Design Information Manual

Facilities Administration
George Mason University
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Contents

PREFACE

This manual is a guideline for Architects and Engineers, as well as anyone who is commissioned to design, renovate and otherwise alter buildings and related facilities for George Mason University (GMU). The intent is to clarify GMU procedures and standards, to indicate preferences on certain materials used in construction of our facilities, to avoid past problems, and to answer some of the miscellaneous questions that arise on building projects. It supplements the requirements of the Owner-Architect Agreement, Design-Build Contract, as well as the CM Contract and should be considered a fundamental part of the Program provided for each individual project. Whenever the term "Architect" is used, it shall apply equally to "Engineer" or "Contractor."

It is the University's intent to maximize the design potential of each campus building project in terms of accommodating the programs to be served, fostering collegiality on the campus, and contributing to the public realm that defines the University campus as a unique place.

In order to achieve the programmatic goals of each project, the design must cost-effectively overlay the specific, user-generated objectives for the project with the University objectives of institutional identity, durability, longevity, flexibility, and adaptability.

This manual will be presented on the Internet at http://facilities.gmu.edu/physicalplant/BldgStandards.htm and is available in loose-leaf form in order to permit periodic updating. Flexibility is inherent and changes will be made when necessary. The Architect, Engineer, or Contractor is responsible for confirming use of the most current version of this manual. Pages have been dated for this purpose.

Architects and Engineers are responsible to produce the best life cycle cost building possible within constraints of budget, and GMU does not wish to handicap their creative efforts by insistence on blind adherence to requirements. Variations will be considered and approved if there is an advantage to the University to do so. **However, intended variations must be brought to the attention of the University for specific written approval. Otherwise, Architects and Engineers will be held responsible for any additional costs resulting from failure to comply with this manual.**

An attempt has been made to establish performance rather than specification standards. The manual is not intended to be a "master specification" and therefore most of the language in this manual will need modification before being included in the Project Specifications.

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

The text of the manual is arranged in four Parts as indicated below.

Part I - General Administrative Procedures

This section defines the administrative procedures that Architects and Engineers must follow in working with the University. This statement of procedures is intended to establish a smooth operating relationship throughout the entire planning and construction and commissioning process.

Part II - Facilities and Spaces

This section defines master plan requirements and space requirements.

Part III - Bid Documents

This section outlines the format which should be used in assembling the project manual.

Part IV - Construction Products and Activities

This section discusses technical requirements of materials and methods of construction. It is arranged on the basis of the Construction Specifications Institute (CSI) 48-Division Specification Format to include all of the 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 the University. In all cases, the Architect, Engineer, or Contractor is to use professional judgment, and, where such judgment indicates material or methods contrary to information found in this manual, the Architect, Engineer, or Contractor should discuss these areas with the Project Manager in charge of their project.

Part V – GMU Standard Details

This section contains standard details. These details are typical standards established by the University and are included to assist Architects, Engineers, and Contractors in preparing Drawings that are acceptable and uniform for all projects.

2012 REVISIONS

GMU Design Information Manual Recent Revisions

NOTE - These revisions are also located at the beginning of each related Division.

Part I

Project Management.....	Updated CPSM Manual version.
Drawing Standards …….	Added requirement for Record Drawings to be provided on Mylar and added other drawing management procedures to reflect GMU's current requirements.
Room Numbering SOP.....	Modified for updated numbering scheme.

Specification Standards ……	Updated edition of CSI Masterformat to 2004 edition and section number of CPSM to 803.10.
Codes and Compliance ……..	Added UFAS requirements and 35% design review requirements.
Earthwork Specifications…….	Updated specification sections to reflect new CSI specification numbering system.
Subsurface Investigation ……	Added requirement for two borings for parking and major roadways.
Storm Drainage ……..	Added storm drainage requirements to reflect GMU's current requirements.
Permit Documentation ……	Added storm water, freshwater wetlands permit, and stream encroachment requirements.

Part II Facilities and Spaces

Master Plan	Added to reflect GMU's current requirements
Space Requirements.....	General update to reflect GMU's current requirements.
Security Conscious Design	Added to reflect GMU's current requirements.
Energy Efficiency Standards.....	General update to reflect GMU's current requirements.

Part III

Bid Document Distribution	General update. Included wording for Design-Build or CM contracts.
Addenda ……	Updated reference to CPSM section 1003.3.
General Conditions, #1 …….	Added requirement for priority of General and Special Conditions over technical specifications and instructions for A/E not to edit the General and Special Conditions.

Part IV

General Update ……..….	Revise specification section numbering per new Masterspec format.

<u>Division 1: General Requirements</u>

Final Site Survey……	Added requirements for GPS.

01 91 00: Commissioning, #2	Update to require list of closeout requirements, provisions for warranties, and requirements for off season testing of HVAC systems.
Division 3: Concrete	
03 30 00: Cast-In-Place Concrete ….	Updated version on ASTM E1155 to 2008 edition or better.
Division 5: Metals	
05 51 00, Metal Stairs ……	Added requirement for stair access to roofs.
Division 6: Wood. Plastic. and Composites	
06 05 73, Wood Treatment……	Added requirement for treated wood to not be in contact with steel.
Division 7: Thermal and Moisture Protection	
07 24 00, #2 Thermal Insulation……	Added requirement for weep holes at bottom of panels.
07 30 00, #6 Shingles……	Added minimum width for membranes.
07 50 00, #1 Membrane Roofing …..	Change from 3 ply to 4 ply.
Division 8: Openings	
08 40 00, #4 Entrances	Added US26D requirement.
08 60 00, Rf. Windows and Skylights .	Added restrictions for skylight use.
08 70 00, #7 Hardware ……..	Revised wording for clarification.
Division 9: Finishes	
09 51 00, #6 Acoutical Ceilings	Added requirement for ceiling to be moisture resistant.
09 68 00, #3 Carpeting.....	Added requirement that back of carpet be impervious.
Division 10: Specialties	
General ……..	Reorganized into sections 10 10 00 Information Specialties, 10 14 00 Identificatio Devices, 0010 20 00 Interior Specialties, 10 40 00 Safety Specialties, and 10 70 00 Exterior Specialties.
10 21 13, Toilet Partitions ……	Added requirement for lockable non-vandal hardware screws.
Division 11: Equipment	

11 53 13, #3M Fume Hoods …….	Added halogen and LED as acceptable light fixtures.
12 21 00, Window Blinds ……..	Added requirement for window blinds to be painted steel.

Division 22: Mechanical

22 00 00, #16 Mech. Gen'l Rqmts …..	Added flexible coupling requirements
22 05 16, #4 to 6 Expansion Comp....	Added piping expansion and contraction provisions.
22 05 23, #10 General Duty Valves …	Added grooved end valve section.
22 05 23, #13 General Duty Valves…	Added balancing valve specifications.
22 05 29, #5 Hangers and Supports ...	Added rigid and flexible coupling requirements.
22 11 13, #2 Pipes and Tubes …….	Added grooved pipe system use.
22 11 13, #5 Pipes and Tubes …..…..	Added grooved joint pipe specification.

Division 23: Heating Ventilating and Air Conditioning

23 05 93, Testg Adjustg, & Balancg …	Revised and added balancing requirements.
23 09 00, Instrumentation.& Control ...	Revised and added instrumentation and controls requirements.
23 21 23, #4 HVAC Pumps ……	Added pump suction diffuser requirements.
23 52 00, #4 Heating Boilers ……..	Eliminated use of electric boilers.
23 65 00, # 9 Pckgd. Cooling Towers ..	Added requirement for piping cooling tower drains to the sanitary sewer per code.

Division 28: Electric Safety and Security

28 31 53, # 4, Fire Alarm Systems …..	Added Edwards as an acceptable provider.

Division 31: Earth work

31 25 00, Erosion Ctrls ……...	Added Erosion and Sedimentation Controls/Storm Water Pollution section.

Division 32: Exterior Improvements

32 06 10, #1 Bases Ballasts and Pavg.	Added note regarding acceptance of cracked concrete.
32 06 10, # 2 Bases Ballasts and Pavg	Changed size on rebar chair from 3" to 2".
32 16 13, Concrete Curbs & Gutters	Added note regarding acceptance of cracked curbs.

32 80 00, #3 Irrigation ……...	Added 6” size requirement for down spouts.
32 91 19.13, Topsoil Plcmt, & Gradg.	Added note for 4”-6” topsoil compacted at 85%.
32 92 00, #2 Turfs and Grasses …….	Added note to require sod use.
32 92 00, #4 Turfs and Grasses …….	Added clarification that note applies to sodded areas.

PART I - GENERAL ADMINISTRATIVE PROCEDURES

RECENT REVISIONS:

Project Management.....	Update CPSM Manual version.
Drawing Standards …….	Added requirement for Record Drawings to be provided on Mylar and added other drawing management procedures to reflect GMU's current requirements.
Room Numbering SOP.....	Modified for updated numbering scheme.
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Project Management

1. The A/E will work primarily with the Project Manager from the Facilities Planning Office. All input and coordination shall be through the Project Manager. Input during design will be generated by the Facilities Planning Office, the Facilities Construction Office, and the Facilities Physical Plant Office.

2. At award of the construction contract, a Representative from the Facilities Construction Office will oversee the contractor's work and administer the construction contract. Roles and responsibilities are defined in the Commonwealth of Virginia's Construction and Professional Services Manual (CPSM), October 1, 2004, Revision 1 (The Capital Outlay Manual).

3. Terms such as “George Mason University," “GMU,” or “the University" used in these Guideline Standards refer to the Facilities Planning Office (Project Manager), especially when approval permission or consultation is referenced.

Invoicing

1. See the Construction and Professional Services Manual (CPSM) section 315.

2. No deduction shall be made from the A/E fee for any penalty or liquidated damages charged to any Contractor. 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.

3. During Pre-Design Analysis (Programmatic Phase), Schematic design, Design Development, and Contract Documents and Bidding, the University will make monthly payments to the A/E 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 will 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 will be made to the A/E in proportion to progress payments made to the Contractor for construction of the Project, as certified by the A/E.

4. Use format in the Construction and Professional Service Manual (CPSM), Appendix C.

5. The A/E cannot proceed on change orders without the written authorization from the University. Change orders cannot be billed without such authorization. See CPSM section 605.1.1.

6. 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.

Drawing Standards

General

All drawings shall be oriented in the same way.

Electronic Format

1. Use the current version of AutoCAD. See also MOU.

2. Use National CAD Standards and The Uniform Drawing System which includes the accepted CAD layer guidelines. See also MOU.

Bid Documents

1. At the time of bid advertisement, provide one electronic copy on CD ROM and 5 paper copies of bid drawings to the University. See also MOU.

2. The original bid set of drawings shall be on Mylar.

Record Drawings

1. Upon completion of record drawings, provide two paper copies to the University for review.

2. Following University reviews, and incorporating comments as applicable, provide one signed and sealed copy of final Record Drawings on Mylar, one on paper and one electronic copy on CD ROM.

Size

30”x42”

Lettering

See the Construction and Professional Services Manual section 802.6.

Title Sheet

See the Construction and Professional Services Manual section 802.1.1. In addition, the title sheet shall include: GMU logo, maximum 3” high, minimum 2” high; name, address, phone number, fax number, and email address of the A/E and any consultants used on the project.

Title Block

The A/E may use his / her standard title block provided it contains the following minimum information:

1. A/E firm name
2. Project name and location
3. Campus name
4. Date drawing was completed
5. Scale of drawing unless noted under each detail
6. Sheet number and drawing number
7. Unique Drawing Number
8. 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.
9. Project Name: shall match the title of the project on the project budget analysis sheet (PBA).
10. Project Number: cross-referenced to budget number.
11. Building Number
12. Area large enough for A/E's signature and seal

13. Approval block: for the signature of the University to approve the drawing

Drawing Arrangement and Number

1. See the Construction and Professional Service Manual section 802.2 and 802.9.

2. Additionally, use "FS" for food service, "FL" for interior design or furniture layout, "LF" for laboratory furniture, and "U" for utilities.

Unique Drawing Number

The University has a drawing numbering system that must be adhered to and used on all drawings. At the completion of a project by the A/E, a disc with each drawing title and corresponding number shall be transmitted to the University.

Unique Drawing Number Assignment

1. A review of the project by A/E is conducted to ascertain the amount of each type of drawing required (i.e. 5-T, 10-C, 15-A, etc.).

2. A request is made to the University Facilities Construction Drawing Archival Branch for a total amount of unique drawing number assignments affecting the project, including all divisions, and reserving additional numbers in the same numbering sequence to insure project number continuity.

3. The University Facilities Construction Drawing Archival Branch will maintain a hard copy project log designed to follow projects from inception to completion. The log will contain drawing and project status on an on-going basis.

Unique Drawing Number Samples

1. Abbreviations: ARL = Arlington Campus; FFX = Fairfax Campus; PWI = Prince William Institute.

2. A sample unique drawing number will look like this: ARL0573A0001, which consists of the campus (ARL for Arlington), building number (0573), drawing type (A for Architectural), and sequence number (0001) respectively.

3. A sample unique drawing number for a utility drawing will look like this: PWI0000U0001, which consists of the campus (PWI for Prince William Institute), building number (0000 for all utility drawings), drawing type (U for Utilities), and the sequence number (0001) respectively.

New Drawing Release Procedure

1. All fields in the title block area of the drawing are to be completed, and a comprehensive description of the project and drawing title is mandatory for documentation and future reference.

2. The University must sign all drawings to be released. **TO WHO?**

3. For original drawing issues (i.e. issued for bids, addenda, record drawings, etc.), the issue column in the revision block area will display a dash line (-). The revision description must also be noted (i.e. "Issued for Bids", "Issued for Addenda", "record drawings").

    - For example: - H.C. 12-6-94 R.O. ISSUED FOR BID ("-" for original issue, issued by H.C., issue date 12-6-94, issue approved by R.O., and issue description ISSUED FOR BID).

4. In the event that a new drawing is created from information extracted and modified from any file drawing, a cross-reference notation in the revision block of the file drawing is to be made to reference the new drawing.

Drawing Revision Procedure

1. A reproducible copy of the original drawing to be revised is made. Revisions are to be made to the reproducible copy. The original drawing remains in tact with the exception that it will be marked "superseded by drawing No._____."

2. The University Facilities Construction Drawing Archival Branch assigns a new unique drawing number to the revised drawing, and also records this number on the superseded original drawing. This will cross reference the two drawings and render the previous issue (on the superseded drawing) intact.

3. The revised drawing is also marked with a reference to the unique drawing number of the original (i.e. "revises FFX0025A0025").

4. Make the change to the copy of the original drawing, and indicate the revision description in the revision block area.

5. The revision issue column in the revision block area will utilize the alphabet (circumscribed by a triangle) to identify each revision.

    - For example: A H.C. 9-9-94 J.R. CHANGED (Revision A, revision made by H.C., revision date 9-9-94, revision approved by J.R., revision description – CHANGED).

Room Numbering Standard Operating Procedure

Purpose: To provide uniform guidance to university personnel and retained design firms for the numbering of rooms at George Mason University.

Proponent: George Mason University, Facilities Administration, Office of Space Management

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.

It is hoped that through this procedure A/E firms will have enough guidance to anticipate all 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. A/E firms are responsible for discussing, coordinating, and validating the room numbering of any particular building with the planning project manager through the design process.

Procedure:

During the design phase the planning project manager, will provide this guidance to the A/E firm responsible for the design of spaces that will eventually require the assignment of a room number. The A/E firm will review this document with the project manager and the Director of Space Management, Facilities Administration at 703-993-2520 prior to the establishment of room numbers for the preliminary drawings on a project.

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

1. Numbering will be conducted by floor level.
    a. The level of the building having the main entrance to the building (if doubt exists concerning what is to be determined to be the main entrance of the building, the planning project manager will make this determination in consultation with space management) will be in the 1XXX series of numbers starting at 1001 and commencing through 1999.
    b. Floors above this level will be numbered in groupings of thousands sequentially increasing (e.g. the level above the main level will be 2XXX, the one above that will be 3XXX, etc.).
    c. Non-exposed floors below this will be numbered in sequential hundred groupings starting with B1XX, then B2XX, and so forth downward.

d. If for some reason 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 will be numbered using a thousand number grouping starting with L001 through L999. In the event there are multiple exposed levels below the main level of a building, contact the planning project manager to discuss how best to handle this situation.

