, Centrifugal Refrigeration Machines, and Chilled Water Valves	0.26	6	All sizes	2″
Flexible Unicellular Equipment Insulation	Flexible Duct Connections	0.26	6	All sizes	2″
Rigid Fiberglass Board Insulation	Supply Air, Outdoor Air and Mixed Air Ductwork and Plenums Located in Mechanical Equipment Rooms	0.23	6	All sizes	1½”
Rigid Fiberglass Board Insulation	Supply Air, Return Air, Exhaust Air and Mixed Air Ductwork and Plenums Located Outdoors	0.23	6	All sizes	2″
Rigid Fiberglass Board Insulation	Terminal Air Boxes, Duct Mounted Coils, and Air-to-Air Heat Exchangers	0.23	6	All sizes	Mfgr's Standard Thickness
Fiberglass Duct Blanket Insulation	Supply Air, Outdoor Air and Mixed Air Ductwork and Plenums	0.31	1.5	All sizes	2″

11. In addition to the thickness of insulation of pipes listed above, the Professional shall consider the use of thicker insulation if required by AHRAE 90.1, latest edition. The insulation shall meet the requirements of International Mechanical Code, latest edition.

12. All supply air, mixed air, and return air ductwork shall be insulated with Ductwrap or rigid fiberglass board (as indicated above). Minimum thickness is 1½” with FSK (Reinforced Foil, aka FRK) laminate facing. It must have a minimum of ¾ density and a minimum an out of package R-value of 5.1.

13. All supply air ductwork in the ceiling used as return air plenum shall be insulated with 1″ thick 1-1/2 lbs./c ft. fiver glass insulation.

14. Duct liners are NOT permitted in the laboratories and the animal use areas.

15. Wherever duct liners are used, the installation shall meet the installation requirements of the manufacturer and SMACNA guidelines.

16. All steam, condensate return, chilled water, hot water, condensate drain, make-up water and ductwork shall be insulated as listed under Insulation Materials.

23 05 93 Testing, Adjusting, and Balancing (TAB)

1. Specify a third party TAB Contractor. The TAB Contractor shall not be subcontracted by the Mechanical Contractor.

2. Agency Qualifications: The independent testing, adjusting, and balancing agency shall be certified by the National Environmental Balancing Bureau (NEBB) or the Associated Air Balance Council (AABC) in the testing and balancing disciplines required for the project, and have at least one Professional Engineer registered in the State of Virginia, certified by NEBB or AABC as a Test and Balance Engineer.

3. In accordance with the submittal specifications and 01810, submit a synopsis of the testing, adjusting, and balancing procedures and proposed agenda.

4. In accordance with the submittal specifications, submit sample forms, if other than those standard forms prepared by the AABC or NEBB are proposed.

5. Submit a detailed testing, adjusting and balancing plan for each system and equipment type that is required to be balanced. Testing, adjusting and balancing work in the field will not be permitted without an approved testing, adjusting and balancing plan for each system and equipment type.

6. All domestic hot water recirculating zones provided with balancing valves shall be tested, adjusted and balanced by the TAB contractor. The TAB contractor shall review the plumbing drawings prior to bidding.

7. Pre-balancing Conference: Prior to beginning the testing, adjusting, and balancing field work, schedule and conduct a conference with Mason, Siemens, the Mechanical Engineer, and representatives of installers of the mechanical systems. The objective of the conference is final coordination and verification of system operation and readiness for testing, adjusting, and balancing.

8. Draft Reports: In accordance with the submittal specifications, prepare and submit draft reports on the approved forms upon completion of testing, adjusting, and balancing procedures. Draft reports may be hand written, but must be complete, factual, accurate, and legible. Organize and format draft reports in the same manner specified for the final reports.

9. Final Report: In accordance with the submittal specifications, prepare and submit a final report. Bind approved report forms complete with schematic systems diagrams and other data in reinforced, vinyl, three-ring binders. Provide binding edge labels with the project identification and a title descriptive of the contents.

10. Report Contents:

    - General Information and Summary: Inside cover sheet to identify the testing, adjusting, and balancing agency, Contractor, Owner, Architect, Mechanical Engineer, and Project Engineer. Include addresses, and contact names and telephone numbers. Also include a certification sheet containing the seal, name, address, telephone number, and signature of the Certified Test and Balance Engineer. Include a listing of the instrumentation used for the procedures along with the proof of calibration within six months prior to starting the project.

    - The remainder of the report shall contain the appropriate approved forms for each respective item and system. Prepare a schematic diagram for each item of equipment and system to accompany each respective report form.

23 06 80 Unitary Air Conditioning Equipment

1. Window air conditioning units are not acceptable unless approved in writing by Mason. If no other options exist, they shall be equipped with a programmable timer which can be shut off when the space is not occupied. The timer can be part of the unit, or at the panel as appropriate.

23 09 00 Instrumentation and Control for HVAC

1. All new buildings shall have a Siemens Building Technologies DDC energy management and control system (EMCS) installed. The new EMCS system will tie into the existing campus EMS system Database. The System Database shall host on the existing Apogee server, and must be able to use Microsoft Internet Explorer or Mozilla Firefox Browsers to remotely view system graphics, monitor, control, and configure the HVAC system and its properties. The energy management and control system shall monitor and control HVAC operations and conditions, alarm abnormal conditions and index control modes and provide AHU optimized start/stop operations, peak demand limiting, demand control ventilation, provide reporting and trend logs. The specific system requirements shall be reviewed with the Mason Building Automation and Energy Management shops during the design phase. All Retail Space will have at a minimum the ability to communicate to the existing campus EMS system as well as the following utility meters:
   - DEM 2000 for tracking electrical use
   - Onicon ultrasonic flow meters for both chilled water and hot water for heating and cooling
   - Onicon ultrasonic flow meter for domestic cold water
   - Onicon gas meter (if applicable) for natural gas consumption
2. In general, the system shall include field level panels receiving information on the status of various sensors in the building and comparing this information with standard instructions relayed from a central processor. The local unit then makes changes required according to programming already present in its memory or overridden by the central processor. All control devices will be electric/electronic with the exception of HTHW or large building CW Valves which will be pneumatic (Refer to Section 230523 for additional HTHW control valve requirements). Control shall generally be DDC, with the exception of general space and equipment room heating and ventilation which shall be electric.
3. The plans and specifications for the EMCS and mechanical system must include a detailed points list showing all monitor and control points and identify all required software and hardware, and must also include a sequence of operations for major equipment and systems. The point list shall also show all alarm conditions. Lab controls, if applicable shall be VAV fume hood type, Siemens lab controls; Phoenix air valves are not acceptable. If chillers are part of the project, consultant shall design the plant using Siemens Demand Flow Program for chiller sizing, plant equipment selection, and chiller system sequences.
4. The EMCS must be capable of alarming to, and allowing interface and programming by any compatible personal computer via Mason's LAN. EMCS shall be expandable and be compatible with the electronic equipment controls. EMCS must have a security password/code for system entry and programming. A network RJ45 jack shall be provided for network communications over Mason's LAN. Aarms must utilize the existing Reno software. Consultant shall specify and identify all EMCS panels for connection to GMU LAN to be connected by the telecom contractor. New laptops or PC workstations are not to be provided in building as part of the project.
5. The EMCS must be capable to perform the following functions: Initiate selected control sequences for AHUs, chillers, boilers pumps, exhaust fans, cooling towers, rooftop mounted units, VFDs, fan coil units, start/stop, occupied/unoccupied modes, optimized equipment start/stop operation, monitor total building electric usage with DEM, chilled water/hot water, domestic water, and dual temp consumption Onicon Ultrasonic 4200 flow meters, demand control ventilation and provide peak

demand limiting routines as determined by Owner. Monitor and alarm selected conditions for temperature, Pressure, Flow, mixed air temperature, supply air temperature, return air temperature, CO2, outside air temperature, static pressure, temperatures of dedicated IT rooms or closets, On/Off, Start/Stop Status; Safety Control Status (Fire, Freeze, and Smoke alarms). Co2 sensors should only be specified where actually required by sequence. Mason does not want inputs for filter status, and valve/damper position unless critical. Mason wants to minimize use of air flow stations and consultant must design adequate straight runs as recommended by manufacturer for accurate reading and TAB set-up.

6. The EMCS control panels shall be located inside the building preferably in the mechanical rooms or one level below the roof if roof mounted equipment is provided. They shall be capable of standalone operation in the event of network communications failure.
7. The EMCS shall include complete graphics that will include all application devices associated with the installed control system including floor-level graphics with links to equipment for each building system. Floor plans will include room numbers, VAV locations and room sensor locations. The graphic start page for each new facility will include links to .pdf files of as-built mechanical plans and as-built control drawings. Samples and templates will be provided by Mason. The Architect must provide background CAD files for creation of floor plans.
8. Provide electric utility metering for each new building and provide setup in Apogee Insight, UCM, and Infocenter. Metering shall be a DEM 2000 installed on building main switchgear. Provide Onicon Ultrasonic 4200 flow meters on all HTHW, CW, HW, Dual Temp, and DHW pipes that serve the building. The flow meters shall be tied into the EMCS system and be setup in Apogee Insight, UCM, and Infocenter. If the building is being retrofitted or upgraded, the consultant shall research and show the existing metering and LANs on the plans and identify for maintained connection and use.
9. Provide CO2 sensors on all air-handling units with economizer control for demand ventilation control, and provide economizer control on AHUs for free cooling. Provide current switches for pump and fan status. VAV terminals shall have room and supply air temperature sensors.
10. Siemens shall provide all VFDs under this section. The VFDs shall be Yaskawa. There will be no substitutes. The VFDs will communicate remotely with the EMCS system via P1 communications and added to the EMCS with the proper unbundled points for control.
11. Integration to other HVAC equipment shall be provided as follows using BACNET MSTP or MODBUS RS485; LON or IP integration is not permitted. Provide integration for CRAC's when there are multiple units and chillers. Integration to boilers, split AC systems, heat pumps, and emergency generators is not required. Specify Siemens controls and EMCS connection for fan coil units, heat recovery units, and roof top air handling units; manufacturer controls are not allowed

23 09 23 Direct Digital Controls

Test Plan

1. Prepare a written test plan indicating in a step-by-step, logical fashion, the procedures by which the automatic control system will be tested, adjusted, and checked.
2. Not less than 6 weeks prior to testing, provide copies of the proposed test plan for approval in accordance with the specifications for submittals. Meet and discuss the test plan, and make agreed changes to the written plan. Resubmit the revised test plan in accordance with the specifications for submittals.
3. The Test Plan shall include, as a minimum, for each system and subsystem of the automatic control work, the following:
   - System name.
   - List of devices with brief description of functional purpose of each.
   - A description of the expected signal values transmitted by the sensor.

- A description of the expected signal values transmitted by the controller to the control device or actuator.
- A description of the expected signal values of the control device over its operating range.
- A description of the instrumentation required to test the system.
- A detailed description of the test.
- A log sheet or sheets on which expected and field read values will be recorded and final field read values indicating that the system is operating in accordance with contract requirements.
- A functional performance test of sequences.
- A functional performance test of sequences.

Testing and Adjusting During and After Installation

1. The testing and adjusting includes the submission of a test plan which shall describe in detail the method by which each component, subsystem, and system will be tested, adjusted, and retested after installation in accordance with the specified sequences of operation and other characteristics of the control system.
2. A report on test results, including set points and operating ranges of all components shall be submitted in accordance with submittal specifications. The set points and operating ranges of all components shall be recorded to be submitted as part of the commissioning tests results.
3. The testing specified in this paragraph shall not replace the testing specified in "Commissioning Tests."
4. The entire test shall be witnessed by the University and the A/E.
5. Upon satisfactory test, a copy of the final test results shall be bound in the Operating and Maintenance Manual.

Commissioning Tests

1. In addition to the "Testing and Adjusting During and After Installation", the contractor shall perform commissioning tests to verify that the entire automatic control systems are designed, installed, and adjusted to perform as required in the contract. This phase is an extension, not a substitute, of the phase "Testing and Adjusting During and After Installation."
2. Demonstrate all calibration and tests performed under "Testing and Adjusting During and After Installation."
3. Point to Point checkout of every control sequence.
4. Verification of Electronic Digital Controllers
    - Verify the operation of the microcomputer operating system of the field panels. Demonstrate proper automatic restart of equipment after power restoration.
    - Verify each required software application routine. They shall include, but not be limited to:
        1) All control sequences specified for each local loop
        2) Time of day scheduling
        3) Chilled/Hot water reset
        4) Outdoor air reset
        5) Occupied/Unoccupied cycle

6) Demand Control Ventilation
7) Start/stop time optimization
8) Event initiated programs
9) Trending
10) Peak demand limiting

- Verify the operation through the use of a laptop connected to the Siemens Field Panel.
- Verify self-diagnostics of the field panel. Each field panel shall be verified by the use of a laptop connected to the Siemens Field Panel.
- Verify the operation of the clock routine in the field panel.
- Demonstrate changing of default values of sensors by the use of a laptop connected to the Siemens Field Panel.
- Demonstrate proper system operation while set points and data are being modified.
- Verify operation of all terminal equipment controllers.
- Verify all graphics for accuracy and that they meet Mason approved standards. Graphics will include all application devices associated with the installed control system including floor-level graphics with links to equipment for each building system. Floor plans will include room numbers, VAV locations and room sensor locations. The graphic start page for each new facility will include links to pdf files of as-built mechanical plans and as-built control drawings.

5. Mechanical system demonstration
   - Demonstration shall include the operation of the entire mechanical system under the control of the contractor and shall include the start-up, operation, and shutdown of the system in accordance with the sequence of operation.
   - The operation of each device shall be performed in accordance with the written instructions contained in the operation and maintenance manual, a copy of which shall be available 10 working days prior to the test. No deviation from the procedures in the operating manual will be permitted.
   - Should the system fail to perform in accordance with the requirements of the operation and maintenance manual, the system shall be repaired, recalibrated, retested as necessary, and a second demonstration performed at no additional expense. The contractor shall reimburse the expenses of the commissioning team for each test after the first.
6. All commissioning tests, verifications, and demonstrations shall be witnessed by Mason Personnel.
7. For any test, verification, or demonstration that fails to meet the specification requirements, the component of the automatic control system causing the control system failure, be it hardware, firmware, or software, shall be repaired, replace, or readjusted. The failed test, verification, or demonstration shall be repeated.
8. Upon satisfactory tests of the automatic control systems, copies of the final test results shall be bound in the Operating and Maintenance Manual.

Final Operational Test and Acceptance

1. The final operational test and acceptance shall constitute an operational test over a 30 day period that the system performs the functions and intent of the contract requirements. During the 30 day test period, Mason's Building Automation and EMS personnel shall operate the system in accordance with the manufacturer's requirements and shall log all deviations, failures, and other deficiencies which constitute contract nonperformance. The requirement for minor adjustments and/or system

modifications shall be submitted in writing stating the scope of said modifications and the need therefore, prior to implementing such changes.

2. During the 30 day test duration, the system shall demonstrate its continuous functional and operational capabilities without breakdown or shutdown defined as “UPTIME.” During the testing period, the UPTIME of all field panels, terminal microprocessors, host computer and peripherals, network, etc. shall not be less than 95%. The tests shall be extended on a day-by-day basis until the UPTIME over 30 consecutive days meets the stated level, at which time the system will be accepted by Mason.
3. Consultant to specify training for the EMCS. Training shall be appropriate for building complexity. 8 hours for complex building systems and 4 hours for all others

23 10 00 Facility Fuel Systems

1. All fuel oil handling equipment and systems such as fill stations, transfer pumps, polishing systems, day tanks, etc. shall be checked out and started up by a factory authorized technician. Training and demonstration to Mason’s operating staff shall also be provided by a factory authorized representative. Training and demonstration shall not be performed concurrent with the start-up.

23 11 00 Facility Fuel Piping

1. Fuel Oil Piping Schedule
    - Above ground fuel oil supply, fuel oil return, fuel oil vent, 2″ and smaller: Carbon steel, threaded joints and cast iron fittings, standard weight.
    - Above ground fuel oil supply, fuel oil return fuel oil vent, 2-1/2″ and larger: Carbon steel, butt welded joints and fittings, standard weight.
    - Below ground fuel oil supply, fuel oil return, fuel oil vent 2″ and smaller: Double containment piping system; Carrier Pipe same as above grade piping described above with socket welded joints and fittings; Secondary Containment Pipe shall be FRP with bell and spigot adhesive bonded joints, Ameron Dualoy 3000/L or approved equal.
    - Below ground fuel oil supply, fuel oil return, fuel oil vent and fuel oil fill 2-1/2 and larger: Double Containment Piping System; carrier pipe same as above grade piping described above with butt welded joints, Ameron Dualoy 3000/L or approved equal.
    - 100% of all below ground carrier pipe welds shall be UT tested.
    - Galvanized piping is prohibited.

23 21 13 Hydronic Piping

1. All hydronic piping shall be in accordance with this section, unless the piping system is High Temperature or Medium Temperature Hot Water. Refer to 23 21 14 for High Temperature and Medium Temperature Hot Water piping requirements.
2. Pipe sizes 2-inch and smaller, above ground:
    - Type L hard drawn copper, ASTM 88 with wrought copper fittings, ASME B16.22. soldered joints; mechanical joints are not acceptable.
    - Schedule 40 steel, ASTM A53, Grade B, ERW with malleable iron fittings, ASME B16.3. Screwed joints; mechanical joints are not acceptable.
3. Pipe sizes 2-1/2 inch and greater, above ground:
    - Schedule 40, ASTM A53 or A106, Grade B, seamless. Wrought Steel fittings; ASME B16.9, ASME B16.28 or ASTM A420. Welded joints; mechanical joints will be allowed in

mechanical equipment rooms and equipment rooms and equipment connection with prior written approval from Mason.

4. Welding Requirements

   - High Temperature and Medium Temperature Hot Water - ASME B31.1 Power Piping. 100% Radiographic testing. Welder qualifications and welder continuity logs shall be a required submittal.
   - Low Temperature Heating Water within Buildings - ASME 31.9 Building Services Piping. 20% UT testing. Welder qualifications and welder continuity logs shall be a required submittal.
   - Chilled Water Piping Below Grade (Carrier Pipe) or in Tunnel (Campus distribution piping) - ASME B31.1 Power Piping. 100% UT testing. Welder qualifications and welder continuity logs shall be a required submittal.
   - Chilled Water Piping within Buildings - ASME 31.9 Building Services Piping. 20% UT testing. Welder qualifications and welder continuity logs shall be a required submittal.
   - Condenser Water Piping within Buildings - Welder qualifications and welder continuity logs shall be a required submittal.

5. Underground distribution piping shall be a manufactured pre-insulated piping system consisting of carrier pipe, insulation, and outer jacket. Acceptable manufacturers are Perma-Pipe, Thermacor, or Rovanco.

6. Inspection and Testing. Weld inspection to include 100% visual inspection on gap alignment and root pass; and, ultrasonic inspection (UT) of at least 15% of the field welds by each certified welder on the job. Any failure in UT testing to result additional testing of 15% of that welder's work. There is to be 100% hydro testing at 200 psig to be witnessed by and coordinated with Mason Central Heating and Cooling Plant personnel and the Project Inspector.

7. Cleaning:

   - Flushing: Perform initial piping system flush to remove core system debris prior to chemical treatment. Typically, this would involving filling the system with water, leaving no air voids, and then flushing the system out at fire hose volumes. In this process, all vents and drains need to be well rinsed until no visible debris or discoloration is visible. The initial rinse water shall be tested and compared to the raw water source to provide a base line for procedure performance. Flushing to be witnessed by and coordinated with Mason Central Heating and Cooling Plant personnel and the Project Inspector.
   - Chemical Cleaning: Chemical cleaning must remove unwanted debris while installing an initial coating of corrosion inhibitor film. The objective is to reduce internal pipe corrosion by at least 95% during the first year of operation. The chemical treatment must remove oils, grease, mill debris, weld slag and other forms of new piping contaminants. The core ingredients of the chemicals used must be biodegradable. Chemicals used must form an initial film of corrosion inhibitor to yield high levels of internal pipe protection. Chemicals used must include an EPA approved micro biocide that provides a broad spectrum kill of unwanted microorganisms that result in corrosion.
   - Recirculation: Provide taps with isolation valves and cross connections as required to isolate and chemically clean each piping system section. Provide circulation pump(s) as required. Circulate the chemical solution for a minimum of 72 hours. During this process, monitor and maintain system pressure at appropriate levels. After 72 hours, flush the system until debris and products are no longer present. The rinse water shall be tested and be verified to be free of treatment products.
   - Inhibitors: After flushing the chemical cleaning solution, inject an initial charge of inhibitors to maintain the system until it is brought into service. If at any time prior to placing the piping system into service, the system is drained and refilled, then an additional charge of corrosion

inhibitors must be injected into the piping system section. Once all treatment is completed, pipe must remain full of water.

- Report. All chemical cleaning to be witnessed by and coordinated with Mason Central Heating and Cooling Plant personnel and the Project Inspector. Provide a written report of cleaning results.

23 21 14 High Temperature and Medium Temperature Hot Water Piping

1. Materials for High Temperature Water Systems:

- Pipe:

2" and Larger:	1-1/2" and Smaller:
Schedule 80	Schedule 80
ASTM A 53, Grade B	ASTM A 53, Grade B
Black	Black
Seamless	Electric Resistance Welded

- Fittings

2" and Larger:	1-1/2" and Smaller:
Schedule 80	3,000 pound
Seamless	Forged Carbon Steel
Butt-welded type	Socket weld
ASA B 16.9	ASA B 16.11
ASTM A 234 Grade B	ASTM A 105 Grade II

Weld ells shall be long-radius pattern.

- Flanges (all sizes): 300 pound class, forged steel, welding neck type, ASA B 16.5 ASTM A 181 Grade I.

- Gaskets (all sizes): Spiral wound, type 304 stainless steel, non-asbestos filled, 3/16" thick with centering guide, 300 pound class, by Garlock, Flexitallic style CG, or approved equal.

- Strainers (all sizes): Y-type; same size as pipe in which they are installed. Strainers shall have cast steel bodies suitable for 425o F temperature and 600 psig pressure, bottoms drilled, directional arrow on body. Strainers shall be equipped with easily removable cover and basket. Basket shall be stainless steel with 3/32" perforations. Net free area through back of basket shall be 2-1/2 times the area of connecting pipe. Flow shall be into basket and out through perforations.

- Unions (normally not to be used on pipe larger than 1"): 3,000-pound class forged steel, socket-welded type, with steel to steel seat, ASTM A 105 Grade II, as manufactured by Henry Vogt Machine Co. or approved equal.

- Welding Rings (to be used on pipe 4" diameter and larger): Carbon steel with knock off spacer pins, for Schedule 40 and/or Schedule 80 pipe dimensions.

- Bolts and Studs: Alloy steel studs threaded full length and fitted with two hexagon nuts per stud for all flanged joints. Bolting to conform to ASTM A 193 Grade B-7, threads class 7 fit. Nuts shall be semi-finished hexagonal, ASA B 18.2 ASTM A 194 Grade 2H.

2. Cleaning:

- Flushing: Perform initial piping system flush to remove core system debris prior to chemical treatment. Typically, this would involving filling the system with water, leaving no air voids, and then flushing the system out at fire hose volumes. In this process, all vents and drains need to be well rinsed until no visible debris or discoloration is visible. The initial rinse water shall be tested and compared to the raw water source to provide a base line for procedure performance. Flushing to be witnessed by and coordinated with Mason Central Heating and Cooling Plant personnel and the Project Inspector.

- Chemical Cleaning: Chemical cleaning must remove unwanted debris while installing an initial coating of corrosion inhibitor film. The objective is to reduce internal pipe corrosion by at least 95% during the first year of operation. The chemical treatment must remove oils, grease, mill debris, weld slag and other forms of new piping contaminants. The core ingredients of the chemicals used must be biodegradable. Chemicals used must form an initial film of corrosion inhibitor to yield high levels of internal pipe protection. Chemicals used must include an EPA approved micro biocide that provides a broad spectrum kill of unwanted microorganisms that result in corrosion.
- Recirculation: Provide taps with isolation valves and cross connections as required to isolate and chemically clean each piping system section. Provide circulation pump(s) as required. Circulate the chemical solution for a minimum of 72 hours. During this process, monitor and maintain system pressure at appropriate levels. After 72 hours, flush the system until debris and products are no longer present. The rinse water shall be tested and be verified to be free of treatment products.
- Inhibitors: After flushing the chemical cleaning solution, inject an initial charge of inhibitors to maintain the system until it is brought into service. If at any time prior to placing the piping system into service, the system is drained and refilled, then an additional charge of corrosion inhibitors must be injected into the piping system section. Once all treatment is completed, pipe must remain full of water.
- Report. All chemical cleaning to be witnessed by and coordinated with Mason Central Heating and Cooling Plant personnel and the Project Inspector. Provide a written report of cleaning results.

23 22 00 Steam and Condensate Piping

1. Steam piping, above ground:
   - Sizes 2 inch and Smaller: Schedule 40 steel, ASTM A53, Grade B, ERW. Malleable iron fittings, ASME 16.3 Screwed joints, mechanical joints are not acceptable.
   - Sizes 2-1/2 inch and greater: Schedule 40 steel type E, ASTM A53 or A106, Grade B. Standard weight wrought steel fittings ASME B16.9 or B16.28. Butt welded joints and fittings; mechanical joints are not acceptable.
2. Condensate piping, above ground:
   - Sizes 2-inch and smaller: Schedule 80 type S, ASTM A53, Grade B. Fittings shall be 300 psig malleable iron, ASME B16.3 Screwed joints and fittings; mechanical joints are not acceptable.
   - Sizes 2-1/2 inch and greater: Schedule 80 type E, ASTM A53 or A106, Grade B. Fittings shall be extra heavy duty wrought steel, ASME B16.9 ASME B16.28 or ASTM A420. Butt welded joints and fittings; mechanical joints are not acceptable.
3. Underground steam and condensate piping:
   - Shall be a manufactured pre-insulated piping system consisting of carrier pipe, insulation and outer jacket. The piping system shall be fully dryable, drainable and air testable. Acceptable manufacturers are Perma-Pipe, Thermacor, and Rovanco.
   - Steam piping 2 inch and smaller: Schedule 40 steel, ASTM A53, Grade B, ERW, steel fittings, socket welded joints.

- Steam piping 2 1/2 inch and greater: Same as indoor steam piping 2 1/2 inch and greater.
- Condensate piping 2 inch and smaller: Schedule 80 type S, ASTM A53, Grade B, steel fittings, socket welded joints.
- Condensate piping 2 1/2 inch and greater: Same as indoor condensate piping 2 1/2 inch and greater.

4. Welding:
    - Steam working pressures 15psig and below - ASME 31.9 “Building Services Piping.” 100% UT testing. Welder qualifications and welder continuity logs shall be a required submittal.
    - Steam working pressures greater than 15 psig - ASME 31.1 “Power Piping.” 100% UT testing. Welder qualifications and welder continuity logs shall be a required submittal.

23 36 00 Air Terminal Units

1. Construction
    - Terminal Casing shall be minimum 22-gauge galvanized steel, internally lined with 1/2″ dual density insulation that complies with UL181 and NFPA 90A. Insulation shall be non-eroding and non water absorbing. Use of fiberglass insulation is allowed only in double wall construction where the insulation is completely protected from the air stream by an inner metal liner.
    - The casing shall have access panels which allow for full service and maintenance to fans, motors, controls.
    - All units that require a motor shall use ECM motors.
    - Fans shall be forward curved steel constructed with permanent lubricated bearings.
    - The primary damper shall be heavy gauge steel with self-lubricating bearings.
2. Noise Criteria
    - Sound ratings for the terminal units shall not exceed NC 35.
    - Sound attenuation shall be provided in consultation with the university.
3. Controls
    - Terminal units shall be provided with factors mounted controls unless approved by the University.
    - The controls manufacturer shall be sole sourced based on the Mason Instrumentation and Controls Standards (see 23 09 00)

23 50 00 Central Heating Equipment

23 52 00 Heating Boilers

1. Modular type condensing boilers rated at 90 % + efficiency are preferred for remote locations.
2. Scotch Marine boilers may be considered for installations larger than 50 horse power. They should be multi-pass and have an efficiency of greater than 90% at the design point. Comply with Factory Mutual requirements. Buy a packaged boiler whenever possible. Consult Mason for use of dual-fuel burners for type of burner to use, turn-down desired and type of control to use.
3. All boilers shall be checked out and started up by a factory authorized technician. Factory start-up services shall include the following as a minimum:

- Pre-functional installation check-out.
- Operation and testing of all operating and safety controls.
- Combustion efficiency testing and reporting (multi-point testing). The engineer shall specify detailed testing requirements.

4. Training and demonstration to Mason's operating staff shall also be provided by a factory authorized representative. Training and demonstration shall not be performed concurrent with the start-up.

23 55 00 Fuel-Fired Heaters

1. Do not use without permission of Mason. If so, use stainless steel heat exchangers that are gas-fired units (not oil fired), using spark ignition only.

23 57 00 Heat Exchangers for HVAC

1. Selection and specifications for liquid-to-liquid, steam-to-liquid, air-to-air, etc. shall be reviewed by the University.
2. HTHW heat exchangers shall be shell and tube type.
   - HTHW shall be in tubes. Tubes shall be 90-10 copper-nickel. Heads shall be steel (forged, steel). Shell pressure rating should be 300PSI.
   - In water-to-water exchangers, the water flow shall be upward.
   - In water-to-steam generators, the controls shall be similar to those used for fired steam generators, excluding low water cutoff.
   - Provide separate over-temperature control on leaving secondary hot water.
   - Provide required level controls, secondary water relief and/or safety valves piped to floor drain on water or steam generators.
   - Provide increase tube pitch on steam generators.
   - HTHW Control valve should be on Supply side for better temperature control.
3. Provide units with a fouling factor of 0.0005 for water or as approved by Mason. For glycol exchangers, consult with Mason. 30% glycol solution should provide adequate freeze protection; consult with Mason if it is felt that a greater percentage is required. Propylene glycol may be required for certain food handling operations.
4. HTHW-to-water heat exchangers shall have the temperature sensing elements operating plus over temp., located in the shell near the outlet nozzle, and immediately adjacent to outlet nozzle.

23 60 00 Central Cooling Equipment

1. Warranty: 5 year parts and labor on all components including the compressor, fan motors, structural components, etc.
2. All equipment shall be checked out and started up by a factory authorized technician. Factory start-up services shall include the following as a minimum:
   - Pre-functional installation check-out.
   - Operation and testing of all operating and safety controls.
   - Verification of refrigerant charge and lubrication levels.

- Verification of proper evacuation and dehydration of all built up systems, custom systems and split systems.

3. Training and demonstration to Mason's operating staff shall also be provided by a factory authorized representative. Training and demonstration shall not be performed concurrent with the start-up.

23 63 00 Refrigerant Condensers

1. Use only on very small projects, with Mason permission. Water-cooled units may be considered for special applications such as back-up refrigeration. Air-cooled units must be justified by life-cycle cost analysis.
2. Limit air cooled condensers to very small systems or for equipment such as constant temperature rooms unless life-cycle cost indicate otherwise.
3. Where air cooled condensers are used, they shall be designed for low ambient temperature operation.
4. Warranty: 5 year parts and labor on all components including the compressor, fan motors, structural components, etc.

23 64 00 Packaged Water Chillers

23 64 16 Centrifugal Chillers – Water Cooled

1. Mason requires as efficient a unit as possible. Units shall be provided with variable frequency drives. Refrigerant type to be approved by Mason. Centrifugal chillers shall not be located outside of the building. A/E shall design all refrigerant relief piping, including all sizes and termination to safe point outside the building.
2. If the unit is pre-purchased, the A/E shall obtain pre-purchase specifications from Mason.
3. Provided condenser shell with marine style water boxes for pipe connection end. Provide hinged or davited water boxes on machines greater than 400 tons.
4. Trane, McQuay or Carrier are approved manufacturers.

23 64 19 Reciprocating Water Chillers

1. Use only on small projects, for remote locations and for special applications such as back-up cooling. Modular type units are preferred. Heat recovery units will require an economic evaluation including life-cycle analysis. Refrigerant type to be approved by Mason.

23 65 00 Packaged Cooling Towers

1. Fan shall be shaft driven.
2. Provide handrail, ladder and cage for access.
3. Provide all needed screens and protective devices. Discharge hoods and sound control measures shall be provided to attain noise levels acceptable to local conditions and ordinances.
4. For multiple cell cooling tower arrangements, provide automatic control valves on each inlet and outlet. Provide equalizer pipe between all cells to maintain equal basin levels under all possible operating conditions.
5. Float type Water level control is preferable. EP, BD and chemical pump should have H-O-A- selection switch.
6. Provide drains near cooling towers to handle overflow. The drains on cooling towers must drain to sanitary sewer as required by code for water treatment reasons.

7. Provide electric basin heaters unless Mason confirms that the cooling tower will be drained down in the winter and does not require basin heat.
8. All cold water basins shall be stainless steel construction.
9. Warranty: 5 year parts and labor on all components including the fan motors, structural components, etc.
10. All equipment shall be checked out and started up by a factory authorized technician. Factory start-up services shall include the following as a minimum:
    - Pre-functional installation check-out.
    - Vibration testing.
    - Operation and testing of all operating and safety controls.
    - Drive and fan blade adjustments.
    - Lubricating system level verification.
11. Training and demonstration to Mason's operating staff shall also be provided by a factory authorized representative. Training and demonstration shall not be performed concurrent with the start-up.

23 70 00 Central HVAC Equipment

23 74 00 Air Handling Units

1. All units shall be modular type unless custom, semi-custom or field erected units are approved by Mason. All air handling units shall be double wall construction.
2. Air handling units over 6,000 CFM capacity shall include the following as a minimum:
    - Double wall access doors, hinged with latches and durable gaskets. Gaskets shall be mechanically secured, they shall not be secured only by adhesives. Access door in positive pressure plenums must swing inward. Access doors in negative pressure plenums must swing outward. All access doors shall be provided with vision panel and the section served shall include a marine light with external switch.
    - All fans shall be non-overloading (backward inclined or airfloil type).
    - Provide all fans with factory mounted inlet airflow measuring devices.
    - Provide field mounted outdoor airflow measuring device and return air flow measuring device (where return fan is not integral to unit).
3. Cooling coil fin density shall not exceed 12 fins per inch.
4. Heating coil fin density shall not exceed 10 fins per inch.
5. Cooling coil section interior liner, supports, framing system and fasteners shall be type 304 or type 316 stainless steel.
6. All individual coils shall be supported by a framing system. Stacked coils shall not be supported by the coil below.
7. Humidifier section interior liner, supports and fasteners shall be type 316 stainless steel.
8. All fans shall be internally isolated.
9. All custom, semi-custom and field erected units:
    - Shall be factory fabricated, assembled and leak. Units shall be broken down in the factory for shipments/rigging. All components requiring field assembly shall be match marked in the factory.

- Shall be leak tested in the field after installation is completed.
- The installation shall be supervised by a factory authorized representative who shall inspect the installation prior to leak testing and start-up.
- The unit shall be started up by a factory authorized representative.
- The engineer shall be responsible for specifying test pressures and allowable leakage rates.
- The factory representative shall be responsible for producing leak test procedures and submitting to Mason for approval. The contractor shall be responsible for leak testing under the supervision of the factory representative. A leak test report shall be submitted to Mason, and shall be certified by the contractor and the factory representative.

10. All outdoor units shall be provided with the following as a minimum:
    - Units with width greater than eight feet shall have slope roof for proper rain water drainage.
    - Units with width exceeding 12 feet shall be provided with rain gutters and downspouts.
    - All exterior access doors shall have drip covers.

23 74 00 Packaged Outdoor HVAC Equipment

Rooftop Heating and Cooling Units

1. These may be used only with Mason approval.
2. When rooftop equipment is suggested for the project, the access to the roof shall be as a minimum a stair tower meeting applicable codes extended full-size to the roof. In addition, an available elevator may be required to extend to the roof.
3. As an alternative, the equipment may be located on an approved ground slab.
4. Coils shall be fully drainable from valve with hose connection.
5. Heating and cooling should be from external sources of hot water (or glycol mixture) or chilled water; do not use gas fired exchangers or air cooled refrigerant (DX) systems without Mason approval.
6. Relief Fan configurations are not acceptable. Return Fans shall be utilized in all applications except where approved in writing by Mason.

23 81 00 Decentralized HVAC Equipment

23 81 13 Packaged Terminal Air Conditioners

1. Use 18 gauge front panels on baseboards.
2. Fan coil units shall have permanent split capacitor motors.

23 81 46 Heat Pumps

1. Mason encourages investigating water-source heat pumps for feasibility. Use only after detailed life cycle cost analysis and approval of Mason.

Division 25 – Integrated Automation

25 00 00 Integrated Automation

1. The following building system and equipment controls shall be integrated through the HVAC Energy Management and Control System (EMCS)
    - HVAC DDC Control System
    - Building Lighting Controls and Day Lighting Controls
    - Data Center Monitoring
    - Power Monitoring
    - Plumbing Equipment Monitoring
    - Fuel oil handling systems and equipment.
    - Building Performance Measurement and Verification.
2. The following building system controls shall not be integrated with the EMCS:
    - Security
    - Audio/visual
    - Laboratory Equipment Monitoring
    - Elevator Controls
    - Fire Alarm
3. All building equipment shall be provided with integral microprocessor based controllers when available through the manufactures. In addition to the he integral equipment controllers functioning with the Siemens Building Technologies DDC system they shall also be capable of communications with the EMCS through industry standard communication protocol such as BACnet (ASHRAE Standard 135.1), Lontalk (LonWorks), or Modbus (Modicon/Schneider Electric).
4. The EMCS shall utilize the HVAC DDC control system network and operator interface for monitoring and adjustment of all integrated systems. The level of integration with integral equipment controllers shall be discussed with Mason and evaluated during the design. Refer to 230900 - “Instrumentation and Control for HVAC” and 230923 - “Direct Digital Controls.”
5. Measurement and verification of building system performance, efficiency and energy usage shall be incorporated into the EMCS.
6. All equipment utilizing programmable controllers shall be provided with a licensed copy of the controller software and software manual for use by Mason.
7. In addition to use of the Siemens Building Technologies DDC system to monitor power, all power monitoring shall also be provided using separate, field mounted power monitoring hardware. Use of integral factory mounted power monitoring hardware in electrical panels and motor control centers is not acceptable.

Division 26 00 00 - Electrical

26 00 00 General Requirements

1. Refer to Part 3.1.5.5.6 of this manual for General Electrical Design Criteria.

26 05 19 Low-Voltage (600V and below) Electrical Power Conductors and Cables

1. All conductors 250 KCMIL and larger can be aluminum installed per NEC, all other conductors shall be copper. All power conductors shall be awg #12 or larger. Minimum control wire shall be AWG #14 and minimum signal wire size no smaller than AWG #22.
2. Wire for low voltage circuits shall be single conductor stranded copper (solid for #12 and smaller) of not less than 98% conductivity with 600 volt, Type THHN/THWN insulation. Type XHHW may be used for sizes #2AWG and larger.
3. Wire and cable No. 10 AWG and smaller, shall be made with approved insulated indentation or spring insert type pressure connectors. Connections and splices in low voltage wire, No. 8 AWG and larger, shall be made with approved insulated spring insert type pressure connectors or bolted or compression-crimped type pressure connectors covered with an insulating filler tape, "Scotch-fil", or approved equal, and two half-lap servings of vinyl electrical tape, Scotch #33 or approved equal. All taped connections exposed to weather or moisture shall be given two coats of weatherproof insulating paint, Okonite, or approved equal.
4. All conductors shall be color-coded where visible and numbered and tagged to each junction box, pull box, panel and device with suitable fireproof tags or adhesive identification bands. Color-coding of conductors for power and branch circuits shall be as follows:

For 120/208 Volt System	For 277/480 volt System
Phase "A": Black	Phase "A": Brown
Phase "B": Red	Phase "B": Orange
Phase "C": Blue	Phase "C": Yellow
Neutral: White	Neutral: Grey
Ground: Green	Ground: Green

5. Feeder sizes and protections shall not be such a large percentage of the main that coordination of devices cannot be achieved.
6. Use two wire circuits with individual neutral conductors for all branch receptacle circuits in administrative, office, computer laboratory and classrooms, and general laboratory areas.
7. Refer to Part 3.1.5.5.6 for Branch Wiring Criteria.

26 05 13 Medium Voltage (600 ~ 15000V) Cables

1. Provide testing of the feeder cables per NETA-ATS and furnish Mason with a copy of the completed test report prior to equipment startup.

2. All cable in manholes shall be wrapped in two "opposing layers" of fireproofing tape secured in place with glass-cloth binder type. Slack cable shall be provided in manholes by routing the cables by the longest path possible through the manholes.
3. All cables in manholes shall be properly supported on cable supports a minimum of every 36". Provide new cable supports in existing manholes as required for proper support of both the new and existing cables.
4. High voltage cables shall be terminated in accordance with the cable manufacturer's recommendations using terminators specifically recommended by the type of cable specified.
5. Terminations and splices shall be performed by a certified experienced cable splicer. Taped "T" splices are not permitted; they will be made using elastimold, or approved equal, disconnectable fittings.
6. Cables shall be identified in manholes as to source and destination.
7. Testing: DC proof testing on high voltage and medium voltage cabling systems including primary / secondary, MCC, motors, etc. Test results to be included in O & M Manual.

26 05 26 Grounding and Bonding for Electrical Systems

1. Provide testing of the ground systems per NETA-ATS 7.13 and furnish Mason with a copy of the completed test report prior to equipment startup.
2. Ground connections that are permanently concealed shall be made by the exothermic process to form solid metal joints. Accessible ground connections shall be made with mechanical pressure type connectors.
3. Grounding conductor in raceways shall be 600 volt green insulated copper conductor sized per NEC code. The neutral bar of the panel shall not be used for equipment grounds.
4. Where concentric knock outs are used on panels or cabinets the paint needs to be removed to ensure metal to metal contact or a bonding bushing is to be used. This includes switchboards, panelboards, cabinets, transformer neutral, transformer ground pad, motor frames, motor starters, lighting fixtures, lightning arresters, conduit systems, and all non-current carrying metal parts of electrical equipment. Steel frame buildings shall be grounded through a low resistance ground system.
5. Convenience outlets shall have a wired ground for continuity of ground path from the device grounding pole.
6. Provide an 8' deep copper-clad driven ground rod at outdoor lighting poles for equipment grounding, and provide an equipment ground wire in PVC underground conduits to the poles per NEC.
7. A system ground shall be provided for each separately derived system including service entrance, each voltage level, and generators per NEC.
8. An isolated ground shall be provided where required for designated sensitive electronic equipment in any facility. An isolated ground bus must be provided in the source panel and connected back to the service ground point by an identified insulated ground conductor per NEC.
9. Grounding shall be per UL 467. Bare grounding conductors shall be stranded copper grounding. Bus shall be predrilled rectangular copper with stand-off insulators.

26 05 33 Raceway and Boxes for Electrical Systems

1. MC type cable is acceptable for electrical and fire alarm concealed applications such as walls and ceiling. Installation and support of the MC type cable shall comply with current NEC.
2. Minimum conduit size shall be ¾". All empty conduits shall have a 65-lb. test polymer (or equivalent) pull string tied off at both ends.

3. Galvanized rigid steel conduit shall be hot-dipped galvanized steel inside and outside comply with UL Standard 6, Federal Specification WW-C-581-D and ANSI C 80.1. Galvanized rigid steel conduit can be used for the following:

   - Buried raceways in concrete slabs (except for main services which shall be PVC conduit concrete encased ductbank) or in the ground. Where directly buried, two coats of asphaltic compound shall be applied.
   - Interior high voltage runs.
   - Exposed exterior raceways.
   - Any raceway in hazardous areas.
     1) Termination of ductbank runs through concrete and into equipment or indoor areas.

4. Electro-Galvanized Steel Metallic Tubing (EMT) shall comply with UL Standard 797, Federal Specification WW-C-563 and ANSI C 80.3. EMT can be used for the following:

   - Interior branch circuits that are exposed.
   - Interior exposed feeders.
   - Interior exposed motor circuit wiring.
   - Interior exposed control, Fire alarm, signal and sound wiring.
   - Use compression fittings only. Set screw type fittings are unacceptable. All fittings shall be steel.

5. Rigid Plastic Conduit, Schedule 40 PVC, can be used for the following:

   - Underground primary or secondary service ductbank encased in red concrete, rigid galvanized steel elbows shall be used where the conduit is run through concrete slab. Also a separate grounding conductor with green insulation shall be provided in these runs.
   - Underground telephone service ductbank encased in concrete.
   - Lightning protection down leads, and individual ground conductors.
   - Interior branch circuits that are exposed in wet or caustic environments.
   - Interior exposed feeders in wet or caustic environments.

6. Underground ductbank runs shall be installed minimum of 30" below grade to top of bank, wherever possible. If 30" is not possible, concrete encased ducts may be installed to minimum burial depth stipulated in NEC. Underground runs cable markers shall be installed for all direct-buried cables and cables in non-metallic and metallic raceways. Marker shall be located directly over buried lines at 8 to 10 inches below finished grade. See also 02580.

7. Liquid-Tight Flexible galvanized steel conduit with continuous copper bonding conductor shall be used for connection, not exceeding 5' in length, to all motors, heating and ventilating controls, and at other locations where vibration, movement, moisture, or oil-vapor atmosphere are encountered.

8. Hot-Dipped galvanized, single strip flexible steel conduit, not exceeding 6' in length shall be used for connections and chain hung lighting fixtures.

9. Plastic jacketed rigid steel galvanized conduit shall be used in corrosive atmospheres.

10. Rigid aluminum conduit may be used in lieu of rigid steel conduit, except where in contact with or in earth, concrete or masonry.

11. Conduit shall be 3/4" size minimum. Flexible steel conduit of 1/2" diameter may be used for connections to be recessed and chain hung lighting fixtures.

12. Where empty conduits are required to be installed, provide a continuous #12 nylon draw line with identification tag securely attached to both ends. The tags must clearly identify location of other end of empty conduit.

13. Suitable expansion and deflection fittings with grounding continuity shall be provided in each conduit run at each point where the conduit run crosses a building expansion joint.

14. All wiring shall be installed concealed in ceilings, walls, slabs, pipe chases and furred spaces whenever possible. Conduit may be installed exposed only in Mechanical Room, Electrical Room and Janitors Closets. Concealed conduit shall be installed in a direct line, with bends as long as practicable. Exposed conduit shall be installed parallel to or at right angles with the lines of the Building, as closely as possible to walls, ceilings, columns and other structural parts, consistent with proper space for access to boxes and so as to occupy a minimum of space. Where exposed conduits are grouped, they shall be run parallel and equally spaced with matching bends.

15. Surface metal raceways with snap-on covers shall be used for exposed runs in finished areas, for counter and workbench power and data outlets where required. Acceptable manufacturers are Wiremold, Mono-systems and Isoduct.

16. Pull and junction boxes shall be of ferrows alloy. Cabinets shall be galvanized steel with hinged cover.

26 11 00 Substations

1. Type and Location of Building Substations:

   - Outdoor compartmental type pad mounted, completely enclosed, liquid filled power transformer with load break primary disconnect, or two "on-off" load break disconnects for loop feed service where required by campus distribution, primary fuses and lightning arresters may be used to serve the building. This shall be located close to building electrical equipment room to keep secondary runs from outdoor transformer to indoor main distribution switchboard as short as possible. Main power distribution switchboard shall be located in building electrical room, NEMA 1 construction. The secondary power distribution switchboard shall be similar to that below for indoor units.

   - Indoor unit substation shall consist of a load break primary disconnect, or two "on-off" load break disconnects for loop feed service where required by campus distribution system, primary fuses, primary lighting arresters; dry type ventilated power transformer; and main secondary power distribution switchboard. Unit substations shall be provided as a completely enclosed, integrated and coordinated line-up by the manufacturer. The two primary "on-off" load interrupter switches for loop feed shall be in individual vertical section connected together on the load side and key interlocked to prevent both incoming circuits from being connected to transformer at the same time. Primary sections shall be equipped with copper ground bus. Incoming primary service shall be underground wherever possible. Primary fuses shall be disconnect type S & C type SM5, or approved equal. Dry-type ventilated transformer to have maximum temperature rise of 115^{o} C. above a 40^{o} C. maximum ambient, to be equipped with provisions for forced cooling, to have 4 - 2-1/2 full capacity taps in high voltage winding 2 above and 2 below normal, and ground pad. Main secondary switchboard shall be front accessible, with vertical sections as required bolted together to form one metal enclosed rigid switchboard constructed to NEMA PB-2 and UL 891 standards. It shall be equipped with Owner's metering section with an ammeter and selector switch, voltmeter and selector switch and KWHR meter demand attachment. Unit shall have a main circuit breaker, and feeder branch circuit breakers as required to serve loads plus two spare feeder breakers. Rating of main bus, circuit breakers, etc. shall be determined based on building transformer rating and building distribution system to serve loads. Interrupting capacity shall be determined and noted on system one line diagram main buses and equipment. Provide a ground copper bus in switchboard for its entire length firmly secured to each vertical section. Provide space for future breakers. Incoming secondary service shall be underground wherever possible. Breaker loading shall be a maximum of 80% of its rating unless breakers are specified and available as fully rated units for switchboard service. Each breaker on the switchboard assembly shall have an engraved lamacoid nameplate to designate load served.

26 24 16 Panelboards

1. All panelboards and Motor Control Centers will tested in accordance with NETA-ATS 7.1 and a copy of the test report will be furnished to Mason prior to equipment start-up.

2. All panelboards shall be rated for the intended voltage and shall be in accordance with Underwriter's Laboratories, Inc., standards for panelboards and standards for cabinets. Panelboard boxes shall be so labeled.

3. Panels shall consist of factory completed dead-front assemblies of sheet steel cabinets, main buses, over-current and switching units and sheet steel trim.

4. Boxes shall be 20 inches wide and fabricated from unpainted, galvanized code gauge sheet steel having multiple knockouts with lapped and screwed or welded corner construction. Boxes shall be of sufficient size to provide a minimum gutter space in accordance with NEC Tables 373-6(a) and (b), but not less than four inches at the side and six inches at top and bottom. Multi-section panelboards shall be provided with a minimum top and bottom gutter space of 8 inches. Where feeder cables supplying a panel are carried through its box to supply other panels the box shall be provided with a separate barriered side gutter. Cables shall be bundled, routed and supported within the gutters. This wiring space shall be in addition to the minimum gutter space specified above. A minimum of four interior mounting studs shall be provided.

5. Trims shall be fabricated from code gauge galvanized sheet steel. Trims shall be fastened to cabinets by means of machine screws with captive nuts or clamps and shall be self-supporting on the cabinet after trim holding screws have been removed. Trim for flush panels shall overlap its perspective box by at least 3/4 inch all around. Surface trim shall have the same width and height as its respective box. Doors and trims shall each be in one piece so designed that door will close without a rabbet.

6. Panel doors shall be fabricated from the same material as the panel trim and shall be fastened thereto by continuous concealed hinges. Doors shall be so installed that no live parts are exposed when the door is opened. Doors shall be complete with flush type combination lock and catch with keys. Doors over 48 inches high shall be provided with vault handle, built-in locks and three point catch fastening door at top, bottom and centers. All panels shall be keyed alike. Doors shall be provided for access to contactors, time clocks, relays, and similar devices as required.

7. Backbox interiors, inside trim, door and exterior shall be treated with a rust inhibiting phosphatized coating after pickling and finished in ANSI-61 gray enamel. A typewritten directory, eight inches by ten inches, with metal frame and clear plastic face shall be furnished and installed upon the inside of the door of each panelboard, indicating the room or area and the service controlled by each circuit.

8. Bus bars shall be hard drawn copper and extend the full height of the panel without reduction. Buses shall be arranged for sequence phasing of branch circuits. Circuit loading shall be distributed evenly over all phases. The neutral bus shall have a suitable lug for each outgoing branch circuit requiring a neutral connection. Neutral bus shall be full size and electrically isolated from the cabinet. Ground bar shall be bare uninsulated and suitable bolted to the cabinet for equipment grounding. Busing shall be braced throughout to conform to industry standard practice governing short circuit stresses in panelboards. Bracing shall be equivalent to, or compatible with, the rated interrupting capacity of the smallest overcurrent device in that panelboard. Spaces for future devices shall be bussed for the maximum device that can be fitted into them with suitable insulation and bracing to maintain proper short circuit rating. All provisions shall be made for ready insertion of future protective devices. Provide an isolated ground bus where required by special sensitive equipment.

9. All interiors shall be completely factory assembled with switching and protective devices, connectors, etc. They shall be so designed that switching and protective devices can be replaced without disturbing adjacent units and without removing the main bus connectors and shall be so designed that circuits may be changed without machining, drilling or tapping. Branch circuits shall be arranged using double row construction.
10. Multiple section panels shall have feed-thru lugs with full capacity taps to adjacent panel sections.
11. Lighting and power panels for 480Y/277 volt system and receptacle, appliance and power panels for 208Y/120 volt system shall be of the bolted circuit breaker type with single, two and three pole branches of quantity and trip setting as required. Panelboards shall be furnished with main overcurrent interrupting devices consisting of circuit breakers of size and capacity as required.
12. Multiple cable lugs for incoming feeder cables shall be furnished where required. Lugs shall be secured to bus by stud bolts. Where several panels are fed by one feeder, solid tap connections shall be made in separate side gutters as required with tap connectors. Suitable lugs or connectors shall be provided for connecting feeders. Tap connections to multiple lug feeders shall be made to all lugs at each tap joint.
13. Square D, Seimens and GE are acceptable manufacturers for panel-boards.

26 29 13 Enclosed Controllers

1. Motor starters (Individual), Magnetic Type:
   - Starter units for three phase motors shall be the combination full voltage type, consisting of a magnetic starter containing three manual reset thermal bimetallic overloads and low voltage protection. Each starter unit shall include a circuit breaker (MCP) disconnect for short circuit protection and provisions for locking switch, handle in the "on" and "off" positions. Each starter unit shall be complete with 2 extra normally open and 2 extra normally closed interlock contacts. Starters shall be mounted in NEMA 1 enclosure indoors and NEMA 4 outdoors. Minimum size shall be NEMA 1.
   - Units shall be equipped with individual 120 volt secondary control transformers as required with two primary and one secondary control fuse. The other secondary lead shall be grounded. Where indicating lights, solenoid valves and additional control components are energized from the control transformer, the capacity of the control transformer shall be proportionally increased.
   - Starter shall have "Hand-Off-Auto" selector switches and indicating red "run". Control units shall be of the heavy duty oil tight type. Lights shall be 120/6 volt type with lamp voltage rated 150% of normal voltage and of the miniature bayonet type only.
2. Manual motor starters for single phase motors shall be 2 pole, have a quick-break quick-make toggle mechanism that can be locked in "off" position, with a neon pilot light to indicate when motor is running, with thermal overload units as required. Enclosure shall be NEMA 1 for indoors, NEMA 4 for outdoors, or NEMA 7-9 for hazardous areas.

26 24 19 Motor Control Centers

1. Motor control centers shall be NEMA Class 1, Type B wiring. The 480V motor control centers shall consist of independent vertical sections, free standing on 4" channel iron sills with sections bolted together to make up the center. The section shall be 90" overall height, including the mounting sills. The width of each section shall be 20" (except large starters or other special panels which may be 30" in width). Structure depth shall be 20" and designed to mount starters in the front only. A maximum of six starter units shall be stacked in one vertical section. Terminal blocks for wiring shall be mounted within each starter unit and shall be factory wired. Each section shall be dead front, and rear access shall not be necessary for connections. Removable rear plates shall, however, be employed on the rear of the structure. Pan type doors shall be used for all units and future spaces. Doors shall be

hinged to the structure with a concealed hinge and fastened with pressure type fasteners. The top of each section shall have removable plates for access to the horizontal feeder bus and for conduit entry. A minimum of 12 gauge steel shall be used throughout the structure, including all doors and plates. All painted steelwork shall be treated with a primer coat and a finish coat.

2. The top of each section shall contain horizontal feeder bus bars of tin plated aluminum or copper which shall run continuously through the center from section to section. Provisions shall be made for easy addition and connection to adjacent sections. The horizontal bus shall be sized as required by the load, but in no case less than 600 amperes. The horizontal bus shall be braced to withstand the maximum fault current available at that point. The bus supports shall be formed of high dielectric strength, low moisture absorbing, high impact material with ample creepage distance between bus bars. Each section shall contain 3 vertical bus bars running the full working height of the section and connected to the horizontal feeder bus bars. The vertical bus bars shall be braced to withstand the maximum fault current available at that point. The bus support shall be formed of high dielectric strength, low moisture absorbing, high impact material with ample creepage distance between bus bars. Vertical bus shall be sized as required by the load, but in no case less than 300 amps.

3. Each section shall have a top horizontal wiring trough in front of the main horizontal bus. This wiring trough shall be protected from the horizontal bus bars by means of a steel barrier plate. The wiring trough shall be equipped with cable supports and the structure shall have a cutout in the end for continuous cable runs through the motor control center. A vertical wiring trough shall run the full working height of each section and shall be equipped with cable tie clamps. This vertical wiring trough shall be designed so as to allow installation wiring to the units with the unit doors open, but with the units in place.

4. Motor starter units shall be of the combination type with motor circuit protectors coordinated with motor overload relays. The interrupting rating assigned to the complete combination motor starters shall exceed the system short circuit capacity at the starter terminals. Starter units shall meet the requirements specified above.

5. A magnetic trip only molded case circuit breaker which serve as a main disconnect shall be provided where required. A horizontal copper ground bus 1/4" x 1" shall be provided with lugs for termination of the feeder and branch circuit ground conductors. Motor starter units shall connect to the vertical bus bar in each section with stab-on connectors shall be free-flowing silver plated clips, self-aligning and backed up with steel springs. Units shall be capable of being withdrawn from the structure with a minimum of difficulty. Unit support brackets shall be provided in the structure to properly align the units. Cam latch fasteners shall be employed on each unit to latch the unit in one of two positions in the structure.

   - The engaged position - Stabbed on the vertical bus.
   - The test position - With units withdrawn from the vertical bus, but still supported by the structure. In the test position, the pull-apart terminal block must still be capable of being engaged for electrical testing purposes.

6. In either engaged or test positions, the cam latching mechanism on the unit must be capable of being padlocked to prevent unauthorized movement of the unit. Units shall have complete steel top and bottom plates to provide maximum isolation between units. Units shall be of modular dimensions so that it is possible to readily interchange units of the same size without modifications in the structure.

7. Motor disconnect switch operating handles shall be interlocked with the door so that the door cannot be opened with the switch in the "on" position, except through a hidden release mechanism. The operating handle shall be arranged for padlocking in the "off" position with up to three padlocks. Motor starters shall be built, tested, and sized in accordance with NEMA Standards for Industrial Control, except that no smaller than NEMA Size 1 starters shall be employed in any unit. Motor overload protection shall be effected by three element overload relays with adjustable heater element positions.

8. Engraved nameplates shall be provided for each unit of the motor control center as well as the assembly. Screw or pin attachment only, no label tape for switchgear.

9. Motor Disconnect Switch: Provide a motor disconnect switch for any motor located from its starter unit. Switch shall be horsepower rated, heavy duty type, switch blades fully visible in off position when door is open, quick-made and quick-break mechanism, handle positions shall indicate and be lockable in "on" and "off" positions. Enclosures shall be NEMA 1 indoors, and NEMA 4 outdoors.
10. Provide a motor disconnect switch within sight of motor.
11. Yaskowa, ABB, and Trane TR 200 VFDs are acceptable manufactures. Same brand throughout project.

26 27 26 Wiring Devices

1. All wiring devices shall be industrial heavy duty specification grade, rated a minimum 20A, 125V.
2. Local wall switches shall be heavy duty specification grade, toggle, quiet type, color as approved by the University, fully enclosed in composition cases, rated 20 amp. 120/277 volt AC; Hubbell #1221 Series, or approved equal.
3. Receptacles generally shall be duplex, specification grade, 2 pole, 3 wire grounding type conforming to latest NEMA standards for 20 amp, 125 volt with back and side wiring, ivory; Hubbell #5362, or approved equal.
4. Receptacles for use with specific equipment, special applications, etc. shall be suitable for the load to be served and of proper configuration for the mating plug.
5. Switches and receptacles for wet hazardous areas shall be an approved type for the environment served. Receptacles near water basin or sink shall be GFCI IAW the code.
6. Receptacles fed from emergency power upon failure of normal power shall have cover of steel with red baked enamel and word "EMERGENCY" marked in white letters on cover.
7. Ground fault interrupter type receptacles shall be duplex 120V. AC 20 amps as required, Class A.
8. Device plates, telephone outlet plates, and blank plates in finished areas shall be .04 gauge 302 stainless steel with brushed finish.
9. Surface mounted multi-outlet system:
   - Multi-outlet systems shall consist of surface mounted metal raceways for use with number and type of wiring devices as required. Systems shall be complete with all fittings, etc. and shall be equal to Wiremold 2000 and G-3000.
   - Systems requiring combination power and telephone/communication multi-outlet with divider shall be equal to Wiremold G-4000 and G-6000 as required.
10. Provide a 20 amp duplex outlet in the corridor near each floor landing of each stair. Provide at least one 20 amp duplex outlet in corridors and space such outlets at 75 feet on center in all corridors.
11. Emergency Power Off (EPO) switches shall be double action to prevent accidental activation. They shall also be labeled as to which panel and breakers are tripped when activated if panel is not located in same room as EPO.
12. Refer to Part 3.1.5.5.6 for wiring devices criteria.
13. Label all outlets with panel and circuit number. Match numbering at panel with directory at panel.

26 28 16 Enclosed Switches and Circuit Breakers:

1. Circuit breakers shall be of the molded case, bolted in type consisting of the number of poles and ampere ratings as required. Two and three pole breakers shall be of the common trip type. Handle extensions providing manual operation will not be accepted.

2. Circuit breakers shall be of the indicating type providing "on", "off" and "tripped" position of the operating handle. When the breaker is tripped the handle shall assume a position between "on" and "off" positions. Breakers shall be of the quick-make and quick-break type toggle mechanism with inverse time trip characteristics. Automatic release shall be secured by a bimetallic thermal element releasing the mechanism latch. In addition, a magnetic armature shall be provided to trip the breaker instantaneously for short circuit currents above the overload range.
3. Circuit breakers shall be rated for the voltage of the circuit on which they are used. Circuit breakers with 225 ampere or larger frame sizes shall have interchangeable trips.
4. Locking tabs shall be provided on all circuit breakers serving emergency lighting, fire alarm system, security systems and other emergency or critical equipment.
5. Interrupting capacity of breakers shall be suitable for the power system. Available short circuit currents shall be noted on single line diagram on all major system buses and on panel schedules.
6. Circuit breakers feeding 120 volt lighting circuits that are not controlled by local wall switches shall be approved type "SWD" circuit breakers.
7. Circuit breakers for Heat Trace systems shall be a GFCI.
8. Breakers 100 amp or greater shall be tested IAW the NETA-ATS standard.

26 32 13 Engine Generator Assemblies

1. The emergency system shall consist of a diesel packaged engine generator set.
2. The generator shall be tested with a portable load bank by the Contractor.
3. Generator shall meet the requirements of NEMA MG1 and NFPA 37.
4. Shall have in-skid fuel tank and be rated at 480V/877V-3 phase 4 wire.
5. Fuel storage shall have adequate capacity in order to provide 24 hour run time at full load of the generator.
6. Outdoor units shall be in sound attenuated enclosure. Indoor units must have acoustical treatments to meet the required project NC rating. Sound attenuation/acoustical and exhaust design must be approved by the University.
7. Shall be provided with a full maintenance service. All generators shall have a minimum 2 year parts and labor warranty.
8. Acceptable manufacturer’s are Onan/Cummins, Kohler, and Caterpillar.
9. For generator design criteria see Part 3.1.5.5.6

26 42 00 Cathodic Protection

Underground steel pipe systems shall be cathodically protected using Pikotec or approved equal.

26 50 00 Lighting

1. Refer to Part 3 of this manual for interior and exterior lighting design criteria.
2. Emergency light fixtures shall be provided with the emergency power.

3. Ballasts
    - Fluorescent ballasts shall be electronic type with following features:

1) High frequency solid state electronic
2) High power factor (90% or higher)
3) Class P thermally protected
4) Have a harmonic distortion of less than 15% and comply with all current ANSI standards
5) Super - quiet operating sound level of 2 dB above a 16 dB ambient
6) Meet FCC requirements governing electromagnetic and radio frequency interference
7) Comply with all applicable State & Federal ballast efficiency standards
8) Listed & Approved by U. L.
9) Designed for use with T5 OCTIC type (265 ma) rapid start lamps.

Ballast manufacturers to be Advance, Universal or EBT.

4. Lamps
   - Fluorescent lamps shall be T5 rapid start Sylvania Octron F032/835 for 4 ft. units, and Sylvania Octron Curvalume FB031/835 (for 1 5/8" leg spacing) or FBO32/835/6 (For 6" leg spacing) for 2' x 2' fixtures, CRI 80 (minimum) 3500K color temperature or equivalent by G. E. or Philips.
   - LED lighting is preferred.
   - Incandescent lamps are not preferred and require specific Univeristy approval for use. When required shall be rated 130 volt for 120 volt circuits.
   - Emergency exit signs shall be Hubbell LED exits, models LED-1EM RB or LED-2EM RB or approved equal with light emitting diodes as the light source.
5. Exterior Lighting:
   - Street and parking lot poles shall be per the details.
6. Lighting Control:
   - Contractor shall provide the initial lighting control setup.
   - If any software/cabling are required, provide the University a copy of the software and a set of said cables.

26 52 00 Emergency Lighting

Emergency lighting shall be provided as required by code; including toilet areas, outdoors at all egress doors, mechanical / main electrical room and in laboratory areas.

Division 27 - Communications

27 00 00 General Communications Provisions (Communications)

1. Use the Section template provided by Mason.

27 05 00 Common Work for Communications

1. Use the Section template provided by Mason.

27 05 26 Grounding and Bonding for Telecommunications Systems

1. Use the Section template provided by Mason.

27 05 28 Conduit and Backboxes for Communications Systems

1. Use the Section template provided by Mason.

27 05 36 Cable Tray for Communications Systems

1. Use the Section template provided by Mason.

27 05 43 Underground Ducts and Raceways for Communications Systems

1. Use the Section template provided by Mason.

27 15 00 Inside Plant Structured Cabling System for Residential Buildings

1. Use the Section template provided by Mason.

27 15 00 Inside Plant Structured Cabling System for Non-Residential Buildings

1. Use the Section template provided by Mason.

SECTION 27 00 00

GENERAL COMMUNICATIONS PROVISIONS (COMMUNICATIONS)

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes the following scope of work:
1. Intent of Drawings.
2. Pre-Bid Site Visit.
3. Definitions.
4. General Standards of Materials.
5. Products and Substitutions.
6. Applicable Codes.
7. Guarantees and Certificates.
8. Quiet Operation and Vibration Control.
9. Temporary Shutdown of Existing Systems.
10. Coordination.
11. Shop Drawings, Product Data, and Samples.
12. Owner Instruction.

1.03 SCOPE OF WORK

A. The scope of the work included under Division 27 of the specifications shall include complete systems as shown in the Contract Documents and specified herein. Any work reasonably inferable or required to result in a complete installation or the intended operation and performance of the systems, shall be included in the Base Bid except where there is specific reference to exclusion and incorporation in other quotations.

1.04 INTENT OF DRAWINGS

A. Provide complete and functional systems for the project. The systems shall conform to the details stated in the specifications and shown on the drawings. Items or work not shown or specified, but required for complete systems, shall be provided and conform with accepted trade practices. The drawings and specifications are presented to define specific system requirements and serve to expand on the primary contract requirements of providing complete systems. The drawings are diagrammatic and indicate the general arrangement and routing of the systems included in this contractors work.

B. Do not scale the drawings. Because of the scale of the drawings, it is not possible to indicate offsets, fittings, valves, or similar items which may be required to provide complete operating systems. Carefully investigate conditions affecting the work associated with this project. Check and verify dimensions and existing conditions at the site. Install systems in such a manner that interferences between pipes, conduit, ducts, equipment, architectural and structural features are avoided. Provide items required to meet the project conditions without additional cost to the owner.

C. These documents may not explicitly disclose final details required for a complete systems installation; however, contractors shall possess the expertise to include the necessary appointments of complete operating systems.

D. Contractors shall be “Experienced” (as defined in Division 1) in this type of construction and realize the extent of the work required.

E. BICSI Certification of Workers
1. The contractor will employ a minimum of one Registered Communications Distribution Designer (RCDD) certified by and in good standing with BICSI. This RCDD must be a direct full time employee of the contractor and the contractor will continue a minimum of one RCDD throughout the duration of the project. An RCDD shall remain assigned to the project from start to finish and be available to provide guidance to the installation team.
2. Ortronics/Berk-Tek must be able extend a NetClear 25-year Static, Dynamic and Applications Warranty to the end user once the Telecommunications contractor fulfills all requirements under Ortronics and Berk-Tek OASIS Program. At least 30 percent of the copper installation and termination crew must be certified by Berk-Tek and Ortronics or by BICSI with a Technician Level of training.

1.05 PRE-BID SITE VISIT

A. Bidders shall visit the site and become completely familiar with existing conditions prior to submitting their bid. No extra charges shall be allowed as a result of existing conditions

1.06 DEFINITIONS

A. Specific terminology, as used herein, shall have the following meanings:
1. “Finished Space” …Space other than mechanical rooms, electrical rooms, furred spaces, pipe chases, unheated spaces immediately below roof, space above ceilings, unexcavated spaces, crawl spaces, tunnels, and interstitial spaces.
2. "Conditioned"...Spaces directly provided with heating and cooling.
3. "Unconditioned"...Spaces without heating or cooling including ceiling plenums.
4. "Indoors"...Located inside the exterior walls and roof of the building.
5. "Outdoors"...Located outside the exterior walls and roof of the building.

1.07 GENERAL STANDARDS OF MATERIALS

A. Equipment and materials, unless otherwise noted, shall be new and of first quality, produced by manufacturers who have been regularly engaged in the manufacture of these products for a period of not less than five years.

B. Equipment of one type shall be the products of one manufacturer; similar items of the same classification shall be identical, including equipment, assemblies, parts and components.

C. Materials furnished shall be determined safe by a nationally recognized testing organization, such as Underwriters' Laboratories, Inc., or Factory Mutual Engineering Corporation, and materials shall be labeled, certified or listed by such organizations. Where third party certification is required for packaged equipment, the equipment shall bear the appropriate certification label.

D. With respect to custom made equipment or related installations which are constructed specially for this project, the manufacturer shall certify the safety of same on the basis of test data. The Owner shall be furnished copies of such certificates.

1.08 PRODUCTS AND SUBSTITUTIONS

A. Where a specific manufacturer's product is specified, the Contract Amount shall be based on that product only. Any substitutions from the specified product shall be offered as a Substitution Request. Refer to Division 1 for requirements. Substitutions shall not be permitted after the bidding phase without a Substitution Request Form included with the bid.

B. Where several manufacturer's products are specified, the Contract Amount shall be based upon the specified products only. Any substitutions from the specified products shall be offered as a Substitution Request. Refer to Division 1 for requirements. Substitutions shall not be permitted after the bidding phase without a Substitution Request Form included with the bid.

C. Where only one manufacturer's product is specified, the associated systems have been designed on the basis of that product. Where several manufacturer's products are specified, the associated systems have been designed on the basis of the first-named manufacturer's product. When products other than those used as the basis of design are provided, the contractor shall pay additional costs related to submissions review, redesign, and system and/or structure modifications required by the use of that product.

D. It is the intent of these specifications that service organizations follow the above substitution procedures.

1.09 APPLICABLE CODES

A. Materials furnished and work installed shall comply with applicable codes listed in Division 1, with the requirements of the local utility companies, and with the requirements of governmental departments or authorities having jurisdiction.

1.10 GUARANTEES AND CERTIFICATES

A. Defective equipment, materials or workmanship, including damage to the work provided under other divisions of this contract resulting from same, shall be replaced or repaired at no extra cost to the Owner for the duration of the stipulated guarantee periods.

1. Unless specifically indicated otherwise, the duration of the guarantee period shall be one (1) year following the date of Substantial Completion. Temporary operation of the equipment for temporary conditioning, testing, etc., prior to occupancy will not be considered part of the warranty period.

1.11 QUIET OPERATION AND VIBRATION CONTROL

A. Equipment and associated items shall operate under conditions of load without sound or vibration deemed objectionable by the Architect. In the case of moving equipment, sound or vibration noticeable outside of the room in which it is installed, or noticeable within the room in which it is installed, shall be deemed objectionable. Sound or vibration deemed objectionable shall be corrected in an approved manner at no extra cost to the Owner. Vibration control shall be provided by means of approved vibration isolators and installed in accordance with the isolator manufacturer's recommendations.

B. The sound pressure levels around mechanical and electrical equipment (fans, pumps, motors, etc.) in equipment spaces shall not exceed 85 dBA at any point three (3) feet from the equipment, with all equipment in the room operating. The sound criteria applies to the complete range of each piece of equipment.

1.12 TEMPORARY SHUTDOWN OF EXISTING SYSTEMS

A. Plan installation of new work and connections to existing work to insure minimum interference with regular operation of existing systems. Some temporary shutdown of existing systems may be required to complete the work.

B. Submit to the Owner in writing for approval, proposed date schedule, time, and duration of necessary temporary shutdowns of existing systems. Submit schedule at least fifteen (15) calendar days in advance of intended shutdown. Shutdowns shall be made at such times as shall not interfere with regular operation of existing facilities and only after written approval of Owner. The Owner reserves the right to cancel shutdowns at any time prior to the shutdowns. To insure continuous operation, make necessary temporary connections between new and existing work. Bear costs resulting from temporary shutdowns and temporary connections. No additional charges shall be allowed for Owner-canceled shutdowns that must be rescheduled.

C. Shutdowns must be performed by the Owner. Do not shut-down any system. The Owner reserves the right to require a walk-through of any shutdown prior to the shutdown. Following electrical shutdowns, verify that affected motors are rotating in the proper direction. Bear costs associated with reverse rotated motors.

1.13 COORDINATION

A. Coordinate and furnish in writing to the Architect information necessary to permit the work to be installed satisfactorily and with the least possible interference or delay.

B. <u>Coordination drawings shall be prepared as defined in Division 1. No installation of permanent systems shall proceed until the coordination drawings are reviewed by the Architect. No extra charges shall be allowed for changes required to accommodate installation of systems provided under other divisions of this contract.</u>

C. Coordination drawings shall be developed from individual system shop drawings and contractor fabrication drawings. Electronic or other reproduced engineering design drawings used as coordination drawings are not acceptable.

D. When work is installed without proper coordination, changes to this work deemed necessary by the Architect shall be made to correct the conditions without extra cost to the Owner.

E. The value of the coordination drawings shall be identified as a line item in the Schedule of Values. If the coordination drawings are not submitted as required, their value shall credited to Owner in accordance with the provisions of Article 7 of the General Conditions. The value of coordination drawings shall be a minimum of two (2.0) percent of this Contract Amount.

1.14 SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES

A. Shop drawings, product data, and samples shall be submitted in accordance with the provisions of Division 1.

B. The following shall be submitted by the Contractor for review:
   1. Scale shop drawings showing system components with sizing indicated, including but not limited to:
      a. equipment locations
      b. raceways
      c. insert and sleeve locations
      d. hangers, anchors and guides
      e. expansion joints
      f. access doors
   2. Product data for system components and materials (including construction standards).
   3. Samples of finishes and trim exposed to view, such as fixture trim, escutcheon plates and similar items.

C. The value of shop drawings, product data and samples shall be identified as a line item in the Schedule of Values. If the shop drawings, product data and samples are not submitted as required, their value shall credited to Owner in accordance with the provisions of Article 7 of the General Conditions. The value of these items shall be a minimum of one (1.0) percent of this Contract Amount.

1.15 OWNER INSTRUCTION

A. After final tests and adjustments have been completed, furnish the services of qualified personnel to instruct representatives of the Owner in the operation and maintenance procedures for equipment and systems installed as part of this project. Operation and maintenance instructions for major items of equipment shall be directly supervised by the equipment manufacturer's representative. Supply qualified personnel to operate equipment for sufficient length of time as required to meet governing authorities' operation and performance tests and as required to assure that the Owner's representatives are properly qualified to take over operation and maintenance procedures. Minimum instruction period shall be 20 man hours. The instruction period shall be broken into segments at the discretion of the Owner.
   1. Notify the Architect, the Owner's representative and equipment manufacturers' representatives, by letter, as to the time and date of operating and maintenance instruction periods approved by the Owner at least one (1) week prior to conducting same.

2. Forward to the Architect the signatures of all those present for the instruction periods.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

SECTION 27 05 00

COMMON WORK FOR COMMUNICATIONS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
1. Communications equipment coordination and installation.
2. Common communications installation requirements.
3. Excavating and backfilling.
4. Demolition
5. Waterproofing.
6. Weatherproofing locations.
7. Cutting and Patching.
8. Painting.
9. Equipment Foundations, Supports, Piers and Attachments.
10. Equipment Guards and Rails.
11. Cleaning, Protecting and Adjusting.
12. Welding.
13. Sleeves for raceways and cables.
14. Sleeve seals.
15. Grout.

1.03 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.

B. NBR: Acrylonitrile-butadiene rubber.

C. Wiring: Cable and/or wire installed in Raceway.

1.04 SUBMITTALS

A. Product Data: For sleeve seals.

1.05 EXCAVATING AND BACKFILLING

A. Excavate and backfill as required for the installation of this work.

B. Trenches for underground wiring shall be excavated to required depths. Where rock is encountered, excavate to a grade 6 inches below the lowest part of the pipe and refill the excavation below pipe grade with sand and gravel. Trenches shall have uniform grade as specified hereafter or shown on the Drawings.

C. Trenches shall not be wider than 4 inches on each side of the raceway but not less than 12 inches wide.

D. Excavations shall be done on an unclassified basis. No extras shall be allowed regardless of type or hardness of material encountered.

E. No backfilling shall be done on any system requiring testing or inspection until such testing or inspection has been completed satisfactorily.

F. Shore and brace as required to maintain banks of excavation and avoid cave-ins and make good any damages to adjoining property or work in place caused by failure to properly shore excavations. Shoring shall conform to OSHA and Department of Labor and Industry requirements.

G. Backfilling shall be made in 6 inch layers, mechanically tamped. Wood, old forms, shoring, etc., shall be removed before backfilling. Backfill shall not contain any frozen material, ashes, slag, combustible material, rocks over 6 inches in the largest dimension, or any other material which the Architect considers unsuitable for the purpose. Particular care shall be exercised in backfilling areas where construction shall be placed above the backfill.

H. Satisfactory soil materials for backfill where contaminated soil is removed whether surplus from the existing site or trucked-in new shall meet the following requirements:
   1. ASTM D 2487 soil classification groups GW, GP, GM, SW, SP, and SM free from rock or gravel larger than 2 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.

I. Compaction of soil and backfill shall be as follows:
   1. Soil and backfill shall be compacted in 12 inch layers with each layer of soil or backfill compacted at 95 percent maximum dry density according to ASTM D 1557.

J. Shoring shall be removed after equipment and wiring have been installed and tested.

K. Keep available at all times pumping equipment which shall be used to pump any or water from trenches and excavation under this Contract.

L. Remove from the site surplus excavated materials resulting from work. Surplus excavated materials include materials not suitable for use as backfill.

M. Notify utility companies and state “one-call” system for verification of underground utilities before any excavation takes place.

N. Refer to specification section 270543 – Underground Ducts and Raceways for Communications Systems for additional information.

1.06 WATERPROOFING

A. Where work pierces waterproofing, including waterproof concrete, the method of installation shall be approved by the Architect prior to performing the work. Furnish necessary sleeves, caulking and flashing required to make openings absolutely watertight.

1.07 WEATHERPROOFING LOCATIONS (WP)

A. Communication apparatus, such as outlet boxes, switches, connection panels, speakers, cameras, and other devices shall be weatherproof gasketed type, NEMA Types 3 or 4 in the following instances:
1. On surface of exterior face of building, including areas where not under canopies, cast boxes with threaded hubs must be used and under canopies steel boxes with gasket connections to devices.
2. In any areas where specifically noted "WP" or required by the NEC or Regulations mentioned herein.
3. Within air conditioning enclosures.
4. In underground splice boxes.
5. On building roof.
6. Within vivarium locations.
7. In unconditioned spaces subject to exterior ambient conditions such as loading docks and parking garages.

1.08 CUTTING AND PATCHING

A. Provide cutting and patching necessary to install the work specified herein. Patching shall match adjacent surfaces. Refer to Division 1, Cutting and Patching for specific directions.

B. No structural members shall be cut without prior approval of the Architect; such cutting shall be done in a manner directed by him.

C. Provide ceiling removal and replacement where work above ceilings is required. Replace ceiling components damaged in the process.

D. Provide patching where communications devices are removed from walls, ceilings or floors.

1.09 ACCESSIBILITY

A. Coordinate to ensure the sufficiency of the size of shafts, and chases, and the adequacy of clearances in hung ceilings and other areas required for the proper installation of this work.

B. Locate equipment which must be serviced, operated or maintained in fully accessible positions. Locations in ceilings requiring access shall be coordinated with, but not limited to lights, curtain tracks, and speakers. Equipment requiring access shall include, but is not necessarily limited to, motors, junction boxes, fire dampers, controllers, switchgear, etc.

C. Indicate the locations of access doors for each concealed device, concealed behind finished construction and requiring service on the coordination drawings. Equipment below floor slab or finished grade shall also be indicated on the coordination drawings.

D. Furnish access doors under this division for installation by General Contractor. Coordinate during bidding phase with General Contractor. Locations of access doors in finished construction shall be submitted in sufficient time to be installed in the normal course of the work.

1. Manufacturers: Subject to compliance with requirements, furnish access doors by one of the following:
   a. Bar-Co., Inc.
   b. J. L. Industries
   c. Karp Associates, Inc.
   d. Nystrom, Inc.
2. Materials and Fabrication:
   a. General: Furnish each access door assembly manufactured as an integral unit, complete with all parts and ready for installation.
   b. Steel Access Doors and Frames: Fabricate units of continuous welded steel construction, unless otherwise indicated. Grind welds smooth and flush with adjacent surfaces. Furnish attachment devices and fasteners of type required to secure access panels to types of support shown.
   c. Frames: Fabricate from 16-gauge steel.
      1) Fabricate frame with exposed flange nominal 1 inch wide around perimeter of frame for units installed in the following construction:
         a) Exposed Masonry
      2) For gypsum drywall or veneer gypsum plaster, furnish perforated frames with drywall bead.
      3) For installation in masonry construction, furnish frames with adjustable metal masonry anchors.
      4) For full-bed plaster applications, furnish frames with galvanized expanded metal lath and exposed casing bead, welded to perimeter of frame.
   d. Flush Panel Doors: Fabricate from not less than 14-gauge sheet steel, with concealed spring hinges or concealed continuous piano hinge set to open 175°. Finish with manufacturer's factory-applied prime paint.
      1) For fire-rated units, provide manufacturer's standard insulated flush panel/doors, with continuous piano hinge and self-closing mechanism.
   e. Locking Devices: Furnish flush, screwdriver-operated cam locks of number required to hold door in flush, smooth plane when closed.

1.10 PAINTING

A. Painting requirements of this section shall conform to Division 9.

B. Provide surface preparation, priming, and final coat application in strict accordance with manufacturer's recommendations.

C. Provide prime coat painting for the following:
   1. Indoor miscellaneous steel and iron provided under this Division of the specifications.
   2. Indoor hangers and supports provided under this Division of the specifications.

1.11 EQUIPMENT FOUNDATIONS, SUPPORTS, PIERS AND ATTACHMENTS

A. Provide necessary foundations, auxiliary steel, supports, pads, bases and piers required for equipment specified in this division; submit drawings in accordance with Shop Drawing Submittal requirements prior to the purchase, fabrication or construction of same.

B. Construction of foundations, supports, and pads where mounted on the floor, shall be of the same materials and same quality of finish as the adjacent and surrounding floor material.

C. Equipment shall be securely attached to the building structure in an approved manner. Attachments shall be of a strong and durable nature and any attachments that are, in the opinion of the Architect, not strong enough shall be replaced as directed, with no additional cost to the Owner.

1.12 CLEANING, PROTECTING AND ADJUSTING

A. Cleaning
1. General cleaning requirements are specified in Division 1.
2. Upon completion of the work, clean the exterior surface of equipment, accessories, and trim installed. Clean, polish, and leave equipment, accessories, and trim in first-class condition.

B. Protection of Surfaces
1. Protect new and existing surfaces from damage during the construction period.
2. Provide plywood or similar material under equipment or materials stored on floors or roofs. Provide protection in areas where construction may damage surfaces.
3. Surfaces damaged during the construction shall be repaired or replaced at the cost of the Contractor at fault. The method or repairing or replacing the surface shall be approved by the Owner and Architect.

C. Protection of Services
1. Protect new and existing services from damage during the construction period.
2. Repair, replace, and maintain in service any new or existing utilities, facilities, or services (underground, overground, interior, or exterior) damaged, broken, or otherwise rendered inoperative during the course of construction.
3. Services damaged during the construction shall be replaced at the cost of the Contractor at fault. The method used in repairing, replacing, or maintain the services shall be approved by the Owner and Architect.

D. Protection of Equipment and Materials
1. Equipment and materials shall be stored in a manner that shall maintain an orderly, clean appearance. If stored on-site in open or unprotected areas, equipment and material shall be kept off the ground by means of pallets or racks, and covered with tarpaulins.
2. Equipment and material, if left unprotected and damaged, shall be repainted or otherwise refurbished at the discretion of the Owner. Equipment and material is subject to rejection and replacement if, in the opinion of the Architect or the manufacturer's engineering department, the equipment has deteriorated or been damaged to the extent that its immediate use or performance is questionable, or that its normal life expectancy has been curtailed.
3. During the construction period, protect equipment from damage and dirt.

E. Adjusting
1. After the entire installation has been completed, make required adjustments to all systems until performance requirements are met.

1.13 SPECIAL TOOLS

A. Provide the Owner's representative with two (2) sets of special tools required for operation and maintenance of equipment provided.

1.14 WELDING

A. General Requirements
1. This paragraph covers the welding of systems. Deviations from applicable codes, approved procedures and approved shop drawings shall not be permitted. Materials or components with welds made off the site shall not be accepted if the welding does not conform to the requirements of this specification. Develop and qualify procedures for welding metals included in the work. Certification testing shall be performed by an approved independent testing laboratory. Bear costs of such testing.
2. Certified welders, previously certified by test, may be accepted for the work without re-certification provided that all of the following conditions are fulfilled:
    a. Submit copies of welder certification test records in accordance with this Division and Division 1 requirements.
    b. Testing was performed by an independent testing laboratory.
    c. The welding procedures and welders are certified in accordance with the "ASME Boiler and Pressure Vessel Code," and base materials, filler materials, electrodes, equipment, and processes conform to the applicable requirements of this specification.
    d. Certification has been within a one (1) year period from the start of the project.
3. Filler metals, electrodes, fluxes and other welding materials shall be delivered to the site in manufacturers' original packages and stored in a dry space until used. Packages shall be properly labeled and designed to give maximum protection from moisture and to assure safe handling.
4. Submit welding certificates for review. Each welder assigned to work covered by this specification shall be certified by performance tests using equipment, positions, procedures, base metals, and electrodes or bare filler wires.
5. Before assigning welders to the work, provide the architect with their names, together with certification that each individual is certified as specified. No welding work shall start prior to submissions. The certification shall state the type of welding and positions for which each is certified, the code and procedure under which each is certified, date certified, and the firm and individual certifying the certified tests.
6. Each welder shall be assigned an identifying number, letter, or symbol that shall be used to identify his welds. A list of the welders' names and symbol for each shall be submitted. To identify welds, either written records indicating the location of welds made by each welder shall be submitted, or each welder shall apply his mark adjacent to his weld using an approved rubber stamp or felt-tipped marker with permanent, weatherproof ink or other approved methods that do not deform the metal. For seam welds, identification marks shall be placed adjacent to the welds at 3 foot intervals. Identification by die stamps or electric etchers shall be confined to the weld reinforcing crown, preferably in the finished crater.

PART 2 - PRODUCTS

2.01 SLEEVES FOR RACEWAYS AND CABLES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

C. Sleeves for Rectangular Openings: Galvanized sheet steel.
   1. Minimum Metal Thickness:
      a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and no side more than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
      b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches (1270 mm) and 1 or more sides equal to, or more than, 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

2.02 SLEEVE SEALS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Advance Products & Systems, Inc.
      b. Calpico, Inc.
      c. Metraflex Co.
      d. Pipeline Seal and Insulator, Inc.
   2. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
   3. Pressure Plates: Stainless steel. Include two for each sealing element.
   4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.03 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

PART 3 - EXECUTION

3.01 COMMON REQUIREMENTS FOR COMMUNICATIONS INSTALLATION

A. Comply with NECA 1.

B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both communications equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

E. Right of Way: Coordinate piping systems installed at a required slope.

F. Apply for detailed and specific information regarding the location of equipment as the final location may differ from that indicated on the drawings. Outlets, equipment or wiring improperly placed because of failure to obtain this information shall be relocated and re-installed without additional expense to the Owner. Determine the actual direction of door swings, so that local switches and other controls shall be installed at the lockside of doors, unless otherwise noted. Improperly located switches shall be relocated without additional expense to the Owner.

G. The design shall be subject to such revisions as may be necessary to overcome building obstructions. No changes shall be made in location of outlets or equipment without written consent of the Architect and Owner.

H. Unless otherwise mentioned or indicated, mounting heights of outlets are shown on the drawings or in the specification. Dimensions given shall be considered to be from center of outlet to finished floor.

I. Coordinate the location and elevation of all communications devices and fixtures with the architectural interior elevation plan and reflective ceiling plan prior to installation.

J. Properly rough in for the communications raceways and equipment under this contract and modify as required for coordination during the construction period.

K. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

L. Coordinate location of access panels and doors for communications items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 Section “Access Doors and Frames.”

M. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section “Penetration Firestopping.”

3.02 WELDING

A. Perform welding in accordance with qualified procedures using certified welders. Welding shall not be done when the quality of the completed weld could be impaired by the prevailing working or weather conditions. Welding of hangers, supports, and plates to structural members shall conform to AWS specifications.

B. Field bevels and shop bevels shall be by mechanical means or by flame cutting. Where beveling is by flame cutting, thoroughly clean surfaces of scale and oxidation just prior to welding. Beveling shall conform to ANSI B31.1 and AWS B3.0.

C. Replace and reinspect defective welds. Repairing defective welds by adding weld material over the defect or by peening shall not be permitted. Welders responsible for defective welds must be re-certified.

D. Store electrodes in a dry heated area, keep free of moisture and dampness during fabrication operations. Discard electrodes that have lost part of their coating.

3.03 SLEEVE INSTALLATION FOR COMMUNICATIONS PENETRATIONS

A. Communications penetrations occur when raceways, cables, wireways, or cable trays penetrate concrete slabs, concrete or masonry walls, fire-rated floor, or wall assemblies.

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

E. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level.

F. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and raceway or cable, unless indicated otherwise.

G. Seal space outside of sleeves with grout for penetrations of concrete and masonry
   1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.

H. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants."

I. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping."

J. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

K. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel or cast iron pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

L. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between raceway or cable and sleeve for installing mechanical sleeve seals.

3.04 SLEEVE-SEAL INSTALLATION

A. Install to seal exterior wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.05 FIRESTOPPING

A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for communications installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 firestopping section.

3.06 DUST, DIRT AND NOISE

A. Carry out new work and make changes, relocations, and installations with a minimum of noise. Site areas and new equipment, floors and walls, shall be adequately protected from dust and dirt caused by the work. Protection shall include suitable temporary barriers or coverings. The exterior and interior premises of each building shall be kept clean as possible during construction. Damages to surfaces or equipment as a result of negligence shall be replaced or corrected as required.

B. School activities may be under way during much of the construction period. It is imperative that school functions and activities are given priority and the highest level of respect. Contractor functions which may be excessively noisy or disruptive shall be scheduled for times when school functions will not be interrupted or disturbed.

3.07 ENVIRONMENTAL AIR PLENUMS

A. In spaces over hung ceiling which are used for environmental air handling purposes as defined by Article 300.22C of the National Electric Code, power data and communications cable must be in conduit or of the type cable rated for air plenum use. Cable type and/or raceway is generally indicated on the drawings and specifications although the Contractor shall be responsible to clearly define ceiling space used for environmental air purposes.

3.08 SPECIAL ENGINEERING SERVICES

A. In the instance of complex or specialized telecommunications, security, and audiovisual systems that are included in Division 27; the installation, final connections, and testing of such systems shall be made under the direct supervision of competent authorized service engineers who shall be in the employ of the respective equipment manufacturer. Provide the Owner with copies of instruction manuals and booklets for each system and piece of equipment installed. Provide any additional instruction to the Owner over and above the listed above in the care, adjustment, and operation of all parts of the communications systems.

SECTION 27 05 26

GROUNDING AND BONDING FOR TELECOMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to the work of this Section.

1.02 SUMMARY

A. Provide all materials and labor for the installation of a grounding and bonding system for communications infrastructure. This section includes requirements for providing a permanent grounding and bonding infrastructure for communications circuits, raceways, and cable tray. These requirements are in addition to any that may exist in Section 16 – "Grounding."

B. Related Sections
   1. Division 26 Section — "Basic Electrical Materials and Methods"
   2. Division 27 Section — "Conduit Raceway and Back Boxes for Communications Circuits Systems"
   3. Division 27 Section — "Inside Plant Communications Circuits Systems"
   4. Division 27 Section — "Outside Plant Communications Underground Ducts and Raceways for Communications Systems Circuits"

1.03 REFERENCES

A. The applicable portions of the following specifications, standards, codes and regulations shall be incorporated by reference into these specifications.
   1. General:
      a. National Electrical Code (NEC)
      b. National Electrical Safety Code (NESC)
      c. Occupational Safety and Health Act (OSHA)
   2. Communications:
      a. TIA/EIA - 568: Commercial Building Telecommunications Cabling Standard
      b. TIA/EIA - 569: Commercial Building Standard for Telecommunication Pathways and Spaces
      c. TIA/EIA - 606: The Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
      d. TIA/EIA - 607: Commercial Building Grounding and Bonding Requirements for Telecommunications
      e. ISO/IEC IS 11801: Generic Cabling for Customer Premises
      f. BICSI: BICSI Telecommunications Cabling Installation Manual
      g. BICSI: BICSI Telecommunications Distribution Methods Manual (TDMM)

h. BICSI: BICSI Customer-Owned Outside Plant Design Manual (CO-OSP)

1.04 DEFINITIONS

A. "TMGB" shall mean *Telecommunications Main Grounding Busbar.* There is typically one TMGB per building, located in the main telecommunications room. This busbar is directly bonded to the electrical service ground.

B. "TGB" shall mean *Telecommunications Grounding Busbar.* There is typically one TGB per telecommunications room. The TGB is connected both to the TMGB and to building structural steel or other permanent metallic systems.

C. "TBB" shall mean *Telecommunications Bonding Backbone.* The TBB is a conductor used to connect TMGBs to TGBs.

1.05 SYSTEM DESCRIPTION

A. Furnish, install, and place into satisfactory and successful operation all materials, devices, and necessary appurtenances to provide a complete, permanent Grounding and Bonding infrastructure for communications circuits, raceways, and cable trays as hereinafter specified and/or shown on the Contract Documents. The Grounding and Bonding system shall support an ANSI/TIA/EIA and lSO/IEC compliant communications Structured Cabling System (SCS).

B. The work shall include materials, equipment and apparatus not specifically mentioned herein or noted on the plans but which are necessary to make a complete working ANSI/TIA/EIA and ISO/IEC compliant Grounding and Bonding system.

1.06 SUBMITTAL INFORMATION

A. Product Data Submittals: Provide submittal information for review before materials are delivered to the job site. Provide product data submittals for all products at the same time.
   1. Submit a letter stating that the materials will be provided as specified, and specifically listing any items that will not be provided as specified. The letter shall also state that the Contractor has reviewed the specified items and agrees that they are applicable to this project in all respects.
   2. For those items noted as allowing "or equal," and which are not being provided as specifically named, submit standard manufacturer's cut sheets or other descriptive information, along with a written description detailing the reason for the substitution.
   3. Provide standard manufacturer's cut sheets and the operating and maintenance (O&M) instructions at the time of submittal review for each device in the system, regardless of whether it is submitted as specified or as an approved equal. These instructions shall detail how to install and service the equipment and shall include information necessary for rough-in and preparation of the building facilities to receive the materials.

B. Closeout Submittals: Provide submittal information for review as follows:
   1. O&M Manual for Communications - At the completion of the project, submit O&M information from product data submittals (above), updated to reflect any changes during the course of construction, to the Designer in the

telecommunications-specific O&M Manual for Communications binder labeled with the project name and description.

2. Records - Maintain at the job site a minimum of one set of Record Drawings, Specification, and Addenda. Record Drawings shall consist of redline markups of drawings, specifications and spreadsheets.
    a. Document changes to the system from that originally shown on the Contract Documents and clearly identify system component labels and identifiers on Record Drawings.
    b. Keep Record Drawings at the job site and make available to the Owner and Designer at any time.
    c. Keep Record Drawings current throughout the course of construction. ("Current" is defined as not more than one week behind actual construction).
    d. Show identifiers for major infrastructure components on Record Drawings.

1.07 SEQUENCING

1.08 CONTRACTOR WARRANTY:

A. Provide a Contractor-endorsed two-year service warranty against defects in materials and workmanship.
1. Provide labor attributable to the fulfillment of this warranty at no cost to the Owner.
2. The Contractor Warranty period shall commence upon Owner acceptance of the work.