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

f. Note that there will be several instances where floor levels may not, easily or otherwise, fit into the schema indicated in a. through e. above (e.g. performing arts centers, arenas, etc.). If this occurs, the A/E firm will need to contact the planning project manager and set up a meeting with space management, facilities planning, commissioning, and any other pertinent parties to discuss the room numbering plan in detail. The goal, however, will be to attempt to follow the guidance herein to the maximum extent possible.

2. Numbering by floor will 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 will 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 should 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 will be numbered ahead of the interior room. See the diagram below for an example of how a floor will be numbered.

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

4. Multiple rooms not having direct access to hallways/corridors, such as suites or a series of multiply-connected room areas, will have a 100 number separation from the previous room in sequence. For instance if an office suite has a central room off the corridor, the central room will 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, will be given numbers in singular sequence, etc. as designators for each room off the central room (e.g. 1101, 1102, 1103, etc.). Once the suites room numbers are complete, then the next room will be numbered in the next century interval (e.g. 1200 continuing the sequence above).

5. In assigning signage for the rooms in a building, the A/E firm will provide standard signage in addition to the room numbers (as indicated above) for the following spaces:

   a. Lobby areas, entry areas, or foyer areas incapable of having furniture being placed in them

b. Elevators, elevator mechanical rooms, or adjoining rooms that are used as mechanical or electrical space only.

c. Corridors, hallways, or other walking paths

d. Restrooms of any sort.

e. Any mechanical, electrical, and/or telephone/data rooms.

f. Any open vertical shafts or spaces made for the passing of mechanical, plumbing, or other systems.

g. Janitors or service closets

h. Any stairways.

i. Vestibules and exterior cavities.

6. The standard signage to be provided will be as indicated by the Office of Space Management. Some areas, such as stairwells, may require special signage as directed by outside agencies, and will need to be coordinated into a well established signage plan. This signage as well as any other applicable signage will be determined in a signage meeting, which is to be conducted prior to the submission of working/construction drawings to BCOM. All such signage will be included in this submission.

Foundation Elevations

Foundation elevations shall be shown at elevation of suitable bearing.

Specification Standards

Coordination

See the Construction and Professional Services Manual section 901. Specifications should be coordinated so that issues are addressed only once, and conflicts are avoided. For instance, the engineering specifications should not reiterate the number of shop drawings needed, or mention additions to the Bid Form. These problems often arise when the Architect uses consulting engineers. The Architect is responsible to review the engineers' specifications and coordinate such items. Make sure that specifications from consultants are submitted to the Architect in enough time to perform this review.

Format

1. Use the Construction Specifications Institute (CSI) MasterFormat™, 2004 Edition, for all specifications. Format should be consistent throughout the entire specification.

2. All articles, paragraphs and subparagraphs should be numbered or lettered in outline form for easy reference.

3. Section Number and Title should be boldly indicated at top of first page of Section. The first Section of each Division should also indicate the Division name and title.

4. Each Section should end with "END OF SECTION" to indicate that this is the last page of the Section. Each page of the Section should have the Section number and page number (sequentially numbered) centered at the bottom of the page. Reason: In 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 16. 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.

Proof Reading

The A/E is responsible to insure that all specifications are proofread. The omission of simple words as "not" will completely change the meaning of a sentence. Also, in the proofreading process, additional thoughts or changes in text are often caught and can be corrected.

Prohibited Language

See the Construction and Professional Services Manual (CPSM) section 803.10. The following words, phrases, and clauses are expressly prohibited:

1. "Plumbing Contractor", "Food Service Contractor", etc. All construction work is bid through single prime Lump Sum General Contracts. Under this type of contract the General Contractor is responsible to perform all work required. It is the General Contractor's business decision as to how the work will be divided amongst their subcontracts (see also CPSM section 803.10.3). **The only exceptions** are for automated building controls and building access systems where GMU uses specific manufacturers.

2. The note "by others" or Not in Contract (NIC). If this is the case, name the specific contractor or agent to provide the item. See CPSM 803.10.6.

3. The words "This Contractor shall..." or "The Contractor shall..." to begin instructions to a contractor. These words are redundant since all instructions are directed to the General Construction Contractor.

4. The word~~s~~ "alternate" to indicate an "option". The word "alternate" should 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" should 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 in which case either the change will be done at no increase in cost to the project or as a credit or deduct.

5. "Is", "are", or "will be". Use the word "shall", or put in imperative mood. 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 designed to sell you on its use rather than indicate the nature of the material or its proper installation.

6. Avoid abbreviations and symbols such as #, @, &, and w/.

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

Codes and Code Compliance

See the Construction and Professional Services Manual (CPSM) section 700.

Barrier Free Design

1. All designs for new construction and renovations to existing facilities shall be designed and constructed in such a manner that the new or renovated facility is readily accessible to and usable by individuals with disabilities consistent with all applicable state and federal mandates. Specifically, design and construction shall be done in compliance with the following:

    a. The Uniform Federal Accessibility Standards, April 1 1988 (UFAS) adopted under the Americans with Disabilities Act of 1990, Title II, Part IV, Department of Justice, 28 CFR Part 35, Nondiscrimination on the Basis of Disability in State and Local Government Services: Final Rule #. ANSI A117.1, ADAAG, and VUSBC Chapter 11 are superceded by the Federal Law. Guidance on the application of the code and provisions by the authority having jurisdiction (DEB) are provided in the CPSM Chapter 7.

    b. Section 504 of the Rehabilitation Act of 1973 ("Section 504") and supporting regulations thereto;

2. Beyond mere compliance, every design component should be examined for its impact on persons with disabilities and adjusted to achieve the optimum balance between user requirements and convenient access to individuals with disabilities. At the 35% design phase of the project, there shall be a consultation with the University to review the project design with reference to applicable federal and state standards.

Materials and Equipment

Specify only established products. Do not specify prototype or new materials and equipment. See also the Construction and Professional Services Manual section 803.9.

Earthwork Specifications

This section of the Specifications shall contain all earthwork requirements for the project. Divisions 22, 23 and 26 shall cross reference the Division 31 Earthwork Section. Do not repeat or reiterate earthwork requirements in Division 22, 23 or 26 to avoid conflicts and confusion.

Estimating Standards

See the Construction and Professional Services Manual (CPSM) section 804.

Area and Volume Calculations

See the Construction and Professional Services Manual (CPSM) section 701A.

Subsurface Investigation

1. See the Construction and Professional Services Manual (CPSM) section 902.

2. At least two borings will 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.

3. Show results on the drawings.

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.

Construction Change Order Procedures

See the Construction and Professional Services Manual section 1019. The only changes which will be made are:

- Changes to make the building function properly
- Changes due to field conditions
- Changes due to owner requirements

Permit Documentation

1. See the Construction and Professional Services Manual (CPSM) section 504.3.

2. Prior to putting the project out to bid, the A/E shall provide the University with the necessary documents to allow GMU to file with the appropriate Soil Conservation District (a site plan indicating the proposed soil erosion and sediment controls as required for each project). The

University requires that the SCD permit be obtained at 90% design completion. The Consultant shall provide GMU with the necessary 100% complete SCD plan for submission to the appropriate district. The A/E shall assist in all follow-up correspondence. The University shall be the prime contact with the conservation district. The SCD approval process takes approximately 4 weeks. This scheduling time should be taken into account so as not to delay bidding or the project as a whole. Remember all permits shall be in hand before the project is bid. The Soil Erosion and Sediment Control Plan shall meet the requirements of the appropriate District Office. See CPSM section 702B.

3. Storm Water:

    a. **Disturbance of land exceeding 1 acre** requires submission of a storm water management plan with calculations to the Department of Conservation and Recreation, Division of Storm Water Management.
    b. **Disturbance of land exceeding 5 acres** or more a discharge permit from the Department of Environmental Quality is required. The A/E shall prepare all necessary documentation so the permit can be obtained at 90% design completion. See Soil Erosion and Sediment Control Plan section above for details on sequencing this work.

4. Freshwater Wetlands Permit:

    a. During the site investigation phase, the A/E shall examine the area for the presence or absence of wetlands within 100 linear feet of the proposed disturbance. Should the presence of wetlands be suspected, the A/E shall immediately bring this to the attention of the Project Manager. Any cost or schedule impact as a result of suspected wetlands shall be reviewed with the University.

    b. Furthermore, the A/E shall delineate, or have delineated by a licensed surveyor or environmental consultant, all suspected wetlands on site. Design will accommodate found wetlands and their attendant transition areas and appropriate permit applications and or mitigation plans will be applied for and secured by the A/E prior to bid of project. See Soil Erosion and Sediment Control Plan section above for details on sequencing this work.

5. Stream Encroachment Permit: If the project will impact a stream or drainage swale, this shall be reviewed with the Project Manager. If a stream is encountered, then the attendant stream encroachment permit application shall be made by the A/E using the services of a licensed surveyor and or environmental consultant. The permit shall be secured prior to bid of the project. See Soil Erosion and Sediment Control Plan section above for details on sequencing this work.

Demolition Materials

Check with GMU recycling services to determine if any materials from demolition are suitable for recycling.

End of Section

PART II – FACILITIES AND SPACES

RECENT REVISIONS:

Master Plan ……	Added to reflect GMU's current requirements
Space Requirements.....	General update to reflect GMU's current requirements.
Security Conscious Design ……	Added to reflect GMU's current requirements.
Energy Efficiency Standards.....	General update to reflect GMU's current requirements.

Master Plan

Design Character

1. Buildings should extend and enhance the underlying planning and architectural strengths of the campus.

2. New buildings should balance individual expression with contextual sensitivity.

3. New buildings should reflect the character of the university as an institution with a rich past, vibrant present, and promising future.

4. Program, site, and budget parameters should all be addressed in an integrated fashion.

Planning

1. Buildings should be sited to reinforce and enhance the spatial structure of the campus and its circulation patterns.

2. Building entries should be clear and coordinated with circulation patterns and landscaping elements.

3. Ground level uses should consider the harmony of interior and exterior activities.

Massing

1. Massing should be simple.

2. Buildings should be tall enough to define adjoining spaces. This will require a minimum 3-story or 45 feet high building.

3. Bays, porches, towers, and other minor adjustments to massing are encouraged.

Roof Forms, Roof Lines and Silhouette

1. Well-developed and articulated rooflines are encouraged.

2. Sloped roofs and flat roofs are both acceptable.

3. Sloped roofs should be of high quality self finished metal.

4. Flat roofs should have carefully selected aggregate or pavers if visible. Visible Roofscapes must be as carefully designed as any other exterior surface of the building.

5. It will be necessary for designers to explain all aspects of their design selection including material, color, patterning, and other details.

6. Parapets should be well articulated and trimmed with cut stone. Profiles and scuppers are acceptable. Other ornamental devices must be approved by GMU.

7. Dormers and pediments are also acceptable and encouraged as are cupolas, chimneys, and other traditional roofing embellishments. Their intersection with the main roof must be well detailed and will receive careful scrutiny. These elements should not be viewed purely as ornamental elements without functional attributes.

Facades

1. Facades should be simple and well ordered.

2. General fenestration patterns should be regular. Some vertical hierarchy is appropriate. Where affordable, cut stone window surrounds are preferred to precast concrete. Window openings should be subdivided to create a vertical proportion where they form horizontal groupings.

3. The use of bays, giant order elements, or special accents to provide a large overall order must be approved by GMU.

4. Special detailing ornament and materials at significant locations must be approved by GMU.
5. Window frames and glass should be set back approximately 6". Sills and heads should be detailed to shed water and alleviate the possibility of unattractive weathering patterns.

Architectural Details

1. Buttresses, coping, string courses, and other traditional architectural details are acceptable and encouraged.

2. The joining of dissimilar materials must be resolved carefully and will be rigorously reviewed.

3. Where possible, caulk joints should be placed in less visible locations such as inside corners or reveals.

4. Extreme care and experienced oversight should be given to details designed to prevent water infiltration.

Ornament

1. The campus currently has minimal ornament reflective of its lengthy history. Future buildings should have well-developed ornamental programs appropriate to a University with such a broad contemporary mission.

2. Heraldry, plant, animal, and geometric motifs are all acceptable and encouraged in a coordinated program.

3. Building identification integrated into building facades are key elements of an ornamental program.

4. The use of new technologies to economically produce ornamental elements is acceptable and encouraged.

5. The creative use of masonry patterning is also acceptable as an ornamental strategy.

Masonry

1. Material selection should be made to reinforce existing campus patterns.

2. Masonry design must comprehensively consider unit size, texture, color, hording pattern, mortar, and striking. These design choices will be rigorously reviewed.

3. Pre-cast concrete, poured-in-place concrete, and cast stone may be proposed as alternatives to limestone trim.

Exterior Doors

1. Wood, metal, and glass doors are all acceptable.

2. Doors should have a quality and character appropriate to the overall façade.

3. Vision panels, reveals, and carving are appropriate and encouraged.

Color

1. Exterior Colors: Significant exterior colors such as brick, mortar, window and curtainwall frame and window colors, etc. shall be established early in the construction stages. These colors shall be reviewed and approved by the University. A mock-up panel shall be made by the Contractor in order to approve final colors and workmanship. Color choices for brick must be coordinated with the existing campus and reinforce the overall campus design

2. Interior Colors: The Interior Design Consultant or Architect will select colors of interior finishes early during construction. The A/E 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 Interior Design Consultant or the A/E 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 GMU Project Manager 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 A/E shall develop a detailed listing for the Contractor indicating the colors selected for each material and location on the project.

    a. Carpet: Avoid solid and light colors. Use flecked colors and shades that don't show dirt and stains as readily.

3. The A/E shall carefully monitor submissions from the Contractor, especially on those items requiring color selection and shall remind the Contractor of any submissions not made which may hold up the color selection. The A/E is encouraged to include in the Specifications clear instructions to the Contractor to make this process as painless as possible.

4. The official GMU "Green" color is represented by Sherwin William, Industrial Enamel, Green (SW-4072). Although this is the official "Green" color, it is not intended to indicate a standard paint manufacturer. Many other paint and coating manufacturers can match this color.

Space Requirements

Space planning for new university facilities shall generally follow the guidelines in Section 701.B of the Commonwealth of Virginia Construction and Professional Services Manual. In addition to those guidelines, the following space guidelines shall be used. The Architect/Engineer 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 the University. These space allocations will become the basis for the development of the project design.

Administrative and Faculty Offices

Administrative & Faculty Offices	Area Guideline
Vice Presidents; Deans	256 sf
Associate Vice Presidents & Deans, Assistant Vice Presidents & Deans, Directors reporting to Vice Presidents, Deans and the President	192 sf
Department Heads	168 sf
Associate and Assistant Department Head	144 sf
Faculty	120 sf

Custodial/Housekeeping Spaces

The following office spaces should be incorporated into the design of new buildings in order for the Physical Plant Department to provide adequate custodial and preventive maintenance services to the building occupants:

1. Custodial Closet: Provide a minimum of one (1) 7'x 8' closet for equivalent space on each building floor (2 closets required on floors greater than 18,000 SF). Additional space may be required depending on the building floor square footage. A minimum of 5' x 7' with a floor sink mounted in a corner. This sink will not be over 8" in height. There will be a mop holder over the sink that will accommodate up to three mops. One wall will have at least three shelves, spaced a minimum of 18" apart and be at least 18" deep. The bottom shelf will be a minimum 24" from the floor. The length of the shelves will be the same as the wall. The shelving can be either wood or steel. The shelves will not be mounted on the same walls that come in contact with the sink. There will be one light fixture suitable to properly illuminate the closet. The closet will be ventilated. The floor will be sloped to a center floor drain sized for this space. The floor will be sealed concrete. The closet door should be hinged to open out and not into the closet. The walls shall be painted a shade of white to enhance the lighting.

2. Custodial Supply Closet: Provide one supply closet located on a floor level accessible from a service entrance or loading dock (not within the proximity of any custodial closet), containing a minimum area of 100 square feet. One wall will have adjustable shelving that is 24" deep (four total) with the bottom shelf being 24" from the floor. Shelving will be made of wood that has been treated with a wood sealer (not pressure treated) or painted steel. Shelving will not be mounted on the walls that come in contact with the sink. There will be one floor sink located in a corner furthest from the door. There will be one mop holder capable of holding three mops located over the sink. The floor will be sealed concrete sloped to a floor drain located in the center of the room sized to the room size. Lighting will be sized to properly illuminate the room. The wall will be painted a shade of white. There will be at least one duplex receptacle, 120 VAC, located

away from the sink, but not on the shelving wall. The room shall be ventilated.

3. Housekeeping Supervisory Office: The supervisor office will be a minimum of 8'x 10'. It will have one duplex receptacle located on each wall. The door will be solid wood and equipped with a door reinforce plate to discourage force entry. There will be a drop ceiling composed of 2' x 2' ceiling tile and recessed lighting. Florescence lighting properly sized will be used. The floor will be tile or carpet. This space will be connected to the building's HVAC for climate control. There will also be one wall mounted key box, 20 gage steel minimum, baked enamel finish, gray color, with concealed hinge, key type lock, 12" x 12" x 2" minimum size.

4. Preventive Maintenance Office: Provide one (1) 12' x 12' office or equivalent space in each building, located on the ground floor of the facility in close proximity to the loading dock.

Recycling Spaces

The following recycling related office space and equipment requirements should be incorporated into the design of new buildings to facilitate waste stream separation and removal:

1. Offices: Provide desktop space for double-compartmented paper collector (10"W x 9-1/2"D x 11"H) or floor space for Deskside three (3) compartmented trash and paper collector (10-3/8"W x 19-3/8"D x 13-5/8"H).

2. Copy Rooms: Provide floor space for one (1) thirty (30) gallon rectangular paper collector (21-3/4"W x 15-5/8"D x 27-5/8"H) for every two (2) copiers (collector to be emptied once a week).

    - Note: For rooms with multiple high speed copiers, provide floor space for one (1) thirty (30) gallon rectangular paper collector (21-3/4"W x 15-5/8"D x 27-5/8"H) for each copier (collector to be emptied daily).

3. Lounges/Mail Rooms: Provide floor space, or alcove, for three (3) rectangular thirty (30) gallon collectors for aluminum cans, newspapers, office paper (21-3/4"W x 15-5/8"D x 27-5/8"H).

4. Corridors:

    a. Provide floor space, or alcove, for two (2) rectangular thirty (30) gallon paper collectors (21-3/4"W x 15-5/8"D x 27-5/8"H) for every ten (10) office workers (collectors to be emptied once a week).

    b. Provide floor space, or alcove, for one (1) rectangular thirty (30) gallon aluminum can collector (21-3/4"W x 15-5/8"D x 27-5/8"H) for each soda vending machine.

5. PC Labs: Provide floor space, or alcove for one (1) thirty (30) gallon paper collector 21-3/4"W x 15-5/8"D x 27-5/8"H) for each printer (collector to be emptied once a week

during normal periods, 2-3 times per week during peek periods).

Trash / Recycling Rooms for Student Housing

1. Provide at least one trash / recycling room(s) on each level to accommodate one 40 gallon trash can *for every 15 students on the floor*. There will also be space for a recycling "center" in each trash room consisting of 3 recycling containers side by side or connected. One is for glass, one for plastic and one for paper.

Loading Docks

1. Loading dock should be an "L" shaped design. Provide floor space along the long leg for multiple storage containers (37-1/2"W x 30-1/2"D x 43"H), one (1) per recyclable. Provide bumpers and dock leveler at each loading dock.

2. Exterior loading dock area should be enclosed with an overhead door, or at a minimum, sheltered from the elements by an overhanging roof.

3. Locate loading dock near the mid-section of the building, rather than at either end.

4. Loading dock should be directly accessible by a service elevator having a 2500 lb. usable capacity.

5. Provide a 60" cardboard bailer in close proximity to each loading dock area if facility generates more than six (6) cubic yards of cardboard per week and does not have an open hopper with cardboard compartment.

6. Consider truck loading dock fumes in relation to make-up air and building openings

Telecommunications Closet

1. Telecommunications closets should be centrally located away from building corners and in close proximity to electrical service. Ensure adequate cooling capacity is provided to these closets to prevent equipment overheating. Limiting the distance between these facilities will include designing an optimal grounding arrangement and minimize intersystem grounding disturbances. A #6 ground should be provided in all telecommunications closets.

2. Size Requirements are based on distributing telecommunications service to one individual work area per 100 sq. ft. of occupied floor space. Minimum telecommunications closet sizes are shown in the table below:

IF THE SERVING AREA IS:	THEN THE CLOSET 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.

3. All Walls of the closet shall be lined with rigidly installed wall-to-wall framing of ¾" trade size A-C plywood, 8 ft. high. Backboards shall be rigidly installed and painted with a nonconductive fire-retardant overcoat.

4. The temperature of the room shall be kept between 64°F and 75°F.

5. Humidity in the telecommunications room shall be kept between 30% and 55% of relative humidity.

6. Floors shall be static free (using asphalt / linoleum tile).

7. Lighting intensity shall be at least 50 foot candles at 3 feet above the floor.

8. Emergency lighting shall be provided.

9. The rated distributed floor loading shall be greater that 250 psf.

10. The rated concentrated floor loading shall be greater that 1000 lbs.

11. Telecommunications closets shall not have door sills or center posts. The door shall be 7' H X 3' W.

12. Sleeves or dam walls around floor slots shall extend 4 inches AFF.

13. Conduits and cable trays located in ceilings shall protrude 2" into the closet.

14. Ventilation shall accomplish one air change per hour (minimum).

15. Closets shall include a minimum of 2 dedicated 110 V AC 20 ampere quad outlets on separate branch circuits.

16. Each floor of the building should have at least one centrally located closet. These closets should be vertically stacked and connected with four - 4" sleeves for a clear cable pull without offsets extending 2" AFF and below ceiling level on the lower floor. Conduits, reamed and bushed at both ends are to be installed with a minimum 200 lb. test pullwire and no more than two 90° bends without a pull box being placed (See the attached diagram for pullbox installations. Bends are to be 10 times the I.D. for all conduits. The sizing and placing of pull or splice boxes shall not be used in place of 90° bends.

Classroom Specialties

Classroom specialties such as chalkboards, tack boards, projection screens, and seating vary significantly depending upon the ultimate use of the space. The A/E should work closely with university personnel to identify the needs of each room.

Health-Safety Requirements

Classroom Configuration

Rooms designed for a capacity of more than fifty (50) students must have two separate exit doors, and all classrooms must have posted occupancy signs.

Laboratory, Shop, Studio, and Office Layouts

1. Egress from a low hazard area (office, conference room) may not be through an area of higher hazard (laboratory, shop, many art studios, darkroom, etc.). Where possible, the office area should have at least one exit directly into a corridor.

2. Office space and/or a break area where workers can eat or drink must be located conveniently and sufficiently close to, but not in, laboratories, shops, art studios, etc.

Work Space

Provide adequate working or use 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.

Decontamination facilities

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

Hazardous Operations Areas

The most hazardous operations areas, such as fume hoods or chemical storage areas must be located away from exits.

Egress

In rooms, such as laboratories, chemical storage rooms, and others where hazardous materials are used or stored, separate, remotely located doors are highly recommended and must be installed whenever possible. Such spaces must have a second door when travel to the door from the most remote point in the room exceeds 50 feet. Teaching laboratories should have two doors, and should be configured to avoid dead-end aisles between benches, other furnishings, and permanent partitions. Bench runs in all laboratories should be placed perpendicular to the main door so that normal circulation patterns are towards the exit.

Darkroom Ventilation

1. Darkrooms where wet chemicals are used must be furnished 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

2. 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.)

Lounge Areas

Lounge and eating areas must be provided in all wet laboratory, shop and studio buildings. There should be sufficient areas convenient to all laboratories to discourage eating and drinking in and continuous occupancy of, potentially hazardous work areas.

Security Conscious Design

Increased security and crime prevention can be brought about through the use of environmental controls. These controls include natural surveillance, natural access control, territorial reinforcement and maintenance as outlined below:

1. Natural Surveillance: Maximize visibility with strategic placement of architecture and physical elements.

2. Natural Access Control: Place entrances, exits, fencing, landscaping and lighting to control movement of people and vehicles.

3. Maintenance: Maintain landscaping, buildings, lighting, etc. in order to maintain visibility, preserve pride in ownership and continue declaration of ownership.

Energy Efficiency Standards

As part of the overall University 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 contractor is encouraged to visit www.energystar.gov for complete product specifications and updated lists of qualifying products. Due diligence must be completed by the contractor 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.

Appliances

- Battery Chargers
- Clothes Washers
- Dehumidifiers
- Dishwashers
- Refrigerators & Freezers
- Room AC
- Room Air Cleaners
- Water Coolers

Heating & Cooling

- Air-source Heat Pumps
- Boilers
- Central AC
- Ceiling Fans
- Dehumidifiers
- Furnaces
- Geothermal Heat Pumps
- Home Sealing (Insulation)
- Light Commercial
- Programmable Thermostats
- Room AC
- Ventilating Fans

Home Envelope

- Home Sealing (Insulation and Air Sealing)
- Roof Products
- Windows, Doors, & Skylights

Home Electronics

- Battery Charging Systems
- Cordless Phones
- Combination Units
- DVD Products
- External Power Adapters
- Home Audio
- Televisions
- VCRs

Office Equipment

- Computers
- Copiers
- External Power Adapters
- Fax Machines
- Laptops
- Mailing Machines
- Monitors
- Multifunction Devices
- Printers
- Scanners

Lighting

- LED
- Compact Fluorescent Light Bulbs (CFLs)
- Residential Light Fixtures
- Ceiling Fans
- Exit Signs
- Traffic Signals

Commercial Food Service

- LED Temperature Readout
- Commercial Fryers
- Commercial Hot Food Holding Cabinets
- Commercial Solid Door Refrigerators & Freezers
- Commercial Steam Cookers

Other Commercial Products

- Battery Charging Systems
- Traffic Signals

Exit Signs
External Power Adapters
Roof Products
Transformers
Vending Machines
Water Coolers

In addition, specifications have been adopted for the following products and any new or replacement equipment must meet or exceed these standards.

Water Conservation - Appendix A
Faucet Aerators
Low flow showerheads
Low flow toilets
Urinals

Lighting – Appendix B
LED
Fluorescent lamps
Electronic Ballasts
Occupancy Sensors
Compact Fluorescent Lamps
Exit Signs

Other Products – Appendix C
Motors
Variable Speed Drives

Energy Saving Performance Contract (ESPC)

1. GMU is currently replacing existing plumbing and lighting fixtures under an ESPC. Designers should specify products that meet or exceed the efficiencies of these fixtures.
2. The ESPC specs are located on our docushare site. Open either Internet Explorer, Firefox or Netscape and type this url into the address window: https://docushare.gmu.edu , or simply click on this link to take you there and this will bring up the 'Xerox Docushare' website; next click on the 'Finance and Administration' folder, next click on the 'Facilities' folder; next click on the 'General Campus Information' folder, next click on the 'Energy Savings Performance Contract (ESPC)'; next double click on the 'ESPC Specs.pdf' file to download to your HDD and use as necessary.

End of Section

PART III, BID DOCUMENTS

RECENT REVISIONS:

Bid Document Distribution	General update. Included wording for Design-Build or CM contracts.
Addenda ……	Updated reference to CPSM section 1003.3.
General Conditions, #1 …….	Added requirement for priority of General and Special Conditions over technical specifications and instructions for A/E not to edit the General and Special Conditions.

Project Manual / Specifications Arrangement

1. See the Construction and Professional Services Manual (CPSM) section 803.2.

2. The final copy should be paginated before printing by the A/E.

3. For final printing**,** specifications must be printed double sided. Each new Section or Division should start on the right hand side of the book.

Bidding Procedures

See the Construction and Professional Services Manual (CPSM) section 504.4, 809, 810.

Bid Document Distribution

A/E or Facilities Project Management & Design Office distributes Bidding documents, including addenda. Projects may be bid via a selected list of pre-qualified bidders in case of Design-Build or CM contracts, which is developed GMU. The list may not be published until it has complete approval.

Addenda

The A/E is to prepare addenda as required. A standard Addenda format and language is stated below. Addenda shall be forwarded to the Facilities Planning Office for review and if acceptable, distribution. The cut-off for distributing addenda is 10 days prior to the bid opening. See the Construction and Professional Services Manual (CPSM) section 1003.3 for exceptions.

"The information contained herein revises, supplements and/or supersedes the specific parts of the documents referred to, and shall be attached to and become part of those documents as if originally forming a part thereof. Except as herein modified, all other provisions of the documents shall remain in full force, unless otherwise described in this Addenda, shall comply with the requirements originally specified for similar work."

General Conditions

1. The Architect / Engineer (A/E) must review the General Conditions, CO-7, CO-7DB, or CO-7CM, to become familiar with the terms and conditions of the Construction contract and to

prevent conflicts between the A/E's technical specifications and the General Conditions. When conflicts occur, the Supplemental General Conditions, the General Conditions (CO-7's), and Special Conditions (SC's) take precedence over the technical specifications. The General Conditions are NOT to be edited or altered in any way by the A/E.

2. For Design-Bid-Build Projects, just prior to printing the final specifications for bidding, the A/E is to schedule a meeting with the Project Manager to confirm the use of the most recent set of Instructions to Bidders (IB), Contract Forms and CO-7's in the documents. The A/E will be required to have a statement of work (limited to one page), a form for pricing additive bid items, and the number of consecutive calendar days to be given to construct the project. The A/E is not to make any changes to the standard boiler plate CO-7. Supplemental General Conditions are allowed.

End of Section

PART IV - CONSTRUCTION PRODUCTS AND ACTIVITIES

Division 1: General Requirements

RECENT REVISIONS:

Final Site Survey……	Added requirements for GPS.
01 91 00: Commissioning, #2	Update to require list of closeout requirements, provisions for warranties, and requirements for off season testing of HVAC systems.

01 30 00: Administrative Requirements

01 32 00: Construction Progress Documentation

01 32 16: Construction Schedule

A. General

1. In accordance with the General Conditions, paragraph 19, if the contract price is greater than $1.5M, a Critical Path Method (CPM) schedule is required.

2. The Contractor's CPM Construction Schedule shall consist of a computerized network diagram together with a mathematical analysis of that network.

3. Display accepted schedule in time-scaled logic network diagram format at site construction office at all times and review with Subcontractors each week.

4. CPM schedule shall clearly show sequential interdependencies.

5. The approved Scheduling Software System shall be capable of baseline comparison analysis. Store (save) an original version of the approved Contractor's CPM Construction Schedule as the baseline "As-Planned" schedule for comparative analysis. As work progresses, provide graphics displaying actual progress bars versus baseline or target bars.

6. Activity durations shall be in work days. The maximum duration for any on-site work activity shall be twenty (20) work days.

7. A sufficient number of activities shall be utilized to accurately depict reviews and approvals, fabrication and delivery, construction sequence, dependencies and progress.

8. Each activity shall be assigned a unique Activity ID number that shall not be changed once assigned. Use skip numbering of activities to allow insertion of additional activities for contract modifications and logic changes.

9. Clearly explain abbreviations used in CPM schedules in legend of symbols, either separate or attached.

10. Except for Contract Award, Notice-to-Proceed with Off-site Work, Notice-to-Proceed with On-Site Construction, and required interim and final completion milestones, activities shall not be constrained by any means other than logic ties to predecessor and successor activities. Relationships with start or finish lags may be used provided the lags are less than 7 working days and can be logically explained.