PART 2 - PRODUCTS

2.01 GENERAL

A. Materials shall consist of busbars, supports, bonding conductors and other incidentals and accessories as required.

2.02 MATERIALS

A. Grounding/Bonding:
1. Telecommunications Main Grounding Bus Bar (TMGB):
    a. Large (20" x 4" x ¼"), Pre-drilled: CPI 10622-020, or equal
    b. Small (10" x 4" x ¼"), Pre-drilled: CPI 10622-010, or equal
2. Telecommunications Grounding Bus Bar (TGB):
    a. Large (20" x 4" x ¼"), Pre-drilled: CPI 10622-020, or equal
    b. Small (10" x 4" x ¼"), Pre-drilled: CPI 10622-010, or equal
3. Telecommunications Bonding Backbone: #6 AWG insulated (green in color) copper conductor.
4. Grounding Conductor: #6 AWG insulated (green in color) copper conductor.

B. Firestopping material: Conform to both Flame (F) and Temperature (T) ratings as required by local building codes and as tested by nationally accepted test agencies per ASTM E814 or UL 1479 fire test in a configuration that is representative of the actual field conditions.

C. Labels: As recommended in ANSI/TIA/EIA 606. Permanent (i.e. not subject to fading or erasure), permanently affixed, and created by a hand-carried label maker or a computer/software-based label making system. Handwritten labels are not acceptable.
   1. Hand-carried label maker:
      a. Brady: ID Pro Plus (or approved equal).
   2. Labels:
      a. Brady: Bradymaker Wire Marking Labels WML-511-292 (or approved equal)

PART 3 - EXECUTION

3.01 GENERAL

A. The Contractor is solely responsible for the safety of the public and workers in accordance with all applicable rules, regulations, building codes and ordinances.

B. All work shall comply with applicable safety rules and regulations including OSHA. All work shall comply with the requirements of the National Electrical Safety Code (NESC) and the NEC except where local codes and/or regulations are more stringent, in which case the local codes and/or regulations shall govern.

C. All work shall comply with the standards, references and codes listed in PART 1 -- REFERENCES above. Where questions arise regarding which standards, references, or codes apply, the more stringent shall prevail.

D. All work shall comply with the requirements and recommendations of the product manufacturers. Where questions arise regarding which requirements and recommendations apply, the more stringent shall prevail.

E. Replace and/or repair to original (or better) condition any existing structures, materials, equipment, etc. inadvertently demolished or damaged by the Contractor during the course of construction at no additional cost to the Owner.

F. Install the grounding and bonding system in a manner ensuring that communications circuits, when installed, are able to fully comply with the ANSI/TIA/EIA and other references listed in Part 1 — References, above.

G. Remove surplus material and debris from the job site and dispose of legally.

3.02 INSTALLATION

A. The grounding and bonding infrastructure system shall not make use of the building plumbing system, unless required to do so by the NEC.
   1. Coordinate the installation of the grounding and bonding system with the electrical power distribution system grounding infrastructure.

B. Ground/Bonding:
   1. TMGB: Provide a minimum of one TMGB per telecommunications entrance room for each building and as shown on the Contract Documents. Install TMGB(s) and directly bond TMGB(s) to electrical service ground and to associated TBB(s). Group protector, busbar bonding, and approved building

grounding conductors toward one end of the TMGB and leave space for equipment grounding conductors on the other end.

2. TGB: Provide a minimum of one TGB per telecommunications room for each building and as shown on the Contract Documents and as required by the standards, references and codes listed in PART 1 -- REFERENCES above. Directly bond each TGB to its associated TBB and to the nearest building structural steel or other permanent metallic system. Group protector, busbar bonding, and approved building grounding conductors toward one end and leave space for equipment grounding conductors on the opposite end.
3. TBB(s) and Grounding Conductors: Provide TBB(s) and grounding conductors as shown on the Contract Documents and as required to bond all non-current carrying metal telecommunications equipment and materials to the nearest TGB. Use TBB(s) to connect the TMGB to each TGB. Route along the shortest and straightest path possible with minimal bends. Bends shall be sweeping. Insulate TBB(s) and conductors from their support. TBB(s) and grounding conductors shall be continuous (without splices).
   a. Ensure that bonding breaks through paint to bare metallic surface of all painted metallic hardware.

C. Firestopping
1. Only employees trained/certified by the firestopping manufacturer shall apply firestopping materials.
2. Maintain the fire rating of all penetrated fire barriers. Fire stop and seal all penetrations made during construction.
   a. Provide firestopping material for through and membrane penetrations of fire-rated barriers.
   b. Install firestops in strict accordance with manufacturer's detailed installation procedures.
   c. Install firestops in accordance with fire test reports, fire resistance requirements, acceptable sample installations, manufacturer's recommendations, local fire and building authorities, and applicable codes and standards referenced in PART 1 – REFERENCES. Apply of sealing material in a manner acceptable to the local fire and building authorities.
   d. For demolition work, apply firestopping to open penetrations in fire rated barriers where cable is removed. Apply firestopping regardless of whether or not the penetrations are used for new cable or left empty after construction is complete.
   e. Firestopping material used to seal open penetrations through which cable passes shall be re-usable/re-enterable.

D. Labels:
1. Label TMGB(s) with "TMGB"
2. Label TGB(s) with "TGB".
3. Label TBB(s) and bonding conductors "WARNING! TELECOMMUNICATIONS BONDING CONDUCTOR. DO NOT REMOVE OR DISCONNECT!"

SECTION 27 05 28

CONDUIT AND BACKBOXES FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Provide all materials and labor for the installation of a pathway system for inside plant communications circuits. This section includes requirements for horizontal and building backbone raceways, fittings, and boxes specific to communications circuits (cabling) for voice and data.

B. Related Sections:
   1. Division 26 Section — "Basic Electrical Materials and Methods"
   2. Division 27 Section — "Grounding and Bonding for Communications Systems"
   3. Division 27 Section — "Inside Plant Communications Systems"

1.03 REFERENCES

A. Incorporate by reference the applicable portions of the following specifications, standards, codes into this specification section.
   1. General:
      a. National Electrical Code (NEC)
      b. National Electrical Safety Code (NESC)
      c. Occupational Safety and Health Act (OSHA)
   2. Communications:
      a. ANSI/TIA/EIA - 568: Commercial Building Telecommunications Cabling Standard
      b. ANSI/TIA/EIA - 569: Commercial Building Standard for Telecommunication Pathways and Spaces
      c. ANSI/TIA/EIA - 606: The Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
      d. ANSI/TIA/EIA - 607: Commercial Building Grounding and Bonding Requirements for Telecommunications
      e. ISO/IEC IS 11801: Generic Cabling for Customer Premises
      f. BICSI: BICSI Telecommunications Cabling Installation Manual
      g. BICSI: BICSI Telecommunications Distribution Methods Manual (TDMM)

1.04 DEFINITIONS

A. "EMT" shall mean Electrical Metallic Tubing.

B. “RMC” shall mean Rigid Metal Conduit.

C. “SMR” shall mean Surface Metal Raceway.

D. “Raceway” shall mean any enclosed channel for routing wire, cable or busbars.

E. “TMGB” shall mean *Telecommunications Main Grounding Busbar.* There is typically one TMGB per building, located in the main telecommunications room. This busbar is directly bonded to the electrical service ground.

F. “TGB” shall mean *Telecommunications Grounding Busbar.* There is typically one TGB per telecommunications room. The TGB is connected both to the TMGB and to building structural steel or other permanent metallic systems.

G. “TBB” shall mean *Telecommunications Bonding Backbone.* The TBB is a conductor used to connect TMGBs to the TGBs.

H. “Pullbox” shall mean a metallic box with a removable cover, used to facilitate pulling cable through conduit runs longer than 100’ or in which there are more than 180 degrees of bends.

I. “Junction box” shall mean a pullbox wherein a feeder conduit transitions to multiple distribution conduits.

1.05 SYSTEM DESCRIPTION

A. Furnish, install, and place into satisfactory and successful operation all materials, devices, and necessary appurtenances to provide a complete Raceway system as hereinafter specified and/or shown on the Contract Documents. The Raceway system shall support an ANSI/TIA/EIA and lSO/IEC compliant communications Structured Cabling System (SCS) as specified in 271500 - Inside Plant Communications Systems

B. The work shall include materials, equipment and apparatus not specifically mentioned herein or noted on the Contract Documents but which are necessary to make a complete working Raceway system.

1.06 SUBMITTALS

A. Product Data Submittals: Provide submittal information for review before materials are delivered to the job site. Provide product data submittals for all products at the same time.

1. Submit a letter stating that the materials will be provided as specified, and specifically listing any items that will not be provided as specified. The letter shall also state that the Contractor has reviewed the specified items and agrees that they are applicable to this project in all respects.
2. For those items noted as allowing “or equal,” and which are not being provided as specifically named, submit standard manufacturer's cut sheets or other descriptive information, along with a written description detailing the reason for the substitution.
3. Provide standard manufacturer’s cut sheets and the operating and maintenance (O&M) instructions at the time of submittal review for each device in the system, regardless of whether it is submitted as specified or as an approved equal. These

instructions shall detail how to install and service the equipment and shall include information necessary for rough-in and preparation of the building facilities to receive the materials.

B. Closeout Submittals: Provide submittal information for review as follows:
   1. O&M Manual for Communications - At the completion of the project, submit all O&M information from product data submittals (above), updated to reflect any changes during the course of construction, to Mason ITU in the telecommunications-specific O&M Manual for Communications binder labeled with the project name and description.
   2. Records - Maintain at the job site a minimum of one set of Record Drawings, Specification, and Addenda. Record Drawings shall consist of redline markups of drawings, specifications and spreadsheets, including maintenance hole/handhole butterfly drawings.
      a. Document changes to the system from that originally shown on the Contract Documents and clearly identify system component labels and identifiers on Record Drawings.
      b. Keep Record Drawings at the job site and make available to the Owner and Designer at any time.
      c. Keep Record Drawings current throughout the course of construction. (“Current” is defined as not more than one week behind actual construction).
      d. Show identifiers for major infrastructure components on Record Drawings.

1.07 CONTRACTOR WARRANTY:

A. Provide a Contractor-endorsed one-year service warranty against defects in materials and workmanship.
   1. Provide labor attributable to the fulfillment of this warranty at no cost to the Owner.
   2. The Contractor Warranty period shall commence upon Owner acceptance of the work.

1.08 QUALITY ASSURANCE

A. Listing and Labeling: Provide raceways and boxes specified in this Section that are listed and labeled.
   1. The Terms "Listed" and "Labeled": As defined in NEC, Article 100.
   2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" as defined in OSHA Regulation 1910.7.

B. Comply with NECA's "Standard of Installation."

C. Comply with NEC.

1.09 COORDINATION

A. Coordinate layout and installation of raceways and boxes with other construction elements to ensure adequate headroom, working clearance, and access.

PART 2 - PRODUCTS

2.01 GENERAL

A. Materials shall consist of conduit, surface metal raceway, outlet boxes, fittings, enclosures, pull boxes, and other raceway incidentals and accessories as required for inside plant communications circuits.

2.02 MATERIALS

A. Conduit:
   1. EMT. 1” minimum conduit size. Flexible metal conduit (FMC) is not acceptable.
      a. Conduit: Galvanized steel tubing meeting ANSI C80.3.
      b. Couplings: Steel, cast iron, or malleable iron compression type employing a split, corrugated ring and tightening nut, with integral bushings and locknuts. Indent-type and setscrew-type couplings are not permitted.
   2. RMC. 1” minimum conduit size.
      a. Conduit: Hot dipped galvanized steel with threaded ends meeting ANSI C80.1.
      b. Couplings: Unsplit, NPT threaded steel cylinders with galvanizing equal to the conduit.
      c. Nipples: Same as conduit, factory-made up to 8 inches in diameter, no running threads.

B. Sleeves: EMT conduit, with insulated throat bushings for each end

C. Surface Raceway: Wiremold V2400 series or equivalent – Two piece, steel, single channel surface raceway.

D. Outlet boxes: Minimum 4”x4” size, 2 1/8” minimum depth, with extension rings (if needed) and single gang covers (i.e. mud rings), unless otherwise noted on the Contract Documents. Combined interior depth of outlet box, extension ring and cover shall be a minimum 2-1/2”. Stamped steel, deep drawn one piece (without welds or tab connections), galvanized, with knockouts for 1” trade size conduit or connector entrance, meeting NEMA OS 1.
   1. Acceptable manufacturers:
      a. Appleton, Raco, Steel City, or equal
   2. Wiremold Extra Deep Switch and Receptacle Box: V5744-2 (two gang), or equal

E. Junction Boxes and Pull Boxes: Stamped steel, deep drawn one piece (without welds or tab connections), galvanized, with knockouts for conduit or connector entrance. Boxes 6”x6”x4” or larger may be code gauge fabricated steel continuously welded at seams and painted after fabrication.
   1. Dry locations: meeting NEMA OS 1.
   2. Wet locations: NEMA OS 3R.

F. Miscellaneous Fittings:
   1. Locknuts and conduit bushings: Malleable iron
      a. Appleton, Crouse Hinds, OZ Gedney, or equal
   2. Through wall seals and floor seals shall be:
      a. OZ Gedney FS and WS series, or equal.

G. Pull Strings: Plastic or nylon with a minimum test rating of 200 lb.

2.03 FIRESTOPPING

A. Material: Conform to both Flame (F) and Temperature (T) ratings as required by local building codes and as tested by nationally accepted test agencies per ASTM E814 or UL 1479 fire test in a configuration that is representative of the actual field conditions.

2.04 LABELING AND ADMINISTRATION

A. Labels: As recommended in ANSI/TIA/EIA 606. Permanent (i.e. not subject to fading or erasure), permanently affixed, typed, and created by a hand-carried label maker or an approved equivalent software-based label making system. Handwritten labels are not acceptable.
   1. Hand-carried label maker:
      a. Brady: ID Pro Plus (or approved equal).
   2. Labels:

      Brady: Bradymaker Wire Marking Labels WML-511-292 (or approved equal)

PART 3 - EXECUTION

3.01 GENERAL

A. The Contractor is solely responsible for the safety of the public and workers in accordance with all applicable rules, regulations, building codes and ordinances.

B. All work shall comply with applicable safety rules and regulations including OSHA. All work shall comply with the requirements of the National Electrical Safety Code (NESC) and the NEC except where local codes and/or regulations are more stringent, in which case the local codes and/or regulations shall govern.

C. All work shall comply with the standards, references and codes listed in PART 1 -- REFERENCES above. Where questions arise regarding which standards, references, or codes apply, the more stringent shall prevail.

D. All work shall comply with the requirements and recommendations of the product manufacturers. Where questions arise regarding which requirements and recommendations apply, the more stringent shall prevail.

E. Install the raceway system in a manner ensuring that communications circuits, when installed, are able to fully comply with the ANSI/TIA/EIA and other references listed in Part 1 — References, above.

F. Replace and/or repair to original (or better) condition any existing structures, materials, equipment, etc. inadvertently demolished or damaged by the Contractor during the course of construction at no additional cost to the Owner.

G. Remove surplus material and debris from the job site and dispose of legally.

3.02 EXAMINATION

A. Examine surfaces and spaces to receive raceways, boxes, enclosures, and cabinets for compliance with installation tolerances and other conditions affecting performance of raceway installation. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.03 INSTALLATION

A. Install raceways, boxes, enclosures, and cabinets as indicated, according to manufacturer's written instructions. Provide a raceway for each location indicated. Do not gang raceway into wireways, pullboxes, junction boxes, etc., without specific approval from the Designer.

B. Conduit:
1. Install EMT unless other conduit is shown on the Contract Documents or is required by Code.
2. Install conduit as a complete, continuous system without wires, mechanically secured and electrically connected to metal boxes, fittings and equipment. Blank-off unused openings using factory-made knockout seals.
3. Run conduit in the most direct route possible, parallel to building lines. Do not route conduit through areas in which flammable material may be stored.
4. Keep conduit at least 6 inches away from parallel runs of flues and steam or hot-water pipes or other heat sources operating at temperatures above one-hundred degrees Fahrenheit. Install horizontal conduit runs above water piping.
5. Keep conduit away from sources of electromagnetic interference as follows:
   a. 5 inches from fluorescent lighting
   b. 12 inches from conduit and cables used for electrical power distribution
   c. 48 inches from motors or transformers
6. Do not exceed 90 meters total length for a given conduit run to be used for distribution cabling (from outlet box to telecommunications room), including intermediate conduits and junction boxes.
7. Install conduit exposed, except in finished areas or unless shown otherwise on the drawings. Do not install conduit below grade/slab unless specifically shown on the Contract Documents as being installed below grade/slab.
8. Install exposed conduit in lines parallel or perpendicular to building lines or structural members except where the structure is not level. Follow the surface contours as much as practical. Do not install crossovers or offsets that can be avoided by installing the conduit in a different sequence or a uniform line.
   a. Run parallel or banked conduits together, on common supports where practical.
   b. Make bends in parallel or banked runs from same centerline to make bends parallel.
9. Conduits concealed above ceilings, furred spaces, etc., which are normally inaccessible may be run at angles not parallel to the building lines.
10. Wherever practical, route conduit with adjacent ductwork or piping and support on common racks. Base required strength of racks, hangers, and anchors on combined weights of conduit and piping.
11. Where conduits cross building expansion joints, use suitable sliding or offsetting expansion fittings. Unless specifically approved for bonding, use a suitable bonding jumper.

12. Support conduits as specified in Section 16050 "Basic Electrical Materials and Methods."
    a. Provide anchors, hangers, supports, clamps, etc. to support the conduits from the structures in or on which they are installed. Do not space supports farther apart than five feet.
    b. Provide sufficient clearance to allow conduit to be added to racks, hangers, etc. in the future.
    c. Support conduit within three feet of each outlet box, junction box, gutter, panel, fitting, etc.
13. Ream conduits to eliminate sharp edges and terminate with metallic insulated grounded throat bushings. Seal each conduit after installation (until cable is installed) with a removable mechanical-type seal to keep conduits clean, dry and prevent foreign matter from entering conduits.
14. Install a pull string in each conduit.
15. For conduits entering through the floor of a telecommunications room, terminate conduits 6” above the finished floor.
16. Do not install communications conduits in wet, hazardous or corrosive locations.
17. Where conduit is shown embedded in masonry, embed conduit in the hollow core of the masonry. Horizontal runs in the joint between masonry units are not permitted.
18. Where conduit is shown embedded in concrete, embed conduit a minimum of two inches from the exterior of the concrete. Do not place conduit in concrete less than 4 inches thick.
    a. One inch trade size conduit shall be used. Conduits sized smaller than one inch trade size conduit are not permitted embedded in concrete without approval from Mason-ITU.
    b. Run conduit parallel to main reinforcement.
    c. Conduit crossovers in concrete are not permitted.
19. Where conduit exits from grade or concrete, provide a rigid steel elbow and adapter.
20. Where conduit enters a space through the floor and terminates in that space, terminate the conduit at 6” above the finished floor.
21. Where conduits terminate at a cable tray, the conduits shall be consistently terminated no more than 8” from the cable tray, and have a visually uniform appearance.
22. Where several circuits follow a common route, stagger pullboxes or fittings.
23. Where several circuits are shown grouped in one box, individually fireproof each conduit.
24. Bend and offset metal conduit with standard factory sweeps or conduit fittings. Keep legs of bends in the same plane and straight legs of offsets parallel, unless otherwise indicated.
    a. Conduit sweeps:
        1) Sweeps shall not exceed 90 degrees.
        2) Do not exceed 180 degrees for the sum total of conduit sweeps for a section of conduit (between conduit termination points).
        3) Sweep radius shall be at least 10 times the internal diameter of the conduit.
        4) 90-degree condulets (LB’s) and electrical elbows are not acceptable.
    b. Factory-manufactured sweeps are required for bends in conduit larger than 1-¼” trade size.

c. For bends in 1 ¼” trade size conduit and larger, field-manufactured bends (using a hydraulic bender with a 1 ¼” boot) are permitted only when factory-manufactured sweeps are not suitable for the conditions. In all other cases, factory-manufactured sweeps are required. “Hickey-bender” use is prohibited.

25. Connect conduit to hubless enclosures, cabinets and boxes with double locknuts and with insulating type bushings. Use grounding type bushings where connecting to concentric or eccentric knockouts. Make conduit connections to enclosures at the nearest practicable point of entry to the enclosure area where the devices are located to which the circuits contained in the conduit will connect.

26. Penetrations for raceways:
    a. Do not bore holes in floor and ceiling joists outside center third of member depth or within two feet of bearing points. Holes shall be 1-¼” diameter maximum.
    b. Penetrate finished walls and finished surfaces with a PVC or sheet metal sleeve with an interior diameter (ID) at least 1/4" greater than the outer diameter (OD) of the conduit, set flush with walls, pack with fiberglass, seal with silicone sealant.
    c. Penetrate poured-in-place walls and free slabs with a cast iron sleeve (or Schedule 40 PVC black pipe sleeve for above-grade only) with retaining ring or washer. Set sleeves flush with forms or edges of slab. Pack around conduit with fiberglass and seal with silicone sealant.

27. Raceway terminations and connections:
    a. Join conduits with fittings designed and approved for the purpose and make joints tight. Do not use set indent-type or screw-type couplings.
    b. Make threaded connections waterproof and rustproof by applying a watertight, conductive thread compound. Clean threads of cutting oil before applying thread compound.
    c. Make conduit terminations tight. Use bonding bushings or wedges at connections subject to vibration. Use bonding jumpers where joints cannot be made tight.
    d. Cut ends of conduit square using a hand saw, power saw or pipe cutter. Ream cut ends to remove burrs and sharp ends. Where conduit threads are cut in the field, cut threads to have same effective length, same thread dimensions and same taper as specified for factory-cut threads.
    e. Provide double locknuts and insulating bushings at conduit connections to boxes and cabinets. Align raceways to enter squarely and install locknuts with dished part against the box. Use grounding type bushings where connecting to concentric or eccentric knockouts.
    f. Where conduits are terminated with threaded hubs, screw raceways or fittings tightly into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align raceways so the coupling is square to the box and tighten the chase nipple so no threads are exposed.

28. Install conduit sealing fittings according to manufacturer's written instructions. Locate fittings at suitable, approved, and accessible locations and fill them with UL-listed sealing compound. For concealed conduits, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:
    a. Where conduits pass from warm to cold locations, such as the boundaries of air conditioned or refrigerated spaces and where conduits enter or exit

buildings from outdoor areas, including underground ducts or conduit runs.

b. Where otherwise required by the NEC.

29. Conduit shall be clean and dry.

C. Sleeves:

1. Provide sleeves where required, sized as noted on the Contract Documents. Where not noted, sleeve sizing shall be determined by the type and quantity of cable to be routed through the sleeve per TIA/EIA 569A cable capacity standards, plus an additional 20% for future expansion.
2. Provide roto-hammering or core drilling where required for installation.
3. Seal between sleeve and wall or floor in which the sleeve is installed. Firestop all penetrations to restore wall or floor to pre-penetration fire-rating.

D. Surface Raceway:

1. Provide surface raceway for all surface mounted telecommunications outlet boxes and as shown on the Contract Documents.
2. Surface raceway shall be routed parallel to and perpendicular to surfaces or exposed structural members, and follow surface contours.
3. Surface raceway color shall match as closely as possible the existing wall finish. Do not paint Surface Raceway.
4. Surface raceway systems shall be completely installed, including insulating bushings and inserts as required by manufacturer's installation requirements. Unused openings in the surface raceway shall be closed using manufactured fittings.
5. Surface raceway shall have a minimum two inch radius control at all bend points.
6. Surface raceway shall be securely supported by screws or other anchor-type devices at intervals not exceeding 10 feet and with no less than two supports per straight raceway section. Surface raceway shall be securely supported in accordance with the manufacturer's requirements. Tape and glue are not acceptable support methods.
7. Mechanically and electrically continuous surface raceway shall be bonded and grounded to the Telecommunications Grounding system.

E. Outlet Boxes:

1. Provide outlet boxes and covers as shown on the Contract Documents and as needed. Verify that the appropriate cover type and depth is provided for each type of wall and finish. Provide extension rings as needed.
2. Coordinate box locations with building surfaces and finishes to avoid bridging wainscots, joints, finish changes, etc.
3. Install boxes in dry locations (not wet, corrosive, or hazardous).
4. Attach boxes securely to building structure with a minimum of two fasteners. Provide attachments to withstand a force of one hundred pounds minimum, applied vertically or horizontally.
5. Install boxes at the following heights to the bottom of the box, except where noted otherwise:
   a. Wall mounted telephones: 48" above finished floor.
   b. Workstation outlets: 18" above finished floor.
   c. Place boxes for outlets on cabinets, countertops, shelves, and similar boxes located above countertops two inches above the finished surface or two inches above the back splash. Coordinate and verify size, style, and

location with the supplier or installer of these items prior to outlet box installation.

6. Recessed mounted outlet boxes:
    a. Recess boxes in the wall, floor, and ceiling surfaces in finished areas. Set boxes plumb, level, square and flush with finished building surfaces within one-sixteenth inch for each condition. Set boxes so that box openings in building surfaces are within one-eighth inch of edge of material cut-out and fill tight to box with building materials. Single gang opening shall extend at least to the finished wall surface and extend not more than 1/8 inch beyond the finished wall surface. Provide backing for boxes using structural material to prevent rotation on studs or joists.
    b. Install floor boxes level and adjust to finished floor surface.
7. Surface-mounted outlet boxes:
    a. For boxes surface-mounted on finished walls, provide Wiremold outlet box or equivalent. Cut box as necessary to accept conduit.
    b. For boxes surface-mounted on unfinished walls (i.e. electrical rooms, mechanical rooms), provide 4”x4” (minimum) outlet box with single gang cover.

F. Floor Boxes:
1. Provide floor boxes as shown on the Contract Documents.
2. Set device boxes plumb, level, square and flush with floor, within 1/16” tolerance for each condition.
3. For floor boxes with combined power and telecommunications circuits, provide metal dividers to separate power from telecommunications circuits.

G. Junction Boxes:
1. Provide junction boxes as shown on the Contract Documents and as required.
    a. Where sizing is not shown on the Contract Documents, size junction box length and depth according to the size of the feeder conduit in the following table:

Feeder Conduit Size	Box Length	Box Depth
1”	12”	4”
1-¼”	12”	4”
1-½”	12”	4”
2”	24”	4”
2-½”	24”	6”
3	36”	6”
3-½”	48”	6”
4”	60”	6”

    b. Where sizing is not shown on the Contract Documents, size junction box width according to the following formula:
        1) From the table below, select the width associated with the largest conduit on the distribution side of the box. For each additional

distribution conduit, add the "Increase Width" value associated with the size of that distribution conduit to the box width for the largest distribution conduit.

a) For example, if the distribution side of the junction box has one 1-¼" distribution conduit and three 1" distribution conduits, the total distribution-side width would be 6"+2"+2"+2"=10".

2) Repeat the above process for the feeder side of the junction box. Junction boxes are typically fed by a single conduit, therefore unless the box has more than one feeder conduit, the "Increase Width" part of the formula is unnecessary.

a) For example, if the feeder side of the junction box has two 2" feeder conduits the total feeder-side width would be 8"+5"=13".

3) The larger of the two width calculations (distribution side vs. feeder side) shall be the width of the junction box to be provided.

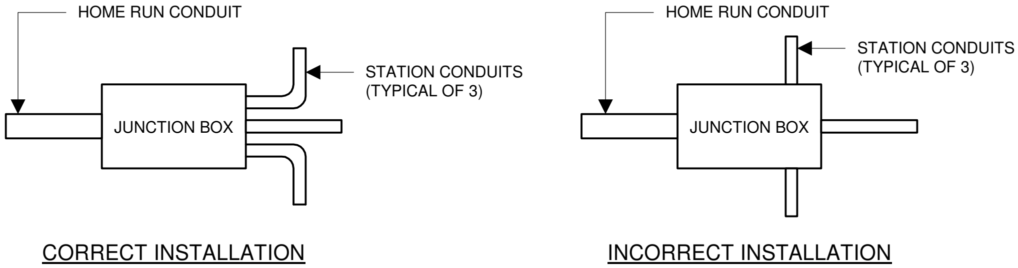
a) For example, if the distribution-side width were 10" and the feeder-side width were 13", provide a 13" wide junction box.

Conduit Size	Box Width	For each additional conduit Increase Width
1"	4"	2"
1-¼"	6"	3"
1-½"	8"	4"
2"	8"	5"
2-½"	10"	6"
3	12"	6"
3-½"	12"	6"
4"	15"	8"

2. A junction box may not be substituted for a 90-degree bend. *90 degree condulets (LB's) are not acceptable.*
3. Install junction boxes in a location readily accessible both at time of construction and after building occupation. Do not install junction boxes in inaccessible interstitial building spaces.
4. Where junction boxes are to be mounted on ceiling structure above ceiling grid, do not mount higher than 4' above grid.
5. Install hinged-cover enclosures and cabinets plumb, and supported at each corner.
6. Install junction boxes so that the access door opens from the side where the cable installer will normally work – typically from the bottom (floor side) of the box.
   a. Where a junction box is installed in a ceiling space, coordinate with other trades to provide full access to the junction box door and adequate working room for both the installation personnel and for proper looping of cable during installation.

b. Provide a lockable access cover (or junction box door if junction box is exposed) in hard lid ceilings.

7. Install junction boxes such that conduits enter and exit at opposite ends of the box as follows:



H. Pull Boxes:

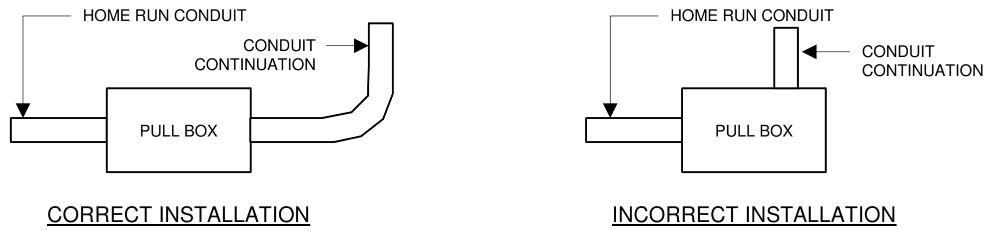
1. Provide pull boxes as shown on the Contract Documents and as required.
   a. Where sizing is not shown on the Contract Documents, size pull boxes as follows:

Size of Largest Conduit	Box Width	Box Length	Box Depth
1”	4”	12”	4”
1-¼”	6”	12”	4”
1-½”	8”	12”	4”
2”	8”	24”	4”
2-½”	10”	24”	6”
3	12”	36”	6”
3-½”	12”	48”	6”
4”	15”	60”	6”

   b. Where a pull box is required with conduits 1” trade size or smaller, an outlet box may be used as a pull box. Where outlet boxes are used as pull boxes, the outlet boxes shall be dedicated for use as a pull box and shall not host cable termination hardware.
2. A pull box may not be substituted for a 90-degree bend. *90 degree condulets (LB’s) are not acceptable.*
3. Install pull boxes in an accessible location, readily accessible both at time of construction and after building occupation. Do not install pull boxes in inaccessible interstitial building space.
4. Where pull boxes are to be mounted on ceiling structure above ceiling grid, do not mount higher than 4’ above grid (mount on wall instead).
5. Install hinged-cover enclosures and cabinets plumb, and supported at each corner.
6. Install pull boxes so that the access door opens from the side where the cable installer will normally work (typically from the bottom, or floor side, of the box).
   a. Where a pull box is installed in a ceiling space, provide full access to the junction box door and adequate working room for both the installation personnel and for proper looping of cable during installation.

b. Provide a lockable access cover (or pull box door if pull box is exposed) in hard lid ceilings.

7. Install pull boxes such that conduits enter and exit at opposite ends of the box as follows:



I. Firestopping:
   1. Only employees trained/certified by the firestopping manufacturer shall apply firestopping materials.
   2. Maintain fire rating of penetrated fire-rated walls. Firestop and seal each penetration made during construction.
      a. Provide firestopping material for through and membrane penetrations of fire-rated barriers.
      b. Installation shall be performed in strict accordance with manufacturer’s detailed installation procedures.
      c. Install firestops in accordance with fire test reports, fire resistance requirements, acceptable sample installations, manufacturer’s recommendations, local fire and building authorities, and applicable codes and standards referenced in PART 1 – REFERENCES. Apply all sealing material in a manner acceptable to the local fire and building authorities.

J. Grounding/Bonding: Grounding and bonding work shall comply with the Virginia Uniform Statewide Building Code, Uniform Fire Code, National Electrical Code, and UL 467, ANSI/TIA/EIA standards and the references listed in PART 1 – REFERENCES above, as well as local codes which may specify additional grounding and/or bonding requirements.
   1. Bond metallic raceway together and to the nearest TGB (as provided under Division 27 Section — “Grounding and Bonding for Communications Systems”). Ensure that bonding breaks through paint to bare metallic surface of painted metallic hardware.

3.04 LABELS:

A. Conduits: For any conduit extending beyond the space or room in which it starts, label each such conduit end in a clear manner by designating the location of the other end of the conduit (i.e. room name, telecommunications room name, pull box identifier, outlet identifier (use the label of the first port of the outlet as the outlet identifier), etc.). Indicate conduit length on the label.
   1. Where a conduit is intended for future cabling use outside of the Contract, the conduit shall be labeled in a clear manner by designating the location of the other end of the conduit (i.e. room name, telecommunications room name, pull box identifier, etc.) along with a sequential number for each spare conduit terminated into a single room. Indicate conduit length on the label.

a. Suggestion: The second spare conduit (whether spare or in use) between Room 100 and telecommunications room 1A might be labeled in the telecommunications room as "Room 100 - #2, __ feet." In Room 100 the same conduit might be labeled "1A - #2, __ feet."

B. Pull Boxes: Label each pullbox with a unique identifier. Identifiers shall be of the form "RN-Y" where "RN" is the room name of the room closest to (or containing) the pull box, and "Y" is the sequential number of the pull box for each "RN".

1. Example: The second pull box in the vicinity of room "100" would have the label "100-2".

C. Pull Strings: For any conduit extending beyond the space or room in which it starts, label its pull string in a clear manner by designating the location of the other end of the pull string (i.e. room name, telecommunications room name, pull box identifier, outlet identifier (use the label of the first port of the outlet as the outlet identifier), etc.).

1. Where a pull string is installed in a conduit intended for future cabling use outside of the Contract, the pull string shall be labeled similar to the spare conduit in which it is installed.

3.05 PROTECTION

A. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and in accordance with accepted industry practice, that ensure coatings, finishes, and cabinets are without damage or deterioration at the time of Substantial Completion.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.06 CLEANING

A. On completion of installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish, including chips, scratches, and abrasions.

SECTION 27 05 36

CABLE TRAY FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to the work of this Section.

1.02 SUMMARY

A. Provide all materials and labor for the installation of a cable tray system for communications infrastructure. This section includes requirements for providing a cable tray system for communications circuits.

B. Related Sections
1. Division 07 Section — "Firestopping"
2. Division 01 Section — "Cutting and Patching"
3. Division 26 Section — "Basic Electrical Materials and Methods"
4. Division 27 Section — "Conduit and Boxes for Communications Systems"
5. Division 27 Section — "Inside Plant Communications Systems"
6. Division 27 Section — "Underground Ducts and Raceways for Communications Systems"

1.03 REFERENCES

A. The applicable portions of the following specifications, standards, codes and regulations shall be incorporated by reference into these specifications.
1. General:
   a. National Electrical Code (NEC)
   b. National Electrical Safety Code (NESC)
   c. Occupational Safety and Health Act (OSHA)
   d. ASTM A123 – Specification for Zinc (Hot Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strip.
   e. ASTM A653 – Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot Dip Process, Structural (Physical) Quality.
   f. ASTM A1011 – Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low Alloy and High-Strength Low-Alloy with Improved Formability.
   g. ASTM A1008 – Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low Alloy and High-Strength Low-Alloy with Improved Formability.
   h. ASTM B633 – Specification for Electrodeposited Coatings of Zinc on Iron and Steel
   i. NEMA VE 1 – Metallic Cable Tray Systems
   j. NEMA VE 2 – Cable Tray Installation Guidelines

2. Communications:
   a. TIA/EIA - 568: Commercial Building Telecommunications Cabling Standard
   b. TIA/EIA - 569: Commercial Building Standard for Telecommunication Pathways and Spaces
   c. TIA/EIA - 606: The Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
   d. TIA/EIA - 607: Commercial Building Grounding and Bonding Requirements for Telecommunications
   e. ISO/IEC IS 11801: Generic Cabling for Customer Premises
   f. BICSI: BICSI Telecommunications Cabling Installation Manual
   g. BICSI: BICSI Telecommunications Distribution Methods Manual (TDMM)

1.04 DEFINITIONS

A. “EMT shall mean Electrical Metallic Tubing.

B. “RMC” shall mean Rigid Metal Conduit.

C. “Raceway” shall mean any enclosed channel for routing wire, cable or busbars.

D. “TMGB” shall mean Telecommunications Main Grounding Busbar. There is typically one TMGB per building, located in the main telecommunications room. This busbar is directly bonded to the electrical service ground.

E. “TGB” shall mean Telecommunications Grounding Busbar. There is typically one TGB per telecommunications room. The TGB is connected both to the TMGB and to building structural steel or other permanent metallic systems.

F. “TBB” shall mean Telecommunications Bonding Backbone. The TBB is a conductor used to connect TMGBs to the TGBs.

G. “Pullbox” shall mean a metallic box with a removable cover, used to facilitate pulling cable through conduit runs longer than 100’ or in which there are more than 180 degrees of bends. Pullboxes shall have no more than one conduit entering and one conduit exiting the box.

H. “Junction box” shall mean a pullbox wherein a conduit run transitions from a feeder conduit to multiple distribution conduits.

1.05 SYSTEM DESCRIPTION

A. Furnish, install, and place into satisfactory and successful operation all materials, devices, and necessary appurtenances to provide a complete, permanent Cable Tray infrastructure for communications circuits as hereinafter specified and as shown on the Contract Documents. The Cable Tray system shall support an ANSI/TIA/EIA and lSO/IEC compliant communications Structured Cabling System (SCS) as specified in 271500 - Inside Plant Communications Systems.

B. The work shall include materials, equipment and apparatus not specifically mentioned herein or noted on the plans but which are necessary to make a complete working ANSI/TIA/EIA and ISO/IEC compliant Cable Tray system.

1.06 SUBMITTAL INFORMATION

A. Product Data Submittals: Provide submittal information for review before materials are delivered to the job site. Provide product data submittals for all products at the same time.
   1. Submit a letter stating that the materials will be provided as specified, and specifically listing any items that will not be provided as specified. The letter shall also state that the Contractor has reviewed the specified items and agrees that they are applicable to this project in all respects.
   2. For those items noted as allowing “or equal,” and which are not being provided as specifically named, submit standard manufacturer's cut sheets or other descriptive information, along with a written description detailing the reason for the substitution.
   3. Provide standard manufacturer’s cut sheets and the operating and maintenance (O&M) instructions at the time of submittal review for each device in the system, regardless of whether it is submitted as specified or as an approved equal. These instructions shall detail how to install and service the equipment and shall include information necessary for rough-in and preparation of the building facilities to receive the materials.

B. Closeout Submittals: Provide submittal information for review as follows:
   1. O&M Manual for Communications - At the completion of the project, submit O&M information from product data submittals (above), updated to reflect any changes during the course of construction, to the Designer in the telecommunications-specific O&M Manual for Communications binder labeled with the project name and description.
   2. Records - Maintain at the job site a minimum of one set of Record Drawings, Specification, and Addenda. Record Drawings shall consist of redline markups of drawings, specifications and spreadsheets.
      a. Document changes to the system from that originally shown on the Contract Documents and clearly identify system component labels and identifiers on Record Drawings.
      b. Keep Record Drawings at the job site and make available to the Owner and Designer at any time.
      c. Keep Record Drawings current throughout the course of construction. (“Current” is defined as not more than one week behind actual construction).
      d. Show identifiers for major infrastructure components on Record Drawings.

1.07 SEQUENCING

1.08 CONTRACTOR WARRANTY:

A. Provide a Contractor-endorsed one-year service warranty against defects in materials and workmanship.
   1. Provide labor attributable to the fulfillment of this warranty at no cost to the Owner.

2. The Contractor Warranty period shall commence upon Owner acceptance of the work.

PART 2 - PRODUCTS

2.01 GENERAL

A. Materials shall consist of tray sections, tray fittings, connectors, supports, expansion joints, blind end plates, barrier strips, radius drops, bonding conductors and other incidentals and accessories as required for a complete, permanent Cable Tray infrastructure. Provide all incidental and/or miscellaneous hardware not explicitly specified or shown on the Contract Documents that is required for a fully operational and warranted system.

B. Physically verify existing site conditions prior to purchase and delivery of the materials.

C. Cable tray components shall be manufactured by a single manufacturer. Components shall not be intermixed between different manufacturers.
   1. The cable tray manufacturer shall be one of the following:
      a. GS Metals
      b. Cablofil
      c. Or approved equivalent
   2. Substitution is not acceptable unless the cable tray manufacturer has been pre-approved prior to bidding. Contractors, in order to obtain approval for cable tray manufacturer substitution, shall submit their request for substitution to the Engineer at least two weeks prior to the bid date. Approval or denial of a substitution request will be based upon the sole judgment of the Engineer.

D. For a given manufacturer, all components shall be part of a single cable tray product line – components shall not be intermixed between a manufacturer's cable tray product lines.
   1. The cable tray product one shall be one of the following:
      a. For GS Metals: Flextray Series
      b. For Cablofil, Inc.: EZ Tray CF54/xxx Series
      c. Or approved equivalent

2.02 MATERIALS AND FINISH

A. Welded wire: Cable tray shall be constructed of welded wire mesh (high strength steel wires) with a continuous safety edge wire lip. Cable tray shall be complete will all tray supports, materials, and incidental and miscellaneous hardware required for a complete cable tray system.
   1. Finish: Carbon steel with electro-plated zinc galvanized finish.
   2. Width: Widths shall be as shown on the Contract Documents. Where cable tray width is not shown on the Contract Documents, it shall be sized according to the amount of cable to be placed in the trays (as shown on the Contract Documents) plus an additional 20% for future expansion capability.
   3. Depth: minimum 2 inches.
   4. Mesh: 2 x 4 inches.
   5. Fittings: Fittings shall be field fabricated from straight sections using manufacturer-approved tools and in accordance with manufacturer's instructions.

B. Grounding/bonding: In accordance with ANSI/NFPA 70 Section 318-7, cable tray shall be complete with bolted splicing hardware for grounding/bonding throughout the entire cable tray system.

2.03 FIRESTOPPING MATERIAL

A. Firestopping material: Conform to both Flame (F) and Temperature (T) ratings as required by local building codes and as tested by nationally accepted test agencies per ASTM E814 or UL 1479 fire test in a configuration that is representative of the actual field conditions.

B. Specified Technologies, Inc's EZ-Path Solution is the preferred fire stop product, where applicable.

2.04 LABELING AND ADMINISTRATION

A. Labels: As recommended in ANSI/TIA/EIA 606. Permanent (i.e. not subject to fading or erasure), permanently affixed, and created by a hand-carried label maker or a computer/software-based label making system. Handwritten labels are not acceptable.
   1. Hand-carried label maker: Brady: ID Pro Plus (or approved equal).
   2. Labels: Brady: Bradymaker Wire Marking Labels WML-511-292 (or approved equal)
   3. Label Clips: Cablofil, Inc. (or approved equal, regardless of cable tray manufacturer)

PART 3 - EXECUTION

3.01 GENERAL

A. The Contractor is solely responsible for the safety of the public and workers in accordance with all applicable rules, regulations, building codes and ordinances.

B. All work shall comply with applicable safety rules and regulations including OSHA. All work shall comply with the requirements of the National Electrical Safety Code (NESC) and the NEC except where local codes and/or regulations are more stringent, in which case the local codes and/or regulations shall govern.

C. All work shall comply with the standards, references and codes listed in PART 1 -- REFERENCES above. Where questions arise regarding which standards, references, or codes apply, the more stringent shall prevail.

D. All work shall comply with the requirements and recommendations of the product manufacturers. Where questions arise regarding which requirements and recommendations apply, the more stringent shall prevail.

E. Replace and/or repair to original (or better) condition any existing structures, materials, equipment, etc. inadvertently demolished or damaged by the Contractor during the course of construction at no additional cost to the Owner.

F. Install the cable tray system in a manner ensuring that communications circuits, when installed, are able to fully comply with the ANSI/TIA/EIA and other references listed in Part 1 — References, above.

G. Remove surplus material and debris from the job site and dispose of legally.

3.02 EXAMINATION

A. Examine surfaces and spaces to receive cable tray for compliance with installation tolerances and other conditions affecting performance of cable tray installation. Do not proceed with installation until unsatisfactory conditions have been corrected.

B. Notify the Engineer/Owner of conditions that may adversely affect the installation, subsequent use, or cause the tray (or circuits to be subsequently installed in the tray) to not comply with ANSI/TIA/EIA standards.

3.03 INSTALLATION

A. Provide cable tray, in the locations and widths shown on the Contract Documents and in accordance with manufacturer's requirements and industry practices (NEMA VE 2). Ensure that the cable tray equipment complies with the requirements of NEC, and applicable portions of NFPA 70B and NECA's "Standards of Installation" pertaining to general electrical installation practices.
   1. Cable tray shall be installed plumb, level and square with finished building surfaces.
   2. Provide factory-manufactured connection hardware between each cable tray segment. Cable tray segments shall be mutually aligned. Connection hardware shall be installed according to the manufacturer's requirements.
   3. Cable tray elevation changes shall be gradual.

B. Slots/sleeves: Provide slots/sleeves where required and where shown on the Contract Documents. Provide roto-hammering, core drilling and saw cutting where required for installation. Seal and firestop (firestop only if fire rated barrier) between slot/sleeve and cable tray.

C. Cable Tray Routing:
   1. Route cable tray as shown on the Contract Documents. Where not shown on the Contract Documents, route cable tray in the most direct route possible, parallel to building lines.
   2. Do not route cable tray through areas in which flammable material may be stored or through wet, hazardous or corrosive areas.

D. Cable Tray Clearance Requirements:
   1. Clearance requirements for cable tray accessibility:
      a. Maintain a clearance of 6" between top of cable tray and ceiling structure or other equipment or raceway.
      b. Maintain a clearance of 8" between at least one side of cable tray and nearby objects.
      c. Maintain a clearance of 6" between bottom of cable tray and ceiling grid or other equipment or raceway.
   2. Clearance requirements from sources of electromagnetic interference (EMI):
      a. Maintain a clearance of 5" or more from fluorescent lighting.

b. Maintain a clearance of 12” or more from conduit and cables used for electrical power distribution.
c. Maintain a clearance of 48” or more from motors or transformers.
d. Pathways shall cross perpendicularly to electrical power cables or conduits.
3. Maintain a clearance of at least 6 inches from parallel runs of flues and steam or hot-water pipes or other heat sources operating at temperatures above one-hundred degrees Fahrenheit.

E. Cable Tray Fittings: Provide field-fabricated fittings from straight sections of cable tray using manufacturer-approved tools and in accordance with manufacturer’s instructions. Bends shall be long radius. Short radius bends and T-sections shall not be used unless specifically called out on the Contract Documents.

F. Cable tray supports shall be provided according to the manufacturer’s recommendations.
1. Supports shall be attached to structural ceiling or walls with hardware or other installation and support aids specifically designed for the cable tray and designed to support the cable tray’s weight and required cable weight and volume.
2. Where cable trays abut walls, provide wall-mounted supports.
3. Do not attach cable tray supports to ceiling support system or other mechanical support systems.
4. Trays shall be supported at 6 foot intervals minimum, or more frequently if required by the manufacturer.

G. Load span criteria: Install tray supports in accordance with the load criteria of L/240, and as shown on the Contract Documents.

H. Cable tray shall be installed free of burrs, sharp edges, or projections which may damage cable insulation.

I. Wire-type cable tray shall be cut with a manufacturer-approved cutter with “offset cutting blade” jaws and a minimum 24 inch handle.
1. The choice and position of the jaws at the point where the cut is to be made shall allow shearing as close as possible to the intersection of the steel wires.
2. Cuts shall ensure the integrity of the galvanic protective layer.

J. Expansion Joints: Provide cable tray sliding or offsetting expansion joints/fittings where cable tray crosses building expansion joints in addition to where shown on the Contract Documents. Provide bonding jumper except where expansion joints are specifically approved for bonding.

K. Thermal contraction and expansion: Install cable tray sections with gap settings between cable tray sections that are appropriate for the range of thermal expansion and contraction expected for the space during construction and also during normal occupancy and operation.

L. Blind End Plates: Close unused openings using factory-made blind end plates.

M. Barrier Strips: Provide barrier strips as recommended by manufacturer.

N. Radius Drops: Provide cable tray radius drops where cable trays cross other telecommunications cable trays or ladder rack in addition to where shown on the Contract Documents.

3.04 GROUNDING AND BONDING

A. Grounding/Bonding: Grounding and bonding work shall comply with the Uniform Building Code, Uniform Fire Code, National Electrical Code, and UL 467, ANSI/TIA/EIA standards and the references listed in PART 1 – REFERENCES above, as well as local codes which may specify additional grounding and/or bonding requirements.

B. Bond metallic raceway (including cable tray) together and to the nearest TGB (as provided under Division 27 Section — "Grounding and Bonding for Communications Systems"). Ensure that bonding breaks through paint to bare metallic surface of painted metallic hardware.

C. Cable tray bonding splices: Provide cable tray splices according to manufacturer requirements to create a continuous bonding conductor throughout the entire cable tray.

D. Bonding conductors:
   1. Bond distribution conduits to cable tray.
   2. Provide bonding jumpers at expansion joints, sleeves and any other locations where electrical continuity is interrupted.
   3. Provide bonding conductor between cable tray and the electrical power distribution system grounding infrastructure.

3.05 FIRESTOPPING

A. Only employees trained/certified by the firestopping manufacturer shall apply firestopping materials.

B. Maintain the fire rating of all penetrated fire barriers. Fire stop and seal all penetrations made during construction.
   1. Provide firestopping material for through and membrane penetrations of fire-rated barriers.
   2. Install firestops in strict accordance with manufacturer's detailed installation procedures.
   3. Install firestops in accordance with fire test reports, fire resistance requirements, acceptable sample installations, manufacturer's recommendations, local fire and building authorities, and applicable codes and standards referenced in PART 1 – REFERENCES. Apply sealing material in a manner acceptable to the local fire and building authorities.
   4. For demolition work, apply firestopping to open penetrations in fire rated barriers where cable is removed. Apply firestopping regardless of whether or not the penetrations are used for new cable or left empty after construction is complete.
   5. Firestopping material used to seal open penetrations through which cable passes shall be re-usable/re-enterable.

3.06 CLEANING AND PROTECTION

A. On completion of installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish, including chips, scratches, and abrasions.

B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and in accordance with accepted industry practice, that ensure coatings, finishes, and cabinets are without damage or deterioration at the time of Substantial Completion.
   1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
   2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.07 TESTING

A. Test cable trays to ensure electrical continuity of bonding and grounding connections. Demonstrate compliance with maximum grounding resistance per NFPA 70B, Chapter 18.

3.08 LABELING AND ADMINISTRATION

A. Provide the following two labels, alternating one label every 10 feet, along the entire length of the cable tray:
   1. Label #1: Label shall read “TELECOMMUNICATIONS / LOW VOLTAGE CABLING ONLY”.
   2. Label #2: Label shall read “WARNING! CABLE TRAY SERVES AS A TELECOMMUNICATIONS BONDING CONDUCTOR. DO NOT DISCONNECT!”

SECTION 27 05 43

UNDERGROUND DUCTS AND RACEWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to the work of this Section.

1.02 SUMMARY

A. Provide all materials and labor for the installation of a pathway system for outside plant communications circuits. Work in this section includes excavation and trenching, conduit (raceway) construction, cutting and patching, concrete, maintenance hole and handhole construction, and landscaping.

B. Related Sections
   1. Division 26 Section — "Basic Electrical Materials and Methods"
   2. Division 27 Section — "Conduit and Backboxes for Communications Systems"
   3. Division 27 Section — "Grounding and Bonding for Communications Systems"

1.03 REFERENCES

A. Incorporate by reference the applicable portions of the following specifications, standards, codes into this specification section.
   1. General:
      a. National Electrical Code (NEC)
      b. National Electrical Safety Code (NESC)
      c. Occupational Safety and Health Act (OSHA)
   2. Communications:
      a. ANSI/TIA/EIA - 758 : Customer-owned Outside Plant Telecommunications Cabling Standard
      b. ANSI/TIA/EIA - 568: Commercial Building Telecommunications Cabling Standard
      c. ANSI/TIA/EIA - 569: Commercial Building Standard for Telecommunication Pathways and Spaces
      d. ANSI/TIA/EIA - 606: The Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
      e. ANSI/TIA/EIA - 607: Commercial Building Grounding and Bonding Requirements for Telecommunications
      f. ISO/IEC IS 11801: Generic Cabling for Customer Premises
      g. BICSI: BICSI Telecommunications Cabling Installation Manual (CIM)
      h. BICSI: BICSI Telecommunications Distribution Methods Manual (TDMM)
      i. BICSI: BICSI Customer-Owned Outside Plant Design Manual (CO-OSP)
   3. Concrete:

a. Reinforcement:
   1) 1) ACI 301: Structural Concrete for Buildings
   2) 2) ACI SP-66: American Concrete Institute - Detailing Manual
   3) 3) ANSI/ASTM A82: Cold Drawn Steel Wire for Concrete Reinforcement
   4) 4) ANSI/AWS D1.4: Structural Welding Code for Reinforcing Steel
   5) 5) ANSI/AWS D12.1: Reinforcing Steel Welding Code
   6) 6) ASTM A615: Deformed and Plain Billet Steel Bars for Concrete Reinforcement
   7) 7) AWS D12: Welding Reinforcement Steel, Metal Inserts and Connections in Reinforced Concrete Construction
b. Cast-in-Place:
   1) 1) ACI 212.3R: Chemical Admixtures for Concrete
   2) 2) ACI 301: Structural Concrete for Buildings
   3) 3) ACI 304: Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete
   4) 4) ACI 305R: Hot Weather Concreting
   5) 5) ACI 306R: Cold Weather Concreting
   6) 6) ASTM C33: Concrete Aggregates
   7) 7) ASTM C39: Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
   8) 8) ASTM C94: Ready-Mixed Concrete
   9) 9) ASTM C150: Portland Cement
   10) 10) ASTM C143: Standard Test Method for Slump of Hydraulic Cement Concrete
   11) 11) ASTM C173: Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
   12) 12) ASTM C231: Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
   13) 13) ASTM C260: Air Entraining Admixtures for Concrete
   14) 14) ASTM C309: Standard Specifications for Liquid Membrane Forming Compound for Curing Concrete
   15) 15) ASTM C494: Chemical Admixtures for Concrete
c. Pre-Cast:
   1) 1) ASTM C478: Standard Specification for Precast Reinforced Concrete Manholes Sections
   2) 2) ASTM C857: Standard Practice for Minimum Structural Design Loading for Underground Precast Utility Structures
   3) 3) ASTM C858: Standard Specification for Underground Precast Concrete Utility Structures
   4) 4) ASTM C891: Standard Practice for Installation of Underground Precast Concrete Utility Structures
   5) 5) ASTM C1037: Standard Practice for Inspection of Underground Precast Concrete Utility Structures
   6) 6) ASTM D1751: Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)

4. Trenching and Backfill:
   a. ASTM D1557: Test Method for Laboratory Compaction Characteristics Using Modified Effort

1.04 DEFINITIONS

A. Aggregate: Mineral materials such as sand or stone used in making concrete

B. Backfill: Earth material used specifically for filling and grading excavations back to a finished state. Backfill is placed on top of the bedding surrounding encased ductbanks and direct-buried conduits.

C. Base: Earth material used specifically to level and grade an excavation's subgrade for the subsequent placement of encased ductbanks, direct-buried conduit, maintenance holes and handholes. Base material is placed on top of the subgrade and beneath the bedding surrounding encased ductbanks, conduits, maintenance holes or handholes.

D. Bedding: Earth material used specifically for filling excavations. Bedding is placed around encased ductbank, conduits, maintenance holes or handholes. Bedding is placed on top of the base and beneath the backfill.

E. Fill: The collective term for base, bedding, and backfill.

F. Handhole (HH): A structure similar to a small maintenance hole through which cable can be pulled, but not large enough for a person to fully enter to perform work.

G. Maintenance Hole or Manhole (MH): A vault located in the ground or earth as part of an underground conduit system and used to facilitate placing, connectorization, and maintenance of cables as well as the placing of associated equipment, in which it is expected that a person will enter to perform work.

H. RNC: Rigid Non-Metallic Conduit (PVC)

1.05 SYSTEM DESCRIPTION

A. Furnish, install, and place into satisfactory and successful operation all materials, devices, and necessary appurtenances to provide a complete Outside Plant pathway system as hereinafter specified and/or shown on the Contract Documents. The Pathway system shall support an ANSI/TIA/EIA and lSO/IEC compliant communications Structured Cabling System (SCS) .

B. The work shall include materials, equipment and apparatus not specifically mentioned herein or noted on the plans but which are necessary to make a complete working ANSI/TIA/EIA and ISO/IEC compliant pathway system.

1.06 SUBMITTAL INFORMATION

A. Product Data Submittals: Provide submittal information for review before materials are delivered to the job site. Provide product data submittals for all products at the same time.

1. Submit a letter stating that the materials will be provided as specified, and specifically listing any items that will not be provided as specified. The letter shall also state that the Contractor has reviewed the specified items and agrees that they are applicable to this project in all respects.
2. For those items noted as allowing "or equal," and which are not being provided as specifically named, submit standard manufacturer's cut sheets or other

descriptive information, along with a written description detailing the reason for the substitution.

3. Provide standard manufacturer's cut sheets and the operating and maintenance (O&M) instructions at the time of submittal review for each device in the system, regardless of whether it is submitted as specified or as an approved equal. These instructions shall detail how to install and service the equipment and shall include information necessary for rough-in and preparation of the building facilities to receive the materials.

B. Quality Assurance/Control Submittals: Provide submittal information for review as follows:

1. Submit a copy of the delivery receipt for each concrete delivery. Include date, strength ordered, and location used.

C. Closeout Submittals: Provide submittal information for review as follows:

1. O&M Manual for Communications - At the completion of the project, submit O&M information from product data submittals (above), updated to reflect any changes during the course of construction, to the Designer in the telecommunications-specific O&M Manual for Communications binder labeled with the project name and description.
2. Records - Maintain at the job site a minimum of one set of Record Drawings, Specification, and Addenda. Record Drawings shall consist of redline markups of drawings, specifications and spreadsheets, including maintenance hole/handhole butterfly drawings.
   a. Document changes to the system from that originally shown on the Contract Documents and clearly identify system component labels and identifiers on Record Drawings.
   b. Keep Record Drawings at the job site and make available to the Owner and Designer at any time.
   c. Keep Record Drawings current throughout the course of construction. ("Current" is defined as not more than one week behind actual construction).
   d. Show identifiers for major infrastructure components on Record Drawings.

1.07 SEQUENCING

1.08 CONTRACTOR WARRANTY:

A. Provide a Contractor-endorsed two-year service warranty against defects in materials and workmanship.

1. Provide labor attributable to the fulfillment of this warranty at no cost to the Owner.
   a. The Contractor Warranty period shall commence upon Owner acceptance of the work.

PART 2 - PRODUCTS

2.01 GENERAL

A. Materials shall consist of fill, topsoil, concrete formwork, concrete, raceway, maintenance holes, handholes and other incidentals and accessories as required.

2.02 BASE, BEDDING AND BACKFILL

A. Use of on-site soils for base, bedding, and backfill is not acceptable.

B. Base: Readily compactable and meet the following gradation requirements.
1. For Maintenance Holes and Handholes (provide gravel):

Sieve Size	Percent Passing
1" Square	100
¼" Square	25 - 80
U.S. No. 200	15 max
Sand Equivalent	30 min

2. For Trenches (provide sand):

Sieve Size	Percent Passing
U.S. No. 10	35 - 100
U.S. No. 20	20 - 80
U.S. No. 40	10 - 55
U.S. No. 100	0 - 10
U.S. No. 200	0 - 3

C. Bedding: Same as Base - For Trenches, above.

D. Backfill:
1. For Maintenance Holes and Handholes - Same as Base - For Maintenance Holes and Handholes, above.
2. For Trenches

Sieve Size	Percent Passing
½" Square	100
¼" Square	65 - 100
U.S. No. 10	40 - 100
U.S. No. 50	3 - 50
U.S. No. 100	0 - 4
U.S. No. 200	0 - 3

2.03 CAST-IN-PLACE CONCRETE

A. Formwork:

1. Forms: Metal or plywood in good condition
   a. Form Release Agent: Burke Form Coating (or equal)
2. Gypsum board

B. Reinforcement:
1. Reinforcing Steel: ASTM A615, Grade 40. Uncoated, free from rust, dirt, and loose scale.
2. Tie Wire: 18 gauge 40 or heavier black annealed wire.
3. Embedded Anchor Bolts: Mild galvanized steel, cold bent.

C. Concrete:
1. Cement: Different types of cement, including the same type of cement provided by more than one manufacturer, are not acceptable: Cement shall conform to:
   a. ASTM C150-7, type 1.
   b. 2500 psi. minimum compressive at 28 days per ASTM C39.
   c. 4 inches maximum slump per ASTM C-143.
2. Aggregate:
   a. Course: ASTM C33-71 with a maximum size of 1-¼”.
   b. Fine: ASTM C33-71.
3. Water: Fresh, clean, potable and not detrimental to concrete.
4. Admixtures:
   a. Air Entrainment: Conform to ASTM C260 and ASTM C173 or C231 with 5% to 7% air entrainment.
   b. Other: Not allowed without prior approval from the Designer.
5. Curing Compound: Conform to ASTM C309. Free from petroleum resins or waxes. Formulated for sealing, surface hardening, and curing concrete.

2.04 CONDUIT AND DUCTBANKS

A. Conduit
1. Rigid Non-Metallic Conduit (RNC):
   a. UL listed, NEMA TC2 and TC6 Schedule 40 or 80 rigid polyvinyl chloride (PVC) approved for burial with concrete encasement.
   b. Fittings: NEMA TC3 and TC9, matched to conduit and material.
2. Fittings:
   a. Sweeps: Factory manufactured with a single arc of not less than a 15 foot radius.
   b. End Caps (Plugs): Pre-manufactured and water-tight. Tape is not an acceptable end cap or cover.
3. Pull Ropes: ¼ inch polypropylene with a minimum tensile strength of 200 pounds.

B. Ductbanks:
1. Conduit Spacers/Supports: High-density plastic interlocking spacers/supports.
2. Warning Tape: Not less than 6” wide by 4 mils thick metallic warning tape, red in color and printed with the words “Caution Communications line buried below”.
3. Grounding/Bonding: #2 bare copper ground

2.05 UNDERGROUND SPACES

A. General: Underground spaces include Maintenance Holes (MH) and Handholes (HH). Incidental and miscellaneous equipment supplied with a MH or HH shall be supplied by the same manufacturer.

B. Maintenance Holes: If precast, conform to ASTM C478 and other ASTM standards and specifications as listed in REFERENCES above. If cast-in-place, reference appropriate Sections. Complete with concrete floors, lockable covers, permanently installed ladders, pulling eyes, and 12” diameter closed sumps.

1. Precast
    a. Utility Vault Company: 4484-TA 6’-0” W x 6’-0” L x 7’-2” H (interior dimensions). Complete with Alternate Top Section 4484-T42E, Center Section 4484-MT, Base Section 4484-BT, and section gaskets. Equipped with (3) galvanized “C” imbedded channels per longitudinal side. Manufactured with conduit entry knockouts: 4” TERM-A-DUCT ’90.
    b. Or equivalent
2. Cast in place:
    a. Re-bar reinforced concrete rated at 4000 psi at 28 days
3. Sizes and Types:
    a. 6’-0” W x 6’-0” L x 7’-0” H (interior dimensions) minimum. Complete with necessary alternate top sections, center sections, base sections, and section gaskets. Equipped with (3) galvanized “C” imbedded channels per longitudinal side. Manufactured with conduit entry knockouts: 4” TERM-A-DUCT ’90 or equivalent.
4. Covers and Frames: Covers shall be circular cast ductile iron, shall be engraved with 1/8” high letters stating “COMMUNICATIONS”, and shall conform to AASHTO H20 loading if located in a roadway and to AASHTO H10 loading otherwise. Cover frames shall be cast ductile iron, conforming to the same AASHTO requirements as the covers.
    a. 30” Diameter Casting with standard hight Frame
5. Racking and Hardware: Galvanized.
6. Risers:
    a. 4 inch high: Utility Vault Company No. 4204 (or equivalent)
    b. 6 inch high: Utility Vault Company No. 4206 (or equivalent)
    c. 12 inch high: Utility Vault Company No. 4212 (or equivalent)

C. Handholes: Precast, conform to ASTM C478 and other ASTM standards and specifications as listed in REFERENCES above. Complete with concrete floors, lockable covers, pulling eyes, and 12” diameter closed sumps.

1. Sizes and Types:
    a. Utility Vault Company: 444-LA 4’-0” W x 4’-0” L x 4’-0” H (exterior dimensions). Complete with Cover Section 44-332P, Base Section 444-BL, and section gaskets. Equipped with one (1) galvanized “C” channel per longitudinal side and one (1) galvanized pulling iron per corner (four (4) total). Manufactured with conduit knockouts: 4” TERM-A-DUCT ’90.
    b. Utility Vault Company: 504-LA 4’-8” W x 4’-8” L x 4’-0” H (exterior dimensions). Complete with Cover Section 55-332P, Base Section 504-BL, and section gaskets. Equipped with one (1) galvanized “C” channel per longitudinal side and one (1) galvanized pulling iron per corner (four (4) total). Manufactured with conduit knockouts: 4” TERM-A-DUCT ’90.

c. Utility Vault Company: 25-TA 2'-3" W x 5'-2.5" L x 2'-7.5" H (exterior dimensions). Complete with Cover Section 38/25-T, Base Section 25-T, and section gaskets. Equipped with one (1) galvanized "C" channel per longitudinal side and one (1) pulling insert per end (two (2) total).
d. Or equivalent

2. Covers: Rectangular diamondplate covers, equipped with a self latching stainless steel slam lock, recessed lift inserts, lock down bolts, shall be labeled with 1/8" high letters stating "COMMUNICATIONS". Shall conform to AASHTO H20 loading if located in a roadway and to AASHTO H10 loading otherwise.
3. Racking and Hardware: Galvanized

D. Grounding:
1. ¾" x 10' copperclad steel ground rods
2. #4/0 pigtail for connection to interior ground conductors.

2.06 FIRESTOPPING MATERIAL:

A. Conform to both Flame (F) and Temperature (T) ratings as required by local building codes and as tested by nationally accepted test agencies per ASTM E814 or UL 1479 fire test in a configuration that is representative of the actual field conditions.

2.07 LABELS:

A. As recommended in ANSI/TIA/EIA 606. Permanent (i.e. not subject to fading or erasure), permanently affixed, typed, and created by a hand-carried label maker or an approved equivalent software-based label making system. Handwritten labels are not acceptable.
1. Hand-carried label maker:
   a. Brady: ID Pro Plus (or approved equal).
2. Labels:
   a. Brady: Bradymaker Wire Marking Labels WML-511-292 (or approved equal)

2.08 LANDSCAPING:

A. Topsoil: Imported from off construction site.

PART 3 - EXECUTION

3.01 GENERAL

A. The Contractor is solely responsible for the safety of the public and workers in accordance with all applicable rules, regulations, building codes and ordinances.

B. All work shall comply with applicable safety rules and regulations including OSHA. All work shall comply with the requirements of the National Electrical Safety Code (NESC) and the NEC except where local codes and/or regulations are more stringent, in which case the local codes and/or regulations shall govern.

C. All work shall comply with the standards, references and codes listed in PART 1 -- REFERENCES above. Where questions arise regarding which standards, references, or codes apply, the more stringent shall prevail.

D. All work shall comply with the requirements and recommendations of the product manufacturers. Where questions arise regarding which requirements and recommendations apply, the more stringent shall prevail.

E. Replace and/or repair to original (or better) condition any existing structures, materials, equipment, etc. inadvertently demolished or damaged by the Contractor during the course of construction at no additional cost to the Owner.

F. Remove surplus material and debris from the job site and dispose of legally.

3.02 EXCAVATING, TRENCHING AND FILL

A. Excavation:
1. Do not excavate when the outside temperature is less than 35° F or when there is standing water or snow on the subgrade.
2. Where crossing of concrete or asphalt is required, saw cut and remove surface material prior to excavating. Remove concrete in complete sections from control joint to control joint regardless of the width of the excavation. Restore concrete and asphalt surfaces following excavation to match existing depth, strength, color, and type of material.
3. If an adjacent structure may be compromised or damaged by excavation work, underpin the structure as required. If the structural integrity is in question, obtain an evaluation and recommendation from a registered structural Designer employed by the Contractor prior to proceeding with the work.
4. Maintain adequate separation between the excavation and adjacent underground utilities. Locate excavations such that ductbanks, maintenance holes, and handholes have a minimum separation of twelve (12) inches between the ductbank and/or MH/HH and the nearest underground utility after installation. For gas lines a minimum separation of eighteen (18) inches is required. For water a minimum separation of thirty-six (36) inches is required. Contact the Designer prior to proceeding if minimum separation distances can not be achieved.
5. Protect excavations at the end of the work shift. Cover with steel sheets and barricade prior to leaving the job site, in accordance with all applicable rules, regulations, building codes, and ordinances.
6. Install, operate and maintain pump or dewatering equipment as necessary to prevent water from accumulating in the excavation.
7. Excavation Depth/Width
   a. For MH/HH: Excavate to a sufficient depth to cover the overall assembled height of the vault plus the added height of risers, covers and bedding material consisting of a minimum 6”-12” of base. Excavate to a sufficient width to provide a minimum of 6” clearance around each side of the MH/HH.
   b. For trenches: Excavate to a sufficient depth to provide a minimum of 30” cover over the conduit or ductbank formation and to allow for the proper alignment of conduits into the MH/HH. Excavate to a sufficient width to provide a minimum of 6” to each side of the ductbank formation.

8. Over-excavate, fill, and compact any soft spots in the subgrade.
9. Run trench excavation true and as straight as possible. Clear trenches of stones and soft spots.
10. Slope trench grade to fall 3” per 100 feet in general and ¼” per foot where possible.
    a. Slope trench toward lower MH/HH or from high points toward MH/HH at both ends.
    b. Slope trench away from building entrances.

B. Fill:
1. Drain and/or pump groundwater and surface water from the recipient area prior to the placement of fill.
2. Do not place frozen fill.
3. Base:
    a. Scarify and moisture-condition the subgrade bed to receive fill prior to placing materials.
    b. Moisture-condition base material to within three (3) percent of optimum moisture content and place in loose, horizontal layers.
    c. Level the subgrade bed using sand for trenches and gravel for MH/HH as necessary to form an even base.
4. Bedding: Do not exceed 4” depth of bedding lifts/layers before compacting
5. Backfill: Do not exceed 6” depth of backfill lifts/layers before compacting.
6. Compaction: Compact using a vibratory plate or roller or other mechanical device. Compaction through jetting and/or pounding is not acceptable. Compact per APWA Standard Specification Paragraph 7-10.3 (11).
    a. Bedding: Compact material to a dense state equaling at least 95% of the maximum dry density per ASTM D1557.
    b. Backfill: Compact material up to two (2) feet below the finished grade with a minimum relative compaction of 90% of the maximum dry density per ASTM D1557. Compact material from two (2) feet below the finished grade up to the finished grade with a minimum relative compaction of 95% of the maximum dry density per ASTM D1557.

C. Waste Disposal: Remove excavation materials and other construction debris from the site in a timely manner and dispose of legally.

3.03 CAST-IN-PLACE CONCRETE

A. Construct concrete in accordance with the applicable portions of the specifications, standards, codes and regulations (latest editions and/or amendments) listed in Section 1, References.

B. Formwork:
1. Construction:
    a. Forms: Use the most advantageous panel sizes and panel joint locations. Neat patches and minor surface imperfections will be permitted. Form surfaces in true planes within ¼” in 10 feet. Clean forms and remove debris prior to pouring concrete. Make braces unyielding and tight to prevent leakage. Maintain formwork construction tolerances complying with ACI 347. Formwork shall be readily removable without impact, shock, or damage to concrete surfaces and adjacent materials. Use chamfer

strips fabricated to produce uniform smooth lines and tight edge joints for exposed corners and edges. Note: chamfer strips are not required for concrete encased ductbank corners and edges.

1) 1) Gypsum board shall not be used for forms except to form concrete encased ductbank.

b. Reinforcement: Construct reinforcement in accordance with ACI SP-6. Weld reinforcement in accordance with ANSI/AWS D1.4 or ANSI/AWS D12.1. Accurately position, support, and secure reinforcement against displacement. Support reinforcement by metal/plastic chairs, runners, bolsters, spacers, hangers, or other incidental materials as required.

c. Where metal or plywood forms are used, coat the forms with a form release agent prior to placement of concrete. Coat faces and edges of forms applied at a rate of 500 to 550 square feet per unit.

d. Curved Surfaces: Use only curved forms for constructing curved structures and surfaces.

2. Slope: For flatwork, construct forms with 1% side slope to both south and east sides.

3. Joints:

a. Control: Build into form.

b. Expansion: Build expansion joints into form, premolded ½" thick, and conforming to ASTM D1751. Seal the top ½" of expansion joints with an approved joint sealer.

4. Removal: Remove forms after concrete has cured (see Curing below) for 7 days or after concrete has attained a compressive strength of 4000 psi.

a. Where gypsum board forms are used to form concrete encased ductbank they can be left in place and backfilled after the specified curing period.

C. Concrete:

1. Transport: Comply with ACI 304. Transport concrete from the mixer to the construction location via methods preventing separation of materials.

2. Application:

a. Prior to placement, inspect and complete formwork construction, reinforcement, and items to be embedded or cast-in.

b. Deposit concrete in forms in layers not deeper than 24" and in a manner to avoid inclined construction joints. Where placement consists of several layers, place each layer on the preceding layer while the preceding layer is still plastic. Cold joints are not acceptable.

c. Deposit concrete in a plastic condition and uniformly work around reinforcements.

d. Consolidate concrete using internal machine vibration (stinger) during pouring.

e. Once concrete work has commenced, work continuously until the work segment and/or section has been completed.

f. Cold Weather: Protect concrete from damage caused by frost, freezing, or low temperatures in compliance with ACI 306R. When temperature is below 40° F, heat water and aggregates before mixing to obtain a concrete mixture of not less than 50° F and not more than 80° F.

g. Hot Weather: Protect concrete from damage caused by hot weather in compliance with ACI 305R. When temperature is above 90° F chill water before mixing to obtain a concrete mixture of not more than 90° F. Cover reinforcing steel with water-soaked burlap if it becomes too hot immediately before placement of concrete. Temperature of steel shall not exceed the ambient air temperature.

3. Curing:
   a. Curing method and rate of application shall be according to manufacturer's recommendations.
   b. Protect concrete from premature drying, rain, excessive temperatures, and mechanical injury during the curing period.
   c. Cure concrete for 7 days in accordance with ACI 301 and keep continuously moist during this time. Maintain concrete temperature between 50° and 90° F during the curing period.
   d. Provide curing and sealing compound to exposed slabs, sidewalks, curbs, etc. as soon as final finishing operations are complete (within 2 hours). Re-coat areas subjected to heavy rainfall within 3 hours of the initial application.
4. Finish:
   a. Consolidate, level and screen surfaces for evenness and uniformity. Remove excess concrete. Fill low spots. Float the surface after water sheen has disappeared from surface.
   b. Finish flatwork with a special tool to match patterned finish of adjacent existing concrete.
   c. Tool edges, control, and expansion joints to make finish work straight and even.
5. Ductbanks:
   a. Reinforce ductbanks along full length with formed sides. Install reinforcement at each corner of the conduit spacers/supports.
   b. Do not pour concrete against trench walls. Consolidate concrete during placement using an internal concrete vibrator.
   c. Provide each MH/HH penetration with reinforcing bars tied to MH/HH reinforcement. Dowel reinforcement in foundation wall of building penetrations.
   d. Secure conduit spacers/supports and reinforcing to prevent movement during concrete placement. Use stakes and/or tie wire to minimize floating and spreading.
6. Protection for exposed concrete: Cover exposed concrete (i.e. sidewalk, driveway, etc.) with plywood, weighted with concrete blocks or similar heavy object in order to prevent surface damage.
7. Bond and ground reinforcement bars to the nearest approved ground.

3.04 CONDUITS AND DUCTBANKS

A. Conduits:
   1. Outdoor underground: Provide RNC Schedule 40 (Type 1), concrete encased.
   2. Outdoor exposed: Provide RGC.
   3. Sweeps:
      a. Shallow curves comprised of continuous lengths of individual straight RNC conduit are permissible with a minimum sweep radius of 40 feet.
      b. Where the conduit sweep radius is less than 40 feet, sweeps shall be factory-manufactured bends with a minimum of 48 inch radius. Bending conduit in the field using manual or mechanical methods is not acceptable.
      c. Do not exceed 90 degrees for an individual sweep.

d. Where unique construction requirements for bend radius or arc length do not permit the use of factory-manufactured sweeps, sweeps shall be field-manufactured using factory-recommended equipment. The internal diameter of the sweep shall not be changed during the sweep field-manufacturing process.
e. A conduit section shall have not more than the equivalent of two 90-degree sweeps (a total of 180 degrees) between pull points. The 180-degree maximum shall include kicks and offsets. Where it is not possible to construct a section of conduit within the 180-degree sweep maximum, an intermediate MH/HH shall be installed.
f. Two 90-degree sweeps separated by less than 10 feet is not permissible.
g. Construct sweeps for conduits within a common ductbank parallel, measured from the same center-point.
h. Do not install LB's, condulets, or 90 degree electrical elbows.

4. Fittings:
   a. Cut conduit ends square and ream to remove burrs and sharp ends. Extend conduits the maximum distance into fittings, couplings, and/or connectors. Tighten fittings securely and seal watertight (see below).
   b. End Caps (Plugs): Provide end caps on conduit ends throughout construction to prevent the intrusion of water or debris. Install end caps on conduit that is not directly being worked on during the work day and on conduits at night. Leave end caps in place upon final completion of the work.
   c. End Bells: Provide end bells for terminating conduit in maintenance holes and handholes. Install protective end bells on conduits flush with MH/HH walls. Do not use TERM-A-DUCT.
5. Sealing: Apply a solvent-type cement (for RNC) to make conduit connections waterproof. Seal and grout conduit terminations in maintenance holes and handholes to ensure that voids in the joints are filled. Seal conduit terminations in buildings until used for cable.
6. Cleaning: After installation, and within five days prior to releasing conduit for cabling installation, clean each conduit with a wire brush and swab. Clean each conduit a minimum of two times in the same direction and swab with clean rags until the rag comes out of the conduit clean and dry. Swab away from buildings for conduit sections connected to buildings.
7. Test Mandrels: Prove out each conduit with a minimum 16 inch long test mandrel that is ¼ inch smaller than the inside diameter of the conduit. Pull the test mandrel after backfilling but prior to the replacement of landscaping. Repair or replace any conduit that does not prove out at no cost to the Owner.
8. Conduit Entrances:
   a. MH/HH: Conduit entrances at opposite ends of a maintenance hole or handhole shall be at the same level and in the same position with respect to the side walls. Ensure that each conduit leaving a MH/HH in any position enters the next MH/HH in the same relative position.
   b. Buildings: Terminate conduits a minimum of 6-inches above the finished floor.
9. Length: Unless otherwise shown on the Drawings, do not exceed 400 feet of ductbank between pulling points. Contact the Designer prior to proceeding if a ductbank section will exceed 400 feet.

10. Pull Ropes: Install in each conduit immediately after the conduit has been cleaned and mandreled. Leave a minimum of 10 feet looped and tied off at each end of the conduit.
11. Protection: Insure that after installation the conduit coatings and finishes are without damage. Repair any Rigid Non-metallic Conduit damage with matching touchup coating recommended by the manufacturer.

B. Ductbanks:
1. Unless otherwise noted on the Contract Documents or required for sweep radius, construct ductbanks in a concrete encasement. Use concrete encased RNC (see CAST-IN-PLACE CONCRETE, above).
2. Encased in Concrete:
    a. See CAST-IN-PLACE CONCRETE, above.
3. Conduit Spacers/Supports: Place supports on eight (8) foot centers if encased in concrete and five (5) foot centers otherwise. Interlock spacers horizontally only. Stagger spacers encased in concrete at least six (6) inches vertically.
4. Warning Tape: Install metallic warning tape half the distance between the top of the ductbank and finished grade.
5. Grounding/Bonding: Install ground wire along length of ductbank. Bond to grounding electrodes of MH/HH and to building service grounds.
6. Slope ductbank grade to fall 3 inches per 100 feet in general and ¼" per foot where possible.
    a. Slope ductbank toward lower MH/HH or from high points toward MH/HH at both ends.
    b. Slope ductbank away from building entrances.

3.05 UNDERGROUND SPACES

A. Provide maintenance holes and handholes in the sizes and locations shown on the Drawings.

B. Precast maintenance holes and handholes shall be free from damaged joint surfaces, cracks, or other damage that would permit infiltration. Repair of defects is not acceptable. MH/HH and incidental and miscellaneous equipment (such as cable racking brackets and supports) shall be supplied by a single manufacturer.

C. Install MH/HH according to manufacturer's instructions.

D. Covers and Frames: Provide 30" wide x 10" high circular frames/covers and provide with minimum 4" and maximum 12" high circular maintenance hole entrance riser sections as required. Use the riser sections to maintain the top of the cover 1" above the existing ground line or finished grade. Taper pavement surfaces up to the top of the maintenance cover. Provide lock-down bolts for HH covers. Covers and frames shall be of uniform quality, free from blowholes, porosity, shrinkage, distortion, cracks and other defects. Repair of defects is not acceptable. Mating surfaces between covers and frames shall be machine-finished to ensure a non-rocking fit.

E. Setting and Placement: Remove water from excavation and properly install bedding material prior to setting the MH/HH. Clean MH/HH section seal surfaces so that they are free from dirt or other material.

1. Set MH/HH in place by lowering each section into the excavation, ensuring that the section is level, plumb, and firmly positioned, and ensuring that the section gasket/seal is properly installed and watertight prior to setting the next section.
2. Carefully set the MH/HH to ensure that the rim or lid elevation is set one inch above finished grade. For vaults located in paved areas, taper pavement up to the MH/HH rim.

F. Knockouts: Open conduit entry knockouts with care preserving the TERM-A-DUCT sidewalls. Glue conduits entering the vault to the opened TERM-A-DUCTs with PVC cement. Preserve intact the conduit entry knockouts that are not intended for current use.

G. Grouting: Apply grout in a manner to insure filling of voids in the joints being sealed. Apply grouting to conduit entrances, risers, and covers in addition to any other voids.

H. Racking and Hardware: Install racking and hardware and incidental materials. Provide three (3) cable racks per longitudinal side (six (6) racks total) per maintenance hole. Provide eight (8) 7-½” cable support arms per manhole. Provide additional incidental hardware for mounting racks and cable support arms.

I. Risers: Provide riser sections that are a minimum of 4” high and a maximum 12” high, sized for the MH entrance. Provide riser sections in quantities sufficient to meet the minimum and maximum height requirements discussed above.

J. Grounding/Bonding: Provide a minimum of one ¾” x 10’ copperclad steel ground rods, and one #4/0 pigtail for connection to interior ground conductors. Bond metallic hardware in the vault to the pre-cast bonding tabs. Bond the bonding tabs to the ground rod.

K. Cleaning: Clean and dry the MH/HH after construction activity is complete and prior to releasing the MH/HH to the Owner for the Owner’s use.

SECTION 27 15 00

INSIDE PLANT STRUCTURED CABLING SYSTEM FOR NON-RESIDENTIAL BUILDINGS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to the work of this section.

1.02 SUMMARY

A. Provide all materials and labor for the installation of an inside plant telecommunication system. This section includes Inside Plant Communications cabling, termination, and administration equipment and installation requirements for the specified Structured Cabling System (SCS - See Definition Below).

B. This document describes the products and execution requirements relating to furnishing and installing Telecommunications Cabling at the new or remodeled residential buildings for Mason. Backbone and horizontal cabling of both copper and fiber, and related support systems are covered under this document.

C. The Horizontal (station outlet) Cabling System shall consist of a minimum of three, Enhanced Category 6 4-pair Unshielded Twisted Pair (UTP) Copper. Some locations will also have one coaxial cable (Quad Jack) added to the station outlet. The cables shall be installed from the station outlet to the Telecommunications Room (TR) located on the same floor, routed to the appropriate rack serving that area, and terminated as specified in this document.

D. Wireless Access points shall consist of a minimum of two Enhanced Category 6 4-pair Unshielded Twisted Pair (UTP) Copper Cables.

E. Wall phones shall consist of one Enhanced Category 6 4-pair Unshielded Twisted Pair (UTP) Copper Cable.

F. Elevator and Fire alarm panels each shall have one Enhanced Category 6 4-pair Unshielded Twisted Pair (UTP) Copper Cable per phone number required.

G. Product specifications, general design considerations, and installation guidelines are provided in this document. If the bid documents are in conflict, this specification shall take precedence. The successful vendor shall meet or exceed all requirements for the cable system described in this document.

H. Related sections include but are not necessarily limited to the following:
   1. Division 07 Section — "Firestopping"
   2. Division 01 Section — "Cutting and Patching"
   3. Division 26 Section — "Basic Electrical Materials and Methods"

4. Division 27 Section — "Conduit and Backboxes for Communications Systems"
5. Division 27 Section — "Grounding for Communications Systems"
6. Division 27 Section — "Underground Ducts and Raceways for Communications Systems"

I. Products furnished (but not installed) under this section:
1. Clarity Modular Category 6 Patch Cords
   a. The following lengths shall be furnished in yellow.
      1) 3, 5, 7 and 9 feet lengths.
   b. The following shall be furnished in blue.
      1) 3, 5, 7 and 9 feet lengths
   c. The following shall be furnished in orange.
      1) 3, 5, 7 and 9 feet lengths

1.03 REFERENCES

A. General:
1. National Electrical Code (NEC)
2. National Electrical Safety Code (NESC)
3. Occupational Safety and Health Act (OSHA)

B. Communications:
1. ANSI/TIA/EIA - 455: Fiber Optic Test Standards
2. ANSI/TIA/EIA - 526: Optical Fiber Systems Test Procedures
3. ANSI/TIA/EIA - 568-B: Commercial Building Telecommunications Cabling Standard
4. ANSI/TIA/EIA - 569: Commercial Building Standard for Telecommunication Pathways and Spaces
5. ANSI/TIA/EIA - 606: The Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
6. ANSI/TIA/EIA - 607: Commercial Building Grounding and Bonding Requirements for Telecommunications
7. ANSI/TIA/EIA -TSB67: Transmission Performance Specifications for Field Testing of Unshielded Twisted Pair Cabling Systems
8. ANSI/TIA/EIA -TSB75: Additional Horizontal Cabling Practices for Open Offices
9. NECA/FOA 301-1997: Standard for Installing and Testing Fiber Optic Cables
10. NECA/BICSI 568-2001: Standard for Installing Commercial Building Telecommunications Systems
11. IEEE 802.3 (series): Local Area Network Ethernet Standard, including the IEEE 802.3z Gigabit Ethernet Standard
12. ISO/IEC IS 11801: Generic Cabling for Customer Premises
13. BICSI: BICSI Telecommunications Cabling Installation Manual
14. BICSI: BICSI Telecommunications Distribution Methods Manual (TDMM)

C. If this document and any of the documents listed above are in conflict, then the more stringent requirement shall apply. All documents listed are believed to be the most current releases of the documents. The Contractor has the responsibility to determine and adhere to the most recent release when developing the proposal for installation

1.04 DEFINITIONS

A. "SCS" shall mean *Structured Cabling System*. The SCS is defined as all required equipment and materials including (but not limited to) ANSI/TIA/EIA 568-B and ISO/IEC 11801 compliant copper station cable (Category 3, Category 5E, Category 6, etc.) and fiber optic cable (multimode and singlemode), patch cables, stations and station connectors, termination blocks, patch panels, racks/enclosures (such as EIA standard equipment racks, enclosures, and vertical and horizontal cable management hardware), pathway/raceway materials (such as conduit, sleeves, D-rings, surface raceway, ladder rack, cable tray, etc.), and other incidental and miscellaneous equipment and materials as required for a fully operational, tested, certified, and warranted system, compliant with all applicable codes and standards.

B. "TMGB" shall mean *Telecommunications Main Grounding Busbar*. There is typically one TMGB per building, located in the main telecommunications room. This busbar is directly bonded to the electrical service ground.

C. "TGB" shall mean *Telecommunications Grounding Busbar*. There is typically one TGB per telecommunications room. The TGB is connected both to the TMGB and to building structural steel or other permanent metallic systems.

D. "TBB" shall mean *Telecommunications Bonding Backbone*. The TBB is a conductor used to connect TMGBs to TGBs.

E. "UTP" shall mean *Unshielded Twisted Pair* cable.

F. "MTS" or "MDF" shall mean the Main Distribution Frame (Room). The MDF is the entrance facility where the Outside Plant connects to the Riser cables from the IDFs (TRs).

G. "TR" or "IDF" shall mean Intermediate Distribution Frame. The IDFs are the floor level rooms where horizontal cable terminates.

1.05 SYSTEM DESCRIPTION

A. Furnish, install, test and place into satisfactory and successful operation all equipment, materials, devices, and necessary appurtenances to provide a complete ANSI/TIA/EIA, NECA/NEIS and lSO/IEC compliant communications Structured Cabling System (SCS) as hereinafter specified and/or shown on the Contract Documents. The system is intended to be capable of integrating voice, data, and video signals

B. The work shall include all materials, equipment and apparatus not specifically mentioned herein or noted on the plans but which are necessary to make a complete working ANSI/TIA/EIA and ISO/IEC compliant SCS.

C. Telecommunication Rooms (IDFs)
   1. Telecommunication Rooms (IDFs) shall be stacked on adjacent floors on all levels. See diagram below.
   2. Buildings with more than 6 IDF's should have a separate MDF room.
      a. The MDF will act as a transition point between OSP (outside plant) and interior cabling.

b. The MDF should be located on the same floor that the OSP ductbank enters the building.
c. The MDF must be within 50 feet of where the OSP ductbank enters the building.
d. All remaining items in this section also apply to the MDF with the exception of 3 (size) and 6 (power).
e. Power for the MDF shall be (2) L6-30R outlets.
f. The MDF room size should be at least 10 feet by 10 feet.

3. Size requirements for IDF's are based on distributing telecommunications service to one individual work area per 100 sq. ft. of occupied floor space. Minimum telecommunications room sizes are shown in the table below:

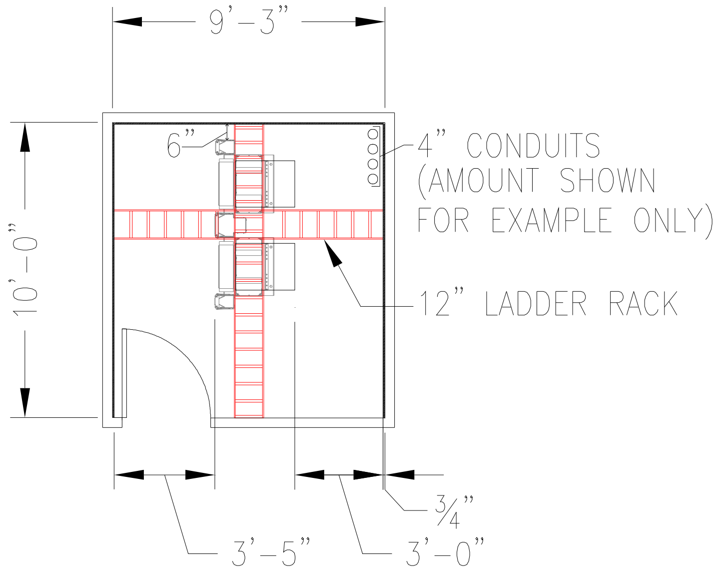
IF THE SERVING AREA IS:	THEN THE ROOMS MUST BE AT LEAST
Less than 5,000 sq. ft.	10 ft. x 7 ft.
Between 5,000 sq. ft. and 8,000 sq. ft.	10 ft. x 9 ft.
Larger than 8,000 sq. ft.	10 ft. x 11 ft.

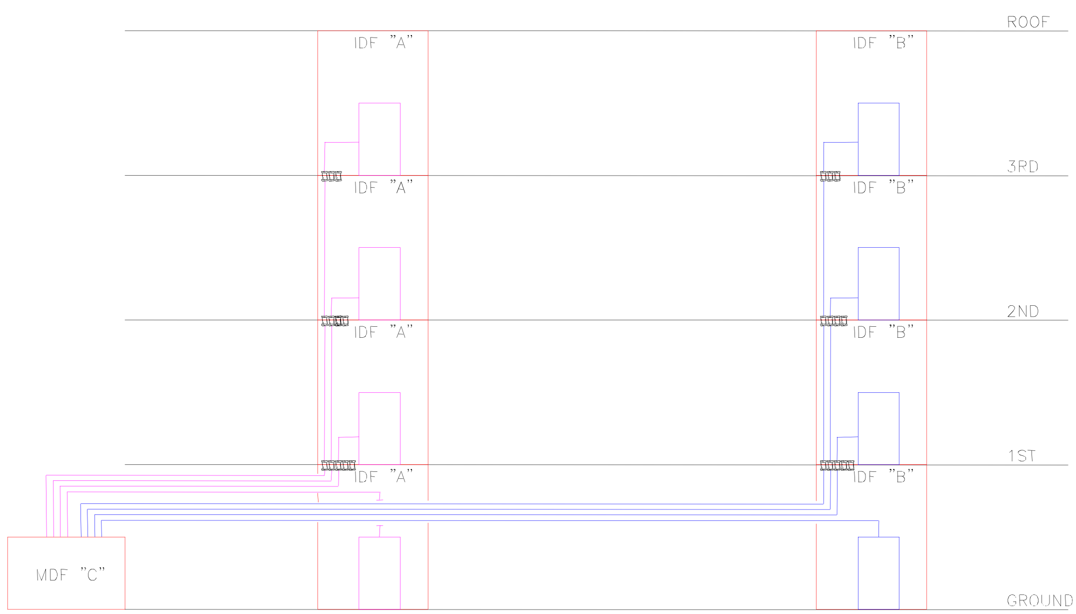
Minimum adequate space provides 3 feet from the farthest extending equipment, shelf or organizer to the wall on the front, back, and one side of the racks.

a. Multiple IDFs may be required to ensure that no horizontal cable length exceeds 90 meters (295 ft.).

4. All walls of each Telecommunications Room to be lined with ¾ inch fire retardant plywood.
5. All Telecommunications Rooms, at a minimum, will have the following electrical outlets: two duplex electrical outlets on the walls and 2 network equipment outlets as specified in 1.5 C 5, the exact locations to be determined at a later date. All electrical outlets in Telecommunications Rooms should be on an emergency building generator if available. In addition, the rooms must provide at least an air flow of one complete air exchange per hour. The temperature must be kept between 64 and 75 degrees Fahrenheit, at all times. The Telecommunications Rooms shall also maintain positive pressure, and humidity levels between 30-40%.
6. As initial design guidelines, Telecommunication Rooms that terminate less than 100 outlet locations will have (2) L5-30R outlets and a heat load of 3500 BTU/HR. Telecommunications Rooms that terminate more than 100 outlet locations will have (2) L6-30R outlets and a heat load of 10000 BTU/HR. Coordinate with NET/ITU at time of 85% drawings for final determination of exact power and heat load.
7. There shall be no exposed pipes in the Telecommunications Rooms, and they shall not be shared with unrelated utilities (i.e. Security, Building Automation, etc…).
8. Floors shall be VCT tile or sealed concrete, carpet is prohibited. The rated distribution floor loading should be greater than 250 psf. The rated concentrated floor loading should be greater than 1000 lbs.
9. Telecommunications Rooms will not have a suspended ceiling. The recommended minimum ceiling height is 8' 6".
10. Lighting requirements shall be a minimum of 50 lumens at 3' AFF. The location of lighting should coordinate closely with rack placement and should be powered by a panel not in the Telecommunications Room. Emergency lighting is recommended.

11. Telecommunications rooms shall not have door sills or center posts. The door shall be 7'H x 3'W. The locks on the doors shall be "store room function".
12. Typical Copper and Fiber Riser diagram is shown below.





TYPICAL COPPER AND FIBER RISER DIAGRAM
SCALE: NONE

1.06 SUBMITTAL INFORMATION

A. Product Data Submittals: Provide submittal information for review before materials are delivered to the job site. Combine product submittals for all products and submit together as a single submittal.

1. Submit a cover letter stating that the materials will be provided as specified, and specifically listing any items that will not be provided as specified. State in the letter that the Contractor has reviewed the specified items and agrees that they are applicable to this project in all respects.

2. Provide standard manufacturer's cut sheets and the operating and maintenance (O&M) instructions at the time of submittal review for each device in the system, regardless of whether it is submitted as specified or as an approved equal. These instructions shall detail how to install and service the equipment and shall include information necessary for rough-in and preparation of the building facilities to receive the materials.
   a. For those items noted as allowing "or equal," and which are not being provided as specifically named, submit a written description detailing the reason for the substitution, along with standard manufacturer's cut sheets or other descriptive information.

B. The telecommunications contractor shall receive approval from an authorized Mason ITU/NET member on all substitutions of material. No substituted materials shall be installed except by written approval from Mason ITU/ NET.

C. Substitutions
1. Any items proposed as substitutions for the above equipment must meet the following four (4) point test for equivalence:
   a. The item must meet or exceed all electrical specifications for the specified item,
   b. The item must be 'replaceable component compatible' with the specified item,
   c. The item must be similar in shape, size, color and detail as to be indistinguishable to the casual observer, when replacing the specified item.
   d. The item must provide equivalent or superior warranty to the specified item as installed.
2. Any item that appears to pass all four (4) of the above tests can then be submitted for final determination of 'equivalence'.
3. GMU NET holds final determination of compliance with the above points.