B. Activity Content:

1. CPM schedule should include, but not limited to, the following activities as they apply to the project:

   (a) Construction tasks (maximum twenty (20) work days duration for any activity)

   (b) Shop drawings submittal and approval process

   (c) Ordering, fabrication, and delivery of major materials and equipment

   (d) Check-out, start-up, and test and balance of major equipment

   (e) Submittals of record drawings and maintenance manuals

   (f) Cleanup and punch out tasks

(g) Important coordination activities required to insure timely support and/or inspections

(h) Owner purchase/install items and/or Owners separate contract work

(i) Pre-final, final inspections and Substantial Completion

(j) Punch-out and Final Completion

(k) Specified interim completion milestones

(l) Owner occupancy

2. Schedule submittal activities to allow sufficient time for work to be procured and installed, even if submittal is unacceptable and resubmittal is required

3. CPM scheduling shall include anticipated events, such as electrical power change over and adverse weather.

4. The CPM Schedule shall account for the normal range of inclement weather and its impact on work operations. Please use the National Weather Service for historical climatological information for the appropriate campus.

5. The following required milestones and finish dates shall be indicated and adhered to:

(a) Contract Award

(b) Notice to Proceed

(c) Complete Roof (including roofing, flashing, skylights and all items necessary to prevent water infiltration to the interior).

(d) Complete Exterior Walls (not including facing, insulation, and windows).

(e) Complete Approval of Materials (including all initial submittal and approval of materials, excluding submittals for information, certifications, testing, and as-built information): Finish no later than 120 calendar days after Award of Contract.

(f) Substantial Completion

(g) Final Completion

6. Activities shall be coded to show, at a minimum, the following:

(a) Phase

(b) Area (e.g. Site, Building Area)

(c) Level (e.g. Foundation, Floor No., Basement, Roof, etc.)

(d) Responsibility (e.g. Subcontractor, Vendor, Supplier, Owner, Authority, etc.)

7. If the contract price is greater than $10M, all activities shall be resource loaded for major equipment and manpower for individual major trades, except for submittal, approval, fabrication and delivery activities.

C. Schedule Submittals:

1. Submit initial, complete CPM schedule, revisions, and monthly updates in one (1) paper copy and one (1) electronic copy.

2. Within sixty (60) calendar days after receipt of a signed contract, submit a complete CPM schedule for the project, consisting of a time-scaled network diagram, a tabular report with bar chart, and narrative. Allow fifteen (15) work days for Owner's review.

3. Submittal of initial and monthly CPM schedule charts shall include one (1) set of all reports as outlined below (Report Formats). Plots shall be in color. Critical path shall be clearly indicated in contrasting color.

4. Resubmit revisions to address Owner's review comments within (10) work days after review. An approved As-Planned Contractor's CPM Construction Schedule shall be a condition for processing the second pay request as well as all future pay requests.

5. Contractor's Superintendent and major Subcontractors shall participate in the development of the CPM schedule. Provide written certification of acceptance of the initial CPM schedule by the major Subcontractors with submittal.

D. Schedule Narrative:

1. For the initial, complete schedule, provide a written narrative explaining the Contractor's plan for meeting the interim and final completion dates. Identify and explain assumptions, sequencing, material and equipment for major work categories and restraints such as manpower and academically sensitive items such as Final Exam week. The academic calendar can be found at http://registrar.gmu.edu/calendars .

2. Identify activities which are planned to be expedited by use of overtime or double shifts, including work on Saturdays, Sundays and holidays.

3. Describe calendars used and provide a listing of holidays, weather days and other non-work periods.

4. Define abbreviations used.

5. For monthly progress updates, provide a narrative that describes problem areas, current and anticipated, delaying factors and their impact, and an explanation of corrective actions taken or proposed.

E. Report Formats:

1. Reports and graphics are to be submitted each month and shall consist of following:

(a) A Tabular Report of all project activities with bar chart. Progress bar chart shall include target or baseline comparison bars. Bar positions shall be early start/early finish with float clearly defined. Sequencing of columns on Tabular Report shall match following:

- Activity/Task Description
- Original Duration
- Remaining Duration
- Percent Complete
- Early Start
- Early Finish
- Late Start
- Late Finish
- Actual Start
- Actual Finish
- Total Float

(b) Time-scaled Network diagram with schedule logic shown.

(1) Sequencing of columns on Time-scaled Network Diagram shall match the following:

- Task/Activity Name
- Original Duration
- Remaining Duration
- Percent Complete
- Early Start
- Early Finish
- Total Float
- Manpower Loading

(2) Critical Path shall be clearly identified.

(3) Group activities together by area and responsibility. Provide titles and subtitles to identify activity groups.

(4) Sheet size of diagram shall be 24 by 36 inches minimum and time scaled in weeks unless approved otherwise.

2. On each page include title block containing as minimum following information:

- Project Title
- Project Number
- Contractor's Business Name
- Date of Submittal and/or Revision
- Progress Computation Date (i.e. Data Date)
- Version Number (see below)
- Legend of Symbols and Abbreviation as applicable

F. Each CPM Schedule shall be identified by a two-part Version number separated by a decimal point.

1. The first part of the Version number shall reflect the Revision Number, beginning with "0" for the initial as-planned schedule. This number will be incremented each time the schedule is revised to add or delete activities, change logic or durations as approved by the Owner.

2. The second part of the Version number shall reflect the Update Number, beginning with "0" for the initial as-planned scheduled (no update information). This number will be incremented each month that the schedule is updated.

3. The approved as-planned schedule will be Version 0.0. The first monthly update for progress will be Version 0.1. By way of example, if the schedule were revised twice by the time of the sixth update, it would be Version 2.6.

G. Schedule Implementation & Monitoring

1. CPM schedule charts and reports updated for the current pay period shall accompany the Contractor's monthly pay request for work completed. Pay requests will not be processed without the required updated CPM schedule submittal.

2. Where the Contractor is shown to be behind schedule, provide accompanying written summary, cause and explanation of planned remedial action.

3. Failure to prepare, submit, and maintain CPM schedule as specified shall be cause for rejection of other schedules submitted and for possible delay of payment.

4. Float time belongs to the Project, not to the Contractor or to the Owner, and may be utilized by both parties.

H. CPM Schedule Updates & Changes

1. Update CPM Schedule for actual progress (i.e. start, finish and percent complete) and submit concurrently with monthly pay request. Monthly update and submittal of the CPM schedule is a prerequisite for processing the Contractor's pay request. The Pay Request submitted must conform to progress reported on the updated CPM schedule.

2. Do not make modifications to the accepted CPM schedule without approval from the Owner. Once CPM schedule is submitted and accepted, identify proposed modifications to activity durations, logic, values or descriptions and submit to Owner in writing. Submittal shall include a proposed revised CPM with the designation "P" preceding the revision number. Submittal shall include all specified reports, graphics and floppy disks except that a time-scaled network diagram shall not be required. Proposed adjustments shall not impact contracted finish date or any required interim milestones.

3. Activity ID numbers and original durations shall not be changed for any activity once accepted by the Owner. Contractor may propose new additional and/or substitute activities for proposed schedule modifications. Contractor may also propose changes of schedule logic for activities previously accepted by the Owner.

I. Three Week Look Ahead Schedule

1. The Contractor shall prepare a Three-Week Look Ahead Schedule for each bi-weekly meeting showing the items worked the previous week and those scheduled to be in progress during the next three weeks. The activities shall be taken from the accepted Contractor's CPM Construction Schedule and shall include information regarding the following:

   - Impact on the critical path
   - Total float for the included activities
   - Activities expected to be started
   - Activities expected to be completed

2. The Three-Week Look Ahead Schedule shall use a bar chart format and be accompanied by a tabular report of the activities included. The previous week's schedule shall be indicated as a "target" schedule for comparison.

J. Change Impact Schedule

1. Each Change Order proposal which is anticipated to impact the Critical Path shall include a separate Change Impact Schedule indicating the effect of this change on the accepted Contractor's CPM Construction Schedule.

2. Include a narrative description of the schedule change and a computer generated comparison of the current and the revised schedule.

3. Where appropriate, provide a detailed and quantified analysis of crews, production rates, materials and equipment to support the Change Impact Schedule.

01 32 33: Construction Photographs

The contractor will take construction photographs once a month. Photographs shall show each building elevation. Photographs shall be digital. One paper print of each photograph taken and the photos on 3.5" disk will be forwarded to the A/E and GMU on 3.5" disks for their files.

01 50 00: Temporary Facilities and Controls

01 51 00: Temporary Utilities

1. See also General Conditions, paragraph 25.

2. The Contractor will be responsible for water and sewage charges on new construction until substantial completion. Show temporary meter(s) on the drawings.

3. The Contractor will be responsible for electrical charges on new construction until substantial completion. Charges should be determined by meter readings. Show temporary meter(s) on the drawings. If a building is to be connected to the GMU electrical distribution system, then a temporary electrical meter should be installed by the Contractor who will be billed monthly. If a building is to be connected to the Public Service electrical system, then the construction Contractor should contact Public Service and pay the bills directly.

01 56 00: Temporary Barriers and Enclosures

01 56 23: Construction Fence

Require the Contractor to construct a 6' high chain-link fence around the entire construction area. Specify the Contractor is responsible to erect, maintain and, upon direction by the A/E, remove the fence and restore the area to its original condition.

Fence posts shall be installed 3’ - 6” into the ground, but need not be set in concrete, except gate posts.

01 56 39: Tree and Plant Protection

1. The Contractor while working the site is responsible for protecting all existing trees to remain such that they will be free from any damage. If damage is done, the Contractor shall be responsible for replacement of damaged trees. All trees affected by construction activities shall be protected with snow fencing per the detail in Part IV to the drip line of the tree.

2. Tree Protection: contractor shall take all precautions necessary to protect existing trees scheduled to remain against injury or damage, including cutting, breaking, or skinning of roots, trunks or branches; smothering by stockpiled construction materials, excavated materials or vehicular traffic within branch spread.

   A. Interfering branches of trees scheduled to remain may be removed when acceptable to the University. It cannot be assumed that permission will be granted. The Contractor must obtain permission from GMU prior to such activities.

   B. Repair trees scheduled to remain and damaged by construction operations in a manner acceptable to GMU. Repair damaged trees promptly to prevent progressive deterioration caused by damage.

3. Tree Replacement: should an existing tree be damaged to the extent that it is deemed to be a complete loss by GMU, or if, due to the Contractor's negligence, a tree on the construction site dies within one year of project completion, the Contractor shall replace the tree according to the following requirements:

   A. Tree Replacement Formula: One square inch of caliper lost will equal one square inch of caliper replaced. This formula is based on tree trunk diameter at breast height. Example: loss of one 12" caliper (same as 6" radius) tree would require replacement with nine (9) 4" caliper trees. [Area of Circle = $3.14 \times r^2 = 3.14x(6^2) = 3.14x(36) = 113.04$ sq. in. Assuming 4" caliper trees (same as 2” radius) will be planted as replacements, calculate the area of a 4" caliper tree: $3.14 \times (2^2) = 12.56$ sq. in. Divide the area of the 4" caliper tree into the area of the 12" caliper tree to determine the number of 4" caliper trees required to replace the loss of the 12" caliper tree. 113.04/12.56= 9 trees.]

   B. Installation: Contractor will be responsible for planting the replacement tree(s) at a location designated by GMU. Installation practices and a one year guarantee shall hold as described in Section 02900 - Planting.

   C. Materials: The replacement tree(s) shall be of the same species and variety as the tree(s) lost. If the species and variety is not available, a substitute must be proposed in writing to the GMU and approved by GMU. The Contractor will be notified of approval of substitution within seven days. Minimum caliper of replacement tree(s) shall be 4".

4. Repair and replacement of trees scheduled to remain and damaged by construction operations or lack of adequate protection during construction operations shall be at Contractor's expense.

01 70 00: Execution Requirements

01 73 00: Execution

Salvaged Materials and Equipment

For renovations and demolition, insure the title to existing materials and equipment of value is specified.

01 78 00: Closeout Submittals

01 78 23: Operation and Maintenance Manuals (O&Ms)

1. As applicable, for each specification section under "Submittals", include "Operation and Maintenance Data: Submit information for all products in accordance with the requirements of Specification Section 01330 and 01780".

2. Submittal Schedule

   A. Before Substantial Completion, submit 2 draft copies for review. Include a complete index or table of contents of each manual. One copy will be returned with comments within 21 days of receipt.

   B. Provide two sets of O&Ms at Final Inspection

3. Format / Organization

   A. Provide material in stiff-backed, 3-ring binders sized to receive 8 ½" x 11" paper. Correlate data in each binder by division. Provide a tab for each specification section used in the project. The tab shall identify the specification section number and title.

   B. Identify each binder on front and spine with the printed title, "Operation and Maintenance Manual," project title, project number, division number and division title. Where two or more binders are necessary to accommodate data, use the following manual organization:

Division	1-14	Architectural
Division	15A	Mechanical
Division	15B	HVAC Controls
Division	16	Electrical

4. Manual Content

   Each manual shall include, but not be limited to, the following:

   A. General system or equipment description, including operation and control sequencing narrative.

B. Design factors and assumptions.

C. Names, addresses and trades of all applicable subcontractors, manufacturers and suppliers who participated in the construction or who furnished materials and equipment.

D. Copies of applicable shop drawings and product data.

E. System or equipment identification, including:

(1) Name of manufacturer
(2) Model number
(3) Serial number of each component

F. Operating instructions including starting and stopping.

G. Emergency instructions.

H. Detailed one-line, color-coded wiring diagrams.

I. Inspection and test procedures.

J. Preventive maintenance procedures and schedules.

K. Precautions against improper use and maintenance.

L. Copy of warranties.

M. Repair instructions including spare parts listing.

N. Sources of required maintenance materials and related services including space parts lists and list of most frequently encountered breakdowns and repairs.

O. Manual index.

P. Detailed catalog data.

01 78 36: Warranties

1. Submittal Schedule

   At final inspection, provide two sets of all warranties in addition to the copy required in the Operation and Maintenance manuals.

2. Format / Organization

A. Provide warranties in stiff-backed, 3-ring binders sized to receive 8 ½" x 11" paper. Correlate data in each binder by division. Provide a tab for each specification section used in the project. The tab shall identify the specification section number and title.

B. Identify each binder on front and spine with the printed title, "Warranties," project title, and project number.

3. Content

   Each warranty shall indicate:

   A. Project Title

   B. Project Number

   C. George Mason University as the Owner

   D. Specification Section

   E. Product Description

   F. Warranty start date that equals the Final Completion date. If GMU takes occupancy before final completion, the warranty start date equals the occupancy date.

   G. Name of company

   H. Address of company.

   I. Telephone number of company.

   J. Name of point of contact

4. When specifying warranty length, confirm availability.

01 78 43,46: Spare Parts and Maintenance Materials

1. A list of spare parts and maintenance materials to be turned over by the Contractor at completion shall be developed by the A/E. These items shall include, but not be limited to, labeled keys, spare fuses, belts, filters (in addition to a new set installed at completion), ceiling tile, VCT floor tile, carpeting, paint for touch-ups, and spare light bulbs.

2. In general, spare parts should be specified for maintenance/minor repair items that would need to be replaced quickly to keep the building system operational (then restocked later), and items very specific to the project such as finishes. Some items specified in the past follow, but the A/E should make adjustments to the list based on applicability and experience:

a. Tile: 1 box for every 10 boxes installed of each type.
b. Resilient floor tile: 1 box for each 50 boxes installed of each type.
c. Resilient wall base: 10 ft. for each 500 ft. installed
d. Acoustical ceiling panel: 1 box for every 10 boxes installed of each type.
e. Acoustical ceiling panel components: 10 each of exposed components
f. Carpet: 10 yd^2
g. Paint: 5 gallons of each color.
h. Diagnostic tools for elevator microprocessor control system
i. Heat exchangers: one spare gasket for each flanged connection for each heat exchanger
j. Fans: one additional complete set of belts for each belt-driven fan
k. Air filters: one complete extra set of filters for each filter bank, including prefilters and afterfilters
l. Variable volume Air Handling Unit: one set of filters for each fan
m. Duct accessories: 10 fusible links of each type installed.

- Control valves for room Fan Coil Units: 5 two-way, 1 three-way
- Digital damper actuators for make-up Air Handling Units: 2
- Pump seals: one set for type of pump installed

n. Switchboards: 3 spare fuses of each size installed
o. Wiring devices: 1 of each type for every 25 installed, but not less than 1
p. Cover plates: 1 of each type for every 25 installed, but not less than 1
q. Lamps: 5 of each type installed.
r. Ballasts: 5 of each type installed
s. Fire Alarm:

- Lamps for Remote Indicating Lamp Units: 5 of each type installed.
- Lamps for strobe units: 5 of each type installed.
- Smoke, fire, flame detectors: 5 of each type installed.
- Detector bases: 5 of each type installed.
- Printer ribbons: 6
- Keys and tools: one extra set for access to locked components

3. Insure quantity of spare parts is realistic for amount installed.

4. An inventory and sign-off of material received and accepted by the University shall be developed by the Contractor. All construction materials not accepted by the University shall be removed from the site by the contractor.

Final Site Survey

Require that the General Contractor engage the services of a Virginia licensed land surveyor to locate and record all underground utilities installed as part of each contract. Survey shall show exact route of each utility invert or depth of cover and connection points to existing utilities. Identify, locate and dimension off of above-ground permanent improvements all manholes, catch basins, valve

boxes or other structures. Tie together into GMU's overall site plan using GPS in a CAD layer. CAD layer must show project in GMU's present site layout as well as future site layout.

01 79 00: Demonstration and Training

Specify all training to be performed on site.

01 90 00: Life Cycle

01 91 00: Commissioning

1. Commissioning shall address verification that systems are installed per specifications and industry standards; that start-up procedures and testing are properly conducted and documented; that receipt of proper as-built drawings, operation and maintenance manuals, required spare parts, certificates and warranties are provided to the Owner; and that Owner's personnel receive useful training on the installed systems. The Architect/Engineer should arrange the specifications to cover these items within the specific section. For commissioning of HVAC systems, see also the Construction and Professional Services Manual, Section 816.0.

2. The A/E shall include a list of closeout requirements in the specifications. In addition to the items above, these shall include witnessed system start-ups and demonstrations, quantities and service provisions for one year from building acceptance for elevators, mechanical systems, air balancing, door adjustments, faulty lighting replacements and dead tree and plantings replacement. HVAC systems are to be demonstrated and signed off while operating in both heating and cooling modes under actual load conditions. As an example, for buildings accepted during the winter months proper operation of both the heating and cooling system shall be demonstrated, but a later demonstration of the cooling system shall be performed by the contractor when the cooling season starts. If accepted during cooling season, the building shall again be demonstrated to operate properly in the first heating season following completion and acceptance.

3. The purpose of the commissioning process is to provide the Owner assurance that systems have been installed in the prescribed manner and will operate within the performance guidelines. Commissioning is intended to enhance the quality of system start-up and aid in the orderly transfer of systems to beneficial use by the Owner.

4. The Contractor verifies installation, provides scheduling and coordination of commissioning activities, performs training, starts-up equipment, conducts functional performance testing, corrects deficiencies, performs retests, and provides documentation of the process.

5. Commissioning procedures and results will be observed by the Owner's designated witnesses (Commissioning Agent and/or Owner's staff). The Contractor is expected to verify the functional readiness of systems to be tested prior to performing the tests

in the presence of the Owner's witness(es). A high rate of failure will indicate that the Contractor has not adequately verified the readiness of the systems.

6. The requirement for a Start-up Plan, Testing, Adjusting, and Balancing Plan, and Functional Performance Test Plan, shall be specified in the specific section for each piece of equipment or system that is to be commissioned.

7. Problems observed during commissioning shall be addressed immediately, in terms of notification to responsible parties, and actions to correct deficiencies.

8. Operations and Maintenance Manuals: see 01780.

Commissioning Plan

Develop a commissioning plan to identify how commissioning activities will be integrated into general construction and trade activities. The plan is the key means for the Test Engineer to inform all parties as to how each system functions, independently and with respect to other systems. The plan shall be updated regularly and redistributed to the commissioning team for review and comment. The intent of the plan is to evoke questions, expose issues, and resolve them with input from the entire commissioning team early in construction. The commissioning plan shall identify how commissioning responsibilities are distributed, and:

a. Be submitted in accordance with the General Conditions within 90 calendar days of Notice to Proceed.

b. Include an organizational chart identifying key General Contractor positions and key subcontractors. Include lines of communication and authority.

c. Identify who will be responsible for producing the various procedures, reports, Owner notifications and forms required in the specifications.

d. Describe the test/acceptance procedure.

e. Identify which subcontractors will participate in each of the tests.

f. Identify instrumentation required for each test.

g. Identify who will provide instrumentation for each test.

h. Include an Operational Description: This shall include, for example, the design criteria, design intent, code requirements, specifics of the equipment to be provided, sequences of operation, operating priorities, protocols, etc.

i. Include the Commissioning Schedule

1) Integrate start-up activities, testing and balancing activities, and functional performance testing activities into the Critical Path Method (CPM) master

construction schedule. Commissioning scheduling is the responsibility of the Contractor.

2) Prior to beginning of start-up, testing and balancing, or functional performance testing activities, update the schedule of commissioning activities monthly.

3) Two weeks prior to the beginning of a start-up, testing and balancing, or functional performance testing activity, provide a detailed two-week look-ahead schedule. Thereafter, update the two-week look-ahead schedule weekly for the duration of commissioning for that construction phase. The two-week look-ahead schedule shall identify the date, time, beginning location, Contractor personnel required, and anticipated duration for each start-up, testing and balancing, or functional performance test activity.

j. Include a Start-up Plan, consisting of the following, for each piece of equipment or system that formal start-up is specified

1) Start-up Schedule

2) Names of firms/individuals required to participate

3) Detailed start-up procedures: These procedures will be reviewed for technical depth, clarity of documentation and completeness.

4) Start-up data forms

k. Include a Test Equipment Identification List, consisting of the following, for each instrument, sorted according to intended use.

1) Manufacturer
2) Model Number
3) Serial Number
4) Calibration Certification
5) Range
6) Accuracy
7) Resolution
8) Intended Use

l. Include a Testing, Adjusting, and Balancing Plan in accordance with 15950, and consisting of the following

1) Testing, Adjusting, and Balancing Schedule

2) Testing, Adjusting and Balancing (TAB) Data Forms

3) Testing, Adjusting and Balancing (TAB) Procedures

4) Testing, Adjusting, and Balancing (TAB) Report

m. Include a Functional Performance Test Plan consisting of the following:

1) Functional Performance Test (FPT) Procedures

a) Each procedure shall have a unique alpha-numeric designator.

b) The same procedure may be applied to multiple identical pieces of equipment or systems.

c) Procedures shall reference the applicable specification section upon which the procedure is based.

d) Procedures will be reviewed for technical depth, clarity of documentation, compliance with "Acceptance Criteria: specified elsewhere, and completeness.

e) Identify the value for all setpoints and inputs, positions of adjustable devices, valves, dampers and switches.

f) Identify the range of acceptable results for each condition tested. As an example, if field verification with the contractor's air balancing firm reveals a variance of more than +/-10% of stated TAB report values on up to 25% of the boxes tested, than the entire TAB report shall be rejected and the entire building re-balanced.

g) FPT procedures shall be detailed test instructions, written with sufficient step-by-step information to allow a test to be repeated under identical conditions with repeatable results.

2) Functional Performance Test (FPT) Data Forms

a) Identify each FPT test data form by a unique designator and a suffix to identify multiple repetitions of the same procedure.

b) Include space to record:

I. Description of the procedure
II. Whether the form is for a retest of a failed procedure
III. Identification and location of the equipment being tested
IV. Identification of instrumentation used, by serial number
V. Observed conditions at each step of the procedure
VI. "Acceptable Results" as specified elsewhere
VII. Date of test
VIII. Names of technicians performing the procedure
IX. Name and signature of the Test Engineer
X. Name and signature of the Commissioning Agent or Owner-designated witness. Signature of witness shall only indicate concurrence with reported results and observations. Acceptance of

results will be reported separately after review of the FPT data forms by the Architect and Commissioning Agent.

3) Functional Performance Test (FPT) Deficiency Report Forms. Include space to record:

   a) Associated FPT test data form number
   b) Date of test
   c) Name of person reporting the deficiency
   d) Description of the observations associated with the failure of the test
   e) Cause of the failure, if apparent at the time of the test
   f) Date and description of corrective action taken
   g) Name and signature of person taking corrective action
   h) Schedule for retest

End of Section

Division 2: Existing Conditions

02 00 00: Existing Conditions

02 08 00: Utility Materials

Hydrants shall be as manufactured by Mueller or as approved by Owner. Generally use National Standard hose threads but A/E shall verify.

02 40 00: Demolition and Structure Moving

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 3'-0" below grade. All basement slabs below the 3'-0" level need not be demolished, but must be broken into approximately 4' square areas or less to allow drainage of water. Require the Contractor to hire the services of a Virginia licensed surveyor to document the location of all foundations left in place below the 3'-0" location, as well as abandoned utilities, and utilities relocated as required by the demolition work. Survey shall become part of the as-built drawing requirements of the Contractor at completion of the work.

2. All demolition debris shall be removed from the University property and disposed of by lawful means. Backfill of buildings shall be with clean fill, compacted to at least 95% minimum density for cohesive material and 95% relative density for cohesionless material. Area shall be topsoiled and seeded.

3. University approval must be obtained prior to any demolition of basement floors, or before making connections into old underground waste systems.

4. All utilities shall be cut and capped. The location of the preceding cuts/ caps shall be annotated on the as-built survey provided by the Contractor.

02775: 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.

2. GMU's standard sidewalk is minimum 6' wide, 4" slab constructed of 3000 psi 4 – 6% air entrained concrete reinforced with 6 x 6 #10 welded plain cold drawn steel flat panel wire mesh, with broom finish. Wire mesh shall be supported by, and attached to, 3" rebar chairs that are spaced adequately to ensure support of the mesh during the concrete pour. A 6mil. vapor barrier shall be used on compacted base of naturally or artificially graded mixture of natural or crushed gravel, crushed stone, crushed slag, natural or crushed sand. Aggregate used within the sidewalk shall be rounded.

3. Install 6'-minimum turning radius at all sidewalk intersections for electric carts.

4. Install ramps where sidewalks intersect roads for electric cart access.

5. Transverse control joints shall occur 6' - 0" on center for 6' - 0" wide sidewalks. Transverse contraction joints with premolded joint fillers shall occur 48' - 0" on center. Premolded joint fillers shall be 1/2" thick asphalt impregnated fiber board 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 of the sidewalk.

6. Consider using non-slip finish on sidewalks, steps, and metal grates where a slipping hazard may exist.

02800: Site Improvements and Amenities

02840: Walk, Road, and Parking Appurtenances

Bollards shall be installed wherever the need exists to prevent non-university vehicles from entering authorized areas or to prevent vehicular traffic onto sidewalks.

End of Section

Division 3: Concrete

RECENT REVISIONS:

03 30 00: Cast-In-Place Concrete …… Updated version on ASTM E1155 to 2008 edition or better.

03 30 00: Cast-In-Place Concrete

1. The latest edition of American Concrete Institute (ACI) standards shall be followed.

2. Testing: The Contractor shall be required to retain and pay for the services of an University approved laboratory to perform all concrete testing and inspections in accordance with applicable ASTM standards. For floors, use ASTM E1155 "Standard Test Methods for Determining Floor Flatness and Levelness Using the F Number System." 2008 Edition or later.

3. Air-entrained concrete shall be used where concrete is exposed to the weather. With the exception of air-entrained agents, no antifreeze or other admixtures are permitted.

4. Newly placed concrete for walks, plazas, pads, and other surfaces exposed to the public shall be placed by Contractor to insure that concrete shall be free of graffiti. Freshly placed concrete with graffiti shall be removed and replaced or repaired by the Contractor at no additional cost to the University.

5. All concrete floors, which will be exposed within the finished building which are not scheduled to receive an applied finish, shall be sealed.

6. All concrete additives, where required must contain not more than 0.1% chloride ions and shall be certified as such by the Contractor.

7. If Concrete is to be used for exterior walls, a mock-up panel shall be constructed. See Division 4 - Masonry for details on panel.

8. Interior and/or exterior structural concrete surfaces should not be scheduled to receive a sandblasted finish unless specifically approved by the university.

9. Building interior structural concrete painted surfaces should not be scheduled to receive a rubbed finish. If a smooth plaster-like finish is desired, specify a thin coat of veneer

plaster over the concrete substrate.

10. Building exterior exposed concrete structural frame should be detailed (incorporating insulation and finish systems) to prevent thermal loss or gain.

11. Exposed interior concrete floors should be sealed. A hardener should be required where the floor surface is subject to heavy, impact, and/or rolling loads.

12. A sample panel of exterior exposed "Architectural" concrete should be provided to establish an acceptable standard of workmanship/quality concerning finishing, texture of formed material, etc. The concrete used in the sample panel should be furnished by the project concrete supplier, and should represent the approved mix for strength and texture.

13. Exterior concrete flatwork should be six inches nominal thickness, 3000 PSI air-entrained concrete, reinforced with welded wire fabric located two inches below the top surface. The flatwork should be placed over a six inch aggregate stone base, and where intermittent vehicular traffic is anticipated, be a minimum of nine feet wide. The top surface should be broom finished with sawn or tooled joints at a maximum of six feet on-center.

03 31 00: Structural (High Temperature Hot Water Tunnel see Part V – Standard Details, HTHW Tunnel Detail, Fairfax Campus, HTHW Tunnel Top Details, HTHW Manhole Detail)

a. Manholes, tunnel and piping to be designed by a Virginia registered Professional Engineer.

b. Construct manholes, tunnel and tops for H-20 loading.

c. 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.

d. Lifting lugs for tunnel top removal shall be located on the sides of the tunnel top, see Tunnel Top Detail.

e. Lifting lugs for tunnel top removal shall be epoxy coated re-bar loop, 4 per tunnel top. If tunnel tops are adjacent to a hard surface, sidewalk, or roadway, coordinate with GMU.

f. Tunnel tops not to exceed 4,500 pounds each.

g. For Expansion Joints, Ball Joints and Anchorage provide hatch access with cover. Hatch to be 4' x 3' min. clearance.

h. Provide foundation drainage. Cover with #57 stone and filter fabric. Stone to extend to bottom of tunnel slab.

i. Provide floor drains in tunnel if necessary.

j. Provide drain channel inside tunnel. Grade drain channel to manhole.

03 40 00: Precast Concrete

All pre-cast concrete that will remain exposed at contract completion shall be protected from rust stains and damage during construction.

03 48 00: Precast Concrete Specialties

03 48 13: Bollards

Bollards to prevent unwanted vehicular traffic on emergency access roads, plazas, etc. shall be Pro Stop collapsable type or equal. Bollards to prevent pedestrian traffic shall be Pro Stop immovable type or equal. Type and style of all bollards must be approved by GMU. See detail in Part V – Standard Details, **Collapsable Bollards, All Campuses**

End of Section

Division 4: Masonry

04 00 00: Masonry

04 05 00: Common Work Results for Masonry

Cast Stone, brick, and concrete copings are prohibited. Metal coping shall be used.

04 05 13: Masonry Mortar

1. All mortar additives, where required must contain not more than 0.1% chloride ions and shall be certified as such by the Contractor.

2. All colored mortar must be pre-approved by the University along with the brick colors as noted below.

04 05 23: Masonry Accessories

1. Thru-wall flashing in exterior cavity walls shall be 20 mil plastic equal to "Nervastral", or approved equal.

2. In exterior masonry cavity walls, plastic weep holes shall be provided spaced not more than 2'-0" o.c. at all interruptions in the cavity caused by thru-wall flashing. Aluminum weep hole vents shall be avoided.

3. Lead coated flashings are prohibited.

04 20 00: Unit Masonry

04 22 00: Concrete Unit Masonry

1. Wherever possible, lightweight concrete block shall be used in masonry walls.

2. Four-inch thick CMU walls shall be avoided.

04 70 00: Manufactured Masonry

04 72 00: Cast Stone Masonry

1. Manufacturer shall have a minimum of 10 years experience in the manufacture of cast stone work.

2. Samples of materials are required for approval before proceeding with any work, showing shape and colors as required. Submit samples of all anchors and relieving angles for A/E approval.

3. Testing-Laboratory: Require that the Contractor submit name and credentials of proposed testing laboratory for approval.