D. Work shall not proceed without the Owner's approval of the submitted items.

E. Quality Control Submittals: Provide submittal information for review as follows:
1. Prior to bidding, in accordance with the QUALITY ASSURANCE requirements below, submit the following contractor-qualifications documentation:
   a. Documentation from the SCS manufacturers demonstrating that the Contractor is trained and certified by the Manufacturers to install, test, and maintain the SCS and is certified by the SCS Manufacturers to provide the SCS a 25 year Manufacturer's Warranty (see PART 1 - WARRANTY).
      1) NetClear Warranty in accordance with the Certified Ortronics and Berk-Tek OASIS program.(for copper and fiber).
   b. Documentation indicating that the Contractor will have only manufacturer-trained and manufacturer-certified employees perform installation, testing, and firestopping work, as detailed below.
      1) A list of the personnel who will be assigned to the project, the type of work they will be performing, and copies of the manufacturers' training certifications for each. If personnel changes are made during the project, submit the above information for any new personnel prior to their commencement of work on the project.
   c. Documentation demonstrating that the Contractor employs a minimum of one Registered Communications Distribution Designer (RCDD) certified

by and in current good standing with BICSI. The document shall declare that the RCDD is a direct full time employee of the Contractor also that the Contractor will continue to employ a minimum of one RCDD throughout the duration of the project. RCDD shall remain assigned to project from start to finish and be available to provide guidance to the installation team.

d. List of references for no less than five similar projects (in terms of size and construction cost) performed by the Contractor under the Contractor's current business name within the past three years. Detail the following for each project:
    1) Project name and location
    2) Construction cost
    3) A brief description of the project, the components involved, and the SCS manufacturer used on the project.
    4) Number of station drops
    5) Customer contact names, phone numbers, and addresses

2. Submit a cable routing and grouping plan as follows:
    a. Where the cable routing and grouping is to be provided as shown on the Contract Documents, do not provide a cable routing and grouping plan. Submit written documentation stating that the cable routing and grouping will be provided as shown on the Contract Documents, that the Contractor has reviewed the routing and grouping on the Contract Documents with applicable Subcontractors and suppliers and agrees that it does not create conflicts with other building utility infrastructure, and that the routing and grouping meets applicable codes, regulations and standards.
    b. Where changes in cable routing and grouping are proposed, submit complete floor plan(s) and/or detail drawing(s) showing the proposed routing, raceway sizes and locations, and cabling in a manner equal to that of the Contract Documents. Ensure that any cabling changes are coordinated with comparable accommodating changes to the raceway routing and grouping. Specifically note each location where the proposed routing and grouping is different from the Contract Documents. Submit written documentation detailing the reason for each change request. Each change request must be approved in writing by the Designer prior to proceeding with the change.

3. Submit wall field termination block and wire management elevations as follows:
    a. Where wall field termination blocks and wire management are to be provided as shown on the Contract Documents, do not submit elevations. Submit written documentation stating that the wall field termination blocks and wire management will be provided as shown on the Contract Documents, that the Contractor has reviewed the elevations on the Contract Documents with applicable Subcontractors and suppliers and agrees that it does not create conflicts between trades, and that the elevations meet applicable codes, regulations and standards.
    b. Where changes to the wall field termination blocks and wire management are proposed, submit wall field termination block and wire management elevations along with written documentation detailing the reason for the change. The change request must be approved in writing by Mason ITU/NET personnel prior to proceeding with the change.

4. Submit a list of proposed test equipment for use in verifying the installation of the SCS. Proposed test equipment shall meet the criteria as stated in PART 3 – TESTING.

a. Submit for each testing device:
   1) Manufacturer and product number
   2) Documentation from the manufacturer showing date and outcome of last re-calibration. Testing device shall have been re-calibrated within the manufacturer's recommended calibration period, encompassing the period of time when the testing device will be used on this project.
   3) Documentation from the manufacturer showing software revision. Software revision shall be most current revision available for the device and shall be based upon the most current ANSI/TIA/EIA testing guidelines.

b. Submit proposed copper and fiber cable test forms (see PART 3 – TESTING for more detail).

F. Closeout Submittals: Provide submittal information for review as follows:
   1. O&M Manual for Communications - At the completion of the project, submit O&M information from product data submittals (above), updated to reflect any changes during the course of construction, to Mason ITU/NET in the telecommunications-specific O&M Manual for Communications binder labeled with the project name and description. Provide three bound copies of the O&M Manual for Communications.
   2. Records - Maintain at the job site a minimum of one set of Record Drawings, Specification, and Addenda. Record Drawings shall consist of redline markups of changes to Contract Documents such as drawings, specifications and spreadsheets, including maintenance hole/handhole butterfly drawings.
      a. Document changes to the system from that originally shown on the Contract Documents and clearly identify system component labels and identifiers on Record Drawings.
      b. Keep Record Drawings at the job site and make available to the Owner and Designer at any time.
      c. Keep Record Drawings current throughout the course of construction. ("Current" is defined as not more than one week behind actual construction).
      d. Show identifiers for major infrastructure components on Record Drawings.
      e. Three set of preliminary "as-builts" shall be submitted to Mason ITU/NET 60 days prior to the Mason scheduled move-in date.
      f. Four sets of the final "as-builts" must be given to Mason ITU/NET within 2 weeks of building closeout.

1.07 QUALITY ASSURANCE

A. Contractor Qualifications:
   1. Contractor shall be trained and certified by the Manufacturers to install, test, and maintain the SCS and be certified by the SCS Manufacturers to provide the SCS Manufacturers' Warranties (see PART 1 - WARRANTY).
   2. Contractor's employees directly involved with the supervision, installation, testing, and certification of the SCS shall be trained and certified by the selected SCS' manufacturers. Training and certifications by employee type are required as shown below:
      a. Supervisors/Project Foremen: All (100%) shall be trained/certified for installation and testing.

b. Test Technicians: All (100%) shall be trained/certified for installation and testing.
c. Installation Technicians: Prior to bidding, half (50%) shall be trained/certified for installation. Upon award of the project, the remaining untrained installation technicians shall be trained and certified by the manufacturer at no cost to the Owner.
d. Other personnel: Personnel not directly responsible for installation supervision, installation, testing or certifying the SCS (i.e. project managers, cleanup crew, etc.) are not required to be manufacturer trained and certified. Otherwise, personnel not manufacturer-trained and certified shall not be allowed on the job site.

3. Contractor's employees whose duties include the application of firestopping material shall be trained and certified by the specified firestopping manufacturer. Training and certifications by employee type are required as shown below:
   a. Supervisors/Project Foremen: All (100%) shall be trained/certified for installation.
   b. Firestopping Technician: All (100%) shall be trained/certified for installation.
4. Contractor shall employ a minimum of one Registered Communications Distribution Designer (RCDD) certified by and in current good standing with BICSI. The RCDD shall be a direct full time employee of the Contractor (i.e. an RCDD consultant/sub-contractor to the Contractor is not acceptable). Contractor shall continue to employ a minimum of one RCDD throughout the duration of the project.
5. Contractor shall have successfully completed no less than five similar projects (in terms of size and construction cost) under the Contractor's current business name within the past three years.

1.08 SEQUENCING

A. Provide coordination with the cabling manufacturers to ensure that manufacturers' inspectors are available to schedule site visits, inspections, and certification of the system. Provide and coordinate any manufacturer-required modifications and have manufacturer re-inspect and certify the system prior to the scheduled use of the system by the Owner.

B. The Contractor is solely responsible for all costs associated with scheduling the manufacturer inspection, the inspection itself and any manufacturer-required re-inspections, and for any modifications to the installation as required by the manufacturers.

1.09 WARRANTY

A. Contractor Warranty:
   1. Provide a Contractor-endorsed two-year service warranty against defects in materials and workmanship.
      a. Provide all labor attributable to the fulfillment of this warranty at no additional cost to the Owner.
         1) The Contractor Warranty period shall commence upon Owner acceptance of the work.

B. SCS Manufacturer Warranties:

1. Provide SCS Manufacturer extended product, performance, application, and labor warranties that shall warrant all passive components used in the SCS. Additionally, these warranties shall cover components not manufactured by the SCS Manufacturers, but approved by the SCS Manufacturers for use in the SCS (i.e. "Approved Alternative Products"). The SCS Manufacturer warranties shall warrant:
   a. That the products will be free from manufacturing defects in materials and workmanship.
   b. That the cabling products of the installed system shall exceed the specification of ANSI/TIA/EIA 568-B and exceed ISO/IEC 11801 standards.
   c. That the installation shall exceed the specification of ANSI/TIA/EIA 568-B and exceed ISO/IEC 11801 standards.
   d. That the system shall be application independent and shall support both current and future applications that use the ANSI/TIA/EIA 568-B and ISO/IEC 11801 component and link/channel specifications for cabling.
2. Provide materials and labor attributable to the fulfillment of this warranty at no cost to the Owner.
3. The SCS Manufacturer Warranties shall be provided by the selected SCS Manufacturers and shall be:
   a. NetClear 25-year System Warranty.
      1) Provide a copy of the warranty registration document to the Owner at the time of submittal to the SCS manufacturer..
4. The SCS Manufacturer Warranty period shall commence upon a Warranty Certificate being issued by the manufacturer. The Warranty Certificates shall be issued no later than three months after Owner acceptance of the work.

PART 2 - PART 2 – PRODUCTS

2.01 GENERAL

A. Mason has standardized on products that support the 25 year NetClear Warranty for all SCS in Mason Facilities

B. Unless specifically stated as "Or equal", equivalent items are not acceptable. Provide items as specified.

C. Physically verify existing site conditions prior to purchase and delivery of the materials, including but not limited to lengths of conduit and/or pathway to be used for routing backbone cabling. Pre-cut materials of insufficient length are the sole responsibility of the Contractor.

D. SCS components shall be manufactured by the manufacturers listed below. Components shall not be intermixed between different manufacturers unless the manufacturer of the SCS has listed (in writing) another manufacturer's component as an "Approved Alternative Product" and will warrant the "Approved Alternative Product" as part of the SCS Manufacturer Warranty (see PART 1 - WARRANTY).
   1. Bid only the following SCS Manufacturers and only bid manufacturers for which the Contractor is certified. The SCS Manufacturers shall be the following. Substitution is not acceptable:

a. Ortronics and Berk-tek for copper and fiber-related products

E. All copper and fiber related components shall be part of the same SCS product line – Components shall not be intermixed between manufacturers' SCS product lines. The SCS product lines shall be engineered "end-to-end" – the system and all of its components shall be engineered to function together as a single, continuous transmission path.

1. The SCS Product Line shall be the following, per manufacturer. Substitution is not acceptable:
    a. For Enhanced Category 6 Copper Distribution: Berk-Tek LANmark-2000.
    b. For Fiber Distribution: Berk-Tek Premise Distribution w/Armor-Tek.

F. Racks, rack cable distribution hardware, ladder rack, and other rack and distribution components shall be manufactured by a single manufacturer unless stated otherwise in this Specification or in the Contract Documents. Do not intermix equipment and components between different manufacturers.

1. Rack/Distribution Equipment: Ortronics Mighty Mo 6.
2. Wall-mount Racks and Cabinets:
    a. Ortronics

G. Provide all incidental and/or miscellaneous hardware not explicitly specified or shown on the Contract Documents that is required for a fully operational, tested, certified and warranted system.

2.02 PATHWAYS AND CABLE SUPPORTS

A. Installation and materials for the raceway and boxes for the SCS shall be as specified under Division 16 Section — "Raceways and Boxes for Communications Circuits" except where noted below.

B. Surface Raceway: UL listed under Section 5 with fittings including (but not limited to) mounting clips and straps, couplings, internal and external elbows, cover clips, bushings, end fittings, outlet boxes and other incidental and miscellaneous hardware required for a complete Surface Raceway system.

1. Surface Plastic Raceway (SPR):
    a. Wiremold 2800/2900/5400 w/Category 6 fittings
2. Surface Metal Raceway (SMR): Wiremold w/Category 6 fittings
3. Sleeves: EMT conduit, with insulated throat bushings for each end.
4. Backboards: ¾ inch A-C non-fire-retardant plywood backboards, void free, 2440-mm (8-ft) high unless otherwise noted.
5. D-Rings:
    a. Metallic: CPI 10941, 10942, 10943

C. Cable Supports (J-Hooks, Straps): Complete with incidental materials and assemblies required for mounting.

1. CADDY CableCat Wide Base Cable Supports (J-Hooks):
    a. CAT12 (up to 16 4-pair/2-strand UTP/fiber cables)
    b. CAT21 (up to 50 4-pair/2-strand UTP/fiber cables)
    c. CAT32 (up to 80 4-pair/2-strand UTP/fiber cables)
2. CADDY CableCat Adjustable Cable Supports (Straps):
    a. CAT425 (up to 425 4-pair/2-strand UTP/fiber cables)

D. Ladder Rack: Complete with fittings including (but not limited to) splice kits, cable radius drop, radius bends, protective end caps, retaining posts, support brackets, foot kits, vertical wall brackets, wall angles, grounding hardware and other incidental and miscellaneous hardware required for a complete ladder rack system. Ladder rack components shall be manufactured by the selected Rack/Distribution Equipment manufacturer.
   1. Unless otherwise indicated, all ladder rack and incidental equipment color shall be:
      a. Black
   2. Ladder rack:
      a. For CPI: Universal Cable Runway 10250-xxx
   3. Horizontal radius bends:
      a. For CPI: Cable Runway E-Bend 10822-xxx
   4. Cable Retaining Posts:
      a. For CPI: 10596-108
   5. Radius Drops:
      a. For CPI: 1210x-xxx
   6. Ladder rack/cable runway Grounding kits:
      a. For CPI: 12061-001

E. Innerduct: 1 ¼” Outside Diameter, bright orange in color.

F. Pull Strings: Plastic or nylon with a minimum test rating of 200 lb.

2.03 FIRESTOPPING

A. Firestopping material: Conform to both Flame (F) and Temperature (T) ratings as required by local building codes and as tested by nationally accepted test agencies per ASTM E814 or UL 1479 fire test in a configuration that is representative of the actual field conditions. Manufactured by:
   1. Specified Tech. Inc. (or approved equal).

2.04 EQUIPMENT RACKS/ENCLOSURES

A. Unless otherwise indicated, equipment racks/enclosures and incidental equipment color shall be:
   1. Black

B. Unless otherwise indicated, equipment rack/enclosure/wall-mounted brackets and incidental materials and equipment shall be provided by the selected Rack/Distribution Equipment manufacturer. Do not intermix products from different manufacturers.

C. Free Standing Equipment Racks: EIA-standard 7-foot high x 19-inch wide racks with universal alternating-hole pattern, complete with top angles, self-supporting bases, and mounting holes on both sides of the rails.

D. Free standing Equipment Rack shall:
   1. Provide the necessary strain relief, bend radius and cable routing for proper installation of high performance cross connect products, meeting all ANSI/TIA/EIA-568-B standards.
   2. Have top cable trough with waterfall and built in patch/horizontal cable distribution separator.

3. Have EIA hole pattern on front and rear.
4. Be available with a 6.5”, 10.5”and 16.25” channel depth and four post server racks.
5. Be available with hook and loop straps for securing bulk cables inside the vertical U-channels.
6. Assemble as 19” (483 mm) with no additional hardware.
7. Be available with three styles of vertical patch cord management: interbay with latches, cable management rings, or fingerduct with covers.
8. Provide floor and ceiling access for cable management and distribution.
9. Provide pre-drilled base for floor attachment of rack.
10. Be available in standard color of black.
11. Be manufactured by an ISO 9001 registered company.

E. The equipment rack shall provide vertical cable management and support for the patch cords at the front of the rack and wire management, support, and protection for the horizontal cables inside the legs of the rack. Waterfall cable management shall be provided at the top of the rack for patch cords and for horizontal cables entering the rack channels for protection and to maintain proper bend radius and cable support. Wire management shall also be mounted above each patch panel and/or piece of equipment on the rack. The rack shall include mounting brackets for cable tray ladder rack to mount to the top of the rack. Velcro cable ties shall be provided inside the rack channels to support the horizontal cable. Rack shall be black in color to match the patch panels and cable management.
   1. Racks: Floor mounted racks shall be Mighty Mo 6 cable management racks, 10.5” Channel depth, 7 feet tall, 45 rack units, Ortronics P/N OR-MM6710
   2. Vertical Cable Management
      a. Vertical Cable management between every 2 racks shall be Mighty Mo 6 cage with hinged doors, include four spools and 12 bend limiting clips, 10” x 13” x 7’ Ortronics P/N OR-MM6VMD710.
      b. Vertical Cable management for every end rack shall be Mighty Mo 6 cage with hinged doors, include four spools and 12 bend limiting clips, 6” x 8” x 7’, Ortronics P/N OR-MM6VMD706.

2.05 GROUNDING AND BONDING

A. As specified under Division 16 Section – “Grounding and Bonding for Telecommunications.”

B. Refer to ANSI/TIA/EIA-607

C. Refer to NEC

2.06 VIDEO DISTRIBUTION EQUIPMENT

A. All video distribution components shall be capable of functioning in a 750mhz sub-split system.
   1. All amplifiers shall be C-Cor Flexmax 900 series. All amplifiers shall be powered “in-line”.

2.07 PATCH PANELS

A. Fiber Patch Panels: Pre-assembled enclosures with connector panels, blank connector panels (for unused connector panel slots), and strain relief, complete with fiber connectors and fiber optic receptacle adapters and with incidental materials necessary for mounting. Fiber patch panels shall be manufactured by the selected SCS Manufacturer:

1. For Fiber:
   a. IDF Fiber Patch Cabinet: Holds six adapter panels, Front locking door, Holds 36 SC fibers, 3.5” H, 2 rack units P/N Ortronics OR-FC02U-P.
   b. MDF Fiber Patch Cabinet: Holds 12 adapter panels, Front locking door, Holds 72 SC fibers, 5.25” H, 3 RU, Ortronics P/N OR-FC04U-P.
   c. Adapter Panel: 3-SC duplex (6 fibers) single-mode, blue adapters, ceramic alignment sleeves Ortronics P/N OR-OFP-SCD12AC.
   d. Adapter Panel: 3-SC duplex (6 fibers) Multimode, aqua adapter, ceramic alignment sleeves, Ortronics P/N OR-OFP-SCD12LC.
2. 2. For Copper
   a. a. The Modular Patch Panels shall
      1) meet category 6 component compliance and be verified by a third-party nationally recognized independent testing laboratory
      2) use low emission IDC contacts
      3) use dual reactance technology to enhance the signal-to-noise ratio
      4) require standard termination practices using a 110 impact tool
      5) use a single piece IDC housing designed to accept larger Category 6 conductors
      6) support both T568B and T568A wiring
      7) include easy to follow wiring labels
      8) include label fields
      9) allow for the use of icons
      10) include full length metal rear cable management
      11) be available in standard or high density
      12) be backward compatible to category 3, and 5
      13) be center tuned to category 6 test specifications
      14) the modular patch panel shall be compliant with the SCS warranty

2.08 CONNECTORS

A. Fiber Connectors:

1. SC OptiMo Field-Installable Pre-Polished Connectors
   a. SC 50/125, 900 Micron Buffer, Pre Polished Connector, Ortronics P/N OR-205KAS9FA-50T.
   b. SC Single-mode, 900 Micron Buffer, Pre Polished Connector Ortronics P/N OR-205KAS9FA-09.
   c. Substitution of Corning connectors may be made with approval from Ortronics/Berk-Tek.

2.09 RISER COPPER TERMINATION BLOCKS

A. Krone

1. Series II, 10 Pair blocks, type 105 can

2.10 STATIONS

A. Station cables shall each be terminated at their designated location in the connector types described in the subsections below. Included are modular telecommunication jacks. These connector assemblies shall snap into a faceplate.

B. The station Outlet Assembly shall accommodate:
1. A minimum of three (3) modular jacks
2. Additional accommodations for specific locations as noted in the plans for coaxial and/or additional copper cables as necessary
3. A blank filler will be installed when extra ports are not used.
4. The same orientation and positioning of jacks and connectors shall be utilized throughout the installation.
5. Prior to installation, the telecommunications contractor shall submit the proposed configuration for each outlet assembly for review by the Owner.
6. The modular jack shall incorporate printed label strip for identifying the outlet. Printed labels shall be permanent and compliant with ANSI/TIA/EIA–606-A standard specifications. Labels shall be printed using Ortronics label program (LabelMo) or using a printer such as a Brady hand held printer. Hand printed labels shall not be accepted.

C. Faceplates: The faceplates shall:
1. be Series II style as appropriate to fit the modular jack used
2. be UL listed and CSA certified.
3. be constructed of high impact, ABS plastic UL 94V-0 construction (except where noted otherwise).
4. be fog white.
5. be compliant with the above requirements along with the following when incorporating optical fiber:
   a. be a low profile assembly,
   b. incorporate a mechanism for storage of cable and fiber slack needed for termination,
   c. position the fiber optic couplings to face downward or at a downward angle to prevent contamination and,
   d. incorporate a shroud that protects the optical couplings from impact damage.
      1) be available as single-gang or dual-gang.
      2) provide easy access for adds, moves, and changes by front removal of jack modules.
      3) possess recessed designation windows to facilitate labeling and identification.
      4) include a clear plastic cover to protect labels in the designation window.
      5) have mounting screws located under recessed designation windows.
      6) comply with ANSI/TIA/EIA-606-A work area labeling standard.
      7) allow for the UTP modules to be inverted in place for termination purposes.
      8) be manufactured by an ISO 9001 registered company.

D. Jack Modules

1. Jacks shall be Series II, 8-position modular jacks and shall be Category 6 performance as defined by the references in this document. All pair combinations must be considered, with the worst-case measurement being the basis for compliance. Modular jack performance shall be third-party verified by a nationally recognized independent testing laboratory.
2. The modular jack shall use dual reactance modular contact array.
3. The modular jack shall have low emission IDC contacts.
4. The modular jack shall use standard termination practice using 110 impact tool
5. The modular jack shall be backwards compatible to Category 3, and 5.
6. The modular jack shall be center tuned to category 6 test specifications.
7. The modular jack shall be designed for the SCS.

E. Stations to be used for wall-mount telephones: Brushed stainless steel with stainless steel mounting lugs suitable for supporting wall-mount telephones:
   1. SUTTLE SE-630AD4, or approved equal.

F. Surface Device Boxes: Surface mount device boxes shall be:
   1. Wiremold

2.11 CABLE

A. General: Cables shall be manufactured by the selected SCS Manufacturer.

B. Copper Cable:
   1. For Horizontal Distribution:
      a. Plenum Enhanced Category 6, 24 AWG, bare copper wire insulated with FEP. Two insulated conductors twisted together to form a pair and four such pairs cabled to form the basic unit jacketed with flame-retardant PVC. Tested at 600 mhz.
      b. Riser Enhanced Category 6, 24 AWG, bare copper wire insulated with polyethylene. Two insulated conductors twisted together to form a pair and four such pairs cabled to form the basic unit jacketed with flame-retardant PVC. Tested at 600 mhz.
         1) 4-pair, UTP, 24 AWG, with solid copper conductors
   2. For Backbone Distribution:
      a. Copper backbone cable shall be non-shielded 24-AWG solid copper conductors insulated with color coded PVC, shall be UL Verified to TIA/EIA 568-B for Category 3 performance. Cable shall be manufactured the selected SCS Manufacturer:

C. Coaxial Cable
   1. For station outlets
      a. All runs shall use Quad Shield RG-6 Coaxial cable.
   2. For Intra-Building Distribution
      a. All Riser and Horizontal distribution shall use Commscope QR 540 JCA Coaxial cable
   3. For Inter-Building Backbone
      a. All Outside Plant Coaxial Backbone shall use Commscope QR 860 JCASS Coaxial cable.

D. Fiber Cable:
   1. For Backbone Distribution:

a. Each Multimode Fiber shall be/have:
   1) Graded-index optical fiber wave-guide with nominal 50/125µm-core/cladding diameter.
   2) Comply with the latest revision of ANSI/EIA/TIA-4920000.
   3) Attenuation measured in accordance with ANSI/EIA/TIA-455-46, 53 or 61.
   4) Information transmission capacity measured in accordance with ANSI/EIA/TIA-455—204 for overfilled launch.
   5) The measurements performed at 23 degrees C +/- 5 degrees.
   6) Maximum attenuation dB/Km @ 850/1300 nm: 3.5/1.5
   7) Bandwidth: > 1500 MHz-km @ 850nm for overfilled launch,
   8) Bandwidth 500 MHz-km @ 1300nm.
   9) Bandwidth 2000 MHz-km characterized using FOTP 220
   10) Optical Fiber laser optimized and guaranteed for 10 Gigabit Ethernet distances of 300m/300m for 850nm and 1300nm respectively
   11) Optical Fiber laser optimized and guarantee Gigabit Ethernet distances of 1000m/600m for 850nm and 1300nm respectively
b. Physical Characteristics:
   1) Shall be rated for environment being distributed.
   2) Shall have 900µm tight-buffered construction
   3) Shall be available with a fiber stand count range from 6 to 144.
   4) Shall have an UL-OFNR/FT4 Flame Rating.
   5) Strength members shall be aramid yarn.
   6) Tight buffered fibers shall be color coded in accordance with EIA/TIA 598 with an overall orange jacket.
   7) Suitable for operation between -20° to 75° C.
   8) Shall comply with ICEA S-83-596
   9) Cables containing Laser Optimized 50/125 µm fibers (Effective Modal Bandwidth equal or greater than 2000 MHz•km at 850 nm) shall have an AQUA jacket
c. Each Single-mode Fiber shall be:
   1) Class IVa dispersion - unshifted single mode optical fibers with Low Water Peak complying with ANSI/EIA/TIA-492BAAA492CAAB-2000.
   2) The zero dispersion wavelength shall be between 1300 nm and 1320 nm. The ANSI/EIA/TIA-455-168 maximum value of the dispersion slope shall be no greater than 0.090 ps/km-nm^2. Dispersion measurements shall be made in accordance with ANSI/EIA/TIA-455-169 or ANSI/EIA/TIA-455-175-B.
   3) The nominal mode field diameter shall be 9.1 µm with a tolerance of ± 0.4 µm at 1310 nm when measured in accordance with ANSI/EIA/TIA-455-191-B.
   4) Transmission Characteristics:
   5) Maximum cabled attenuation dB/km @ 1310/1550 nm: 1.0/1.0
   6) The cabled cutoff wavelength shall be ≤1260 nm when measured in accordance with ANSI/EIA/TIA-455-80-C
   7) Distance vs. bandwidth using a Laser transmitter operating at a 1310 nm wavelength

d. Physical Characteristics:
   1) Shall be rated for environment being distributed.
   2) Shall be available with a fiber strand count range from 6 to 144.
   3) Bundled cable constructions shall have a sub-unit core size of 5.2mm for 12 fibers and 4.5mm for 6 fibers.
   4) Shall have and be marked with an UL-OFNR and OFN FT4 Flame Rating.
   5) Shall comply with Telcordia GR-409.
   6) Shall comply with the requirements of ICEA S-83-596.
   7) Strength members shall be dielectric and may be either FGE/aramid/yarn.
   8) Buffered fibers shall be color coded in accordance with EIA/TIA-598 with an overall yellow jacket.
   9) Shall have a ripcord for overall jacket.
   10) Suitable for operation between -20°C to +75°C
   11) Shall be of an all dielectric design
   12) Cables containing Single-mode shall have a YELLOW jacket
   13) Single-mode shall be tight buffered and manufactured by the selected SCS Manufacturer

2.12 CABLE ASSEMBLIES (PATCH CORDS) AND CROSS-CONNECTS

A. Hook and Loop Cable Managers: Reusable hook and loop (similar to Velcro) style, adjustable tension, roll or spool dispensed

B. The contractor shall provide factory terminated and tested UTP and optical fiber patch cords and equipment cords for the complete cabling system. The UTP patch cables shall meet the requirements of ANSI/TIA/EIA-568-B for patch cord testing.
   1. Copper (UTP) patch cords shall:
      a. be a Category 6 Clarity patch cord.
      b. use 8 position connector with impedance matched contacts and designed using dual reactance.
      c. be constructed of 100 ohm, 4 pair, 24 AWG, stranded conductor, unshielded twisted pair copper per the requirements of the ANSI/TIA/EIA-568-B.2 and standard.
      d. meet TIA Category 6 component specifications in ANSI/TIA/EIA-568-B
         1) 100% factory tested to meet Category 6 performance and
         2) ETL or any other nationally recognized 3rd party verification
      e. be center tuned to Category 6 performance specifications by using paired bi-level contact array
      f. be capable of universal T568A or T568B wiring schemes.
      g. Modular connector shall maintain the paired construction of the cable to facilitate minimum untwisting of the wires.
      h. have a performance marking indelibly labeled on the jacket (by the manufacturer).
      i. have the ability to accept color-coded labels and icons to comply with ANSI/TIA/EIA-606-A labeling specifications.
      j. have “snagless” protection for the locking tab to prevent snagging and to protect locking tab in tight locations and provide bend relief
      k. be available in three standard colors
      l. be available in 3 foot, 5 foot, 7 foot, 9 foot, and 15 foot standard lengths

m. be backwards compatible to Category 3, 5 and 5E
n. be manufactured by an ISO 9001 registered company.
o. shall be manufactured by the selected SCS Manufacturer

2. Optical Fiber patch cords shall:
   a. contain two (2) multi-mode optical fibers.
   b. use multi-mode, graded-index fibers with a 850 nm Laser Optimized 50.omicron core.
   c. be capable of transmission at both 850 nm and 1300 nm wavelengths.
   d. include listing of actual loss of patchcord when packaged
   e. be manufactured in standard lengths of 1 m (3.27 ft), 2 m (6.56 ft), 3 m (9.84 ft), 4 m (13.11 ft), 7 m (22.95 ft), and 10 m (32.79 ft), and special ordered in any other lengths.
   f. be manufactured by an ISO 9001 registered company.
   g. be manufactured by the selected SCS Manufacturer

C. Copper Jumper Wire: Category 5 (for cross connects):

2.13 LABELING AND ADMINISTRATION

A. Labels:
1. As recommended in ANSI/TIA/EIA 606. Permanent (i.e. not subject to fading or erasure), permanently affixed, and created by a hand-carried label maker or a computer/software-based label making system. Handwritten labels are not acceptable.
   a. For Station Cable:
      1) 1) Brady: Bradymaker Wire Marking Labels WML-511-292 (or approved equal)
   b. For Backbone Cable:
      1) 1) Panduit Marker Tie (or approved equal)

B. Hand-carried label maker:
1. Brady: ID Pro Plus (or approved equal).

PART 3 - EXECUTION

3.01 GENERAL

A. The Contractor is solely responsible for the safety of the public and workers in accordance with all applicable rules, regulations, building codes and ordinances.

B. All work shall comply with applicable safety rules and regulations including OSHA . All work shall comply with the requirements of the National Electrical Safety Code (NESC) and the NEC except where local codes and/or regulations are more stringent, in which case the local codes and/or regulations shall govern.

C. All work shall comply with the standards, references and codes listed in PART 1 -- REFERENCES above. Where questions arise regarding which standards, references, or codes apply, the more stringent shall prevail.

D. All work shall comply with the requirements and recommendations of the product manufacturers. Where questions arise regarding which requirements and recommendations apply, the more stringent shall prevail.

E. Replace and/or repair to original (or better) condition any existing structures, materials, equipment, etc. inadvertently demolished or damaged by the Contractor during the course of construction at no additional cost to the Owner.

F. Remove surplus material and debris from the job site and dispose of legally.

G. Cleaning: Clean Telecommunication Rooms after installation activities are complete and prior to releasing them to the Owner for the Owner's use. This includes all debris, extra material, packaging, and boxes. Wipe down network racks, cabinets, horizontal and vertical managers to remove dust, dirt, etc.

3.02 RACEWAY

A. Surface Raceway: Provide for all surface mounted stations as shown in the Contract Documents.
   1. Size surface raceway according to the quantity of cable to be routed through it according to ANSI/TIA/EIA 569 cable capacity standards, plus an additional 100% for future expansion. Size fittings/bends to accommodate Category 5/6 and fiber optic bend radii as specified in ANSI/TIA/EIA 569.
   2. Match surface raceway finish as close as possible to the finish of the wall it is to be mounted on but do not paint surface raceway. Surface raceway shall be:
      a. Installed per Article 352 of the NEC. Surface raceway shall be installed as mechanically and electrically continuous and bonded in accordance with NEC and ANSI/TIA/EIA 607 codes and standards.
      b. Installed according to ANSI/TIA/EIA standards for fiber optic and Category 5/6 bend radii. Bend points shall have a minimum two inch radius control.
      c. Securely supported using screws or other anchor-type devices (tape or glue is not an acceptable support medium) at intervals not exceeding 5 feet and with no less than two supports per straight raceway section. Surface raceway shall be supported in accordance with the manufacturer's installation requirements.
      d. Completely installed including insulating bushings and inserts where required by manufacturer's installation requirements.
      e. Installed parallel and perpendicular to surfaces or exposed structural members, and following surface contours where possible.
      f. Close any unused raceway openings.

B. Backboards: Provide backboards as shown on Contract Documents. Backboards shall be capable of supporting attached equipment, and painted with a minimum of two coats (over primer) of fire retardant, non-conductive paint, and one coat of white colored semi gloss top coat paint. Mount A-C plywood backboards with the "A" side exposed.

C. Sleeves: Provide sleeves where required for cable pass-thru through building structures and/or fire rated barriers. Provide roto-hammering or core drilling where required for sleeve installation. Seal (and if a fire rated barrier, firestop) between sleeve and building structure and/or barrier. Size sleeves:
   1. As noted in the Contract Documents.

2. Where not noted, size sleeves a minimum of 2 inches in diameter or by the type and quantity of cable to be routed through the sleeve per ANSI/TIA/EIA 569 cable capacity standards plus an additional 100% for future expansion - whichever is greater.

D. D-Rings: Provide D-Rings as necessary to route exposed cables in telecommunications rooms and on backboards and for raceway for routing cable in non-exposed open access environments, and as shown in the Contract Documents. D-Rings may be affixed to wall/ceiling structures or other supports, but not attached to a ceiling support system. In telecommunications rooms, mount D-Rings at 12 inch intervals and as shown in the Contract Documents. Mount D-rings used for raceway in open access environments at 4 foot intervals unless otherwise specified in the Contract Documents.
1. Size D-Rings as noted in the Contract Documents.
2. Where not noted, size D-Rings according to the type and quantity of cable to be routed through the ring per TIA/EIA 569 cable capacity standards, plus an additional 100% for future expansion, but not less than a minimum of 2 inches in diameter.

E. Cable Supports (J-Hooks, Straps): Provide cable supports for routing cable in non-exposed open access environments as shown in the Contract Documents. Cable supports may be affixed to wall/ceiling structures or other supports, but not attached to a ceiling support system. Mount cable supports at 4 foot intervals unless otherwise specified in the Contract Documents. Do not use cable supports for more cables than they were designed to support. Provide multiple cable supports where the total cable count exceeds the maximum cable count for which the support was designed. Size according to the type and quantity of cable to be routed through the ring per ANSI/TIA/EIA 569 cable capacity standards, plus an additional 50% for future expansion.

F. Ladder Rack: Install ladder rack per manufacturer's instructions with flat (rung) side up. Provide ladder rack to affix tops of racks to walls, to route cable from walls to racks within telecommunications rooms, and in locations shown in the Contract Documents. Size and install as shown in the Contract Documents. Cut ends of ladder rack square. Ream cut ends to remove burrs and sharp edges. Cap cut ends with manufacturer's recommended caps. Mount retaining posts as required. Provide Cable Radius Drops wherever cable is to drop from one section of ladder rack to another lower section of ladder rack or onto racks or cabinets. Provide 90-degree horizontal radius bends for each 90-degree change in direction of ladder rack angle. Provide Cable Retaining Posts for all sides of ladder rack within a telecommunications room not directly adjacent to a wall. Affix posts at 2 foot centers and at corners and/or junctions. Provide Cable Runway Grounding kits across ladder rack splices and where ladder racks end at or are connected to racks/cabinets.

G. Innerduct: Provide bright orange innerduct as pathway for backbone fiber optic cables (backbone only – not station cables), from backbone fiber patch panels to conduit or plenum entrances, and as shown in the Contract Documents. Innerduct installed in plenum rated environments shall be plenum rated.

H. Pull Strings: Provide a pull string in existing conduits that are to remain vacant after existing cable is demolished and in existing and new conduits that have new cable installed under this project.

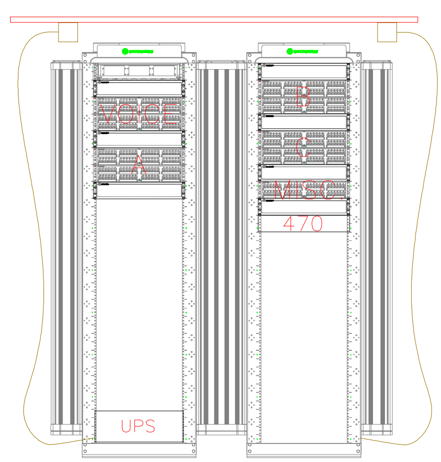
3.03 FIRESTOPPING

A. Only employees trained/certified by the firestopping manufacturer shall apply firestopping materials.

B. Maintain fire rating of penetrated fire barriers. Fire stop and seal penetrations made during construction.
1. Provide firestopping material for through and membrane penetrations of fire-rated barriers.
2. Install firestops in strict accordance with manufacturer’s detailed installation procedures.
3. Install firestops in accordance with fire test reports, fire resistance requirements, acceptable sample installations, manufacturer’s recommendations, local fire and building authorities, and applicable codes and standards referenced in PART 1 – REFERENCES. Apply of sealing material in a manner acceptable to the local fire and building authorities.
4. For demolition work, apply firestopping to open penetrations in fire rated barriers where cable is removed. Apply firestopping regardless of whether or not the penetrations are used for new cable or left empty after construction is complete.
5. Firestopping material used to seal open penetrations through which cable passes shall be re-usable/re-enterable.

3.04 EQUIPMENT RACKS/ENCLOSURES

A. Provide EIA racks/cabinets and all associated hardware according to locations, elevations, and plan views as shown in the Contract Documents. A typical two rack elevation is shown below.



B. For Floor Mount Racks/Cabinets:
1. Using ladder rack, horizontally affix the top of a given rack/cabinet to the wall as shown on the Contract Documents. Bolt horizontal ladder rack to rack/cabinet and to walls. Bolt rack/cabinet to floor.

C. Free Standing Equipment Racks:
1. Coordinate with Owner to identify desired location for shelf. Provide shelf, installed per Owner’s direction.

2. Coordinate with Owner to identify desired location for lockable storage drawer. Provide drawer, installed per Owner's direction.

3.05 GROUNDING AND BONDING

A. Grounding and bonding work shall comply with the Uniform Building Code, Uniform Fire Code, WAC, National Electrical Code, and UL 467, ANSI/TIA/EIA standards and the references listed in PART 1 – REFERENCES above, as well as local codes which may specify additional grounding and/or bonding requirements.
   1. Provide a minimum of one wall-mountable telecommunications ground bus bar per telecommunications room and as shown on the Contract Documents.
   2. Grounding conductor shall be installed to bond all non-current carrying metal telecommunications equipment and materials to the nearest TMGB or TGB (as provided under Division 16 Section — "Grounding for Communications Circuits and Raceway").
      a. Ensure that bonding breaks through paint to bare metallic surface of all painted metallic hardware.
      b. Provide ladder rack grounding kits to bond each section of ladder rack and bond ladder rack to racks/cabinets where ladder racks are connected.
   3. In multi-story buildings, if there is more than (1) IDF per floor, the TGBs must be bonded together at top floor and at every third floor interval per ANSI/TIA/EIA-607.

3.06 VIDEO DISTRIBUTION

A. The Video Distribution for the project shall be designed to connect to the existing 750mhz sub-split video plant.
   1. Outside Plant Backbone Cable will be Commscope QR 860 JCASS extending from the exist plant to the project. The exact location for the interconnection to the existing plant will be coordinated with Mason ITU/NET upon review of project cable plant design.
   2. Riser cable will be Commscope QR 540 JCA from the MDF to the IDFs. Amplifiers will be installed as required to provide adequate signal levels.
   3. Commscope QR 540 JCA will be used for horizontal distribution from the IDFs to a location within 150 feet of the station outlet. Tap locations will be designed and installed to provide an appropriate signal level for either 75 or 150 foot station outlet cables.
   4. Station outlet cables will be Quad Shield RG-6 coaxial cable of either 75 or 150 foot length and attached to an appropriate tap to provide 0db +-4db at the station outlet. Tilt between channel 3 and channel 105 will be no greater than 4db.

3.07 PATCH PANELS

A. Provide patch panels and horizontal wire management according to locations, elevations, and plan views as shown on the Contract Documents.
   1. Fiber: Size and install rack-mountable patch panels as shown on the Contract Documents. Use fiber patch panels to terminate multimode and/or singlemode fiber backbone cables.
   2. Horizontal Wire Management: Provide horizontal wire management as shown on the Drawings.

3.08 CONNECTORS

A. Copper Connectors (modular jacks):
   1. 1. For Horizontal Distribution:
      a. Terminate Category 6 cable using the T568B wiring pattern.

3.09 COPPER TERMINATION BLOCKS

A. Provide vertical and horizontal cable management for jumper/patch cables between termination blocks. Provide termination blocks and (jumper troughs) with or without legs based on the following mounting conditions:
   1. 1. Mounting on Backboards: Provide termination blocks, jumper troughs, and distribution rings with legs and as shown on the Contract Documents. Use jumper troughs above and below each termination block in a column. Use a distribution ring backboard in place of jumper troughs in the vertical middle of each column of 600 pair or more.
   2. 2. Mounting on Racks: Provide termination blocks and jumper troughs without legs. Use rack mount brackets to mount termination blocks on EIA standard 19” floor and wall-mount racks.

B. Provide one horizontal cable termination block with connecting blocks, designation strips, and labels, to Owner for spare.

C. Provide one backbone cable termination block with connecting blocks, designation strips, and labels, to Owner for spare.

D. Route cable horizontally along base of backboard until it reaches the termination block column on which it is to terminate and then route vertically to the termination block.

E. Install termination block wall field according to the elevations shown in the Drawings.

F. Install termination block punch downs for riser cable as follows:
   1. Terminate the cable consecutively on the Krone, Series 2, 10 pair blocks.
   2. On the connections from the Krone blocks to the racks, terminate the cables consecutively on the Voice riser patch panel (DO NOT DROP THE 25^{TH} PAIR IN EACH BINDER). Example: If the voice riser is 50 pair, the patch panel will be pairs 1-48, not terminating the last 2 pair of the 50 pair cable.

G. Punch down cable using only the selected SCS Manufacturer approved impact tool.

3.10 STATION OUTLETS

A. Faceplates: Provide faceplates for stations in the locations and gang counts shown on the Contract Documents. Faceplates shall completely conceal outlet boxes, reducer plates, etc. Faceplates shall provide a snug and sure fit for connectors – loose connectors are not acceptable.

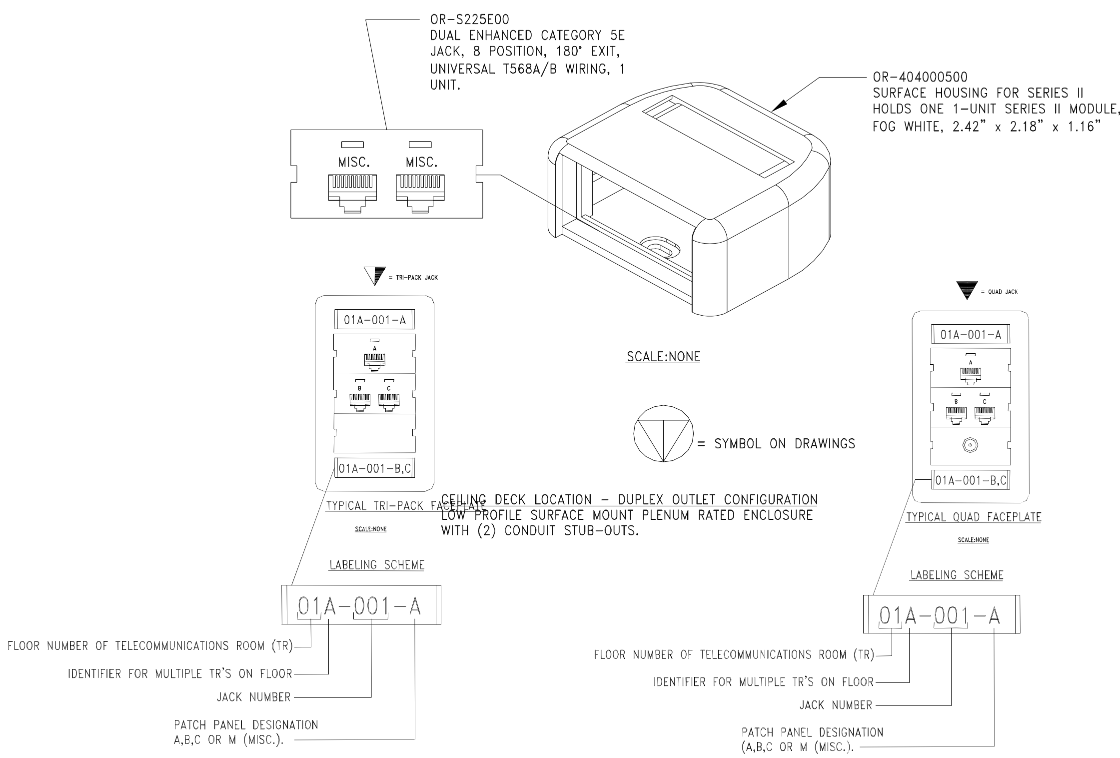
B. Faceplates shall be level and plumb.

C. Faceplate Mounting Brackets: Provide faceplate mounting brackets as required and as shown for flush mounted communications outlets.

D. Surface Device Boxes: Provide surface mount device boxes as required and as shown for surface mounted communications outlets.

E. Dual Port RJ45 outlet will be installed and concealed above the common area ceiling for wireless access points (WAP). The outlet must be installed in an appropriate enclosure for the location. The number and locations will need to be sufficient to provide adequate coverage for all bedrooms and common areas. See drawing below.

F. Station Outlets: Provide appropriate amount of Enhanced Category 6 cable and coax (if applicable) to the outlet. All outlets shall be wired with the T568B standard. All outlets containing three Enhanced Category 6 cables shall be wired in an (A, B, C) configuration. Each outlet shall have a single RJ45 jack insert in the top position, and a dual RJ45 insert in the middle and a single F connector in the bottom position. Each outlet shall be wired with the top single RJ45 port labeled "A" to the horizontal patch panel in the telecommunications room labeled "A". The middle left RJ45 port labeled "B" to the horizontal patch panel labeled "B". The middle right RJ45 port labeled "C" to the horizontal patch panel labeled "C". All outlets with one or two Enhanced Category 6 cables shall terminate on a separate appropriately sized patch panel, marked "miscellaneous", in the Telecommunications Room. No horizontal cable can exceed a length of 90 meters (295 ft.) from patch panel to station jack. See drawing below.



3.11 CABLE

A. General (applicable to all cable types): Provide non-plenum (CM/CMR, OFNR) rated cable for locations where cable is to be installed in conduit. For cable not installed in conduit, provide plenum (CMP, OFNP) rated cable if cable is installed in a plenum air space environment, non-plenum rated otherwise. Cabling shall bear plenum or non-plenum markings for the environment in which it is installed.

1. For Horizontal Distribution: Provide station cable in types, sizes, and quantities as defined by the Symbol Schedule and as shown on the Contract Documents. Install cable between the station and its associated telecommunications room. Provide one cable per each connector at each station.
2. Install cable in compliance with ANSI/TIA/EIA and ISO/IEC 11801 requirements and BICSI TCIM practices.
3. Penetrations through floor and fire-rated walls shall utilize metallic sleeves and shall be fire-stopped after installation and testing, utilizing a firestopping system approved for that application.
4. Adhere to the bending radius and pull strength requirements as detailed in the ANSI/TIA/EIA standards and the manufacturer's installation recommendations during cable handling and installation.
   a. Pull all cables simultaneously where more than one cable is being installed in the same raceway.
   b. Use pulling compound or lubricant where necessary. Use compounds that will not damage conductor or insulation (Polywater, or approved equal).
   c. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips that will not damage media or raceway. Repair or replace conduit bushings that become damaged during cabling installation.
5. Install cable in a continuous (non-spliced) manner unless otherwise indicated.
6. Install exposed cable parallel to and perpendicular to surfaces on exposed structural members and follow surface contours where possible.
7. Tie or clamp cabling. Attaching cables to pipes, electrical conduit, mechanical items, existing cables, or the ceiling support system (grids, hanger wires, etc.) is not acceptable. Install tie-wraps in conformance with the SCS manufacturer's installation recommendations. Do not over-tighten tie wraps or cause cross-sectional deformation of cabling.
8. Cable at the backboards:
   a. Lay and dress cables to allow other cables to enter raceway (conduit or otherwise) without difficulty at a later time by maintaining a working distance from these openings.
   b. Route cable as close as possible to the ceiling, floor, sides, or corners to insure that adequate wall or backboard space is available for current and future equipment and for cable terminations.
   c. Lay cables via the shortest route directly to the nearest edge of the backboard from mounted equipment or blocks. Support cables so as not to create a load on the equipment upon which the cables are terminated. Tie-wrap similarly routed and similar cables together and attach to D-rings vertically and/or horizontally, then route over a path that will offer minimum obstruction to future installations of equipment, backboards or other cables.
   d. See COPPER TERMINATION BLOCKS above for details on routing copper cabling to termination blocks.
9. Cable in the telecommunications rooms:
   a. For telecommunications rooms with ladder rack, lay cable neatly in ladder rack in even bundles and loosely secure cabling to the ladder rack at regular intervals with tie-wraps or hook-and-loop straps.
10. Cable terminating on patch panels located on racks:

a. Route cables in telecommunications rooms to patch panels on racks by routing across ladder rack across top of rack and then down vertical ladder rack to patch panel.

B. Copper Cable: Terminate all pairs within a cable. Un-terminated cable pairs are not acceptable.

1. For horizontal distribution: Provide station cable in the locations shown on the Contract Documents. Provide service loops with a minimum length of 12 inches in outlet boxes and no less than 10 feet in the ER/TR's.
   a. For workstation outlets with both Category 6 and coaxial cable for TV Distribution, terminate Category 6 cabling after coaxial cable has been installed and terminated.
   b. Route station cable that is exposed (not in conduit) to comply with ANSI/TIA/EIA-569 requirements for avoiding potential EMI sources and as follows:
      1) 48 inches from motors or transformers
      2) 12 inches from conduit and cables used for electrical power distribution
      3) 5 inches from fluorescent lighting

C. Fiber Cable: Terminate all fiber strands within a fiber cable. The installation of "dark fiber" is acceptable upon approval by Mason ITU/NET.

3.12 CABLE ASSEMBLIES (PATCH CORDS) AND CROSS-CONNECTS

A. Furnish copper patch cables for modular copper cross-connects. Use a quantity of 1.25, 9ft patch cables for every station outlet for budgeting purposes. Exact quantities and colors to be coordinated with Mason ITU/NET at the time that the preliminary as-builts, as specified in Section 1.6 F, are delivered. Cables to be delivered to Mason ITU/NET within 6 weeks of the quantities being provided.

B. Furnish fiber patch cables for fiber cross connects. Deliver patch cables to Owner in the lengths and quantities below:

1. For Multimode:
   a. Length (e.g. 3m) - (Qty. 20), Type: (Duplex SC-to-SC)
   b. Length (e.g. 1m) - (Qty. 20), Type: (Duplex SC-to-SC)

C. Furnish one (1) spool of Category 5 jumper wire for each telecommunications room for cross connects and deliver unopened to Owner.

D. Furnish hook-and-loop cable managers for managing patch cords in the telecommunications rooms. Provide in colors, sizes and quantities as indicated below. Cable managers shall be the same color as the patch cable type that they manage.

1. Furnish four (4) cable managers each 6 inches in length for each telecommunications room with fiber connectivity
2. Furnish one roll of 50 cable managers each 6 inches in length for use in Main Equipment Room.

3.13 LABELING AND ADMINISTRATION

A. General: Labeling and administration shall comply with ANSI/TIA/EIA 606 and standard industry practices.

B. Telecommunications Rooms: Affix a permanent label to the door of each telecommunications room. Where telecommunications room names are required in other labels, use the telecommunication room name shown on the Contract Documents.

C. Racks: Label racks as shown on the Contract Documents. Affix label centered across top cross-member of rack.

D. Grounding/Bonding Conductors: Label bonding conductors; “WARNING! TELECOMMUNICATIONS BONDING CONDUCTOR. DO NOT REMOVE OR DISCONNECT!”

E. Cables:
1. Label Location: Affix at each end of the cable.
2. Station Cables: Label station cables with the same label as the station connector (see STATION CONNECTORS (PORTS) below) that terminates the cable at the station location. Include a clear vinyl adhesive wrapping applied over the label in order to permanently affix the label to the cable. Using transparent tape to affix labels to cables is not acceptable.
3. Provide labels at each end of each cable within 24” of telecommunications room entrance and again within 24” of termination point.

F. Termination Blocks:
1. General:
   a. Label termination block ports/pairs sequentially beginning on the first row of each termination block column. Begin with “001” for the first port/pair.
   b. Label termination strip pairs sequentially (left to right).
2. For Horizontal Distribution:
   a. Label station outlets in accordance with EIA/TIA-606 using typed or computer printed labels that fit the jack insert and are consistent with the patch panel labeling in the Telecommunications Room. (I.E. The top label on the faceplate of the first outlet from the First Floor A Telecommunications Room will be 1A-001-A and the bottom label on the same outlet will be 1A-001-B, C. Label jacks with three UTP cables as follows:
      1) First character – The floor designator, 1.
      2) Second character – Telecommunications Room Designator, A.
      3) Third, fourth, and fifth character – a three-digit number identifying each outlet, numbered sequentially.
      4) Sixth character - A, B, or C based on the position of the port in the outlet.
   b. Label cables and patch panels with designations that are the same as the outlet.
   c. Outlets shall be numbered on the patch panels sequentially starting with 001. DO NOT skip outlet numbers on the patch panels. If a pre-numbered outlet has been deleted, leave that position blank on the patch panel.

G. Conduits: Label each conduit end (existing or new) in a clear manner by designating the location of the other end of the conduit (i.e. room name, telecommunications room identifier, pull box identifier, outlet identifier (use the label of the first port of the outlet as the outlet identifier), etc.). Indicate conduit length on the label.

H. Pull Strings: Label each pull string in a clear manner by designating the location of the other end of the pull string (i.e. room name, telecommunications room name, pull box identifier, outlet identifier (use the label of the first port of the outlet as the outlet identifier), etc.).

3.14 TESTING

A. Provide test records on a form approved by the Owner and Designer. Include the test results for each cable in the system. Submit the test results for each cable tested with identification as discussed under LABELING AND ADMINISTRATION above. Include the cable identifier, outcome of test, indication of errors found, cable length, retest results, and name and signature of technician completing the tests. Provide test results to the Owner and Designer for review and acceptance within two weeks of Substantial Completion.

   1. Print test records for each cable within the system directly from the tester and submit in paper form (in a binder) and in electronic form (on diskette or CDROM) to the Owner and Designer for review. Handwritten test results will not be accepted.

B. Test the SCS after installation for compliance to all applicable standards as follows:

   1. Copper:
      a. For Horizontal Distribution: Test all pairs of each copper station cable, for conformance to ANSI/TIA/EIA 568-B Category 6, and ANSI/TIA/EIA 568-B standards. To the extent possible, perform tests with building electrical systems fully powered on (i.e. Lights, HVAC, etc.).
         1) Test each end-to-end link (the entire channel from the connector at the station to the connector or termination in the telecommunications room) utilizing sweep tests, for continuity, shorts, polarity, near-end cross talk (NEXT), far-end cross talk (FEXT), attenuation, installed length, transposition (wire map), mutual capacitance, characteristic impedance, resistance, ACR, and presence of AC voltage. Use the Power Sum method to test NEXT and FEXT. Test each cable in both directions.
            a) Testing Device: Fluke DSP-4000 with latest software and hardware releases.

   2. Fiber: Test fiber optic cable on the reel upon delivery to the job site prior to installation, and again after installation.
      a. Prior to testing, calculate the cable loss budget for each fiber optic cable and clearly show the result on the test documentation. Calculate maximum loss using the following formula, assuming no splices:
         1) For Horizontal Distribution:
            b) Max Loss = 2.0db (per ANSI/TIA/EIA 568-B)

         2) For Backbone Distribution:
            c) Max Loss = [(allowable loss/km) * (km of fiber)] + [(.3db) * (# of connectors)]

            d) A mated connector to connector interface is defined as a single connector for the purposes of the above formula.

e) A given fiber strand shall not exceed its calculated maximum loss (per the above formula).

b. Test all strands using a bi-directional end-to-end optical transmission loss test instrument (such as an OTDR) trace performed per ANSI/TIA/EIA 455-61 or a bi-directional end-to-end power meter test performed per ANSI/TIA/EIA 455-53A, and ANSI/TIA/EIA 568-B.
   1) Calculate loss numbers by taking the sum of the two bi-directional measurements and dividing that sum by two.
   2) Provide test measurements as follows:
      f) For Multimode Cable: Test at both 850 and 1300nm.

c. For Singlemode Cable: Test at both 1310 and 1550nm.
d. Test results shall conform to:
   1) The criteria specified in ANSI/TIA/EIA-568B
   2) The Contractor's calculated loss budget above
   3) The criteria specified in IEEE 802.3z (1000Base-X Gigabit Ethernet)
      g) In addition to the above, perform tests both recommended and mandated by manufacturer. Tests shall confirm/guarantee compliance to manufacturer's performance standards and also IEEE 802.3z for a maximum end-to-end dB loss of 2.5 dB.

   4) The criteria specified in IEEE 802.3z (1000Base-X Gigabit Ethernet)

C. Identify cables and equipment that do not pass to the Owner and Designer. Determine the source of the non-compliance and replace or correct the cable or the connection materials, and retest the cable or connection materials at no additional expense to the Owner. Provide new test results to the Owner and Designer in the same manner as above.
1. In addition to the above, if it is determined that the cable is at fault, remove the damaged cable and replace it with a new cable. Cable "repairs" are not acceptable. The procedure for removing the cable shall be as follows:
   a. Prior to removal of damaged cable and installation of new cable:
      1) Inform the Owner and Designer of the schedule for the removal and installation.
      2) Test the new cable on the reel per paragraph B, above.
      3) Test cables that occupy the same innerduct or conduit (if not in innerduct) as the damaged cable per paragraph B, above, regardless of whether or not they are new cables installed as part of this project or existing cables installed prior to this project.
      4) Provide test results to the Owner and Designer for approval by the Owner and Designer.
   b. Remove the damaged cable and provide new cable.
   c. After the removal of the damaged cable and installation of the new cable:
      1) Test the new cable per the paragraph titled TESTING.
      2) Test cables that occupy the same innerduct or conduit (if not in innerduct) as the damaged cable per paragraph B, above, regardless

of whether they are new cables installed as part of this project or existing cables installed prior to this project.

h) If any of the cables requiring testing are in use, coordinate with the Owner to schedule an outage opportunity during which the testing can be performed.

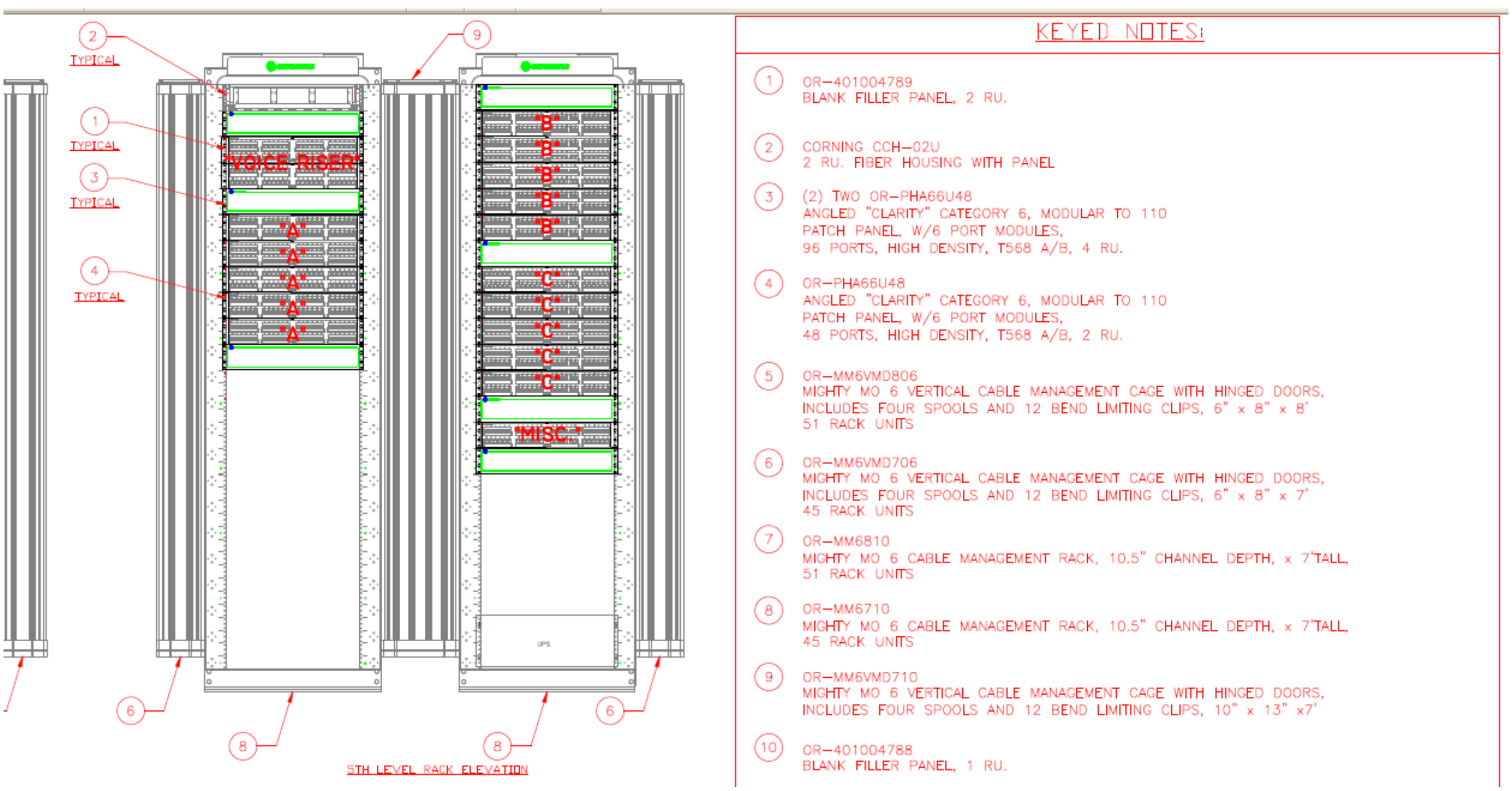
3) Provide test results to the Owner and Designer for approval by the Owner and Designer.

d. If a cable which occupies the same innerduct or conduit (if not in innerduct) as a damaged cable is damaged by the extraction and installation process, replace the cable at no additional expense to the Owner.

1) Damaged cables which are replaced shall be subject to the testing procedures of the paragraph titled TESTING.

3.15 FOLLOW UP

A. For the first four weeks that the system is in full operation, provide technical assistance for trouble shooting, training, and problem solving by phone and (within 24 hours of notice) on site. Provide up to 40 hours of assistance (in addition to any warranty-related work), including phone, travel, and on site time during this period.



SECTION 27 15 00

INSIDE PLANT STRUCTURED CABLING SYSTEM FOR RESIDENTIAL BUILDINGS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to the work of this section.

1.02 SUMMARY

A. Provide all materials and labor for the installation of an inside plant telecommunication system. This section includes Inside Plant Communications cabling, termination, and administration equipment and installation requirements for the specified Structured Cabling System (SCS - See Definition Below).

B. This document describes the products and execution requirements relating to furnishing and installing Telecommunications Cabling at the new or remodeled residential buildings for Mason. Backbone and horizontal cabling of both copper and fiber, and related support systems are covered under this document.

C. The Horizontal (station outlet) Cabling System shall consist of a minimum of three, Category 5E 4-pair Unshielded Twisted Pair (UTP) Copper and one coaxial cable (Quad Jack) to each station outlet unless otherwise noted for specific locations. The cables shall be installed from the station outlet to the Telecommunications Room (TR) located on the same floor, routed to the appropriate rack serving that area, and terminated as specified in this document.

D. Wireless Access points shall consist of a minimum of two Category 5E 4-pair Unshielded Twisted Pair (UTP) Copper Cables.

E. Wall phones shall consist of one Category 5E 4-pair Unshielded Twisted Pair (UTP) Copper Cable.

F. Elevator and Fire alarm panels each shall have one Category 5E 4-pair Unshielded Twisted Pair (UTP) Copper Cable per phone number required.

G. Product specifications, general design considerations, and installation guidelines are provided in this document. If the bid documents are in conflict, this specification shall take precedence. The successful vendor shall meet or exceed all requirements for the cable system described in this document.

H. Related sections include but are not necessarily limited to the following:
   1. Division 07 Section — "Firestopping"
   2. Division 10 Section — "Cutting and Patching"
   3. Division 26 Section — "Basic Electrical Materials and Methods"

4. Division 27 Section — "Conduit and Backboxes for Communications Systems"
5. Division 27 Section — "Grounding for Communications Systems"
6. Division 27 Section — "Underground Ducts and Raceways for Communications Systems"

I. Products furnished (but not installed) under this section:
   1. Clarity Modular Category 5E Patch Cords
      a. The following lengths shall be furnished in yellow.
         1) 3, 5, 7 and 9 feet lengths.
      b. The following shall be furnished in blue.
         1) 3, 5, 7 and 9 feet lengths

1.03 REFERENCES

A. General:
   1. National Electrical Code (NEC)
   2. National Electrical Safety Code (NESC)
   3. Occupational Safety and Health Act (OSHA)

B. Communications:
   1. ANSI/TIA/EIA - 455: Fiber Optic Test Standards
   2. ANSI/TIA/EIA - 526: Optical Fiber Systems Test Procedures
   3. ANSI/TIA/EIA - 568-B: Commercial Building Telecommunications Cabling Standard
   4. ANSI/TIA/EIA - 569: Commercial Building Standard for Telecommunication Pathways and Spaces
   5. ANSI/TIA/EIA - 606: The Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
   6. ANSI/TIA/EIA - 607: Commercial Building Grounding and Bonding Requirements for Telecommunications
   7. ANSI/TIA/EIA -TSB67: Transmission Performance Specifications for Field Testing of Unshielded Twisted Pair Cabling Systems
   8. ANSI/TIA/EIA -TSB75: Additional Horizontal Cabling Practices for Open Offices
   9. NECA/FOA 301-1997: Standard for Installing and Testing Fiber Optic Cables
   10. NECA/BICSI 568-2001: Standard for Installing Commercial Building Telecommunications Systems
   11. IEEE 802.3 (series): Local Area Network Ethernet Standard, including the IEEE 802.3z Gigabit Ethernet Standard
   12. ISO/IEC IS 11801: Generic Cabling for Customer Premises
   13. BICSI: BICSI Telecommunications Cabling Installation Manual
   14. BICSI: BICSI Telecommunications Distribution Methods Manual (TDMM)

C. If this document and any of the documents listed above are in conflict, then the more stringent requirement shall apply. All documents listed are believed to be the most current releases of the documents. The Contractor has the responsibility to determine and adhere to the most recent release when developing the proposal for installation

1.04 DEFINITIONS

A. "SCS" shall mean *Structured Cabling System*. The SCS is defined as all required equipment and materials including (but not limited to) ANSI/TIA/EIA 568-B and

ISO/IEC 11801 compliant copper station cable (Category 3, Category 5E, Category 6, etc.) and fiber optic cable (multimode and singlemode), patch cables, stations and station connectors, termination blocks, patch panels, racks/enclosures (such as EIA standard equipment racks, enclosures, and vertical and horizontal cable management hardware), pathway/raceway materials (such as conduit, sleeves, D-rings, surface raceway, ladder rack, cable tray, etc.), and other incidental and miscellaneous equipment and materials as required for a fully operational, tested, certified, and warranted system, compliant with all applicable codes and standards.

B. "TMGB" shall mean *Telecommunications Main Grounding Busbar*. There is typically one TMGB per building, located in the main telecommunications room. This busbar is directly bonded to the electrical service ground.

C. "TGB" shall mean *Telecommunications Grounding Busbar*. There is typically one TGB per telecommunications room. The TGB is connected both to the TMGB and to building structural steel or other permanent metallic systems.

D. "TBB" shall mean *Telecommunications Bonding Backbone*. The TBB is a conductor used to connect TMGBs to TGBs.

E. "UTP" shall mean *Unshielded Twisted Pair* cable.

F. "MTS" or "MDF" shall mean the Main Distribution Frame (Room). The MDF is the entrance facility where the Outside Plant connects to the Riser cables from the IDFs (TRs).

G. "TR" or "IDF" shall mean Intermediate Distribution Frame. The IDFs are the floor level rooms where horizontal cable terminates.

1.05 SYSTEM DESCRIPTION

A. Furnish, install, test and place into satisfactory and successful operation all equipment, materials, devices, and necessary appurtenances to provide a complete ANSI/TIA/EIA, NECA/NEIS and lSO/IEC compliant communications Structured Cabling System (SCS) as hereinafter specified and/or shown on the Contract Documents. The system is intended to be capable of integrating voice, data, and video signals

B. The work shall include all materials, equipment and apparatus not specifically mentioned herein or noted on the plans but which are necessary to make a complete working ANSI/TIA/EIA and ISO/IEC compliant SCS.

C. Telecommunication Rooms (IDFs)
   1. Telecommunication Rooms (IDFs) shall be stacked on adjacent floors on all levels. See diagram below.
   2. Buildings with more than 6 IDF's should have a separate MDF room.
      a. The MDF will act as a transition point between OSP (outside plant) and interior cabling.
      b. The MDF should be located on the same floor that the OSP ductbank enters the building.
      c. The MDF must be within 50 feet of where the OSP ductbank enters the building.

d. All remaining items in this section also apply to the MDF with the exception of 3 (size) and 6 (power).
e. Power for the MDF shall be (2) L6-30R outlets.
f. The MDF room size should be at least 10 feet by 10 feet.

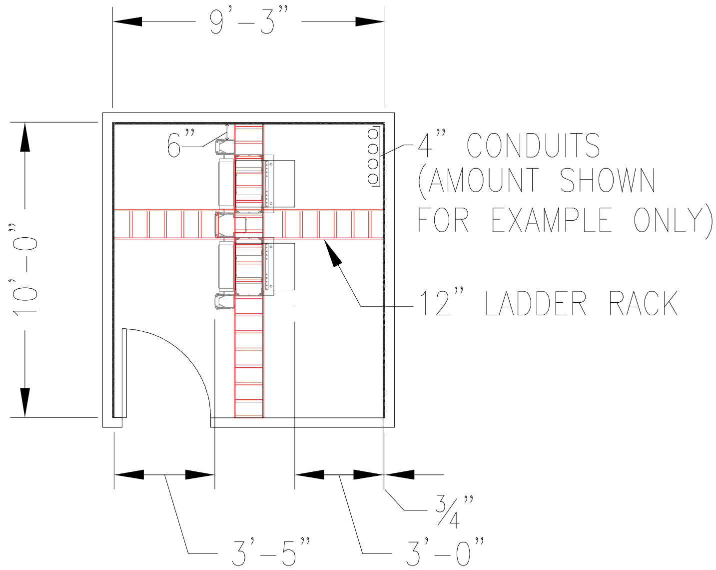
3. Size requirements for IDF's are based on distributing telecommunications service to one individual work area per 100 sq. ft. of occupied floor space. Minimum telecommunications room sizes are shown in the table below:

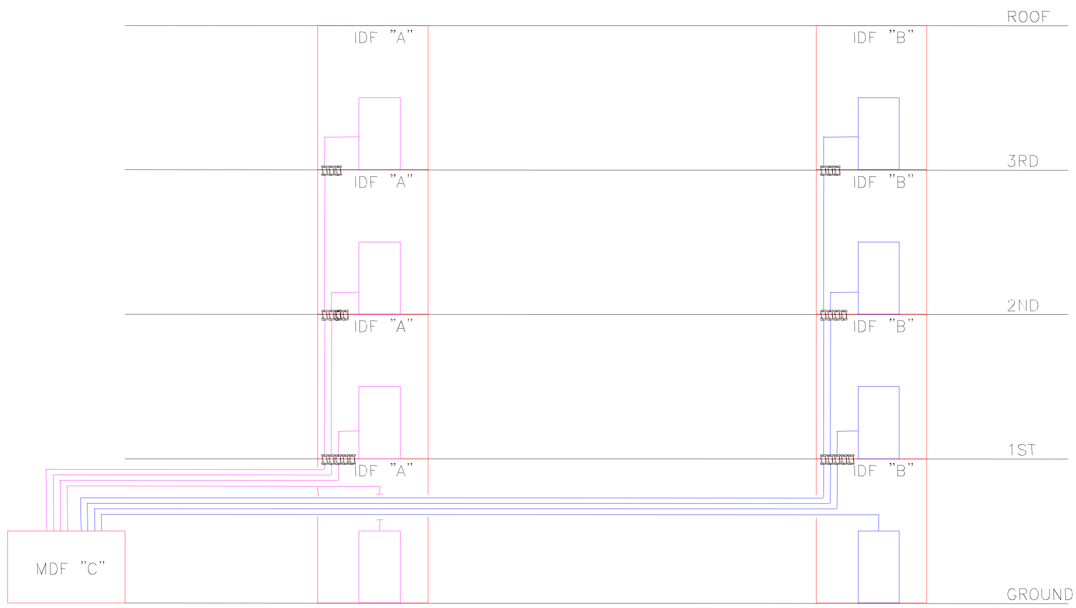
IF THE SERVING AREA IS:	THEN THE ROOMS MUST BE AT LEAST
Less than 5,000 sq. ft.	10 ft. x 7 ft.
Between 5,000 sq. ft. and 8,000 sq. ft.	10 ft. x 9 ft.
Larger than 8,000 sq. ft.	10 ft. x 11 ft.

Minimum adequate space provides 3 feet from the farthest extending equipment, shelf or organizer to the wall on the front, back, and one side of the racks.

a. Multiple IDFs may be required to ensure that no horizontal cable length exceeds 90 meters (295 ft.).

4. All walls of each Telecommunications room to be lined with ¾ inch fire retardant plywood.
5. All Telecommunications rooms, at a minimum, will have the following electrical outlets: two duplex electrical outlets on the walls and a L5-30 per rack, each on a separate circuit, the exact locations to be determined at a later date. All electrical outlets in Telecommunications rooms should be on an emergency building generator if available. In addition, the rooms must provide an air flow of one complete air exchange per hour. The temperature must be kept between 64 and 75 degrees Fahrenheit, at all times. The telecommunications rooms shall also maintain positive pressure, and humidity levels between 30-40%.
6. As initial design guidelines, Telecommunication Rooms will have a heat load of 3500 BTU/HR. Coordinate with NET/ITU at time of 85% drawings for final determination of exact power and heat load
7. There shall be no exposed pipes in the Telecommunications rooms, and they shall not be shared with unrelated utilities (i.e. Security, Building Automation, etc…) .
8. Floors shall be VCT tile or sealed concrete, carpet is prohibited. The rated distribution floor loading should be greater than 250 psf. The rated concentrated floor loading should be greater than 1000 lbs.
9. Telecommunications rooms will not have a suspended ceiling. The recommended minimum ceiling height is 8' 6".
10. Lighting requirements shall be a minimum of 50 lumens at 3' AFF. The location of lighting should coordinate closely with rack placement and should be powered by a panel not in the Telecommunications room. Emergency lighting is recommended.
11. Telecommunications rooms shall not have door sills or center posts. The door shall be 7'H x 3'W. The locks on the doors shall be "store room function".
12. Typical Copper and Fiber Riser diagram is shown below.





TYPICAL COPPER AND FIBER RISER DIAGRAM
SCALE: NONE

1.06 SUBMITTAL INFORMATION

A. Product Data Submittals: Provide submittal information for review before materials are delivered to the job site. Combine product submittals for all products and submit together as a single submittal.

1. Submit a cover letter stating that the materials will be provided as specified, and specifically listing any items that will not be provided as specified. State in the letter that the Contractor has reviewed the specified items and agrees that they are applicable to this project in all respects.
2. Provide standard manufacturer's cut sheets and the operating and maintenance (O&M) instructions at the time of submittal review for each device in the system, regardless of whether it is submitted as specified or as an approved equal. These

instructions shall detail how to install and service the equipment and shall include information necessary for rough-in and preparation of the building facilities to receive the materials.

a. For those items noted as allowing "or equal," and which are not being provided as specifically named, submit a written description detailing the reason for the substitution, along with standard manufacturer's cut sheets or other descriptive information.

B. The telecommunications contractor shall receive approval from an authorized Mason ITU/NET member on all substitutions of material. No substituted materials shall be installed except by written approval from Mason ITU/ NET.

C. Substitutions

1. Any items proposed as substitutions for the above equipment must meet the following four (4) point test for equivalence:
   a. The item must meet or exceed all electrical specifications for the specified item,
   b. The item must be 'replaceable component compatible' with the specified item,
   c. The item must be similar in shape, size, color and detail as to be indistinguishable to the casual observer, when replacing the specified item.
   d. The item must provide equivalent or superior warranty to the specified item as installed.
2. Any item that appears to pass all four (4) of the above tests can then be submitted for final determination of 'equivalence'.
3. GMU NET holds final determination of compliance with the above points.

D. Work shall not proceed without the Owner's approval of the submitted items.

E. Quality Control Submittals: Provide submittal information for review as follows:

1. Prior to bidding, in accordance with the QUALITY ASSURANCE requirements below, submit the following contractor-qualifications documentation:
   a. Documentation from the SCS manufacturers demonstrating that the Contractor is trained and certified by the Manufacturers to install, test, and maintain the SCS and is certified by the SCS Manufacturers to provide the SCS a 25 year Manufacturer's Warranty (see PART 1 - WARRANTY).
      1) NetClear Warranty in accordance with the Certified Ortronics and Berk-Tek OASIS program.(for copper and fiber).
   b. Documentation indicating that the Contractor will have only manufacturer-trained and manufacturer-certified employees perform installation, testing, and firestopping work, as detailed below.
      1) A list of the personnel who will be assigned to the project, the type of work they will be performing, and copies of the manufacturers' training certifications for each. If personnel changes are made during the project, submit the above information for any new personnel prior to their commencement of work on the project.
   c. Documentation demonstrating that the Contractor employs a minimum of one Registered Communications Distribution Designer (RCDD) certified by and in current good standing with BICSI. The document shall declare that the RCDD is a direct full time employee of the Contractor also that the Contractor will continue to employ a minimum of one RCDD throughout

the duration of the project. RCDD shall remain assigned to project from start to finish and be available to provide guidance to the installation team.

d. List of references for no less than five similar projects (in terms of size and construction cost) performed by the Contractor under the Contractor's current business name within the past three years. Detail the following for each project:
   1) Project name and location
   2) Construction cost
   3) A brief description of the project, the components involved, and the SCS manufacturer used on the project.
   4) Number of station drops
   5) Customer contact names, phone numbers, and addresses

2. Submit a cable routing and grouping plan as follows:
   a. Where the cable routing and grouping is to be provided as shown on the Contract Documents, do not provide a cable routing and grouping plan. Submit written documentation stating that the cable routing and grouping will be provided as shown on the Contract Documents, that the Contractor has reviewed the routing and grouping on the Contract Documents with applicable Subcontractors and suppliers and agrees that it does not create conflicts with other building utility infrastructure, and that the routing and grouping meets applicable codes, regulations and standards.
   b. Where changes in cable routing and grouping are proposed, submit complete floor plan(s) and/or detail drawing(s) showing the proposed routing, raceway sizes and locations, and cabling in a manner equal to that of the Contract Documents. Ensure that any cabling changes are coordinated with comparable accommodating changes to the raceway routing and grouping. Specifically note each location where the proposed routing and grouping is different from the Contract Documents. Submit written documentation detailing the reason for each change request. Each change request must be approved in writing by the Designer prior to proceeding with the change.

3. Submit wall field termination block and wire management elevations as follows:
   a. Where wall field termination blocks and wire management are to be provided as shown on the Contract Documents, do not submit elevations. Submit written documentation stating that the wall field termination blocks and wire management will be provided as shown on the Contract Documents, that the Contractor has reviewed the elevations on the Contract Documents with applicable Subcontractors and suppliers and agrees that it does not create conflicts between trades, and that the elevations meet applicable codes, regulations and standards.
   b. Where changes to the wall field termination blocks and wire management are proposed, submit wall field termination block and wire management elevations along with written documentation detailing the reason for the change. The change request must be approved in writing by Mason ITU/NET personnel prior to proceeding with the change.

4. Submit a list of proposed test equipment for use in verifying the installation of the SCS. Proposed test equipment shall meet the criteria as stated in PART 3 – TESTING.
   a. Submit for each testing device:
      1) Manufacturer and product number

2) Documentation from the manufacturer showing date and outcome of last re-calibration. Testing device shall have been re-calibrated within the manufacturer's recommended calibration period, encompassing the period of time when the testing device will be used on this project.
3) Documentation from the manufacturer showing software revision. Software revision shall be most current revision available for the device and shall be based upon the most current ANSI/TIA/EIA testing guidelines.

b. Submit proposed copper and fiber cable test forms (see PART 3 – TESTING for more detail).

F. Closeout Submittals: Provide submittal information for review as follows:

1. O&M Manual for Communications - At the completion of the project, submit O&M information from product data submittals (above), updated to reflect any changes during the course of construction, to Mason ITU/NET in the telecommunications-specific O&M Manual for Communications binder labeled with the project name and description. Provide three bound copies of the O&M Manual for Communications.
2. Records - Maintain at the job site a minimum of one set of Record Drawings, Specification, and Addenda. Record Drawings shall consist of redline markups of changes to Contract Documents such as drawings, specifications and spreadsheets, including maintenance hole/handhole butterfly drawings.
   a. Document changes to the system from that originally shown on the Contract Documents and clearly identify system component labels and identifiers on Record Drawings.
   b. Keep Record Drawings at the job site and make available to the Owner and Designer at any time.
   c. Keep Record Drawings current throughout the course of construction. ("Current" is defined as not more than one week behind actual construction).
   d. Show identifiers for major infrastructure components on Record Drawings.
   e. Three set of preliminary "as-builts" shall be submitted to Mason ITU/NET 60 days prior to the Mason scheduled move-in date.
   f. Four sets of the final "as-builts" must be given to Mason ITU/NET within 2 weeks of building closeout.

1.07 QUALITY ASSURANCE

A. Contractor Qualifications:

1. Contractor shall be trained and certified by the Manufacturers to install, test, and maintain the SCS and be certified by the SCS Manufacturers to provide the SCS Manufacturers' Warranties (see PART 1 - WARRANTY).
2. Contractor's employees directly involved with the supervision, installation, testing, and certification of the SCS shall be trained and certified by the selected SCS' manufacturers. Training and certifications by employee type are required as shown below:
   a. Supervisors/Project Foremen: All (100%) shall be trained/certified for installation and testing.
   b. Test Technicians: All (100%) shall be trained/certified for installation and testing.

c. Installation Technicians: Prior to bidding, half (50%) shall be trained/certified for installation. Upon award of the project, the remaining untrained installation technicians shall be trained and certified by the manufacturer at no cost to the Owner.

d. Other personnel: Personnel not directly responsible for installation supervision, installation, testing or certifying the SCS (i.e. project managers, cleanup crew, etc.) are not required to be manufacturer trained and certified. Otherwise, personnel not manufacturer-trained and certified shall not be allowed on the job site.

3. Contractor's employees whose duties include the application of firestopping material shall be trained and certified by the specified firestopping manufacturer. Training and certifications by employee type are required as shown below:
   a. Supervisors/Project Foremen: All (100%) shall be trained/certified for installation.
   b. Firestopping Technician: All (100%) shall be trained/certified for installation.
4. Contractor shall employ a minimum of one Registered Communications Distribution Designer (RCDD) certified by and in current good standing with BICSI. The RCDD shall be a direct full time employee of the Contractor (i.e. an RCDD consultant/sub-contractor to the Contractor is not acceptable). Contractor shall continue to employ a minimum of one RCDD throughout the duration of the project.
5. Contractor shall have successfully completed no less than five similar projects (in terms of size and construction cost) under the Contractor's current business name within the past three years.

1.08 SEQUENCING

A. Provide coordination with the cabling manufacturers to ensure that manufacturers' inspectors are available to schedule site visits, inspections, and certification of the system. Provide and coordinate any manufacturer-required modifications and have manufacturer re-inspect and certify the system prior to the scheduled use of the system by the Owner.

B. The Contractor is solely responsible for all costs associated with scheduling the manufacturer inspection, the inspection itself and any manufacturer-required re-inspections, and for any modifications to the installation as required by the manufacturers.

1.09 WARRANTY

A. Contractor Warranty:
   1. Provide a Contractor-endorsed two-year service warranty against defects in materials and workmanship.
      a. Provide all labor attributable to the fulfillment of this warranty at no additional cost to the Owner.
         1) The Contractor Warranty period shall commence upon Owner acceptance of the work.

B. SCS Manufacturer Warranties:
   1. Provide SCS Manufacturer extended product, performance, application, and labor warranties that shall warrant all passive components used in the SCS.

Additionally, these warranties shall cover components not manufactured by the SCS Manufacturers, but approved by the SCS Manufacturers for use in the SCS (i.e. "Approved Alternative Products"). The SCS Manufacturer warranties shall warrant:

a. That the products will be free from manufacturing defects in materials and workmanship.
b. That the cabling products of the installed system shall exceed the specification of ANSI/TIA/EIA 568-B and exceed ISO/IEC 11801 standards.
c. That the installation shall exceed the specification of ANSI/TIA/EIA 568-B and exceed ISO/IEC 11801 standards.
d. That the system shall be application independent and shall support both current and future applications that use the ANSI/TIA/EIA 568-B and ISO/IEC 11801 component and link/channel specifications for cabling.

2. Provide materials and labor attributable to the fulfillment of this warranty at no cost to the Owner.
3. The SCS Manufacturer Warranties shall be provided by the selected SCS Manufacturers and shall be:
   a. NetClear 25-year System Warranty.
      1) Provide a copy of the warranty registration document to the Owner at the time of submittal to the SCS manufacturer..
4. The SCS Manufacturer Warranty period shall commence upon a Warranty Certificate being issued by the manufacturer. The Warranty Certificates shall be issued no later than three months after Owner acceptance of the work.

PART 2 - PRODUCTS

2.01 GENERAL

A. Mason has standardized on products that support the 25 year NetClear Warranty for all SCS in Mason Facilities

B. Unless specifically stated as "Or equal", equivalent items are not acceptable. Provide items as specified.

C. Physically verify existing site conditions prior to purchase and delivery of the materials, including but not limited to lengths of conduit and/or pathway to be used for routing backbone cabling. Pre-cut materials of insufficient length are the sole responsibility of the Contractor.

D. SCS components shall be manufactured by the manufacturers listed below. Components shall not be intermixed between different manufacturers unless the manufacturer of the SCS has listed (in writing) another manufacturer's component as an "Approved Alternative Product" and will warrant the "Approved Alternative Product" as part of the SCS Manufacturer Warranty (see PART 1 - WARRANTY).

1. Bid only the following SCS Manufacturers and only bid manufacturers for which the Contractor is certified. The SCS Manufacturers shall be the following. Substitution is not acceptable:
   a. Ortronics and Berk-tek for copper and fiber-related products

E. All copper and fiber related components shall be part of the same SCS product line – Components shall not be intermixed between manufacturers' SCS product lines. The SCS product lines shall be engineered "end-to-end" – the system and all of its components shall be engineered to function together as a single, continuous transmission path.
   1. The SCS Product Line shall be the following, per manufacturer. Substitution is not acceptable:
      a. For Category 5E Copper Distribution: Berk-Tek LANmark-350.
      b. For Fiber Distribution: Berk-Tek Premise Distribution w/Armor-Tek.

F. Racks, rack cable distribution hardware, ladder rack, and other rack and distribution components shall be manufactured by a single manufacturer unless stated otherwise in this Specification or in the Contract Documents. Do not intermix equipment and components between different manufacturers.
   1. Rack/Distribution Equipment: Ortronics Mighty Mo 6.
   2. Wall-mount Racks and Cabinets:
      a. Ortronics

G. Provide all incidental and/or miscellaneous hardware not explicitly specified or shown on the Contract Documents that is required for a fully operational, tested, certified and warranted system.

2.02 PATHWAYS AND CABLE SUPPORTS

A. Installation and materials for the raceway and boxes for the SCS shall be as specified under Division 16 Section — "Raceways and Boxes for Communications Circuits" except where noted below.

B. Surface Raceway: UL listed under Section 5 with fittings including (but not limited to) mounting clips and straps, couplings, internal and external elbows, cover clips, bushings, end fittings, outlet boxes and other incidental and miscellaneous hardware required for a complete Surface Raceway system.
   1. Surface Plastic Raceway (SPR):
      a. Wiremold 2800/2900/5400 w/Category 5E fittings
   2. Surface Metal Raceway (SMR): Wiremold w/Category 5E fittings
   3. Sleeves: EMT conduit, with insulated throat bushings for each end.
   4. Backboards: ¾ inch A-C non-fire-retardant plywood backboards, void free, 2440-mm (8-ft) high unless otherwise noted.
   5. D-Rings:
      a. Metallic: CPI 10941, 10942, 10943

C. Cable Supports (J-Hooks, Straps): Complete with incidental materials and assemblies required for mounting.
   1. CADDY CableCat Wide Base Cable Supports (J-Hooks):
      a. CAT12 (up to 16 4-pair/2-strand UTP/fiber cables)
      b. CAT21 (up to 50 4-pair/2-strand UTP/fiber cables)
      c. CAT32 (up to 80 4-pair/2-strand UTP/fiber cables)
   2. CADDY CableCat Adjustable Cable Supports (Straps):
      a. CAT425 (up to 425 4-pair/2-strand UTP/fiber cables)

D. Ladder Rack: Complete with fittings including (but not limited to) splice kits, cable radius drop, radius bends, protective end caps, retaining posts, support brackets, foot kits, vertical wall brackets, wall angles, grounding hardware and other incidental and miscellaneous hardware required for a complete ladder rack system. Ladder rack components shall be manufactured by the selected Rack/Distribution Equipment manufacturer.

1. Unless otherwise indicated, all ladder rack and incidental equipment color shall be:
   a. Black
2. Ladder rack:
   a. For CPI: Universal Cable Runway 10250-xxx
3. Horizontal radius bends:
   a. For CPI: Cable Runway E-Bend 10822-xxx
4. Cable Retaining Posts:
   a. For CPI: 10596-108
5. Radius Drops:
   a. For CPI: 1210x-xxx
6. Ladder rack/cable runway Grounding kits:
   a. For CPI: 12061-001

E. Innerduct: 1 ¼” Outside Diameter, bright orange in color.

F. Pull Strings: Plastic or nylon with a minimum test rating of 200 lb.

2.03 FIRESTOPPING

A. Firestopping material: Conform to both Flame (F) and Temperature (T) ratings as required by local building codes and as tested by nationally accepted test agencies per ASTM E814 or UL 1479 fire test in a configuration that is representative of the actual field conditions. Manufactured by:
1. Specified Tech. Inc. (or approved equal).

2.04 EQUIPMENT RACKS/ENCLOSURES

A. Unless otherwise indicated, equipment racks/enclosures and incidental equipment color shall be:
1. Black

B. Unless otherwise indicated, equipment rack/enclosure/wall-mounted brackets and incidental materials and equipment shall be provided by the selected Rack/Distribution Equipment manufacturer. Do not intermix products from different manufacturers.

C. Free Standing Equipment Racks: EIA-standard 7-foot high x 19-inch wide racks with universal alternating-hole pattern, complete with top angles, self-supporting bases, and mounting holes on both sides of the rails.

D. Free standing Equipment Rack shall:
1. Provide the necessary strain relief, bend radius and cable routing for proper installation of high performance cross connect products, meeting all ANSI/TIA/EIA-568-B standards.
2. Have top cable trough with waterfall and built in patch/horizontal cable distribution separator.
3. Have EIA hole pattern on front and rear.

4. Be available with a 6.5”, 10.5”and 16.25” channel depth and four post server racks.
5. Be available with hook and loop straps for securing bulk cables inside the vertical U-channels.
6. Assemble as 19” (483 mm) with no additional hardware.
7. Be available with three styles of vertical patch cord management: interbay with latches, cable management rings, or fingerduct with covers.
8. Provide floor and ceiling access for cable management and distribution.
9. Provide pre-drilled base for floor attachment of rack.
10. Be available in standard color of black.
11. Be manufactured by an ISO 9001 registered company.

E. The equipment rack shall provide vertical cable management and support for the patch cords at the front of the rack and wire management, support, and protection for the horizontal cables inside the legs of the rack. Waterfall cable management shall be provided at the top of the rack for patch cords and for horizontal cables entering the rack channels for protection and to maintain proper bend radius and cable support. Wire management shall also be mounted above each patch panel and/or piece of equipment on the rack. The rack shall include mounting brackets for cable tray ladder rack to mount to the top of the rack. Velcro cable ties shall be provided inside the rack channels to support the horizontal cable. Rack shall be black in color to match the patch panels and cable management.
   1. Racks: Floor mounted racks shall be Mighty Mo 6 cable management racks, 10.5” Channel depth, 7 feet tall, 45 rack units, Ortronics P/N OR-MM6710
   2. Vertical Cable Management
      a. Vertical Cable management between every 2 racks shall be Mighty Mo 6 cage with hinged doors, include four spools and 12 bend limiting clips, 10” x 13” x 7’ Ortronics P/N OR-MM6VMD710.
      b. Vertical Cable management for every end rack shall be Mighty Mo 6 cage with hinged doors, include four spools and 12 bend limiting clips, 6” x 8” x 7’, Ortronics P/N OR-MM6VMD706.

2.05 GROUNDING AND BONDING

A. As specified under Division 16 Section – “Grounding and Bonding for Telecommunications.”

B. Refer to ANSI/TIA/EIA-608

C. Refer to NEC

2.06 VIDEO DISTRIBUTION EQUIPMENT

A. All video distribution components shall be capable of functioning in a 750mhz sub-split system.
   1. All amplifiers shall be C-Cor Flexmax 900 series. All amplifiers shall be powered “in-line”.

2.07 PATCH PANELS

A. Fiber Patch Panels: Pre-assembled enclosures with connector panels, blank connector panels (for unused connector panel slots), and strain relief, complete with fiber connectors and fiber optic receptacle adapters and with incidental materials necessary for mounting. Fiber patch panels shall be manufactured by the selected SCS Manufacturer:

1. For Fiber:
    a. IDF Fiber Patch Cabinet: Holds six adapter panels, Front locking door, Holds 36 SC fibers, 3.5" H, 2 rack units P/N Ortronics OR-FC02U-P.
    b. MDF Fiber Patch Cabinet: Holds 12 adapter panels, Front locking door, Holds 72 SC fibers, 5.25" H, 3 RU, Ortronics P/N OR-FC04U-P.
    c. Adapter Panel: 3-SC duplex (6 fibers) single-mode, blue adapters, ceramic alignment sleeves Ortronics P/N OR-OFP-SCD12AC.
    d. Adapter Panel: 3-SC duplex (6 fibers) Multimode, aqua adapter, ceramic alignment sleeves, Ortronics P/N OR-OFP-SCD12LC.
2. For Copper
    a. The Modular Patch Panels shall
        1) meet category 5E component compliance and be verified by a third-party nationally recognized independent testing laboratory
        2) use low emission IDC contacts
        3) use dual reactance technology to enhance the signal-to-noise ratio
        4) require standard termination practices using a 110 impact tool
        5) use a single piece IDC housing designed to accept larger Category 6 conductors
        6) support both T568B and T568A wiring
        7) include easy to follow wiring labels
        8) include label fields
        9) allow for the use of icons
        10) include full length metal rear cable management
        11) be available in standard or high density
        12) be backward compatible to category 3, and 5
        13) be center tuned to category 5E test specifications
        14) the modular patch panel shall be compliant with the SCS warranty

2.08 CONNECTORS

A. Fiber Connectors:
1. SC OptiMo Field-Installable Pre-Polished Connectors
    a. SC 50/125, 900 Micron Buffer, Pre Polished Connector, Ortronics P/N OR-205KAS9FA-50T.
    b. SC Single-mode, 900 Micron Buffer, Pre Polished Connector, Ortronics P/N OR-205KAS9FA-09.
    c. Substitution of Corning connectors may be made with approval from Ortronics/Berk-Tek

2.09 RISER COPPER TERMINATION BLOCKS

A. Krone
1. Series II, 10 Pair blocks, type 105 can

2.10 STATIONS

A. Station cables shall each be terminated at their designated location in the connector types described in the subsections below. Included are modular telecommunication jacks. These connector assemblies shall snap into a faceplate.

B. The station Outlet Assembly shall accommodate:
   1. A minimum of three (3) modular jacks
   2. Additional accommodations for specific locations as noted in the plans for coaxial and/or additional copper cables as necessary
   3. A blank filler will be installed when extra ports are not used.
   4. The same orientation and positioning of jacks and connectors shall be utilized throughout the installation.
   5. Prior to installation, the telecommunications contractor shall submit the proposed configuration for each outlet assembly for review by the Owner.
   6. The modular jack shall incorporate printed label strip for identifying the outlet. Printed labels shall be permanent and compliant with ANSI/TIA/EIA–606-A standard specifications. Labels shall be printed using Ortronics label program (LabelMo) or using a printer such as a Brady hand held printer. Hand printed labels shall not be accepted.