4. Inspection: The A/E should inspect all material, equipment, fabrication, curing and storing of cast stone work at the cast stone plant. Units shall be marked for identification and the day of casting of each unit recorded.

5. Tests: The A/E may select or cause to be selected at random from the job, representative pieces of cast stone for testing. Tests shall be made at the Manufacturer's expense and pieces of cast stone taken for testing shall be replaced by the Manufacturer without charge. A minimum of one unit per 50 units may be selected from the stone delivered to the job to be sent to an approved testing laboratory. Samples shall be tested to destruction in accordance with ASTM C 116 and test reports shall be submitted to the A/E and University.

04800: Masonry Assemblies

Coursing for both brick and CMU shall be coordinated with windows and door heads so that fractions of courses are minimized.

Sample Panels

Sample panels: Prior to installation of masonry work, the Contractor shall be required to erect up to 3 sample wall panels representative of completed masonry work required for project with respect to qualities of appearance, materials and construction. Locate mockups on site in locations as directed by A/E. Retain mockups during construction as standard for judging completed masonry work. As a minimum, the sample panel shall be "L" shaped 4'-0" high by 4'-0" wide with 2'-0" leg. Brick shall be on outside corner of panel. Panels shall show the proposed color range, texture, bond, mortar joints, and workmanship of all facing materials and shall include a sample of the proposed fenestration. If contrasting elements such as doors and frames are proposed, a sample of these materials shall be included in each mock-up panel. Obtain A/E and University approval prior to start of exposed finished masonry work. Approved panels shall become the standard of comparison for all materials included and the panels shall remain undisturbed at the jobsite until the project is accepted by the University. The contractor shall then demolish mockups and remove from site after completion.

04900 Masonry Restoration and Cleaning

1. Cleaning of masonry, be it brick or stone, shall be done using brushes (not those with metal bristles) and water. Diluted detergents may be used. Repeated washings are preferred to fewer washings that are too abrasive or chemically laden.

2. Sandblasting of masonry is prohibited.

3. For all structures, mortar joint profiles and mortar colors are critical and must be specifically approved by the University.

4. Waterproof covering of masonry work is required during nonworking hours and for freshly laid masonry during periods of inclement weather.

5. Experience Clause: A 5-year experience record of the subcontractor performing the restoration work is required.

End of Section

Division 5: Metals

RECENT REVISIONS:

05 51 00, Metal Stairs …… Added requirement for stair access to roofs.

05 10 00: Structural Metal Framing

1. For erection of structural steel, the Contractor is required to provide an affidavit, at the completion of the job, to the effect that the structural steel frame is plumb and level within the normal tolerances specified by code, or the more stringent tolerances specified in the Specifications, if applicable.

2. The Contractor shall provide a certified survey showing the exact location of the centers of the columns at their top most level, exactly as installed. This information shall be incorporated into the "as built" drawings.

3. If metal is to be used for exterior walls, a mock-up panel shall be constructed. See Division 4 Masonry for details on panel.

05 30 00: Metal Decking

Galvanized metal decks conforming to ASTM A 525, G 60 are the only material to be used for metal decks, floor slabs and roof decks. Prime painted decks are not acceptable. Where applicable, the proper adhesion of sprayed on fireproofing to the decking used must be confirmed when developing specifications.

05 40 00: Cold-Formed Metal Framing

05 45 00: Metal Support Assemblies

See 15060 for mechanical hangars and supports.

05 50 00: Metal Fabrications

1. Ventilation shafts penetrating the roof shall be equipped with welded anti-personnel screening to prevent unauthorized access to the building.

2. All exterior miscellaneous steel shall be galvanized and prime painted, ready for field finishing.

05 51 00: Metal Stairs

Roofs must be accessible by stairs and not by vertical ladders. Any exceptions to this requirements must be approved in writing by the Director of Facilities Management.

05 52 00: Metal Railings

Powder coated or stainless steel handrails should be used outside of buildings. Interior handrails should be painted steel. Protection from dissimilar metals and lime mortar (type N).

End of Section

Division 6: Wood, Plastic, and Composites

RECENT REVISIONS:

06 05 73, Wood Treatment…… Added requirement for treated wood to not be in contact with steel.

06 00 00: Wood, Plastic, and Composites

06 05 00: Common Works Results for Wood, Plastic, and Composites

1. For both woods and plastics, special attention is called to matters such as flame spread, fuel contribution, smoke generation and toxicity.

2. For exterior wood or plastic framed structures, see Division 4 for dimensions of Sample Panel.

06 05 73: Wood Treatment

Where fireproofed wood is used, the fireproofing treatment shall be accomplished by means of pressurization. The same is true for preservation treatment for wood, such treatments being required for all wood in damp areas or in contact with earth, concrete, masonry, plaster or roofing. No treated wood in contact with steel.

06 06 00: Schedules for Woods, Plastics, and Composites

All lumber shall be properly seasoned or kiln-dried.

06 10 00: Rough Carpentry

All lumber must be inspected, marked according to grade and certified by the appropriate bureau governing that product.

06 13 00: Heavy Timber Construction

Timber Trusses

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 meets requirements of the specifications and complies with requirements of all codes and ordinances applicable to the particular project.

06 20 00: Finish Carpentry

Materials and Fabrication: Conform to Architectural Woodwork Institute specifications for economy or custom quality work as a minimum.

06 40 00: Architectural Woodwork

1. Plastic laminates: When specified by the designer, due consideration must be given to the particular condition of usage that will be encountered. Of special concern are flame spread, chemical resistance, fuel contribution, smoke generation and toxicity for plastic laminates and for the adhesives used to install them.

2. Prior to delivery of materials on site for installation, the Contractor shall provide the proper environmental controls for material storage (i.e. weatherproofing, climate control, etc.). These controls shall be maintained for the duration of the project.

06 41 00: Architectural Wood Casework

1. Cabinet Work: Materials and fabrication shall conform to Architectural Woodwork Institute specifications for custom quality work.

2. Cabinet hardware shall be furnished and installed by the installer of cabinetry.

End of Section

Division 7: Thermal and Moisture Protection

RECENT REVISIONS:

07 24 00, #2 Thermal Insulation…… Added requirement for weep holes at bottom of panels.

07 30 00, #6 Shingles…… Added minimum width for membranes.

07 50 00, #1 Membrane Roofing ….. Change from 3 ply to 4 ply.

07 00 00: Thermal and Moisture Protection

07 05 00: Common Work Results for Thermal and Moisture Protection

Match color of roofing nails/screws/spikes to underside of exposed interior metal decking.

07 10 00: Dampproofing and Waterproofing

1. Waterproofing of below grade spaces is required.

2. Material shall be protected against damage during backfill by minimum 1" thickness of extruded polystyrene insulation.

3. Damproofing shall be applied to the exterior of all below grade walls.

07 17 00: Bentonite Waterproofing

If bentonite is used, the preferred manufacturers are American Colloid Company and Paramount Technical Products. The A/E should be aware that installation procedures are different for these two manufacturers. When required, bentonite shall be applied below the floor slab, extended down and below the footings and up the walls to within 6" of finished grade or slab-on-grade.

07 19 00: Water Repellents

Generally, water repellents shall not be used on exterior brick or masonry walls. Where required on existing buildings, silane based water repellents such as the following shall be used:

1. Chem-Trete BSM 40 as manufactured by Huls Inc., Edison, New Jersey.

2. SIL-ACT ATS-42 as manufactured by Advanced Chemical Technologies Co., Oklahoma City, OK.

3. Stifel as manufactured by Nox-Crete Chemicals, Inc., Omaha, Nebraska.

4. Klereseal 940-S as manufactured by Pecora Corporation, Harleysville, PA.

07 20 00: Thermal Protection

07 21 00: Thermal Insulation

Fiberglass batt insulation shall be installed to minimize exposed fiberglass in areas needing to be accessed for inspections, maintenance, etc. Designs should encapsulate fiberglass using foil or pre-applied backing, plastic or gypsum board covering.

07 24 00: Exterior Insulation and Finish Systems (EIFS)

1. It is preferred that such systems be avoided. When required, only the "hardcoat" systems defined as Class PM, Type A, polymer modified protective finish coating, externally reinforced as developed by the Exterior Insulation Manufacturers Association (EIMA) may be used. Such systems require mechanical fastening of extruded polystyrene insulation and reinforcing mesh, and rigid acrylic modified cement plaster finish.

2. The A/E shall pay special attention to locations of crack control joints and details of flashing and sealing at penetrations to insure a properly designed and watertight installation. All installations shall have weepholes at bottom of panels.

07300: Shingles, Roof Tiles, and Roof Coverings

1. See the Construction and Professional Services Manual (CPSM) section 707.B.

2. The Department of Engineering & Buildings (DEB) shall approve roofing system design.

3. Consider “Cool Roof” technologies from manufacturers such as Duro-Last, Advanced Coating Systems and Dow Corning for possible energy cost savings.

4. Contractors shall recycle non-asbestos containing roofing materials that are removed as part of the contract.

5. Roofs over occupied spaces that have public access (i.e. plazas with concrete pavers over roofing / waterproofing system) shall be avoided.

6. Slope roof designs shall incorporate ice and water shield membrane at perimeter eaves and valleys. Minimum Width 3’

07310: Shingles

1. Roof shingles underlayment shall be at least 30 lb. felt.

2. Slate shingles, where appropriate, shall be a minimum of ¼ inch thick, weighing not less than 900 pounds per square.

07400: Roofing and Siding Panels

Roof parapets are preferred on buildings greater than one-story in height for safety purposes.

07 50 00: Membrane Roofing

1. 4-ply Built-Up Asphalt roofing is required. As Per BCOM

2. See the Construction and Professional Services Manual (CPSM) section 707.B for approved types.

3. Ballasted and/or loose laid membrane roofs must be approved in advance by the University.

4. Single-ply roofing systems (60 Mil) should be specified for low slope (less than 4 in 12 pitch) applications. Fully adhered systems are preferred. Ballasted systems must be approved in advance by the University. Mechanically fastened systems are not acceptable.

5. Ballast (if approved) should be clean, river washed gravel meeting ASTM-C-136.

6. Specify a flood test for new roof installations prior to final acceptance.

07 60 00: Flashing and Sheet Metal

07 62 00: Sheet Metal Flashing and Trim

1. Specify thin wall 16 gauge copper flashing between parapet walls and capstone.

2. Gutters and downspouts shall be (minimum) 16 gauge copper.

3. Downspouts shall tie directly to underground storm drainage system.

07 70 00: Roof and Wall Specialties and Accessories

07 71 00: Roof Specialties

Metal coping shall be used. Cast Stone, brick, and concrete copings are prohibited.

07 72 00: Roof Accessories

1. Walkway pads shall be provided to all roof equipment and appurtenances requiring maintenance.

2. Specify service walkways (minimum 2'0" wide) appropriately located to service all roof top equipment from the roof access.

3. Provide snow guards over entrances on all roofs with a slope of 6 in 12 or greater. Snow guards to be screwed **and** adhered to roof.

4. Access to the roof from both the interior and exterior of a building shall be restricted. If interior roof hatches are used, they must be padlocked and located in areas restricted to the general public and accessible only by authorized personnel.

5. Specify roof hatches that are insulated and lockable.

6. Roofs shall be accessible by stairs and not by vertical ladders.

7. Smoke relief vents shall be accessible from a 10' ladder for maintenance.

07 80 00: Fire and Smoke Protection

07 81 00: Applied Fireproofing

Carefully select the appropriate fireproofing material and application method to ensure compatibility with deck and column finishes.

07900: Joint Protection

1. The A/E shall pay special attention to the use and misuse of the word "caulk". Such materials are generally no longer used in modern construction and consist of oil-based materials used to glaze windows. "Caulk" is not used as a sealant in masonry joints or other exterior wall joints.

2. The use of 2-part polysulfide, 2-part polyurethane or silicone-synthetic rubber type sealant is preferable. The A/E shall determine which particular sealant type is best applicable to each individual design. Specify pourable urethane base sealants for construction joints in traffic bearing locations such as concrete walks, patios, steps and similar locations.

End of Section

Division 8: Openings

RECENT REVISIONS:

08 40 00, #4 .....Added US26 D requirement.Remove Precision from preferred manufacturers of panic devices.

08 60 00 ……Added requirements for skylight use.

07 70 00, 37 ……..Revised wording

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 review door manufacturer list early in the design process and receive approval for the list from the University.

08 11 00: Metal Doors and Frames

1. Exterior doors shall be not less than 16 gauge steel. The top channel of each metal door shall be solid without pockets which collect dirt and water. All exterior doors and frames shall be galvanized.

2. Interior doors shall be not less than 18 gauge steel.

3. All door frames shall be 16 gauge. Knock-down frames are prohibited unless specifically approved in writing by the University.

08 14 00: Wood Doors

1. Exterior wood doors are prohibited except if replacing existing doors.

2. All interior wood doors shall be solid core, either mineral core where a fire rating is required, high density particle board core, or wood stave core.

3. Wood doors which are to receive clear or stained finish shall be factory finished and pre-machined for hardware. Specify that the door edges are fabricated of matching wood to the face.

08 30 00: Specialty Doors and Frames

08 33 00: Coiling Doors and Grilles

Specify only fusible links for automatically closed, rolling steel fire doors. Do not specify both detectors and fusible links.

Fire Shutters

Provide water curtains in lieu of fire shutters.

08 40 00: Entrances, Storefronts, and Curtain Walls

1. Aluminum doors shall have minimum 5" stiles, 5" stop rail and 6-1/2" bottom rail (wide stile doors).

2. All hardware, with the exception of cylinders, shall be provided and installed by the aluminum door manufacturer. Cylinders shall be provided under finish hardware section of the Specifications.

3. Hardware: The following hardware shall be provided (No substitutions except those indicated):

ITEM	MANUFACTURER	MODEL NO.
Hinge	Roton Continuous or Stanley	FBB-199 US32D
Closer	LCN	4040 x CUSH x Alum.
Panic Device	Von Duprin	99 rim x 990NL (RHRB Door)
Mullion	Reed	8000 Series (Steel)
Threshold	Reese, or Approved Equal	
Weather-strip by door manufacturer		

4. All finish hardware shall be supplied US26D, with the exception of door closers which shall be sprayed aluminum finish.

5. Overhead concealed door closers, floor closers, pivot hung doors and door manufacturer's pull trims are not acceptable.

6. Typical door schedule follows:

   A. Pair Aluminum Entry Doors:

      Each Leaf;
      1 - Hinge Roton 780-053HD X Alum.
      1 - Panic Device Von Duprin 99 X 99ONL X US26D
      1 - Door Closer LCN 4040 X CUSH X Alum.

Per Pair;
I - Removable Mullion Yale M-100
1 - Threshold Zero or Approved Equal.

B. Single Aluminum Entry Door

1 - Hinge Roton 780-053HD X Alum.
1 - Panic Device Von Duprin 99 X 99ONL X US26D
1 - Door Closer LCN 4040 X CUSH X Alum.
Threshold Zero or Approved Equal
Silencers GJ-64

08 42 00 Entrances

08 42 29: Automatic Entrance Doors

ITEM	MANUFACTURER	MODEL NO.
Hinge	Roton or Select Products Limited. No Substitution	
Automatic Operator	Besam (Low Energy Type). No Substitutions	
(*) Electric Strike	Von Duprin 6000 Series 24VDC Fail secure	Model to suit application. No Substitution
(*) Panic 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.

1. Hinge and Panic Device shall be installed with thru-bolts. All exposed screw and bolt heads shall be spanner head.

2. Sufficient reinforcement shall be provided for overhead surface mounted door operators.

3. 120VAC power shall be supplied to each operator.

4. Door operator controls: A self contained solid state circuit shall control the operations and switching of the swing power operator. The electronic control shall provide low voltage power supply for all means of actuation. No external or auxiliary

low voltage power source will be allowed. The control shall also include time delay 1-60 seconds, for normal cycle, as well as the following built-in features:

A. Torque limiting for controlled forces on opening,

B. Acceleration control for smooth starts and recycle,

C. 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:

   A. 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.

   B. Solid state electronics interfaced to alternating rows of light emitting diodes and receivers contained within the extruded aluminum housing.