C. Faceplates: The faceplates shall:
   1. be Series II style as appropriate to fit the modular jack used
   2. be UL listed and CSA certified.
   3. be constructed of high impact, ABS plastic UL 94V-0 construction (except where noted otherwise).
   4. be fog white.
   5. be compliant with the above requirements along with the following when incorporating optical fiber:
      a. be a low profile assembly,
      b. incorporate a mechanism for storage of cable and fiber slack needed for termination,
      c. position the fiber optic couplings to face downward or at a downward angle to prevent contamination and,
      d. incorporate a shroud that protects the optical couplings from impact damage.
   6. be available as single-gang or dual-gang.
   7. provide easy access for adds, moves, and changes by front removal of jack modules.
   8. possess recessed designation windows to facilitate labeling and identification.
   9. include a clear plastic cover to protect labels in the designation window.
   10. have mounting screws located under recessed designation windows.
   11. comply with ANSI/TIA/EIA-606-A work area labeling standard.
   12. allow for the UTP modules to be inverted in place for termination purposes.
   13. be manufactured by an ISO 9001 registered company.

D. Jack Modules
   1. Jacks shall be Series II, 8-position modular jacks and shall be Category 5E performance as defined by the references in this document. All pair combinations must be considered, with the worst-case measurement being the basis for compliance. Modular jack performance shall be third-party verified by a nationally recognized independent testing laboratory.
   2. The modular jack shall use dual reactance modular contact array.
   3. The modular jack shall have low emission IDC contacts.
   4. The modular jack shall use standard termination practice using 110 impact tool
   5. The modular jack shall be backwards compatible to Category 3, and 5.
   6. The modular jack shall be center tuned to category 5E test specifications.

7. The modular jack shall be designed for the SCS.

E. Stations to be used for wall-mount telephones: Brushed stainless steel with stainless steel mounting lugs suitable for supporting wall-mount telephones:
   1. SUTTLE SE-630AD4, or approved equal.

F. Surface Device Boxes: Surface mount device boxes shall be:
   1. Wiremold

2.11 CABLE

A. General: Cables shall be manufactured by the selected SCS Manufacturer.

B. Copper Cable:
   1. For Horizontal Distribution:
      a. Plenum Category 5E, 24 AWG, bare copper wire insulated with FEP. Two insulated conductors twisted together to form a pair and four such pairs cabled to form the basic unit jacketed with flame-retardant PVC. Tested at 350 mhz.
      b. Riser Category 5E, 24 AWG, bare copper wire insulated with polyethylene. Two insulated conductors twisted together to form a pair and four such pairs cabled to form the basic unit jacketed with flame-retardant PVC. Tested at 350 mhz.
         a) 4-pair, UTP, 24 AWG, with solid copper conductors

   2. For Backbone Distribution:
      a. Copper backbone cable shall be non-shielded 24-AWG solid copper conductors insulated with color coded PVC, shall be UL Verified to TIA/EIA 568-B for Category 3 performance. Cable shall be manufactured the selected SCS Manufacturer:

C. Coaxial Cable
   1. For station outlets
      a. All runs shall use Quad Shield RG-6 Coaxial cable.
   2. For Intra-Building Distribution
      a. All Riser and Horizontal distribution shall use Commscope QR 540 JCA Coaxial cable
   3. For Inter-Building Backbone
      a. All Outside Plant Coaxial Backbone shall use Commscope QR 860 JCASS Coaxial cable.

D. Fiber Cable:
   1. For Backbone Distribution:
      a. Each Multimode Fiber shall be/have:
         1) Graded-index optical fiber wave-guide with nominal 50/125µm-core/cladding diameter.
         2) Comply with the latest revision of ANSI/EIA/TIA-4920000.
         3) Attenuation measured in accordance with ANSI/EIA/TIA-455-46, 53 or 61.
         4) Information transmission capacity measured in accordance with ANSI/EIA/TIA-455—204 for overfilled launch.
         5) The measurements performed at 23 degrees C +/- 5 degrees.

6) Maximum attenuation dB/Km @ 850/1300 nm: 3.5/1.5
7) Bandwidth: > 1500 MHz-km @ 850nm for overfilled launch,
8) Bandwidth 500 MHz-km @ 1300nm.
9) Bandwidth 2000 MHz-km characterized using FOTP 220
10) Optical Fiber laser optimized and guaranteed for 10 Gigabit Ethernet distances of 300m/300m for 850nm and 1300nm respectively
11) Optical Fiber laser optimized and guarantee Gigabit Ethernet distances of 1000m/600m for 850nm and 1300nm respectively

b. Physical Characteristics:
1) Shall be rated for environment being distributed.
2) Shall have 900µm tight-buffered construction
3) Shall be available with a fiber stand count range from 6 to 144.
4) Shall have an UL-OFNR/FT4 Flame Rating.
5) Strength members shall be aramid yarn.
6) Tight buffered fibers shall be color coded in accordance with EIA/TIA 598 with an overall orange jacket.
7) Suitable for operation between -20° to 75° C.
8) Shall comply with ICEA S-83-596
9) Cables containing Laser Optimized 50/125 µm fibers (Effective Modal Bandwidth equal or greater than 2000 MHz•km at 850 nm) shall have an AQUA jacket

c. Each Single-mode Fiber shall be:
1) Class IVa dispersion - unshifted single mode optical fibers with Low Water Peak complying with ANSI/EIA/TIA-492BAAA492CAAB-2000.
2) The zero dispersion wavelength shall be between 1300 nm and 1320 nm. The ANSI/EIA/TIA-455-168 maximum value of the dispersion slope shall be no greater than 0.090 ps/km-nm^2. Dispersion measurements shall be made in accordance with ANSI/EIA/TIA-455-169 or ANSI/EIA/TIA-455-175-B.
3) The nominal mode field diameter shall be 9.1 µm with a tolerance of ± 0.4 µm at 1310 nm when measured in accordance with ANSI/EIA/TIA-455-191-B.
4) Transmission Characteristics:
5) Maximum cabled attenuation dB/km @ 1310/1550 nm: 1.0/1.0
6) The cabled cutoff wavelength shall be ≤1260 nm when measured in accordance with ANSI/EIA/TIA-455-80-C
7) Distance vs. bandwidth using a Laser transmitter operating at a 1310 nm wavelength

d. Physical Characteristics:
1) Shall be rated for environment being distributed.
2) Shall be available with a fiber strand count range from 6 to 144.
3) Bundled cable constructions shall have a sub-unit core size of 5.2mm for 12 fibers and 4.5mm for 6 fibers.
4) Shall have and be marked with an UL-OFNR and OFN FT4 Flame Rating.
5) Shall comply with Telcordia GR-409.
6) Shall comply with the requirements of ICEA S-83-596.

7) Strength members shall be dielectric and may be either FGE/aramid/yarn.
8) Buffered fibers shall be color coded in accordance with EIA/TIA-598 with an overall yellow jacket.
9) Shall have a ripcord for overall jacket.
10) Suitable for operation between -20°C to +75°C
11) Shall be of an all dielectric design
12) Cables containing Single-mode shall have a YELLOW jacket
13) Single-mode shall be tight buffered and manufactured by the selected SCS Manufacturer

2.12 CABLE ASSEMBLIES (PATCH CORDS) AND CROSS-CONNECTS

A. Cable Management
1. Hook and Loop Cable Managers: Reusable hook and loop (similar to Velcro) style, adjustable tension, roll or spool dispensed

B. The contractor shall provide factory terminated and tested UTP and optical fiber patch cords and equipment cords for the complete cabling system. The UTP patch cables shall meet the requirements of ANSI/TIA/EIA-568-B for patch cord testing.
1. Copper (UTP) patch cords shall:
a. be a Category 5E Clarity patch cord.
b. use 8 position connector with impedance matched contacts and designed using dual reactance.
c. be constructed of 100 ohm, 4 pair, 24 AWG, stranded conductor, unshielded twisted pair copper per the requirements of the ANSI/TIA/EIA-568-B.2 and standard.
d. meet TIA category 5E component specifications in ANSI/TIA/EIA-568-B
1) 100% factory tested to meet category 5E performance and
2) ETL or any other nationally recognized 3rd party verification
e. be center tuned to category 6 performance specifications by using paired bi-level contact array
f. be capable of universal T568A or T568B wiring schemes.
g. Modular connector shall maintain the paired construction of the cable to facilitate minimum untwisting of the wires.
h. have a performance marking indelibly labeled on the jacket (by the manufacturer).
i. have the ability to accept color-coded labels and icons to comply with ANSI/TIA/EIA-606-A labeling specifications.
j. have “snagless” protection for the locking tab to prevent snagging and to protect locking tab in tight locations and provide bend relief
k. be available in three standard colors
l. be available in 3 foot, 5 foot, 7 foot, 9 foot, and 15 foot standard lengths
m. be backwards compatible to Category 3 and 5
n. be manufactured by an ISO 9001 registered company.
o. be manufactured by the selected SCS Manufacturer
2. Optical Fiber patch cords shall:
a. contain two (2) multi-mode optical fibers.
b. use multi-mode, graded-index fibers with a 850 nm Laser Optimized 50.omicron core.
c. be capable of transmission at both 850 nm and 1300 nm wavelengths.

d. include listing of actual loss of patchcord when packaged
e. be manufactured in standard lengths of 1 m (3.27 ft), 2 m (6.56 ft), 3 m (9.84 ft), 4 m (13.11 ft), 7 m (22.95 ft), and 10 m (32.79 ft), and special ordered in any other lengths.
f. be manufactured by an ISO 9001 registered company.
g. be manufactured by the selected SCS Manufacturer

C. Copper Jumper Wire: Category 5 (for cross connects):

2.13 LABELING AND ADMINISTRATION

A. Labels:
1. As recommended in ANSI/TIA/EIA 606. Permanent (i.e. not subject to fading or erasure), permanently affixed, and created by a hand-carried label maker or a computer/software-based label making system. Handwritten labels are not acceptable.
a. For Station Cable:
1) Brady: Bradymaker Wire Marking Labels WML-511-292 (or approved equal)
b. For Backbone Cable:
1) Panduit Marker Tie (or approved equal)

B. Hand-carried label maker:
1. Brady: ID Pro Plus (or approved equal).

PART 3 - EXECUTION

3.01 GENERAL

A. The Contractor is solely responsible for the safety of the public and workers in accordance with all applicable rules, regulations, building codes and ordinances.

B. All work shall comply with applicable safety rules and regulations including OSHA . All work shall comply with the requirements of the National Electrical Safety Code (NESC) and the NEC except where local codes and/or regulations are more stringent, in which case the local codes and/or regulations shall govern.

C. All work shall comply with the standards, references and codes listed in PART 1 -- REFERENCES above. Where questions arise regarding which standards, references, or codes apply, the more stringent shall prevail.

D. All work shall comply with the requirements and recommendations of the product manufacturers. Where questions arise regarding which requirements and recommendations apply, the more stringent shall prevail.

E. Replace and/or repair to original (or better) condition any existing structures, materials, equipment, etc. inadvertently demolished or damaged by the Contractor during the course of construction at no additional cost to the Owner.

F. Remove surplus material and debris from the job site and dispose of legally.

G. Cleaning: Clean Telecommunication Rooms after installation activities are complete and prior to releasing them to the Owner for the Owner's use. This includes all debris, extra material, packaging, and boxes. Wipe down network racks, cabinets, horizontal and vertical managers to remove dust, dirt, etc.

3.02 RACEWAY

A. Surface Raceway: Provide for all surface mounted stations as shown in the Contract Documents.
   1. Size surface raceway according to the quantity of cable to be routed through it according to ANSI/TIA/EIA 569 cable capacity standards, plus an additional 100% for future expansion. Size fittings/bends to accommodate Category 5/6 and fiber optic bend radii as specified in ANSI/TIA/EIA 569.
   2. Match surface raceway finish as close as possible to the finish of the wall it is to be mounted on but do not paint surface raceway. Surface raceway shall be:
      a. Installed per Article 352 of the NEC. Surface raceway shall be installed as mechanically and electrically continuous and bonded in accordance with NEC and ANSI/TIA/EIA 607 codes and standards.
      b. Installed according to ANSI/TIA/EIA standards for fiber optic and Category 5/6 bend radii. Bend points shall have a minimum two inch radius control.
      c. Securely supported using screws or other anchor-type devices (tape or glue is not an acceptable support medium) at intervals not exceeding 5 feet and with no less than two supports per straight raceway section. Surface raceway shall be supported in accordance with the manufacturer's installation requirements.
      d. Completely installed including insulating bushings and inserts where required by manufacturer's installation requirements.
      e. Installed parallel and perpendicular to surfaces or exposed structural members, and following surface contours where possible.
      f. Close any unused raceway openings.

B. Backboards: Provide backboards as shown on Contract Documents. Backboards shall be capable of supporting attached equipment, and painted with a minimum of two coats (over primer) of fire retardant, non-conductive paint, and one coat of white colored semi gloss top coat paint. Mount A-C plywood backboards with the "A" side exposed.

C. Sleeves: Provide sleeves where required for cable pass-thru through building structures and/or fire rated barriers. Provide roto-hammering or core drilling where required for sleeve installation. Seal (and if a fire rated barrier, firestop) between sleeve and building structure and/or barrier. Size sleeves:
   1. As noted in the Contract Documents.
   2. Where not noted, size sleeves a minimum of 2 inches in diameter or by the type and quantity of cable to be routed through the sleeve per ANSI/TIA/EIA 569 cable capacity standards plus an additional 100% for future expansion - whichever is greater.

D. D-Rings: Provide D-Rings as necessary to route exposed cables in telecommunications rooms and on backboards and for raceway for routing cable in non-exposed open access environments, and as shown in the Contract Documents. D-Rings may be affixed to wall/ceiling structures or other supports, but not attached to a ceiling support system. In telecommunications rooms, mount D-Rings at 12 inch intervals and as shown in the Contract Documents. Mount D-rings used for raceway in open access environments at 4 foot intervals unless otherwise specified in the Contract Documents.

1. Size D-Rings as noted in the Contract Documents.
2. Where not noted, size D-Rings according to the type and quantity of cable to be routed through the ring per TIA/EIA 569 cable capacity standards, plus an additional 100% for future expansion, but not less than a minimum of 2 inches in diameter.

E. Cable Supports (J-Hooks, Straps): Provide cable supports for routing cable in non-exposed open access environments as shown in the Contract Documents. Cable supports may be affixed to wall/ceiling structures or other supports, but not attached to a ceiling support system. Mount cable supports at 4 foot intervals unless otherwise specified in the Contract Documents. Do not use cable supports for more cables than they were designed to support. Provide multiple cable supports where the total cable count exceeds the maximum cable count for which the support was designed. Size according to the type and quantity of cable to be routed through the ring per ANSI/TIA/EIA 569 cable capacity standards, plus an additional 50% for future expansion.

F. Ladder Rack: Install ladder rack per manufacturer’s instructions with flat (rung) side up. Provide ladder rack to affix tops of racks to walls, to route cable from walls to racks within telecommunications rooms, and in locations shown in the Contract Documents. Size and install as shown in the Contract Documents. Cut ends of ladder rack square. Ream cut ends to remove burrs and sharp edges. Cap cut ends with manufacturer’s recommended caps. Mount retaining posts as required. Provide Cable Radius Drops wherever cable is to drop from one section of ladder rack to another lower section of ladder rack or onto racks or cabinets. Provide 90-degree horizontal radius bends for each 90-degree change in direction of ladder rack angle. Provide Cable Retaining Posts for all sides of ladder rack within a telecommunications room not directly adjacent to a wall. Affix posts at 2 foot centers and at corners and/or junctions. Provide Cable Runway Grounding kits across ladder rack splices and where ladder racks end at or are connected to racks/cabinets.

G. Innerduct: Provide bright orange innerduct as pathway for backbone fiber optic cables (backbone only – not station cables), from backbone fiber patch panels to conduit or plenum entrances, and as shown in the Contract Documents. Innerduct installed in plenum rated environments shall be plenum rated.

H. Pull Strings: Provide a pull string in existing conduits that are to remain vacant after existing cable is demolished and in existing and new conduits that have new cable installed under this project.

3.03 FIRESTOPPING

A. Only employees trained/certified by the firestopping manufacturer shall apply firestopping materials.

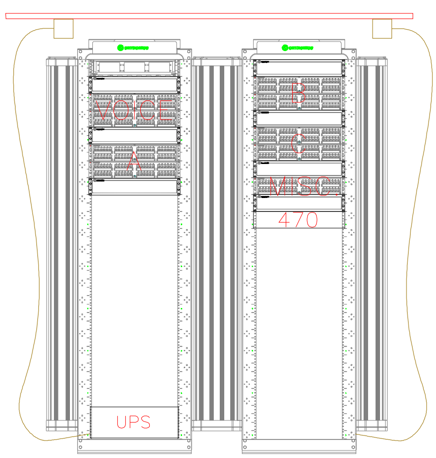
B. Maintain fire rating of penetrated fire barriers. Fire stop and seal penetrations made during construction.

1. Provide firestopping material for through and membrane penetrations of fire-rated barriers.

2. Install firestops in strict accordance with manufacturer's detailed installation procedures.
3. Install firestops in accordance with fire test reports, fire resistance requirements, acceptable sample installations, manufacturer's recommendations, local fire and building authorities, and applicable codes and standards referenced in PART 1 – REFERENCES. Apply of sealing material in a manner acceptable to the local fire and building authorities.
4. For demolition work, apply firestopping to open penetrations in fire rated barriers where cable is removed. Apply firestopping regardless of whether or not the penetrations are used for new cable or left empty after construction is complete.
5. Firestopping material used to seal open penetrations through which cable passes shall be re-usable/re-enterable.

3.04 EQUIPMENT RACKS/ENCLOSURES

A. Provide EIA racks/cabinets and all associated hardware according to locations, elevations, and plan views as shown in the Contract Documents. A typical two rack elevation is shown below.



B. For Floor Mount Racks/Cabinets:
   1. Using ladder rack, horizontally affix the top of a given rack/cabinet to the wall as shown on the Contract Documents. Bolt horizontal ladder rack to rack/cabinet and to walls. Bolt rack/cabinet to floor.

C. Free Standing Equipment Racks:
   1. Coordinate with Owner to identify desired location for shelf. Provide shelf, installed per Owner's direction.
   2. Coordinate with Owner to identify desired location for lockable storage drawer. Provide drawer, installed per Owner's direction.

3.05 GROUNDING AND BONDING

A. Grounding and bonding work shall comply with the Uniform Building Code, Uniform Fire Code, WAC, National Electrical Code, and UL 467, ANSI/TIA/EIA standards and the references listed in PART 1 – REFERENCES above, as well as local codes which may specify additional grounding and/or bonding requirements.

1. Provide a minimum of one wall-mountable telecommunications ground bus bar per telecommunications room and as shown on the Contract Documents.
2. Grounding conductor shall be installed to bond all non-current carrying metal telecommunications equipment and materials to the nearest TMGB or TGB (as provided under Division 16 Section — "Grounding for Communications Circuits and Raceway").
   a. Ensure that bonding breaks through paint to bare metallic surface of all painted metallic hardware.

   b. Provide ladder rack grounding kits to bond each section of ladder rack and bond ladder rack to racks/cabinets where ladder racks are connected.
3. In multi-story buildings, if there is more than (1) IDF per floor, the TGBs must be bonded together at top floor and at every third floor interval per ANSI/TIA/EIA-607.

3.06 VIDEO DISTRIBUTION

A. The Video Distribution for the project shall be designed to connect to the existing 750mhz sub-split video plant.
   1. Outside Plant Backbone Cable will be Commscope QR 860 JCASS extending from the exist plant to the project. The exact location for the interconnection to the existing plant will be coordinated with Mason ITU/NET upon review of project cable plant design.
   2. Riser cable will be Commscope QR 540 JCA from the MDF to the IDFs. Amplifiers will be installed as required to provide adequate signal levels.
   3. Commscope QR 540 JCA will be used for horizontal distribution from the IDFs to a location within 150 feet of the station outlet. Tap locations will be designed and installed to provide an appropriate signal level for either 75 or 150 foot station outlet cables.
   4. Station outlet cables will be Quad Shield RG-6 coaxial cable of either 75 or 150 foot length and attached to an appropriate tap to provide 0db +-4db at the station outlet. Tilt between channel 3 and channel 116 will be no greater than 4db.

3.07 PATCH PANELS

A. Provide patch panels and horizontal wire management according to locations, elevations, and plan views as shown on the Contract Documents.
   1. Fiber: Size and install rack-mountable patch panels as shown on the Contract Documents. Use fiber patch panels to terminate multimode and/or singlemode fiber backbone cables.
   2. Horizontal Wire Management: Provide horizontal wire management as shown on the Drawings.

3.08 CONNECTORS

A. Copper Connectors (modular jacks):
   1. 1. For Horizontal Distribution:
      c. Terminate Category 5E cable using the T568B wiring pattern.

3.09 COPPER TERMINATION BLOCKS

A. Provide vertical and horizontal cable management for jumper/patch cables between termination blocks. Provide termination blocks and (jumper troughs) with or without legs based on the following mounting conditions:
   1. 1. Mounting on Backboards: Provide termination blocks, jumper troughs, and distribution rings with legs and as shown on the Contract Documents. Use jumper troughs above and below each termination block in a column. Use a distribution ring backboard in place of jumper troughs in the vertical middle of each column of 600 pair or more.
   2. 2. Mounting on Racks: Provide termination blocks and jumper troughs without legs. Use rack mount brackets to mount termination blocks on EIA standard 19" floor and wall-mount racks.

B. Provide one horizontal cable termination block with connecting blocks, designation strips, and labels, to Owner for spare.

C. Provide one backbone cable termination block with connecting blocks, designation strips, and labels, to Owner for spare.

D. Route cable horizontally along base of backboard until it reaches the termination block column on which it is to terminate and then route vertically to the termination block.

E. Install termination block wall field according to the elevations shown in the Drawings.

F. Install termination block punch downs for riser cable as follows:
   2. Terminate the cable consecutively on the Krone, Series 2, 10 pair blocks.

   3. On the connections from the Krone blocks to the racks, terminate the cables consecutively on the Voice riser patch panel (DO NOT DROP THE 25TH PAIR IN EACH BINDER). Example: If the voice riser is 50 pair, the patch panel will be pairs 1-48, not terminating the last 2 pair of the 50 pair cable.

G. Punch down cable using only the selected SCS Manufacturer approved impact tool.

3.10 STATION OUTLETS

A. Faceplates: Provide faceplates for stations in the locations and gang counts shown on the Contract Documents. Faceplates shall completely conceal outlet boxes, reducer plates, etc. Faceplates shall provide a snug and sure fit for connectors – loose connectors are not acceptable.

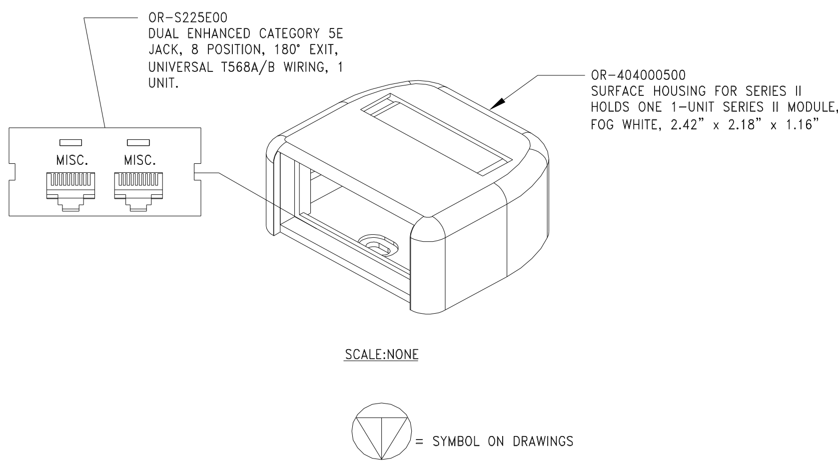
B. Faceplates shall be level and plumb.

C. Faceplate Mounting Brackets: Provide faceplate mounting brackets as required and as shown for flush mounted communications outlets.

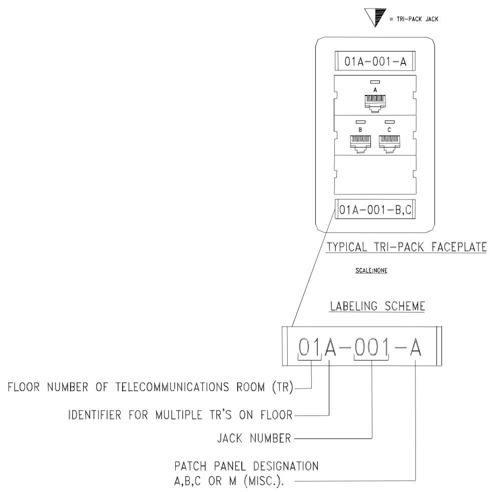
D. Surface Device Boxes: Provide surface mount device boxes as required and as shown for surface mounted communications outlets.

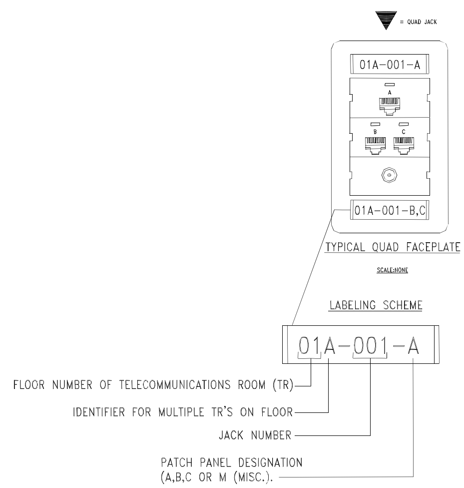
E. Dual Port RJ45 outlet will be installed and concealed above the common area ceiling for wireless access points (WAP). The outlet must be installed in an appropriate enclosure for the location. The number and locations will need to be sufficient to provide adequate coverage for all bedrooms and common areas. See drawing below.

F. Station Outlets: Provide appropriate amount of Enhanced Category 5E cable and coax to the outlet. All outlets shall be wired with the T568B standard. All outlets containing three Enhanced Category 5E cables shall be wired in an (A, B, C) configuration. Each outlet shall have a single RJ45 jack insert in the top position, and a dual RJ45 insert in the middle and a single F connector in the bottom position. Each outlet shall be wired with the top single RJ45 port labeled "A" to the horizontal patch panel in the telecommunications room labeled "A". The middle left RJ45 port labeled "B" to the horizontal patch panel labeled "B". The middle right RJ45 port labeled "C" to the horizontal patch panel labeled "C". All outlets with one or two Enhanced Category 5E cables shall terminate on a separate appropriately sized patch panel, marked "miscellaneous", in the Telecommunications Room. See drawing below.



CEILING DECK LOCATION – DUPLEX OUTLET CONFIGURATION
LOW PROFILE SURFACE MOUNT PLENUM RATED ENCLOSURE
WITH (2) CONDUIT STUB-OUTS.





3.11 CABLE

A. General (applicable to all cable types): Provide non-plenum (CM/CMR, OFNR) rated cable for locations where cable is to be installed in conduit. For cable not installed in conduit, provide plenum (CMP, OFNP) rated cable if cable is installed in a plenum air space environment, non-plenum rated otherwise. Cabling shall bear plenum or non-plenum markings for the environment in which it is installed.

1. For Horizontal Distribution: Provide station cable in types, sizes, and quantities as defined by the Symbol Schedule and as shown on the Contract Documents. Install cable between the station and its associated telecommunications room. Provide one cable per each connector at each station.
2. Install cable in compliance with ANSI/TIA/EIA and ISO/IEC 11801 requirements and BICSI TCIM practices.
3. Penetrations through floor and fire-rated walls shall utilize metallic sleeves and shall be fire-stopped after installation and testing, utilizing a firestopping system approved for that application.
4. Adhere to the bending radius and pull strength requirements as detailed in the ANSI/TIA/EIA standards and the manufacturer's installation recommendations during cable handling and installation.
   a. Pull all cables simultaneously where more than one cable is being installed in the same raceway.

   b. Use pulling compound or lubricant where necessary. Use compounds that will not damage conductor or insulation (Polywater, or approved equal).

   c. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips that will not damage media or raceway. Repair or replace conduit bushings that become damaged during cabling installation.

5. Install cable in a continuous (non-spliced) manner unless otherwise indicated.
6. Install exposed cable parallel to and perpendicular to surfaces on exposed structural members and follow surface contours where possible.
7. Tie or clamp cabling. Attaching cables to pipes, electrical conduit, mechanical items, existing cables, or the ceiling support system (grids, hanger wires, etc.) is not acceptable. Install tie-wraps in conformance with the SCS manufacturer's installation recommendations. Do not over-tighten tie wraps or cause cross-sectional deformation of cabling.
8. Cable at the backboards:
   d. Lay and dress cables to allow other cables to enter raceway (conduit or otherwise) without difficulty at a later time by maintaining a working distance from these openings.

   e. Route cable as close as possible to the ceiling, floor, sides, or corners to insure that adequate wall or backboard space is available for current and future equipment and for cable terminations.

   f. Lay cables via the shortest route directly to the nearest edge of the backboard from mounted equipment or blocks. Support cables so as not to create a load on the equipment upon which the cables are terminated. Tie-wrap similarly routed and similar cables together and attach to D-rings vertically and/or horizontally, then route over a path that will offer minimum obstruction to future installations of equipment, backboards or other cables.

   g. See COPPER TERMINATION BLOCKS above for details on routing copper cabling to termination blocks.

9. Cable in the telecommunications rooms:
   h. For telecommunications rooms with ladder rack, lay cable neatly in ladder rack in even bundles and loosely secure cabling to the ladder rack at regular intervals with tie-wraps or hook-and-loop straps.

10. Cable terminating on patch panels located on racks:
   i. Route cables in telecommunications rooms to patch panels on racks by routing across ladder rack across top of rack and then down vertical ladder rack to patch panel.

B. Copper Cable: Terminate all pairs within a cable. Un-terminated cable pairs are not acceptable.
1. For horizontal distribution: Provide station cable in the locations shown on the Contract Documents. Provide service loops with a minimum length of 12 inches in outlet boxes and no less than 10 feet in the ER/TR's.
   j. For workstation outlets with both Category5E and coaxial cable for TV Distribution, terminate Category 5E cabling after coaxial cable has been installed and terminated.

   k. Route station cable that is exposed (not in conduit) to comply with ANSI/TIA/EIA-569 requirements for avoiding potential EMI sources and as follows:

      1) 48 inches from motors or transformers

      2) 12 inches from conduit and cables used for electrical power

distribution

3) 5 inches from fluorescent lighting

C. Fiber Cable: Terminate all fiber strands within a fiber cable. The installation of "dark fiber" is acceptable upon approval by Mason ITU/NET.

3.12 CABLE ASSEMBLIES (PATCH CORDS) AND CROSS-CONNECTS

A. Furnish copper patch cables for modular copper cross-connects. Use a quantity of 1.25, 9ft patch cables for every station outlet for budgeting purposes. Exact quantities and colors to be coordinated with Mason ITU/NET at the time that the preliminary as-builts, as specified in Section 1.6 F, are delivered. Cables to be delivered to Mason ITU/NET within 6 weeks of the quantities being provided.

B. Furnish fiber patch cables for fiber cross connects. Deliver patch cables to Owner in the lengths and quantities below:
1. For Multimode:
   a. Length (e.g. 3m) - (Qty. 20), Type: (Duplex SC-to-SC)
   b. Length (e.g. 1m) - (Qty. 20), Type: (Duplex SC-to-SC)

C. Furnish one (1) spool of Category 5 jumper wire for each telecommunications room for cross connects and deliver unopened to Owner.

D. Furnish hook-and-loop cable managers for managing patch cords in the telecommunications rooms. Provide in colors, sizes and quantities as indicated below. Cable managers shall be the same color as the patch cable type that they manage.
1. Furnish four (4) cable managers each 6 inches in length for each telecommunications room with fiber connectivity
2. Furnish one roll of 50 cable managers each 6 inches in length for use in Main Equipment Room.

3.13 LABELING AND ADMINISTRATION

A. General: Labeling and administration shall comply with ANSI/TIA/EIA 606 and standard industry practices.

B. Telecommunications Rooms: Affix a permanent label to the door of each telecommunications room. Where telecommunications room names are required in other labels, use the telecommunication room name shown on the Contract Documents.

C. Racks: Label racks as shown on the Contract Documents. Affix label centered across top cross-member of rack.

D. Grounding/Bonding Conductors: Label bonding conductors; "WARNING! TELECOMMUNICATIONS BONDING CONDUCTOR. DO NOT REMOVE OR DISCONNECT!"

E. Cables:
1. Label Location: Affix at each end of the cable.
2. Station Cables: Label station cables with the same label as the station connector (see STATION CONNECTORS (PORTS) below) that terminates the cable at the station location. Include a clear vinyl adhesive wrapping applied over the label in

order to permanently affix the label to the cable. Using transparent tape to affix labels to cables is not acceptable.

3. Provide labels at each end of each cable within 24” of telecommunications room entrance and again within 24” of termination point.

F. Termination Blocks:

1. General:

   l. Label termination block ports/pairs sequentially beginning on the first row of each termination block column. Begin with “001” for the first port/pair.

   m. Label termination strip pairs sequentially (left to right).

2. For Horizontal Distribution:

   n. Label station outlets in accordance with EIA/TIA-606 using typed or computer printed labels that fit the jack insert and are consistent with the patch panel labeling in the Telecommunications Room. (I.E. The top label on the faceplate of the first outlet from the First Floor A Telecommunications Room will be 1A-001-A and the bottom label on the same outlet will be 1A-001-B, C. Label jacks with three UTP cables as follows:

      1. First character – The floor designator, 1.

      2. Second character – Telecommunications Room Designator, A.

      3. Third, fourth, and fifth character – a three-digit number identifying each outlet, numbered sequentially.

      4. Sixth character - A, B, or C based on the position of the port in the outlet.

   o. Label cables and patch panels with designations that are the same as the outlet.

   p. Outlets shall be numbered on the patch panels sequentially starting with 001. DO NOT skip outlet numbers on the patch panels. If a pre-numbered outlet has been deleted, leave that position blank on the patch panel.

G. Conduits: Label each conduit end (existing or new) in a clear manner by designating the location of the other end of the conduit (i.e. room name, telecommunications room identifier, pull box identifier, outlet identifier (use the label of the first port of the outlet as the outlet identifier), etc.). Indicate conduit length on the label.

H. Pull Strings: Label each pull string in a clear manner by designating the location of the other end of the pull string (i.e. room name, telecommunications room name, pull box identifier, outlet identifier (use the label of the first port of the outlet as the outlet identifier), etc.).

3.14 TESTING

A. Provide test records on a form approved by the Owner and Designer. Include the test results for each cable in the system. Submit the test results for each cable tested with identification as discussed under LABELING AND ADMINISTRATION above. Include the cable identifier, outcome of test, indication of errors found, cable length, retest results, and name and signature of technician completing the tests. Provide test results to the Owner and Designer for review and acceptance within two weeks of Substantial Completion.

1. Print test records for each cable within the system directly from the tester and submit in paper form (in a binder) and in electronic form (on diskette or CDROM) to the Owner and Designer for review. Handwritten test results will not be accepted.

B. Test the SCS after installation for compliance to all applicable standards as follows:
  1. Copper:
     a. For Horizontal Distribution: Test all pairs of each copper station cable, for conformance to ANSI/TIA/EIA 568-B Category 5E, and ANSI/TIA/EIA 568-B standards. To the extent possible, perform tests with building electrical systems fully powered on (i.e. Lights, HVAC, etc.).
        1) Test each end-to-end link (the entire channel from the connector at the station to the connector or termination in the telecommunications room) utilizing sweep tests, for continuity, shorts, polarity, near-end cross talk (NEXT), far-end cross talk (FEXT), attenuation, installed length, transposition (wire map), mutual capacitance, characteristic impedance, resistance, ACR, and presence of AC voltage. Use the Power Sum method to test NEXT and FEXT. Test each cable in both directions.
           a) Testing Device: Fluke DSP-4000 with latest software and hardware releases.
  2. Fiber: Test fiber optic cable on the reel upon delivery to the job site prior to installation, and again after installation.
     a. Prior to testing, calculate the cable loss budget for each fiber optic cable and clearly show the result on the test documentation. Calculate maximum loss using the following formula, assuming no splices:
        1) For Horizontal Distribution:
           a) Max Loss = 2.0db (per ANSI/TIA/EIA 568-B)
        2) For Backbone Distribution:
           a) Max Loss = [(allowable loss/km) * (km of fiber)] + [(.3db) * (# of connectors)]
           b) A mated connector to connector interface is defined as a single connector for the purposes of the above formula.
        3) A given fiber strand shall not exceed its calculated maximum loss (per the above formula).
     b. Test all strands using a bi-directional end-to-end optical transmission loss test instrument (such as an OTDR) trace performed per ANSI/TIA/EIA 455-61 or a bi-directional end-to-end power meter test performed per ANSI/TIA/EIA 455-53A, and ANSI/TIA/EIA 568-B.
        1) Calculate loss numbers by taking the sum of the two bi-directional measurements and dividing that sum by two.
        2) Provide test measurements as follows:
           a) For Multimode Cable: Test at both 850 and 1300nm.
     c. For Singlemode Cable: Test at both 1310 and 1550nm.
     d. Test results shall conform to:
        1) The criteria specified in ANSI/TIA/EIA-568B
        2) The Contractor's calculated loss budget above

3) The criteria specified in IEEE 802.3z (1000Base-X Gigabit Ethernet)
   a) In addition to the above, perform tests both recommended and mandated by manufacturer. Tests shall confirm/guarantee compliance to maufacturer's performance standards and also IEEE 802.3z for a maximum end-to-end dB loss of 2.5 dB.
4) The criteria specified in IEEE 802.3z (1000Base-X Gigabit Ethernet)

C. Identify cables and equipment that do not pass to the Owner and Designer. Determine the source of the non-compliance and replace or correct the cable or the connection materials, and retest the cable or connection materials at no additional expense to the Owner. Provide new test results to the Owner and Designer in the same manner as above.
1. In addition to the above, if it is determined that the cable is at fault, remove the damaged cable and replace it with a new cable. Cable "repairs" are not acceptable. The procedure for removing the cable shall be as follows:
   a. Prior to removal of damaged cable and installation of new cable:
      1) Inform the Owner and Designer of the schedule for the removal and installation.
      2) Test the new cable on the reel per paragraph B, above.
      3) Test cables that occupy the same innerduct or conduit (if not in innerduct) as the damaged cable per paragraph B, above, regardless of whether or not they are new cables installed as part of this project or existing cables installed prior to this project.
      4) Provide test results to the Owner and Designer for approval by the Owner and Designer.
   b. Remove the damaged cable and provide new cable.
   c. After the removal of the damaged cable and installation of the new cable:
      1) Test the new cable per the paragraph titled TESTING.
      2) Test cables that occupy the same innerduct or conduit (if not in innerduct) as the damaged cable per paragraph B, above, regardless of whether they are new cables installed as part of this project or existing cables installed prior to this project.
         a) If any of the cables requiring testing are in use, coordinate with the Owner to schedule an outage opportunity during which the testing can be performed.
      3) Provide test results to the Owner and Designer for approval by the Owner and Designer.
   d. If a cable which occupies the same innerduct or conduit (if not in innerduct) as a damaged cable is damaged by the extraction and installation process, replace the cable at no additional expense to the Owner.
      1) Damaged cables which are replaced shall be subject to the testing procedures of the paragraph titled TESTING.

3.15 FOLLOW UP

A. For the first four weeks that the system is in full operation, provide technical assistance for trouble shooting, training, and problem solving by phone and (within 24 hours of notice) on site. Provide up to 40 hours of assistance (in addition to any warranty-related work), including phone, travel, and on site time during this period.

Division 28 - Electronic Safety and Security

28 13 00 Access Control – Housing Only

Electronic Access Control Requirement Preamble:

It is the request of George Mason University (GMU) for the Security Integrator to be pre-approved from their preferred vendor list and to have an office and warehouse facility within a seventy-five (75) mile radius of the Fairfax campus of GMU. **No exception will be permitted**. GMU reserves the right to reject any Security Integrator they believe cannot fulfill the Quality Assurance requirements as specified within Section 281300. Cross reference with Section 087100 for proper coordination of this section. Section 281300 is **NOT** part of the Electrical Contractor's package, except where noted.

Any Finish Hardware or Electronic Access Control item provided that does not fulfill the owner’s requirements, shall be removed and replaced at the no expense to the owner. All internal corridor doors must be tied into the fire alarm system and “Fail Safe” upon activation of fire alarm system. All exterior doors will fail secure. All access control is also to be tied into the emergency generator for seamless operation in the event of power loss.

1. Related Documents
   - Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
2. Summary
   - Retain items below that are included in this Section, or include others as necessary.
     1) Section includes the following for the integrated access control security and site management system:
     2) Electrified and Integrated Access Control Door Hardware.
     3) Monitoring and Signaling Equipment.
     4) System Network Control Processors.
     5) Reader Controller Interfaces and Modules.
     6) Input Monitor and Output Control Interfaces and Modules.
     7) Card Readers.
     8) Multiplexers and Channel Input and Relay Modules.
     9) Cards and Credentials.
     10) Access Control System Application Software.
     11) Electrified Hardware and Access Control System Power Supplies, Back-Ups and Surge Protection.
   - Related Sections:
     1) Retain Division Sections below related to this Section, or include others as necessary.
     2) Division 08 Section 081100 "Steel Doors and Frames."
     3) Division 08 Section 081400 "Flush Wood Doors."

4) Division 08 Section 084100 "Aluminum-Framed Entrances and Storefronts."

5) Division 08 Section 087100 "Door Hardware".

6) Division 14 Section "Elevators" for security access to elevator floor selection controls.

7) Division 26 Sections (inclusive) for connections to electrical power system and for low-voltage wiring work.

8) Division 27 Section "Communications Horizontal Cabling" for connections to LAN.

9) Division 28 Section "Conductors and Cables for Electronic Safety and Security."

10) Division 28 Section 281600 "Intrusion Detection."

11) Division 28 Section 282300 "Video Surveillance."

12) Division 28 Section 283100 "Fire Detection and Alarm."

- References:

1) ANSI A117.1 (1998) - Accessible and Usable Buildings and Facilities.

2) IBC [2003, 2006] - International Building Code.

3) NFPA 70 (2002) - National Electrical Code.

4) NFPA 80 (1999) - Fire Doors and Windows.

5) NFPA 101 (2006) - Life Safety Code.

6) VUSBC Chapter 10 Means of Egress. To achieve compliance with the VUSBC; the Access/ Security Control Locking Systems (the complete system in its entirety) is to be *UL listed* for the specific application, or submit documentation that demonstrates that each of the components are listed for the intended use and that per the manufacturer's documentation the specific components are compatible with each other.

7) UL 294 - Access Control Systems.

8) UL 1076 - Proprietary Burglar Alarm Units and Systems.

- Products furnished, but not installed, under this Section include the following. Coordinating, purchasing, delivering, and scheduling remain requirements of this Section.

1) Patented and security construction keyed cylinders required for mechanical override access. In new construction, permanent cores are to be installed by the EAC sub contractor or his designee in consultation and direction from owner. Any cut hard keys accompanying the cores will be turned over to owner. In renovated buildings using existing cores, the owner will re install cores.

3. Submittals

- Product Data: Manufacturer's product data sheets including installation details, material descriptions, dimensions of individual components and profiles, operational descriptions and finishes.

- Shop Drawings: Details of electrified integrated locking hardware and access control firmware, indicating the following:

1) Wiring Diagrams: Upon receipt of approved schedules, submit detailed system wiring diagrams for power, signaling, monitoring, communication and control of the access control system electrified hardware and firmware. Differentiate between manufacturer-installed and field-installed wiring. Include the following:

a. Complete (risers, point-to-point) access control system block wiring diagrams.

b. Elevation diagram of each unique access controlled opening showing interconnection of major system components.

c. System Operational Descriptions: Include description of component functions including, but not limited to, the following situations: normal secured/unsecured state of door; authorized access; authorized egress; unauthorized access; unauthorized egress; fire alarm and loss of power conditions, and interfaces with other building control systems.

- Operating and Maintenance Manuals: Provide manufacturers hardware, software, operating and maintenance manuals for each item comprising the complete access control and site management installation in quantity as required in Division 01, Closeout Submittals. The manual to include the name, address, and telephone number of the supplier/integrator providing the installation and the nearest service representatives for each item of equipment included in the system. The final copies delivered after completion of the installation test to include "as built" modifications made during installation, checkout, and acceptance.

1) As-Built Drawings: During system installation, the Contractor to maintain a separate hard copy set of drawings, elevation diagrams, and wiring diagrams of the access control system to be used for record drawings. This set to be kept up to date by the Contractor with all changes and additions to the access control system accurately recorded.

- Warranties and Maintenance: Special warranties and maintenance agreements specified in this Section.

4. Quality Assurance

- Manufacturers Qualifications: Engage qualified manufacturers with a minimum (5) years of documented experience in providing access control and security systems equipment and software similar to that indicated for this Project and that have a proven record of successful in-service performance.

1) Software and access control systems components to have been previously and thoroughly tested together with proven installations similar in size and functionality to the design requirements indicated for this Project.

- Installer Qualifications: Factory trained and certified Systems Integrators, acceptable by the product manufacturers, with a minimum five (5) years documented experience installing complete integrated access control systems similar in material, design, and scope to that indicated for this Project and whose work has resulted in construction with a proven record of successful in-service performance. Qualifications include, but are not necessarily limited, to the following:

1) References: Provide a minimum of five (5) references for similar projects including contact name, phone number, name, and type of project. Two of the five references provided must be projects that consisting of one hundred (100) or more card readers installed during the base project.

2) Professional Staffing: Firms to have a dedicated access control systems integration department with full time, experienced professionals on staff

experienced in providing on site consulting services for both electrified door hardware and integrated access control systems installations.

3) Factory Training: Installation and service technicians are to be competent factory trained and certified personnel capable of maintaining the system. Vendor must be certified by the software manufacturer and must provide certifications from for Advance Level 2 Training.

4) Service Center: Firms to have a service center capable of providing training, in-stock parts, and emergency maintenance and repairs at the Project site with 24-hour/7-days a week response time, with a maximum of a 4 hour emergency response time on site.

5) Software/Integrator/Technicians/ Programmers must be, at a minimum, 2003 Microsoft Certified Systems Engineers (MCSE). (Not installers of Hardware)

6) Vendor must have an internal Technical Support Department staffed with a minimum of at least (3) technical support specialists whose sole job function is to support GMU on high level software related issues. This staff must be separate from installation and service technicians.

7) The Vendor preferably has previous “on-site” experience of the GMU campus and the existing security system(s).

8) All work must be performed directly by the Vendors own internal employees. No work is to be performed by subcontractors.

9) To ensure quality assurance and best of practice installation methods, Vendor must be UL2050 certified for security systems installation. A current copy of this certification must be provided with bid response.

10) Vendor must provide proof of being in business for at least ten (10) years.

- Supplier Qualifications: Factory authorized Supplier/Dealers, in good standing with the primary product manufacturers, with a minimum (3) years experience supplying integrated access control systems similar in material, design, and scope to that indicated for this Project and whose work has resulted in construction with a proven record of successful in-service performance.
- Supplier Certifications: Security Integrators must provide valid certificates from the specified manufacturers listed in this section in order to be pre-qualified to bid on this project.
- Source Limitations: Obtain each type and variety of electrified door hardware and access control system firmware and software from a single source, qualified supplier unless otherwise indicated.

1) Provide electrified integrated door hardware from the same manufacturer as mechanical door hardware, unless otherwise indicated. Electrified modifications or enhancements made to a source manufacturer's product line by a secondary or third party source will not be accepted.

- Regulatory Requirements: Comply with NFPA 70, NFPA 80, NFPA 101 and ANSI A117.1 requirements and guidelines as directed in the model building code including, but not limited to, the following:

1) Comply with NFPA 70 "National Electrical Code", including electrical components, devices, and accessories listed and labeled as defined in Article 100 by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

2) Where indicated to comply with accessibility requirements, comply with Americans with Disabilities Act (ADA), "Accessibility Guidelines for Buildings and Facilities (ADAAG)," ANSI A117.1.

3) Comply with NFPA 80 "Fire Doors and Windows" for fire labeled opening assemblies.

4) Comply with Virginia Uniform Statewide Building Code.

5) The installed access control system shall conform to all local jurisdiction requirements.

- Pre-Installation Conference: Conduct conference in compliance with requirements in Division 01 Section "Project Meetings" with attendance by representatives of Supplier/Dealer, Systems Integrator, and Contractor to review proper installation methods and the procedures for receiving and handling the access control system hardware. At completion of installation, provide written documentation that components were applied to manufacturer's instructions and recommendations and according to approved schedules.

1) Inspect and discuss Division 26 electrical roughing-in and similar preparatory work performed by other trades.

2) Review and verify sequence of operation descriptions for each unique access controlled opening.

3) Review and finalize construction schedule and verify availability of materials.

4) Review the required inspecting, testing, commissioning, and demonstration procedures.

5. Delivery, Storage, And Handling

- Do not store electronic access control hardware, software, or accessories at Project site without prior authorization.

1) Access control firmware and software: Where approved and directed, inventory upon receipt and store electronic access control equipment in a secure, temperature and humidity controlled environment in original manufacturer's sealed containers.

- Tag each item or package separately with identification related to the final Access Control Door Schedule, and include basic installation instructions with each item or package.
- Deliver permanent keys, cores, access control credentials, software, and related accessories directly to Owner via registered mail or overnight package service. Instructions for delivery to the Owner established at the “Pre-Installation Conference".

6. Coordination

- Coordinate quantity and arrangement of assemblies with ceiling space configuration and with components occupying ceiling space, including structural members, pipes, air-distribution components, raceways, cable trays, recessed lighting fixtures, and other items.
- Access Control System: Coordinate with the appropriate trades the layout and installation of scheduled electrified door hardware and access control equipment with required connections to source power junction boxes, power supplies, sealing of fire penetrations, detection and monitoring hardware and fire alarm system.

- Templates: Obtain and distribute to the parties involved templates for doors, frames, and other work specified to be factory prepared for installing electrified door hardware and access control system components. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing access control system hardware to comply with indicated requirements.
- Door and Frame Preparation (New Doors/Frames only): Related Division 08 Sections (Steel, Aluminum and Wood) doors and corresponding frames are to be prepared, reinforced and pre-wired (if applicable) to receive the installation of the specified electrified, monitoring, signaling and access control system hardware without additional in-field modifications.

7. Warranty

- General Warranty: Reference Division 01, General Requirements. Special warranties specified in this Article will not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and are in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.
- Warranty Period: Written warranty agreeing to repair or replace components of the installed access control system hardware and software that fail in materials or workmanship, including all related parts and labor, for a minimum period of (24) months after final testing and acceptance by the Owner. Failures include, but are not limited to, the following:
  1) Structural failures including excessive deflection, cracking, or breakage.
  2) Faulty operation of the hardware.
  3) Deterioration of metals, metal finishes, and other materials beyond normal weathering.
  4) Electrical component defects and failures within the systems operation.
- Special Warranty Periods (Electrified Access Control Door Hardware):
  1) Two years for Electrified, Wiegand Output, and IP-Enabled Access Control Door Hardware.
- Support and Extended Service Agreement: Submit for Owner’s consideration an optional extended service agreement for the installed access control system, including support for software related issues. The extended service agreement is considered elective without a manufacturer's requirement stipulating mandatory annual agreements covering owner and/or vendor system support.
  1) A published copy of this agreement to be included with the submittal package
  2) Support for the installed access control system components is provided through the vendor under a 24 hour technical assistance program.
  3) Access control and management system components are to be available on a one-day turnaround time frame from the manufacturer.
  4) Primary systems manufacturer to offer and provide remote modem or internet access for direct factory support to the vendor. The factory level support to include diagnostics and troubleshooting support on systems related issues at no additional cost to the owner.
- Access Control Software Upgrades: Version upgrades and "fix" releases to the access control system software are available at no extra charge as long as the

version of software provided under this specification remains the current manufacturer's version or for up to (2) years after a new version release.

1) Major access control software revisions that provide new functionality to the product provided free of charge for up to one (1) year from the date of substantial completion.

2) Access control system software is to be upgradable as may be required or as necessary, to expand, and manage the owner's site or sites. Upgrades are to be offered at a published flat fee for the primary system software, with single license modules included in the primary fee structure. System upgrades offered at a costing structure based upon the original number of licensed modules issued, or on those to be purchased at a future date, are not allowed.

3) As part of the submittal package, provide a list of available software upgrades and/or expansions modules. List to identify related costs for upgrades, or expansions to the original system, up to the next qualifying operational level.

8. Maintenance Service

- Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of the installed access control system hardware and components.

- Maintenance Service: Beginning at Substantial Completion, provide continuous (6) months full maintenance by skilled employees of the Systems Integrator. Include preventive maintenance, repair, or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper door opening operation. Provide parts and supplies as used in the manufacture and installation of original products.

9. Scope of Work

- Furnish and install at the indicated locations the specified electrified and integrated door hardware and access control firmware and software for a completely operational access control and security site management system. The proposed system MUST be able to fully and seamlessly integrate into GMU Housing's current access control system**. Please note that ALL doors (with a few exceptions noted by owner) WILL have some form of electronic access control installed. With very few exceptions, exterior doors will be hard wired, online lock with readers, while interior doors will be wireless, online locks.**

- Installation requirements:

1) Security Contractor: All Access Control components as specified within Section 281300 will be furnished and installed as a turnkey system by an Single Security Contractor; including but not limited to the following items: Access Control Software, licensing, Access Control Panels, Input/Output Panels, Card Readers, Electrified Locking Hardware, Power Supplies, Door Contacts, Request-to-exit Devices and all low voltage wiring, including final terminations of all security devices at both ends as well as door operators, if applicable. In addition, the Security Contractor must include any and all licensing as required to fully operate the system.

- System includes, but is not necessarily limited, to the following:

1) Electrified integrated card reader locks and exit hardware, override cylinders, network control processors, reader controller panels, I/O monitor/control

interfaces, door position switches, remote card readers and display terminals, access cards and credentials, system application software, special tools, operating manuals, and required cabling and accessories as detailed below and listed in the Access Control Hardware Sets at the end of Part 3.

a. Provide the appropriate number of reader controller panels and I/O monitoring/control expansion interfaces as needed to handle the number of card readers, locking devices, door status devices, and identified alarm inputs specified in this section, and as shown on the security drawings.

b. Provide manufacturer approved integrated card reader locks, exit hardware, and remote mounted card readers [mullion, jamb, wall mounted] that are functionally compatible with the specified access control equipment interfaces.

c. All doors with card readers shall permit free egress at all times to comply with the Virginia Uniform Building Code and BOCA.

d. All doors specified to receive electrified locking hardware shall have the function of either a night latch or storeroom; if a key override is used the electrified locking hardware will remain in a locked state.

e. All doors specified to receive electrified locking hardware shall be provided with an electric hinge. Armored door loops will not be accepted by the owner.

f. All doors specified to receive card readers shall also have door contacts to monitor the door position and request-to-exit devices to shunt the door contact upon exit. Request-to-exit devices shall be integrated into the electrified locking hardware. Wall mounted passive infrared request-to-exit devices can only be used if they cannot be integrated into the electrified locking hardware.

g. Magnetic locks are not an acceptable electrified locking method unless they are required to satisfy Building Codes.

- Access control system equipment to be installed in an enclosure box compatible with the specified components. This enclosure to include, but is not necessarily limited to, the network control processor, I/O monitor/control interface panels, power supplies, terminal strips, wire ducts, keyed lock cylinder, integrated outlet for A/C power, and standoffs.

    1) Enclosure box to be located in a designated Housing Server room(s) with connection to the campus wide local area network for communication back to the central server host.

- Owner to provide necessary computer hardware and network consisting of:

    1) Central Server Host Computer

    2) Client Workstations

    3) Owner will be responsible for ensuring that each computer hardware component includes the required interfaces, expansion boards, and peripherals that will be necessary to allow the system to operate as described within this specification and as indicated on the drawings.

    4) Network Control Processor Connections

- Power Supplies, including battery backup and separately fused surge protection, required for the electrified door hardware and access control equipment.

- Installation, final configuration, and commissioning of electrified door and access control system hardware, communication firmware, power supplies, and related accessories.
- System application software including installation, programming, and end user training of the access control system demonstrating operating, repair and maintenance procedures. Include no fewer than 8 hours of on-site central server training for designated personnel (facilities maintenance, security, IT, administration) by a factory certified representative.
    1) Include minimum of 4 hours of Client Software Application (client workstation) training at each of the remote installed facilities for local administrative staff.
- Provide manufacturer required power controllers, interface boards, and programming that may be required for approved electric latch retraction exit devices supplied under this Section.
- Electrical contractor (Division 26) to provide the following for New Construction:
    1) Source power wiring (120VAC) as required for the electrified locking and access control hardware, equipment, accessories, and power supplies. This includes quad outlets as required on a dedicated circuit in the designated HOUSING server room (separate room from the GMU/ITU Telecom room) and the related conduit, stub-in, junction and back boxes, pull strings and connectors required for the source power delivery and connections.
    2) Provide required conduit, stub-in, junction and back boxes, pull strings and connectors for both the electrified locking hardware and access control equipment at each of the access controlled or monitored openings per plan drawings and specs. Supply and install conduit between each of the aforementioned devices and between the electrical junction boxes, power supplies, and access control equipment located on or above the door opening.
        a. At wall mounted remote readers, provide conduit on the secured side of the door, 36" from the finish floor and 6" from the edge of the frame, to the related power supplies and access control equipment.
        b. At electrical hardware power transfers provide conduit on the secured side of the opening from the power transfer, thru-wire hinge, or serviceable panel location on the frame jamb to the related power supplies and access control equipment.
    3) Electrical Contractor to provide all 120VAC cabling connections and terminations from the electrical junction boxes to these electrical devices.
    4) All electronic access control 120VAC power shall be tied into the Emergency Power circuit by the Electrical Contractor.
- Access Control System Integrator to provide the following:
    1) Low voltage wiring (12/24VDC) and communication cabling (RS-232/RS-485) from network control processors to reader controllers, I/O monitor/control interface panels, electrified and integrated locking hardware, remote card readers, keypads, or display terminals, monitoring and signaling switches, and power supplies. Work includes related connectors, final terminations, and hook-ups required for a complete and functional access controlled opening in accordance with applicable codes and specified system operational narratives.
- Elevator Contractor to provide the following:
    1) Interface or landing of interface cable onto the elevator call button will be performed by a certified elevator contractor.

2) Coordinate with access control systems integrator provisions for a card reader with output allowing the elevator call button to be activated. A validated card read will be required for activation.

- Final connections to fire alarm system, if required, by electrical and fire alarm system contractors.
- Provide permits, submittals, and approvals required by the authority having jurisdiction, prior to commencing with work.

10. System Architecture - Access Control and Site Management System (Acsms)

- General: The ACSMS must utilize the existing system in place at George Mason University. The ACSMS is a modular and networked based system providing physical access control security to a Wide Area campus enterprise. The system to be capable of controlling and integrating multiple security functions including the configuration, management and monitoring of cardholder access, locking hardware units, events, alarms, visitors, and real-time tracking and reporting. The ACSMS is to be alterable at any time depending on the facility requirements and will allow for easy upgradeability or modification of network processors, controller, interface modules, card data, inputs, outputs, and remote work stations. The ACSMS to include, but is not be limited to, the following features and functions:

1) An "Enterprise" class access control software application.

2) Client/Server model operating central server host software modules and client workstation software applications in a multi-user and a multi-tasking environment.

a. The ACSMS to permit multiple instances of client software applications to run simultaneously on the network. The base system to include 3 single client and 3 web client software application licenses.

3) Partitioning: The system to support security partitioning enabling system administrator to segment the configuration database and group multiple entities within the security partition.

a. Security partitions limit what users can view in the configuration database. Administrators, who have all rights and privileges, can segment a database into multiple security partitions. A user who is given access to a specific partition will only be able to view entities (components) within the partition they have been assigned.

4) Encryption: The system to support encrypted communication between the central server software and client software applications (sever-to-server and client-to-server) using a 128-bit AES encryption algorithm (at a minimum). Systems that do not provide encrypted communication will NOT be considered.

a. Communication between the central server host software module and system controllers are to be encrypted.

b. The ACSMS client software applications to be password protected with passwords stored in the central server database in an encrypted manner.

5) Distributed Processing: The system is a fully distributed processing application allowing information, including time, date, zones, valid codes, tasks, access levels, and similar data, to be downloaded from the central host station to controller interface devices allowing access-control decisions with or without central host station communication. If communications to a central host station are lost, the controllers will automatically buffer event transactions until

communications are restored and events are automatically uploaded to the central host station.

a. Provide for a higher level of distributed database management at defined perimeter access points such that no-single-point-of-failure will allow more than two access points to fail, or affect more than two access points at perimeter points system wide.

6) Single Data Base: The system to support a single database for access control site setup, credential and identity file creation, alarm and control setup, and system user operation and command functions.

7) System Access Management: The system to allow operators through password authentication the ability to make access granted or denied decisions, define access levels, time zones, holidays, assign cardholders, access groups, develop tasks, and generally manage access control, alarm monitoring and response activities system wide from a single login. Operator and user privileges are managed by a system administrator allowing for different levels of system access and system control. Authorization management is fully Owner definable.

8) Cardholder Management: The system to include a cardholder management system integrated within the access control system. This cardholder management functionality allows the enrollment of cardholders into the database, and import/export of employee data.

9) Access Groups and Access Levels: The system to provide adequate access groups and access level assignment capability to meet Owner requirements for the specified project. If required, software application can be expandable to support unlimited access groups and access levels.

10) Alarm Monitoring: The system is able to monitor, report, and provide information about the time and location of alarms, along with their priority.

11) Event Monitoring: The system is able to monitor, report, and archive network access control activity.

12) Transaction Logs: The system to support an unlimited number of logs and historical transactions (events and alarms) with the maximum allowed being limited by the amount of hard disk space available.

13) System Monitoring: The system to have ability to report on the integrity of all network assigned devices, circuits and communications and provide a diagnostics screen showing field level communications system wide

14) Lock/Unlock Commands: The system to allow an operator to manually lock and unlock doors overriding scheduled access control restrictions and configurations if necessary.

15) Hardware Interface: The system to integrate with and control specified electrified hardware, signaling and monitoring devices.

16) Report Generator: The system to have the ability to generate and output reports with any and all combinations of system fields and data including, but not limited to: by cardholder, by door, by site, by time, by groups of doors and by cardholder field. Any and all combinations of fields must be available for reporting. The report feature to allow exporting of generated reports over a network connection or by remote printing.

17) Multi-User/Web Based Network Capabilities: The system to support multiple operator workstations via local area network/wide area network (LAN/WAN),

the Internet, or VPN. The system to be capable of supporting minimum of 4 concurrent users/clients with software expansions to an unlimited number of workstations based on the Owners network requirements.

18) Systems Integration: The system shall be fully and seamlessly integrated with the specified video surveillance (CCTV) systems in Section 282300.

- Open Architecture: The access control system infrastructure will be based on an open architecture design capable of supporting multiple access control hardware manufacturers and integrate with multiple non-proprietary network processors, controllers, interface modules, integrated locking hardware, remote card readers, keypads and display terminals, and other third party applications.
- Open Protocol: The ACSMS manufacturer to provide non-proprietary, open protocol hardware for the system control processors and associated device sub-controllers. Systems utilizing a single manufacturer solution that encompasses combined proprietary software and integrated electronic hardware combinations are not acceptable. In addition, integrated electronic locking hardware requiring a processor or sub-controller module upgrade, or extensive access control firmware upgrades to accommodate integrating with an alternate software package, will not be considered.
- Network Support: Communication network connecting the central server host software modules, client workstation software applications, and hardware controllers to be designed to support all of the following:

1) LAN/Ethernet enterprise ring topology and localized star topology based on TCP/IP.

2) Direct-connected RS-232 and RS-485 communication cabling.

11. Manufacturers

- General: Provide integrated electrified door hardware and access control system equipment and accessories for each designated opening to comply with requirements in this Section and with the Access Control Hardware Sets listed at the end of Part 3.

1) Access Control Hardware Sets: Requirements for quantity, item, model, design, grade, finish, size, and other distinctive qualities of each type of electrified door and access control hardware are indicated in the Access Control Hardware Sets at the end of Part 3.

2) Named Manufacturer's Products: Product designation and manufacturers are listed for the purpose of establishing requirements.

- System Design: The equipment and materials supplied are standardized components regularly manufactured and utilized within the source manufacturer’s access control systems.

1) System components (electronic integrated locking hardware) to be non-proprietary in design and implementations, providing for an open protocol platform with multiple manufacturers having functional software capable of integrating with the hardware specified. The installed integrated product is to be part of a single, cohesive management and access control system.

- Substitutions: Requests for substitution and product approval for inclusive integrated electronic door hardware and access control systems in compliance with these specifications must be submitted in writing and in accordance with the procedures and time frames outlined in Division 01, Substitution Procedures. Approval of requests is at the discretion of the architect, owner, and their designated consultants.

- GMU currently uses the following Access Control and Site Management System Manufacturers
  1) RS2 Technologies. (Access Control System Control Processors, Reader Controllers, I/O Monitor/Control Modules, Entry/Display Terminals, Multiplexers, Channel Input/Output Modules, System Application Software)
  2) Mercury Hardware (Remote Card Readers)
  3) Sargent Manufacturing (Integrated Card Reader Locking Devices and Accessories)
  4) Altronix (Power Supplies)

12. Access Control and Site Management System Hardware

- General: Provide all necessary access control field hardware devices required to receive alarms and administer all access granted/denied decisions. Field hardware devices must be designed to meet UL 1076 and UL 294 standards and installed in accordance with applicable electrical codes.
  1) The access control system to interface and be connected to electronic door control hardware not specified in this section (electrified exit devices) and as described under Division 8 "Door Hardware".
- Central Computer Host Server (Owner Provided): The central server is interconnected to all system components, including client workstations and field installed controllers, providing operator interface, interaction, display, control, and real-time monitoring.
- System Control Processor Dual Reader Interface: The System Control Processor (SCP) Dual Reader Interface is a 32-bit micro-controller utilized as the enhanced management processor between down line access readers, input monitors and relay output modules, and the host system and software.

  The SCP Dual Reader Interface supports up to (2) security industry standard reader communication and control ports. Each port terminates with industry standard access control readers, data entry/display terminals (keypad with display), and/or integrated reader-in-trim locking units for authorized access and egress management. Each SCP access port will include supervised portal monitoring (door status), request to exit monitoring (manual or automated inputs) and electrified lock output control.

  The SCP must meet the following, minimum, design, and performance specifications.
  1) Internal memory minimum of 16 Mbytes with a minimum of 6 Mbytes of memory set aside for user configuration.
  2) Support for up to (32) I/O module addresses.
  3) Capacity for up to, and in any combination, 64 reader locations including status/ position monitoring, egress request automation and electric lock control, (512) input monitoring points, and (512) relay output points.
  4) User selection of serial, dial-up and/or Ethernet (TCP/IP) communications to the host computer with the specified system software. No external network card or attachment is required for the SCP to connect to the host system on a conventional Ethernet. Users have the ability to connect with the SCP using static IP or DHCP conventions.
  5) Provide 128-bit AES data encryption with the host system.

6) On-board Network Interface Circuit (NIC) supporting 10/100-BaseT automation.

7) Support a minimum of (8) active card formats per processor.

8) Support anti-pass back functions including free pass, exempt flags, last area accessed, last reader accessed and time and date of last access.

9) Support area management functions including two man rules, two card rules, multiple occupancy, maximum occupancy, and nested areas. Area management functions defined in minimum of (32) Access Area assignments per SCP. Access Areas shall be treated within the system as a single logical point and any controls applied manually or by automation will apply to all of the access points assigned within the Access Area.

10) Support alarm management functions incorporating inputs and reader events into Alarm Zones allowing the zones to be armed and disarmed creating various user definable events that are supported in SCP tasks and host macro processing. Support a minimum of 64 fully user configurable Alarm Zones per processor.

11) Alarm management to provide task as well as arm/disarm functionality using a standard keypad/display terminal/card reader with features for user command and key selection. Support down loads to the display of the keypad for date and time, zone status, error messages and special text messaging defined by the user.

12) Support up to (256) user definable tasks configured to execute pre-defined process commands in response to manual user commands, input or event changes, time zone activations, automated commands or Macro operations.

13) Support up to (256) user definable user commands configured to execute pre-defined process commands in response to manual user commands, input or event changes, time zone activations, automated commands or Macro operations.

14) Allow variable stored transaction storage from 1,000 to 100,000 events per SCP.

15) Allow variable local card database storage from 5,000 to 250,000 records per SCP.

16) Operational programming is stored in non-volatile Flash Memory allowing for on-line program upgrades.

17) Provide on board memory battery backup to retain all database information during a complete power loss for up to sixty (60) days, per manufacturer's specifications.

18) Provide ports for tamper and power failure notification.

19) Provide status LED's for heartbeat, battery status, upstream communication, and downstream communication.

20) Utilize two-wire RS-485 communications. The minimum data rate is 38,400KBps at IEEE standards for up to 4000 feet for interconnection to up to (31) access reader, monitor input and relay output modules.

The SCP Dual Reader to support the following:

21) Support up to (2) security industry standard readers, data entry/display terminals (keypad with display), and/or integrated reader-in-trim locking units for access or egress authorizations.

22) Reader ports to provide up to 150 mA of unregulated 12 VDC power for each reader. At a minimum card/data input support to be Wiegand, TTL or RS-485 format. Single and dual wire LED output provided supporting bicolor display and reader buzzer support.

23) Provide (8) on-board fully supervised monitoring points (inputs). Monitoring points configured as follows: (2) monitoring points dedicated for access portal status (door contact inputs) one per reader port. (2) monitoring points dedicated for exit request inputs (manual or automated egress) one per reader port. (4) monitoring points as auxiliary and fully user defined for monitoring other devices or points within the site.

24) Input monitoring point settings are user defined as normally open, normally closed, or supervised normally open or normally closed. At a minimum input supervision to be a series parallel 1/4W, 1%, 1K by 1K Ohm resistor circuit.

25) Provide (4) on-board output relays for controlling electrified devices or switching inputs. Relays configured as follows: (2) relays dedicated for electric portal locking device control one per reader port. (2) relays as auxiliary and fully user defined for controlling or switching other devices or points within the site.

26) Output relays are Form-C, 5A@30 VDC, resistive relays.

27) Output relays allow configuration for fail safe or fail secure operation and support ON, OFF, and PULSE, command states.

- Access Control Dual Reader Input/Output Module: System Control Processor (SCP) to provide distributed processing and management for each Dual Reader I/O Module incorporated in the system Dual Reader I/O Module to meet the following, minimum, design and performance specifications:

1) Support security industry standard magnetic, Wiegand, and proximity and specified biometrics readers.

2) Support integrated reader-in-trim locking units, keypads, and keypad readers.

3) Support connectivity and interface with system arm/disarm functionality using a standard keypad/display terminal/card reader with features for user command and key selection. Support down loads from the SCP to the display of the keypad for date and time, zone status, error messages and user defined special text messaging.

4) Hardware interface and card format settings to be loaded through software commands from the specified system software to associated SCP modules to each Dual Reader I/O Module.

5) Support up to (2) security industry standard readers, data entry/display terminals (keypad with display), and/or integrated reader-in-trim locking units access or egress authorizations.

6) Support different reader technologies on the same module, user defined.

7) Reader ports to provide up to 150 mA of unregulated 12 VDC power for each reader. At a minimum card/data input supports Wiegand, TTL or RS-485 format. Single and dual wire LED output shall be provided supporting bicolor display and reader buzzer support.

8) Provide (8) on-board fully supervised monitoring points (inputs). Monitoring points configured as follows: (2) monitoring points dedicated for access portal status (door contact inputs) one per reader port. (2) monitoring points dedicated

for exit request inputs (manual or automated egress) one per reader port. (4) monitoring points as auxiliary and fully user defined for monitoring other devices or points within the site.

9) Input monitoring point settings are user defined as normally open, normally closed, or supervised normally open or normally closed. At a minimum input supervision shall be a series parallel 1/4W, 1%, 1K by 1K Ohm resistor circuit.

10) Provide (6) on-board output relays for controlling electrified devices or switching inputs. Relays configured as follows: (2) relays dedicated for electric portal locking device control one per reader port. (4) relays as auxiliary and fully user defined for controlling or switching other devices or points within the site.

11) Output relays are Form-C, 5A@30 VDC, resistive relays.

12) Output relays to allow configuration for fail safe or fail secure operation and support ON, OFF, and PULSE, command states.

13) In the event of a communication failure with a System Control Processor (SCP), the Dual Reader I/O Module capable of locally processing access requests based on facility code verification.

14) Operational programming is stored in non-volatile Flash Memory allowing for on-line program upgrades.

15) Utilize two-wire, RS-485 communications with data rates up to 38,400KBps up to an IEEE standard of 4000 feet.

16) Up to (32) Dual Reader I/O Modules are allowed to connect with any SCP within the system.

- Access Control Panel Enclosures: Access control panel enclosures as required for the System Control Processors and Dual Reader Input/Output Modules must be approved to meet the design standards of GMU security personnel prior to being installed on-site. The access control panel enclosure to meet the following, minimum, design, and performance specifications.

1) NEMA Type 1 lockable enclosure, 36” x 24” x 5”.

2) Completely wired for board power, RS485 communications, and door control.

3) Complete wire management system.

4) 12/24 VDC 20 A power supply/charger with door control relay board and fire alarm interface.

5) 110 VAC Dual outlets with illuminated reset switch/breaker.

6) Each Panel must include a sticker inside the enclosure listing the following:

a. Vendor name, Installation Date, Service Phone number

b. Warranty expiration dates for both parts and labor

- On-Line Wireless (Wi-Fi) Networked Locking Mortise Devices:

1) Mortise Lockset: BHMA certified extra heavy duty, lever type mortise lock conforming to ANSI 156.13 Series 1000, Grade 1 standard and meeting ANSI A117.1 accessibility guidelines. Motorized locking control with 3/4" anti-friction deadlocking latch and 1" case-hardened steel deadbolt. UL listed and labeled for up to 3 hour fire rated openings. Locks must include the latest version of firmware from the vendor BEFORE installation at the job site.

2) Completely intelligent and integrated locking unit with on-board memory and network communication capability directly from the lock back to the central system server via an 802.11b/g wireless network.

   a. Communication from the lock back to the central system server does not require additional access control hardware or components to be able to interface into the network (excluding wireless access point).

3) Networked locks are able to read, analyze, and control access to level of authorization encoded on keycard. Centralized control allows updating of user permissions, and retrieval of audit trails (event history) and alarm reporting over a communication network without having to visit each lock unit.

   a. Users per door: 2,000.

   b. Audit trail maintained by lock: 10,000 events

   c. Time schedules: 32

   d. User Groups: 32

   e. Exception Periods (holidays): 64

4) Access by vertical swiping of magnetic stripe card and/or keypad pin number or by vertical swiping of magnetic stripe card only.

   a. Card track: Track 2

5) Monitoring and Signaling: Latch bolt, auxiliary latch, request-to-exit, door position status (requires hard wiring option). Provide alarm monitoring capability including door forced, door propped, access denied, and low battery condition.

6) Emergency override access capability through system-generated special access keycards and keypad codes, which are time, date, and location specific.

   a. Provide mechanical key override capability with no electronic activation necessary for latch or lock retraction.

   b. Deadbolt overriding capability available from outside on any level keycard, keypad code, or mechanical key.

   c. ALL mortise cylinders must accept the "BEST" 7-Pin interchangeable cores

7) Inside lever retracts latch bolt and deadbolt simultaneously.

8) Locks to be water resistant on external installations with keypads having all metal external parts.

9) Power Supply: 6 AA alkaline batteries with a minimum typical life cycle of 1 to 3 years (approximately 65,000 transactions) depending on usage. Supervised with advance low capacity warning. Hard wiring power option available.

   a. Batteries and electronics, except card reader heads and keypads, to be sealed on secure side of door for security and exposure to weather.

10) Wireless Radio Requirements:

   a. Comply with IEEE 802.11b/g Wi-Fi standard for Wireless LAN communications.

   b. All wireless locks MUST be WPA2 compatible

c. Frequency Range: Worldwide product covering 2.4 to 2.5 GHz, programmable for different country regulations.

d. Maximum Output Power: 100 mW.

e. Power Management: Continuous aware power saving polling mode.

f. Supports AES-128 encryption for end-to-end link security.

g. 802.11b/g Wireless Access Point by Owner.

- On-Line Wireless (Wi-Fi) Networked Locking Cylindrical Devices:

1) Bored (Cylindrical) Lockset: ANSI/BHMA A156.2 Grade 1 bored lockset with integrated magnetic stripe card reader and request to exit signaling in one complete unit. Motor driven locking/unlocking control of the lever handle trim with ½ " deadlocking stainless steel latch lock is UL listed and labeled for use on up to 3 hour fire rated openings. Locks must include the latest version of firmware from the vendor BEFORE installation at the job site.

2) Completely intelligent and integrated locking unit with on-board memory and network communication capability directly from the lock back to the central system server via an 802.11b/g wireless network.

a. Communication from the lock back to the central system server does not require additional access control hardware or components to be able to interface into the network (excluding wireless access point).

3) Networked locks are able to read, analyze, and control access to level of authorization encoded on keycard. Centralized control allows updating of user permissions, and retrieval of audit trails (event history) and alarm reporting over a communication network without having to visit each lock unit.

a. Users per door: 2,000.

b. Audit trail maintained by lock: 10,000 events

c. Time schedules: 32

d. User Groups: 32

e. Exception Periods (holidays): 64

4) Access by vertical swiping of magnetic stripe card and/or keypad pin number or by vertical swiping of magnetic stripe card only.

a. Card track: Track 2.

5) Monitoring and Signaling: Provide alarm monitoring capability including door forced, access denied, and low battery condition.

6) Emergency override access capability through system-generated special access keycards and keypad codes (with keypad module (optional,)) which are time, date, and location specific.

a. Provide mechanical key override capability with no electronic activation necessary for latch or lock retraction.

b. ALL key override capabilities must accept the "BEST" 7-Pin interchangeable cores.

7) Locks to be water resistant on external installations with keypads having all metal external parts.

8) Power Supply: 6 AA alkaline batteries with a minimum typical life cycle of 1 to 3 years (approximately 65,000 transactions) depending on usage. Supervised with advance low capacity warning. Hard wiring power option available.

   a. Batteries and electronics, except card reader heads and keypads (if chosen,) to be sealed on secure side of door for security and exposure to weather.

9) Wireless Radio Requirements:

   a. Comply with IEEE 802.11b/g Wi-Fi standard for Wireless LAN communications.

   b. All wireless locks MUST be WPA2 compatible

   c. Frequency Range: Worldwide product covering 2.4 to 2.5 GHz, programmable for different country regulations.

   d. Maximum Output Power: 100 mW.

   e. Power Management: Continuous aware power saving polling mode.

   f. Supports AES-128 encryption for end-to-end link security.

   g. 802.11b/g Wireless Access Point by Owner

- Remote Card Readers: Access control remote card readers to interface with the access control reader modules and the door control hardware as specified in the Access Control Hardware Sets under Part 3. Card readers to meet the following, minimum, design, and performance specifications.

  1) Reader technology to be either magnetic stripe as required by Owner.

  2) Reader to be weatherproof type when installed in exterior or other wet environments.

  3) Reader to communicate with the reader I/O modules using industry standard Wiegand protocol interface.

  4) Reader to operate on 5VDC power from the reader I/O modules at a maximum current rating of 150 mA per reader.

  5) Card reader type and model to meet the design application need of each entry point as indicated on the drawings.

  6) Card readers will have an integrated tamper switch.

  7) All card readers must be installed with appropriate security screws

- Power Supplies: Provide UL294 and UL1481 Listed 12VDC or 24VDC (field selectable) filtered and electronically regulated power supplies. Provide the least number of units, at the appropriate amperage level, sufficient to exceed the required total draw for the specified electrified hardware and access control equipment.

  1) Provide short circuit and thermal overload protection.

  2) Provide battery backup with built-in charger for sealed lead acid or gel type batteries. Battery backup shall provide enough power for up to 1 hour of normal operation.

  3) Provide automatic switch over to stand-by battery when AC fails with zero voltage drop.

4) Provide low battery, battery presence, and AC fail supervision (form “C” contacts).

5) Rated for Fail-Safe and/or Fail-Secure operation.

6) Provide separate power supplies for locking power and control panel power.

13. Access Control and Site Management System Application Software

- The access control application software provides the interface for control and configurations of all access control points, monitors input points, and relay controlled outputs as indicated on the drawings and described in this specification.
- The basic access control application software for this project will tie into the existing campus wide system. Any licensing fees as required to expand the existing campus wide system are to be included as part of the turnkey system provided within this specification. At a minimum, vendor must provide 2 additional seat licenses to GMU.

14. Cables and Wiring

- Comply with Division 28 Section "Conductors and Cables for Electronic Safety and Security."
- All Access Control low voltage wire will be furnished and installed by Section 281300 Security Contractor.
- All low voltage wire shall be plenum rated and terminated at all door and panel locations.

15. Hardware Finishes

- Standard: Comply with BHMA A156.18.
- Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- Where specified, finishes on integrated card key locksets or exit hardware to incorporate an FDA recognized antimicrobial coating (MicroShield™) listed for use on equipment as a suppressant to the growth and spread of a broad range of bacteria, algae, fungus, mold and mildew.
- BHMA Designations: Comply with base material and finish requirements indicated by the following:

1) BHMA 626: Satin chromium plated over nickel, over brass or bronze base metal.

2) BHMA 628: Satin aluminum, clear anodized, over aluminum base metal.

3) BHMA 630: Satin stainless steel, over stainless-steel base metal.

16. Execution

- Examine scheduled openings, with Installer present, for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance of the installed access control system.
- Examine roughing-in for electrical source power to verify actual locations of wiring connections before electrified and integrated access control door hardware installation.
- Examine pathway elements intended for cables. Check raceways and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation.

- Examine roughing-in for LAN and control cable conduit systems to PCs, controllers, card readers, and other cable-connected devices to verify actual locations of conduit and back boxes before device installation.
- Notify architect of any discrepancies or conflicts between the specifications, drawings, and scheduled access controlled hardware. Proceed only after such discrepancies or conflicts have been resolved in writing.

17. Preparation

- Doors and frames at scheduled access controlled openings to be properly prepared to receive specified electrified and access control hardware and connections.

18. Installation

- Install each item of electrified door hardware and access control equipment to comply with manufacturer's written instructions and according to specifications.
- Mounting Heights: Mount integrated access control door hardware units at heights indicated in following applicable publications, unless specifically indicated or required to comply with governing regulations:
  1) Standard Steel Doors and Frames: DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."
  2) Wood Doors: DHI WDHS.3, "Recommended Locations for Architectural Hardware for Wood Flush Doors."
  3) Where indicated to comply with accessibility requirements, comply with ANSI A117.1 "Accessibility Guidelines for Buildings and Facilities."
- Boxed Power Supplies: Verify locations.
  1) Configuration: Provide the least number of power supplies required to adequately serve doors with access control equipment.
- Install cables and wiring according to requirements in Division 28 Section "Conductors and Cables for Electronic Safety and Security."
  1) RS-232 Cabling: Install at a maximum distance of 50 feet.
  2) RS-485 Cabling: Install at a maximum distance of 4000 feet.
  3) Integrated Card Key Locking Hardware, Remote Card Readers, Keypads, and Display Terminals: Install appropriate number of conductor pairs, in the wire gage (AWG) recommended by manufacturer, corresponding to the electronic locking functions specified, amperage drawn, and distances covered between the power supplies, transfer hinges, electrified hardware, and access control equipment.
  4) All low voltage wire shall be plenum rated
- Final connect the system control switches (integrated card key locking hardware, remote readers, keypads, display terminals, biometrics), and monitoring, and signaling equipment to the related Controller devices at each opening to properly operate the electrified door and access control hardware according to system operational narratives.
- System Application Software: Install, and test application(s) software and databases for the complete and proper operation of systems involved. Assign software license(s) to Owner.

19. Field Quality Control

- Comply with AIA A201 1997, section 3.3.1, which reads as follows: "The Contractor shall be solely responsible for and have control over construction means, methods, techniques, sequences and procedures and for coordinating all portions of the Work under the Contract, unless the contract Documents give other specific instructions concerning these matters."
- Field Inspection: Engage a factory authorized service representative to perform a final inspection of the installed electrified door hardware and integrated access control system and state in report whether installed work complies with or deviates from requirements, including whether each component representing the opening assembly is properly installed, adjusted, operating and performing to system operational narratives.
- Commissioning and Testing Schedule: Prior to final acceptance of the access control system installation, the following testing and documentation will be performed by the integrator and the final results provided to the Owner.
    1) Inspection: Verify that units and controls are properly installed, connected, and labeled and that interconnecting wires and terminals are identified.
        a. Each reader input will be labeled with the appropriate door number
        b. Any auxiliary inputs and outputs will be labeled
        c. Power Supply location and outputs will be labeled
        d. Each Panel must have a typed address list of readers and boards located inside the panel. Listing will include: reader ID/Door number; Address; Fail Safe/Secure; Any special configurations; and locations of any external power supplies, if applicable. In addition, these lists will be duplicated and turned over to the owner for record.
    2) Pre-testing: Program and adjust the system and pretest all components, wiring, and functions to verify they conform to specified requirements. Provide testing reports indicating devices tested, pass/fail status, and actions taken to resolve problem(s) on failed tests. Items required to be tested includes, but not limited to, all door lock hardware, readers, REX, door contacts and relays
    3) Acceptance Test Schedule: Correct deficiencies identified by tests and observations and retest until specified requirements are met.
    4) Provide “as designed” drawings showing each device and wiring connection and electronic enclosure legends indicating cabling in and out.
    5) Provide a complete set of operating instructions for access control hardware devices and a complete software user manual. The documentation includes module reference guides for each electronic enclosure.

20. Adjusting

- Adjust and check each operating item of integrated access control door hardware, and each door opening to ensure proper secured operation and function of every unit. Replace units that cannot be adjusted to operate as intended.
- One week before student occupancy, vendor is required to run a battery report on all wireless locks installed and replace any batteries that have less than 25% battery life remaining with fresh, new batteries.

21. Cleaning And Protection

- Clean adjacent surfaces soiled by access control system installation.

- Clean operating items as necessary to restore proper finish and provide final protection and maintain conditions that ensure access control door hardware is without damage or deterioration at time of owner occupancy.
- One week before occupancy, Vendor is required to clean all card readers with a manufacturer approved cleaning device. Normally, alcohol cleaning cards are used for this purpose.

22. Demonstration
    - Engage a factory-authorized representative to train Owner's maintenance personnel to adjust, operate, and maintain electrified door hardware and the integrated access control system.
23. Access Control System Hardware Sets
    - The access control system hardware sets listed below represent the design intent and direction of the owner, architect, and security consultant (if applicable). They are intended as a guideline only and should not be considered a detailed opening schedule. Discrepancies, conflicting, and missing items should be brought to the attention of the architect with corrections made prior to the bidding process.
24. Inventory
    - EAC Contractor shall provide 1,000 magnetic stripe cards to the owner for inventory.
    - EAC Contractor shall provide 50 read head cleaning cards to the owner for inventory.
    - EAC Contractor shall provide for owner stock each installed item in Section 2.3 totaling 2% of the total of each type installed, not less than 1 of each type to the owner.
    - Provide 1 electronic key/card machine that accepts Best interchangeable cores and internal storage of key cards. Key box must hold 8 hard keys and 8 key cards. Electronic key box must use dual validation via PIN pad and card swipe access to remove keys/cards. See keystorage.com for more information

END OF SECTION 281300

SECTION 28 23 00 VIDEO SURVEILLANCE

1. Related Documents
    - Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
2. Summary
    - An IP, PoE, Closed Circuit Television (CCTV) system. Number of cameras will be equal to or greater than 1 camera per 2,700 square feet of total gross building space. There also will be one NVR for each set of 32 cameras. Include all software and licensing to make the system useable. Cameras are also required in each elevator. Owner will approve final camera layout.
    - This camera specification of H.264 (MPEG 4, Part 10) must provide a minimum 1280 x 1024 megapixel (1.3 megapixel camera) resolution with minimum video frame rates of 24fps.
3. Performance Requirements

- Delegated Design: Design this project element, including comprehensive engineering analysis by a qualified design professional, to meet or exceed the program requirements, performance requirements, code compliance, applicable ASTM quality standard, and design criteria as outlined and / or referenced within this RFP package.

4. Quality Assurance

- Comply with NFPA 70, National Electrical Code.

5. Video Management System

- Video Management System - Software Overview

1) The Video Management System (VMS) software shall be used to view live and recorded video from capture cards and IP devices connected to local and wide area networks. The VMS software shall have a client/server-based architecture that can be configured as a standalone VMS system with the client software running on the server hardware and/or the client running on any network-connected TCP/IP workstation. Multiple client workstations shall be capable of simultaneously viewing live and/or recorded video from one or more servers. Multiple servers shall also be able to simultaneously provide live and/or recorded video to one or more workstations. The VMS server software shall also have the ability to be installed on an IP edge device—such as an IP camera or encoder that allows for 3rd party applications—allowing the device to serve as both a server and IP video recording device.

2) The VMS shall not charge for the number of concurrent clients.

3) The VMS system shall utilize manufacturer built servers, commercial-off-the-shelf (COTS) computer workstations, servers, IP edge devices that allow for third-party application installation, networking devices and storage equipment.

4) Recording of all video transmitted to the VMS shall be continuous, uninterrupted, and unattended.

5) The VMS system shall offer the capability of video motion detection recording, such that video is recorded when the NVRMS detects motion within a region of interest of the camera's view. Video prior to the detection of the motion shall also be stored with recording using the pre-recorded feature.

6) The VMS system shall manage the video it has been configured to monitor. Loss of video signal shall be configured to annunciate on VMS client by an on-screen visual indication alerting operators of video loss.

7) The VMS software shall have an open architecture supporting IP cameras and encoders from multiple manufacturers providing best-of-breed solutions ranging from low-cost, entry-level features to high-resolution, megapixel features.

8) The VMS client software shall be able to view live video and audio, recorded video and audio and be able to configure the complete system all from a single application.

9) The VMS shall continue to record video and audio at all times during the administration and configuration of any feature.

10) The VMS client software shall have the same functionality when connected remotely as it does when it is run locally on the same computer as the server software.

11) The VMS client software shall add and remove features based on the permissions of the user and the licensed functionality.

12) The VMS client software shall operate on all of the following operating systems:

a. Microsoft Windows Server 2003/2008

b. Microsoft Windows XP (all versions)

c. Microsoft Windows Vista (all versions)

d. Microsoft Windows 7 (all versions)

e. Linux Ubuntu 8.04/10.04 Debian Package

f. Mac OSX (operating on Intel CPU)

13) The VMS software shall allow the user to have any combination of VMS client applications running on any of the supported operating systems and be able to connect to any of the VMS servers running on any of the supported operating systems. For example, a VMS client running on Microsoft Windows 7 shall be able to simultaneously connect to four (4) different VMS servers all running on different operating systems, such as Windows Server 2003, Windows XP, Vista, and Linux.

14) The VMS software shall have the capability to run multiple client applications simultaneously on one workstation with multiple monitors. Up to 12 monitors shall be configured on a single workstation with one (1) client application running on each monitor. Because decompressing video is CPU-intensive, the PC workstation shall have multiple core processors with a recommendation of one core for each VMS client application.

15) The VMS shall also allow an authorized user to view video through a web client interface. The web client interface shall allow authorized users to view live video; view recorded video, control pan-tilt zoom (PTZ) cameras and activates triggers. The web client interface shall allow connections to multiple VMS servers simultaneously.

16) The web client interface shall operate without requiring installation of any software.

17) When using the web client interface, the VMS server shall transcode the video into a JPEG file of the size as the browser screen before sending it to the browser.

18) The web client interface shall support the following browsers:

a. Internet Explorer 6 and later

b. Firefox 2 and later

c. Opera 9 and later

d. Safari and later

e. Chrome

f. The web client interface shall also connect with non-JavaScript browsers and shall be compliant with HTML 4.0 (www.w3.org).

19) The VMS server software shall record and retrieve video, audio and alarm data and provide it to the VMS clients upon request.

20) The VMS software shall provide at no additional charge a purpose built mobile application capable of viewing multiple simultaneous live video streams and

playing a recorded video stream. Application shall be provided for both iOS and Android operating systems (including Kindle Fire).

21) The VMS server software shall operate on any of the following operating systems:

a. Microsoft Windows Server 2003/2008

b. Microsoft Windows XP (all versions)

c. Microsoft Windows Vista (all versions)

d. Microsoft Windows 7 (all versions)

e. Linux Ubuntu 8.04/10.04 Debian Package

22) The VMS server shall not decode video for the purpose of motion detection.

23) The VMS server shall not decode video for the purpose of repacking it for transmission to clients.

24) The VMS server software shall record video based on metadata generated by an edge network device. The edge network devices shall generate the metadata and transmit it with the video stream to the VMS server software.

25) The VMS shall license the total number of cameras on the system. This license shall be based on the MAC address of a single network card that is present on the system. The VMS shall only require that this network card be enabled and does not require that data is actually sent through it.

26) The VMS shall not require the manufacturer to be contacted when a camera fails.

27) The VMS server software shall run as a service. The VMS shall not require any application to be running in order to operate.

28) The VMS shall be able to use the Active Directory or LDAP features of a network to authenticate users and determine which permissions they will have on each server.

29) The VMS shall allow for a user's permissions to be configured across multiple servers from a single screen.

30) The VMS shall allow the use of maps. The maps will be accessible to users with the appropriate permission levels and display video sources and their status.

31) The VMS shall allow maps to be embedded inside of maps (i.e. hierarchical or nested maps). When an event happens on a map that is embedded inside of a map, it shall transmit the alert to all parent maps and change the color of the icon on the parent map and all subsequent parent maps.

32) The VMS allows soft triggers to be placed, viewed, and triggered from a map.

33) The VMS shall have a single page that displays the status of all servers and cameras currently connected. This page shall display any alarms, events, MAC addresses, camera configuration, format and frame rate from each individual camera.

34) The VMS shall support the use of a panoramic lens on an analog or IP camera. The VMS client shall de-warp the image on both live and recorded video.

35) The VMS software shall have three methods of allowing third-party integration: command line, API, and web SDK. The command line shall allow for the most

basic of interfaces, calling up the appropriate video when requested using command line functionality. The API shall allow for a deeper interface, allowing video to be transmitted from the VMS software into the party software interface. The web SDK shall use the web server to transcode the video and send it to the third-party software interface. The web SDK method shall use standard HTML, XML, CGI, and JavaScript commands.

- Video Management System - Software Features

1) When in live display mode, the user shall be able to view live video, live audio, point of sale (POS) data and alarm information.

2) The VMS shall be able to organize the camera video view panel in the following patterns:

   a. 1-camera (full-screen) layout

   b. 4-camera (2x2) layout

   c. 8-camera (3 large views and 4 small views) layout

   d. 10-camera (2 large views and 8 small views) layout

   e. 13-camera (1 large view and 12 small views) layout

   f. 16-camera (4x4) layout

   g. 8-camera (1 very large view and 7 small views) layout

   h. 9-camera (3x3) layout

   i. 6-camera (2x3) widescreen layout

   j. 12-camera (4x3) widescreen layout

   k. 20-camera (5x4) widescreen layout

   l. 30-camera (6x5) widescreen layout

   m. 48-camera (8x6) widescreen layout

3) The VMS shall allow the customization of the user interface to allow software triggers to be shown. This shall allow them to activate events through the push of a button, which could trigger recording, PTZ presets, output triggers, or email.

4) The VMS shall allow the user to pick their own icon and select the software triggers to display in the client. The VMS shall also display the status of any soft triggers on connected VMS servers.

5) The VMS software shall allow control of PTZ cameras to authorized users and be used to maneuver a PTZ camera. When used on a non-PTZ camera, it shall allow you to digitally pan, tilt, and zoom on any video whether in live or recorded mode.

6) The VMS shall allow following methods of controlling a PTZ camera to be available:

   a. PTZ graphics control windows

   b. Live graphic overlay PTZ control icons

   c. Keyboard control (up, down, left, right arrows; page up, page down for zoom)

   d. PTZ presets

e. Digital PTZ

f. USB joystick to control PTZ cameras

g. Proportional PTZ control by clicking the mouse in the center and moving it

7) The VMS software shall allow virtual matrix functionality by designating a cell to do so. This video cell shall automatically show video as it is triggered.

8) The VMS software shall have a feature for viewing logical groups of cameras. This shall allow efficient viewing of cameras in a logical order.

9) The VMS software shall have a feature to organize your cameras into preset views. Views are preconfigured arrangements of the video panels so that they may be easily recalled later. A view can save the location of the video streams, audio streams, POS data, maps, and event views. These views shall be accessible in both live and recorded video modes.

10) The VMS software shall have the capability to automatically cycle through two or more saved views to create a video tour. The VMS shall allow the configuration of the dwell time and the different views it shall use.

11) The VMS client software shall be used to search for and play back recorded video, audio, and events from VMS servers.

12) The VMS software shall have the capability to search for and play back video from multiple cameras simultaneously. All recorded video shall be played back and displayed in a synchronized multi-camera layout.

13) The VMS software shall support searching through recorded video based on time, date, video source, and image region and have the results displayed as both a clickable timeline and a series of thumbnail images.

14) The VMS software shall allow search and play back of audio in synchronization with video.

15) The VMS software shall allow you to search on a specific area of recorded video and only display the frames where motion happened in that area.

16) The VMS software shall have the capability to export video, maps, POS data and audio files.

17) The VMS software shall provide the option of exporting the file in the following formats:

a. Standalone Exe (*.exe) – includes an executable player with the video and audio data

b. AVI File (*.avi) – a multimedia container format

c. PS File (*.ps) – a format for multiplexing video and audio

d. QuickTime File (*.mov) – native for Macintosh computers

18) The VMS standalone player shall package all of the exported video into a single executable. The VMS standalone player shall be able to authenticate that the video has not been tampered with using a keyed Hash Message Authentication Code (HMAC).

19) The VMS client software shall be able to connect to multiple systems simultaneously. Each of the systems could have individual permissions, thereby

limiting the client's configuration or viewing abilities for that system, but not affecting the abilities on the other systems.

20) The VMS system shall be able to display system information about users that are currently logged into the system, plug-in file version information number, and status, and a system log that contains a detailed history of the processes that occur on the system.

21) The VMS system shall have the ability to record an audit trail of when users log in that shows what changes they have made, what video they have viewed and what they have exported.

22) The VMS system shall allow the configuration of the video devices to be performed in the client and pushed out to the devices. The configuration itself is stored both on the camera and on the VMS.

23) The VMS shall allow monitoring of the inputs on both network devices and on manufacturer provided hardware. The VMS shall also allow triggering of outputs on the network devices and manufacturer provided hardware.

24) The VMS shall allow for the configuration of what drives to use for recording video. Those drives may be local drives, direct attached storage drives or iSCSI drives.

25) The VMS shall allow for the configuration of rules of how to record the video. These rules shall allow you to set a maximum number of days or minimum number of days on a per video stream basis.

26) The VMS shall not require a database when recording video.

27) The VMS shall use the operating systems native file system for recording the video. For example, if there was video that was recording on March 1, 2012 from 10:00 AM to 10:35 AM. Files for that day would be in the data drive, in the path 2012 for year, subfolder 03 for the month, with a sub folder 1st for the day, and then the 10 sub-folder for the hour. So when the client sends a request to search for video, the VMS shall look in the D:\2012\03\01\10 directory. Each video stream shall be kept in 5-minute increments in a paired video and index file. The video file shall contain the data of the video, audio, and include Meta data. The index file shall contain the index of the metadata from the network device. So when the VMS searches for the video, it shall gather up the information in the index files and display those results. When the client then requests to display the video, the VMS will then transmit the video file data from the server to the client.

28) The VMS shall have the ability to receive ASCII data through the COM port on the server or over the network.

29) The VMS shall have the ability to look for keywords in the ASCII data and use these to execute various events such as PTZ presets, recording video, recording audio and sending email notifications.

30) The VMS software shall be able to send a predefined email based on an event trigger. The VMS software shall also support SSL and TLS connections for transmissions of the mail.

31) The VMS software shall have a feature to export a video segment from specific cameras or audio inputs to a CD or DVD upon an input trigger or other event being activated.

32) The VMS software shall be used to connect different types of events, such as input triggers, to a desired action such as recording video or triggering an alarm. The VMS software shall recognize the following event types:

a. Video Motion

b. Video Loss

c. Input Trigger

d. POS Port

e. POS Profile

f. Health

g. IP Camera Connection

h. Software Trigger

i. Analytics

33) The VMS software shall be able to execute the following action types:

a. Record Video

b. Output Trigger

c. Output Video

d. Send an email

e. Burn a CD/DVD

f. Call a PTZ Preset

34) The VMS software shall have the ability to configure each video input's recording time on an hourly basis. This shall allow the user to schedule when to record on motion, when to record on event and when to not record.

35) The VMS shall use a combination of a user name and a password to authenticate the user's permission level.

36) The VMS shall allow granularity of permissions by creating custom user groups. The members of these custom user groups shall all have the same permissions.

37) The VMS client shall be able to use OpenGL and Direct 3D to decompress and render video.

38) The VMS shall allow the user to perform a visual thumbnail search. The user can select one camera to see one image per set time period. The user shall be able to play video from that image or zoom in to a time range.

39) The VMS client can be configured to automatically switch views on any trigger within the event monitoring function.

- Server Network Video Recorder Hardware Features

1) The server hardware shall operate on either the Microsoft XP Pro or Linux operating systems.

2) The server shall be capable of simultaneously recording, displaying, and playing back digitized video from IP cameras and analog cameras through the use of a video encoder. IP Server models shall be capable of being licensed to add IP cameras in increments from one (1) to 64 camera licenses.

3) The server shall support recording resolutions from CIF to 20 megapixel (camera dependent) and shall be user selectable. MJPEG, MPEG-4, and H.264 video compression format shall be user selectable depending on the IP camera configured to the IP Server. Video recording shall be available at up to 30 images per second per input channel depending on IP camera type selected.

4) Each server shall have serial port capabilities to communicate with serial devices such as point of sale (POS) terminals and automated teller machines (ATM). Once the serial device is connected to the serial port with a cable the serial port shall be configured. Transaction data shall be received from each serial device into a text database and associated with recorded video. User shall be able to search transaction data to locate the associated video.

5) Each server shall have a serial port capable of communicating with pan-tilt-zoom (PTZ) cameras.

6) Each server shall have two Gbit 1000Base T RJ-45 Ethernet connections for networking to Remote PC clients. Multiple servers shall be accessible by multiple clients located anywhere on the network. Each server shall record video, audio, and text while displaying live video or playback video. In the event that there is no client actively attached to the server, the server shall continue to record video and audio, monitor events and all other server functions.

7) Recorded video shall be triggered by the motion detection sensor of the IP camera, an external input device, or in continuous record mode.

8) Each server shall have the capability of automatically exporting a predetermined time frame of video to the internal DVD/CD device upon an external trigger input connected to the server. Such input shall export to the DVD/CD device a user defined amount of video and video camera source both pre and post event schedulable to the maximum capacity of the DVD/CD media selected.

9) Each server shall have the ability to link specific events in an "if-then" scenario. Linked events types shall include video motion, video loss, input trigger, POS port, POS profile, and temperature. Sources of these events shall be any camera connected to the specific server. Action from these events shall include record video, record audio, enable output trigger, output video, notify (send e-mail), and output video to DVD.

10) The server hardware shall have an internal DVD/CD device that will allow the server to export video clips to the device in Standalone.Exe (*exe), AVI files (*.avi) and PS files (*ps) formats.

11) A RAID-5 option shall be available consisting of a 4U chassis and eight hot swappable hard drives. The RAID-5 option shall be internal to the server and shall provide notification of a drive failure to the administrator.

- Specifications And Model Numbers

1) 2U Rack mount IP Server

a. All 2U Rack mount Servers shall have the following specifications:

- Dimensions (L x W x H): (21.25" x 16.75" x 3.5") (54.7 x 42.6 x 8.9 cm)
- Weight: 27 – 31 lbs. (12.3 – 14.1 kg)
- Input Voltage: 120/240 VAC auto-sensing
- Power Consumption: <250 watts (150 watts typical)

- Video Standard: NTSC (30ips) or PAL (25ips)
- Recording Resolution: CIF to 20 megapixel (camera dependent)
- Compression: MJPEG, MPEG-4 or H.264 by camera or encoder
- Alarm Inputs: 8 optional
- Alarm Outputs: 8 optional
- Serial Connections: 1 serial port
- NIC: 2 Gbit 1000Base T RJ-45 (standard), 4 (optional)
- USB 2.0 Ports: 6 (6 x USB 2.0)
- Audio Inputs: 4 optional
- Hard Drive Storage: Enterprise Class (see models below)
- VGA Output: 1 VGA + 2 HDMI 1.4 (including DVI-D converter), maximum 2 simultaneous monitors
- Keyboard & Mouse: Included
- DVD/CD RW: Included, front panel access
- Operating System: Windows 7 Pro or Server 2008 on 30 GB HDD PartitionO
- Operating Temperature: 40° – 95°F (4.5° – 35°C)
- Relative Humidity: 5 – 95% RH (non-condensing)

b. In addition to the specifications listed above, each 2U Rack mount IP Server shall have unique features defined by the hard disk storage capacity described below:

- IPS-0500-R2 500GB
- IPS-1000-R2 1 TB
- IPS-2000-R2 2 TB
- IPS-3000-R2 3 TB
- IPS-4000-R2 4 TB
- IPS-6000-R2 6 TB

c. 4U Rack mount IP Server

d. All 4U Rack mount IP Servers shall have the following specifications:

- Dimensions (L x W x H): (28” x 16.75” x 7.0”) (71.2 x 42.6 x 17.8 cm)
- Weight: 44 – 60 lbs. (20 – 27.3 kg)
- Input Voltage: 120/240 VAC auto-sensing
- Power Consumption: 500 watts
- Recording Resolution: CIF to 20 megapixel (camera dependent)

- Compression: MJPEG, MPEG-4 or H.264 by camera or encoder
- Alarm Inputs: 8 optional
- Alarm Outputs: 8 optional
- Serial Connections: 1 serial port
- NIC: 2 Gbit 1000Base T RJ-45 (standard), 4 (optional)
- USB 2.0 Ports: 6 (6 x USB 2.0)
- Audio Inputs: 4 optional
- Hard Drive Storage: Enterprise Class (see models below)
- VGA Output: 1 VGA + 2 HDMI 1.4 (including HDMI-DVI-D converter), maximum 2 simultaneous monitors
- Keyboard & Mouse: Included
- DVD/CD RW: Included, front panel access
- Operating System: Windows 7 Pro or Server 2008 on 30 GB HDD Partition
- Operating Temperature: 40° – 95°F (4.5° – 35°C)
- Relative Humidity: 5 – 95% RH (non-condensing)

e. In addition to the specifications listed above, each 4U Rack mount IP Server shall have unique features defined by the hard disk storage capacity described below:

- IPS-8000-R4 8 TB
- IPS-010T-R4 10 TB
- IPS-012T-R4 12 TB
- IPS-014T-R4 14 TB
- IPS-016T-R4 16 TB

f. All 4U Rack mount RAID-5 IP Servers shall have the following specifications:

- Dimensions (L x W x H): (28” x 16.75” x 7.0”) (71.2 x 42.6 x 17.8 cm)
- Weight: 44 – 60 lbs. (20 – 27.3 kg)
- Input Voltage: 120/240 VAC auto-sensing
- Power Consumption: <250 watts (150 watts typical)
- Recording Resolution: CIF to 20 megapixel (camera dependent)
- Compression: MJPEG, MPEG-4 or H.264 by camera or encoder
- Serial Connections: 1 serial port
- NIC: 2 Gbit 1000Base T RJ-45 (standard), 4 (optional)

- USB 2.0 Ports: 6 (6xUSB 2.0)
- Hard Drive Storage: Enterprise Class (see models below)
- VGA Output: 1 VGA + 2 HDMI 1.4 (including HDMI-DVI-D converter), maximum 2 simultaneous monitors
- Keyboard & Mouse: Included
- DVD/CD RW: Included, front panel access
- Operating System: Windows 7 Pro or Server 2008 on 30 GB HDD Partition
- Operating Temperature: 40° – 95°F (4.5° – 35°C)
- Relative Humidity: 5 – 95% RH (non-condensing)

g. In addition to the specifications listed above, each 4U Rack mount RAID5 Server shall have unique features defined by the hard disk storage capacity described below:

- IPS-4000-R4-RAID5 3 TB
- IPS-6000-R4-RAID5 5 TB
- IPS-8000-R4-RAID5 6 TB
- IPS-010T-R4-RAID5 8 TB
- IPS-012T-R4-RAID5 10 TB
- IPS-014T-R4-RAID5 12 TB
- IPS-016T-R4-RAID5 14 TB

- Certifications

1) CE and FCC, Class A (all models)

- Warranty

1) 3-year warranty on parts and labor and a 3-year Software Subscription Agreement (SSA)

- Video Management System Hardware

1) Minimum Server Requirements: The VMS client software shall operate on the following minimum requirements:

a. Processor: Intel® Atom® D525 1.8GHz or higher

b. Graphics: 1280 x 1024 x 32 bits

c. RAM: 1GB

d. NIC: 1x100 Mbps (minimum), 1 Gbps (preferred)

e. Hard Disk: 80GB Serial ATA drive

f. Operating Systems:

- Microsoft® Windows 2003 Server (or)
- Microsoft® Windows 7 (all version)

2) Minimum Client Requirements

a. Processor: Intel® Atom D525 1.8 GHz or greater

b. Graphics: 1280x1024x32 bits

c. RAM: 1 GB

d. NIC: 10/100/1000 baseT Ethernet

e. Disk Drive: Western Digital Enterprise Class drive (RE4 or better), or Seagate Barracuda ES.2 Drives or better

f. Operating Systems:

- Microsoft Windows XP (all versions) or higher
- Linux Ubuntu 8.04 or higher
- Mac OSX 10.4 or higher

3) Recommended Server Requirements

a. Processor: Intel® Core i7-2600 Processor, 3.4 GHz or Xeon E3-1220

b. Graphics: 1280x1024

c. RAM: 4 GB

d. NIC: 2x1Gbps (minimum), 4x 1 Gbps (preferred)

e. Disk Drive: RAID-5 (minimum), RAID-6 (preferred), minimum sustained non-sequential write capacity 70 MBps

f. Operating Systems:

- Microsoft Windows XP (all versions)
- Microsoft Windows Vista (all versions)
- Microsoft Windows 2008 Server (all versions)
- Microsoft Windows 7 Pro (all versions)

4) Recommended Client Requirements (Single Monitor)

a. Processor: Intel® Core i3 2100 Processor, 3.1 GHz or greater

b. Graphics: 1280x1024

c. RAM: 2 GB

d. NIC: 10/100/1000BASE-T Ethernet

e. Disk Drive: Western Digital Enterprise Class drive (RE4 or better), or Seagate Barracuda ES.2 Drives or better

f. Video: 64 MB video card (Direct3D / OpenGL compatible)

g. Operating Systems:

- Microsoft Windows 7 (all versions) or higher
- Linux Ubuntu 8.04 or higher
- Mac OSX 10.4 or higher

5) Multi-Monitor PC Requirements (4 VGA monitors at up to 1920x1200 resolution) The VMS client software shall operate on the following minimum requirements:

a. Processor: Intel® Core i7-2600K 3.4GHz or higher

b. Graphics: Multi-output display adapter

c. RAM: 4 GB

d. NIC: 10/100/1000BASE-T Ethernet

e. Hard Disk: 80GB Serial ATA drive

f. Video: 512 MB video card (Direct3D/OpenGL compatible)

g. Operating Systems:

- Microsoft® Windows 7 (all version)
- Mac OSX 10.6
- Linux Ubuntu 10.04

6. Camera Specification

- The camera shall be compatible with the Video Management Software specified above.
- The camera shall utilize a high sensitivity 1.3 Megapixel effective CMOS sensor with 1/2.7” optical format.
- The camera shall have a dome enclosure with IP66 for water and dust protection.
- The camera dome chassis shall be vandal resistant constructed of aluminum with a 4” polycarbonate dome bubble with IK10 impact rating.
- The camera shall have a 3-axis gimbal with 360˚ pan, 90˚ tilt and 180˚ Z-rotation for easy and accurate positioning
- The camera shall have dual standard compression support with simultaneous streaming of both H.264 and MJPEG formats.
- The camera is fully compatible with PSIA industry standard and passes PSIA conformance tests.
- The camera shall have privacy masking, the ability to select multiple regions of an arbitrary shape to block the video. This feature will support both HTTP and TFTP protocols, as well as the on-camera web interface.
- The camera shall have extended motion detection grid, a higher granularity grid of 1024 distinct motion detection. User can select between 64 zone based motion detection and extended motion detection to provide backward compatibility with the existing Video Management System (VMS) integration. This feature will support both in HTTP and TFTP, as well as the on-camera web interface.
- The camera shall be able to be cropped to any resolution divisible by 2 and maintain H.264 compression.
- The camera shall have multi-streaming support of up to 8 non-identical concurrent streams (different frame rate, bit rate, resolution, quality, and compression format).
- The camera’s bit rate control shall be selectable from 100 Kbps to 10 Mbps for each independent stream.
- The camera’s shutter speed shall be 1ms - 500ms.
- The camera shall have Real Time Streaming Protocol (RTSP) support allowing for compatibility with media players such as Apple QuickTime, VLC Player and others.

- The cameras H.264 implementation shall maintain full real time video frame rates.
- The camera shall output at a minimum resolution of 1280(H) x 1024(V) pixels up to frame rate of 24 frames per second (FPS).
- It shall be possible to program the camera to output a variety of lower resolution image and increase frame rate.
- The camera shall feature streaming of the full field of view (FOV) and simultaneous multiple regions of interest (ROI) for forensic zooming.
- The camera shall be equipped with a 100 Mbps LAN connector.
- The camera shall provide 21 levels of compression quality for optimal viewing and archiving.
- The camera shall support a minimum HTTP, RTSP, and RTP over TCP, RTP over UDP and TFTP network protocols.
- The camera shall feature automatic exposure, automatic multi-matrix white balance, shutter speed control, 50/60Hz selectable flicker control, programmable brightness, saturation, gamma, sharpness, windowing and decimation, simultaneous delivery of full-field view and zoomed images at video frame rate, instantaneous electronic zoom, pan and tilt, and electronic image rotation by 180 degrees.
- The camera shall incorporate necessary algorithms and circuits to detect motion in low light with clarity.
- The camera shall support a minimum illumination of 0.1 Lux @ F1.2 in color mode and 0 Lux in B/W mode.
- The camera’s primary power source shall be Power over Ethernet (PoE) complying with the IEEE 802.3af standard.
- The camera shall have the alternative option to be powered via DC power from 12V to 48V DC or 24V AC power source.
- The camera shall have 9 watts max power consumption and 12.8 watts max power consumption with heater.
- The Camera shall provide total PoE solution to drive heater without any external power input.
- The Camera’s heater shall switch on -40˚C (-40°F) to 17C° (62.6 °F) and Off: 30 °C (86 °F)
- The camera’s operating ambient temperature shall be minimally -20˚C (-4°F) to 50ºC (122ºF) without heater; -40˚C (-40°F) to 50ºC (122ºF) with heater, stable image temperature is 0˚C (32 °F) to +50˚C (122°F); storage temperature -40˚C (-40°F) to +60˚C (140 °F) at the humidity 0% to 90% (non condensing).
- The camera shall be UL listed (CB Scheme).
- The camera shall integrate with the Video Management System
- The camera shall have a minimum 1 Year parts and labor
- Central IT infrastructure may be used for network traffic but not for PoE. Instead a PoE injector must be used to power the cameras.

END OF SECTION

28 31 11 Fire Alarm Systems

Fire alarm systems shall be installed in buildings when required by this section.

1. Purpose:

   - The primary purpose of a fire alarm system is to notify the appropriate people and initiate the proper response from those people who are notified.
   - The secondary purpose is to initiate fire safety functions, which are building and fire control functions that are intended to increase the level of safety for occupants or to control the spread of the harmful effects of fire.
   - The fire alarm system operation must be coordinated with the facility fire plan.

   Note: This does not preclude the fire plan from being modified to meet the fire alarm system operation.

2. General Requirements:

   - The fire alarm system shall be installed where required by NFPA 101 and shall be designed to meet the requirements contained in NFPA 72 (2007), National Fire Alarm Code, Virginia Statewide Fire Prevention Code (2006) and this manual.
   - Do not combine fire alarm systems with other systems such as building automation, energy management, security, etc. Down time for any of these non-life safety systems will also take the fire alarm system out of service. This is not acceptable to Mason.
   - All fire alarm wiring shall be installed in raceway separate from all other systems.
   - Installation of Fire Alarm Systems, including all conduit, supports, wiring, peripheral devices etc.; shall be installed according to all applicable codes referenced in the VUSBC, signed Architectural Drawings, and project Specifications Manual. All Fire Alarm equipment shall meet the requirements of UL 864 Ninth Edition.
   - All wiring shall be installed in a protected raceway e.g.; conduit, Greenfield, Liquid Tight, MC cable with proper color band for fire alarm use. Under no condition shall free air wiring be installed.
   - Wiring for local building fire alarm systems shall be specified as defined in NFPA 72 as follows:
     1) Initiating Device Circuits (IDC): Class B.
     2) Signaling Line Circuits (SLC): Class B.
     3) Notification Appliance Circuits (NAC): Class B.
   - System shall include an elevator pre-action system.
   - There will be no performance spec system.
   - System shall be approved by BECOM.
   - Existing systems that are obsolete, shall be removed not abandoned in place.
   - Amv does first F.A. inspection.
     1) Communications between building fire alarm control units: Class X.

Note: Class B signaling line circuits (these are not initiating device circuits by definition) are preferable for local building fire alarm systems because it permits the *circuits to be t-tapped and the allowable length of the circuits are not shortened. No clear advantage is seen for running Class A circuits except where signaling line circuits are run between building fire alarm control units. Where signaling line circuits are run between fire alarm control units in separate buildings, fiber optic circuits are preferred because they are not susceptible to damage from lightning strikes. Where Class X copper circuits are installed, provide isolation modules that will ensure that only one building is lost (will not respond) during any type of fault. Although desirable, it is not required that Class X circuits be run in separate conduits from each other.*

Note: Installation of the Fire Alarm System shall consume no more than 80% of the systems maximum capacity in all respects. In particular, all addressable circuits shall allow for the future installation of at least (15) additional devices, without requiring additional components in the FACP or new "home-run" wiring. All visual notification circuits shall allow for the future installation of at least (200) linear feet of additional circuit length, with (4) 15cd strobes at the end of the new circuit.

- The use of “wire nuts” shall be strictly prohibited. If it becomes necessary to create a junction point, all wiring shall be terminated under a terminal screw and printed labels showing each wire’s origin and destination shall be affixed to the wire and a clear protective covering over the label shall be used.
- The FACP shall be equipped with the means to disable ALL audio/visual devices, (including sounder bases if so equipped) elevator recall, AHU shutdown, door release, and solenoids for any pre-action or sprinkler dry pipe systems without having to go through menu options, e.g.; single push button for each event listed.
- Analog addressable systems are encouraged where many smoke detectors are required to be installed. These systems do not require the frequent sensitivity testing for smoke detectors that the hard-wired systems require and the savings in testing will pay for the extra cost of the system.

  1) It is the intention of the University to obtain competitive bids for maintenance and repair services and material for the fire alarm system provided. Any special tools, prints, technical data, layouts, hardware, software, etc. required throughout the life of the equipment and which cannot be obtained from multiple suppliers, must be provided by the manufacturer to the Owner at substantial completion of the project.

  2) Mason will accept the following systems, or any viable alternative with RFI approval from Mason:

     a. Notifier

     b. FCI (Fire Control Instruments)

     c. Simplex

     d. Siemens

  3) Any and all maintenance diagnostic tools, electrical schematic wiring diagrams and any access codes and passwords required to perform any maintenance function over the life of the equipment such as diagnostics, adjustments or reprogramming shall be provided to the Owner on the Date of Substantial Completion. Tools may be handheld or built into the control system and shall function for the life of the equipment without the requirement to return them to the Manufacturer. Provide complete operations and maintenance manuals including diagnostics instructions for troubleshooting the system. The Owner

shall not be required to sign licensing agreements related to the use of maintenance or repair tools.

4) The fire alarm control panel shall be listed under UL <u>Category UOJZ</u> for <u>each</u> of the following:

a. Type: "P (PPU)" (proprietary fire alarm, protected premises control unit).

b. Type Services: "A" (automatic fire alarm), "M" (manual fire alarm), "WF" (waterflow alarm), and "SS" (sprinkler supervisory).

c. Type Signaling: "DAC" (digital alarm communicator).

Note: No other category or use types will be considered

- Upon Date of Substantial Completion, the installing contractor shall provide the Owner all of the following;

1) Four (4) complete sets of binders containing OEM Manuals including the Maintenance, Operation and Programming Instructions

2) Bill of Material of all installed equipment, part numbers, and the replacement cost of each item. Prices shall remain valid for two (2) years including the warranty period

3) Cut sheets and wiring diagrams

4) Device point list and contact ID transmission data (to be programmed into Keltron)

5) Electronic copy of the FACP program

6) Written sequence of operation

7) Complete battery calculation sheets

8) Four (4) sets of reproducible as-built drawings

3. Typical Operations:

- Table 7.3(1) & (2) is provided to identify the typical operation required by the respective fire alarm systems. A table similar to this should be added to the contract documents to indicate the specific operation required of the system.

TABLE 7.3(1) ADMINISTRATION BUILDING'S GENERAL MATRIX

INPUT DEVICE / OUTPUT --->	1. Sound general building alarm	2. Initiate alarm to GMU Police via Digital alarm communicator	3. Initiate supervisory signal to GMU Police	4. Close associated smoke barrier doors on the floor	5. Shutdown air handeler served by detector	6. Recall elevator	7. Initiate elevator shut down and disconnect elevator	8. Open all locked egress doors.	9. Disconnect fuel source from cooking equipment.
Duct Smoke Detector			X		X				
Area Smoke Detector	X	X						X	
Door Release Smoke Detector	X	X		X				X	
Elevator Smoke Detector	X	X				X		X	
Manual Pull Station	X	X		X				X	
Elevator Machine Room Heat Detector	X	X					X	X	
Generator Room Heat Detector	X	X						X	
Sprinkler Waterflow/Pressure Switch	X	X		X				X	
Water Control Valve Tamper			X						
Fire Pump (Any alarm condition required by NFPA 20)			X						
High/Low Pressure Dry-Pipe Sprinkler System			X						
Kitchen Hood Suppression System	X	X		X				X	X
Gas Extinguishing Systems	X	X		X				X	
Dry Pipe Valve Room Temperture Alarm			X						

TABLE 7.3(2) STUDENT HOUSING BUILDING'S GENERAL MATRIX

INPUT DEVICE / OUTPUT --->	ANNUNCIATION: 1. Alarm Annunciation FACP, Remote Annun & Send Status to receiving station & Printer	ANNUNCIATION: 2. Supervisory Annunciation FACP, Printer, Graphic Annunciator & Send Status to Receiving Station	ANNUNCIATION: 3. Trouble Annunciation FACP, Printer, Graphic Annunciator & Send Status to Receiving Station	NOTIFICATION: 4. Sound General Evacuation Horns, Strobes & Audible bases throughout Building	NOTIFICATION: 5. Sound Audible Bases Throughout Associated Dwelling Unit (Also Activates Strobes in Dwelling Unit for ADA or HI Unit)	CONTROL: 6. Activate Elev Recall to Primary Floor	CONTROL: 7. Activate Elev Recall to Alternate Floor	CONTROL: 8. Initiate Elevator Shunt Trip	CONTROL: 9. Activate Exterioro Electric Bell Device	CONTROL: 10. Open Smoke Damper Associated with the Vent at Top of Elev Hoistway	CONTROL: 11. Shutdown Applicable Air Handling Unit & Associated Dampers	CONTROL: 12.Close Service Counter Door	CONTROL: 13. Disconnect Power to Access Control Power Supply
Manual Pull Station	X			X									X
General Area/Corridor Smoke Sensor	X			X									X
First Dwelling Unit Smoke Sensor		X			X								
Second Dwelling Unit Smoke Sensor	X			X									X
Service Counter Door Smoke Sensor	X			X								X	X
Elev Lobby Smoke Sensor (all except first floor)	X			X		X				X			X
First Floor Elev Lobby Smoke Sensor	X			X			X			X			X
Elev Machine Room Smoke Sensor	X			X		X				X			X
Elec Machine Room Heat Sensor	X			X		X		X		X			X
Duct Smoke Sensor for AHU		X									X		
Sprinkler Flow (Floor)	X			X					X				X
Sprinkler Flow (Top of Hoistway/Elev Closet)	X			X					X	X			X
Sprinkler Tamper Switch		X											
High/Low Air PSI (Dry pipe System)		X											
Pressure Alarm Switch (Dry Pipe System)	X			X					X				X
Fire Pump Running		X											
Fire Pump Phase Reversal		X											
Fire pump Phase Loss		X											
Fire Pump on Emergency Power		X											

- Provide initiating devices in accordance with NFPA 101, NFPA 72.
- Notification Appliances: Placement and spacing of notification appliances shall be in accordance with NFPA 72.
- In accordance with NFPA 72 and 101, provide smoke alarms in domiciliary resident sleeping rooms, family/staff quarters, on-call staff sleeping rooms, hotel sleeping rooms, and other sleeping rooms. ABA and ADA require a minimum of 1 unit, and 1 out of each 25 rooms in each occupancy category, to be provided with visible appliances (strobe lights) activated by the smoke alarm. Facilities are encouraged to provide additional visible notification appliances (combination smoke detector/visible notification appliance) up to 100%, where possible. See NFPA 72 for light intensity and mounting instructions.

Note: If visible notification appliances are provided in only 1 in 25 rooms, the facility will have to ensure that hearing-impaired persons are assigned only to those rooms where accommodation (visible notification) is provided. Installing strobes in all rooms will allow a hearing-impaired person to occupy any room. In addition, for every room which contains a strobe light activated by a smoke alarm and where a building fire alarm system is present, the room must also contain a strobe light activated by the building fire alarm system.

- Smoke detectors are to be installed only where required by the National Fire Codes, this design manual, or where required by an equivalency. All smoke detectors shall be photoelectric type only. Alarm verification shall not be used for smoke detectors installed for the purpose of early warning. **Exception: All student sleeping dormitories shall provide at minimum 30sec alarm verification.**

Note: Dormitory smoke detectors shall be supervisory on 1st smoke detector alarm, it will sound all sounder bases within the suite or apartment. If smoke detector does not clear within the verification period the general alarm shall sound throughout the building. If two smoke detectors get activated the general alarm shall activate immediately.

- Heat detectors are not required unless used in conjunction with elevator shutdown, where used as a substitute for smoke detectors in environments unsuitable for smoke detectors, or where used to protect emergency generators that are not equipped with automatic sprinklers.
- Indicate the capacity of all air-handling units. Duct smoke detectors are to be installed only where required by NFPA 101 or NFPA 90A. Where a duct smoke detector is located above a ceiling or in a difficult to reach location, provide a remote indicating lamp and a test key switch on nearby wall at 7ft AFF to facilitate testing.
- ALL Modules e.g., Monitor Modules, Control Modules, Relay Modules etc. shall be installed in their own individual junction box. **Exception: 1) Modules mounted on a DIN Rail or other supporting means and installed within the cabinet of the FCAP shall be acceptable. 2) Where space is limited for the installation of multiple modules, they may be installed on a DIN Rail or other supporting means within a lockable cabinet keyed to the same lock on the FACP. 3) Mini-modules used for addressing manual pull stations and installed in the same box as the pull station shall be acceptable.**

Note: All cover plates for modules shall have the means for module LED's to be seen without having to remove the cover plate. All modules shall have a typed label affixed to the cover plate showing loop number and device address. ALL initiating devices shall *have typed labels affixed to the exterior of the device showing loop number and device address. Modules shall NOT be installed in Troughs or larger junction boxes.*

- When an annunciator is required, it shall be located at the building entrances where the fire fighters will respond. The main control panel can act as an annunciator. Coordinate the location with the local fire department. Circuits from the fire alarm control panel to a remote annunciator shall be supervised.
- Elevators: Elevator fire protection shall comply with the requirements of NFPA 13, NFPA 70, NFPA 72, and ANSI/ASME A17.1 or A17.3 as applicable.

Note: Designers are reminded of the requirement in Chapter 7 of NFPA 101 for independent ventilation or air conditioning systems to maintain proper temperature during elevator fire fighters service operation for elevator machine rooms that contain solid-state equipment for elevators having a travel distance of more than 50 feet above the level of exit discharge or more than 30 feet below the level of exit discharge, and the requirement that when standby power is connected to the elevator, the machine room ventilation or air conditioning shall be connected to standby power.

Note: Elevators have been an ongoing fire protection problem, not only for Mason, but also for the entire industry. Many conflicting requirements seem to exist at any given time. Although other methods are permitted in the National Fire Alarm Code for power shut down when sprinkler protection is present, Mason uses the heat detector option as identified in the National Fire Alarm Code and as clarified below.

1) Provide smoke detection for Phase I recall for new elevators. Provide smoke detection for Phase I recall for existing elevators that have a travel distance of 25 feet or more above or below the level of fire department response (this is generally a building greater than three stories).

Note: The requirements for Phase I recall do not apply when the hoistway, or portion thereof, is not required to be fire-resistive construction, the travel does not exceed 6 ft 8 in, and the hoistway does not penetrate a floor.

a. Provide smoke detectors in the elevator lobbies, in elevator machine rooms, and elevator machine and control spaces to initiate Phase I recall. Provide smoke detectors at the top of the elevator hoistway to initiate Phase I recall only when sprinklers are installed at the top of the hoistway.

Note: Smoke detectors are only required above the elevator machine room equipment in larger rooms that contain other mechanical equipment. Some rooms have a lot of space that is not dedicated to elevator equipment; smoke detection would not be required for that space.

b. Provide three supervised control circuits from the fire alarm system to a point within three feet of the elevator controller for the purpose of providing an interface with the elevator system. When actuated, the three circuits will, respectively, 1) initiate recall to the alternate floor, 2) initiate recall to the designated floor, and 3) initiate flashing of the firefighter helmet symbol in the elevator car.

2) Where sprinklers are installed in elevator machine rooms or elevator hoistways, provide heat detection to remove power from the elevator prior to water discharge from these sprinklers. In non-combustible hoistways and where cars meet the flammability requirements of ASME A17.1, the sprinkler at the top of the hoistway should be omitted. Sprinklers can be omitted from elevator pits of enclosed, noncombustible shafts where there are no combustible hydraulic fluids contained in the shaft. Sprinklers, when installed in the pits, shall be sidewall type installed no more than 2 feet above the floor.

Note: Elevator cars which were built to the requirements of the ANSI code since 1985 have a flame spread no greater than 75 and a smoke developed rating no greater than 450 (Class B, per ASTM E 84 / NFPA 255). Where the elevator cars meet these requirements, NFPA 13 allows sprinklers to be omitted from the top of the hoistway as well as from the pit as indicated. When sprinklers are omitted from the top of the hoistway, NFPA 72 does not require, nor does it permit, a smoke detector to be installed at the top of the hoistway due to the difficulty experienced with performing testing and maintenance.

a. Elevator main line power shutdown (commonly known as "shunt trip"): Power to the elevator must be removed prior to or immediately upon release of water from a sprinkler in the elevator machine room (including machine space, control room, or control space) or hoistway. Operation of a heat detector used to initiate shunt trip shall cause the shunt breaker to operate, thereby removing power from the elevator(s) within the common hoistway or controlled by equipment in a common machine room. Cars sharing the same hoistway or the same machine room shall have power removed independently from cars within other hoistways or those controlled from equipment in other machine rooms.

Note: The industry expects that the removal of elevator power (caused by operation of the heat detector) will not trap any occupants on the elevator because sequences under Phase I operation will have already moved the car(s) to the recall level and placed the doors in the open position. Smoke detection required for Phase I initiation is provided at all of the spaces where heat detection is provided for power shut down.

b. Provide 57° C (135° F) rate compensation heat detectors within two feet of each sprinkler in the elevator machine room and hoistway in accordance with NFPA 72. Do not provide a heat detector for the pit sprinkler. Higher temperature rated heat detectors may be used where local conditions warrant; however, the heat detectors must have a lower temperature rating than the sprinklers. The sprinklers in the elevator machine rooms and hoistways must be standard response type; quick response sprinklers are prohibited in these areas.

c. Provide a supervised control circuit from the fire alarm system to a supervised relay within three feet of the shunt breaker. This signal is the input to remove the mainline power to the elevator.

d. Provide a 110-vac power source to the shunt breaker independent of the elevator controller. This power circuit shall be supervised by the fire alarm system as a supervisory signal.

Note: The shunt breaker requires 110-vac to operate and the source must be independent of the elevator in accordance with ANSI A17.1. The intent of the code is to have to a reliable power source and not to rely on one that may be on fire. Without supervision of *the 110-vac power circuit needed for the shunt breaker, the condition of the power necessary for the shunt breaker to operate during a fire is unknown. There have been instances where the breaker to the 110-vac power source for the shunt breaker has been turned off and the elevator power would not shunt upon operation of the heat detector.*

3) Fire alarm system elevator interface summary: As described above, there will be five supervised control circuits from the fire alarm system that will interface with the elevator system. They are as follows (see following pictorial and the accompanying notes):

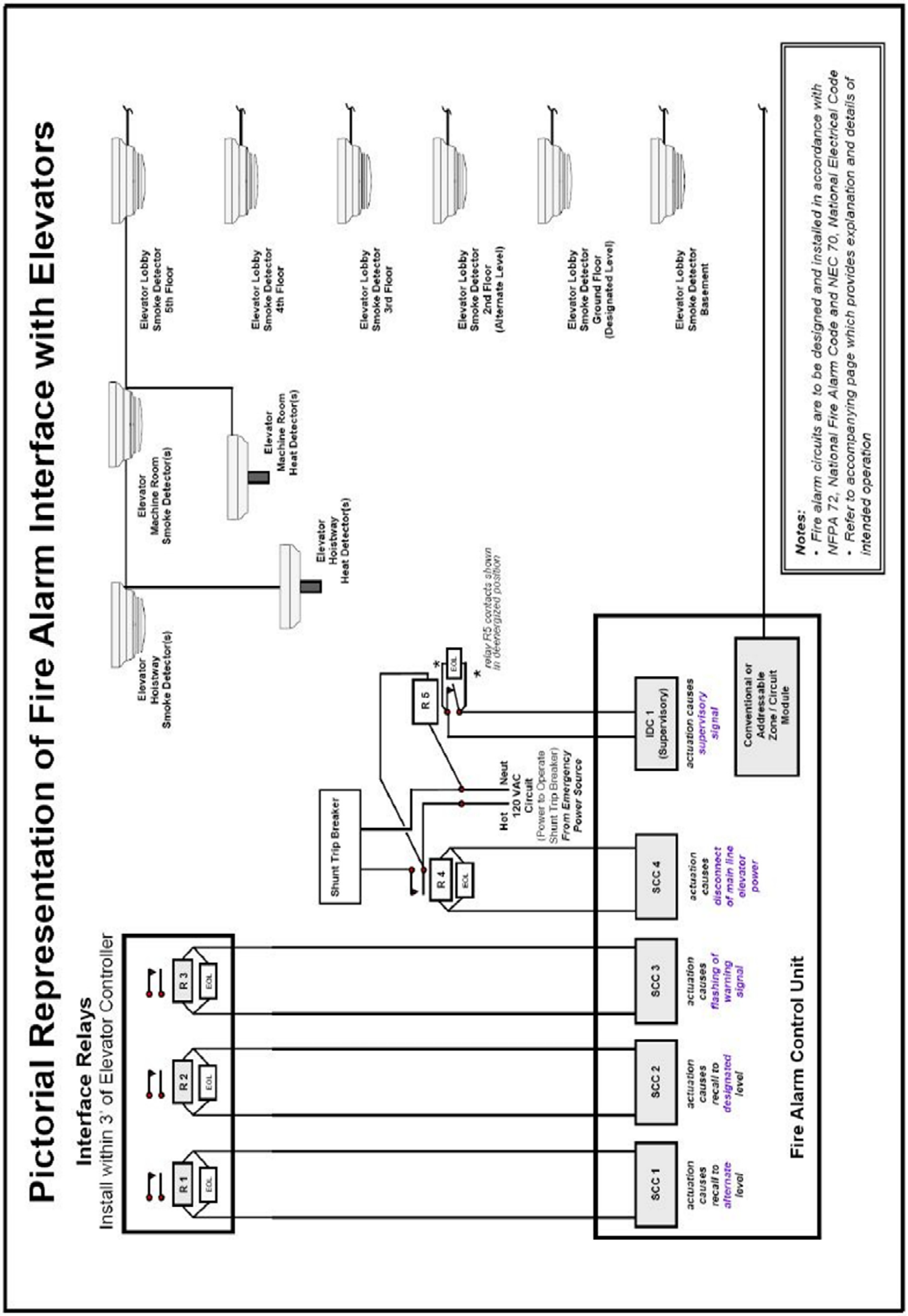
a. Input to elevator controller for Phase I recall to the designated level from actuation of smoke detectors other than at the designated level lobby.

b. Input to elevator controller for Phase I recall to the alternate level from actuation of a smoke detector at the designated level lobby.

c. Input to elevator controller to flash the firefighter helmet signal when recall is initiated by a smoke detector in the elevator machine room or hoistway.

d. Input to elevator main line power shunt trip breaker for power shut down from actuation of heat detectors in the hoistway or machine room.

e. Supervision of the 110-vac power source to the shunt breaker.


Pictorial Representation of Fire Alarm Interface with Elevators
Interface Relays
Install within 3' of Elevator Controller
R 1
EOL
R 2
EOL
R 3
EOL
R 4
EOL
R 5
EOL
Shunt Trip Breaker
Hot
Neut
120 VAC Circuit
(Power to Operate Shunt Trip Breaker)
From Emergency Power Source
relay R5 contacts shown in deenergized position
SCC 1
actuation causes recall to alternate level
SCC 2
actuation causes recall to designated level
SCC 3
actuation causes flashing of warning signal
SCC 4
actuation causes disconnect of main line elevator power
IDC 1 (Supervisory)
actuation causes supervisory signal
Conventional or Addressable Zone / Circuit Module
Fire Alarm Control Unit
Elevator Hoistway Smoke Detector(s)
Elevator Hoistway Heat Detector(s)
Elevator Machine Room Smoke Detector(s)
Elevator Machine Room Heat Detector(s)
Elevator Lobby Smoke Detector 5th Floor
Elevator Lobby Smoke Detector 4th Floor
Elevator Lobby Smoke Detector 3rd Floor
Elevator Lobby Smoke Detector 2nd Floor (Alternate Level)
Elevator Lobby Smoke Detector Ground Floor (Designated Level)
Elevator Lobby Smoke Detector Basement
Notes:
• Fire alarm circuits are to be designed and installed in accordance with NFPA 72, National Fire Alarm Code and NEC 70, National Electrical Code
• Refer to accompanying page which provides explanation and details of intended operation

Explanation of Fire Alarm Interface with Elevators

Notes:

- There can be many variations of the accompanying “Pictorial Representation of Fire Alarm Interface with Elevators.”
- In this example, the smoke and heat detectors are addressable initiating devices and the operating relays are “hardwired.”
- To achieve supervision, the relay circuits are operated from supervised control circuits. Sometimes NACs (Notification Appliance Circuits) are used to accomplish this function.
- The supervisory initiating device that monitors the power for the shunt trip circuit is connected to a supervisory IDC (Initiating Device Circuit).
- The scenario assumes that:
- There is a sprinklered elevator hoistway.
- Means to disconnect the main line power to the elevator is via a shunt trip breaker.
- System operation is in accordance with NFPA 72.

4) Relay (R5) and an IDC (Initiating Device Circuit) have been included to provide indication (via a supervisory alarm) of absence of voltage (power) to operate shunt trip breaker.

<u>Components Function</u>

R1 ---------------Signal to elevator controller for recall to designated level.

R2 ---------------Signal to elevator controller for recall to alternate level.

R3 ---------------Signal to elevator controller for firefighter notification.

R4 ---------------Signal to activate shunt trip relay.

R5 ---------------Supervisory relay to monitor presence of voltage (power) to operate shunt trip breaker.

SCC1 -----------Supervised Control Circuit for operating R1.

SCC2 -----------Supervised Control Circuit for operating R2.

SCC3 -----------Supervised Control Circuit for operating R3.

SCC4 -----------Supervised Control Circuit for operating R4.

IDC1------------Initiating Device Circuit to supervise R5 contacts (monitoring power to operate shunt trip breaker).

4. Communications between Buildings:

   - Buildings shall communicate trouble, supervisory, and alarm signals to Mason’s Proprietary Keltron system, 24-hour staffed by Mason police and have the UL Proprietary designation. All signals must be transmitted via True Point Contact ID format via digital dialer. Provide a printer to make a hard copy of all signals and operator responses. Coordinate with the facility.

------END-----

Division 31 – Earthwork

31 10 00 Site Clearing

1. Topsoil shall be stripped to the depth determined by the Soils Engineer, usually not less than 4 inches. Topsoil shall be stockpiled in accordance with the requirements of the approved E&S Plan in locations as coordinated with the University. Under no circumstances shall topsoil be removed from University property without written University Approval. Topsoil shall not be mixed with subsoil or other site debris.

31 20 00 Earth Moving

1. The Contractor shall obtain from the University the Land Disturbance Permit prior to any onsite activities. All work shall be in accordance with the Permit requirements. A Preconstruction meeting shall be held with the University prior to land disturbance.

31 23 00 Excavation and Fill

1. All excavation for Mason projects shall be unclassified excavation, meaning that whatever material is encountered during excavation must be removed. If the soils reports indicate large quantities of rock at the elevations of the building footings, this procedure may be modified, with the permission of the University. The Contractor shall be instructed to stop excavation if anything of archaeological value is encountered. Contact Miss Utility prior to excavation and follow the requirements of the Mason Land Disturbance Permit.
2. Contractor is required to coordinate with Mason's Geotechnical Engineer to perform inspection and testing of all earthwork. Mason's Geotechnical Engineer shall provide all field and laboratory services required to:
   - Test and evaluate all samples of proposed fill materials to determine optimum moisture density relationship in accordance with VTM-1.
   - Test all samples to assure compliance with gradation requirements of this Specification. Grain size analysis shall be performed in accordance with ASTM D 422.
   - Determine depth of topsoil stripping. Existing site topsoil shall be reviewed to determine the need for importing offsite topsoil for use in final landscaping. Existing university topsoil at the Fairfax, Prince William and Arlington Campuses have not produced desired finished lawns around new facilities. Augmenting or supplementing onsite topsoil may be required.
   - Inspect all proof rolling and determine the presence of any local soft pockets.
   - Inspect excavation in natural soil to determine if bearing stratum meets design criteria.
   - Inspect and test compacted fill to determine compliance with these Specifications. Field densities shall be determined by VTM-1.
   - Keep written records of all tests and field instructions, and summaries of these reports shall be mailed weekly to A/E, the Contractor, and the University. Final written summaries shall be provided to The University upon completion of work.

31 25 00 Erosion and Sedimentation Controls

1. All erosion and sediment control measures will meet the requirements of the state of Virginia's Department of Conservation and Recreation's "Erosion and Sediment Control Manual", (www.dcr.virginia.gov/stormwater_management/e_and_s-ftp.shtml)

2. the latest edition of the Mason Annual Standards and Specification for Erosion and Sediment Control and Stormwater Management (http://facilities.gmu.edu/LandDevelopment/erosion1.htm), and the Mason Design Guidelines.

Division 32 – Exterior Improvements

1. Except as otherwise supplemented in this manual, these items must meet the requirements and standards of VDOT's "Road and Bridge Specifications" and "Construction Manual". (VDOT Manuals)

32 06 10 13 Pedestrian Walkway Schedule (Sidewalks)

1. In general all permanent sidewalks shall be cast-in-place concrete. If temporary walkways are required, they may be asphalt. Concrete will not be accepted if graffiti is present. Concrete with graffiti shall be removed by the Contractor and replaced at Contractor's expense. Cracked concrete will not be accepted, except as approved in writing by the University.
2. Mason's standard sidewalk is minimum 6 feet wide, 4 inch slab. The precise geometry of the cross section of the sidewalk shall be determined based upon the hierarchy established elsewhere in this manual. Thickness shall be provided proportionally to the width as noted in the details. Sidewalks shall be constructed of 3000 psi, 4 – 6% air entrained concrete reinforced with 6 x 6 #10 welded plan cold drawn steel flat panel wire mesh, with broom finish. Wire mesh shall be supported by, and attached to, 2 inch rebar chairs that are spaced adequately to ensure support of the mesh during the concrete pour. Sidewalks shall be on a compacted base of VDOT 21A crushed stone. Aggregate used within the sidewalk shall be rounded. Sidewalks shall be graded so as to drain fully and away from buildings/entrances, shall have no surface indentation that permits standing water (e.g. "bird baths"), or back-up into curb/yard inlets.
3. Install 3'chamfers at all sidewalk intersections for electric carts.
4. Install ramps where sidewalks intersect roads for general accessibility and electric cart access. Consult Mason Facilities for exceptions.
5. Control, construction, and contraction joints shall be coordinated with the architectural and landscape designs to ensure the pattern is acceptable. Transverse control joints shall occur 6 feet on center for 6 foot wide sidewalks. Transverse contraction joints with premolded joint fillers shall occur 48 feet on center. Premolded joint fillers shall be ½ inch thick asphalt impregnated fiber board conforming to ASTM C 1751. Control joints shall be made with tools that provide slightly curved edges and no flats on the surface of the sidewalk.
6. Use non-slip finish on sidewalks, steps, and metal grates where a slipping hazard may exist.
7. Ensure that any and all drainage grates that are provided in pedestrian walkway areas provide an opening of no more than ½ inch diameter (i.e. "heel safe").

32 12 00 Flexible Pavement

1. All asphalt pavements shall conform to the following minimum thickness for the use intended as noted below. The subgrade bearing capacity shall be determined by tests. During preparation of the subgrade, the Contractor shall request CBR tests be performed. CBR test results can take several weeks to be obtained so the contractor needs to factor this into their schedule. Final pavement design shall be based on CBR results, but at a minimum thickness as shown below. Pavement designs shall be in conformance with VDOT requirements. Proof rolling with a fully loaded, 3 axle, tandem dump truck shall be required with the University and its geotechnical engineer present. The proof rolling is to identify any localized soft spots in the subgrade. Areas not acceptable to the Geotechnical engineer shall be undercut and have acceptable material installed until an acceptable proof roll is achieved

VALUE PAVEMENT TYPE	MIN. CBR TYPE	TYPE & THICKNESS OF BASE COURSE	TYPE & THICKNESS OF SURFACE COURSE

Primary Arterial roads and service roads with heavy truck & bus traffic	5 FX 10 PW	3” Intermediate Mix, 3” Base Mix, 8” Untreated Aggregate	1 ½” Surface Mix
SecondaryFeeder Roads which carry bus & truck traffic and bus & truck parking lots	5 FX 10 PW	3” Intermediate Mix, 3” Base Mix, 6” Untreated Aggregate	1 ½” Surface Mix
Tertiary Driveways which carry only passenger cars and passenger car parking lots	5 FX 10 PW	3” Base Mix, 7” Untreated Aggregate	1 ½” Surface Mix

32 13 13 Rigid Paving (Concrete Paving)

1. Specify cast-in-place concrete for permanent sidewalks. If temporary walkways are required, they may be asphalt.
   - Specify that the Contractor protect newly placed concrete exposed to the public to insure that concrete is not defaced prior to complete setting up. Replacement of defaced concrete is included in the Contract Sum.
   - Specify 3000 psi air-entrained concrete for exterior paving, reinforced with 6 x 6 #10 welded wire fabric delivered in flat sheets and not rolled. Design paving with a 6 inch aggregate base. Specify a heavy broom finish perpendicular to the direction of travel, with sawn or tooled joints at a maximum of 6 feet on-center. Specify premolded 1/2-inch thick asphalt impregnated fiber board joint filler for construction joints and where full separation is required.
   - See above for Mason’s standard sidewalk information.
   - Control, construction, and contraction joints shall be coordinated with the architectural and landscape designs to ensure the pattern is acceptable. Transverse control joints shall occur 10’ on center for wide slabs, each direction. Coordinate with Mason and Landscape Architect. Transverse contraction joints with premolded joint fillers shall occur 48’ on center, conforming to ASTM C 1751 and caulked with an appropriate type for this application. Control joints shall be made with tools that provide slightly curved edges and no flats on the surface.
   - Fairfax Campus concrete paving: Specify naturally buff-colored concrete, or include some color admixture, avoiding cool-gray toned concrete.
   - Prince William Campus concrete paving: Intermix concrete and unit pavers incorporating the same tones as indicated above for pavers on this campus. Avoid strong yellow or brown tones.
   - Arlington Campus concrete paving: Specify concrete with tan or beige tones.

- Additional requirements for concrete work are included in Division 03.
- Requirements for exterior railings are included in Division 05.

32 14 00 Unit Pavers

1. Specify a mixture of paving colors, textures, patterns, and materials.
    - Specify paver patterns with high Solar Reflectance Indices (SRIs) of at least 29.
    - Fairfax Campus pavers: specify red, buff, tan, and clay tones.

    Cambridge Pavingstones (Lyndhurst, NJ) KingsCourt or RoundTable Collections with ArmorTec in the following colors:
    - Chestnut
    - Chestnut/Salmon
    - Toffee/Onyx
    - Sahara
    - Onyx/Chestnut
    - Salmon/Onyx
    - Golden/Onyx
    - Onyx/Natural
    - Sahara/Chestnut
    - Chestnut/Bronze
    - Salmon

    - Prince William Campus pavers: specify brick red, grays, and white tones.

    Cambridge Pavingstones KingsCourt or RoundTable Collections with ArmorTec in the following colors:
    - Onyx
    - Ruby
    - Salmon
    - Onyx/Natural
    - Ruby/Onyx
    - Salmon/Onyx

    - Arlington Campus pavers: specify brick red, grays, and white tones. Traditional brick pavers may also be used.

    Unilock (Brewster, NY) Series 3000
    - Black Granite
    - Coral Gem
    - Crystal Rose
    - Ice Grey
    - Renaissance
    - Starlight

32 14 43 Porous Surfaces

1. Where possible specify permeable surfaces that allow water to relieve into the strata below.

    Cambridge Pavingstones Crusader Collection Aqua Bric Type 1 (refer to campus details above for color choice)

32 16 13 Concrete Curbs and Gutters

1. Concrete curbs shall be formed of minimum 4000 psi concrete. Voids will not be accepted in the back of curbs. Cracked concrete will not be accepted, except as approved in writing by the University.

32 17 00 Paving Specialties

1. Requirements for bollards are in Division 03.

32 17 23 Parking Space Marking

1. Non-handicap parking stalls shall normally be 8.5 foot wide and 18 feet deep with a 22 foot aisle. Stall line markings shall be 4 inches wide single line, white color. If required include directional arrows in the contract.

32 31 00 Fences and Gates

1. Fencing is required around all climbing hazards and grade installed mechanical and electrical equipment (i.e. cooling towers, emergency generators, etc.).

32 32 00 Retaining Walls

1. Finishes and materials must be approved by the University.

32 70 00 Wetlands

1. All projects must fully conform with the requirements of the U.S. Army Corp of Engineers and the State of Virginia's Department of Environmental Quality as it relates to regulatory wetlands and waters of the U.S. (www.deq.virginia.gov/programs/water/wetlandsstreams/permitsfeesregulations.aspx) See the Campus Environmental Constraints Maps for additional information. Corps JD letter must be provided by the Contractor unless otherwise specified by the University.

32 80 00 Irrigation

1. All new buildings shall be prepared for irrigation systems whether these systems are part of the project or not. Systems shall be vandal-proof and include programmable boxes and rain meters. Sprinkler heads shall be "pop-up" type that fully retract when not in use. The system must also possess a drain valve(s) so the system can be flushed or drained using air pressure. Preparation shall include a location within an appropriate Mechanical or Electrical equipment Room for a controller, with a designated circuit breaker, and an empty 1 inch conduit with pull rope to a point 5 foot outside the building, 3feet below grade, with shutoff valve inside the building in an accessible location. Regardless of the system being installed, a backflow preventer must be installed as part of irrigation system under the building contract. Additionally, all irrigation systems must be separately metered.
2. New buildings shall also be provided with outside water access. Coordinate locations and quantity of outside water hydrants/hose bibs with the university. Turn-on valves must fit a standard four way universal water key with hose connections sized for a standard garden hose.

32 91 00 Planting Preparation

1. Preparation of Subgrade: Specify that subsoil shall be loosened to a depth of 5 inches and graded to remove all ridges and depressions so that it will be parallel to proposed finished grade. Remove stones over 1 inch in any dimension, sticks, rubbish and other extraneous matter.

32 91 19 13 Topsoil Placement and Grading

1. Specify that all topsoil shall be tested against the following Specifications:

Quantity	Size Fraction	Range of Particle Diameter
Percent by oven dry weight	inches	mm
Less than 2% gravel	Larger than 1	25
Less than 3% gravel	¼ to 1	6-25
Less than 10% gravel	2/25 to ¼	2-6
40% to 65% sand	1/500 to 2/25	.05-2.00

25% to 60% silt	1/12,500 to 1/500	.002-.05
Less than 20% clay	Smaller than 1/12,500	.002

- Amounts of sand, silt, and clay – determined by official hydrometer method or mechanical analysis of the soil. Gravel sized particles should be determined by separation on screens with appropriate size openings.
- Soil should be relatively free of under composed organic material like roots, sticks, leaves and paper and of any other undesirable trash like glass, plastic or metal fragments that would have to be removed before seeding or planting. Topsoil should be 4 inches-6 inches compacted 85%.
- Organic matter content (% over dry weight of soil): Sandy loam 1.25% to 20%, Loam and Silt Loam 2.5% to 20%.
- On soil with less than 10% organic matter, use wet oxidation method of analysis. On soil with more than 10% organic matter, use loss on ignition method of analysis.
- Soil reaction – pH of 4.5 to 7.0
- Soluble salt content: conductivity (ECe, milliohms per centimeter)

  Less than 1.00 mmhos/cm for a 1:1 soil: water ratio,

  Less than 0.50 mmhos/cm for a 1:2 soil: water ratio,

  Less than 0.33 mmhos/cm for a 1:3 soil: water ratio.

32 92 00 Turf and Grasses

1. Lawns and plantings may have an underground irrigation system based on the direction of the University. See Section 32 80 00.
2. Sod shall be used for ground cover for all disturbed areas on the East Campus, in the grass strip of the typical road section, and within five (5) feet of either side of walkways and buildings, sports fields. Seeding is acceptable for Erosion and Sediment Controls but must be replaced with sod. Hydro-seeding is not preferred. Mason will indicate the type of lawn treatment that will prevail.
3. Preferred sod shall be turf type tall fescue. Sod should be ½ inch-1 inch thick rolled sod is acceptable upon approval of the Project Manager.
4. All new lawn sodded areas shall have the entire perimeter staked and roped off immediately upon completion. Stakes shall be no less than 30 inches high installed and string banner shall be two strands stake to stake. After turf establishment (2-3 weeks), watering and regular mowing is required by the contractor for 60 days beyond establishment of turf, and a 6 month final inspection of the turf shall be conducted at which time areas requiring additional treatment at the contractor's expense will be identified.
5. Straw Mulching: Salt hay with nonasphaltic liquid tackifier is preferred. For finished grades having slopes in excess of 20% shall be mulched with erosion control fabric run vertically from top to bottom of slope and stapled with wire staples .125 inches in diameter or greater and spaced at 48 inch intervals. In areas of high velocity runoff such as receiving swales and drainage ditches fabric of sufficient strength and density shall be used and installed in direction of flow and stapled at 24 inch intervals.
6. AOSCA (Association of Seed Certification Agencies) certified seed. Sowed at a rate of 4-5 lbs/1,000 square feet.
   - Full Sun Mixture: 50% Kentucky Bluegrass

     10% Perennial Ryegrass

10% Perennial Ryegrass
15% Chewing Fescue
15% Creeping Red Fescue

- Shade Mixture: 30% Chewing Fescue
15% Creeping Red Fescue
30% Kentucky Bluegrass
35% Hard Fescue
- Tri-Plex Rye Mixture: 33.3% Perennial Ryegrass
33.3% Perennial Ryegrass
33.3% Perennial Ryegrass
- Drought Mixture: 90% Turf-type Tall Fescue
10% Kentucky Bluegrass

7. Inspections will be made at completion of the following tasks:
   - At completion of the soil loosening phase to insure that the minimum depths have been achieved.
   - At completion of the removals and/or screening phase to insure that specified dimension material has been removed.
   - At completion of the top soiling phase to insure that full depth of cover has been achieved.
   - At completion of the fine grading phase to insure that specified slopes, uniformity and positive drainage have been achieved.
   - At completion of the seeding and mulching phase to insure adequate coverage.
   - At the end of the 60 Day Maintenance Period to insure adequate percentage of growth and coverage as specified has been achieved.
8. It is the responsibility of the Contractor to notify the Project Manager of the completion of each task in writing for approvals prior to proceeding to the next phase. Unsatisfactory conditions much be corrected at Contractor's expense before beginning next phase tasks.

32 93 00 Plants

1. Specify that the Contractor shall guarantee newly installed plants for a period of one year after date of acceptance against defects, including death and unsatisfactory growth. Trees which are not healthy, dying, or the design value of which, in the opinion of the A/E or Mason, has been destroyed through root damage, loss of branches, bark damage, etc. shall be replaced by the Contractor at no cost to the University. Exceptions are defects resulting from abuse or damage by others, or unusual phenomena or incidents which are beyond landscape installer's control.
2. Specify that plants which are determined to be defective shall be replaced at the proper season or planting time after the guarantee period is complete and replacement plants will be guaranteed by the Contractor for an additional growing season under an extended guarantee at no addition cost.
3. Specify that, during the guarantee period, the Contractor shall, from time to time, inspect the watering and other maintenance practices carried on by the University and promptly report to the University any practices which he considers unsatisfactory and not in his interests or good horticultural practices. The failure of the Contractor to inspect or report shall be construed as an acceptance by him of the University's maintenance practices and shall not thereafter claim that any defects which may later develop are the result of such practice.

32 93 43 Trees

1. Trees shall be from the University Planting pallet.

32 94 13 Landscape Edging

1. A Mowing Edge shall be installed at all trees and around perimeter of the building. This edge shall be of steel or metal quality and not rubber/plastic.

32 94 33 Planters

1. Install drainage in outdoor plant boxes.

Division 33 – Utilities

1. Mason is the sole owner and maintainer of the following utility infrastructure:
    - Storm sewer system
    - High Temperature Hot Water (HTHW) distribution system
    - Dual Temperature (DT) distribution system
    - Chilled Water (CW) distribution system
    - Data/Comm (except for the trunk lines feeding the campuses)
    - Site lighting
    - Fuel oil distribution system

2. The remainder of the utility infrastructures servicing the various campuses are owned and/or maintained by the following:

Campus	Utility	Owner	Pt. of Departure	Reference
Fairfax	Domestic Water	Fairfax City Utilities	Water Meter	Note h
	Sanitary Sewer	Fairfax County	1st MH (≥8" only)[a]	Note d
	Electric Power	Dominion	Service Point Enclosure[b]	Note c
	Natural Gas	Washington Gas	Gas Meter	Note i
Arlington	Domestic Water	Arlington County Utilities	Water Meter	Note j
	Sanitary Sewer	Arlington County Utilities	1st MH (≥8" only)[a]	Note j
	Electric Power	Dominion	Service Point Enclosure[b]	Note c
	Natural Gas	Washington Gas	Gas Meter	Note i
Prince William	Domestic Water	Prince William Service Authority	Water Meter	Note e
	Sanitary Sewer	Prince William Service Authority	1st MH (≥8" only)[a]	Note e
	Electric Power	NOVEC	Primary Meter	
	Natural Gas	Washington Gas Colonial Gas[g]	Gas Meter	
Loudoun	Domestic Water	na		Note k
	Sanitary Sewer	na		Note k
	Electric Power	na		Note k
	Natural Gas	na		Note k
SCBI	Domestic Water	SI	Water Meter	
	Sanitary Sewer	SI	1st MH (≥8" only)[a]	
	Electric Power	SI	Service Point Enclosure	
	Natural Gas	na		
POV	Domestic Water	Fairfax County	Water Meter	
	Sanitary Sewer	Mason	na	
	Electric Power	Dominion	Service Point Enclosure[b]	Note c
	Natural Gas	na		
PSC	Domestic Water	PWCSA	Water Meter	Note e
	Sanitary Sewer	PWCSA	1st MH (≥8" only)[a]	Note e
	Electric Power	Dominion	Service Point Enclosure[b]	Note c
	Natural Gas	na	Gas Meter	

Notes:

a) Maintenance only
b) Mason prefers that the Service Point Enclosure be located to meet Dominion's 'Five Foot Rule', and that the transformer be located <50' from the facility, so that Dominion will own the secondary cabling
c) https://www.dom.com/dominion-virginia-power/customer-service/for-businesses/pdf/bluebook.pdf
d) http://www.fairfaxcounty.gov/dpwes/publications/guidelines/02000.pdf, http://www.fairfaxcounty.gov/dpwes/publications/pfm/
e) http://www.pwcsa.org/documents/USM/Utility%20Standards%20Manual%20Master.pdf
f) http://www.loudoun.gov/documents/14/1525/FSM%20Table%20of%20Contents%20-%20Effective%2011_1_12%20(3)_201211011224143495.pdf
g) Freedom Center only; all other facilities use Washington Gas
h) http://www.fairfaxva.gov/PublicWorks/PFM.asp
i) http://washingtongas.com/
j) http://www.arlingtonva.us/departments/CountyBoard/CountyCode/file74526.pdf
k) Furnished by landlord.

33 00 00 Utilities

1. Underground steel pipe systems shall be cathodically protected using Pikotec or approved equal.
2. Utility Marker
   - All underground utility runs, mechanical, electrical, plumbing, or what have you, shall be protected with buried marker. Markers are to be of a marker ball type; see detail. Marker balls must be compatible with university detection equipment.
   - Balls to be placed 12 inches directly above top of pipe, over entire length of run.
   - Balls to be placed on top of 4 inches deep x 6 inches wide layer of clean white sand.
   - Any existing tape which is encountered, removed or disturbed during excavation shall be replaced in conformance with items no 1-3 above and to the approval of the University, prior to backfilling.

33 10 00 Water Utilities

1. Major water mains shall comply with local utility design requirements.
2. Provide a water meter for each separate facility that is constructed.

33 30 00 Sanitary Sewer Utilities

1. Comply with local utility design requirements.
2. Provide a sanitary meter for any building where the sanitary outflow is less than 20% of the designed water inflow.
3. Minimum cover under roads for Sanitary Sewer systems shall be 42 inches and minimum slope shall be 1 inch in 15 feet (.55% slope).

33 40 00 Storm Drainage Utilities

1. Unless otherwise supplemented here, storm drainage facilities and construction must meet the requirements of VDOT's "Road and Bridge Specifications" and "Construction Manual". (www.virginiadot.org/manuals-default.asp)

33 41 00 Storm Drainage

1. Trench type storm drains are to be avoided.
2. Road grates shall VDOT approved All grates shall be bicycle safe grates.
3. The top of lawn grates shall be set minimum ½ inch below finished grade level to facilitate drainage. Lawn grates smaller than 2 feet shall be round.
4. Contractor shall clean interior of piping after installation, see below.
5. Where down spouts are utilized, these should be tied into adjacent storm drainage. All buried down spouts are required to be 6 inches or larger. No corrugated plastic pipes are allowed..

SECTION 33 42 00

PIPE SEWER TV INSPECTION

PART 1 - GENERAL

1.01 SCOPE

A. Work consists of furnishing all materials, labor, supervision, and equipment for the television inspection of new pipe sewers.

B. Related Work Specified Elsewhere May Include But Is Not Limited To:
   1. Sanitary Sewer Utilities
   2. Storm Drainage Utilities
   3. Storm Drainage

1.02 QUALITY ASSURANCE

A. Experience:
   1. Television inspection work shall be performed by a Contractor who is regularly engaged in work of the character required.

B. Equipment:
   1. All equipment, devices and tools required for the contract shall be owned (or leased) and operated by the TV Inspection Contractor.

1.03 SUBMITTALS

A. Before commencing work, the Contractor shall submit to the University for approval:
   1. Specific documentation, information, and references that the TV Inspection Contractor and the on-site supervisor for the work have had successful experience in similar work under similar conditions.
   2. Detailed written descriptions, including pertinent supplemental drawings, literature, tables and other material, of equipment, methods, procedures and scheduling proposed for the work.

B. A television inspection log shall be maintained during the television inspection work. This log shall be on a printed form and shall include the following:
   1. Job/work assignment number;
   2. Date of inspection;
   3. Location and identification of sewer section televised;
   4. Size and type of pipe;
   5. Length of sewer section televised;
   6. Locations of all service connections;
   7. Locations of all structural problems encountered such as cracked or broken pipe; offset or open joints; protruding service connections;
   8. Sags (including length and estimated depth);
   9. Incidence of root intrusion;
   10. Areas where further cleaning is required;

11. Recommendation of lining requirement.
12. Locations of service connections as referenced by horizontal distance from identified manhole and circumferential position with respect to pipe axes.

C. A summary report shall be submitted to the University within ten days of the conclusion of TV inspection work including copies of all television inspection logs. The report shall be neatly bound in a protective cover.
   1. DVD/CDs shall be submitted to the University within ten days of the conclusion of fieldwork.

1.04 MEASUREMENT

A. Unit of measure will be the job with no direct measure taken, or per linear foot as provided in the Schedule of Prices and the Contract.

1.05 PAYMENT

A. Payment for Pipe Sewer TV Inspection will be made at Contract price, as specified, which price and payment will include preparation of logs for all sections inspected, television equipment, and a complete DVD of each section, and all labor, materials, tools, equipment, and incidentals needed to perform television inspection as specified.

PART 2 - EQUIPMENT

2.01 TELEVISION INSPECTION EQUIPMENT

A. Television inspection equipment shall include at least the following minimum items:
   1. A color, sewer television camera, specifically designed for operation through a minimum of 2,000 feet of single conductor cable in sanitary and storm sewers.
      a. Camera outside diameter no greater than 3-inches to allow for inspection in small size pipes. Camera operating temperature range of 0 to 50 degrees C.
      b. Capable of providing 320 lines of horizontal resolution and 350 lines of vertical resolution.
      c. Solid-state image pickup device containing in excess of 250,000 picture elements (pixels).
      d. 525 scanning lines, 60 fields, 30 frames, interlaces 2:1 - NTSC Color Standard, with geometrical image distortion not exceeding two percent (picture transmission systems requiring use of R.F. suppressors and subject to local transmitter interference not acceptable).
      e. Full, true color, sharp image video bandwidths with no sacrifice or visible streaking of low frequency response; also no visible streaking of the low frequency test bars when viewing a standard EIA Test Chart.
      f. l.OV (140 IRE units) composite camera video signal at the monitor after transmission through 2,000 feet of single conductor cable.
      g. Equipped with an f/l.4 wide angle lens with optical viewing angle to 70 degrees, auto iris type to control the illumination range for an acceptable picture between 10 and 100,000 Lux, with manual override remotely controlled from the viewing station.
      h. A minimum of 1,000 linear feet of cable to transmit picture from camera to recording and viewing unit.

2. DVDs documenting all the television inspection with a ninety (90) minutes duration maximum, with "labels" indicating project address identification, date, along with voice description of sewer inspected during video recording.
3. An on-board television viewing monitor consisting of high quality, industrial grade color unit providing in excess of 500 lines of resolution.
    a. High-resolution "trinitron" type picture tube or approved equivalent, measuring a minimum of 12 inches diagonally.
    b. Include voltage compensation circuits to reduce picture distortion to less than one percent under voltage conditions varying from l05V to l20V.
    c. Housed in a steel cabinet which acts as shield to minimize effects of local magnetic fields such as transformers, coils, wraps of cable, etc. (monitors having inadequate or no protection from local magnetic fields, thereby contributing to loss of color picture purity, not acceptable).
    d. Equipped with a speaker to allow for audio playback from the DVD recording.
4. Lighting Equipment:
    a. The halogen lighting system or approved equivalent system shall be comprised of controlled-beam, reflector-sealed lamps with an automatic light compensator. The lighting system shall be capable of supplying variable light of high intensity.

B. Camera Transport:
1. Portable, manual winches or motorized mechanical equipment of indirect drive type shall be provided complete with sufficient cable or rods to permit inspection of all sewer sections specified and capable of moving camera through the sewer pipe in either direction at a uniform, slow rate.

C. Metering Device:
1. A remote reading, footage metering device(s) shall be provided such that camera location at ground level is visually displayed at all times on the television screen. Footage metering device shall be designed so that the distance recorder can be set at zero when camera is at entrance of pipe. Metering device shall have an accuracy of one percent + of actual distance between manholes. Marking of cable or similar means that require interpolation of depth of sewer, will not be permitted.
2. A measuring target in front of the television camera shall be an exact measurement reference point, and the meter reading shall show the exact location of the reference point.

D. Monitor Trailer:
1. A lighted trailer or other suitable shelter, complete with table and chairs, shall be provided for observation of the television monitor and record keeping. Trailer shall be large enough to accommodate at least three people at any time for the purpose of viewing the monitor while TV inspection is in progress.

E. Accessories:
1. Accessory items shall include barricades, ladders, pulleys, safety equipment, etc.

PART 3 - EXECUTION

3.01 TV INSPECTION

A. General

1. The interior of new pipe sewers and the interior of existing pipe sewers and building sewers shall be visually inspected as directed by means of closed circuit television in the presence of the University.
2. Inspection for all sewers shall be performed by moving the camera through the line along the axis of the pipe in either direction at a uniform slow rate by remote means, stopping at each joint or defect to allow adequate evaluation by the University. For sewers 42-inches diameter and larger, camera movement shall be on a "hand held" basis.
3. The University shall have access to the television monitor and all other operations at all times. The Contractor shall provide space for two University personnel at the same time in the trailer.
4. Picture quality and definition shall be as approved by the University. If unsatisfactory, Contractor shall remove equipment, replace it with satisfactory equipment and repeat the inspection at no additional cost to the University.
5. The Contractor shall make visual (with audio) tape recordings of each sewer inspection. Date, station (distance from manhole) and manhole identification shall be visually displayed on the videotape at all times.
6. All points of interest including all obstructions, broken pipe and other problems shall be indicated via audio during inspection.
7. Throughout the television inspection activities, the University reserves the right to alter the speed at which the camera is moved through the sewer. Should the quality of the television picture fail to provide a clear view of the entire sewer, the Contractor shall make appropriate adjustments in his monitoring equipment or discontinue work until the University agrees an acceptable picture has been obtained. Telephones or other suitable means of communication shall be set up between the two winches and the control monitor to coordinate the work.
8. Should the camera become stuck in the sewer, the Contractor will be responsible for its removal at no additional cost to the University.

B. Safety:

1. Contractor is responsible for safety of personnel and the public during Contract period. The Contractor shall provide all devices, material and equipment necessary to assure the safety and health of personnel and the public.

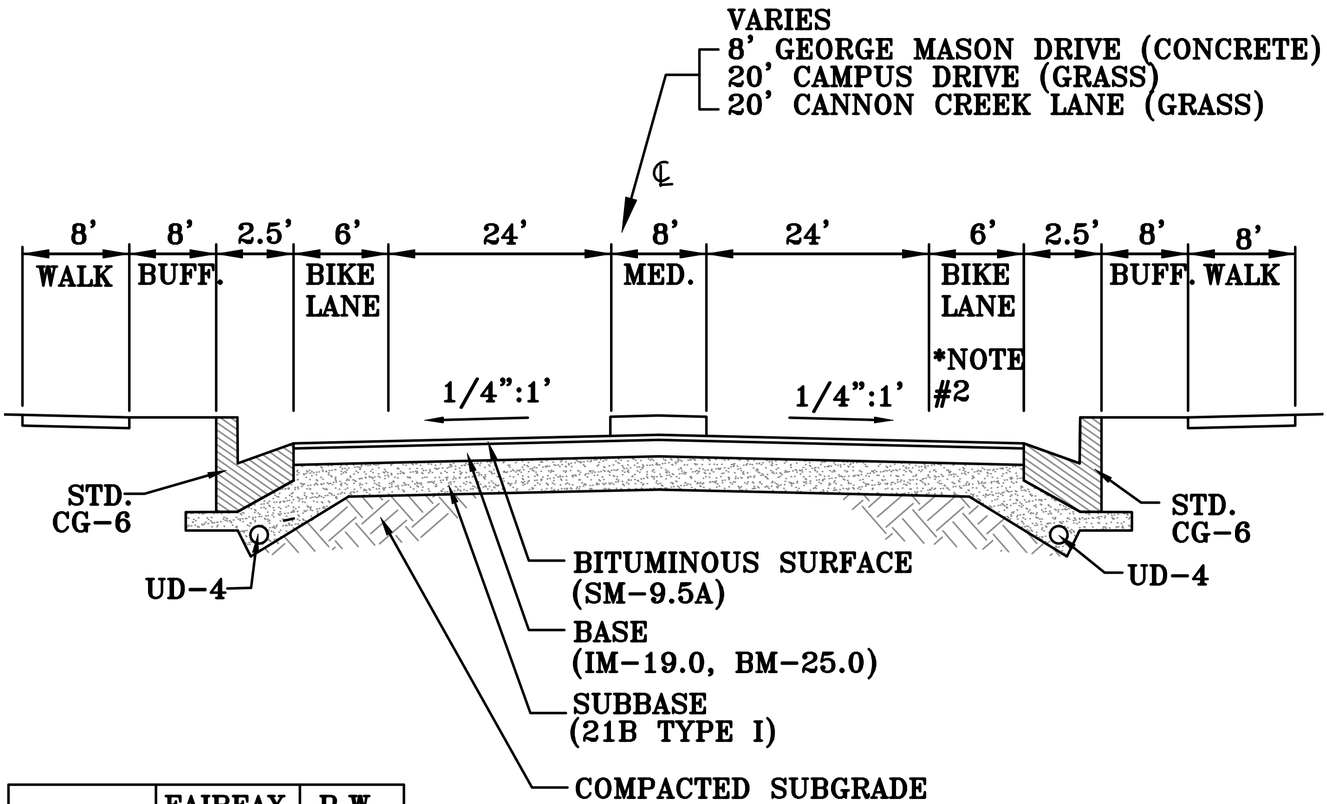
Chapter 5

Mason Standard Details

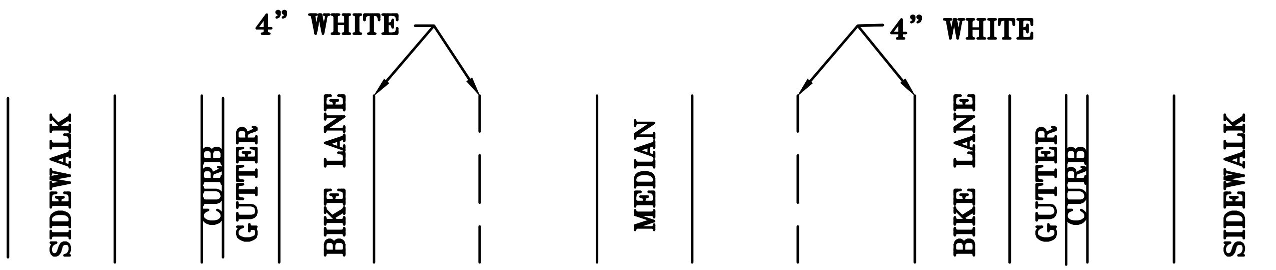
PLANNING AND DESIGN - EXTERIOR

Date: 6-3-2013

GEORGE MASON UNIVERSITY



		FAIRFAX	P.W.
SURFACE		1.5"	1.5"
BASE	IM	3"	3"
	BM	3"	4"
SUBBASE		8"	8"



STRIPING PLAN VIEW

NOTES:
1) Subbase depth is based on CBR value of 10. soils test of subgrade will be performed for actual determination of required subbase thickness prior to the placement of subbase.

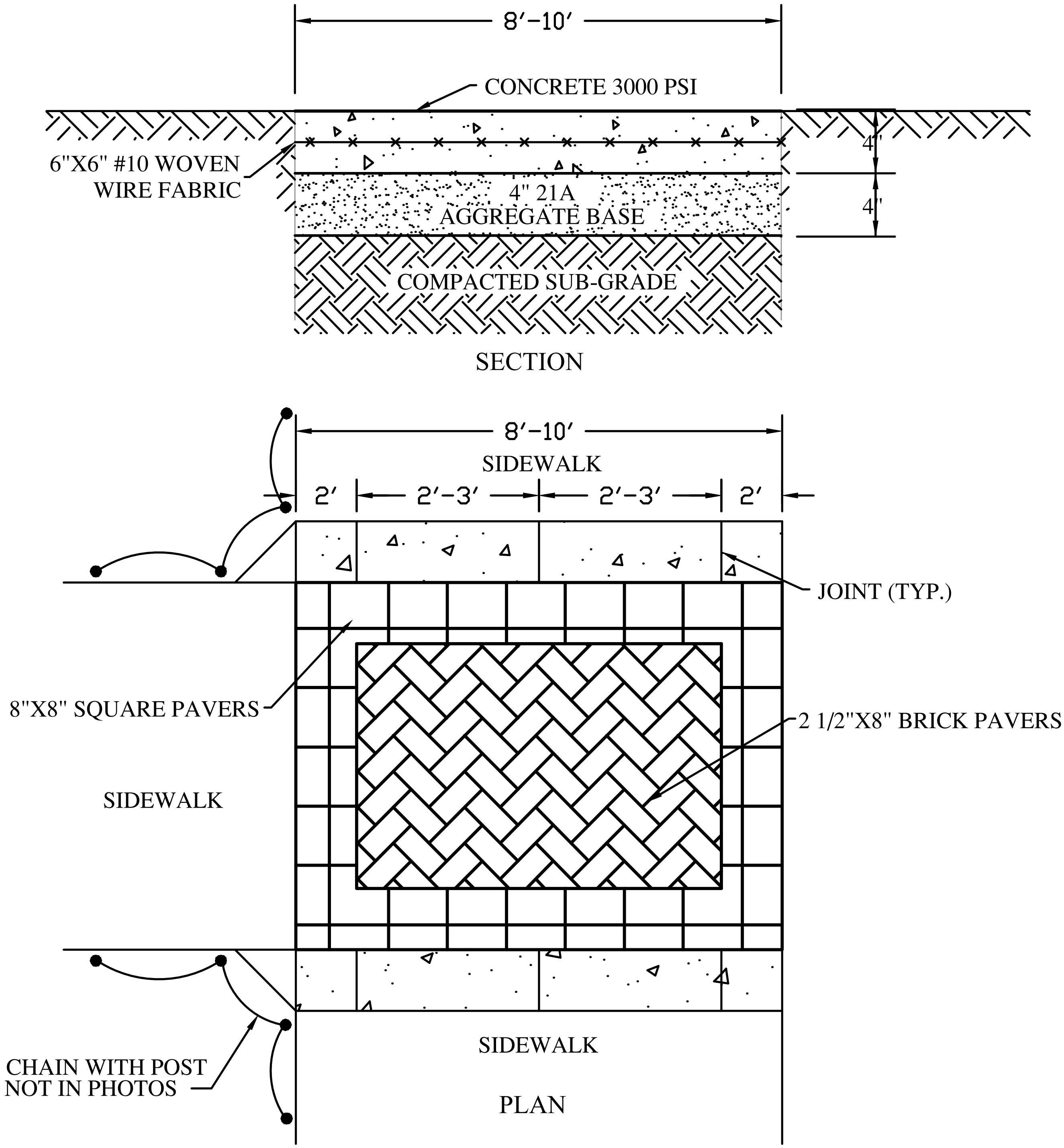
NTS

Date: 6-3-2013

PRIMARY ROAD - TYPICAL STREET SECTION

GEORGE MASON UNIVERSITY

Detail No: 3.1-1



NOTES:
1) Primary walks shall be 8-10' wide.
2) All walks wider than 8' must be reinforced.
3) Concrete to be class A3.
4) Color patterns with university approval.

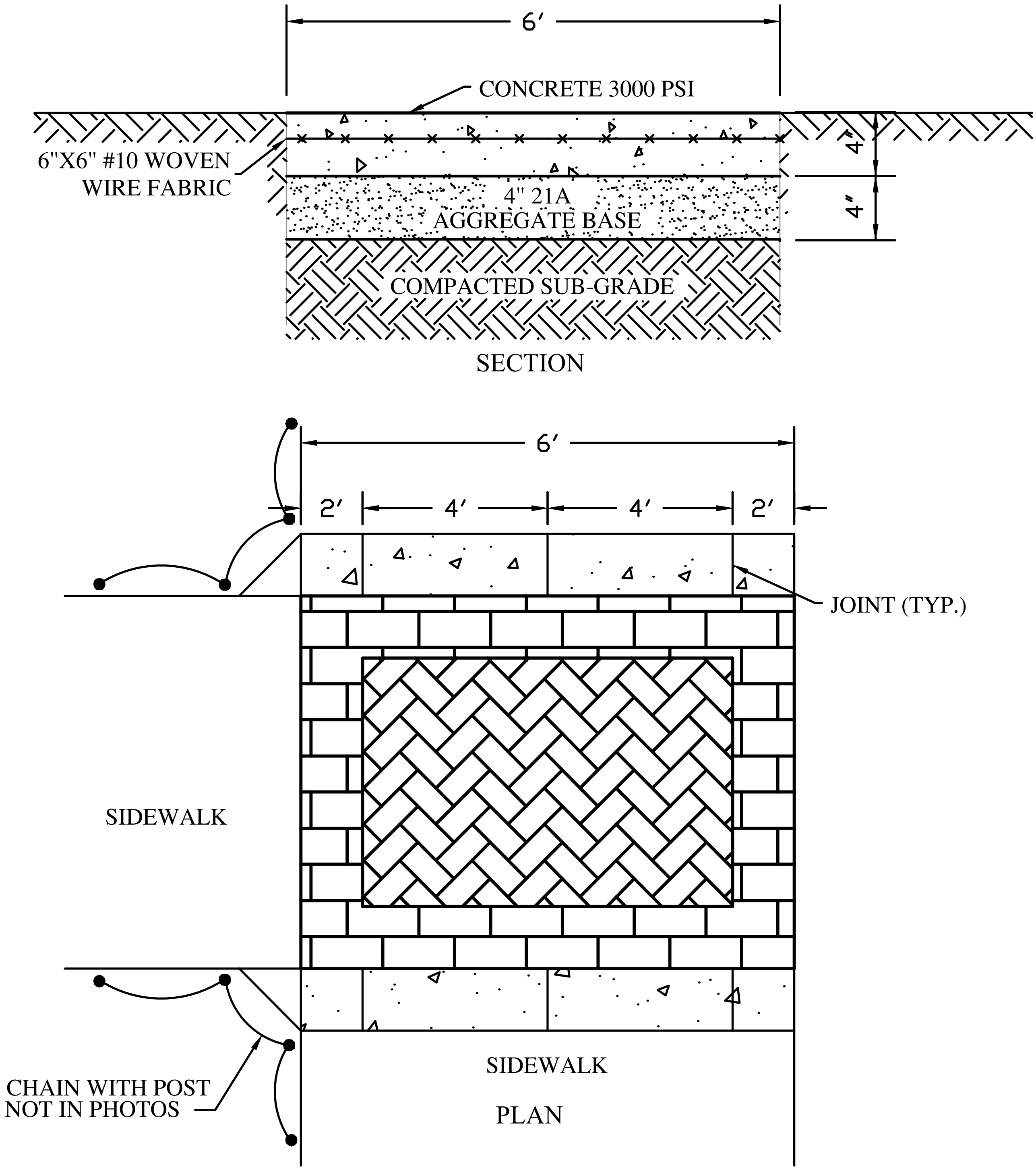
NTS

Date: 6-3-2013

SECONDARY WALK SECTION AND PLAN

GEORGE MASON UNIVERSITY

Detail No: 3.1-10



NOTES:

1) Primary walks shall be 6' wide.
2) All walks wider than 8' must be reinforced.
3) Concrete to be class A3.
4) Color patterns with university approval.

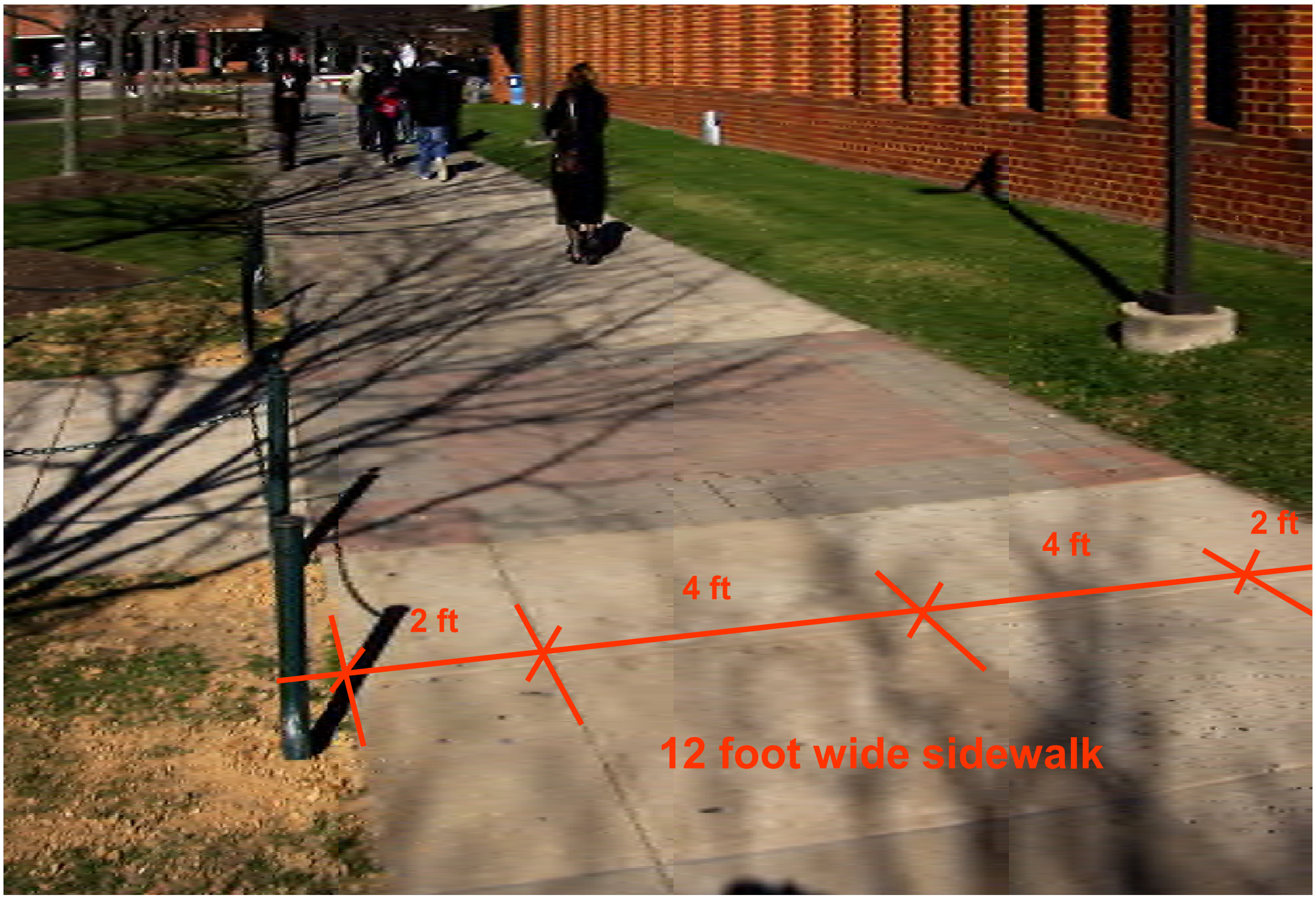
NTS

Date: 6-3-2013

TERTIARY WALK SECTION AND PLAN

GEORGE MASON UNIVERSITY

Detail No: 3.1-11



NTS

Date: 6-3-2013

GEORGE MASON UNIVERSITY

TYPICAL 12' PRIMARY WALK - PAVER DIMENSIONS

Detail No: 3.1-12

NTS

Date: 6-3-2013

INTERSECTION AT WALKWAY

GEORGE MASON UNIVERSITY

Detail No: 3.1-13

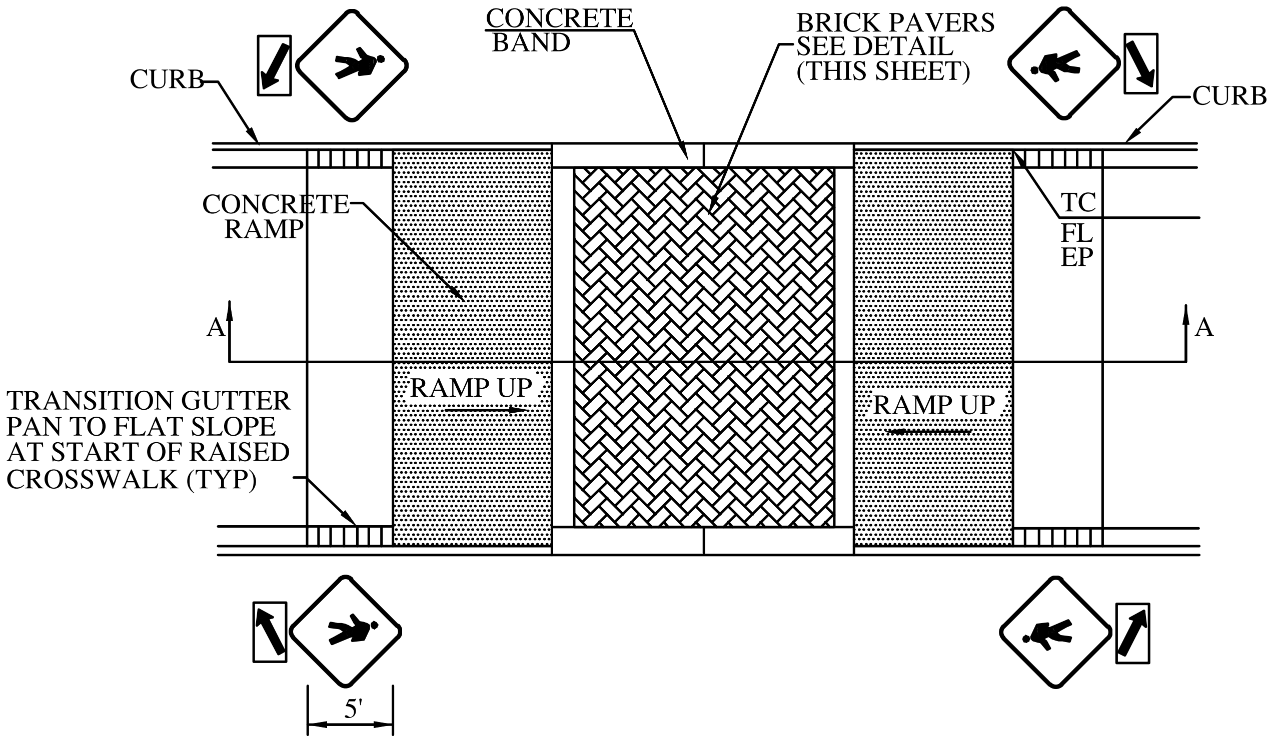
NTS

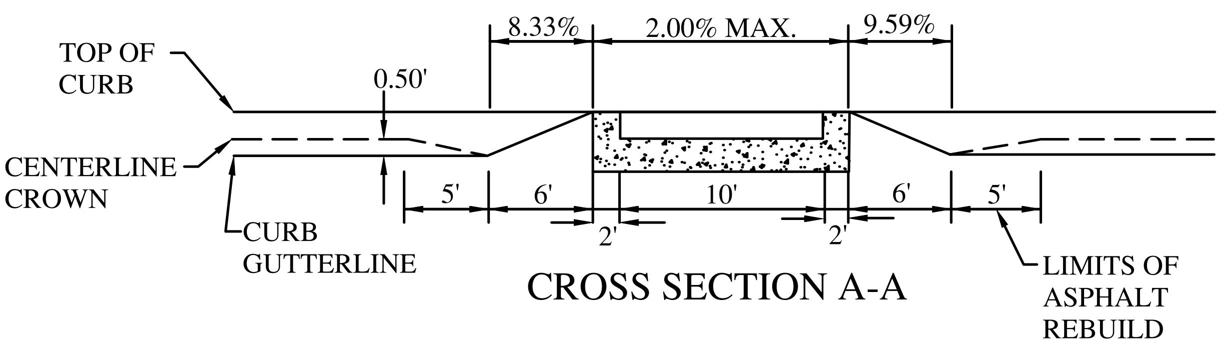
Date: 6-3-2013

GEORGE MASON UNIVERSITY

SECONDARY WALK - PAVER DIMENSIONS

Detail No: 3.1-14





CROSS SECTION A-A

NOTES:

1) Signs and markings shall be in accordance with the MUTCD.

2) Maximum vertical difference between top of adjacent brick pavers shall be 1/8” misshapen or deformed bricks are not acceptable.

3) Roadway drainage needs to be closely monitored.