   C. Long/short range switch and flexible cable.

   D. 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.

08 50 00: Windows (Exterior & Interior)

1. Specify standard glass not requiring special order or premium price.

2. Wherever possible, windows should be specified that have the muntins installed between the panes of glass.

08 60 00: Roof Windows and Skylights

Skylights shall be avoided. Special permission for the use of skylights must be obtained from the University and generally will not be granted without extremely strong reasons. Should perform flash inspection as installed, sky lights are good if done right.

08 70 00: Hardware

The following hardware for the types of buildings indicated shall be provided.

ITEM	MANUFACTURER	MODEL NO. ACADEMIC	MODEL NO. HOUSING

		BUILDINGS	FACILITIES
Butts (Int.)	Stanley	FBB-179 4-1/2 USP or approved equal	FBB-179 4-1/2 USP
Butts (Ext.)	Stanley	FBB-199 4-1/2 US32D or Approved Equal	FBB-199 4-1/2 US32D
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
Panic 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”	18-8”
Kick Plates	Rockwood or Approved Equal	18-12”	18’12”
Silencers	Glynn-Johnson or Approved Equal	No. 64	No. 64

1. Specifying hardware by allowance is prohibited. Hardware sets shall be developed for each unique condition for the building.

2. The Virginia Uniform Construction Code, Barrier Free Subcode requires that door handles be easily grasped by handicapped persons. This necessitates lever handles on virtually all doors in University buildings.

3. Mop plates and kick plates shall be 1" less than width of door on hinge side, 1-1/2" less than width of door on stop side.

4. Hardware items, not set forth herein, shall be subject to verification by application, on a per project basis.

5. Floor type or overhead Concealed door closers are NOT acceptable.

6. Concealed Vertical Rod Type Panic Devices are NOT acceptable. Panic devices by manufacturers other than specified above are NOT acceptable. Panic devices by the specified manufacturers, shall be acceptable ONLY in the SERIES specified herein.

7. Specify push-bars that latch at the center in lieu of vertical rods.

8. Removable Mullions, as specified herein, shall be used on entry doors, where doors are paired.

9. As hardware applications may vary, due to special requirements, or code restrictions. These applications shall be considered on a per project basis.

10. At drywall or plaster walls, use closers with CUSH function. Wall bumpers on drywall or plaster are prohibited. Floor bumpers are prohibited.

11. Exterior doors which are not the main access point to the building shall be exit only, and shall be connected to the fire alarm system. Such doors shall be clearly marked on the inside that opening the door will sound an alarm.

12. Provide power circuit(s) for automatic door openers.

13. Typical Door Schedules are as follows:

    A. 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

    B. 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

    C. 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

D. Public Toilet
1-1/2 pr. Butts Stanley FBB179 X US26D
1 Pull Plate Rockwood or approved equal
1 Push Plate Rockwood or approved equal
I Kickplate Rockwood or approved equal
1 Mop Plate Rockwood or approved equal
I Closer LCN 4041
Silencers GJ-64

E. Classrooms, Laboratories
1-1/2PR. Butts Stanley FBB179 X US26D
1 - Lockset Best 93K Series
1 - Closer LCN 4041 (optional)
Silencers GJ-64

Elevator and Fire Alarm Panel Keys

Specify locking hardware for elevators and fire alarm panels such that it can be operated with existing keys.

08 71 00: Finish Hardware Master Specification

PART 1 - GENERAL

1.01 SUMMARY:

A. Section Includes: Finish hardware except as otherwise specified or specifically omitted herein.

B. Related Sections:

1. Section 06200 - Finish Carpentry: Installation of finish hardware.
2. Section 08100 - Standard Steel Doors and Frames.
3. Section 08210 - Wood Doors.
4. Section 08910 - Aluminum Storefront Doors & Frames
5. Section 16000 - Access Control System

C. Specific Omissions: Hardware for the following is specified or indicated elsewhere.

1. Windows
2. Cabinets of all kinds, including open wall shelving and locks.
3. Signs, except as noted.

4. Toilet accessories of all kinds including grab bars.
5. Installation.
6. Rough hardware.
7. Folding partitions, except cylinders where detailed.
8. Sliding aluminum doors.
9. Angle sill threshold.
10. Corner guards.

D. References / Industry Standards: Hardware specified in this section subject to compliance of the follows agency:

1. NFPA-80 Standard for Fire Doors and Windows.
2. NFPA-101 Life Safety Code.
3. ADA – The American with Disabilities Act – Title III – Public Accommodations.
4. UL – Underwriter's Laboratories.
5. WHI – Warnock Hersey International.
6. ANSI / BHMA – American National Standards Institute / Builders Hardware Manufactures Association.
7. State and Local Codes, including the "Authority Having Jurisdiction".
8. DHI – Door and Hardware Institute

1.02 SUBSTITUTIONS & SUBMITTAL

A . Items listed with NO SUBSTITUTE have been requested by University to match existing products. No alternate products will be considered for review, provide products as specified.

B. SUBMITTALS: Submit, for review, six (6) complete copies of the finish hardware schedules within three (3) weeks after the hardware supplier receives the purchase order. Organize schedule into "Hardware Sets" with an index of doors and heading, indicating complete designations of every item required for each door or opening. Include the following information:

1. Type, style, function, size, quantity and finish of each hardware item.
2. Name, part number and manufacturer of each item.
3. Fastenings and other pertinent information.
4. Location of hardware set cross referenced to indications on drawings both on floor plans and in door schedule.
5. Explanation of all abbreviations, symbols, and codes contained in schedule.

6. Mounting locations for hardware.

7. Door and frame sizes and materials.

8. Submit manufacture's technical data and installation instructions for the electronic hardware.

9. Catalog cuts.

10. Submit any samples necessary, as required by the Architect/Owner.

C. Templates: Where required, furnish hardware templates to each fabricator of doors, frames and other work to be factory-prepared for the installation of hardware.

1.03 QUALITY ASSURANCE:

A. Qualifications:

1. Obtain each kind of hardware (latch and locksets, exit devices, hinges, and closers) from only one manufacturer, although several may be indicated as offering products complying with requirements.

2. Hardware supplier to be a qualified, Factory Authorized, direct Contract Hardware Distributor of the products to be furnished. In addition, the supplier to have in their regular employment an certified Architectural Hardware Consultant (AHC) who will be made available at reasonable times to consult with the Owner, Architect, and/or Contractor regarding any matters affecting the finish hardware on this project.

3. The hardware supplier should maintain an office and warehouse within a sixty-five (65) miles radius of the job and maintain an inventory and field service staff in order to service the project properly.

4. Pre-Installation Conference for Finish Hardware and/or Electronic Hardware: Prior to installation of the hardware, the hardware consultant shall arrange a conference between the contractor, installers and related trades to review materials, procedures and coordinating related work.

B. Schedule Designations: Except as otherwise indicated, the use of one manufacturer's numeric designation system in schedules does not imply that another manufacturer's products will not be acceptable, unless they are not equal in design, size, weight, finish function, or other quality of significance. See 1.02 A for substitutions.

C. Exit Doors: Openable at all times from the inside without the use of a key or any special knowledge or effort.

D. Fire-rated openings: Provide hardware for fire-rated openings in compliance with NFPA Standard No. 80. This requirement takes precedence over other requirements for such hardware. Provide only such hardware which has been tested and listed by UL for the type and size of door required, and complies with the requirements of the door and the door frame labels. Latching hardware, door closers, ball bearing hinges, and seals are required whether or not listed in the Hardware schedule.

1. Where panic exit devices are required on fire-rated doors, provide supplementary marking on door UL label on exit device indicating "Fire Exit Hardware."

1.04 DELIVERY, STORAGE, AND HANDLING:

A. Acceptance at the Site: Individually package each unit of finish hardware complete with proper fastening and appurtenances, clearly marked on the outside to indicate contents and specific locations in the Work.

B. Deliver packaged hardware items at the times and to the locations (shop or field) for installation, as directed by the Contractor.

1.05 PROJECT CONDITIONS:

A. Coordination: Coordinate hardware with other work. Furnish hardware items of proper design for use on doors and frames of the thickness, profile, swing security and similar requirements indicated, as necessary for the proper installation and function, regardless of omissions or conflicts in the information on the Contract Documents.

B. Upon request, check the Shop Drawings for doors and entrances to confirm that adequate provisions will be made for the proper installation of hardware.

1.06 WARRANTY:

A. Provide written guarantee from hardware manufacture, as well as hardware supplier, as follows:

1. Locksets: Five (5) years
2. Exit Devices: Five (5) years
3. Closers: Ten (10) years
4. Electronic closers: Two (2) years.
5. All other Hardware: Two (2) years.

Warranty shall commence with substantial completion of the project.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Approval of manufacturers other than those listed shall be in accordance with paragraph 1.02 A, except for items marked No Substitute.

Item:	Manufacturer:	Approved:	Approved
Hinges	Hager	Stanley	Mckinney
Locks	Best	No Substitute	
Cylinders/Cores/Keys	Best	No Substitute	
Closers	Ryobi	LCN	Sargent
Exit Devices	Precision	Von Duprin	Sargent
Keyed Removable Mullion	Precision		Von Duprin Sargent
Pulls	Rockwood	Hager	Ives
Silencers	Rockwood	Hager	Ives
Kickplates	Rockwood	Hager	Ives
Stops	Rockwood	Hager	Ives
Key Cabinet	Lund	Telkee	
Thresholds	National Guard	Zero	Pemko
Seals/Sweeps	National Guard	Zero	Pemko

B. Furnish all items of hardware required to complete the work in accordance with specifications and plans.

C. Carefully inspect Project for the extent of the finish hardware required to complete the Work. Where there is a conflict between these Specification and the existing hardware furnish finish hardware to specification.

2.02 MATERIALS:

A. 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” deep box construction, and have sufficient length to clear trim and protect clothing.

1. Lock Series, Design and Finish: Best 93K7 15D x 626
2. Cores / Cylinders: Best 7-Pin with “Premium” Keyway to match existing system.

B. 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" in width. All hinge open widths shall be 4.5" 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.

1. Furnish 3 hinges per leaf to 7 foot 6 inch height. Add one for each additional 30 inches in height or fraction thereof.
2. Provide hinges as listed in schedule.

C. 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.

1. 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.

2. Exit Device Series: Von Duprin 99 series rim with cylinder dogging (CD) at narrow stile aluminum door openings. Omit CD at fire rated doors.

3. Keyed Removable Mullions: Von Duprin 99 series rim. Mullion shall be furnished with a cylinder keyed into the existing GMU keying system.

4. Heavy Duty Lever Trim: Von Duprin 99 series rim. Vandal Resistant Lever Trim.

D. . 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.

1. Closer Series: Ryobi D-4550 / D-4551 Forged Heavy Duty Arm (HDA)
2. Provide multi-size 1 through 6 at all doors rated or not.
3. Exterior and high frequency openings to receive D-4550 Series with HDA.
4. Interior and low frequency openings to receive D-3551 Series with HDA.

5. All closers shall be R14 die cast aluminum alloy material.
6. Flush transom offset brackets shall be used where parallel arm closers are listed for doors with fixed panels over.
7. Drop brackets are required at narrow head rails.
8. 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.
9. All closers shall come standard with barrier free feature and all weather fluid.

E. 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.

G. 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.

H. Screws: All exposed screws shall be Phillips head.

I. Silencers: Furnish silencers on all interior frames, 3 for single doors, 2 for pairs. Omit where any type of seals occur.

2.03 FINISH:

A. Generally to be BHMA 626, Satin Chrome Finish.

1. Protection Plates, Push, Pulls shall be BHMA 630, Stainless Steel Finish.

B. Unless otherwise noted, spray door closers to match other hardware.

C. Aluminum items shall be finished to match predominant adjacent material. Seals to coordinate with frame color.

2.04 KEYING REQUIREMENTS:

A. All keyed locksets and cylinders shall 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 the University permanent Best keying system or furnished on the same keyway (or key section) as the University permanent Best keying system. Permanent Best cores and keys shall be prepared according to the approved keying schedule and will be furnished to GMU by the local Best factory representative, prior to occupancy.

B. All cylinders shall 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.)

C. 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."

D. Furnish keys in the following quantities:
1. Zero (0) each Grand Masterkeys
2. Zero (0) each Masterkeys per set
3. Four (4) each Change Keys each keyed core
4. Zero (0) each Permanent Control key
5. Nine (9) each Construction Keys
6. One (1) each Construction Control key
7. Two hundred (200) key blanks

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.

E. The Owner, or the Owner's agent, 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.

F. Keying schedule: Submit three copies of separate detailed schedule indicating clearly how the Owner's final instructions on keying of locks has been fulfilled.

2.05 KEY CABINET:

A. 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.

PART 3 - EXECUTION

3.01 HARDWARE LOCATIONS:

A. Hinges:

1. Bottom Hinge: 10 inches from door bottom to bottom of hinge.
2. Top Hinge: 5 inches from door top to top of hinge.
3. Center Hinge: Center between top and bottom hinge.
4. Extra Hinge: 6 inches from bottom of top hinge to top of extra hinge.

B. Lock: 38 inches from finished floor to center of lever or knob.

C. Push Bar: 44 inches from bottom of door to center of bar.

D. Push Plate: 44 inches from bottom of door to center of plate.

E. Pull Plate: 42 inches from bottom of door to center of pull.

F. Exit Device: 39-13/16 inches from finished floor to center of pad.

G. Deadlock Strike: 44 inches from floor, centered.

3.02 INSTALLATION:

A. Hardware is to be installed by experienced finish hardware installers only.

C. Install finish hardware in accordance with the approved hardware schedule, the manufacturers' printed instructions and in accordance with Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames, by the Door and Hardware Institute. Prefit hardware before finish is applied; remove and reinstall after finish is complete and dry. Install and adjust hardware so that parts operate smoothly, close tightly, and do not rattle.

C. Installation shall conform to local governing agency security ordinance.

3.03 ADJUSTING:

A. Adjust and check each operating item of hardware and each door to ensure proper operation or function of every unit. Replace units which cannot be adjusted to operate freely and smoothly.

B. Inspection: Hardware supplier shall inspect all hardware furnished within 10 days of contractor's request and include with his guarantee a statement that this has been accomplished. Inspector or Contractor shall sign off the hardware as being complete and correctly installed and adjusted. Further corrections of defective material shall be the responsibility of his representative.

3.04 SCHEDULE OF FINISH HARDWARE:

A. Legend of listed manufacturers:

HA Hager
BE Best
PR Precision
RY Ryobi
NG National Guard
RO Rockwood

B. The items listed in the following "Schedule of Finish Hardware" shall conform throughout to the requirements of the foregoing specification. The last column of letters in the Hardware Schedule refers to the manufacturer abbreviation listed above.

C. The Door Schedule on the Drawings indicates which Hardware Set is used with door.

3.05 ACCESS CONTROL SYSTEM:

A. Coordinate the preparation of doors and frames with the University access control system
shall be the responsible of the door/frame/ hardware distributor. Doors and frames scheduled to receive access control devices shall be preparation at the factory to accept the hardware listed in the hardware sets, and, in other noted spec section.

3.06 HARDWARE SETS:

Special Note: Architect / Hardware Consultant, please insert hardware sets as necessary for project, below:

Hardware Set 01

Each opening shall have:

08 74 00: Access Control Hardware

08 74 13: Card Key Access Control Hardware

1. Card Access Control (CAC) systems shall be specified for all building entrances at a minimum, and meet the following criteria:

   A. The University uses Best Access Systems. CAC system shall be low voltage, flexible and expandable. It shall employ state of the art digital and coding technologies, be designed and manufactured for high speed processing and maximum reliability. It shall be of modular design capable of interfacing with IBM or compatible type PC's.

   B. Software programs employed in the system(s) shall be capable of controlling from one (1) to eight hundred (800) access points per site. All access attempts are to be recorded, printed and/or displayed at the operator's option.

   C. The CAC system shall be designed to operate in automatic and command programming modes, respond to alarm generated reports and modify the data

base configuration with all activities available to be stored, printed or displayed at the operator's option.

2. Operator interface with the system shall be through a video display monitor and/or automatic printer and/or IBM or compatible type PC's. Monitor displays and printed information shall use clear, complete English language descriptions and shall not require the operator to interpret numeric or coded data.