NTS

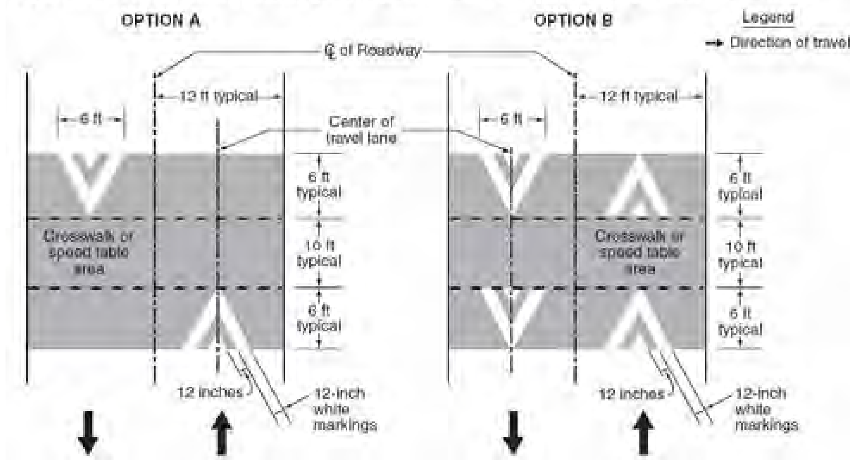
Date: 6-3-2013

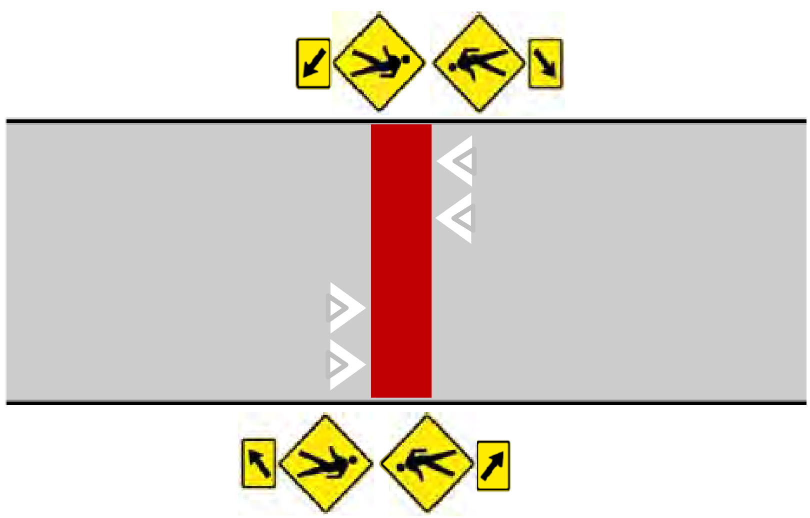
RAISED CROSSWALK

GEORGE MASON UNIVERSITY

Detail No: 3.1-15

Figure 3B-30. Pavement Markings for Speed Tables or Speed Humps with Crosswalks



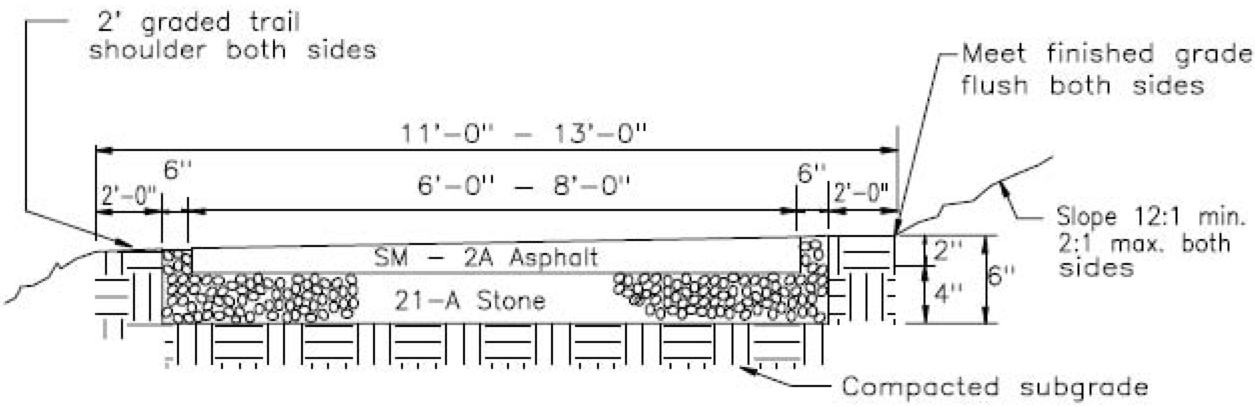


NTS

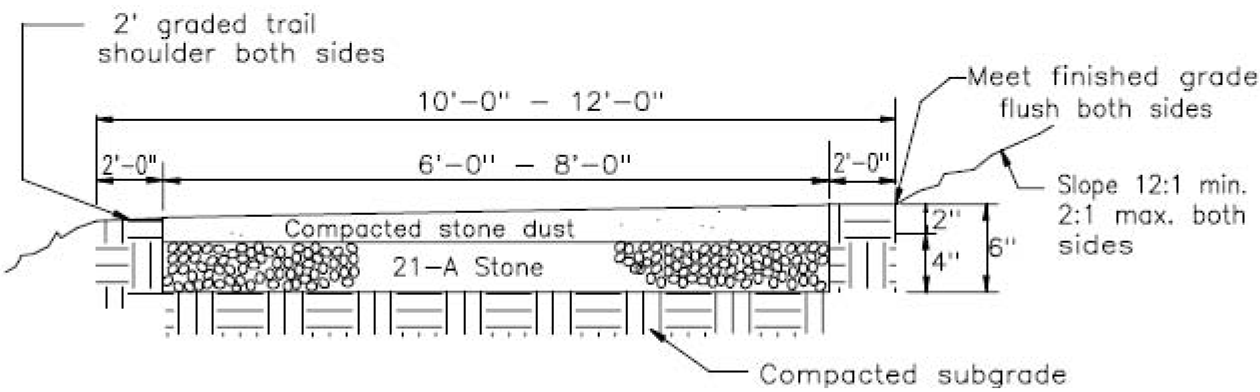
Date: 6-3-2013

RAISED CROSSWALK

Detail No: 3.1-16



TYPE I



TYPE II

NTS

Date: 6-3-2013

GEORGE MASON UNIVERSITY

TRAIL CROSS-SECTIONS

Detail No: 3.1-17

Administrative Zone

Academic Zone

Residential Zone

Support Zone

Natural Zone - Forested Riparian Corridors

Natural Zone - Forested Buffer

Campus Character Zones

NTS

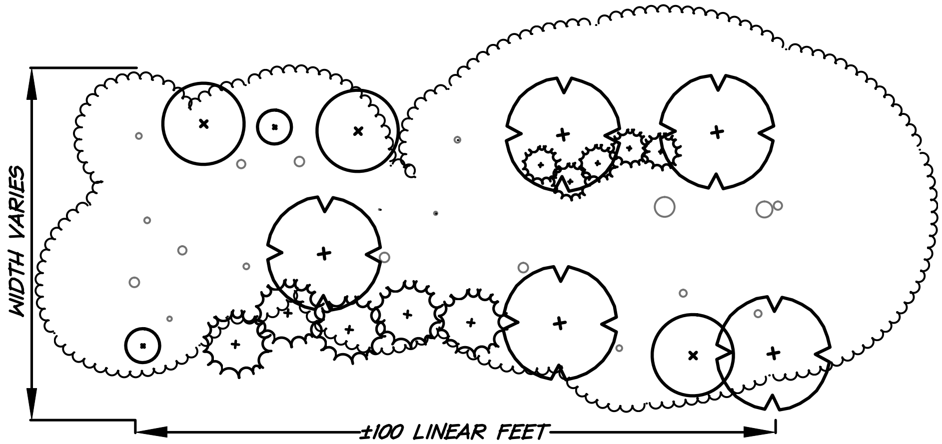
Date: 6-3-2013

CAMPUS CHARACTER ZONES

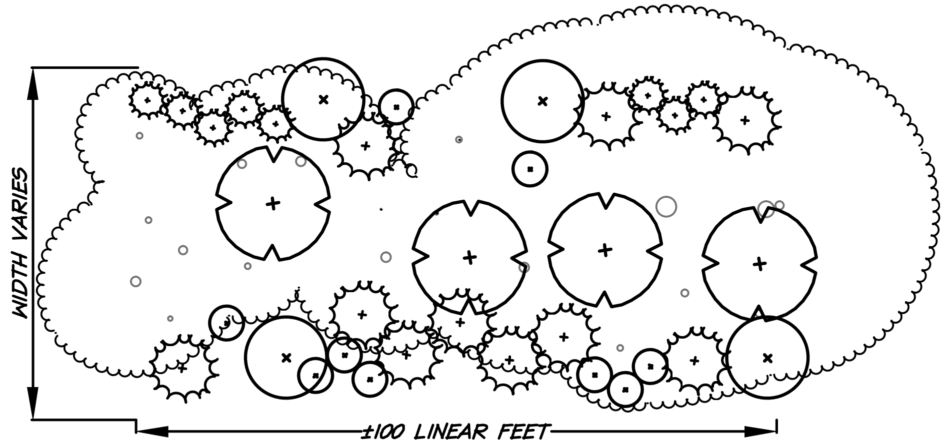
GEORGE MASON UNIVERSITY

Detail No: 3.1-18

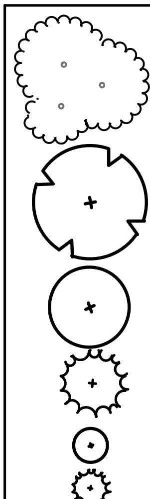
ALTERNATIVE A



ALTERNATIVE B



LEGEND



EXISTING TREELINE AND TRUNK LOCATIONS

PROPOSED OVERSTORY DECIDUOUS TREE

PROPOSED UNDERSTORY DECIDUOUS TREE

PROPOSED EVERGREEN TREE

PROPOSED DECIDUOUS SHRUB

PROPOSED EVERGREEN SHRUB

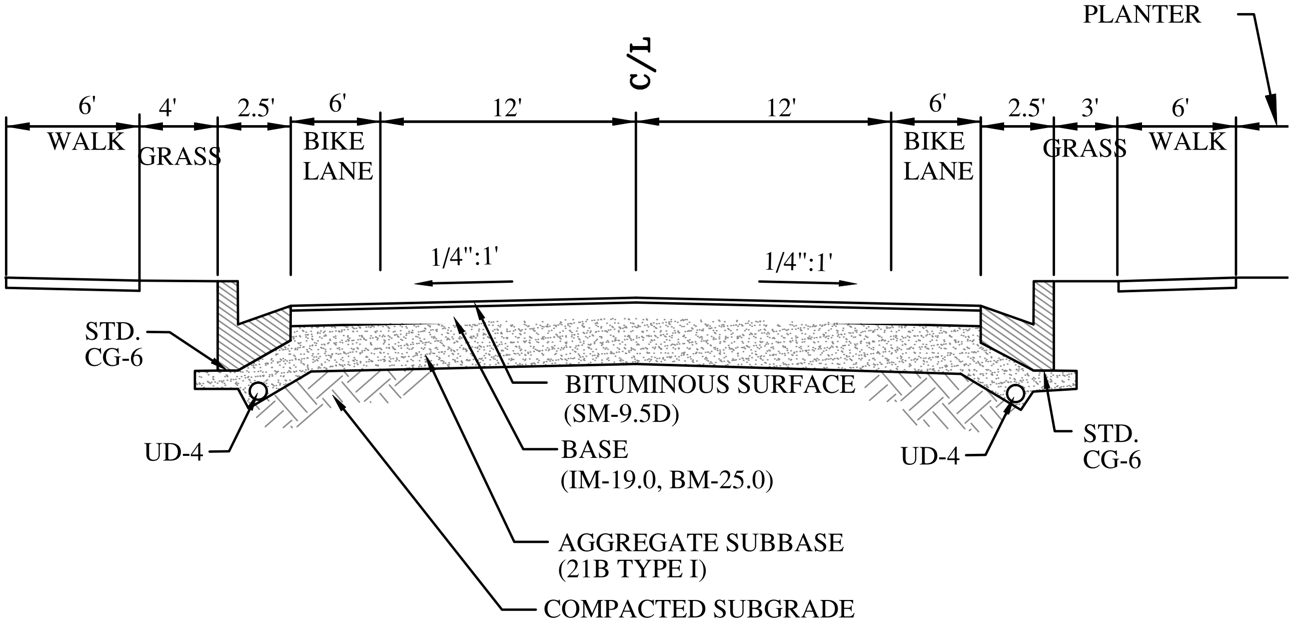
NTS

Date: 6-3-2013

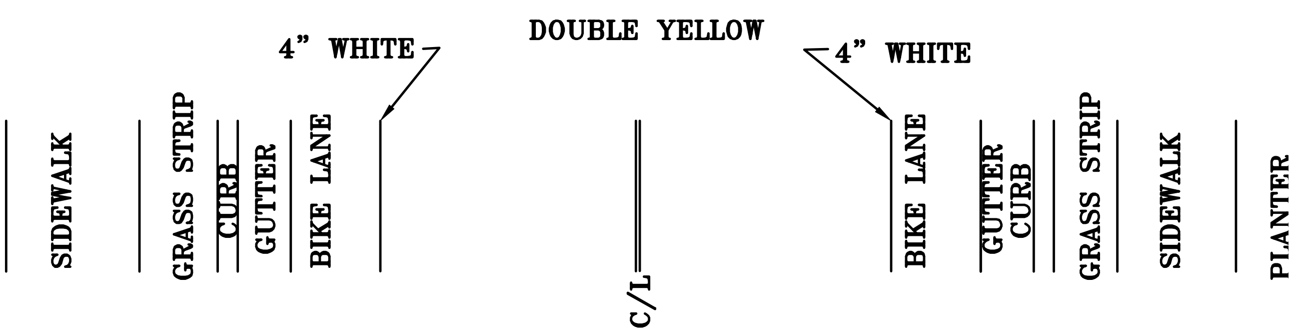
GEORGE MASON UNIVERSITY

LANDSCAPE BUFFER DETAIL

Detail No: 3.1-19



	FAIRFAX	P.W.
SURFACE	1.5”	1.5”
BASE IM	3”	2.5”
BASE BM	3”	3”
SUBBASE	6”	8”



STRIPING PLAN VIEW

NOTES:

1) Subbase depth is based on CBR value of 10. Soils test of subgrade will be performed for actual determination of required subbase thickness prior to the placement of subbase.

NTS

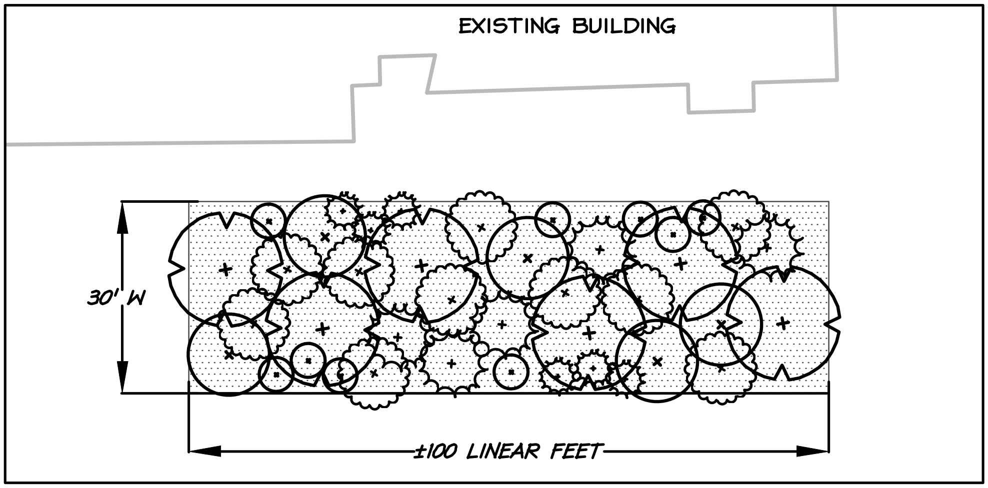
Date: 6-3-2013

SECONDARY ROAD - TYPICAL STREET SECTION

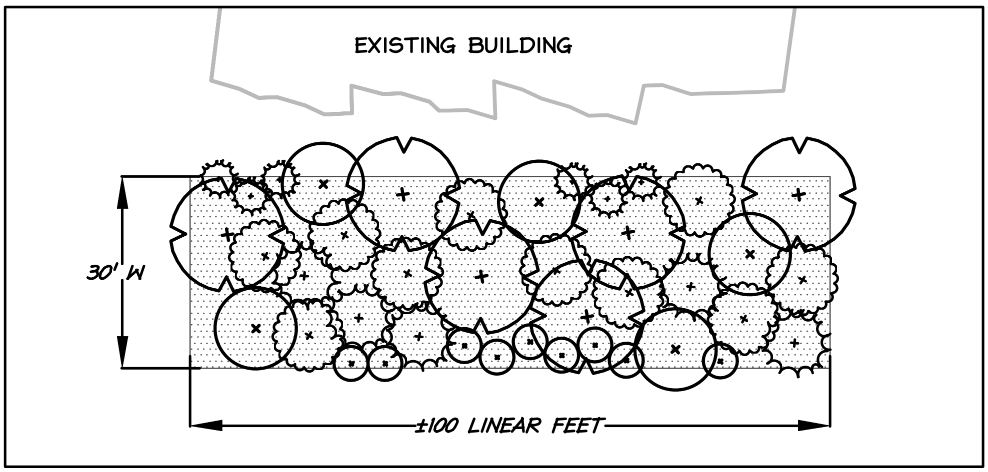
GEORGE MASON UNIVERSITY

Detail No: 3.1-2

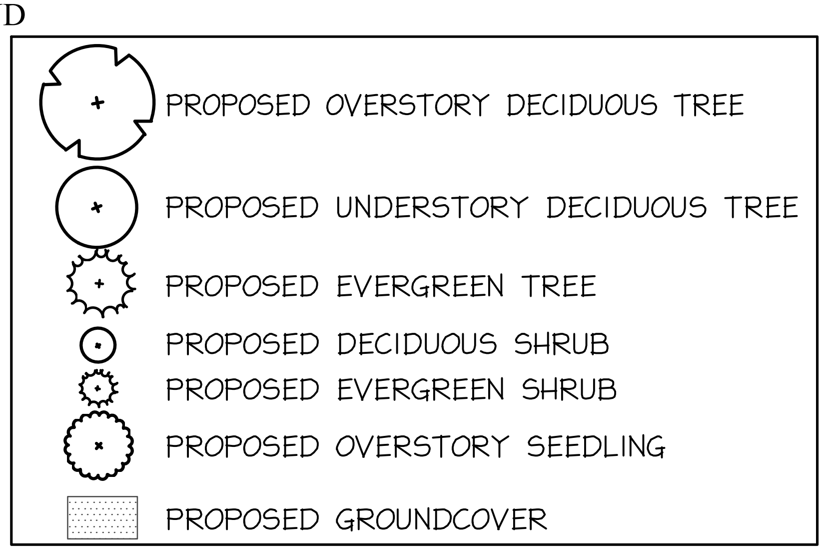
ALTERNATIVE A



ALTERNATIVE B



LEGEND



NTS

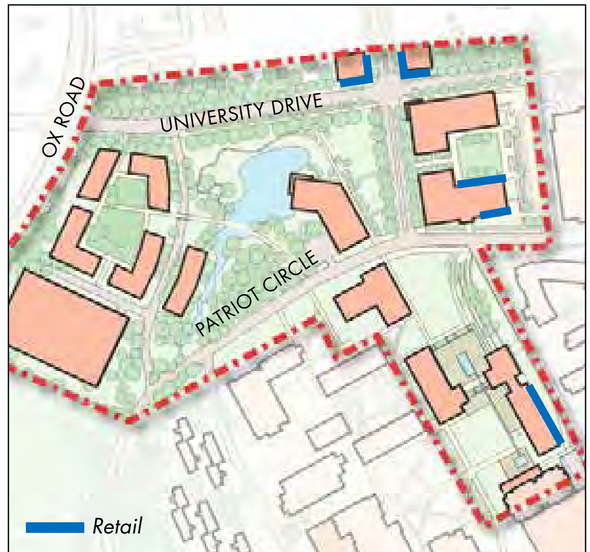
Date: 6-3-2013

LANDSCAPE BUFFER DETAIL

GEORGE MASON UNIVERSITY

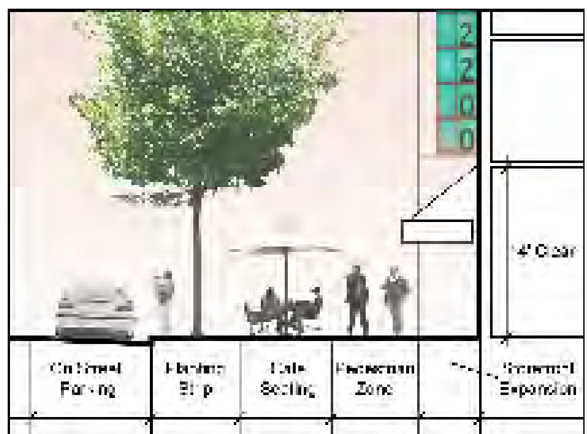
Detail No: 3.1-20

Precedent: Layered Retail Street



Preferred location for retail within the North Sector plan

Precedent: Retail Street Section



Individualized Storefront Design

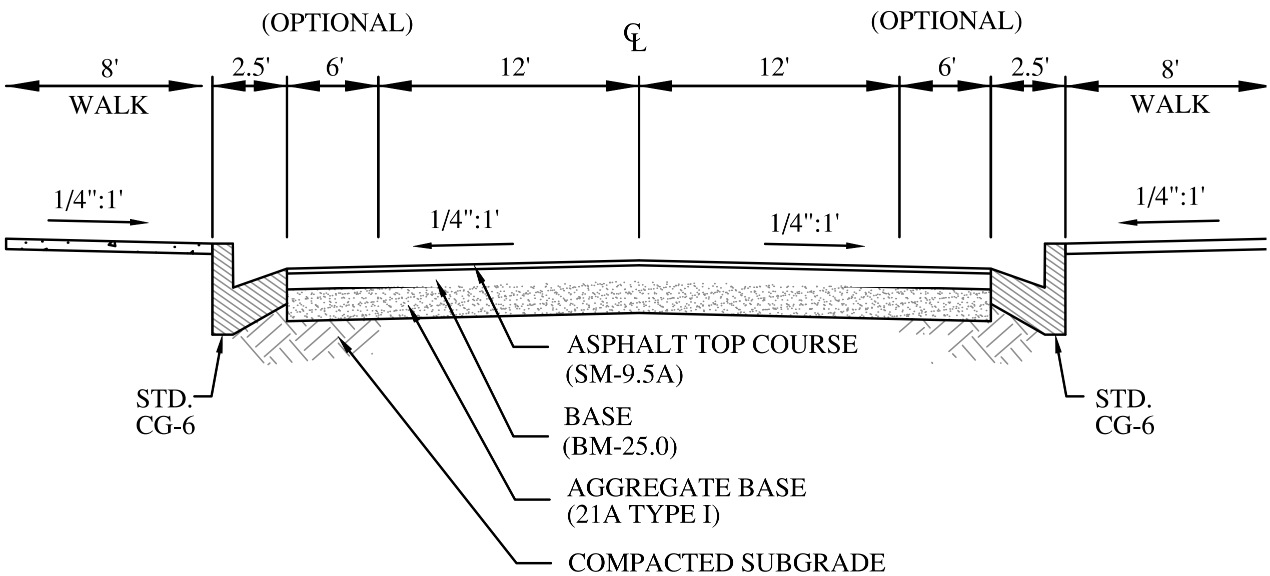
NTS

Date: 6-3-2013

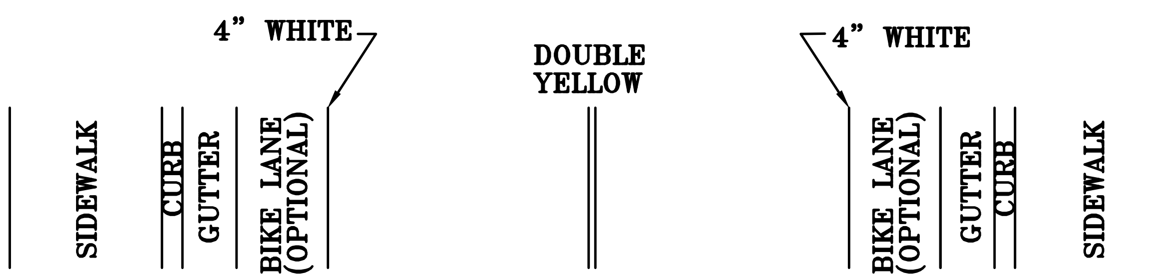
RETAIL GUIDELINES

GEORGE MASON UNIVERSITY

Detail No: 3.1-21



	FAIRFAX	P.W.
SURFACE	1.5"	1.5"
BASE	3"	3"
SUBBASE	7"	6"



STRIPING PLAN VIEW

NOTES:
1) Subbase depth is based on CBR value of 10. Soils test of subgrade will be performed for actual determination of required subbase thickness prior to the placement of subbase.

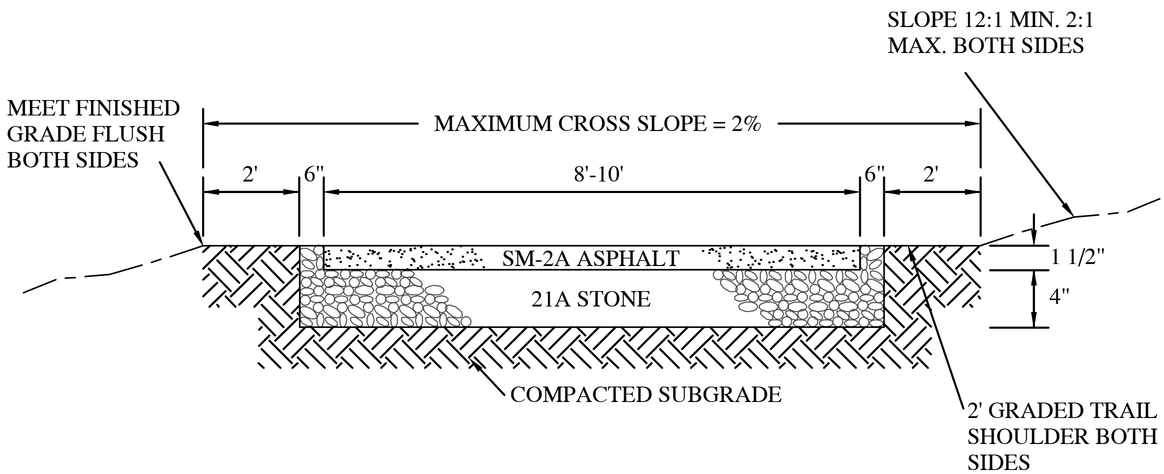
NTS

Date: 6-3-2013

TERTIARY ROAD - TYPICAL STREET SECTION

GEORGE MASON UNIVERSITY

Detail No: 3.1-3



NOTES:
1) Suitable for bicycle and general pedestrian use.
2) Where soil is well drained and compacted, 4" aggregate base may be eliminated and this section replaced by a full-depth asphalt section using 3" of BM-25.0 and 1 1/2" of SM-9.5A.
3) Asphalt trail needs to be on a subgrade compacted to 95% density.

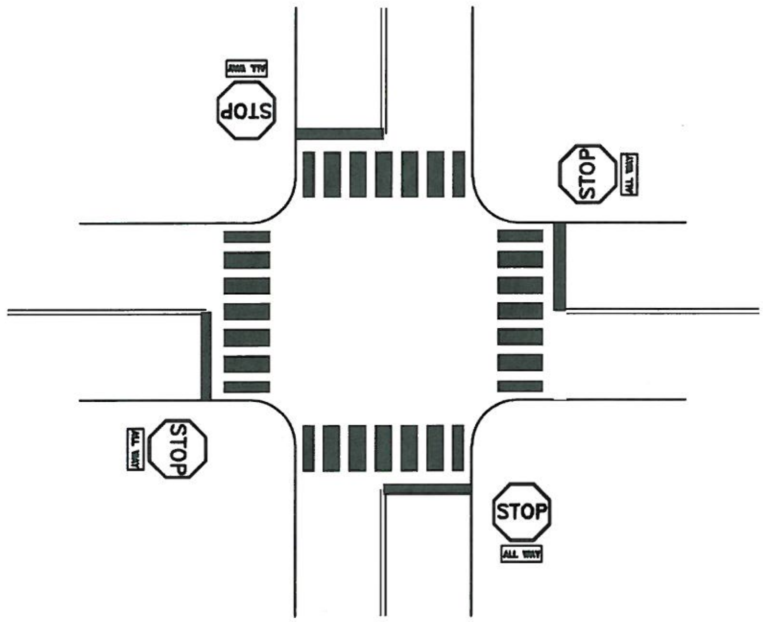
NTS

Date: 6-3-2013

SHARED USE TRAIL DETAIL

GEORGE MASON UNIVERSITY

Detail No: 3.1-4



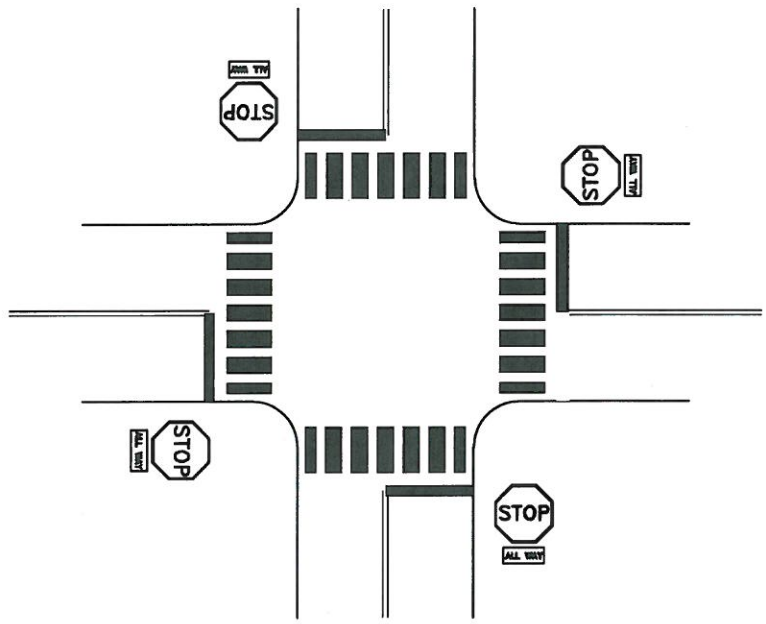
NTS

Date: 6-3-2013

ALL WAY STOP INTERSECTION

GEORGE MASON UNIVERSITY

Detail No: 3.1-5



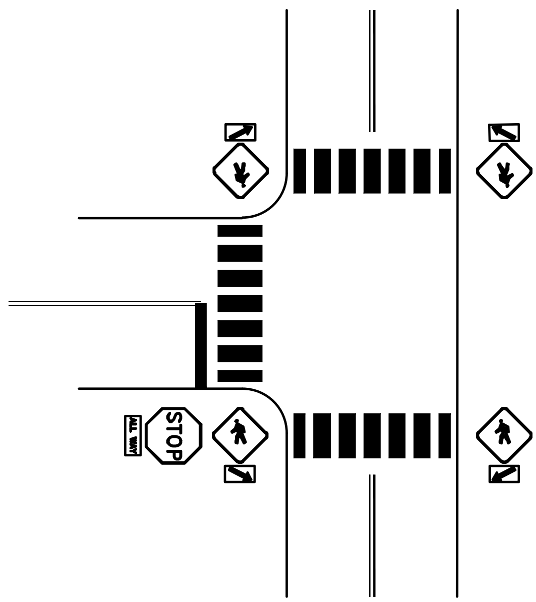
NTS

Date: 6-3-2013

ALL WAY STOP INTERSECTION

GEORGE MASON UNIVERSITY

Detail No: 3.1-5



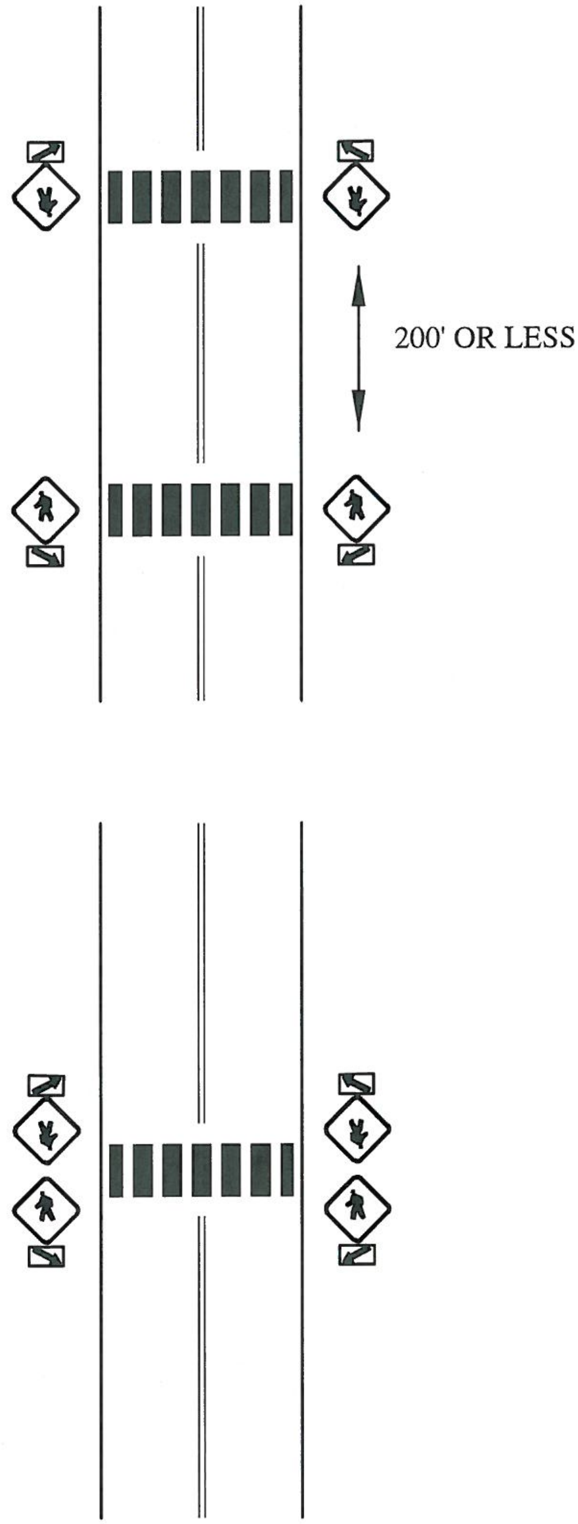
NTS

Date: 6-3-2013

SIDE STREET STOP INTERSECTION

GEORGE MASON UNIVERSITY

Detail No: 3.1-6



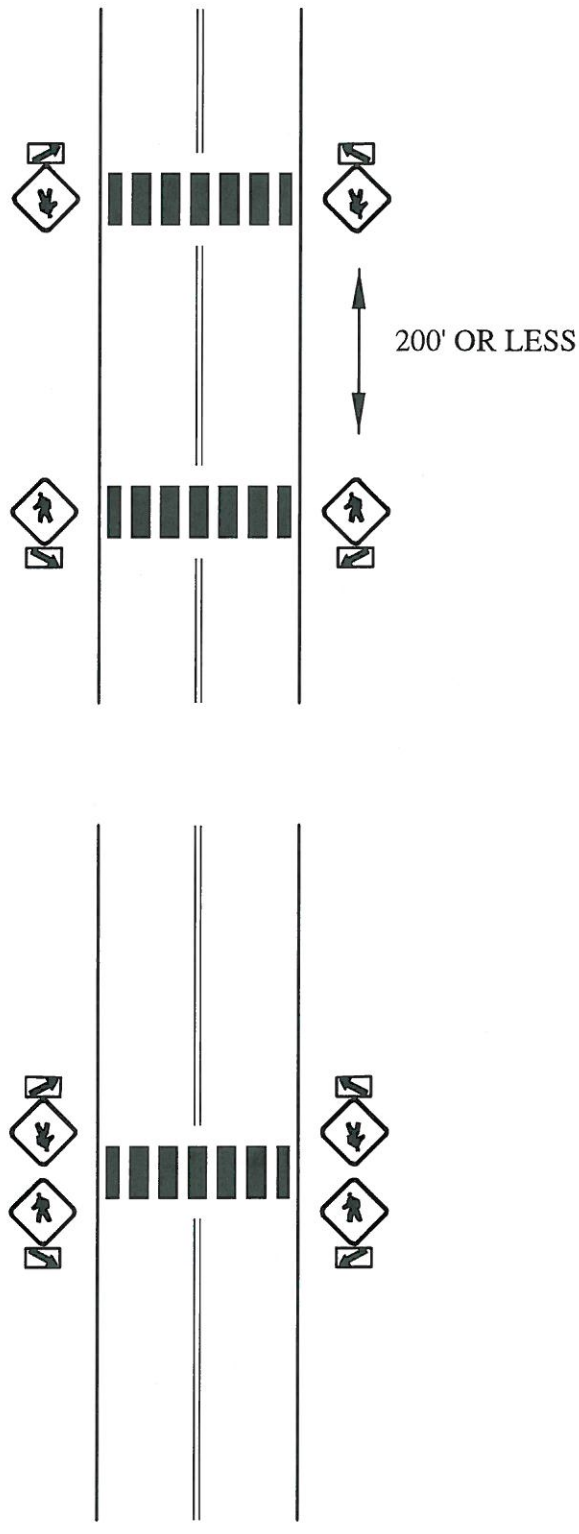
NTS

Date: 6-3-2013

GEORGE MASON UNIVERSITY

MAJOR MID-BLOCK/CLOSELY SPACED MID-BLOCK CROSSING

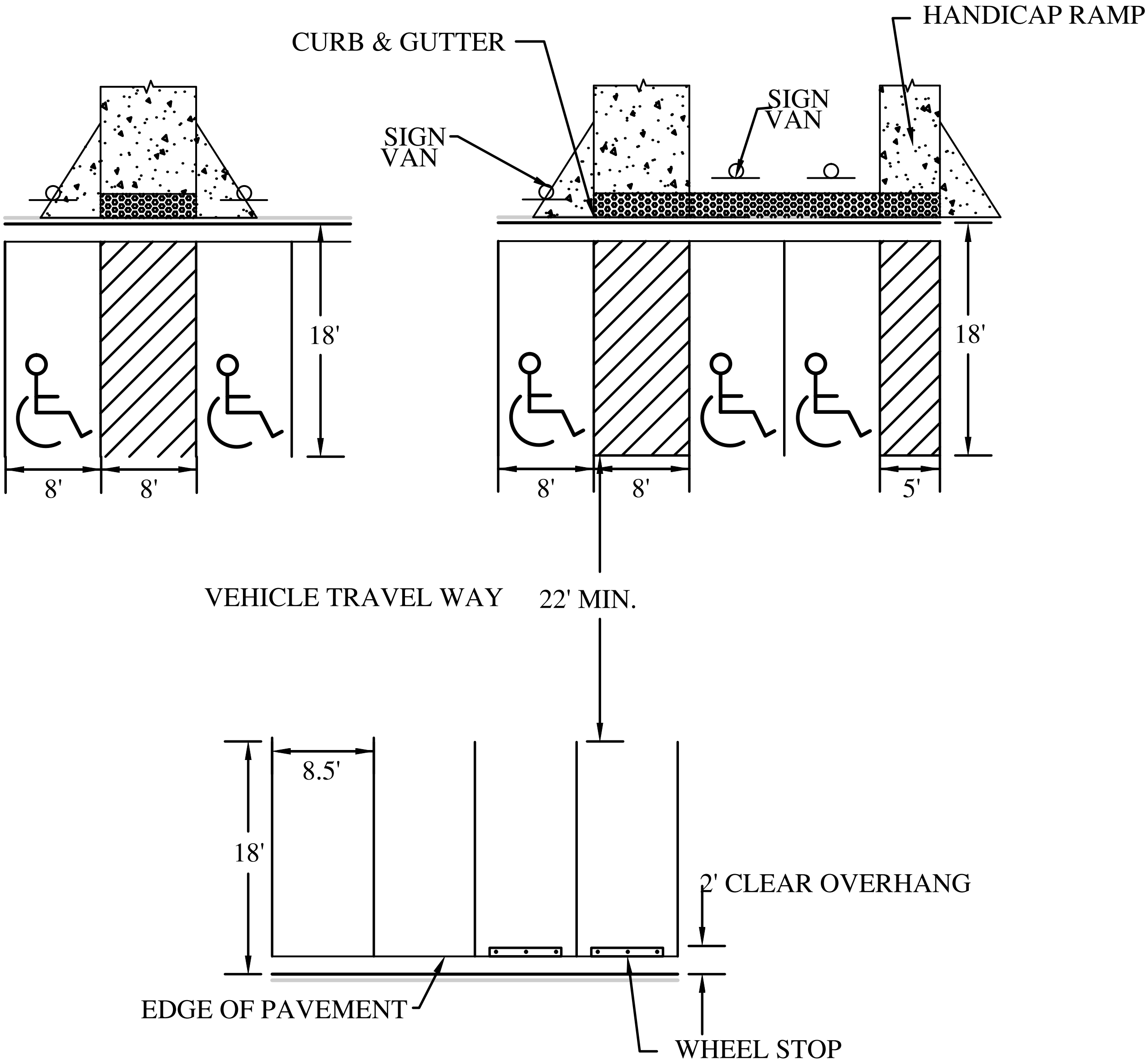
Detail No: 3.1-7



NTS

Date: 6-3-2013

MAJOR MID-BLOCK/CLOSELY SPACED
MID-BLOCK CROSSING
Detail No: 3.1-7



NOTES:

1) Dimensions typical unless otherwise noted.
2) All spaces less tan 8.5’ are compact spaces and must be marked with signage and have a painted end line to prevent larger vehicles from parking there.
3) End spaces in garages must be dedicated compact spaces to create better sight lines.
4) Avoid angled parking spaces. When necessary, use 60 angle.
5) Surface parking lots shall be constructed of flexible pavement.
6) Max slope allowed in any directions is 5% (2% for all ADA accessible spaces). Min. slope allowed in any direction is 1%.

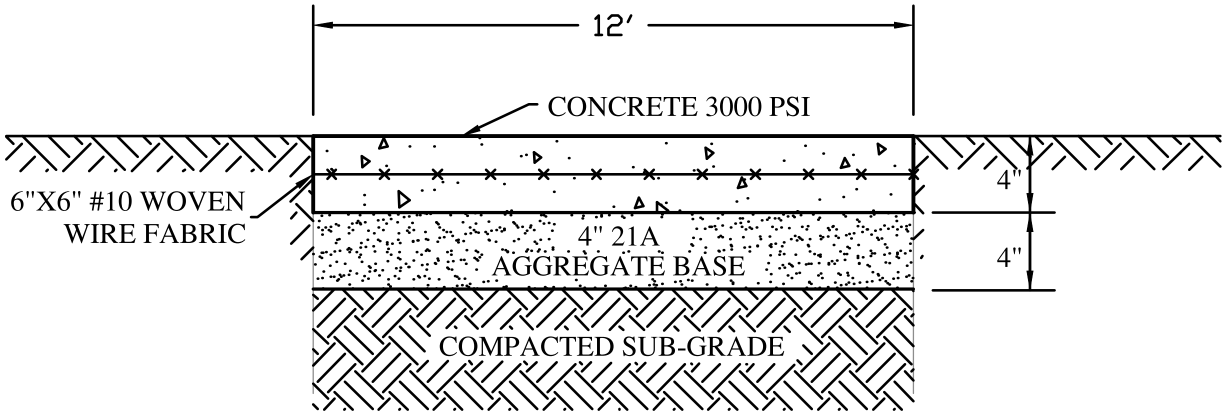
NTS

Date: 6-3-2013

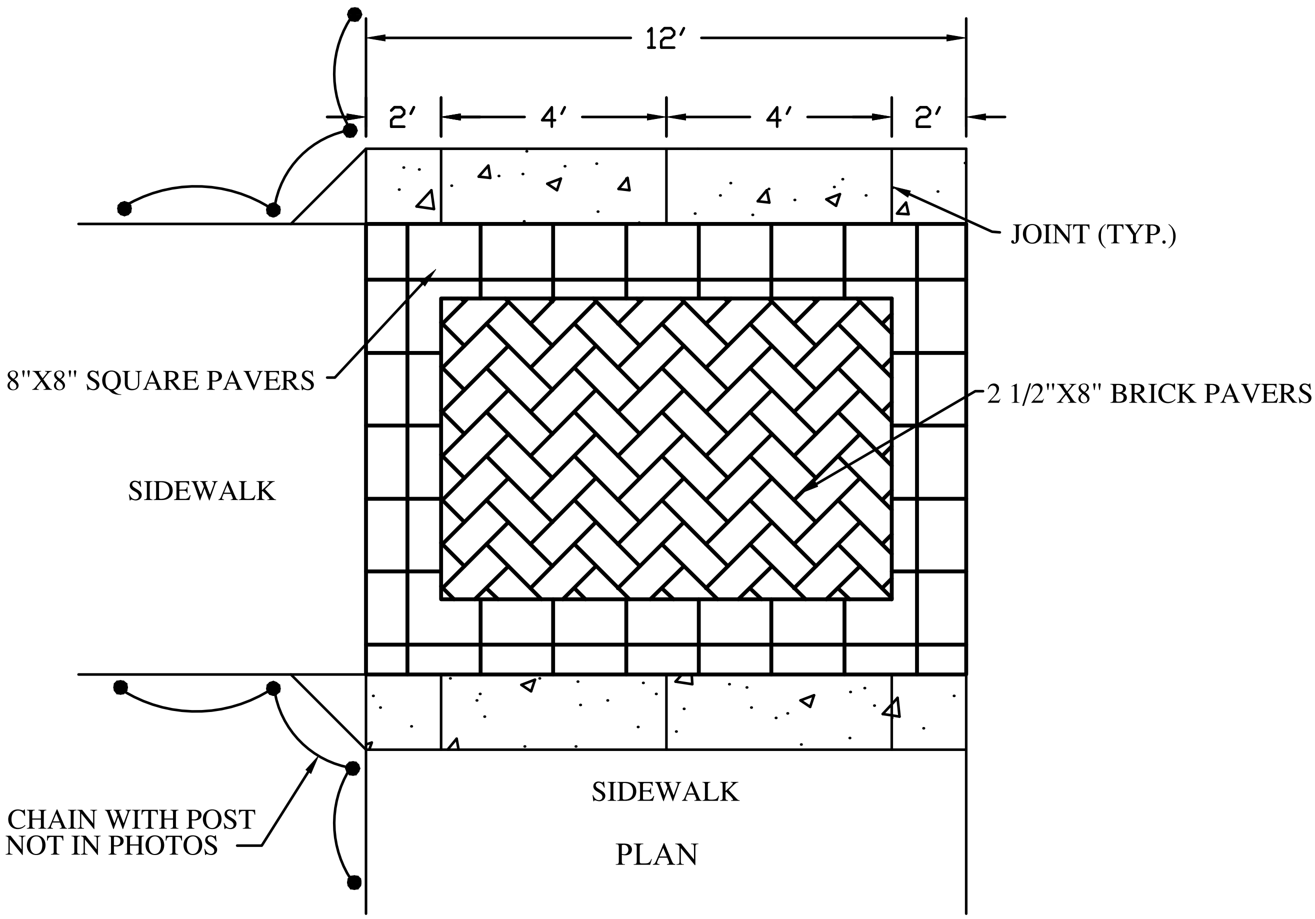
PARKING BAY/TRAVEL WAY

GEORGE MASON UNIVERSITY

Detail No: 3.1-8



SECTION



PLAN

NOTES:

1) Primary walks shall be 12' wide, measured inside clear area on ramps.
2) All walks wider than 8' must be reinforced.
3) Concrete to be class A3.
4) Color patterns with university approval.

NTS

Date: 6-3-2013

PRIMARY WALK SECTION AND PLAN

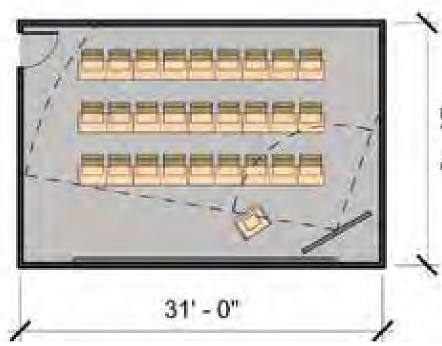
GEORGE MASON UNIVERSITY

Detail No: 3.1-9

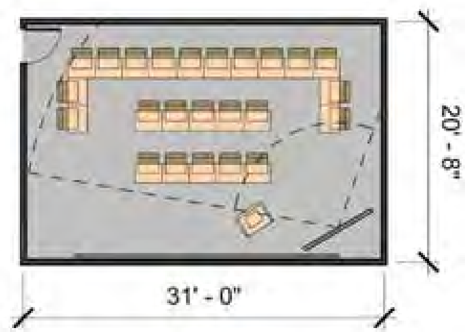
PLANNING AND DESIGN - INTERIOR

Date: 6-3-2013

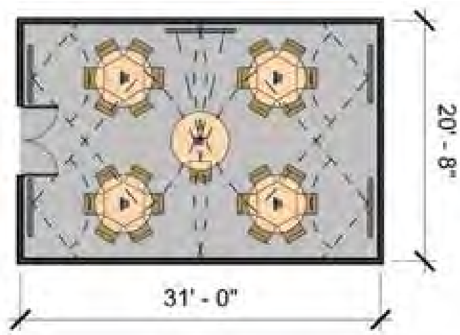
GEORGE MASON UNIVERSITY



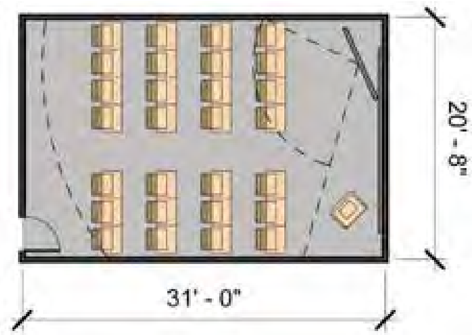
Classroom - 27 stud.



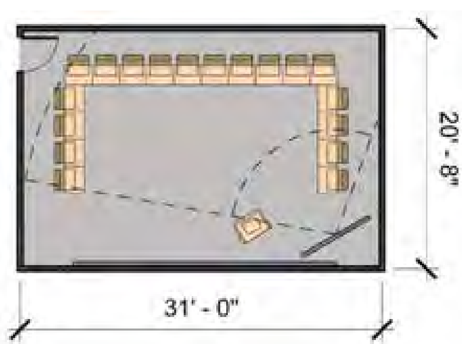
Classroom - 24 stud.



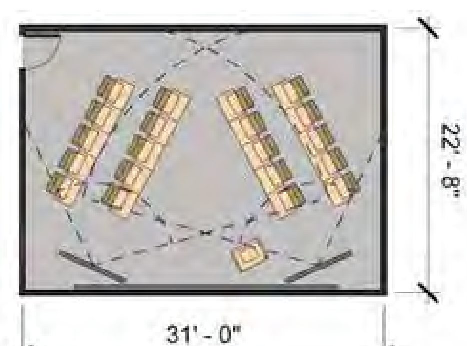
Classroom - 24 stud.



Classroom - 28 stud.



Classroom - 18 stud.



Classroom - 20 stud.

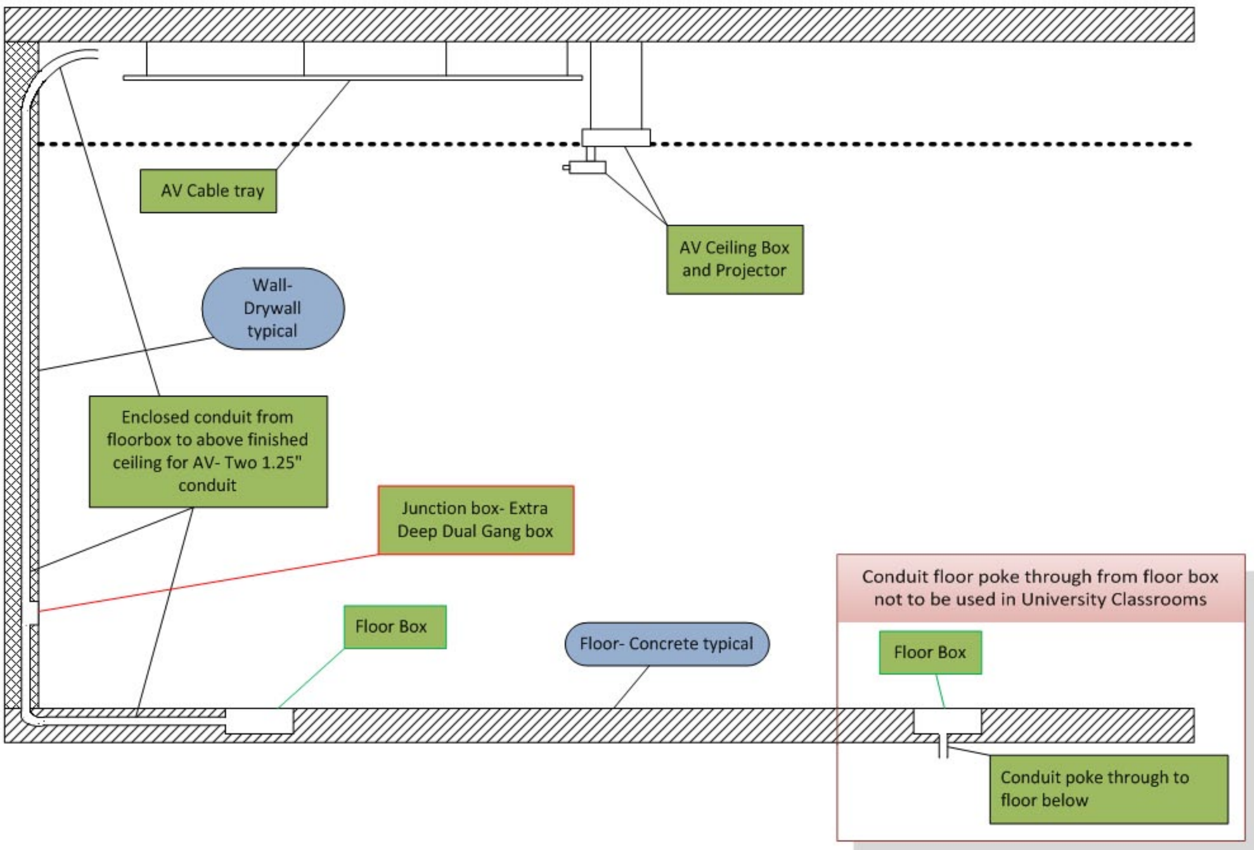
NTS

Date: 6-3-2013

GEORGE MASON UNIVERSITY

FLEXIBLE CLASSROOMS - 8-27 Students

Detail No: 3.2-1



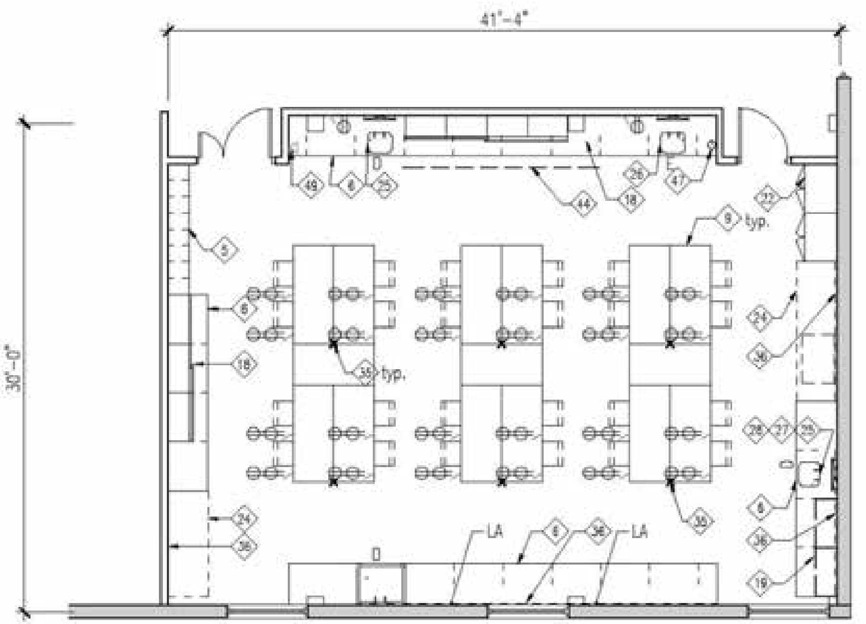
NTS

Date: 6-3-2013

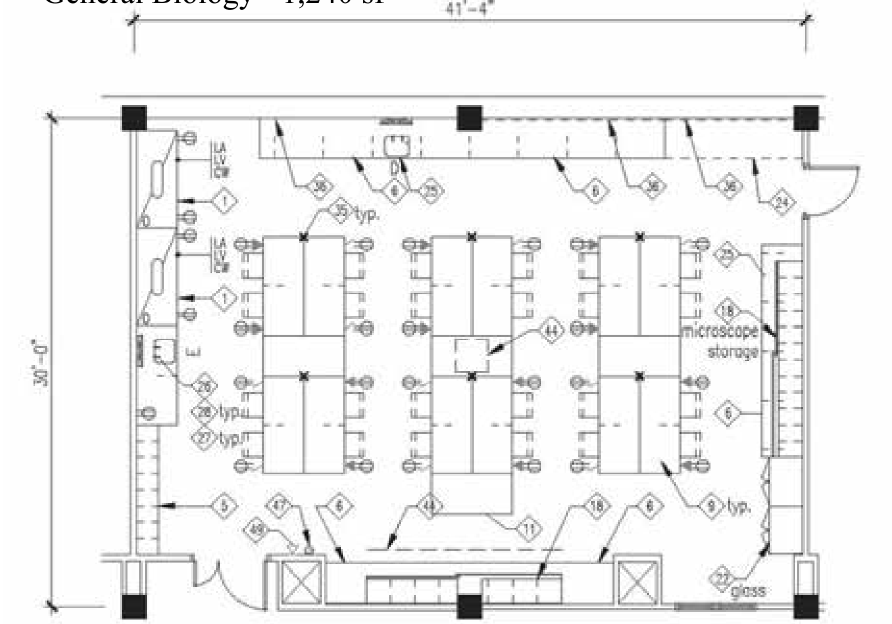
AV FLOORBOX AND CONDUIT

GEORGE MASON UNIVERSITY

Detail No: 3.2-10



General Biology - 1,240 sf



Biology (Majors) Principles 1 - 1,240 sf

Lab Furnishings Legend

1. Chemical Fume Hood
2. ADA Chemical Fume Hood
3. Biological Safety Cabinet
4. Snorkel Exhaust
5. Cubbies for Coats / Backpacks
6. Lab Bench Standing Height (fixed)
7. Lab Bench Sitting Height (fixed)
8. Lab Table Standing Height (moveable)
9. Lab Table Sitting Height (moveable)
10. Adjust. Height Moveable Lab Tables
11. Moveable Demonstration Bench
12. Desk / Writing table
13. Balance Table
14. ADA Height Workstation
15. Movable Demonstration Bench
16. Mobile Base Cabinet (below)
17. Wall Cabinet Solid Doors
18. Wall Storage behind Marker/Black Boards
19. Adjustable Wall Shelves
20. Reagent Shelves Above Casework
21. Industrial Adjustable Shelving
22. Tall Storage Cabinet
23. Vented Storage Cabinet
24. Equipment Space
25. Laboratory Sink
26. ADA Sink
27. Utility or Pipe Drop Enclosure
28. Pegboard
29. Cupsink
30. Processing Sink
31. Cylinder Rack
32. Safety Shower
33. Eyewash
34. Overhead Service Carrier
35. Flexible Power/Data Drop
36. Electrical Raceway
37. Glassware Washer
38. Glassware Dryer
39. Autoclave
40. Wire Shelving
41. White Markerboard
42. Black Chalkboard
43. Tackboard
44. A/V Screen
45. Ceiling Data/Power for P
46. File Cabinet
47. Fire Extinguisher
48. Black-Out Shades
49. Wall Mount Telephone
50. Rolling Cart (by owner)
51. Lattice Rod Assembly
52. Down Draft Exhaust
53. Gas Tank Rack

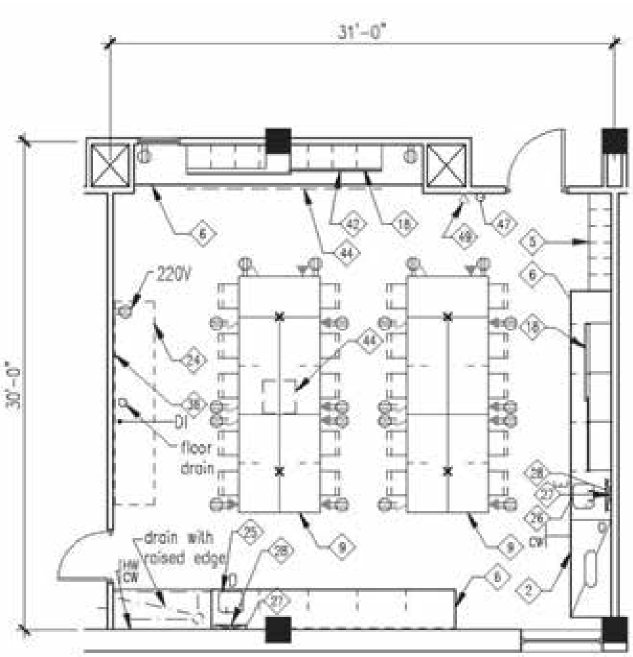
NTS

Date: 6-3-2013

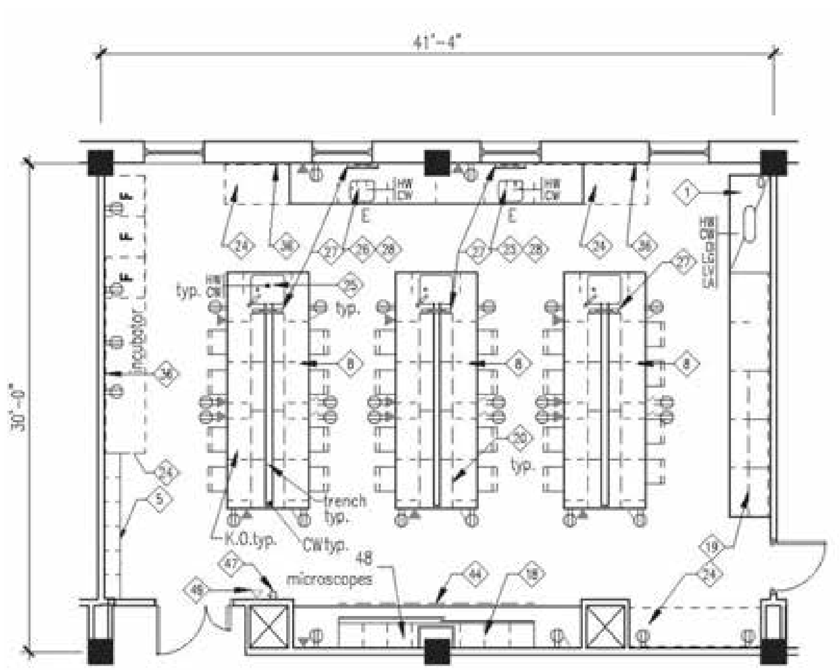
BIOLOGY LAB DIAGRAMS

GEORGE MASON UNIVERSITY

Detail No: 3.2-11



Ecology/Plant Biology - 930 sf



Genetics MicroBiology - 1,240 sf

Lab Furnishings Legend

1. Chemical Fume Hood
2. ADA Chemical Fume Hood
3. Biological Safety Cabinet
4. Snorkel Exhaust
5. Cubbies for Coats / Backpacks
6. Lab Bench Standing Height (fixed)
7. Lab Bench Sitting Height (fixed)
8. Lab Table Standing Height (moveable)
9. Lab Table Sitting Height (moveable)
10. Adjust. Height Moveable Lab Tables
11. Moveable Demonstration Bench
12. Desk / Writing table
13. Balance Table
14. ADA Height Workstation
15. Movable Demonstration Bench
16. Mobile Base Cabinet (below)
17. Wall Cabinet Solid Doors
18. Wall Storage behind Marker/Black Boards
19. Adjustable Wall Shelves
20. Reagent Shelves Above Casework
21. Industrial Adjustable Shelving
22. Tall Storage Cabinet
23. Vented Storage Cabinet
24. Equipment Space
25. Laboratory Sink
26. ADA Sink
27. Utility or Pipe Drop Enclosure
28. Pegboard
29. Cupsink
30. Processing Sink
31. Cylinder Rack
32. Safety Shower
33. Eyewash
34. Overhead Service Carrier
35. Flexible Power/Data Drop
36. Electrical Raceway
37. Glassware Washer
38. Glassware Dryer
39. Autoclave
40. Wire Shelving
41. White Markerboard
42. Black Chalkboard
43. Tackboard
44. A/V Screen
45. Ceiling Data/Power for Pojector
46. File Cabinet
47. Fire Extinguisher
48. Black-Out Shades
49. Wall Mount Telephone
50. Rolling Cart (by owner)
51. Lattice Rod Assembly
52. Down Draft Exhaust
53. Gas Tank Rack

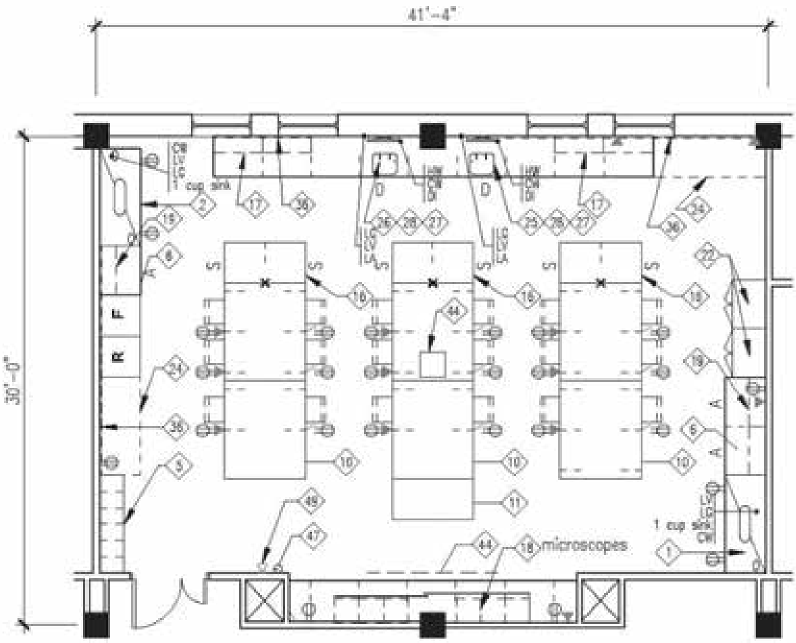
NTS

Date: 6-3-2013

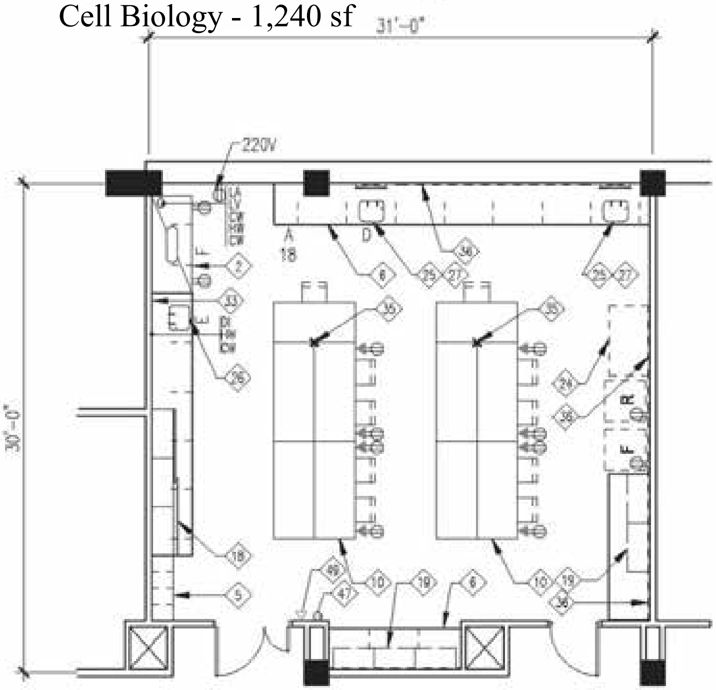
BIOLOGY LAB DIAGRAMS

GEORGE MASON UNIVERSITY

Detail No: 3.2-12



Cell Biology - 1,240 sf



Animal Anatomy - 930 sf

Lab Furnishings Legend

1. Chemical Fume Hood
2. ADA Chemical Fume Hood
3. Biological Safety Cabinet
4. Snorkel Exhaust
5. Cubbies for Coats / Backpacks
6. Lab Bench Standing Height (fixed)
7. Lab Bench Sitting Height (fixed)
8. Lab Table Standing Height (moveable)
9. Lab Table Sitting Height (moveable)
10. Adjust. Height Moveable Lab Tables
11. Moveable Demonstration Bench
12. Desk / Writing table
13. Balance Table
14. ADA Height Workstation
15. Movable Demonstration Bench
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34. Overhead Service Carrier
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38. Glassware Dryer
39. Autoclave
40. Wire Shelving
41. White Markerboard
42. Black Chalkboard
43. Tackboard
44. A/V Screen
45. Ceiling Data/Power for Pojector
46. File Cabinet
47. Fire Extinguisher
48. Black-Out Shades
49. Wall Mount Telephone
50. Rolling Cart (by owner)
51. Lattice Rod Assembly
52. Down Draft Exhaust
53. Gas Tank Rack

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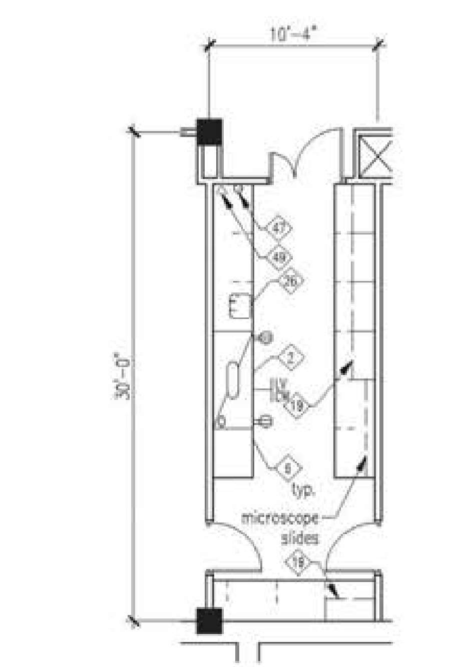
Date: 6-3-2013

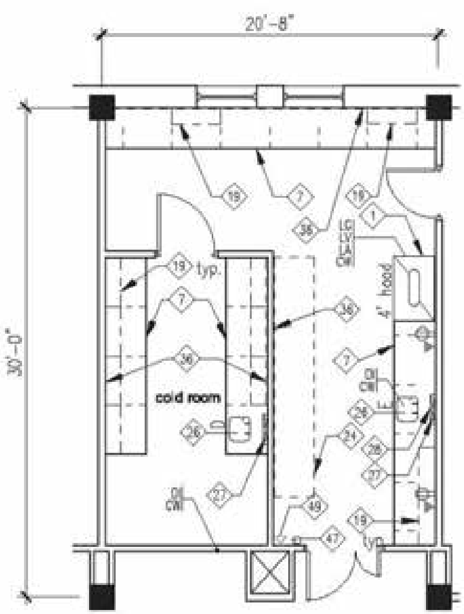
BIOLOGY LAB DIAGRAMS

GEORGE MASON UNIVERSITY

Detail No: 3.2-13



General Biology Prep - 310 sf



Cell & Molecular Bio. Prep - 620 sf

Lab Furnishings Legend

1. Chemical Fume Hood
2. ADA Chemical Fume Hood
3. Biological Safety Cabinet
4. Snorkel Exhaust
5. Cubbies for Coats / Backpacks
6. Lab Bench Standing Height (fixed)
7. Lab Bench Sitting Height (fixed)
8. Lab Table Standing Height (moveable)
9. Lab Table Sitting Height (moveable)
10. Adjust. Height Moveable Lab Tables
11. Moveable Demonstration Bench
12. Desk / Writing table
13. Balance Table
14. ADA Height Workstation
15. Movable Demonstration Bench
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28. Pegboard
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31. Cylinder Rack
32. Safety Shower
33. Eyewash
34. Overhead Service Carrier
35. Flexible Power/Data Drop
36. Electrical Raceway
37. Glassware Washer
38. Glassware Dryer
39. Autoclave
40. Wire Shelving
41. White Markerboard
42. Black Chalkboard
43. Tackboard
44. A/V Screen
45. Ceiling Data/Power for Pojector
46. File Cabinet
47. Fire Extinguisher
48. Black-Out Shades
49. Wall Mount Telephone
50. Rolling Cart (by owner)
51. Lattice Rod Assembly
52. Down Draft Exhaust
53. Gas Tank Rack

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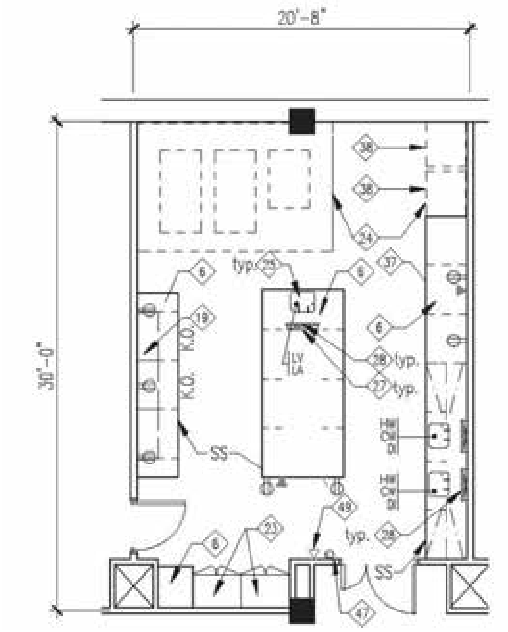
Date: 6-3-2013

BIOLOGY LAB DIAGRAMS

GEORGE MASON UNIVERSITY

Detail No: 3.2-14



Autoclave & Glasswash Biology - 620 sf

Lab Furnishings Legend

1. Chemical Fume Hood
2. ADA Chemical Fume Hood
3. Biological Safety Cabinet
4. Snorkel Exhaust
5. Cubbies for Coats / Backpacks
6. Lab Bench Standing Height (fixed)
7. Lab Bench Sitting Height (fixed)
8. Lab Table Standing Height (moveable)
9. Lab Table Sitting Height (moveable)
10. Adjust. Height Moveable Lab Tables
11. Moveable Demonstration Bench
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34. Overhead Service Carrier
35. Flexible Power/Data Drop
36. Electrical Raceway
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38. Glassware Dryer
39. Autoclave
40. Wire Shelving
41. White Markerboard
42. Black Chalkboard
43. Tackboard
44. A/V Screen
45. Ceiling Data/Power for Pojector
46. File Cabinet
47. Fire Extinguisher
48. Black-Out Shades
49. Wall Mount Telephone
50. Rolling Cart (by owner)
51. Lattice Rod Assembly
52. Down Draft Exhaust
53. Gas Tank Rack

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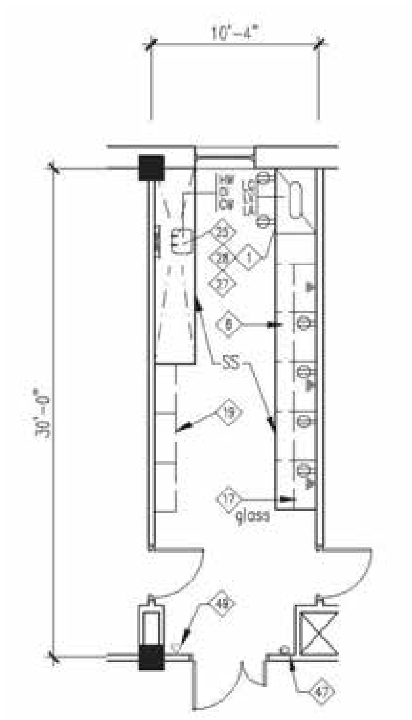
Date: 6-3-2013

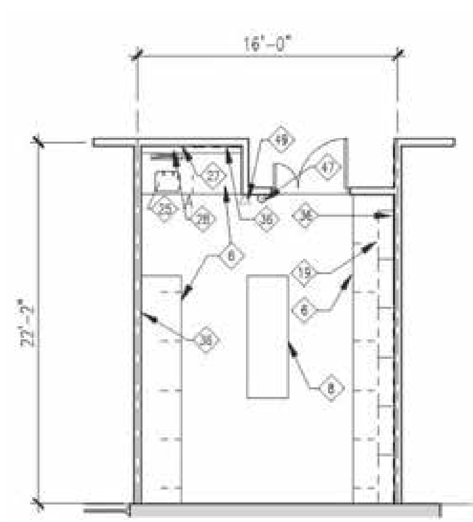
BIOLOGY LAB DIAGRAMS

GEORGE MASON UNIVERSITY

Detail No: 3.2-15



Media Prep - 310 sf



Animal Collection Room - 435 sf

Lab Furnishings Legend

1. Chemical Fume Hood
2. ADA Chemical Fume Hood
3. Biological Safety Cabinet
4. Snorkel Exhaust
5. Cubbies for Coats / Backpacks
6. Lab Bench Standing Height (fixed)
7. Lab Bench Sitting Height (fixed)
8. Lab Table Standing Height (moveable)
9. Lab Table Sitting Height (moveable)
10. Adjust. Height Moveable Lab Tables
11. Moveable Demonstration Bench
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28. Pegboard
29. Cupsink
30. Processing Sink
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32. Safety Shower
33. Eyewash
34. Overhead Service Carrier
35. Flexible Power/Data Drop
36. Electrical Raceway
37. Glassware Washer
38. Glassware Dryer
39. Autoclave
40. Wire Shelving
41. White Markerboard
42. Black Chalkboard
43. Tackboard
44. A/V Screen
45. Ceiling Data/Power for Pojector
46. File Cabinet
47. Fire Extinguisher
48. Black-Out Shades
49. Wall Mount Telephone
50. Rolling Cart (by owner)
51. Lattice Rod Assembly
52. Down Draft Exhaust
53. Gas Tank Rack

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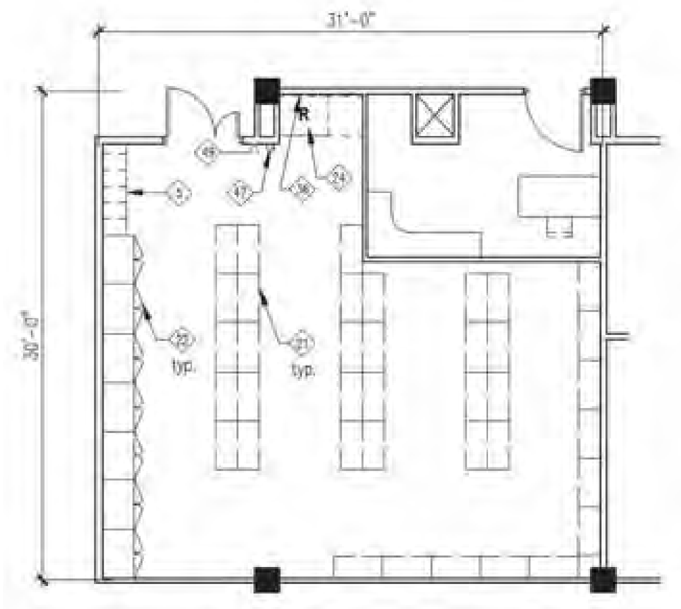
Date: 6-3-2013

BIOLOGY LAB DIAGRAMS

Detail No: 3.2-16



Biology Stockroom - 930 sf

Lab Furnishings Legend

1. Chemical Fume Hood
2. ADA Chemical Fume Hood
3. Biological Safety Cabinet
4. Snorkel Exhaust
5. Cubbies for Coats / Backpacks
6. Lab Bench Standing Height (fixed)
7. Lab Bench Sitting Height (fixed)
8. Lab Table Standing Height (moveable)
9. Lab Table Sitting Height (moveable)
10. Adjust. Height Moveable Lab Tables
11. Moveable Demonstration Bench
12. Desk / Writing table
13. Balance Table
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28. Pegboard
29. Cupsink
30. Processing Sink
31. Cylinder Rack
32. Safety Shower
33. Eyewash
34. Overhead Service Carrier
35. Flexible Power/Data Drop
36. Electrical Raceway
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39. Autoclave
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43. Tackboard
44. A/V Screen
45. Ceiling Data/Power for Pojector
46. File Cabinet
47. Fire Extinguisher
48. Black-Out Shades
49. Wall Mount Telephone
50. Rolling Cart (by owner)
51. Lattice Rod Assembly
52. Down Draft Exhaust
53. Gas Tank Rack

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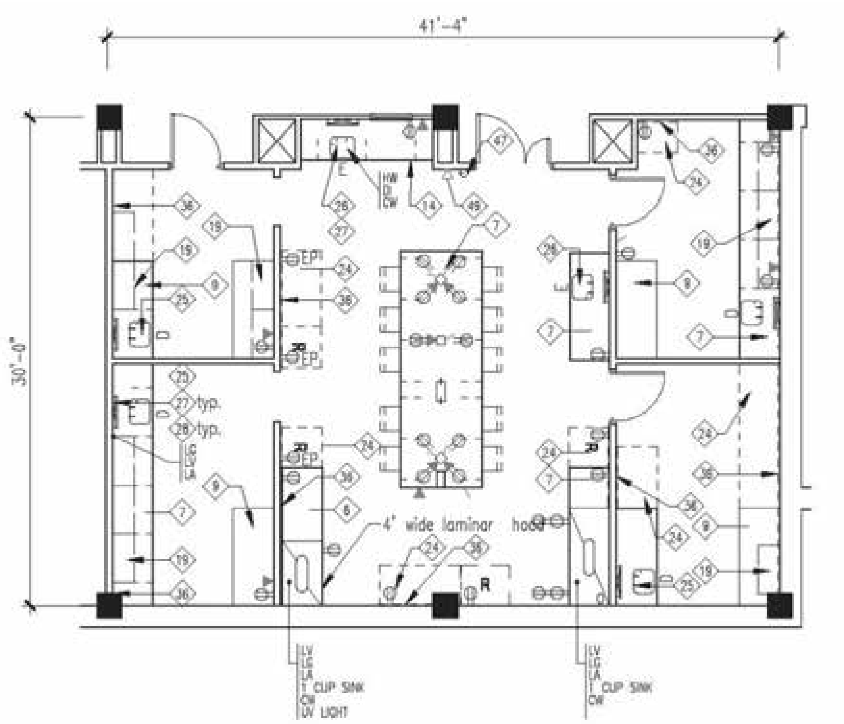
Date: 6-3-2013

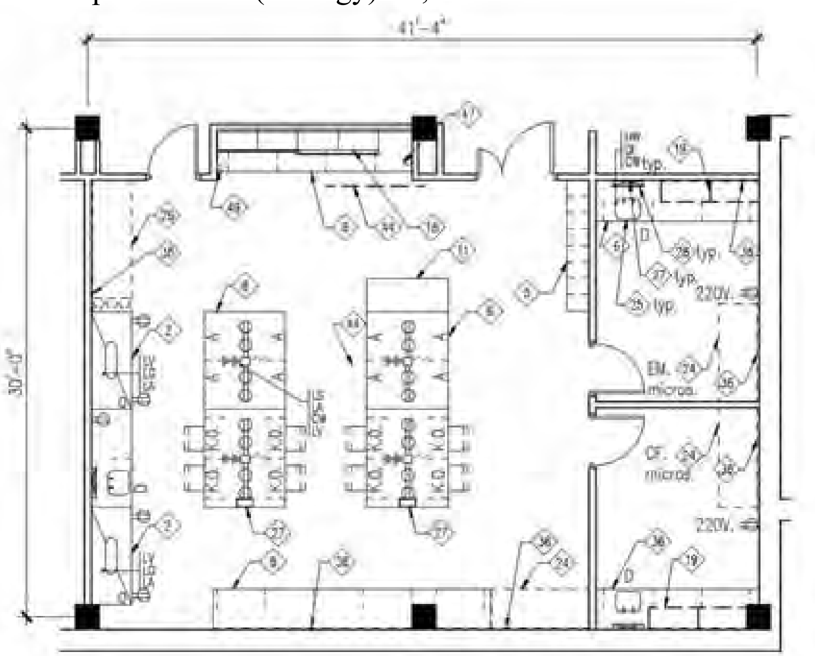
BIOLOGY LAB DIAGRAMS

GEORGE MASON UNIVERSITY

Detail No: 3.2-17



Capstone Labs (Biology) - 1,240 sf



Research Capstone Labs - 1,240 sf

Lab Furnishings Legend

1. Chemical Fume Hood
2. ADA Chemical Fume Hood
3. Biological Safety Cabinet
4. Snorkel Exhaust
5. Cubbies for Coats / Backpacks
6. Lab Bench Standing Height (fixed)
7. Lab Bench Sitting Height (fixed)
8. Lab Table Standing Height (moveable)
9. Lab Table Sitting Height (moveable)
10. Adjust. Height Moveable Lab Tables
11. Moveable Demonstration Bench
12. Desk / Writing table
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14. ADA Height Workstation
15. Movable Demonstration Bench
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39. Autoclave
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42. Black Chalkboard
43. Tackboard
44. A/V Screen
45. Ceiling Data/Power for Pojector
46. File Cabinet
47. Fire Extinguisher
48. Black-Out Shades
49. Wall Mount Telephone
50. Rolling Cart (by owner)
51. Lattice Rod Assembly
52. Down Draft Exhaust
53. Gas Tank Rack

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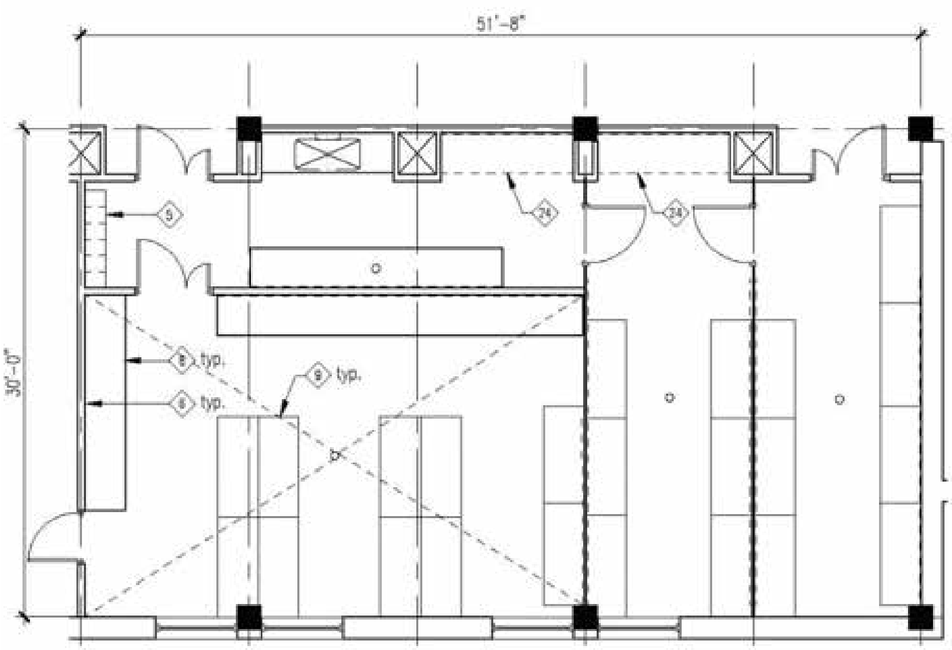
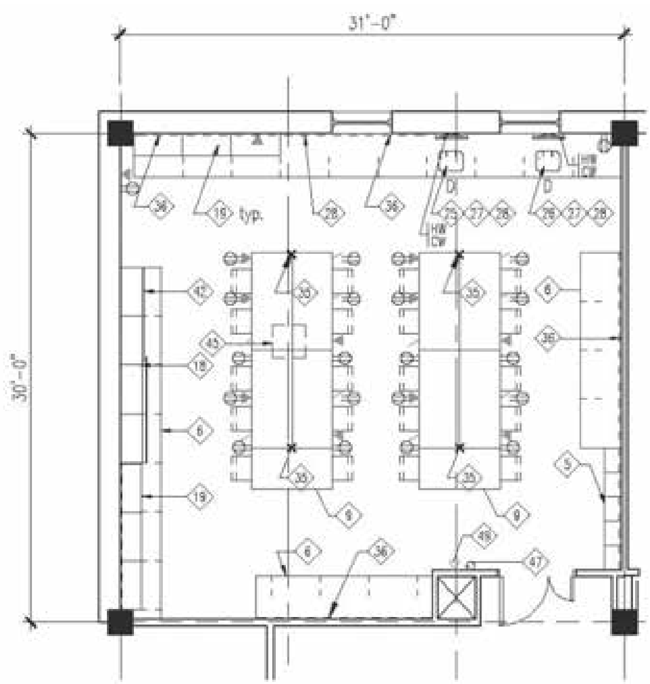
BIOLOGY LAB DIAGRAMS

Detail No: 3.2-18



GreenHouse HeadHouse - 1,560 sf



Research (Biology) - 930 sf

Lab Furnishings Legend

1. Chemical Fume Hood
2. ADA Chemical Fume Hood
3. Biological Safety Cabinet
4. Snorkel Exhaust
5. Cubbies for Coats / Backpacks
6. Lab Bench Standing Height (fixed)
7. Lab Bench Sitting Height (fixed)
8. Lab Table Standing Height (moveable)
9. Lab Table Sitting Height (moveable)
10. Adjust. Height Moveable Lab Tables
11. Moveable Demonstration Bench
12. Desk / Writing table
13. Balance Table
14. ADA Height Workstation
15. Movable Demonstration Bench
16. Mobile Base Cabinet (below)
17. Wall Cabinet Solid Doors
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33. Eyewash
34. Overhead Service Carrier
35. Flexible Power/Data Drop
36. Electrical Raceway
37. Glassware Washer
38. Glassware Dryer
39. Autoclave
40. Wire Shelving
41. White Markerboard
42. Black Chalkboard
43. Tackboard
44. A/V Screen
45. Ceiling Data/Power for Pojector
46. File Cabinet
47. Fire Extinguisher
48. Black-Out Shades
49. Wall Mount Telephone
50. Rolling Cart (by owner)
51. Lattice Rod Assembly
52. Down Draft Exhaust
53. Gas Tank Rack

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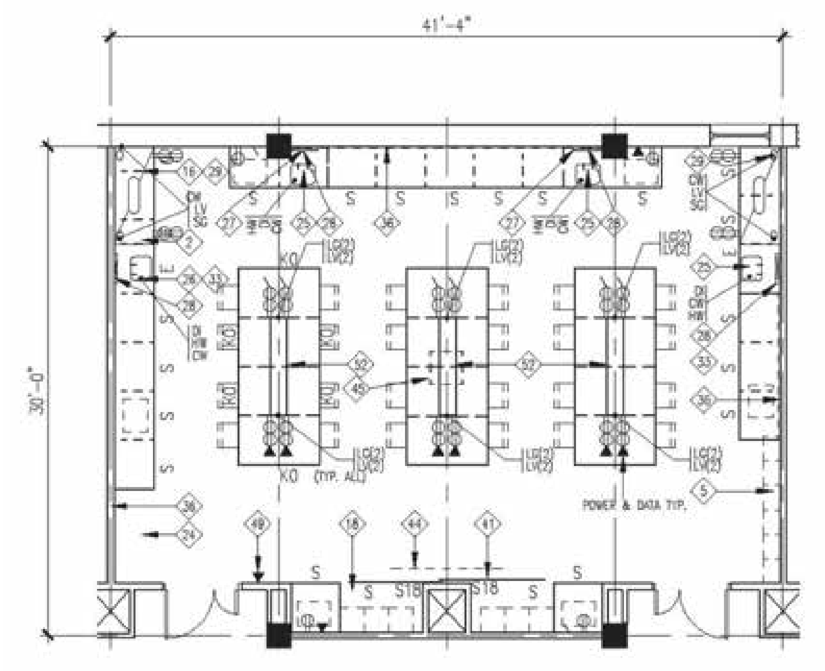
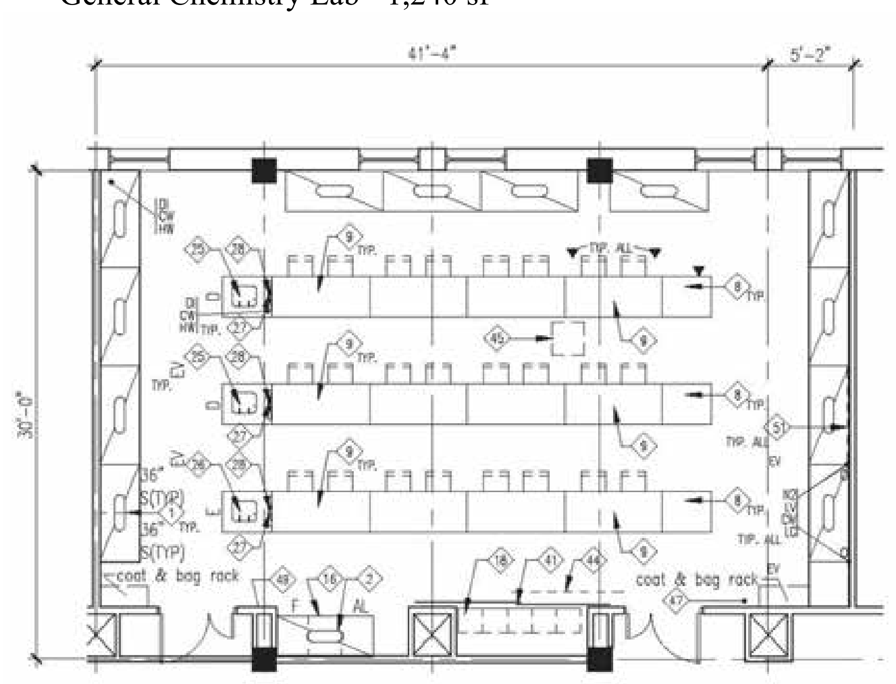
BIOLOGY LAB DIAGRAMS

GEORGE MASON UNIVERSITY

Detail No: 3.2-19



General Chemistry Lab - 1,240 sf



Organic Chemistry - 1,490 sf

Lab Furnishings Legend

1. Chemical Fume Hood
2. ADA Chemical Fume Hood
3. Biological Safety Cabinet
4. Snorkel Exhaust
5. Cubbies for Coats / Backpacks
6. Lab Bench Standing Height (fixed)
7. Lab Bench Sitting Height (fixed)
8. Lab Table Standing Height (moveable)
9. Lab Table Sitting Height (moveable)
10. Adjust. Height Moveable Lab Tables
11. Moveable Demonstration Bench
12. Desk / Writing table
13. Balance Table
14. ADA Height Workstation
15. Movable Demonstration Bench
16. Mobile Base Cabinet (below)
17. Wall Cabinet Solid Doors
18. Wall Storage behind Marker/Black Boards
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28. Pegboard
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30. Processing Sink
31. Cylinder Rack
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35. Flexible Power/Data Drop
36. Electrical Raceway
37. Glassware Washer
38. Glassware Dryer
39. Autoclave
40. Wire Shelving
41. White Markerboard
42. Black Chalkboard
43. Tackboard
44. A/V Screen
45. Ceiling Data/Power for Pojector
46. File Cabinet
47. Fire Extinguisher
48. Black-Out Shades
49. Wall Mount Telephone
50. Rolling Cart (by owner)
51. Lattice Rod Assembly
52. Down Draft Exhaust
53. Gas Tank Rack

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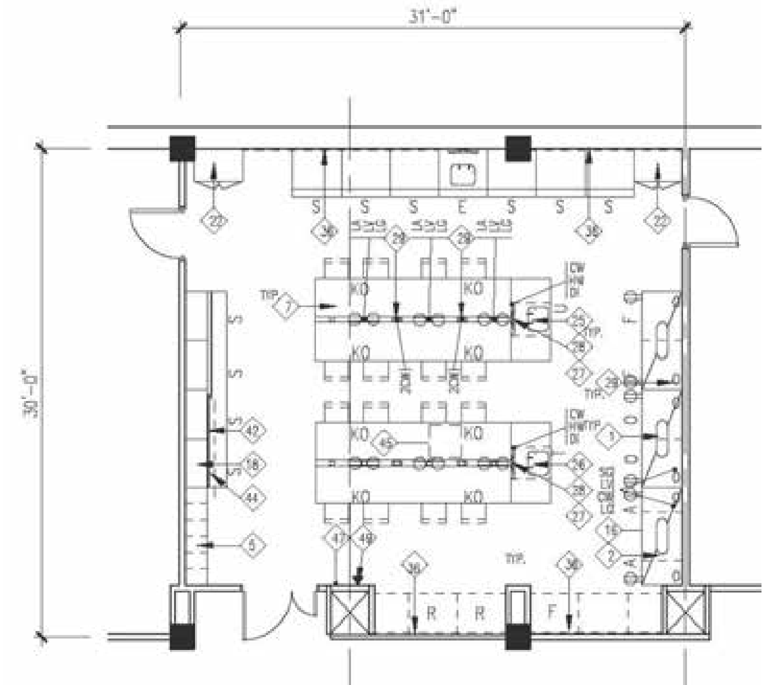
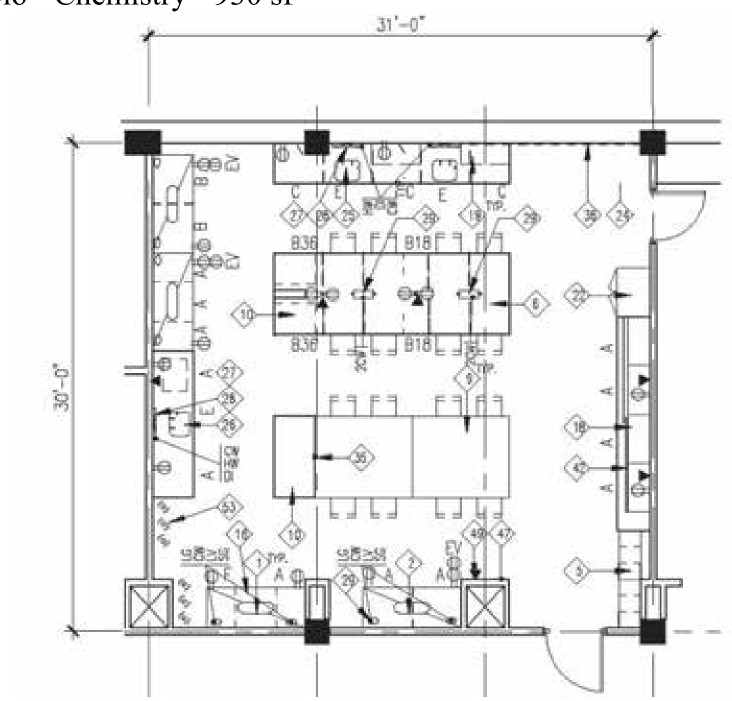
CHEMISTRY LAB DIAGRAMS

GEORGE MASON UNIVERSITY

Detail No: 3.2-20



Bio - Chemistry - 930 sf



Quant. / Phy. Chem. Inorganic - 930 sf

Lab Furnishings Legend

1. Chemical Fume Hood
2. ADA Chemical Fume Hood
3. Biological Safety Cabinet
4. Snorkel Exhaust
5. Cubbies for Coats / Backpacks
6. Lab Bench Standing Height (fixed)
7. Lab Bench Sitting Height (fixed)
8. Lab Table Standing Height (moveable)
9. Lab Table Sitting Height (moveable)
10. Adjust. Height Moveable Lab Tables
11. Moveable Demonstration Bench
12. Desk / Writing table
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33. Eyewash
34. Overhead Service Carrier
35. Flexible Power/Data Drop
36. Electrical Raceway
37. Glassware Washer
38. Glassware Dryer
39. Autoclave
40. Wire Shelving
41. White Markerboard
42. Black Chalkboard
43. Tackboard
44. A/V Screen
45. Ceiling Data/Power for Pojector
46. File Cabinet
47. Fire Extinguisher
48. Black-Out Shades
49. Wall Mount Telephone
50. Rolling Cart (by owner)
51. Lattice Rod Assembly
52. Down Draft Exhaust
53. Gas Tank Rack

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CHEMISTRY LAB DIAGRAMS

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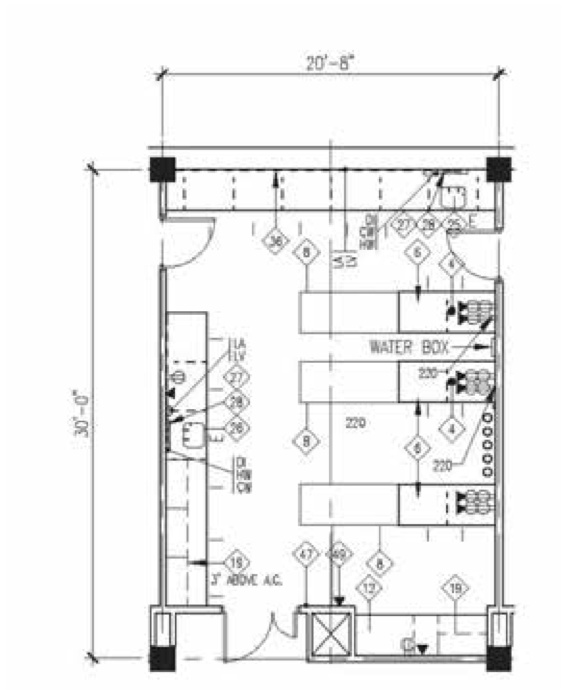
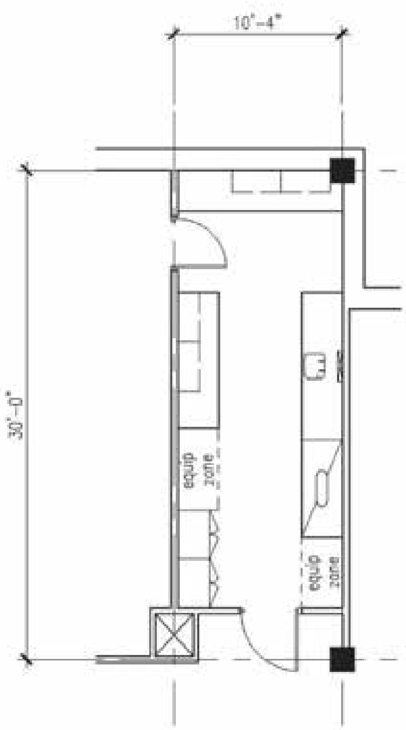
Detail No: 3.2-21



Common Instrument Lab - 620 sf



Chemistry - Prep Storage - 310 sf

Lab Furnishings Legend

1. Chemical Fume Hood
2. ADA Chemical Fume Hood
3. Biological Safety Cabinet
4. Snorkel Exhaust
5. Cubbies for Coats / Backpacks
6. Lab Bench Standing Height (fixed)
7. Lab Bench Sitting Height (fixed)
8. Lab Table Standing Height (moveable)
9. Lab Table Sitting Height (moveable)
10. Adjust. Height Moveable Lab Tables
11. Moveable Demonstration Bench
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45. Ceiling Data/Power for Pojector
46. File Cabinet
47. Fire Extinguisher
48. Black-Out Shades
49. Wall Mount Telephone
50. Rolling Cart (by owner)
51. Lattice Rod Assembly
52. Down Draft Exhaust
53. Gas Tank Rack

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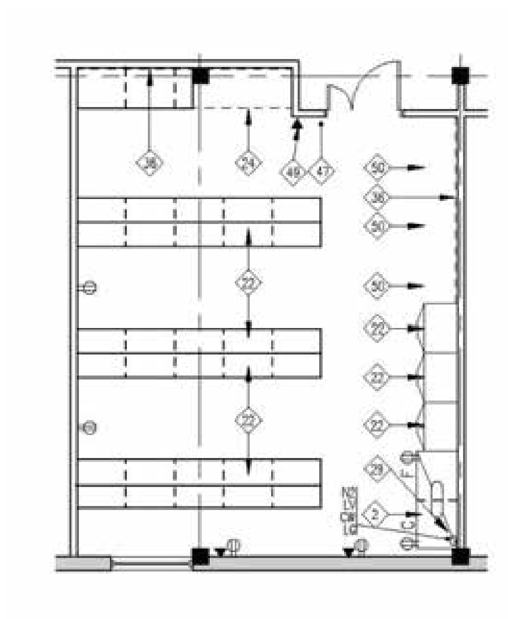
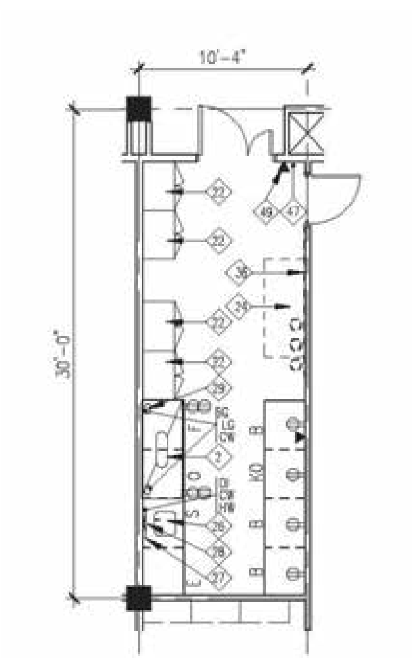
CHEMISTRY LAB DIAGRAMS

GEORGE MASON UNIVERSITY

Detail No: 3.2-22



Chemical Store Room - 620 sf



Chemical Prep Area - 310 sf

Lab Furnishings Legend

1. Chemical Fume Hood
2. ADA Chemical Fume Hood
3. Biological Safety Cabinet
4. Snorkel Exhaust
5. Cubbies for Coats / Backpacks
6. Lab Bench Standing Height (fixed)
7. Lab Bench Sitting Height (fixed)
8. Lab Table Standing Height (moveable)
9. Lab Table Sitting Height (moveable)
10. Adjust. Height Moveable Lab Tables
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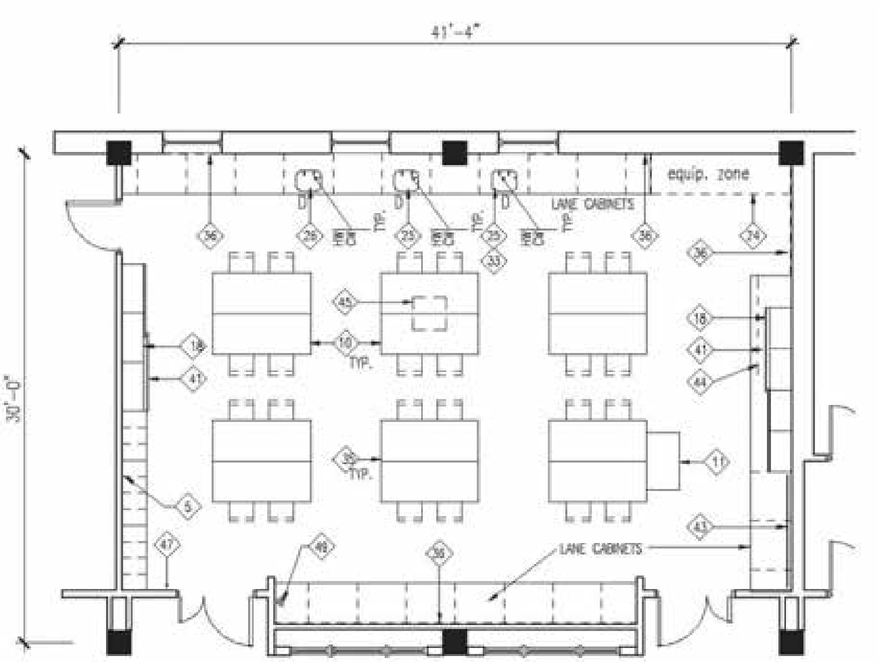
45. Ceiling Data/Power for Pojector
46. File Cabinet
47. Fire Extinguisher
48. Black-Out Shades
49. Wall Mount Telephone
50. Rolling Cart (by owner)
51. Lattice Rod Assembly
52. Down Draft Exhaust
53. Gas Tank Rack

NTS

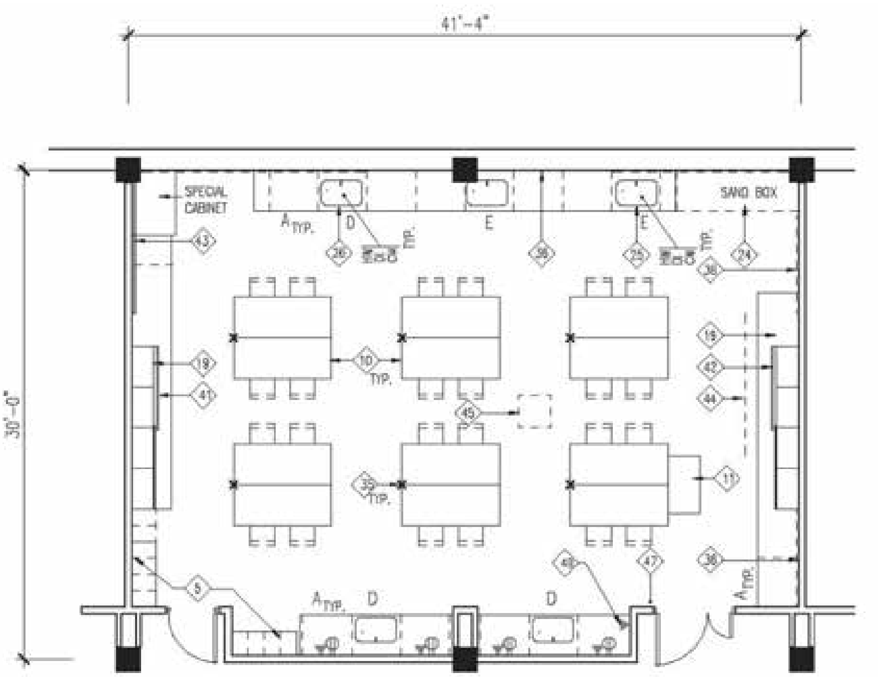
Date: 6-3-2013

CHEMISTRY LAB DIAGRAMS

Detail No: 3.2-23



Introduction to GeoScience - 1,240 sf



Rivers / Minerals / Ecology - 1,240 sf

Lab Furnishings Legend

1. Chemical Fume Hood
2. ADA Chemical Fume Hood
3. Biological Safety Cabinet
4. Snorkel Exhaust
5. Cubbies for Coats / Backpacks
6. Lab Bench Standing Height (fixed)
7. Lab Bench Sitting Height (fixed)
8. Lab Table Standing Height (moveable)
9. Lab Table Sitting Height (moveable)
10. Adjust. Height Moveable Lab Tables
11. Moveable Demonstration Bench
12. Desk / Writing table
13. Balance Table
14. ADA Height Workstation
15. Movable Demonstration Bench
16. Mobile Base Cabinet (below)
17. Wall Cabinet Solid Doors
18. Wall Storage behind Marker/Black Boards
19. Adjustable Wall Shelves
20. Reagent Shelves Above Casework
21. Industrial Adjustable Shelving
22. Tall Storage Cabinet
23. Vented Storage Cabinet
24. Equipment Space
25. Laboratory Sink
26. ADA Sink
27. Utility or Pipe Drop Enclosure
28. Pegboard
29. Cupsink
30. Processing Sink
31. Cylinder Rack
32. Safety Shower
33. Eyewash
34. Overhead Service Carrier
35. Flexible Power/Data Drop
36. Electrical Raceway
37. Glassware Washer
38. Glassware Dryer
39. Autoclave
40. Wire Shelving
41. White Markerboard
42. Black Chalkboard
43. Tackboard
44. A/V Screen
45. Ceiling Data/Power for Pojector
46. File Cabinet
47. Fire Extinguisher
48. Black-Out Shades
49. Wall Mount Telephone
50. Rolling Cart (by owner)
51. Lattice Rod Assembly
52. Down Draft Exhaust
53. Gas Tank Rack

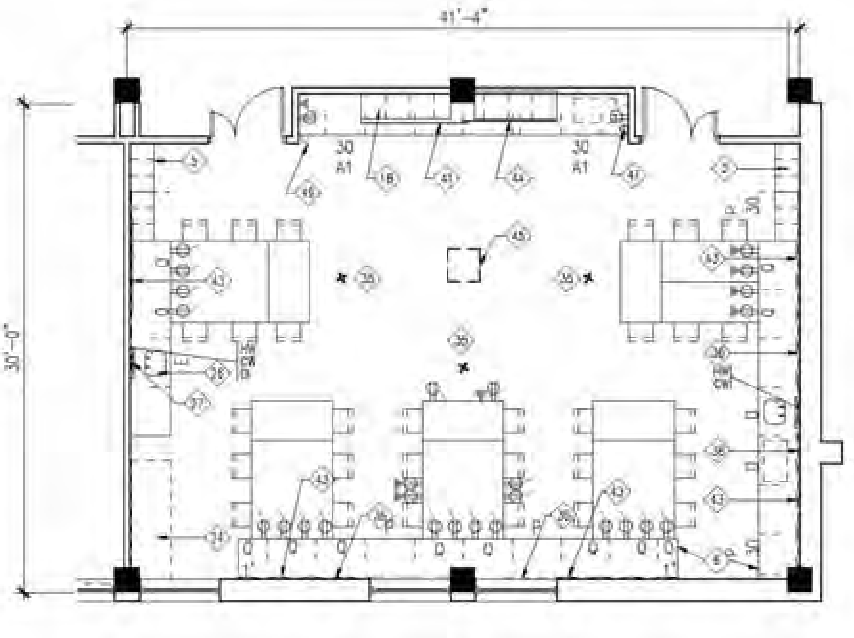
NTS

Date: 6-3-2013

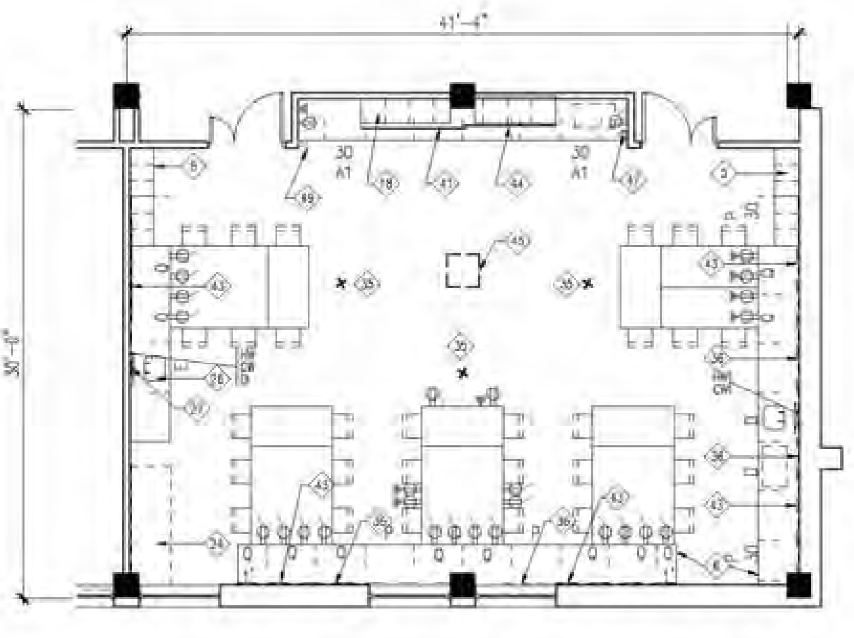
GEOSCIENCE LAB DIAGRAMS

GEORGE MASON UNIVERSITY

Detail No: 3.2-24



General Physics - 1,240 sf



Gen./ Principles / Modern Physics - 1,240 sf

Lab Furnishings Legend

1. Chemical Fume Hood
2. ADA Chemical Fume Hood
3. Biological Safety Cabinet
4. Snorkel Exhaust
5. Cubbies for Coats / Backpacks
6. Lab Bench Standing Height (fixed)
7. Lab Bench Sitting Height (fixed)
8. Lab Table Standing Height (moveable)
9. Lab Table Sitting Height (moveable)
10. Adjust. Height Moveable Lab Tables
11. Moveable Demonstration Bench
12. Desk / Writing table
13. Balance Table
14. ADA Height Workstation
15. Movable Demonstration Bench
16. Mobile Base Cabinet (below)
17. Wall Cabinet Solid Doors
18. Wall Storage behind Marker/Black Boards
19. Adjustable Wall Shelves
20. Reagent Shelves Above Casework
21. Industrial Adjustable Shelving
22. Tall Storage Cabinet
23. Vented Storage Cabinet
24. Equipment Space
25. Laboratory Sink
26. ADA Sink
27. Utility or Pipe Drop Enclosure
28. Pegboard
29. Cupsink
30. Processing Sink
31. Cylinder Rack
32. Safety Shower
33. Eyewash
34. Overhead Service Carrier
35. Flexible Power/Data Drop
36. Electrical Raceway
37. Glassware Washer
38. Glassware Dryer
39. Autoclave
40. Wire Shelving
41. White Markerboard
42. Black Chalkboard
43. Tackboard
44. A/V Screen
45. Ceiling Data/Power for Pojector
46. File Cabinet
47. Fire Extinguisher
48. Black-Out Shades
49. Wall Mount Telephone
50. Rolling Cart (by owner)
51. Lattice Rod Assembly
52. Down Draft Exhaust
53. Gas Tank Rack

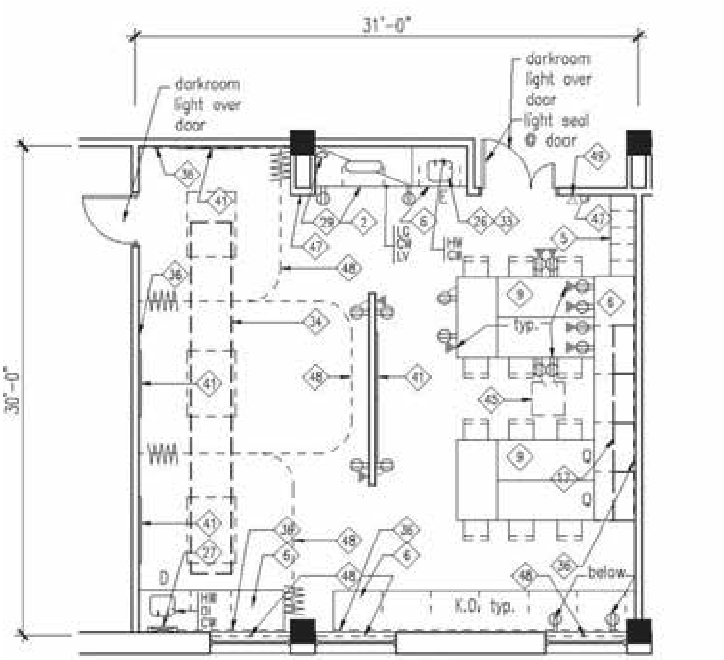
NTS

Date: 6-3-2013

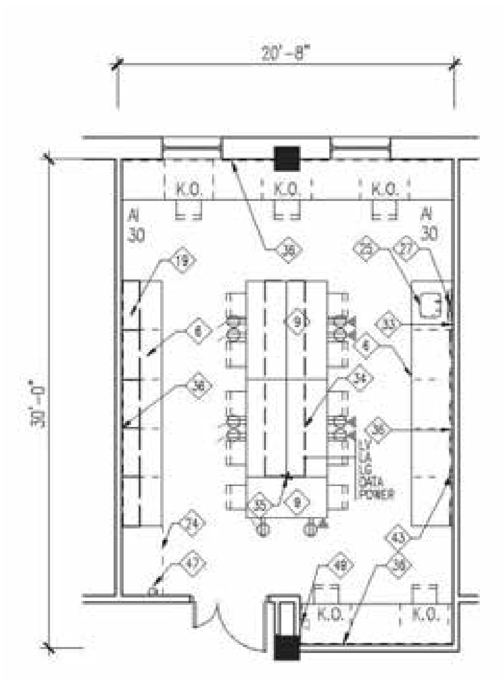
PHYSICS LAB DIAGRAMS

GEORGE MASON UNIVERSITY

Detail No: 3.2-25



Advanced Physics - 930 sf



Student/Faculty Research - 620 sf

Lab Furnishings Legend

1. Chemical Fume Hood
2. ADA Chemical Fume Hood
3. Biological Safety Cabinet
4. Snorkel Exhaust
5. Cubbies for Coats / Backpacks
6. Lab Bench Standing Height (fixed)
7. Lab Bench Sitting Height (fixed)
8. Lab Table Standing Height (moveable)
9. Lab Table Sitting Height (moveable)
10. Adjust. Height Moveable Lab Tables
11. Moveable Demonstration Bench
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26. ADA Sink
27. Utility or Pipe Drop Enclosure
28. Pegboard
29. Cupsink
30. Processing Sink
31. Cylinder Rack
32. Safety Shower
33. Eyewash
34. Overhead Service Carrier
35. Flexible Power/Data Drop
36. Electrical Raceway
37. Glassware Washer
38. Glassware Dryer
39. Autoclave
40. Wire Shelving
41. White Markerboard
42. Black Chalkboard
43. Tackboard
44. A/V Screen
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46. File Cabinet
47. Fire Extinguisher
48. Black-Out Shades
49. Wall Mount Telephone
50. Rolling Cart (by owner)
51. Lattice Rod Assembly
52. Down Draft Exhaust
53. Gas Tank Rack

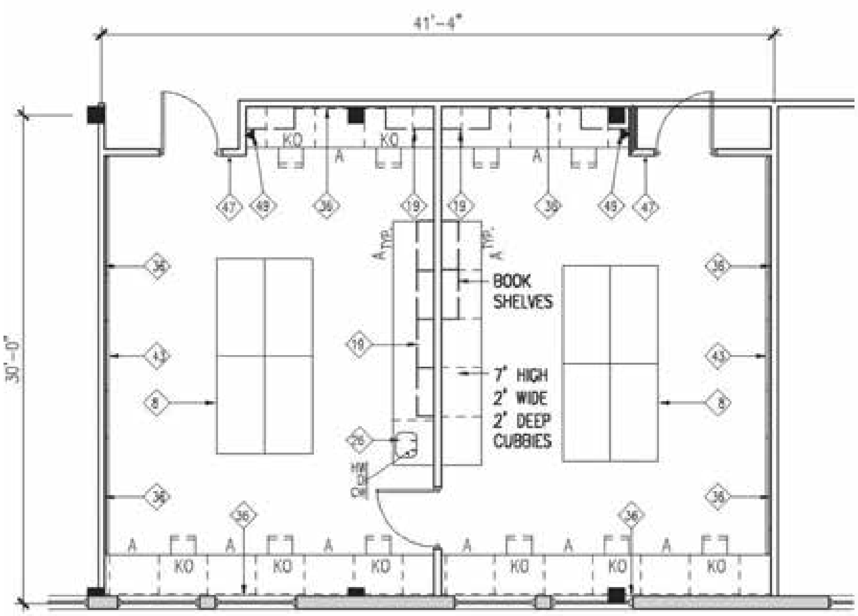
NTS

Date: 6-3-2013

GEORGE MASON UNIVERSITY

PHYSICS LAB DIAGRAMS

Detail No: 3.2-26



Physics Research - 1,240 sf

Lab Furnishings Legend

1. Chemical Fume Hood
2. ADA Chemical Fume Hood
3. Biological Safety Cabinet
4. Snorkel Exhaust
5. Cubbies for Coats / Backpacks
6. Lab Bench Standing Height (fixed)
7. Lab Bench Sitting Height (fixed)
8. Lab Table Standing Height (moveable)
9. Lab Table Sitting Height (moveable)
10. Adjust. Height Moveable Lab Tables
11. Moveable Demonstration Bench
12. Desk / Writing table
13. Balance Table
14. ADA Height Workstation
15. Movable Demonstration Bench
16. Mobile Base Cabinet (below)
17. Wall Cabinet Solid Doors
18. Wall Storage behind Marker/Black Boards
19. Adjustable Wall Shelves
20. Reagent Shelves Above Casework
21. Industrial Adjustable Shelving
22. Tall Storage Cabinet
23. Vented Storage Cabinet
24. Equipment Space
25. Laboratory Sink
26. ADA Sink
27. Utility or Pipe Drop Enclosure
28. Pegboard
29. Cupsink
30. Processing Sink
31. Cylinder Rack
32. Safety Shower
33. Eyewash
34. Overhead Service Carrier
35. Flexible Power/Data Drop
36. Electrical Raceway
37. Glassware Washer
38. Glassware Dryer
39. Autoclave
40. Wire Shelving
41. White Markerboard
42. Black Chalkboard
43. Tackboard
44. A/V Screen
45. Ceiling Data/Power for Pojector
46. File Cabinet
47. Fire Extinguisher
48. Black-Out Shades
49. Wall Mount Telephone
50. Rolling Cart (by owner)
51. Lattice Rod Assembly
52. Down Draft Exhaust
53. Gas Tank Rack

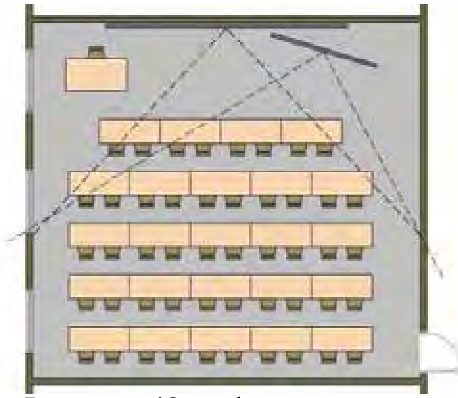
NTS

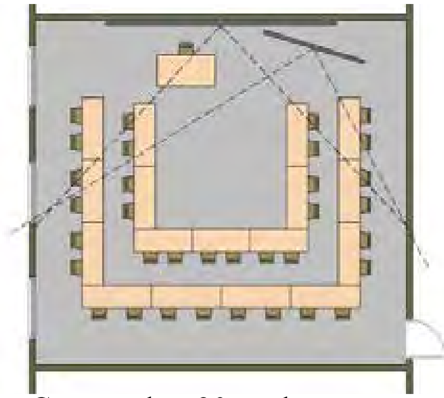
Date: 6-3-2013

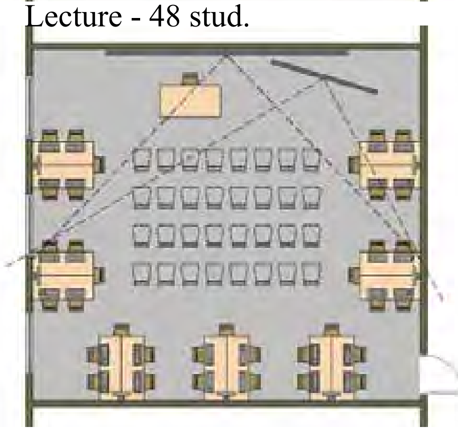
PHYSICS LAB DIAGRAMS

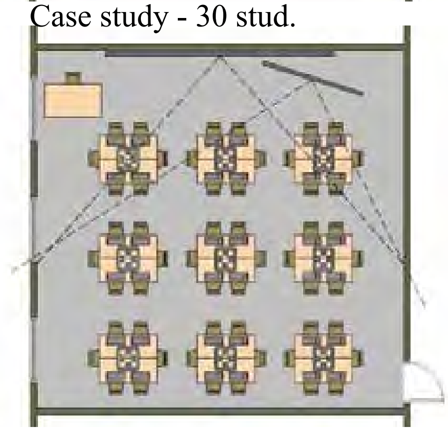
GEORGE MASON UNIVERSITY

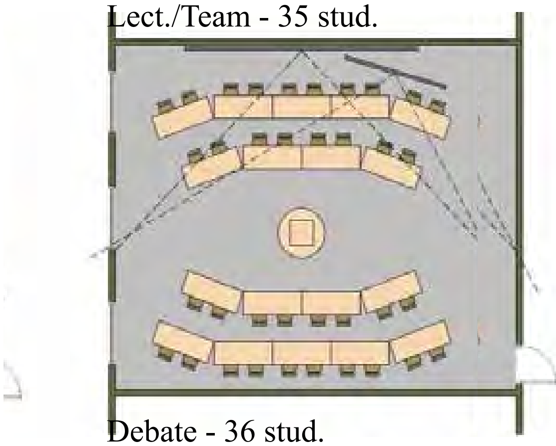
Detail No: 3.2-27

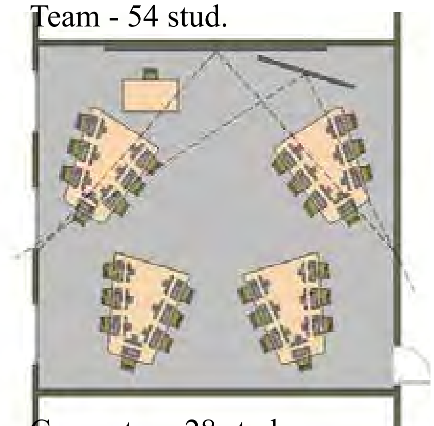

Lecture - 48 stud.

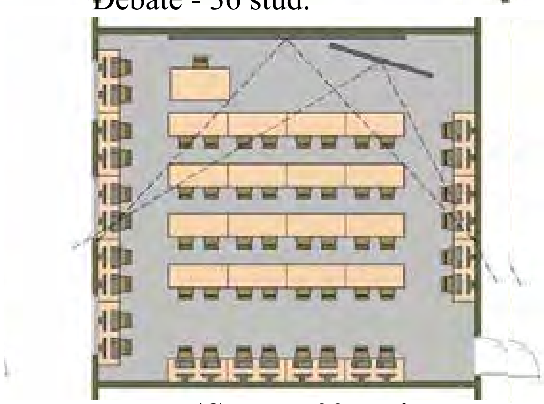

Case study - 30 stud.

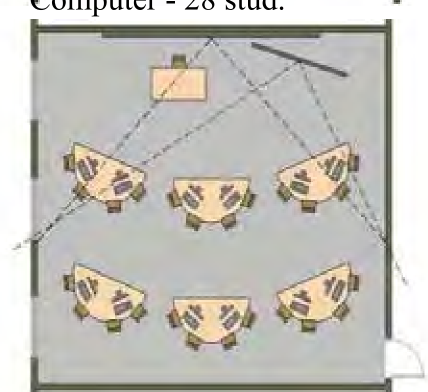

Lect./Team - 35 stud.


Team - 54 stud.


Debate - 36 stud.


Computer - 28 stud.


Lecture/Comp. - 32 stud.


Computer - 24 stud.

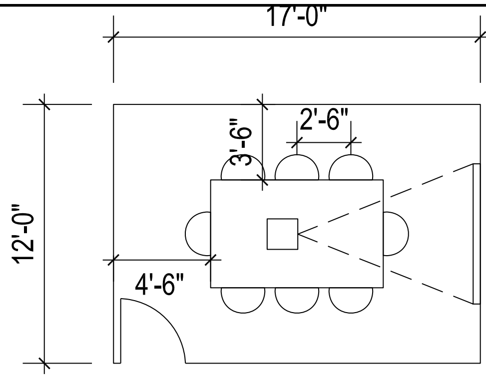
NTS

Date: 6-3-2013

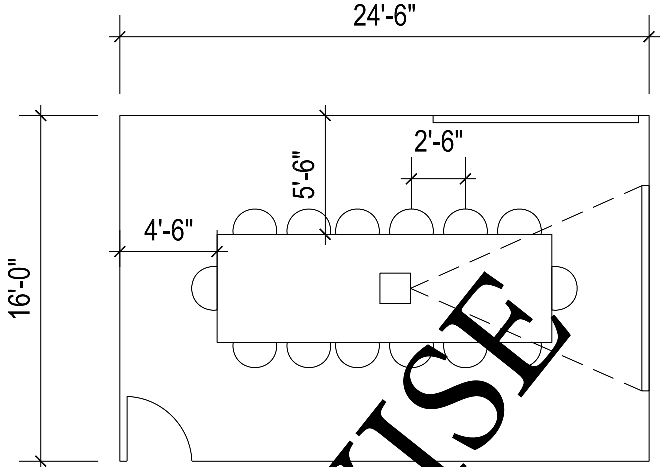
GEORGE MASON UNIVERSITY

FLEXIBLE CLASSROOMS - 24-54 Students

Detail No: 3.2-2

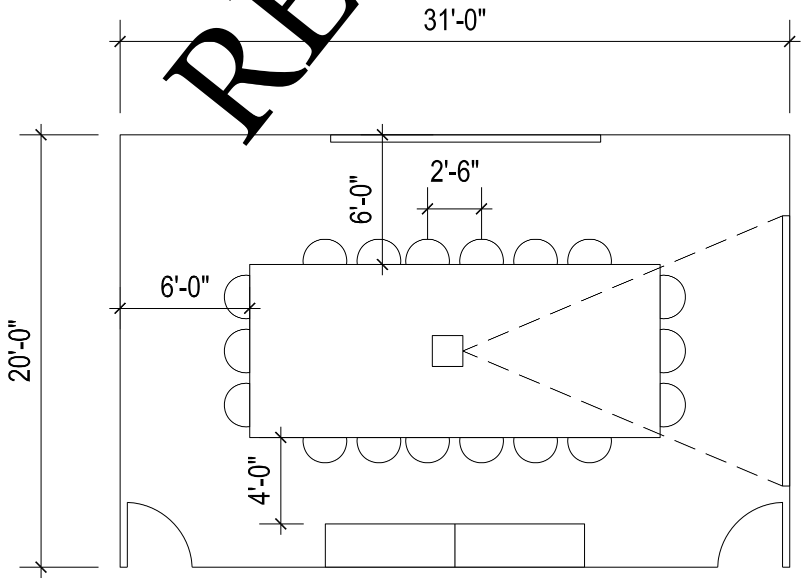


204sf - 26sf/pp
8 seats



392sf - 28sf/pp
14 seats

REVISE



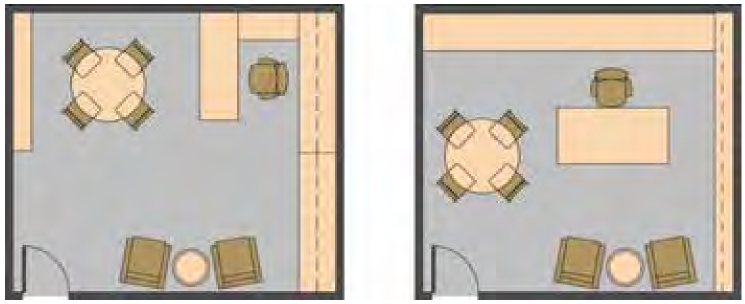
620sf - 34sf/pp
18 seats

NTS

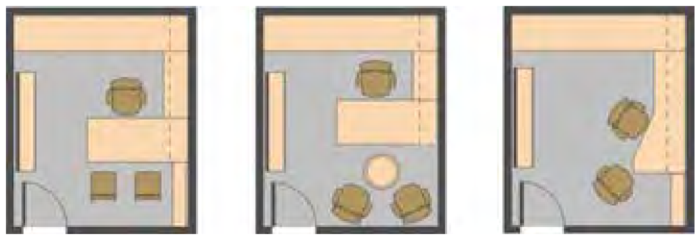
Date: 6-3-2013

GEORGE MASON UNIVERSITY

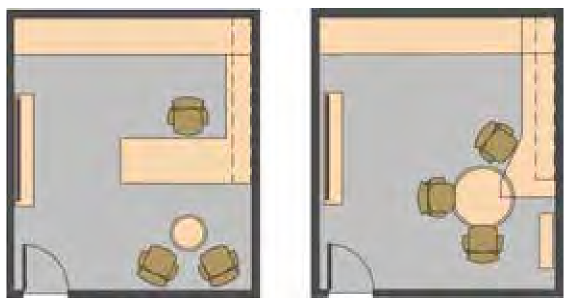
Detail No: 3.2-28



Dean's Office - 256 ASF

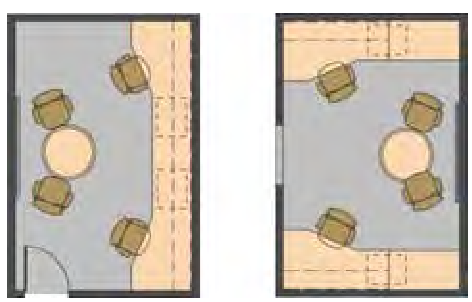


Single Occupancy - 120 ASF



Dept. Chair - 180 ASF

Single Occupancy - 144 ASF



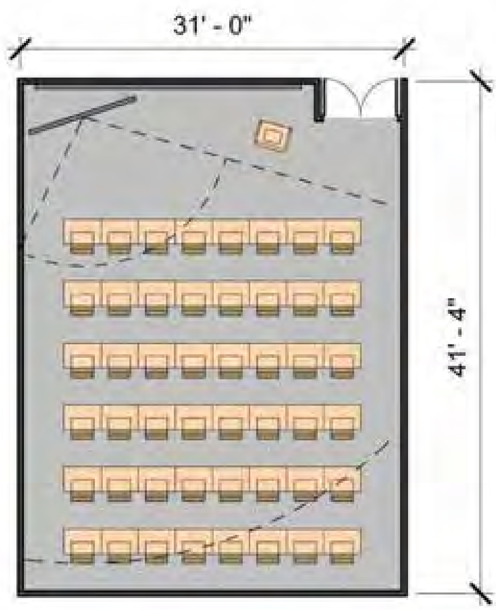
Double Occupancy 144 ASF

NTS

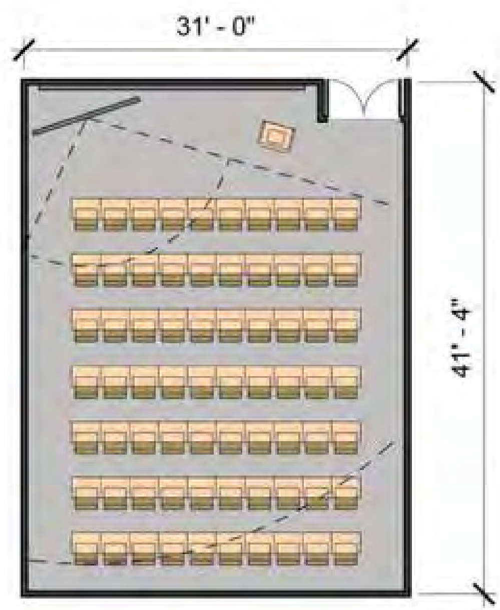
Date: 6-3-2013

FACULTY OFFICES

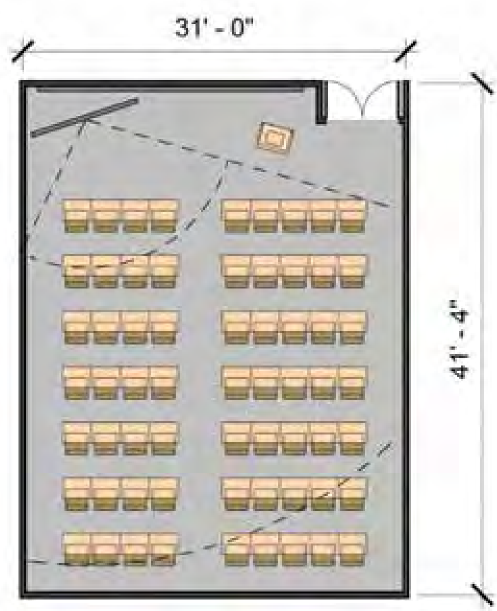
Detail No: 3.2-29



Classroom - 48 stud.



Classroom - 70 stud.



Classroom - 63 stud.

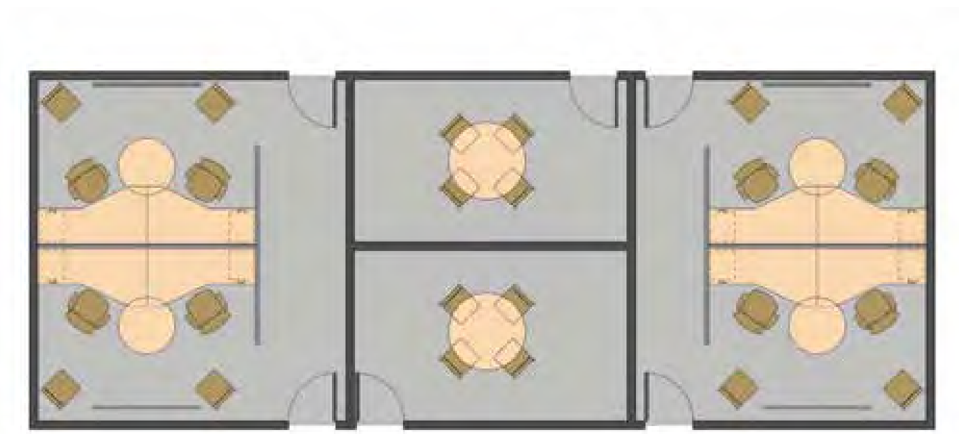
NTS

Date: 6-3-2013

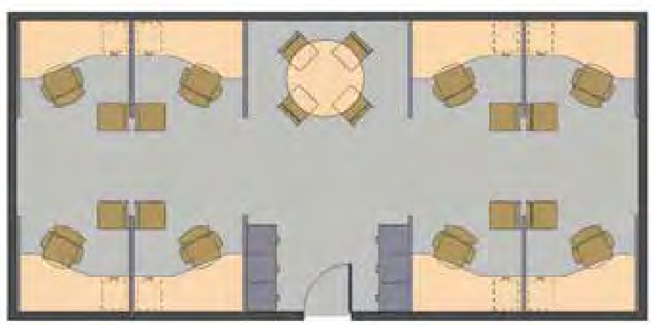
GEORGE MASON UNIVERSITY

HIGH VOLUME/DENSITY CLASSROOMS - 48-70 Students

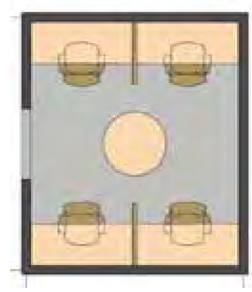
Detail No: 3.2-3



Shared Faculty Offices



Graduate Teaching Assistant Offices



Graduate Research
Assistant Offices

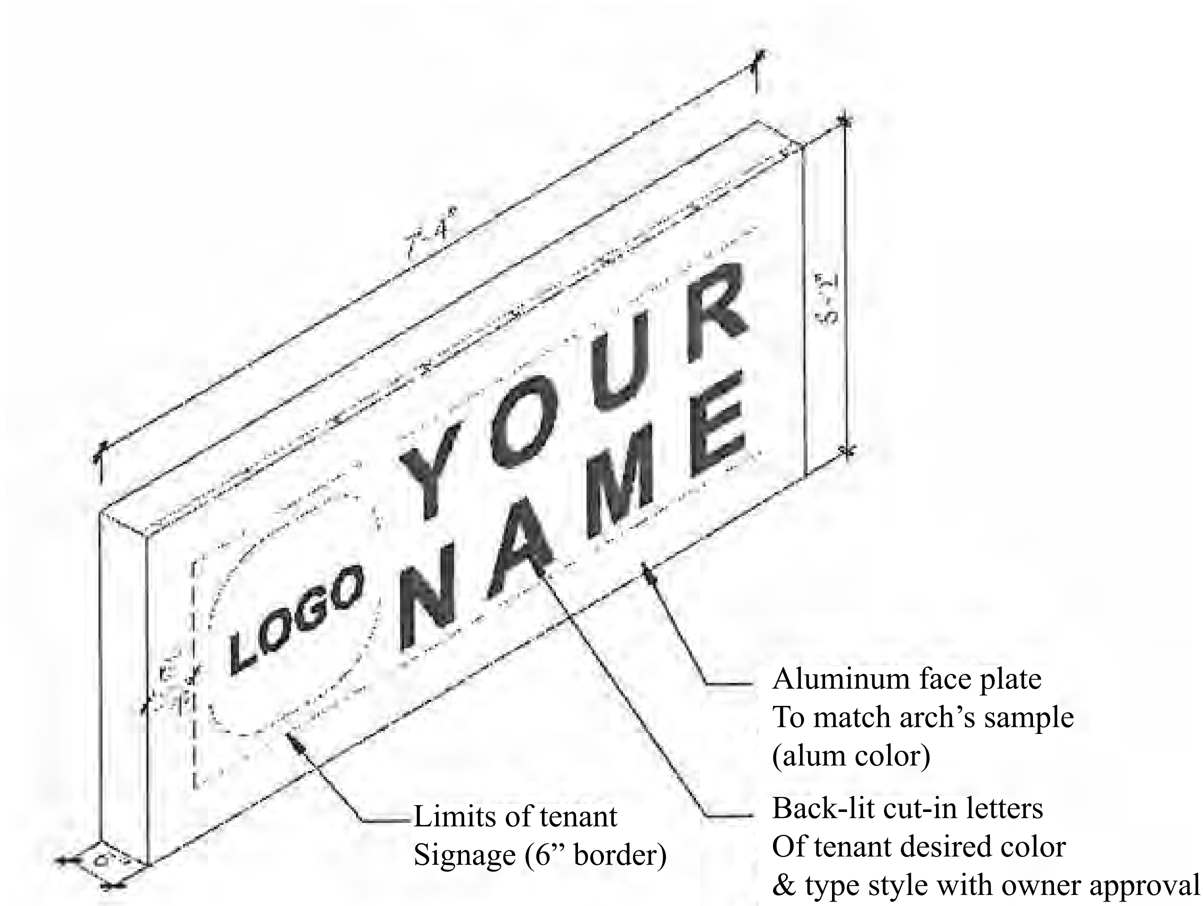
NTS

Date: 6-3-2013

GEORGE MASON UNIVERSITY

COLLABORATION ENVIRONMENTS FOR PART-TIME FACULTY, GRA'S AND GTA'S

Detail No: 3.2-30



- To be wall mounted on masonry
- To be located over entry only

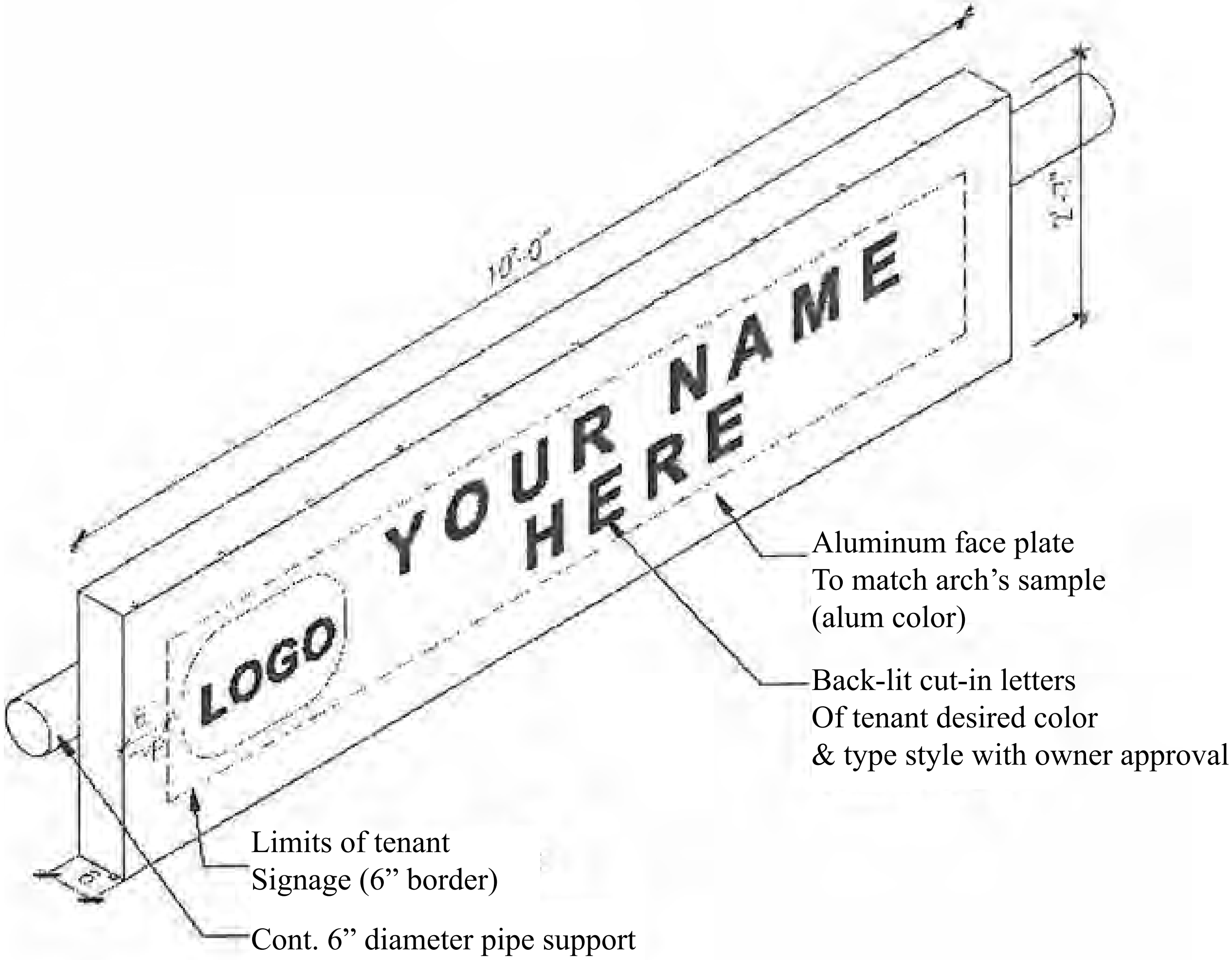
NTS

Date: 6-3-2013

SIGN TYPE A

GEORGE MASON UNIVERSITY

Detail No: 3.2-31



- To be attached to building mounted
Horizontal rail systems
- To be located all along the storefront

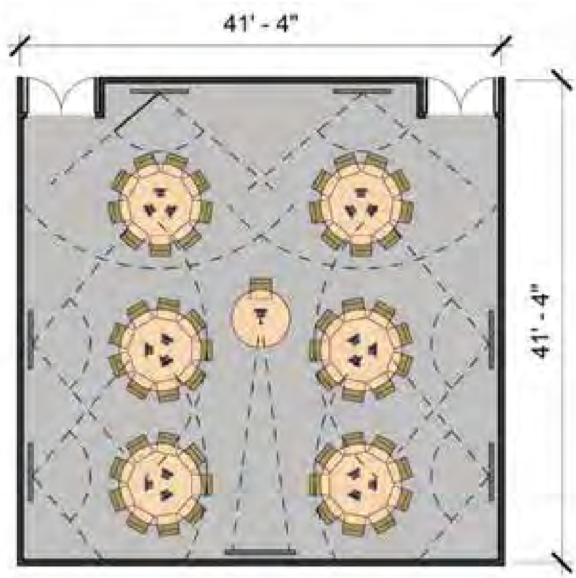
NTS

Date: 6-3-2013

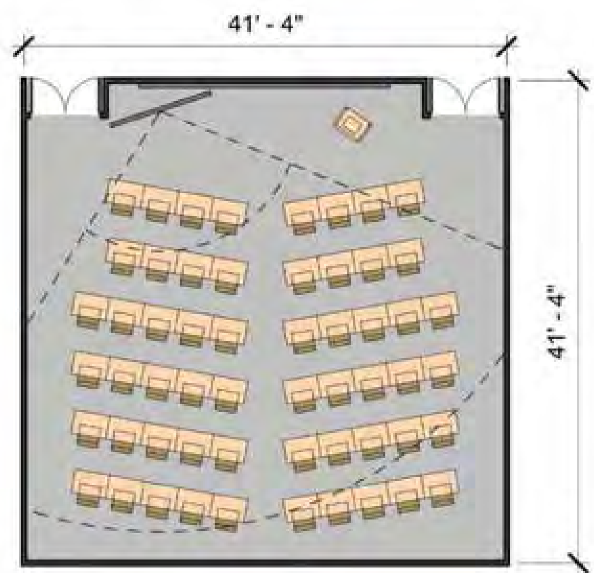
SIGN TYPE B

GEORGE MASON UNIVERSITY

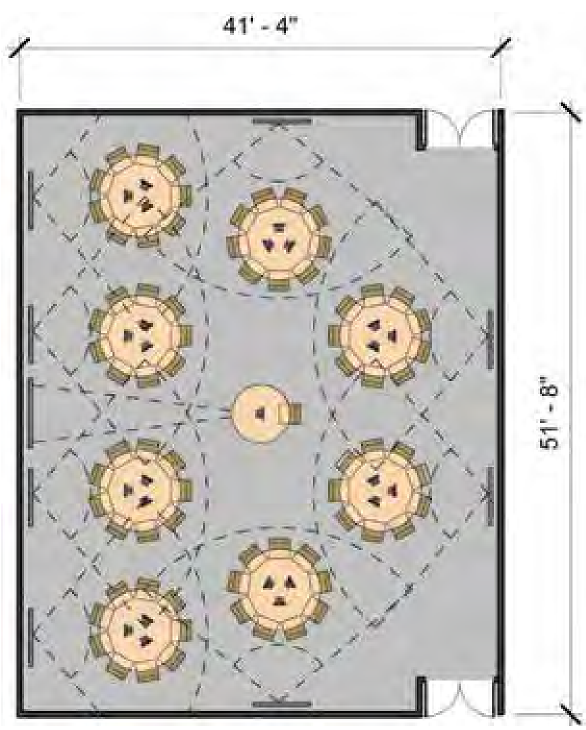
Detail No: 3.2-32



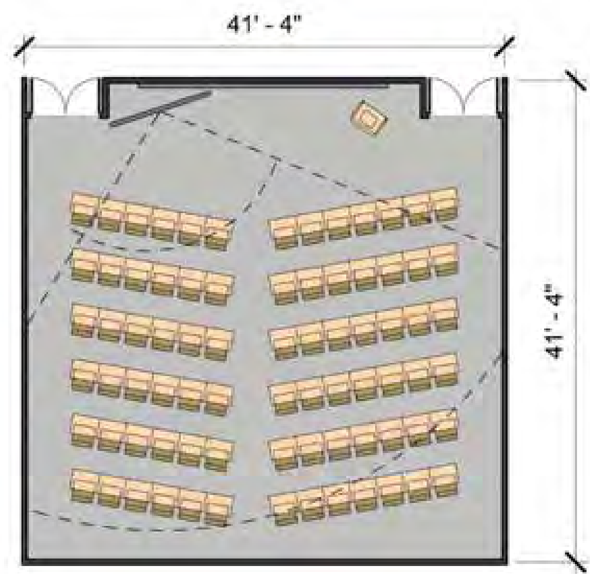
TEAL Scale-up - 54 stud.



56 stud.



Scale Up - 72 stud.



78 stud.

NTS

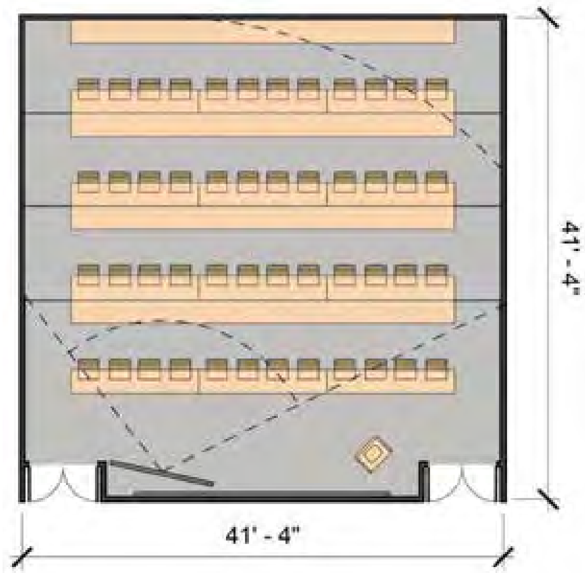
Date: 6-3-2013

GEORGE MASON UNIVERSITY

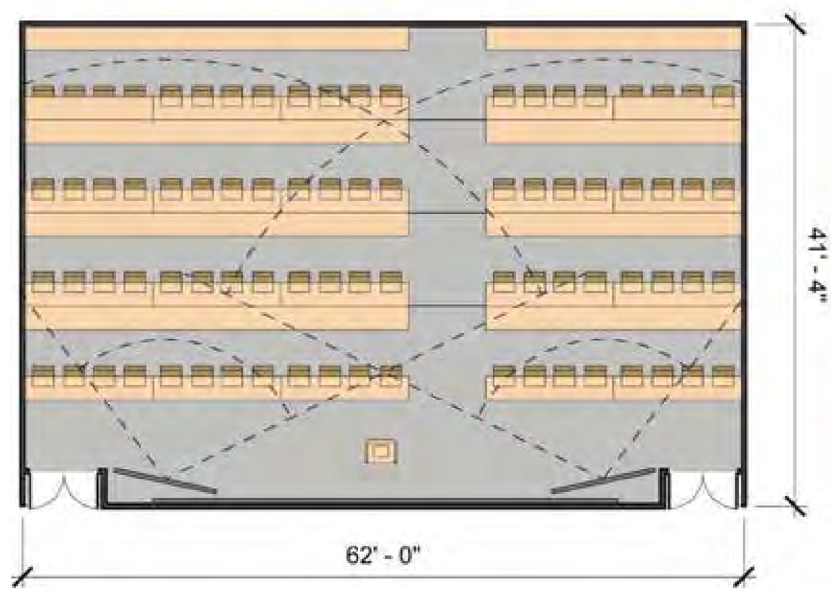
MASON INNOVATIVE LEARNING SPACE(MILS)

54-78 Students

Detail No: 3.2-4



48 stud.



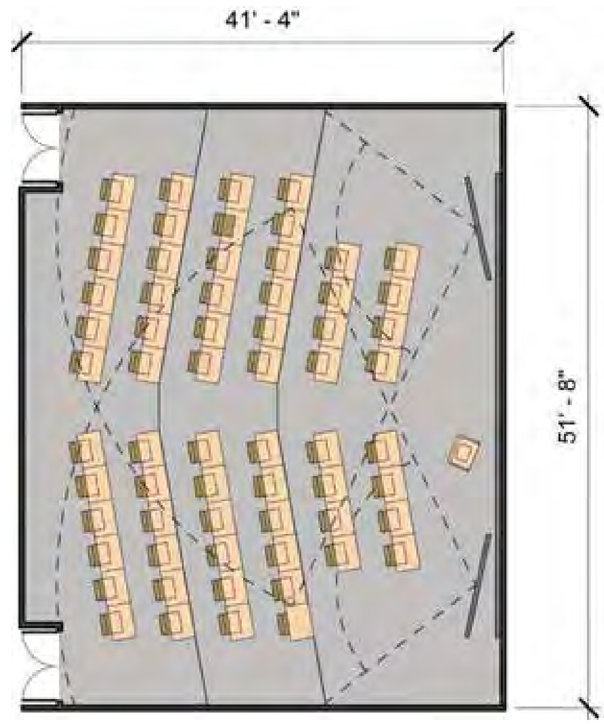
72 stud.

NTS

Date: 6-3-2013

LECTURE HALL - 48-72 Students

Detail No: 3.2-5



Team Lecture - 64 stud.

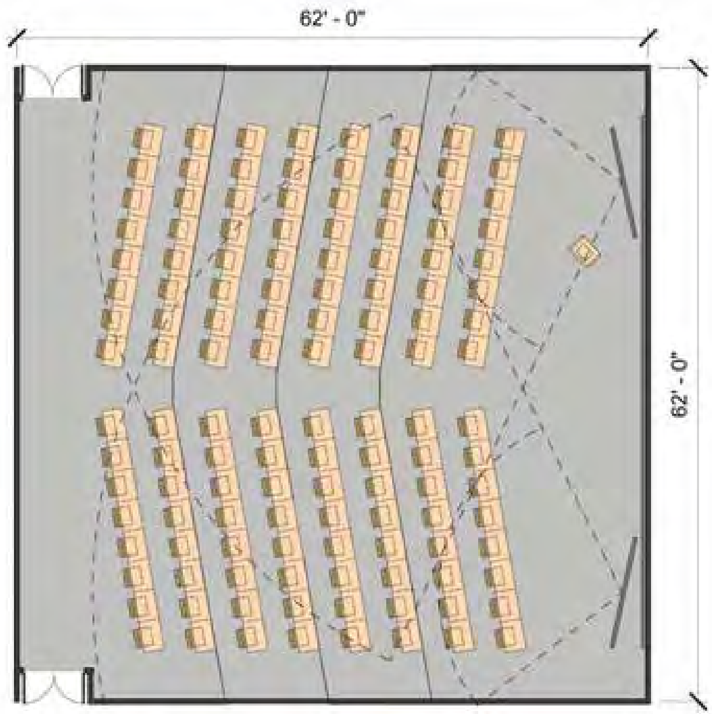
NTS

Date: 6-3-2013

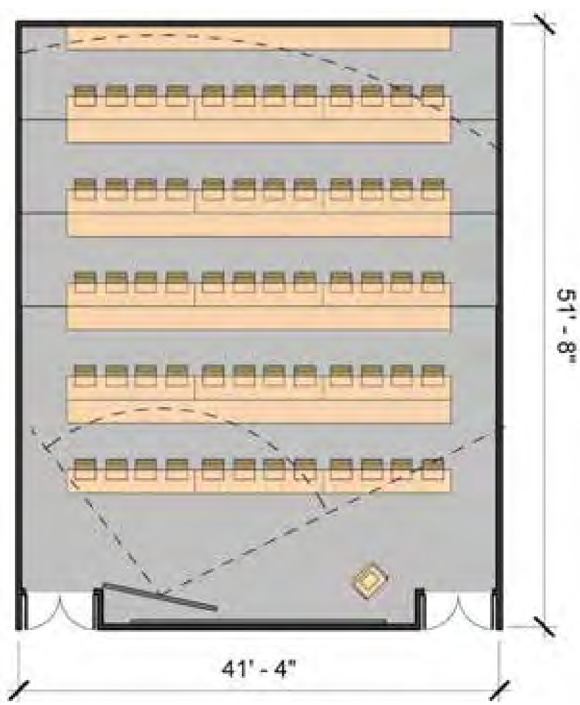
TIERED CLASSROOM

GEORGE MASON UNIVERSITY

Detail No: 3.2-6



Lecture - 128 stud.



Lab Lecture - 60 stud.

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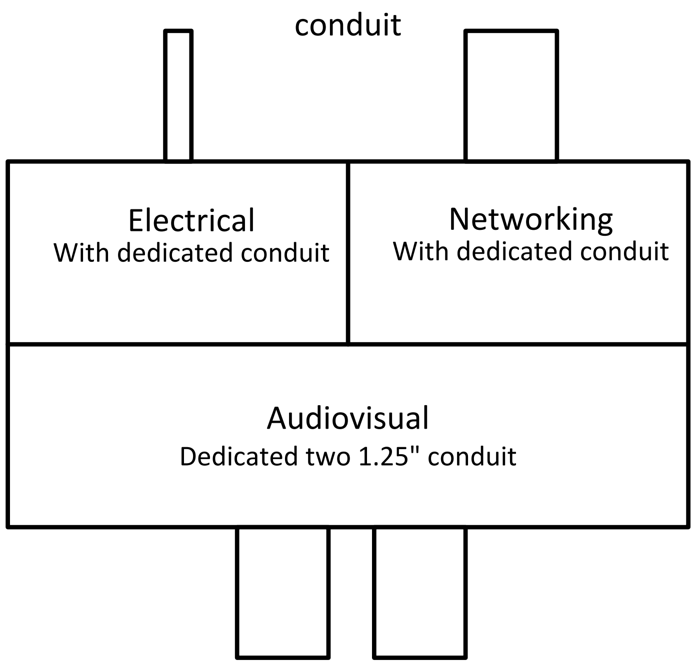
Date: 6-3-2013

GEORGE MASON UNIVERSITY

LECTURE HALL
60-128 Students
Detail No: 3.2-7



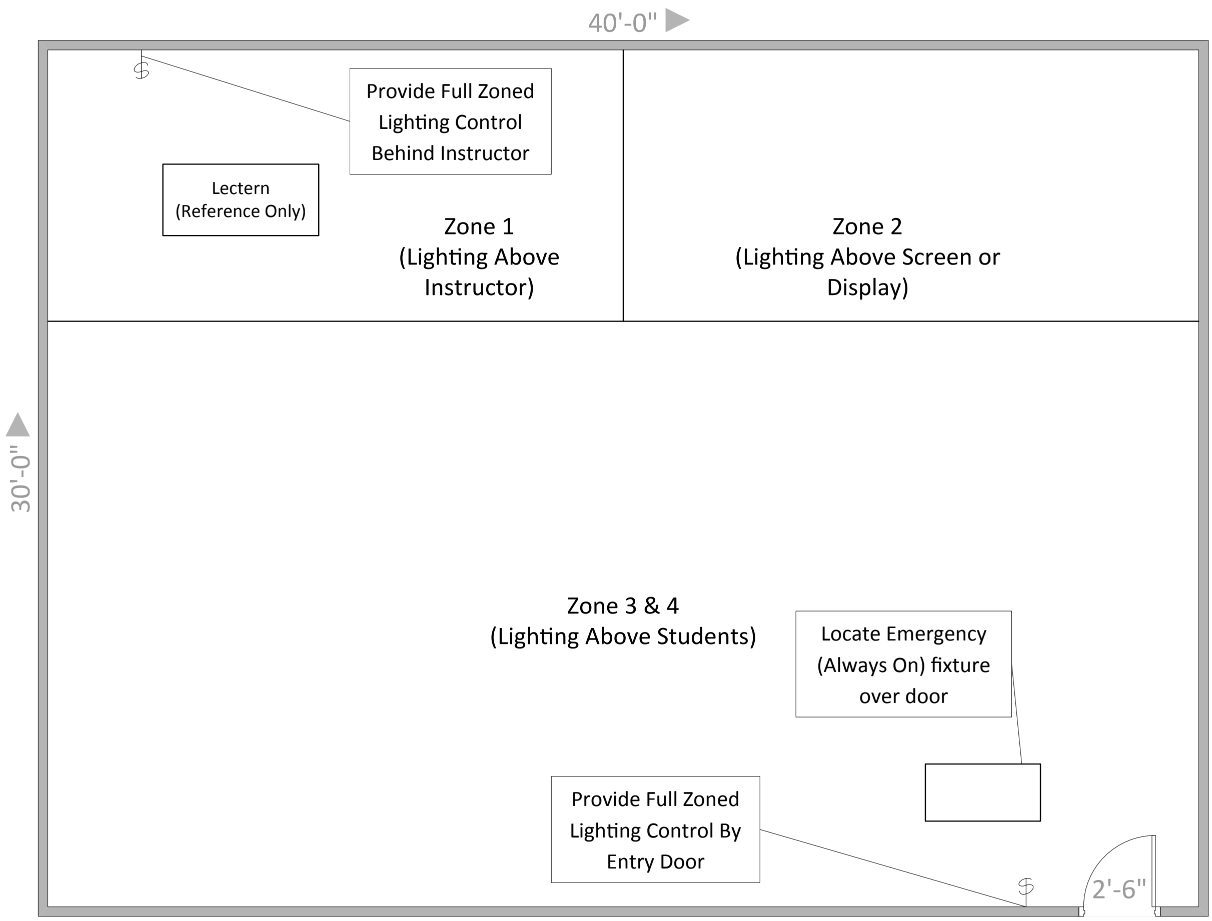
NTS

Date: 6-3-2013

AV FLOOR BOX SEPARATION AND CONDUIT

GEORGE MASON UNIVERSITY

Detail No: 3.2-8



NTS

Date: 6-3-2013

SINGLE PROJECTION CLASSROOM

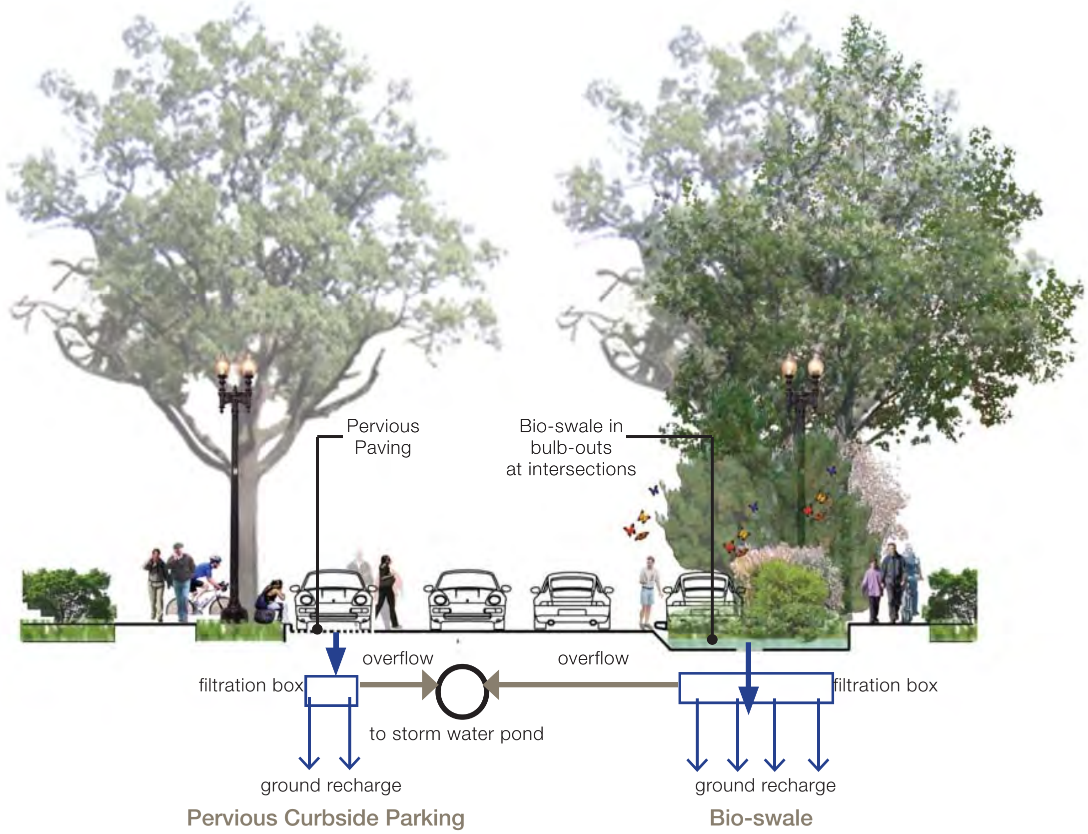
GEORGE MASON UNIVERSITY

Detail No: 3.2-9

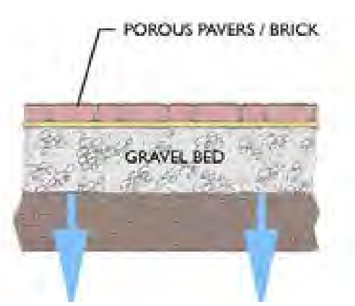
PLANNING AND DESIGN - ENVIRONMENTAL

Date: 6-3-2013

GEORGE MASON UNIVERSITY



Streetside bioswale



Porous Paving in Parking Areas

Rain Garden

NTS

Date: 6-3-2013

STORMWATER MANAGEMENT CONCEPTS

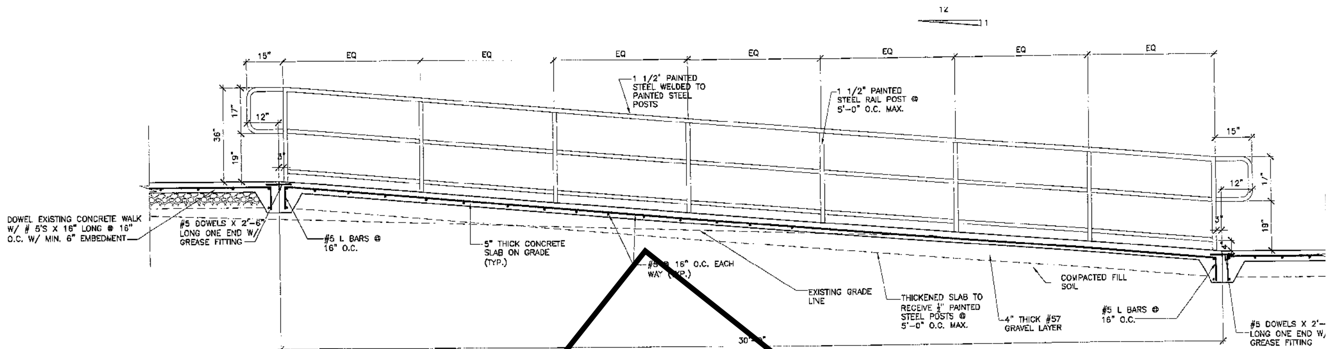
GEORGE MASON UNIVERSITY

Detail No: 3.4-1

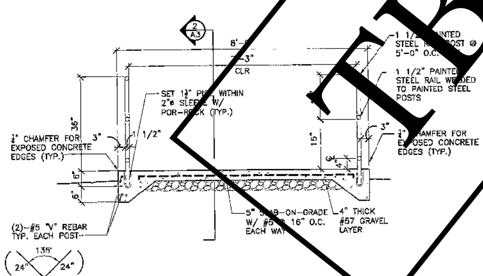
PLANNING AND DESIGN - ACCESSIBILITY

Date: 6-3-2013

GEORGE MASON UNIVERSITY



Typical Ramp Section



Cross Section Through Ramp

GENERAL NOTES

DESIGN LOADS:
CODE: 2003 IBC

EXISTING CONDITIONS:
Contractor shall field verify the accuracy of existing conditions shown and shall notify the Owner of any discrepancies discovered prior to fabrication or installation of new work.

SHOP DRAWINGS:
Submit six (6) sets of shop drawings of handrail to the engineer for review and approval prior to construction.

CONCRETE:
All concrete work shall be furnished and installed in accordance with the American Concrete Institute's ACI-318 and 301, latest edition, and the Concrete Reinforcing Steel Institute's Design Handbook standards.
Foundation concrete shall have a minimum 28-day compressive strength of 3,000 PSI. Slabs-on-grade and flat-work exposed to the weather shall have a minimum 28-day compressive strength of 4,000 PSI.
Minimum concrete cover over reinforcing steel shall be as follows:
3" for bottom surfaces poured on the ground;
2" for formed surfaces in contact with the ground
or exposed to weather;
1-1/2" for all other surfaces.
Use air-entering admixture in all concrete, providing 6% entrained total air content, plus or minus 1%, for concrete exposed to freezing and thawing, and from 2% TO 4% for other concrete.
Concrete slabs-on-grade shall be 5" min. concrete with #5 rebars at 16" O.C. each way, on 4" Thick # 57 Gravel layer, over firm insitu soil or compacted backfill.

REINFORCING STEEL:
Reinforcing steel bars shall conform to ASTMA 615 grade 60.

STEEL HANDRAILS:
Handrails shall be continuous 1 1/2" schedule 40 steel pipe, capped with a rounded end cap. Prime and apply two coats enamel semi-gloss paint to handrails after fabrication. Touch-up paint after installation as necessary. Color selected by owner's representative.

MASONRY:
CMU shall be concrete Hollow Load Bearing Units, Grade N, Type I, Normal Weight and with minimum compressive strength of Fm=2500 PSI as per ASTM C90 specification.
The Ultimate Compressive Strength of the CMU Walls Fm' shall be greater than 1500 PSI. Where required and noted CMU shall be Solid units similar to above, as per ASTM C 1107.
Mortar shall be Type S in accordance to ASTM C270. All grout in Masonry shall be fien or course grout complying with ASTM C476, with a minimum ultimate compressivestrength of 2500 PSI.

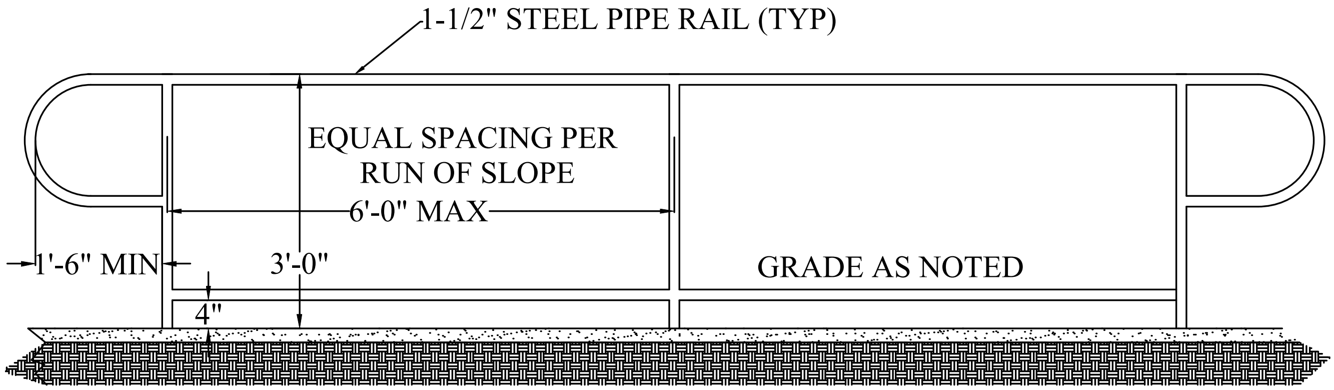
Horizontal joint reinforcement shall be provided on 8" Vertical Spacing in CMU Walls below grade, 16" Vertical spacing in CMUWalls Above grade . Joint reinforcement shall be 3/16" Dia. Truss Type DUR-O-WALL, with splices lapped 6" minimum and using prefabricated Tees and corners.

NTS

Date: 6-3-2013

GEORGE MASON UNIVERSITY

Detail No: 3.5-1



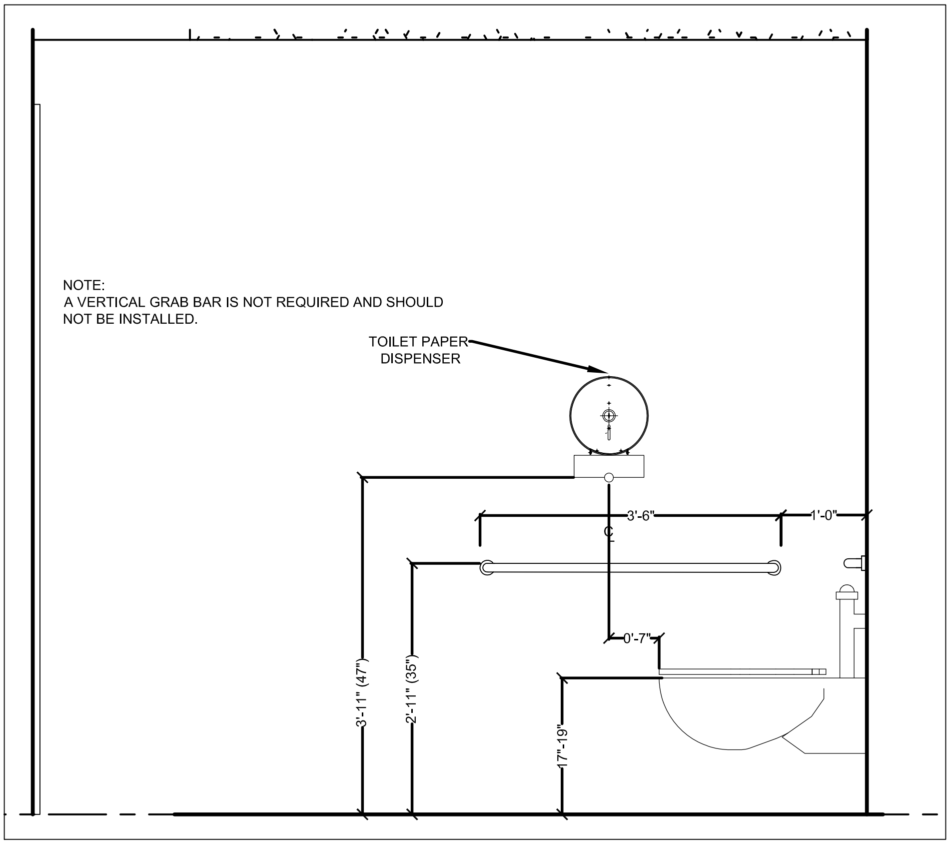
NTS

Date: 6-3-2013

ADA HANDRAIL DETAIL

GEORGE MASON UNIVERSITY

Detail No: 3.5-1B



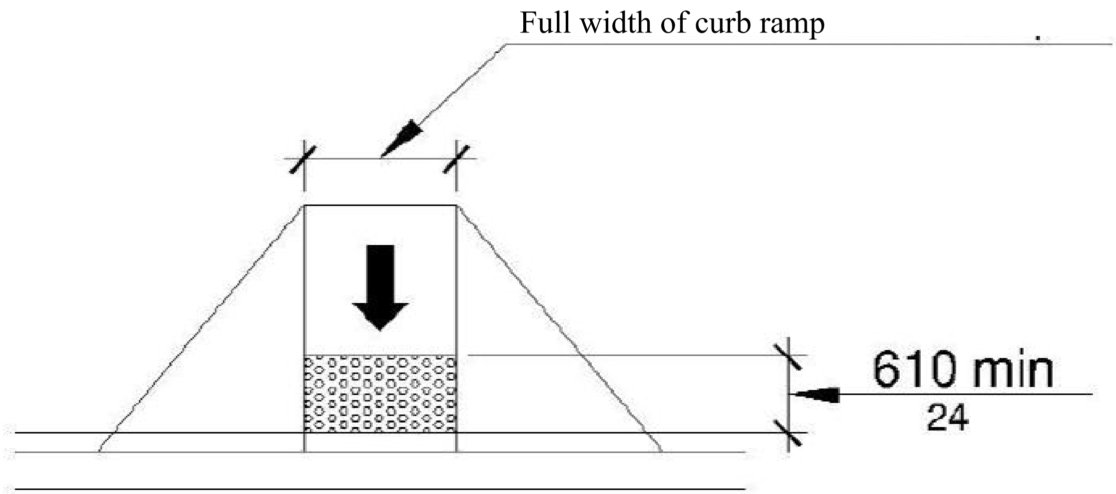
NTS

Date: 6-3-2013

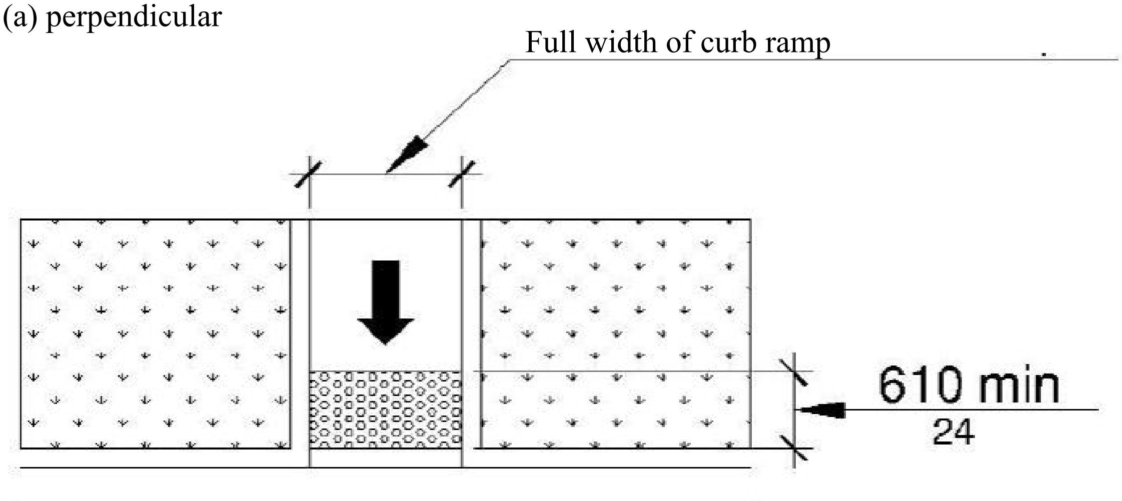
GEORGE MASON UNIVERSITY

TOILET FIXTURE + ACCESSORY MOUNTING HEIGHT

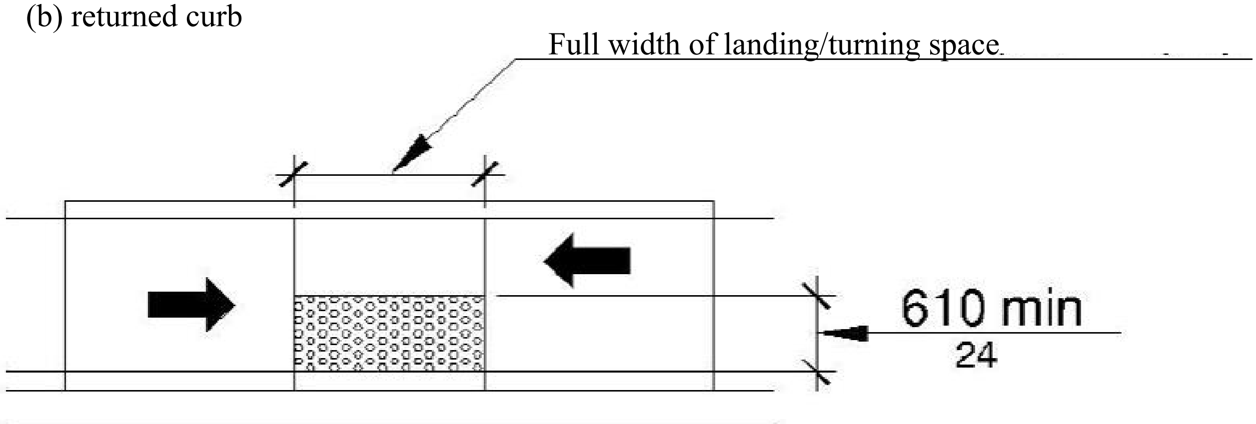
Detail No: 3.5-2



(a) perpendicular



(b) returned curb



(c) parallel

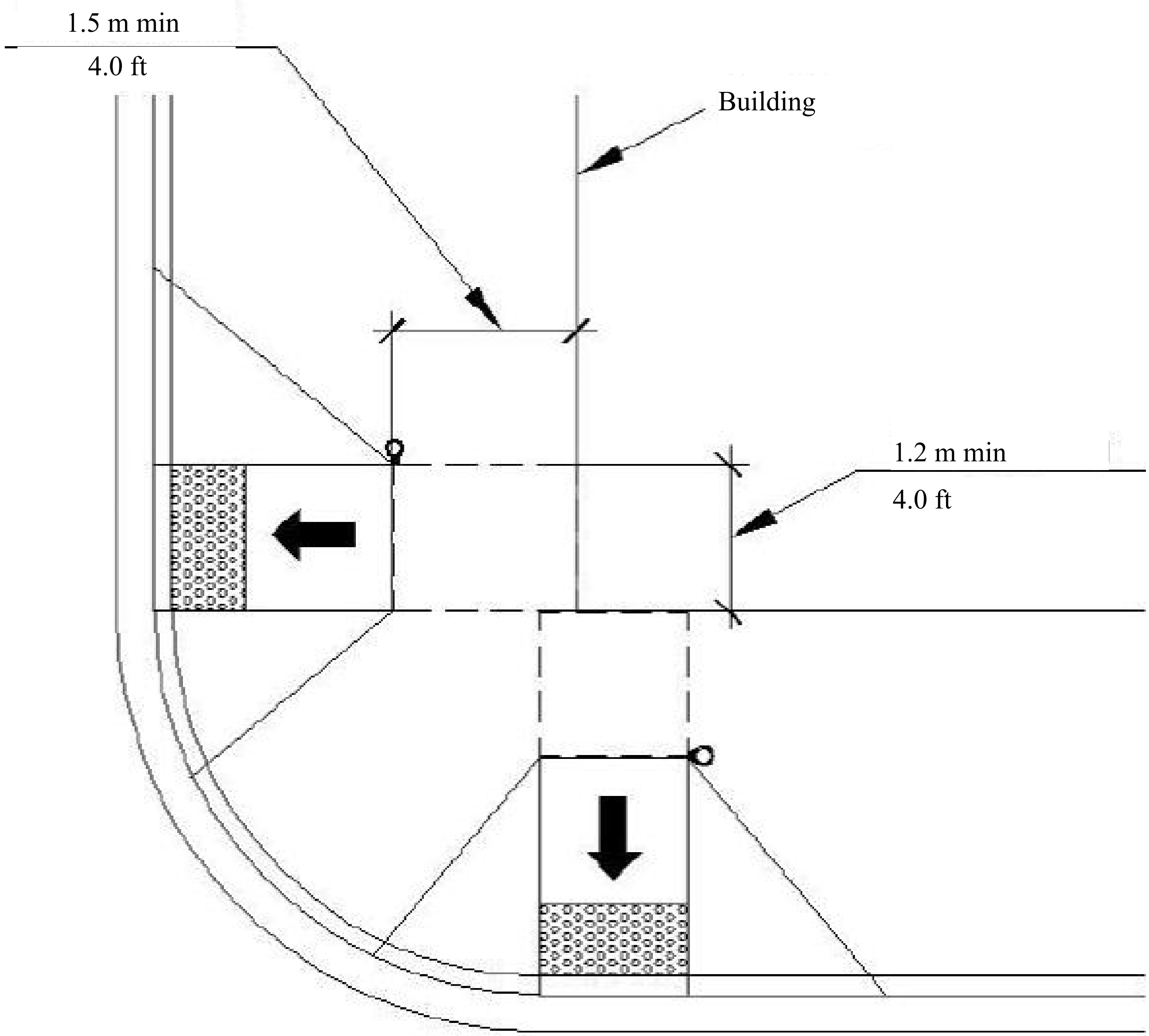
NTS

Date: 6-3-2013

RAMPS AT MID-BLOCK CROSSING

GEORGE MASON UNIVERSITY

Detail No: 3.5-3



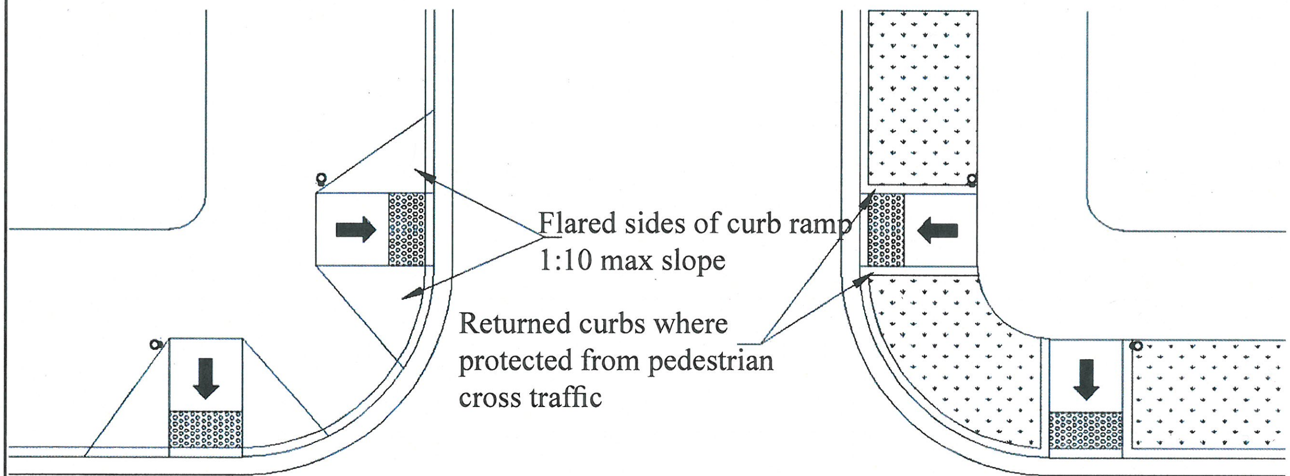
NTS

Date: 6-3-2013

RAMPS AT CORNER CROSSING

GEORGE MASON UNIVERSITY

Detail No: 3.5-4



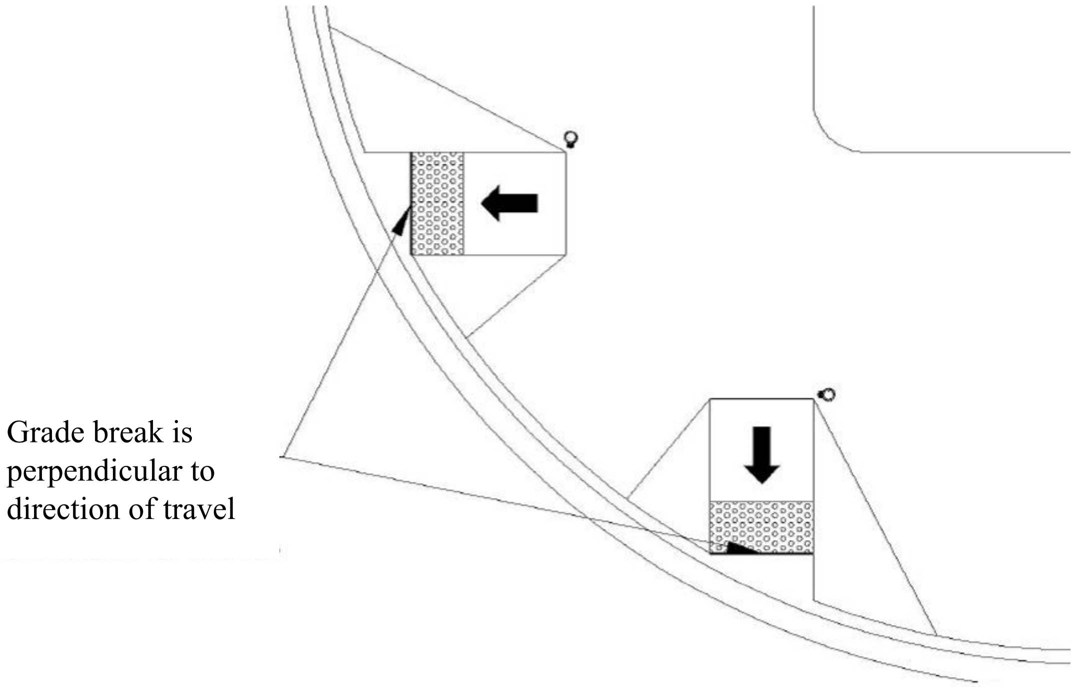
NTS

Date: 6-3-2013

RAMPS - FLARED SIDES

GEORGE MASON UNIVERSITY

Detail No: 3.5-5



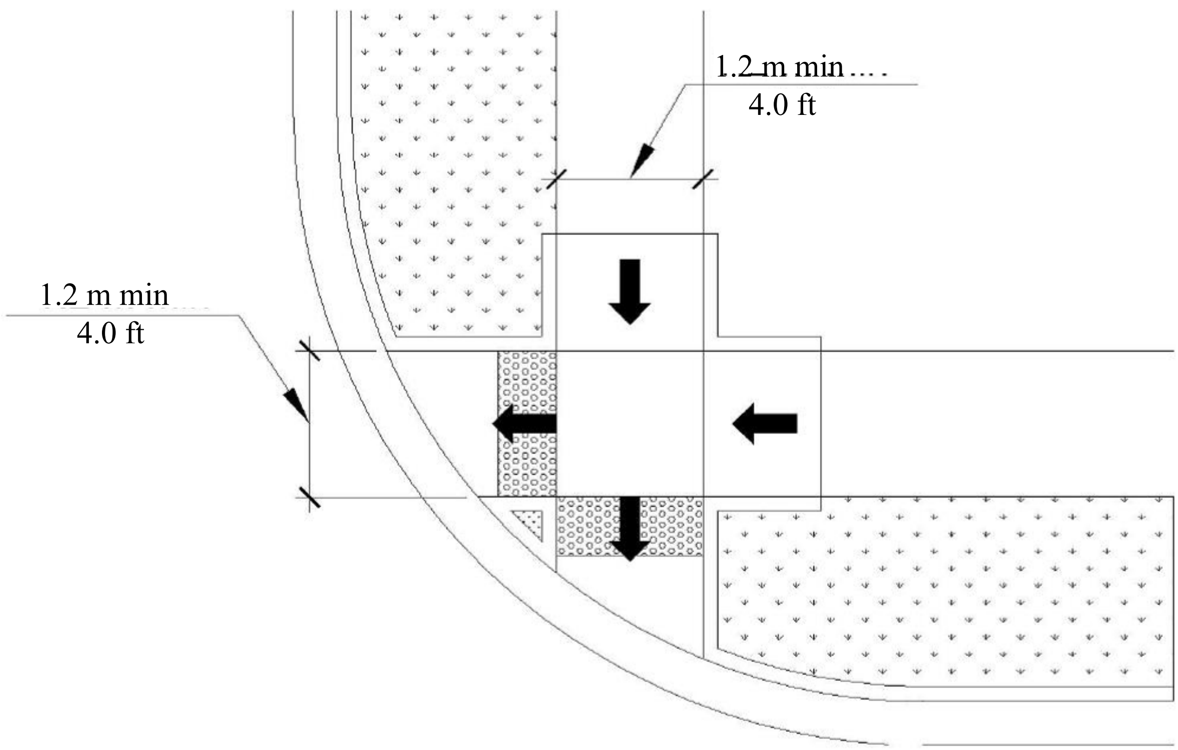


Figure R304.5.1
Width

NTS

Date: 6-3-2013

RAMPS - GRADE BREAKS

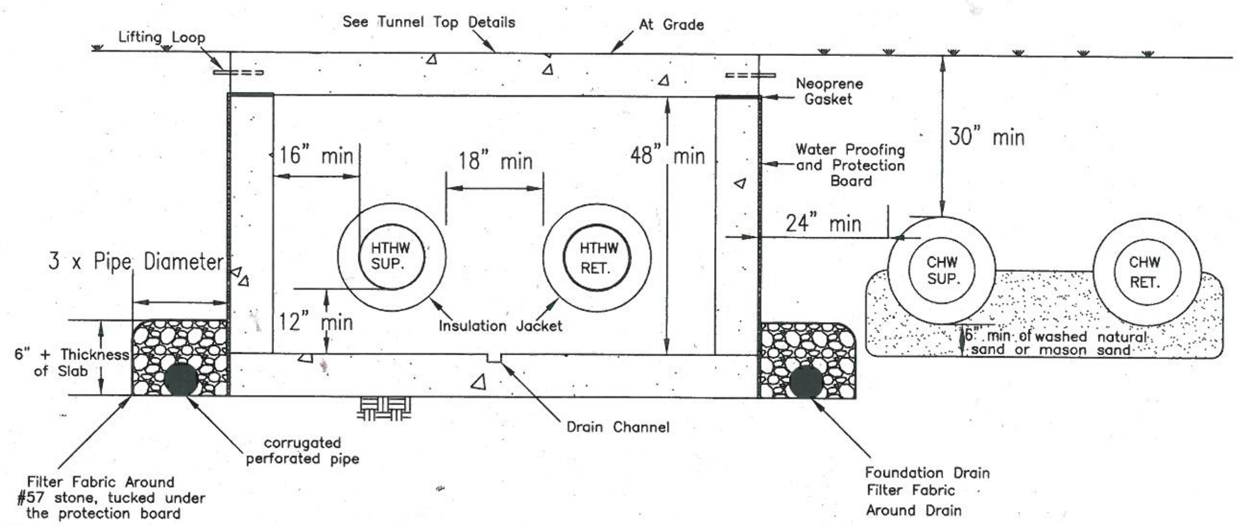
GEORGE MASON UNIVERSITY

Detail No: 3.5-6

CONSTRUCTION PRODUCTS AND ACTIVITIES - FACILITY CONSTRUCTION

Date: 6-3-2013

GEORGE MASON UNIVERSITY



NOTES:

1) Manholes, tunnel and piping to be designed by a Virginia rgistered professional engineer.

2) Construct tunnel and tops for H-20 loading.

3) Design tunnel and piping with as little abrupt elevational and lateral direction change as possible to avoid additional anchorage and expansion joints. Tunnel height can vary with site contour but height shall not exceed 8'. Tops at grade unless precluded by abrupt grade changes, road crossing or other obstruction.

4) Provie floor drains in tunnel if necessary, otherwise grade drain channel to manhole.

5) Lifting lugs for tunnel top removal shall be located on the sides of the tunnel top, see tunnel top detail.

6) For expansion joints, ball joints and anchorage provide hatch access with cover. Hatch to be 4' x 3' min. clearnace.

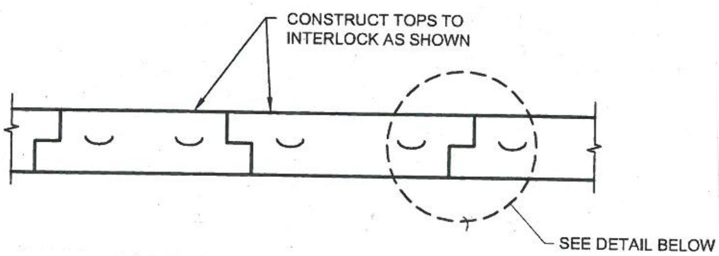
NTS

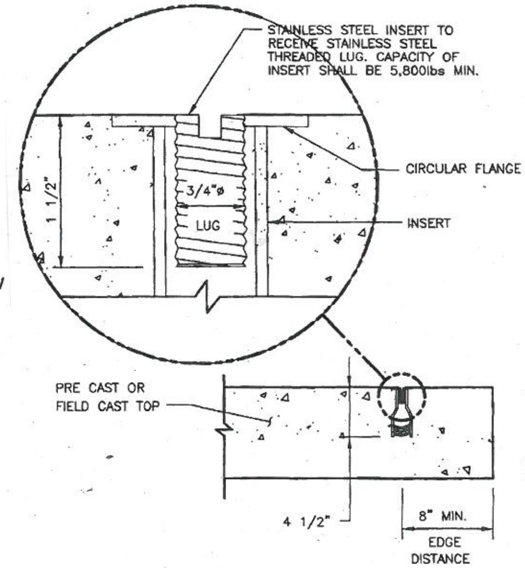
Date: 6-3-2013

HTHW TUNNEL DETAIL, FAIRFAX CAMPUS

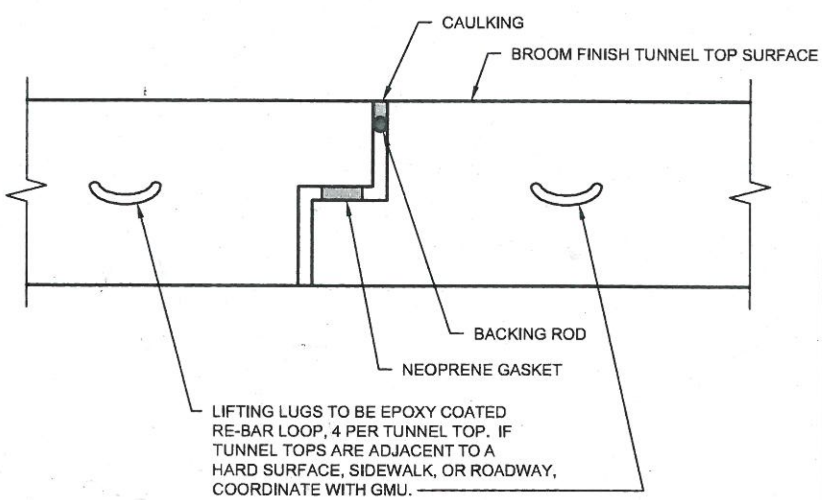
GEORGE MASON UNIVERSITY

Detail No: 4.1-1





LIFTING INSERT DETAILS
FOR TOPS @ GRADE



NOTES:
1) Construct tunnel and tops for H-20 loading.
2) Tops at grade unless precluded by abrupt grade changes, road crossing or other obstruction.
3) Tunnel tops not to exceed 4,500 pounds each.

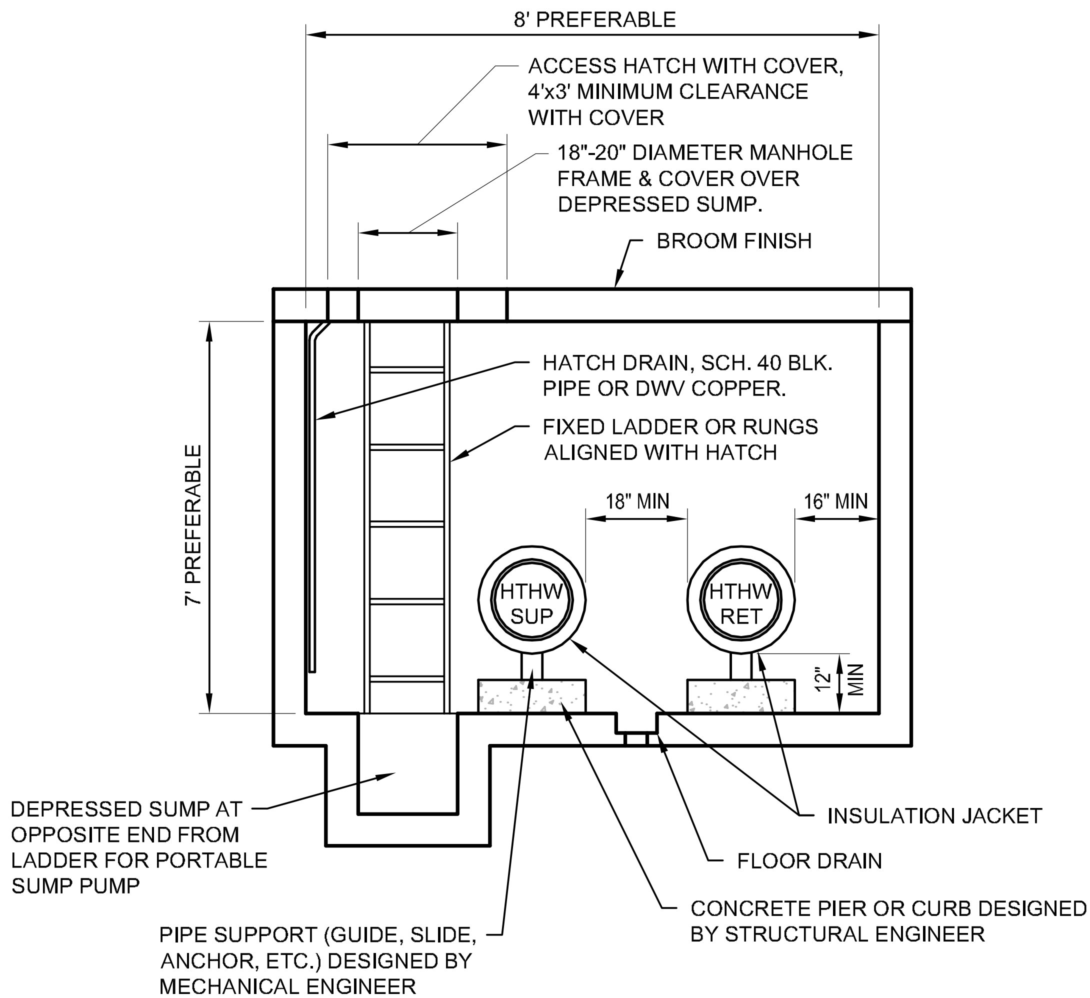
NTS

Date: 6-3-2013

HTHW TUNNEL TOP DETAILS

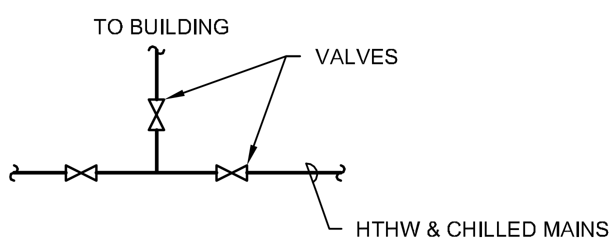
GEORGE MASON UNIVERSITY

Detail No: 4.1-2



NOTES:

1) Construct manhole for H-20 loading.
2) Manholes are required at building take-offs and valve locations only.
3) Floor drain to be piped to storm sewer.
4) At lowest manhole in the piping run include HTHWS & R drains piped to a tempering tank, to be discharged into sanitary sewer.
5) If a sump pump is required, power to the sump pump to be connected to emergency power.
6) Include a three-valve combination on the supply and return for each building take-off to accommodate back-feed capability, see below:



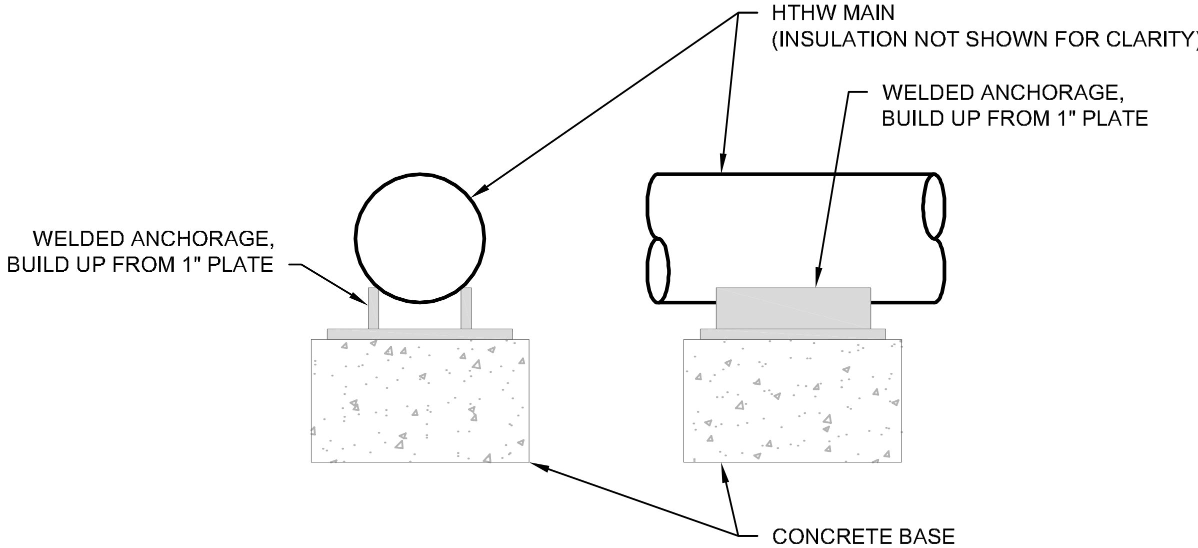
NTS

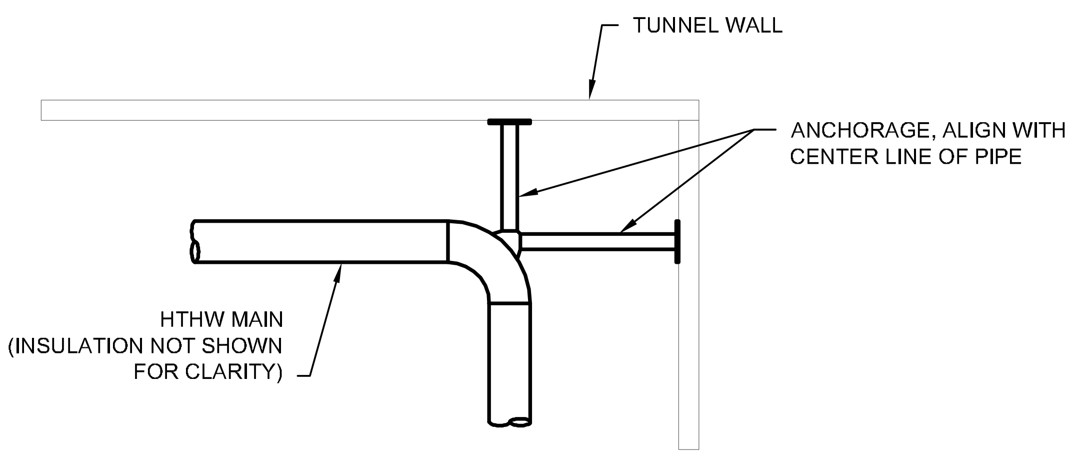
Date: 6-3-2013

HTHW MANHOLE DETAIL

GEORGE MASON UNIVERSITY

Detail No: 4.1-3





NTS

Date: 6-3-2013

PREFERRED CORNER ANCHORAGE

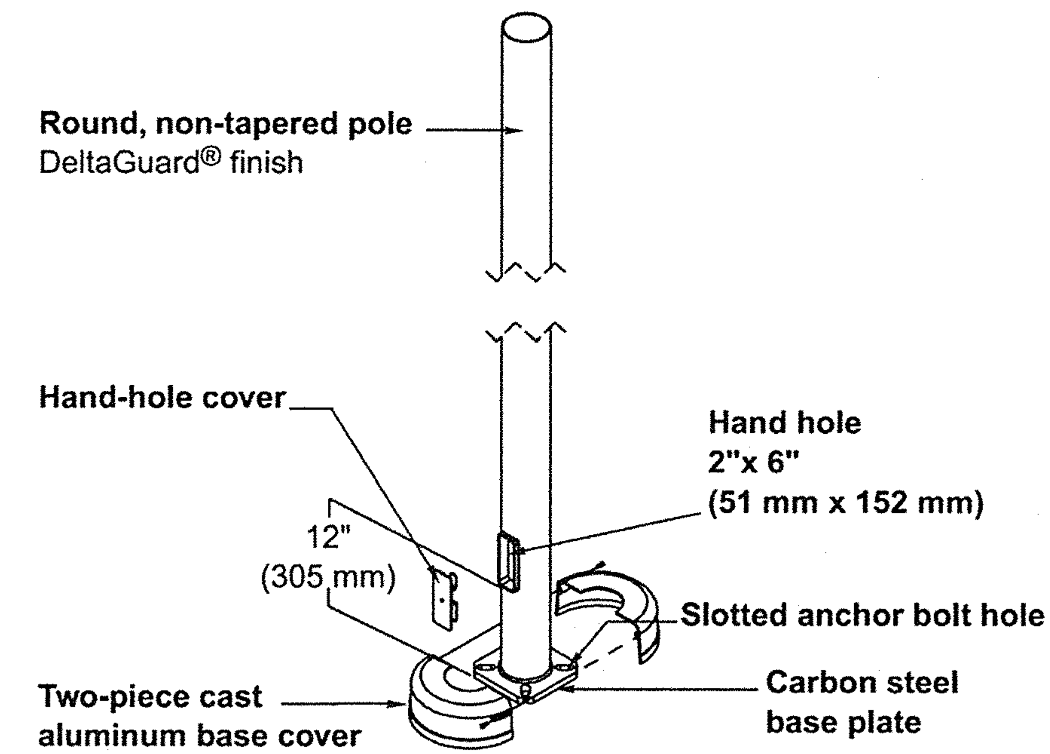
GEORGE MASON UNIVERSITY

Detail No: 4.1-4

CONSTRUCTION PRODUCTS AND ACTIVITIES - FACILITY SERVICES

Date: 6-3-2013

GEORGE MASON UNIVERSITY



Beta Catalog Number: PS5R22C - 1 - SV

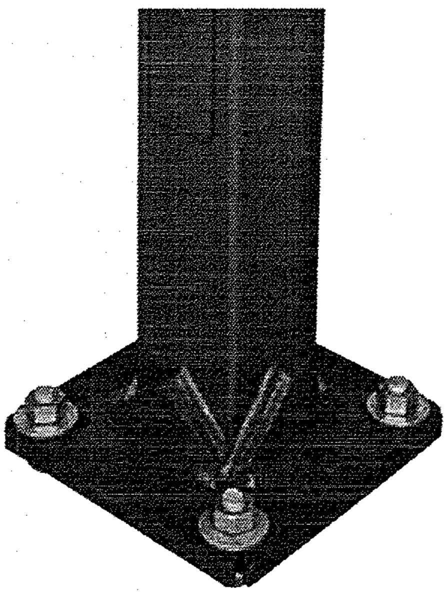
NTS

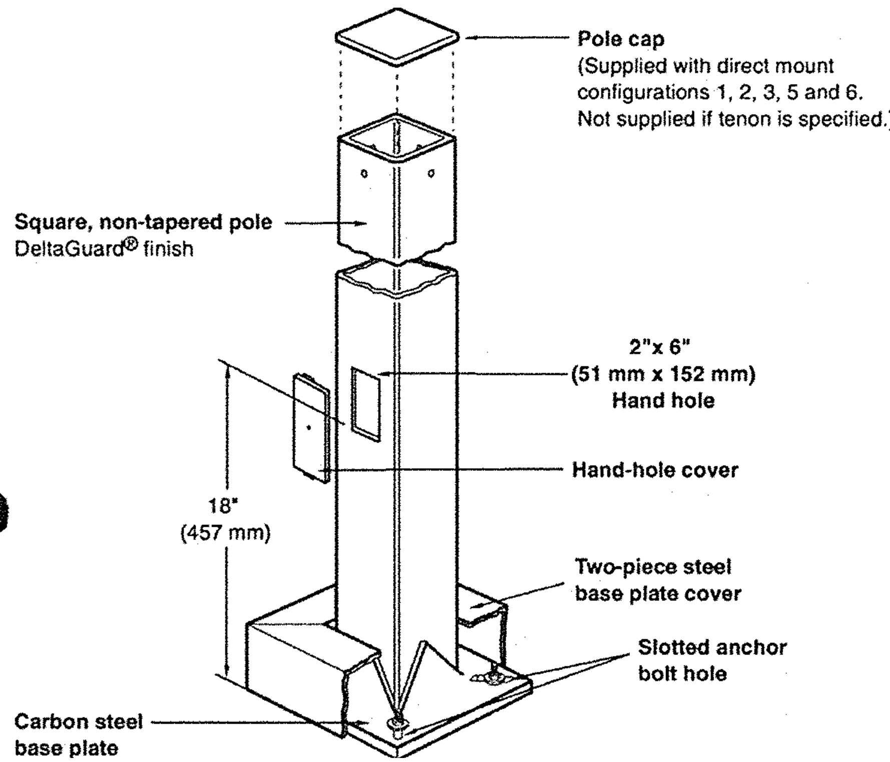
Date: 6-3-2013

LIGHT POLE - TYPE III MEDIUM

GEORGE MASON UNIVERSITY

Detail No: 4.2-15





Beta Catalog Number: PS3S15C - 1 - BZ

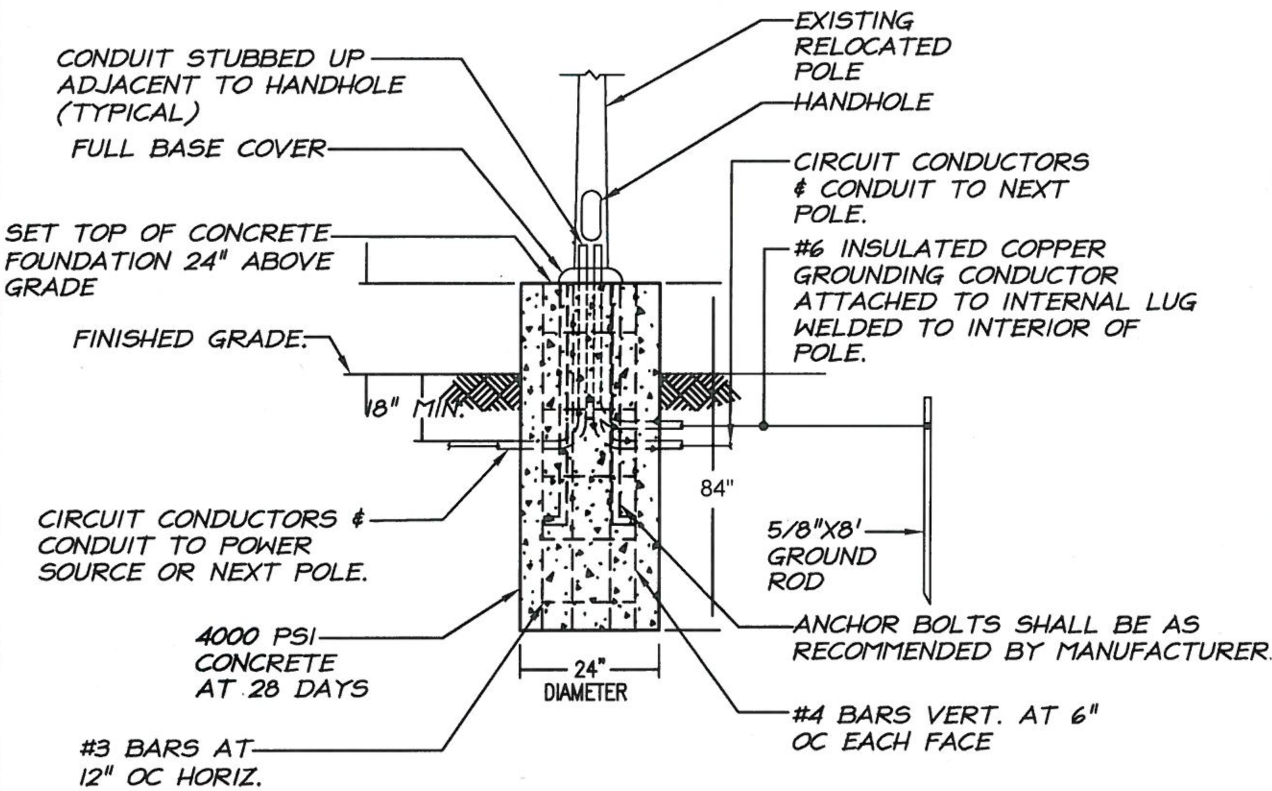
NTS

Date: 6-3-2013

LIGHT POLE - TYPE V MEDIUM

GEORGE MASON UNIVERSITY

Detail No: 4.2-16



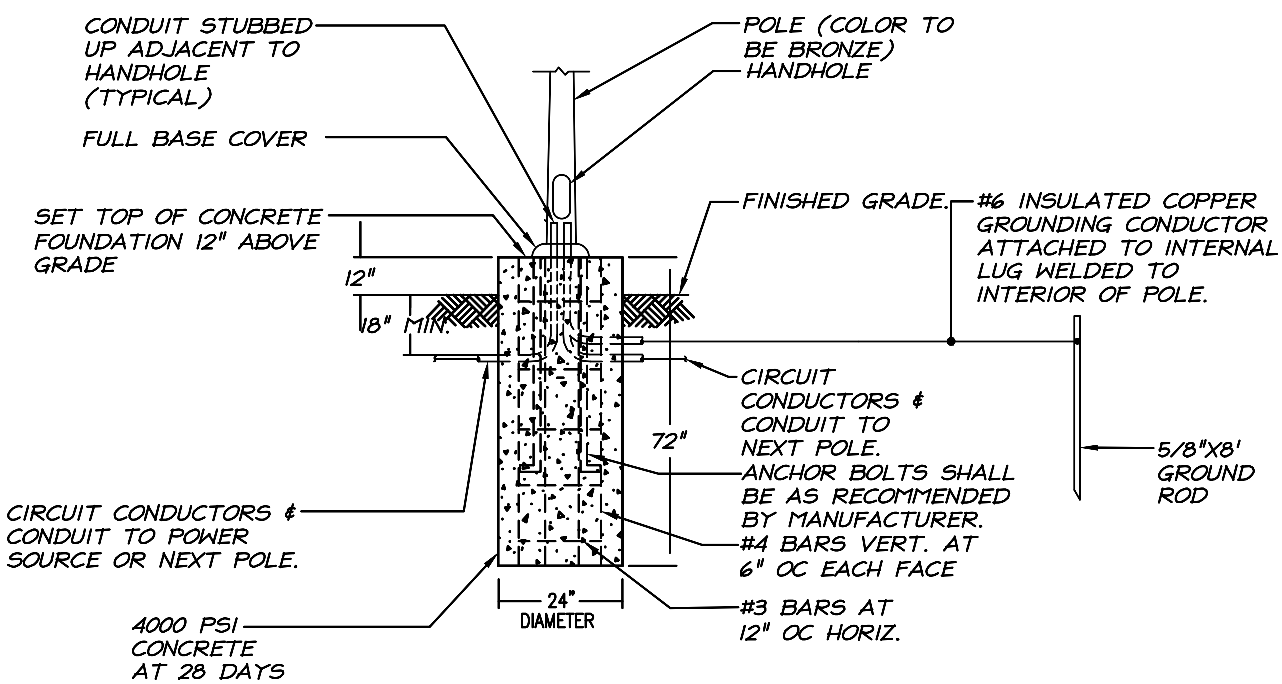
NTS

Date: 6-3-2013

GEORGE MASON UNIVERSITY

TYPE III ROADWAY LIGHTING POLE
BASE FOUNDATION DETAIL

Detail No: 4.2-17



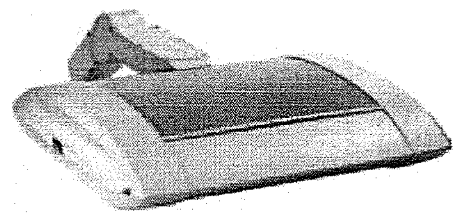
NTS

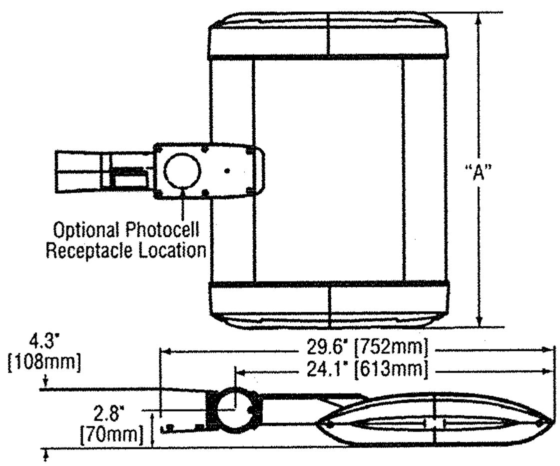
Date: 6-3-2013

GEORGE MASON UNIVERSITY

TYPE V SIDEWALK LIGHTING POLE BASE FOUNDATION DETAIL

Detail No: 4.2-18





# of LEDs	Dim. "A"
20	12.06" [306mm]
40	12.06" [306mm]
60	14.06" [357mm]
80	16.06" [408mm]
100	18.06" [459mm]
120	20.06" [510mm]
140	22.06" [560mm]
160	24.06" [611mm]
200	28.06" [713mm]
240	32.06" [814mm]

BetaLED Catalog #: ARE - EDG - 3M - AA - 12 - D - UH - SV - 350

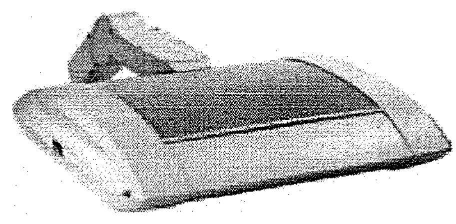
NTS

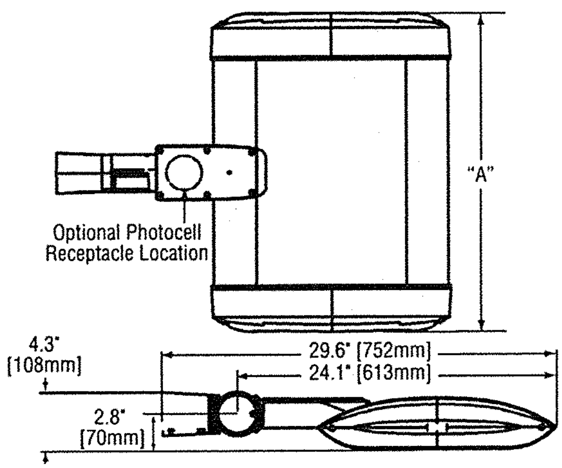
Date: 6-3-2013

GEORGE MASON UNIVERSITY

THE EDGE LED AREA LIGHT - TYPE III MEDIUM (120 LEDs)

Detail No: 4.2-19





# of LEDs	Dim. "A"
20	12.06" [306mm]
40	12.06" [306mm]
60	14.06" [357mm]
80	16.06" [408mm]
100	18.06" [459mm]
120	20.06" [510mm]
140	22.06" [560mm]
160	24.06" [611mm]
200	28.06" [713mm]
240	32.06" [814mm]

BetaLED Catalog #: ARE - EDG - 5M - AA - 08 - D - UL - BZ - 350

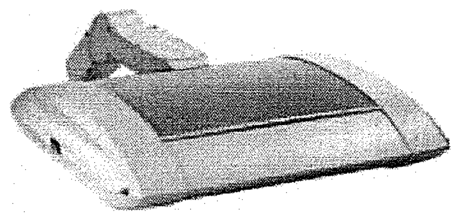
NTS

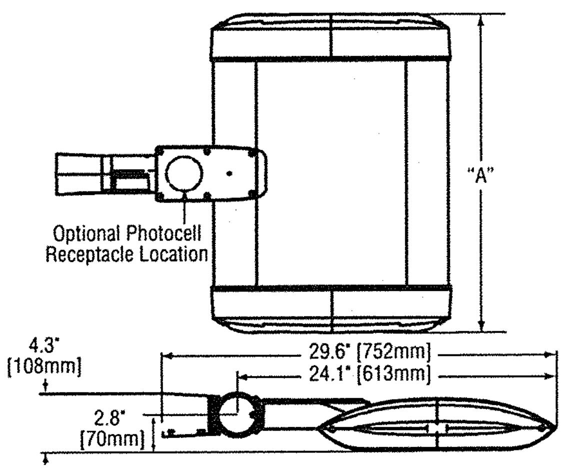
Date: 6-3-2013

GEORGE MASON UNIVERSITY

THE EDGE LED AREA LIGHT -
TYPE V MEDIUM (80 LEDs)

Detail No: 4.2-20





# of LEDs	Dim. "A"
20	12.06" [306mm]
40	12.06" [306mm]
60	14.06" [357mm]
80	16.06" [408mm]
100	18.06" [459mm]
120	20.06" [510mm]
140	22.06" [560mm]
160	24.06" [611mm]
200	28.06" [713mm]
240	32.06" [814mm]

BetaLED Catalog #: ARE - EDG - 5M - AA - 04 - D - UL - BZ - 350

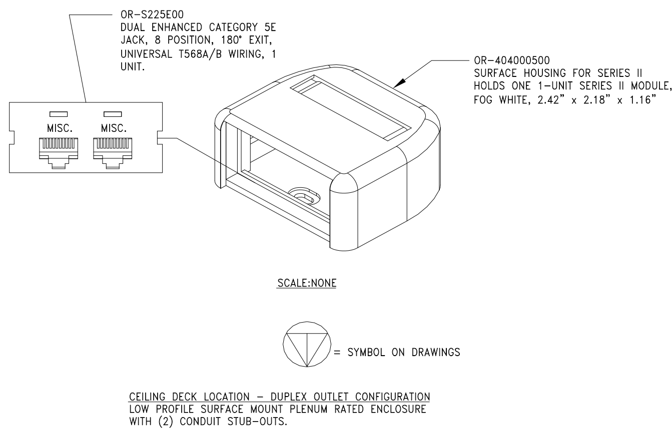
NTS

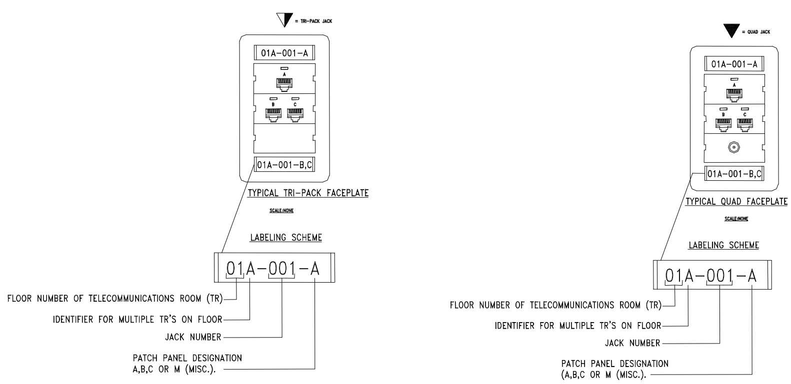
Date: 6-3-2013

GEORGE MASON UNIVERSITY

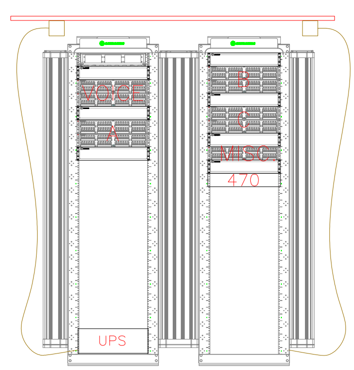
THE EDGE LED AREA LIGHT -
TYPE V MEDIUM (40 LEDs)

Detail No: 4.2-21





Station Outlets (Refer to Division 27)



Typical Two-Rack Equipment Rack/Enclosure (Refer to Division 27)

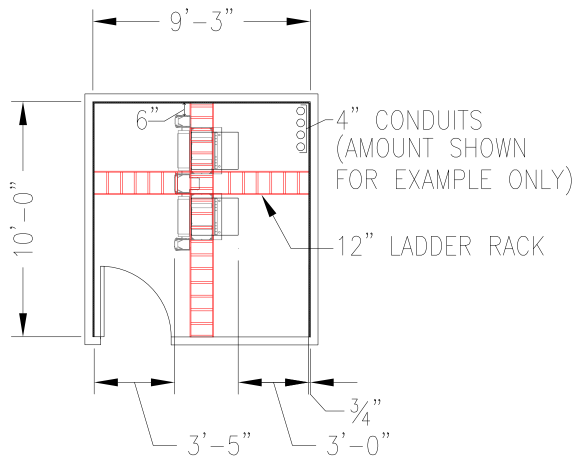
NTS

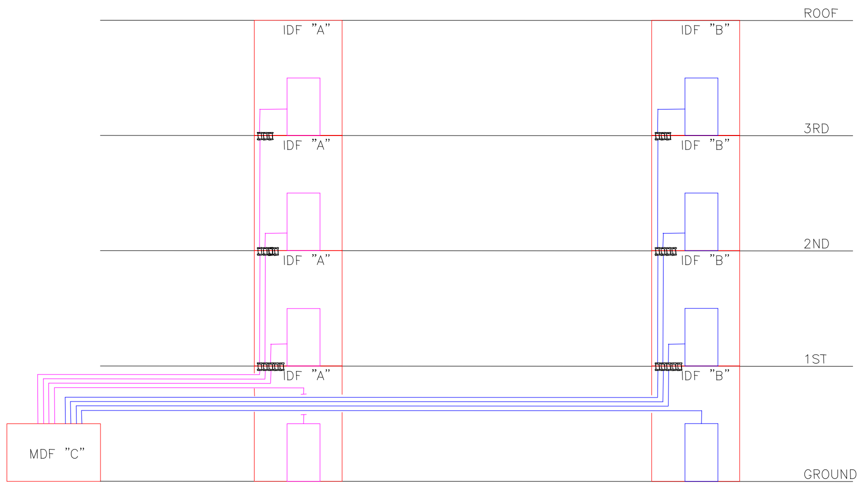
Date: 6-3-2013

COMMUNICATIONS DETAILS

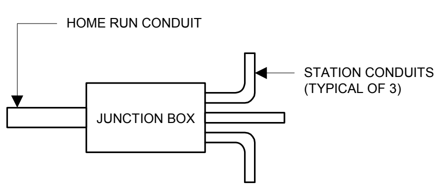
GEORGE MASON UNIVERSITY

Detail No: 4.2-22

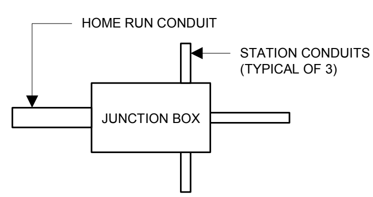




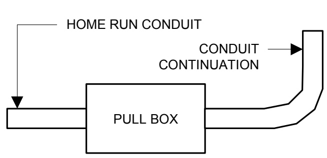
TYPICAL COPPER AND FIBER RISER DIAGRAM
SCALE: NONE



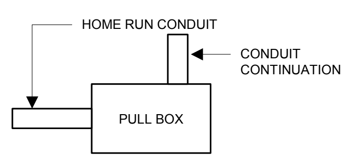
CORRECT INSTALLATION



INCORRECT INSTALLATION



CORRECT INSTALLATION



INCORRECT INSTALLATION

NTS

Date: 6-3-2013

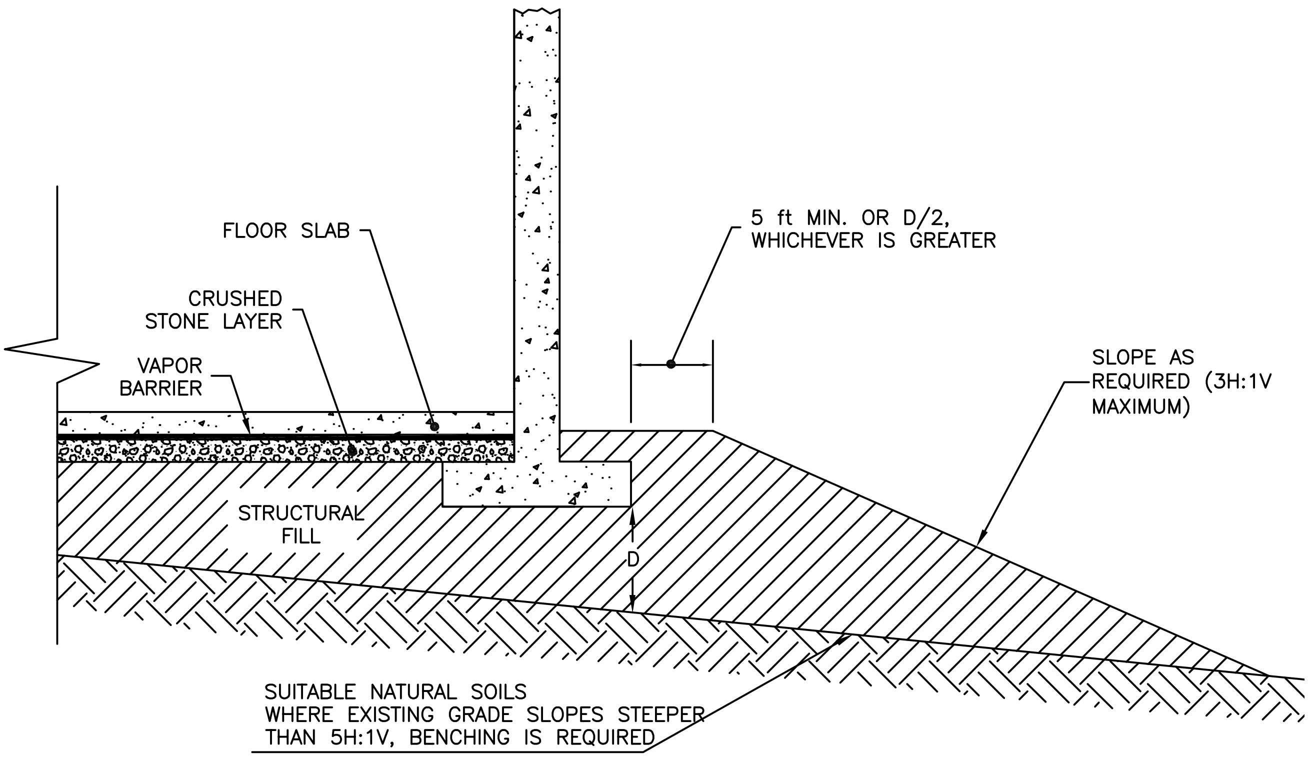
TYPICAL COPPER AND FIBER RISDER DIAGRAM

Detail No: 4.2-23

CONSTRUCTION PRODUCTS AND ACTIVITIES - SITE AND INFRASTRUCTURE

Date: 6-3-2013

GEORGE MASON UNIVERSITY



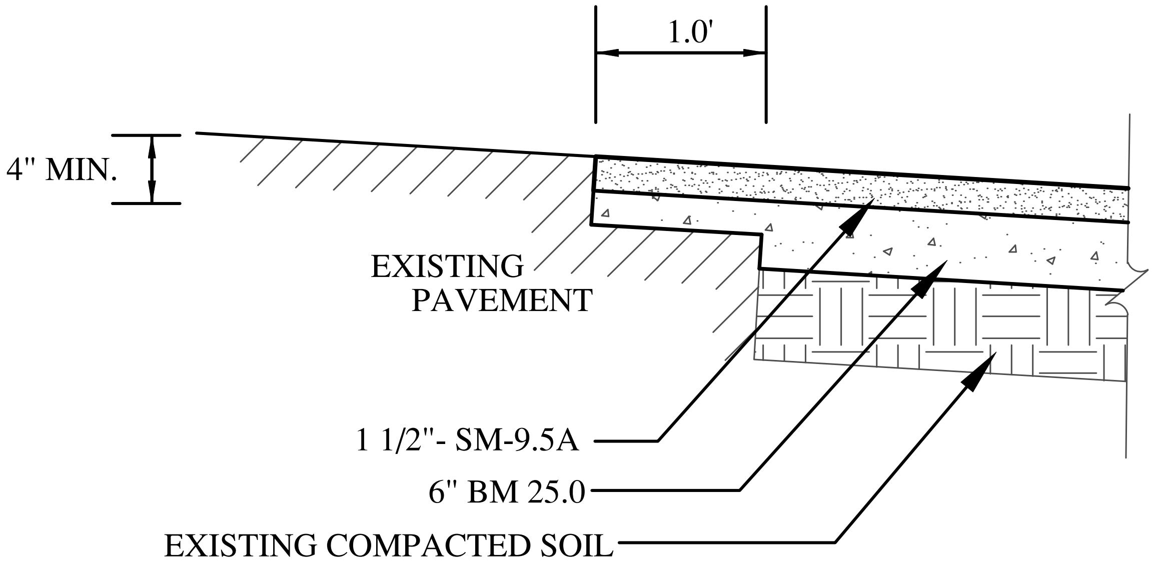
NTS

Date: 6-3-2013

GEORGE MASON UNIVERSITY

GENERAL RECOMMENDATIONS FOR STRUCTURAL FILL

Detail No: 4.3-1



BOTTOM AND ALL SIDES OF CUT TO BE PREPPED
WITH ASPHALT PRIOR TO PLACING ASPHALT MIX.

(To be used for pavement additions an utility repairs)

NOTES:
1. Subgrade to be compacted to 95% of maximum density as determined by AASHTO T-99, within plus or minus 20% of optimum moisture content.
2. Contractor to provide a clean straight cut of existing pavement and verify and match existing pavement section as a minimum.

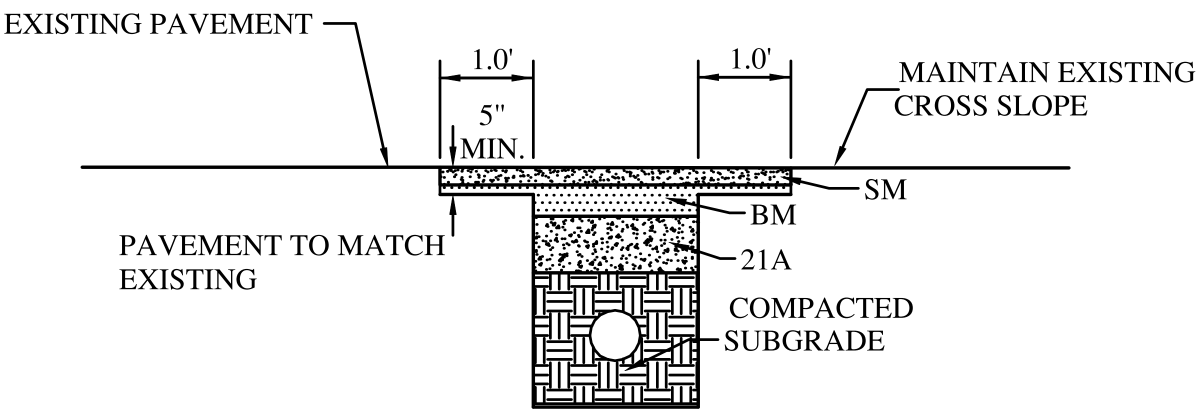
NTS

Date: 6-3-2013

PAVEMENT WEDGING DETAIL

GEORGE MASON UNIVERSITY

Detail No: 4.3-10



NOTES:

1. Subgrade to be compacted to 95% of maximum density as determined by AASHTO T-99, within plus or minus 20% of optimum moisture content.
2. Contractor to provide a clean straight cut of existing pavement and verify and match existing pavement section as a minimum.

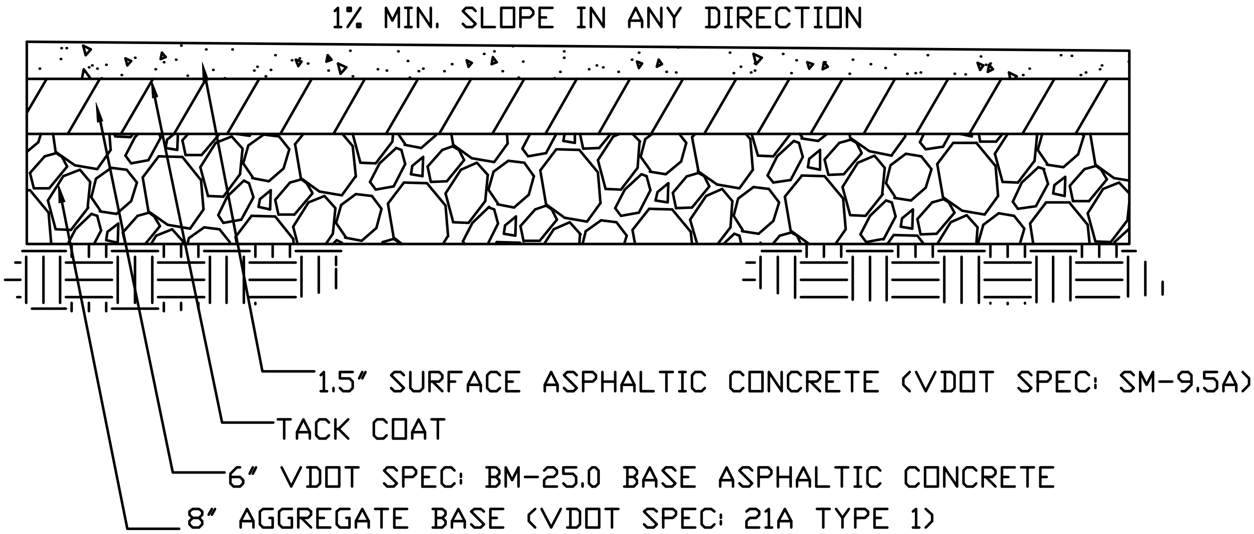
NTS

Date: 6-3-2013

PAVEMENT PATCH DETAIL

GEORGE MASON UNIVERSITY

Detail No: 4.3-11



NOTES:
1. For use on all parking areas, service areas and roads, unless an alternate section is provided by mason land development.

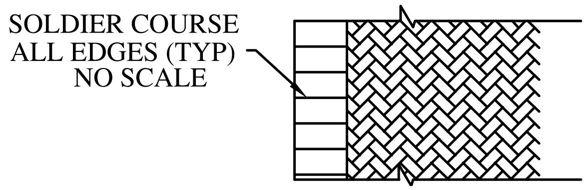
NTS

Date: 6-3-2013

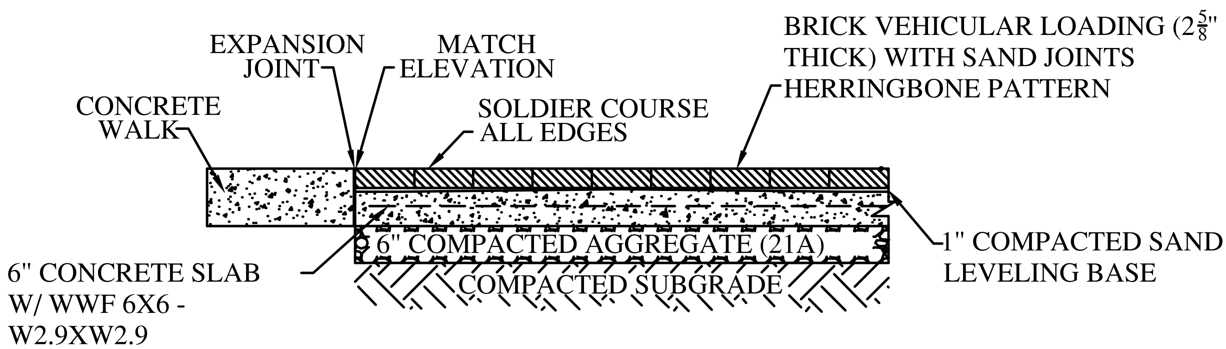
TYPICAL ASPHALT PAVEMENT SECTION

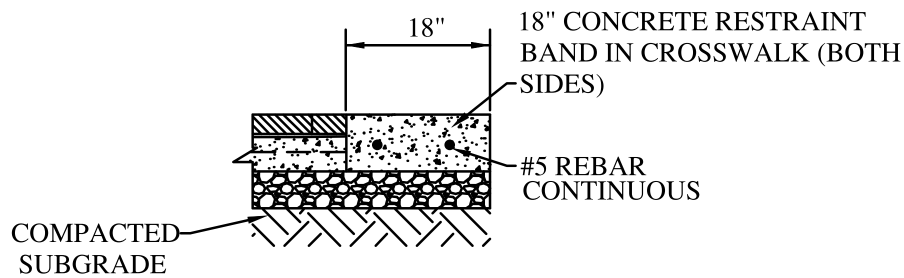
GEORGE MASON UNIVERSITY

Detail No: 4.3-12



PLAN VIEW





NOTES:

1) Signs and markings shall be in accordance with the MUTCD.

2) Maximum vertical difference between top of adjacent brick pavers shall be 1/8” misshapen or deformed bricks are not acceptable.

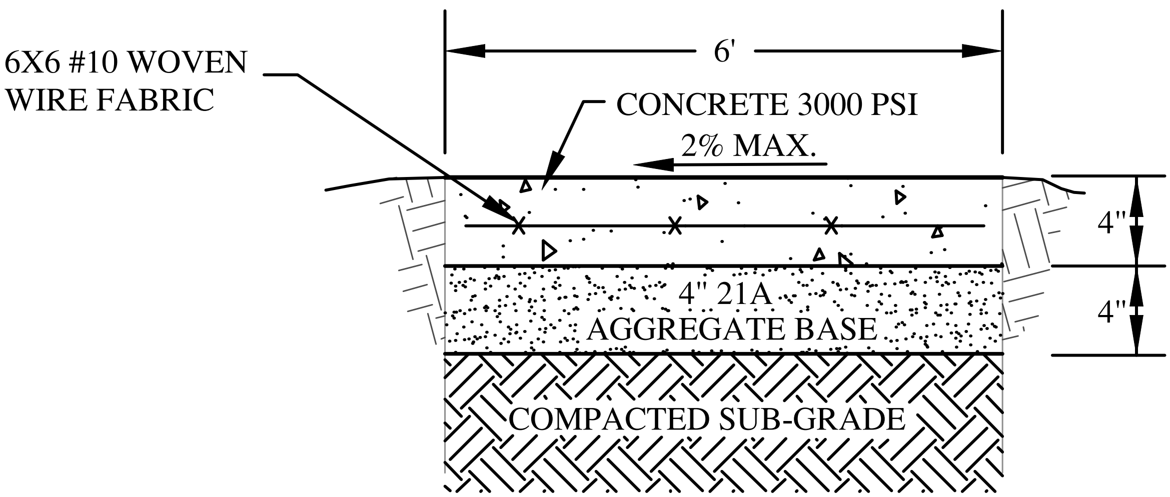
NTS

Date: 6-3-2013

BRICK PAVER DETAIL

GEORGE MASON UNIVERSITY

Detail No: 4.3-13



NTS

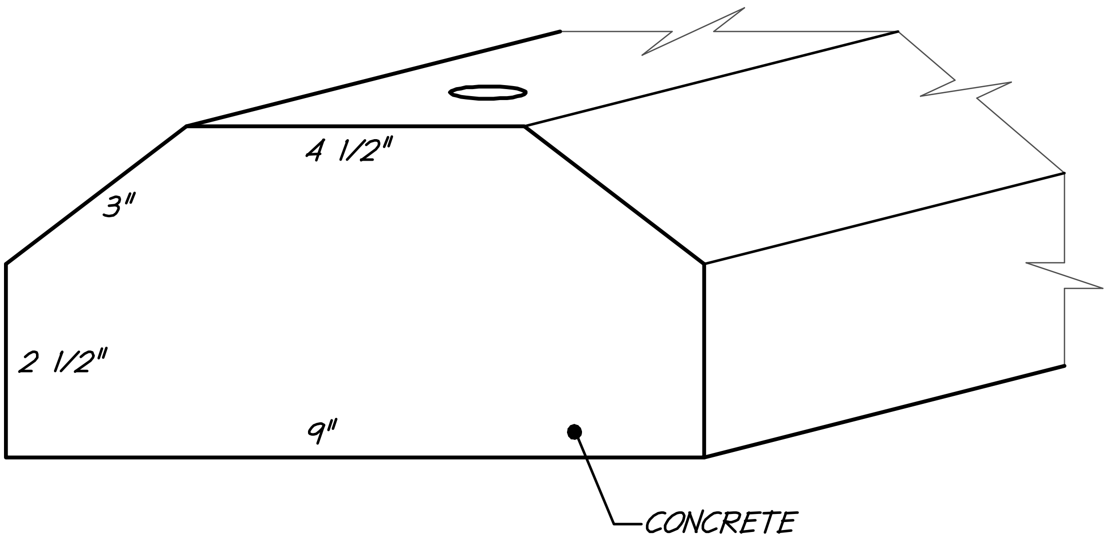
Date: 6-3-2013

SIDEWALK DETAIL

GEORGE MASON UNIVERSITY

Detail No: 4.3-14

6 FT. - CONCRETE
9" WIDE
5" HIGH
2 STEEL BARS - REINFORCED
2 PRE-FORMED HOLES
APPROXIMATE WEIGHT - 210 LBS.



NOTES:
1. Attach wheelstop to ground using steel reinforcing bars 2’ in length, driven down flush with wheelstop or as approved by owner.

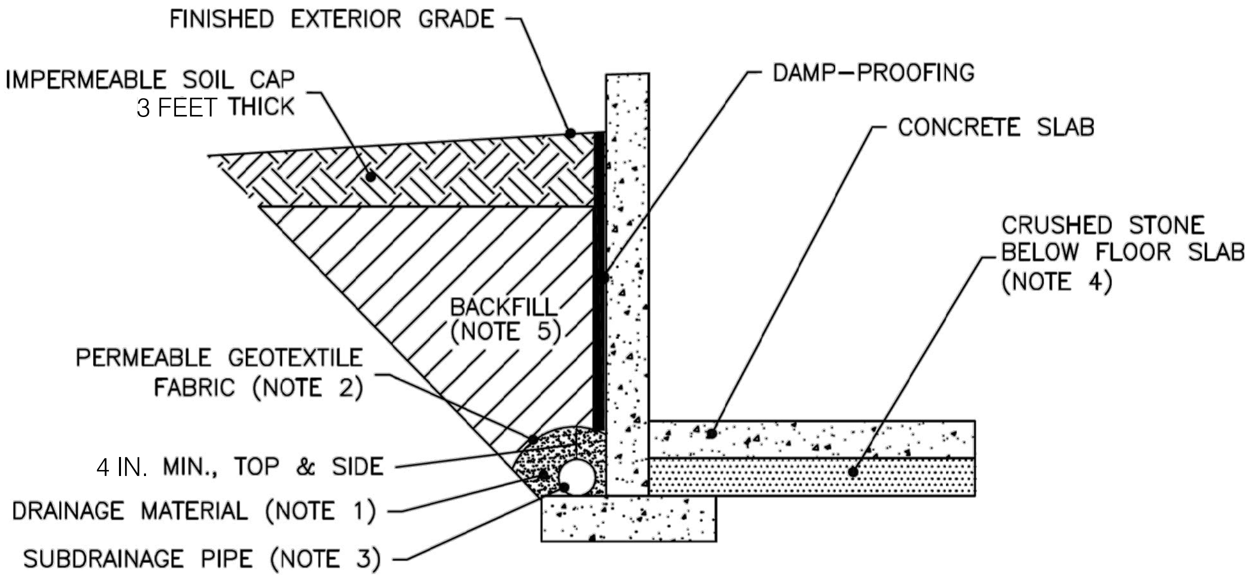
NTS

Date: 6-3-2013

WHEELSTOP DETAIL

GEORGE MASON UNIVERSITY

Detail No: 4.3-15



NOTES:

1) Drainage material should satisfy requirements for ASTM C-33 No. 57.

2) Permeable fabric should have an equivalent opening size not larger than the no. 70 U.S. standard sieve size. The fabric may be replaced with 4 inches of sand meeting the requirements of ASTM C-33 fine aggregate.

3) Subdrainage piping should be 4 inches diameter slotted corrugated polyethylene (PE) tubing according to ASTM F-405 with maximum 1/8 inch slot width. Pipe should extend to a storm sewer, suitable gravity outlet, or sump pit.

4) See geotechnical report for details on placement of crushed stone below floor slab.

5) Backfill should consist of material classified SC, SM, SP, SW, GC, GM, GP or GW, per ASTM D-2487 with a liquid limit less than 40 and plasticity index less than 20.

6) This is a basic detail, final geotechnical report shall govern.

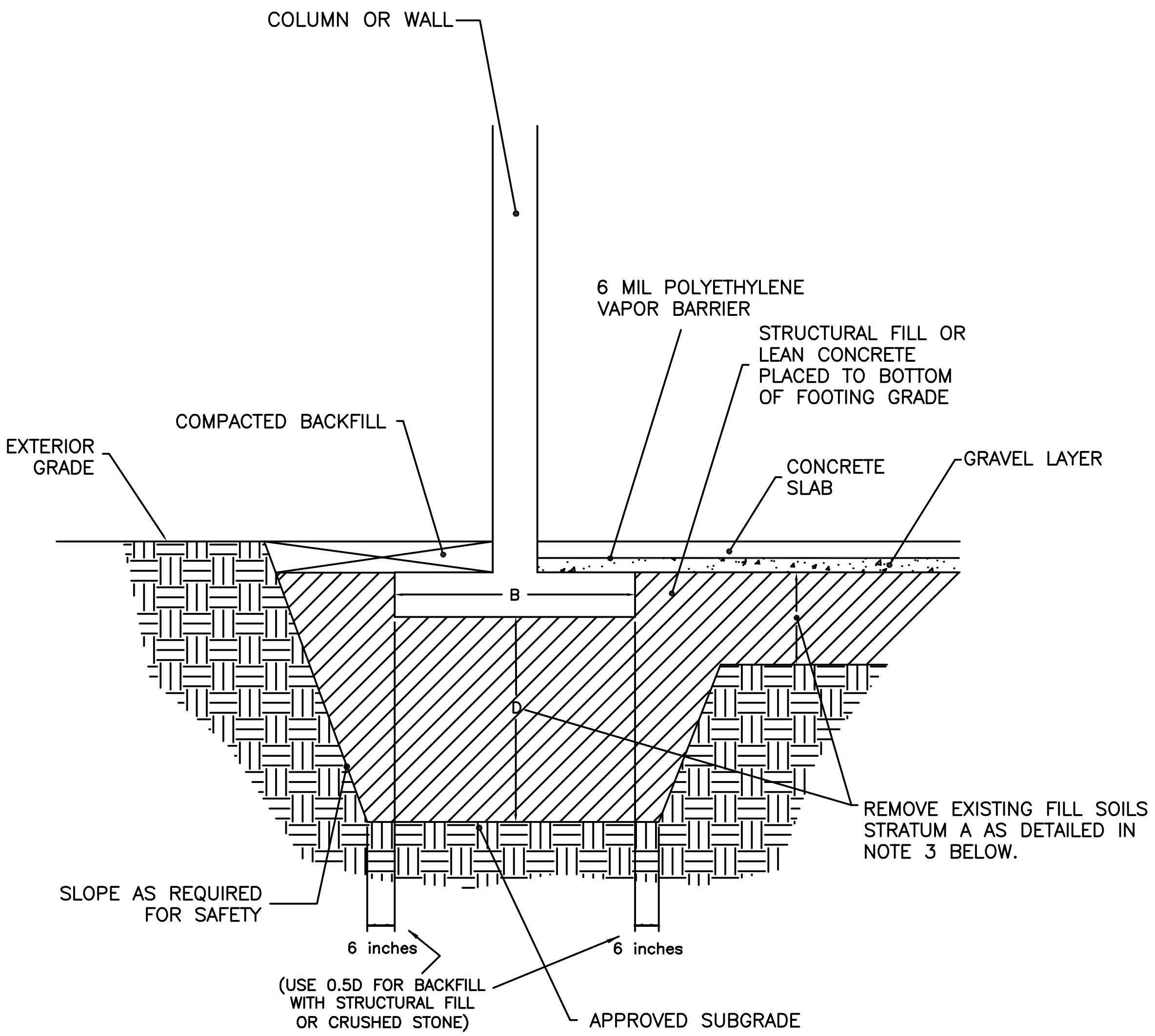
NTS

Date: 6-3-2013

GEORGE MASON UNIVERSITY

SUBDRAIN DETAIL FOR BELOW GRADE AND SITE RETAINING WALLS

Detail No: 4.3-2



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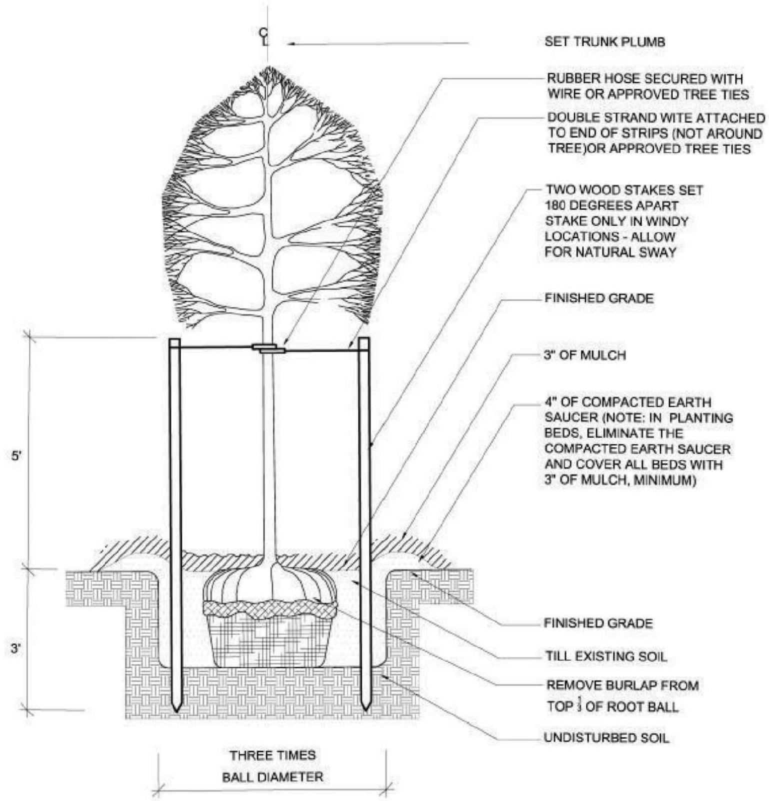
Date: 6-3-2013

FOOTING UNDERCUT DETAIL

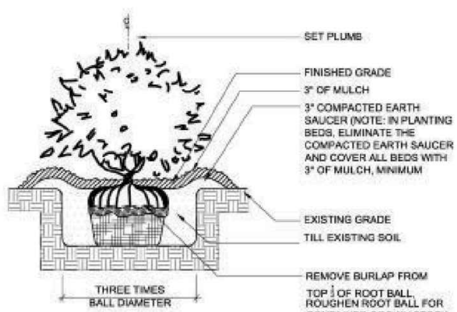
GEORGE MASON UNIVERSITY

Detail No: 4.3-3



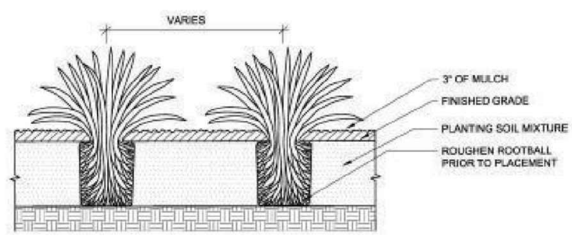
A TREE PLANTING

NTS



B SHRUB PLANTING

NTS



C PERRENNIAL PLANTING

NTS

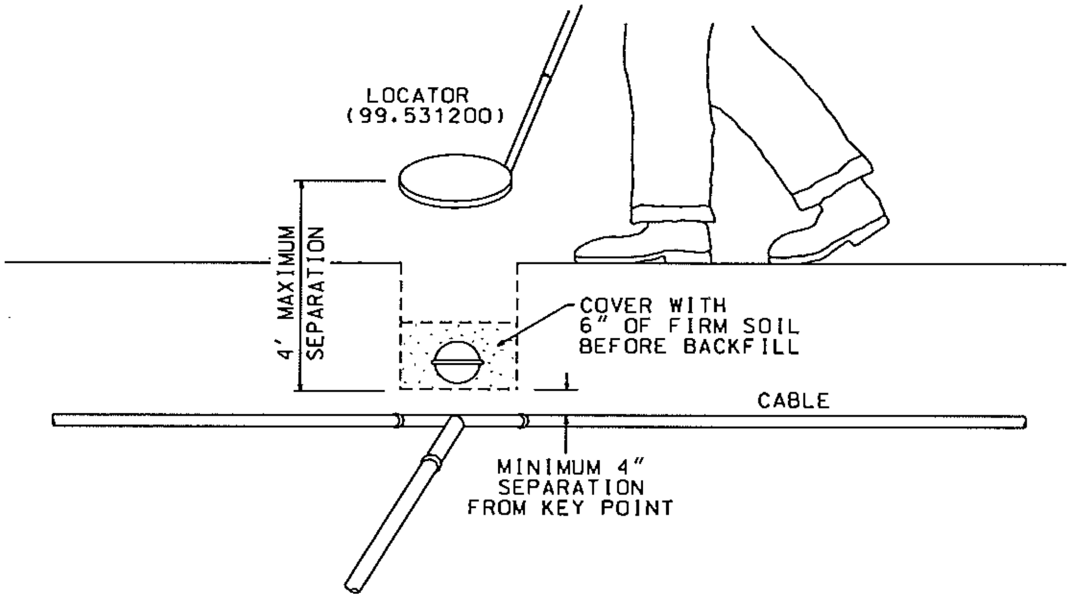
NTS

Date: 6-3-2013

PLANTING DETAILS

GEORGE MASON UNIVERSITY

Detail No: 4.3-4



NOTES:
1. Place minimum of four inches of dirt over the key point.
2. Insert the ball marker over the desired point. Don't bury it more than four feet deep. It cannot re-radiate the locator's signal more than four feet from the locator.
3. Handfill a minimum of six inches of soil over the marker.
4. Backfill hole.

C.U. - BMARK
(76.0250)

REF: 3M Company

NTS

Date: 6-3-2013

BALL MARKER INSTALLATION - MCI100

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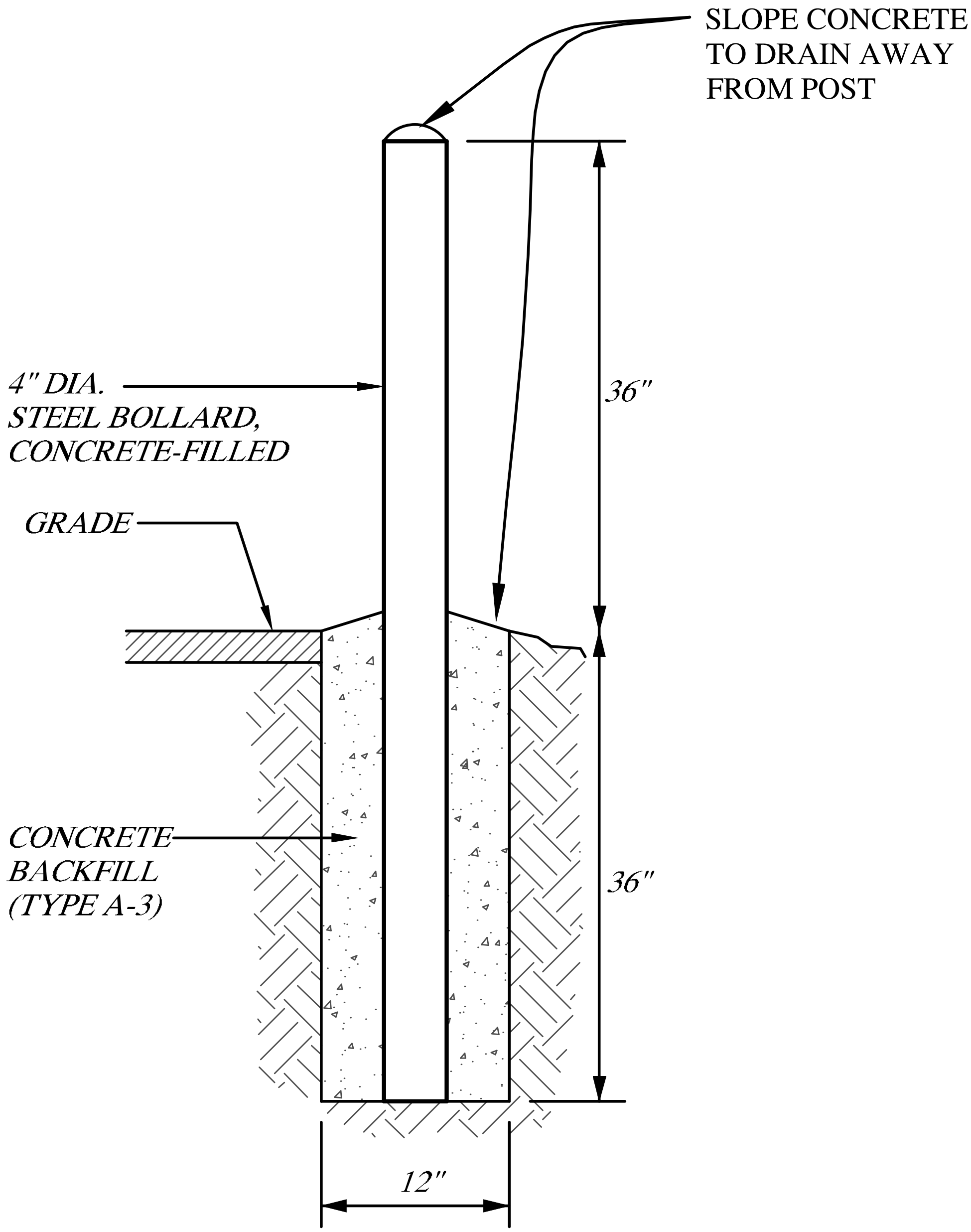
Detail No: 4.3-5



NOTES:
1. Bollard to be primed and painted yellow.
2. Subbase shall be compacted to 95% density at optimum moisutre content per ASTM D-698.

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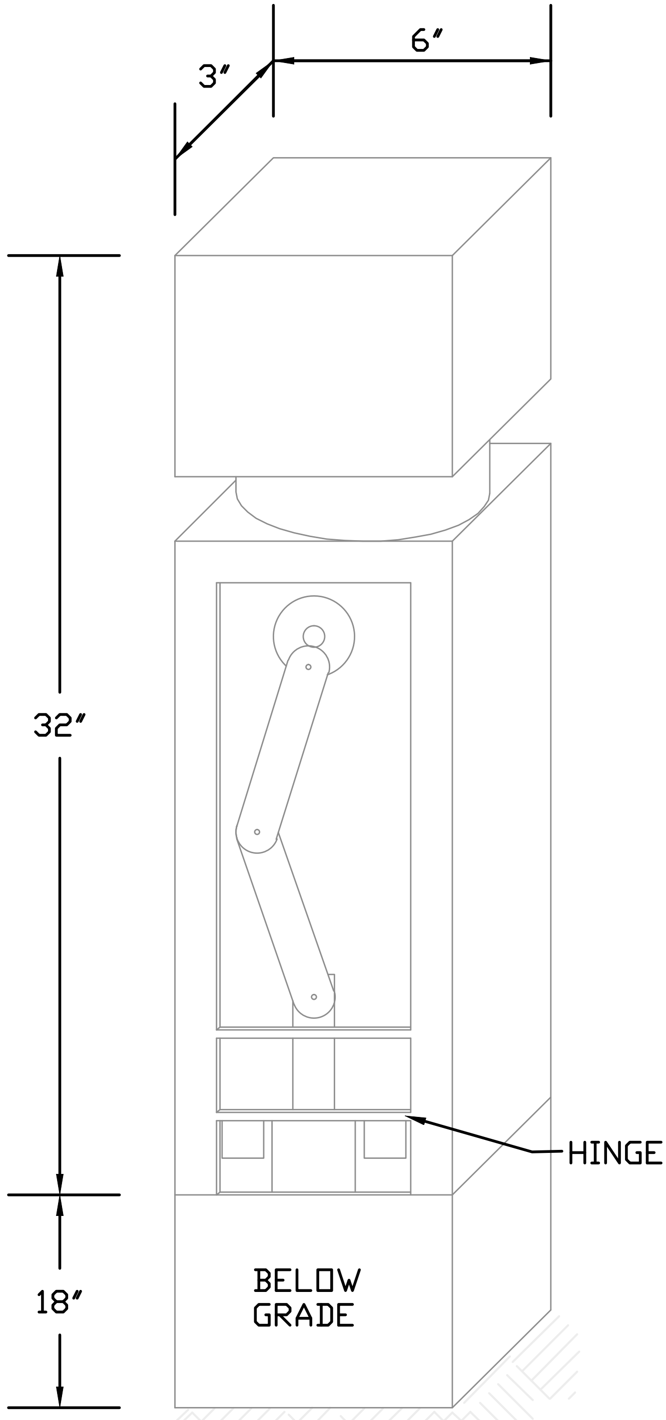
Date: 6-3-2013

BOLLARD DETAIL

GEORGE MASON UNIVERSITY

Detail No: 4.3-6



NOTES:
1. Bollard to be primed and painted yellow.
2. Subbase shall be compacted to 95% density at optimum moisutre content per ASTM D-698.

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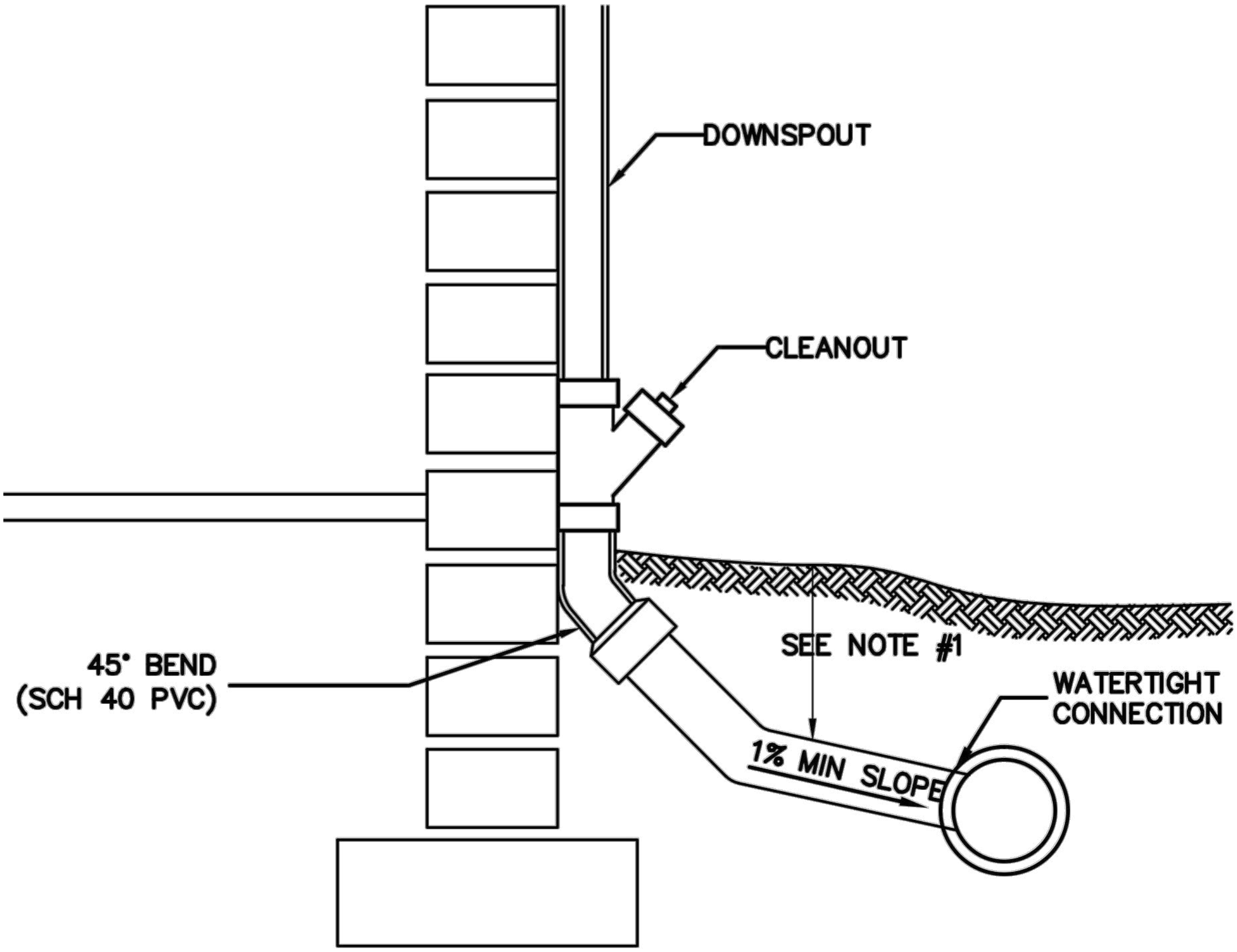
Date: 6-3-2013

COLLAPSIBLE BOLLARD DETAIL

GEORGE MASON UNIVERSITY

Detail No: 4.3-7



NOTES:

1. For all depths of cover less than two (2) feet, pipe must be schedule 40 PVC. For depths of cover greater than two (2) feet, flexible pipe may be used.
2. A watertight connection shall be maintained at all transitions from schedule 40 PVC to any other pipe type.

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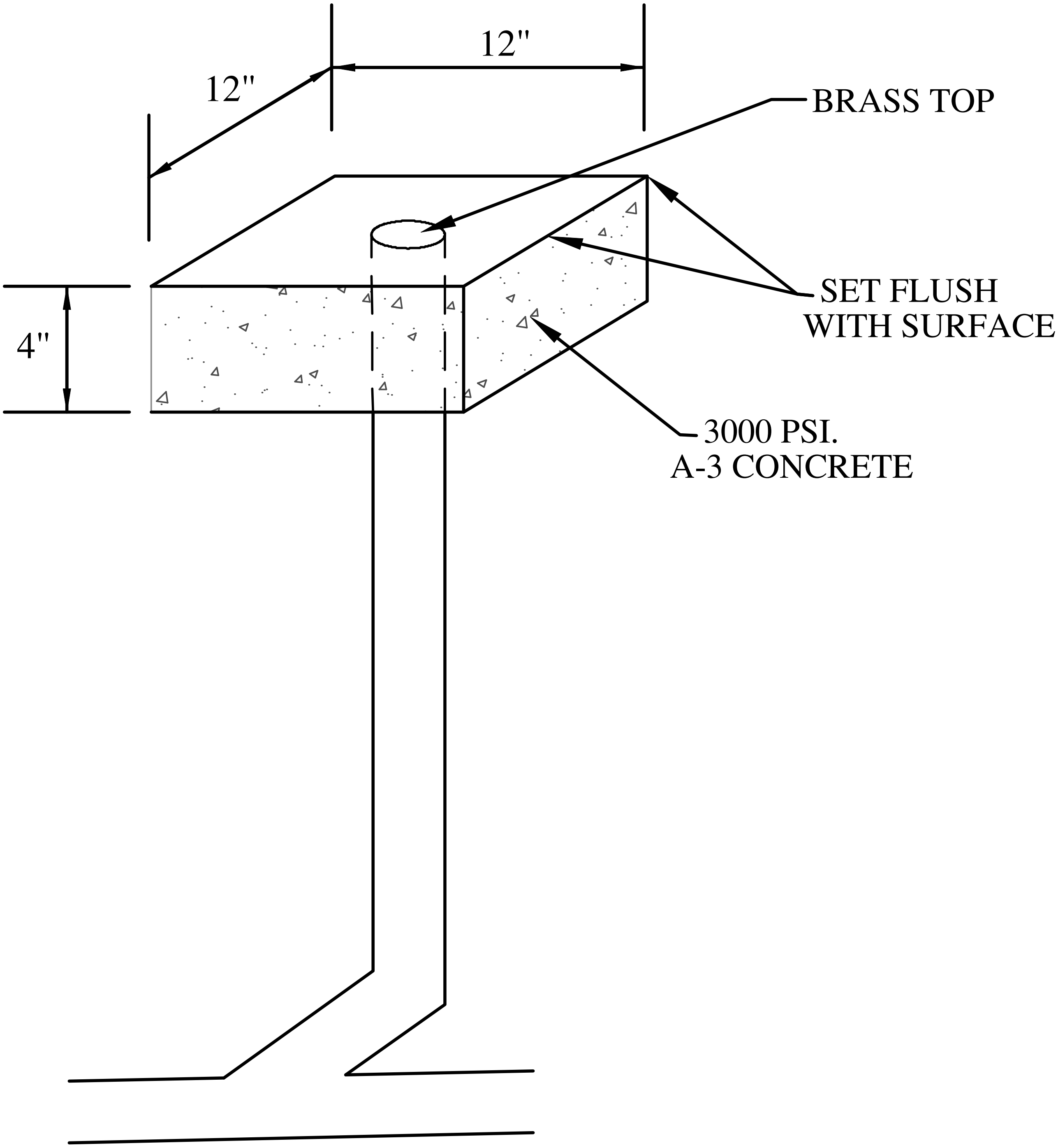
Date: 6-3-2013

DOWNSPOUT CLEANOUT

GEORGE MASON UNIVERSITY

Detail No: 4.3-8



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Date: 6-3-2013

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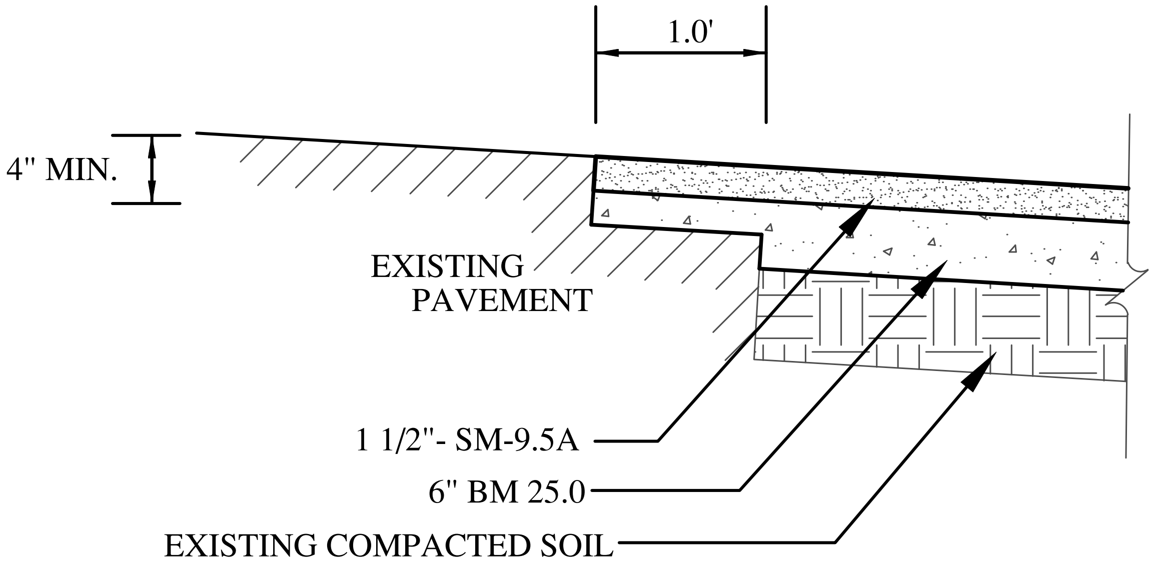
SANITARY SEWER LATERAL CLEANOUT DETAIL

Detail No: 4.3-9



BOTTOM AND ALL SIDES OF CUT TO BE PREPPED WITH ASPHALT PRIOR TO PLACING ASPHALT MIX.

(To be used for pavement additions an utility repairs)

NOTES:
1. Subgrade to be compacted to 95% of maximum density as determined by AASHTO T-99, within plus or minus 20% of optimum moisture content.
2. Contractor to provide a clean straight cut of existing pavement and verify and match existing pavement section as a minimum.

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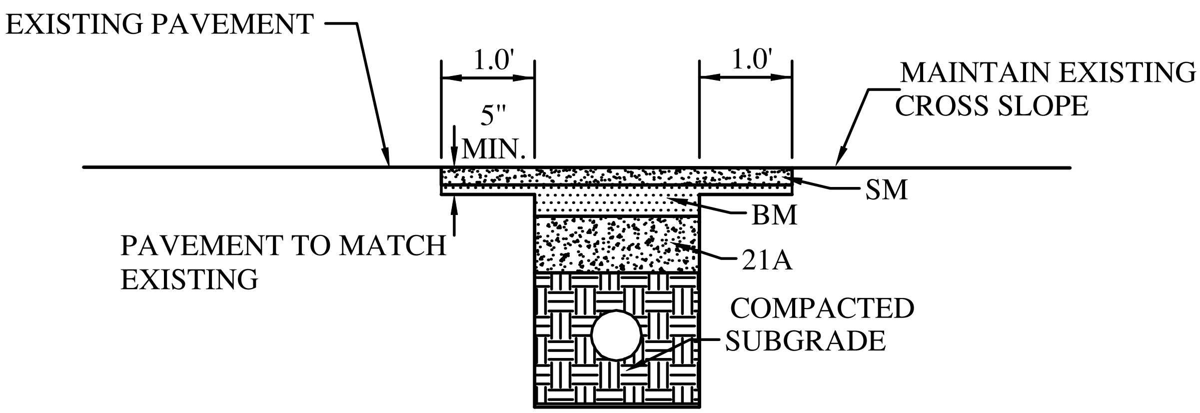
Date: 6-3-2013

PAVEMENT WEDGING DETAIL

GEORGE MASON UNIVERSITY

Detail No: 4.3-10



NOTES:

1. Subgrade to be compacted to 95% of maximum density as determined by AASHTO T-99, within plus or minus 20% of optimum moisture content.
2. Contractor to provide a clean straight cut of existing pavement and verify and match existing pavement section as a minimum.

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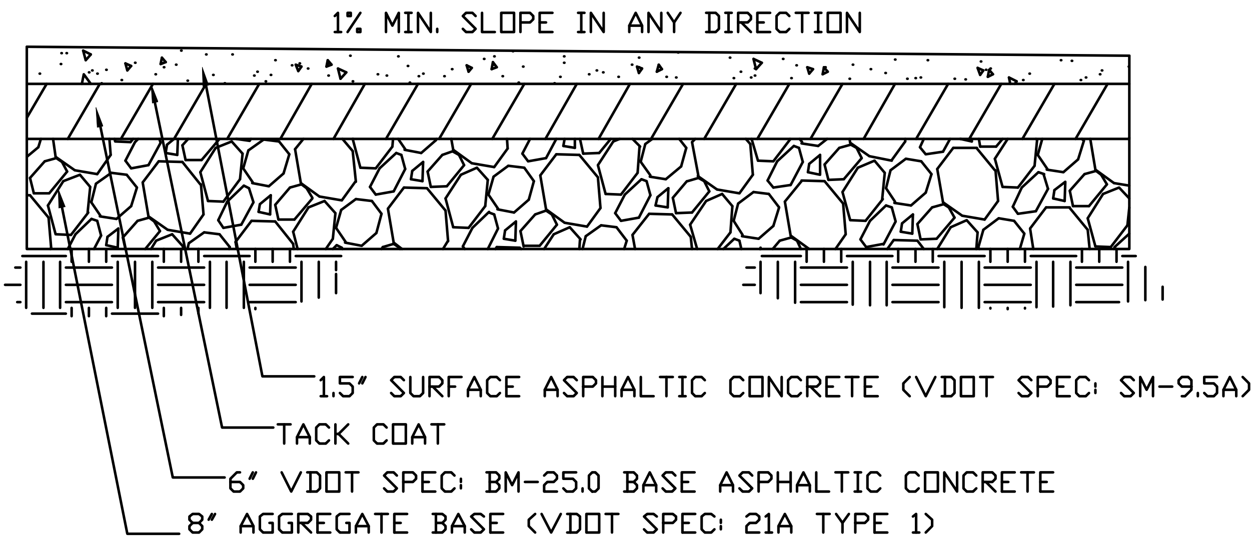
Date: 6-3-2013

PAVEMENT PATCH DETAIL

GEORGE MASON UNIVERSITY

Detail No: 4.3-11



NOTES:
1. For use on all parking areas, service areas and roads, unless an alternate section is provided by mason land development.

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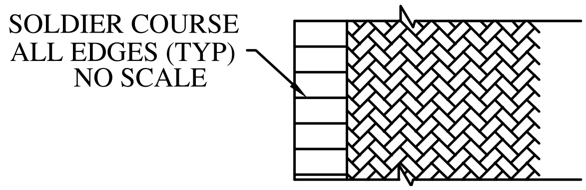
Date: 6-3-2013

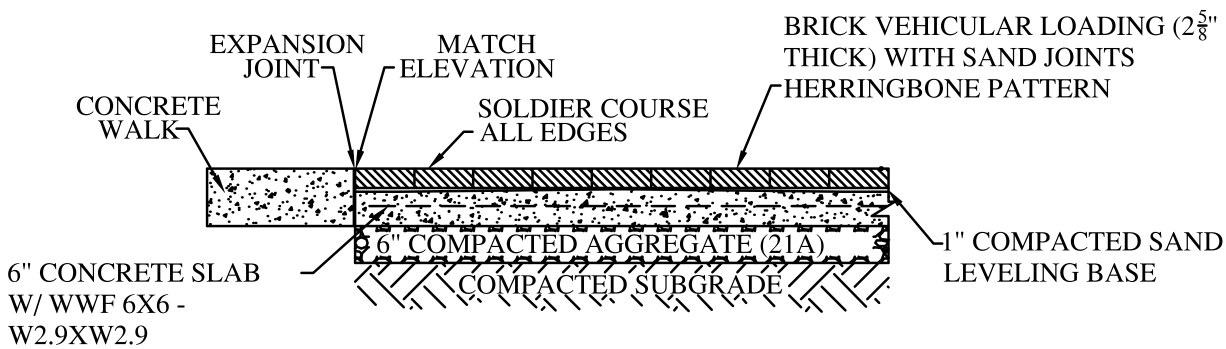
TYPICAL ASPHALT PAVEMENT SECTION

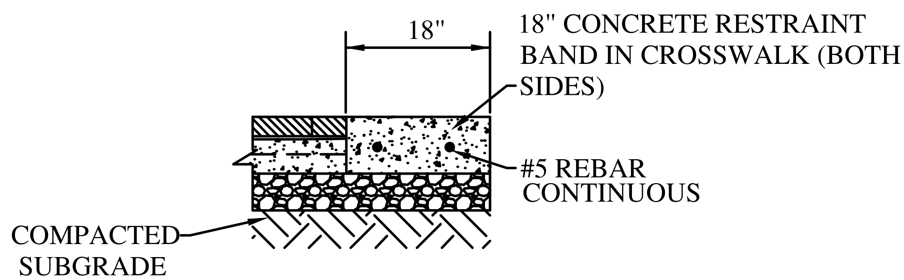
GEORGE MASON UNIVERSITY

Detail No: 4.3-12



PLAN VIEW





NOTES:
1) Signs and markings shall be in accordance with the MUTCD.
2) Maximum vertical difference between top of adjacent brick pavers shall be 1/8" misshapen or deformed bricks are not acceptable.

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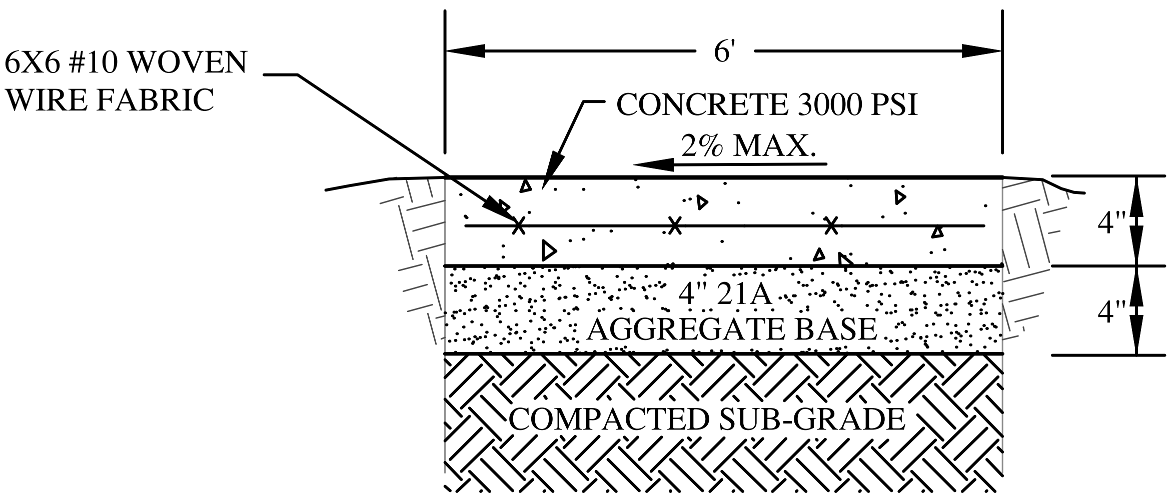
Date: 6-3-2013

BRICK PAVER DETAIL

GEORGE MASON UNIVERSITY

Detail No: 4.3-13



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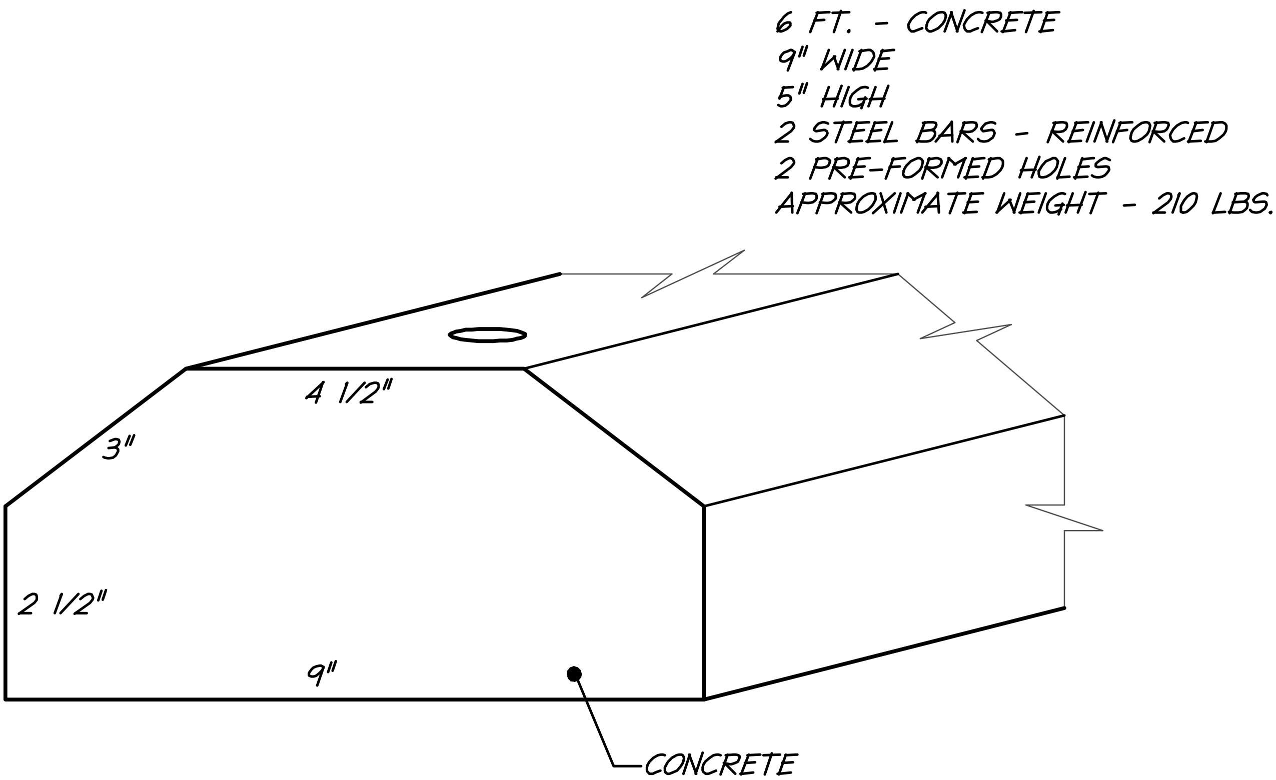
Date: 6-3-2013

SIDEWALK DETAIL

GEORGE MASON UNIVERSITY

Detail No: 4.3-14



NOTES:
1. Attach wheelstop to ground using steel reinforcing bars 2’ in length, driven down flush with wheelstop or as approved by owner.

NTS

Date: 6-3-2013

WHEELSTOP DETAIL

GEORGE MASON UNIVERSITY

Detail No: 4.3-15