3. If a card key access control system is required for the building interior, specific specifications may be obtained from the Project Manager.

4. The card key system shall be coordinated with the University Security Systems Manager.

5. Insure metal studs do not interfere with magnetic card readers.

End of Section

Division 9: Finishes

RECENT REVISIONS:

09 51 00, #6 Acoustical Ceilings ..... Added requirement for ceiling to be moisture resistant.

09 68 00, #3 Carpeting..... Added requirement that back of carpet be impervious.

09 00 00: Finishes

09 05 00: Common Work Results for Finishes

1. Extravagant, costly and/or high maintenance finishes should be avoided.

2. The University must approve the color selections of all finishes.

3. Finishes that have minimal tolerances and place unrealistic expectations on the installing contractor(s) should be avoided.

4. The following is a general guideline for finishes in various locations. This is offered a suggestion only and is subject to the A/E's judgment and the specific building requirements.

a. Offices: Carpet.
b. Seminar and conference rooms: Carpet.
c. Library and reading rooms: Carpet.
d. Restrooms: Ceramic tile, dark colored grout. Dark grout and ceramic tile covered base should extend up walls at least 4".
e. Classrooms: Vinyl composition (VCT).
f. Corridors: Terrazzo or VCT. Carpet may be used on upper floors in buildings where spills are not anticipated.
g. Lounges: VCT unless no vending area nearby, in which case carpeting may be considered.
h. Stairs: Terrazzo or rubber tile.
i. Laboratories: Seamless Epoxy or Sheet Vinyl (vinyl tile is prohibited).
j. Entrances and Vestibules: Pedigrid/pedimat for recessed and on-surface areas (recessed preferred).
k. Lobbies: Terrazzo, Ceramic Tile or VCT.
l. Multi-Purpose Rooms: Wood flooring.
m. Janitor's Closets: Ceramic tile with 4" base and dark colored grout,

5. Special attention shall be given to flame spread ratings of all finishes. All materials shall be specified with flame spread requirements. Require the Contractor to indicate the actual ratings on all submissions.

6. 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).

7. 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).

8. Where floor coverings meet building expansion joints, details will be provided to ensure smooth transitions occur 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.

9. For ceilings, use tile in lieu of gypsum board when possible for better maintenance access.

09 30 00: Tiling

09 30 13: Ceramic Tile

1. Floor Tile: 2" x 2" porcelain ceramic tile equal to Dal-Keystone Porcelain Ceramic Mosaics by Dal-Tile Corporation. Standard Grade quality conforming to ANSI 137.1-1980.

2. Wall Tile: 4-1/2" x 4-1/2" glazed ceramic tile equal to Dal-Tile Glazed Interior Wall Tile by Dal-Tile Corporation. Standard Grade quality conforming to ANSI 137.1-1980.

3. Ceiling Tile: Ceramic panels, 2' x 2' x 5/8" high density, resistant to moisture, steam and chemicals, equal to Ceramaguard 601A by Armstrong.

09 30 16: Quarry Tile

Quarry Tile Care: In instances where quarry tile is specified as the building floor covering, the Contractor will clean the quarry tile floor with Hillyard Seal - 341 or approved equal. Colors selected shall minimize the showing of dust and/or footprints.

09 50 00: Ceilings

09 51 00: Acoustical Ceilings

1. Do not use “accessible concealed spline” ceilings. Such materials may only be used where acoustical materials are directly adhered to the underside of concrete slabs and as approved by the Project Manager.

2. For suspended ceiling systems, ceiling grids, runners and tees shall not be less than 15/16” wide in profile.

3. Specify standard ceiling tiles not requiring special order or premium price.

4. Acoustical Tile: 2' x 2' 5/8", non-directional, mineral board lay-in panels, equal to Armstrong #770 or Clotex #157 Safetone, fissure tone.

5. Suspended Grid: 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.

6. Ceilings must be moisture resistant

09 60 00: Flooring

1. Provide section details of expansion/control joints and for all locations where different types of finish floor materials meet.

2. Specify the type of floor sealer and wax to be used by the contractor at building turnover.

09 65 00: Resilient Flooring

1. Avoid use of fissured, or ribbed or otherwise textured vinyl composition or rubber tile, unless slip resistance is important.)

2. Select color and finish to make imperfections less noticeable. High gloss application tends to show too much of the floor imperfections.

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.

09 68 00: Carpeting

1. Notarized Statement from Manufacturer: All carpeting and assembly (including padding) shall be certified to have a minimum flame spread and smoke developed rating that meets the requirements of the VUSBC.

2. Color: see PART II – FACILITIES AND SPACES, Master Plan, Color.

3. Back of carpet must be impervious. Cleaning solutions and water must not remove glue holding carpet down.

09 90 00: Painting and Coating

1. Specify eggshell paint in lieu of flat paint.

2. See 15075 for mechanical identification

End of Section

Division 10: Specialties

RECENT REVISIONS:

General …….. Reorganized into sections 10 10 00
Information Specialties, 10 14 00
Identificatio Devices, 0010 20 00 Interior

	Specialties, 10 40 00 Safety Specialties, and 10 70 00 Exterior Specialties.
10 21 13, Toilet Partitions ……	Added requirement for lockable non-vandal hardware screws.

10 10 00: Information Specialties

10 11 00: Visual Display Boards

10 11 13: Chalkboards

Vitrasite, standard black with trim, chalk rails and track for map hooks. Sliding boards to allow for greater flexibility. Chalkboards should be specified only when specifically requested by the University.

10 11 16: Markerboards

Dry marker boards are preferred.

10 11 23: Tackboards

Tack Boards – Above or adjacent to chalk boards

10 14 00: Identification Devices

Exterior Signage

Site planning concepts should include suggested exterior signage locations. Typically, no signage is attached directly to the exterior of a building, in conformance to the Campus Master Plan. A construction sign cannot be a requirement of the contract documents. Should the contractor choose to have a construction sign, the sign must conform to the requirements set forth by the university.

Interior Signage

1. Interior signage for all Capital Improvements Projects will be listed on a schedule provided by the A/E to the University.

Signage Sample:

Manufacturer: New Hermes, all components

Frame: 6" x 6" #743-536

Braille Panel: Gray #271-226 2.220" x 5.930"

Braille: Routed 1/2" tall strip, Dots: .239" tall

White Gravotac Numerals .8" Tall, 1/32 thick, Helvetica Med.

Name Panel: Red # 248-226 3.711" x 5.930" Name: .4" tall

10 20 00: Interior Specialties

10 21 00: Compartments and Cubicles

10 21 13: Toilet Partitions

Toilet partitions shall be ceiling hung or wall hung. In either case, adequate structure shall be employed to prevent sagging and warping. Will have non-vandal Hardware Screws lockable

10 28 00: Toilet, Bath, and Laundry Accessories

10 28 13: Toilet Accessories

1. Toilet Tissue Dispensers: Provided by the University.

2. Roll-Towel Dispensers: Provided by the University.

3. Soap Dispensers: Provided by the University.

4. Sanitary Dispensing Vendors: Rochester Midland Model J2 White Enamel Metal 14 3/4" w 6 1/2" d x 20"d x 20"h, or approved equal.

5. Consider the need for baby changing areas in the entry level Men's and Woman's bathrooms.

6. Electric Hand Dryers: N/A.

10 40 00: Safety Specialties

10 44 00: Fire Protection Specialties

10 44 13: Fire Extinguisher Cabinets

1. Break-glass faced fire extinguisher cabinets are prohibited. Use solid cabinet with small window made of polycarbonate or other plastic glazing to verify the presence of fire extinguisher and sized to accommodate the extinguisher size stated above.
2. Bottom of cabinet shall be mounted a minimum of 16" and no higher than 48" above floor.
3. Fire extinguishers cabinets shall be incorporated into all projects as required by code.

10 44 16: Fire Extinguishers

1. Use 5 pound ABC type extinguishers. This allows 75 feet travel distance for Class A light hazards. .

2. Fire extinguishers shall be incorporated into all projects as required by code.

10 70 00: Exterior Specialties

10 75 00: Flagpoles

Coordinate flagpole placement with the University.

End of Section

Division 11: Equipment

RECENT REVISIONS:

11 53 13, #3M Fume Hoods ……. Added halogen and LED as acceptable light fixtures.

11 40 00: Food Service Equipment

The A/E shall use the services of a food service equipment specialist in preparation of kitchen areas and other food preparation areas when required in the building. Such areas shall be designed in close coordination with the University food service personnel.

11 50 00: Educational and Scientific Equipment

11 53 00: Laboratory Equipment

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 GMU.

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 GMU. 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 GMU 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. All autoclaves shall have a floor drain installed under them capable of handling the discharge.
2. A Stainless Steel drip pan will be installed 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. Eyewash units shall be installed 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. Safety showers are to be installed in a conspicuous location, within the space generating the requirement. They must be 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. Safety showers must be installed in locations that are clearly marked and accessible at all times.

2. Safety showers are to be installed 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.

End of Section

Division 12: Furnishings

RECENT REVISIONS:

12 21 00, Window Blinds …….. Added requirement for window blinds to be painted steel.

12 20 00: Window Treatments

12 21 00: Window Blinds

Horizontal blinds are preferred over vertical blinds. The A/E should allow for blinds in designing window heads, including but not limited to blocking. Only blinds which are lead free shall be specified. Blinds are to be painted steel.

12 30 00: Casework

12 35 00: Specialty Casework

12 35 53: Laboratory Casework

12 35 53.19: Wood Laboratory Casework

Materials: All material shall be clear of defects and discoloration. All casework surfaces exposed to view after installation including those behind glass doors shall be Oak. All casework not exposed to view after installation shall be hardwood plywood. Ends shall be oak hardwood plywood, 3/4" thick.

12 40 00: Furnishings and Accessories

1. Building furnishings including, but not limited to desks, chairs, tables, lockers, window treatments, lecterns, etc. shall be identified by the A/E but not included in the building contract.

2. The A/E shall provide to the University minimal specifications and a budget cost estimate for furnishings specified to be owner furnished.

12 48 00: Rugs and Mats

12 48 13: Entrance Floor Mats and Frames

12 48 13.13Entrance Floor Mats

1. GMU provides "walk off '' mats and shall be of the type which are easily picked up and moved for cleaning purposes. Mats should be recessed pedigrid wherever possible.

2. Design entryways to accommodate GMU provided mats.

12 50 00: Furniture

1. Building furnishings including, but not limited to, desks, chairs, tables, lockers, window treatments, lecterns, etc. shall be identified by the A/E but not included in the building contract.

2. Identify furniture of a higher quality than laminated.

3. The A/E shall provide to the University minimal specifications and a budget cost estimate for furnishings specified to be owner furnished.

4. Classroom chairs to be Piretti Upholstered Armless Chair #3516 from VCE.

12 56 00: Institutional Furniture

12 56 53: Laboratory Furniture

1. Furniture should be approved for laboratory work, i.e. chemical resistant, impervious and easily cleaned.

2. As a general rule, desks are discouraged in laboratories. When required, desk locations should be carefully selected to prevent accidents, spills or releases of toxic materials from endangering the occupants. Desk space design should be limited to laboratory work only.

3. The following manufacturers are preferred for laboratory furniture: Kewaunee, Fisher-Hamilton, VWR, Duralab, Labconco, NuLab

4. Sheet Metal furniture:

   A. Materials: sheet steel, cold rolled furniture stock. All gauges shall be U. S. standard.

   B. Gauges: drawer bodies, shelves, interior door panels, security panes, sloping tops shall be 20 gauge. Ends, backs, case tops and bottoms, bases, exterior door panels, and vertical posts shall be 18 gauge. Top front and intermediate rails, gussets, table legs, frames, leg rails, and stretchers shall be 16 gauge. Drawer suspensions, door and case hinge reinforcements, and L-shaped front corner gussets shall be 14 gauge. Table leg corner brackets and leveler gussets shall be 11 gauge.

   C. Construction:

      1) All exposed welds shall be polished smooth.

      2) Base units which are 3' and greater shall not have center support posts, cupboards to open full width. All units shall have adjustable leveling screws which can be accessed in the toe base.

      3) Drawers shall be full suspension type.

5. Wood Casework: See 12350, Specialty Casework, Wood Laboratory Casework

12 60 00: Multiple Seating

12 61 00: Fixed Audience Seating

Fixed seating, if requested, shall be included in the contract documents and be included in the A/E "design to" budget.

12 90 00: Other Furnishings

12 93 00: Site Furnishings

12 93 13: Bicycle Racks

Standard bicycle rack is The Ribbon ® Rack by AAA Ribbon ® Rack Co. (www.ribbonrack.com). See Part V for standard details. Dark green color Dupont 7498, size capacity as required.

12 93 43: Site Seating and Tables

12 93 43.13 Site Seating

1. George Mason University has adopted the following standard benches for use on the campuses noted. See Part V, Standard Details.

   Fairfax Campus
   Manufacturer: Custom Structures, Inc.
   Model: P18S (Pullman Series w/o back)

   Arlington Campus
   Manufacturer: Victor Stanley, Inc.
   Model: The "Dunkirk"

   Prince William Campus
   Manufacturer: Custom Structures, Inc.
   Model: P18S (Pullman Series w/o back)

2. All benches shall be placed on hard surfaces (concrete walks, plazas, etc.).

12 93 23: Trash and Litter Receptors

All exterior site receptacles shall be as follows:

1. Trash Receptacles

   All Campuses:

   Manufacturer: Victor Stanley
   Model: S-42, Ironsites – Bethesda Series or equal 36 gallon litter receptacle with 3/8" solid steel bars standard tapered spun-steel lid, 36 gal high density plastic liner, vs green color. See Part V, Standard Details.

   Parking Lots:

   Manufacturer: Parkside receptacles or equal
   Model: Landscape series, WR-34 with security chain, green

2. Snuffers (Cigarette urns)

All Campuses
Manufacturer: Provided by GMU.
Model:

End of Section

Division 13: Special Construction

13 30 00: Special Structures

1. All pre-engineered building specifications shall include a complete listing of structural requirements for the building including, but not necessarily limited to the following:

    - 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 indicated loading requirements and codes of authorities having jurisdiction.

3. Trailer structures must meet applicable codes for industrial facilities.

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. All tanks, steel or fiberglass, if installed shall be as approved by GMU. Tanks shall be installed with anchors, cathodic protection, and leak detection in accordance with manufacturer's instructions. Anchor system and tank beds shall be as approved by GMU.

End of Section

Division 14: Conveying Equipment (Systems)

14 20 00: Elevators

See the Construction and Professional Services Manual (CPSM) section 714.

1. Perform work in accordance with the following:

    - ANSI A117.1 Specifications for Making Buildings and Facilities Accessible to and Usable by Physically Handicapped People.
    - ANSI/ASME A17.1 – Safety code for Elevators and Escalators.
    - ANSI/UL 108 – Fire Tests of Door Assemblies

2. All elevators shall meet the requirements of the Virginia Barrier Free Sub code.

3. The following are University approved elevators:

    - Thyssen/Krupp
    - Otis Elevator
    - Schindler
    - Esco Elevators, Inc.

4. Electrical provisions for elevators:

    a. Power wiring shall be run to the elevator line terminals and a circuit breaker line switch provided adjacent to elevator controller.

    b. An emergency circuit to mid-point of the hoist way shall be provided in each elevator pit.

    c. A light, light switch and convenience duplex receptacle shall be provided in each elevator pit.

5. Submittals:

    A. Require the Contractor to provide, at completion of installation, as-built installation information on reproducible mylar drawings indicating the control wiring, motor data, and all pertinent elevator information necessary for maintenance purposes.

    B. Submittals shall include shop drawings, schematic wiring diagram, product data and maintenance manuals.

    C. Maintenance manuals are required and shall minimally include operating and maintenance instructions, parts listing, recommended parts inventory listing, purchase source listing for major and critical components, and emergency instructions. Provide two sets of maintenance manuals for the Owner's use after approval of all shop drawings.

    D. Contract documents shall require a letter from the elevator manufacturer (on manufacturer's letterhead) verifying that the manufacturer acknowledges and will comply with all requirements of the specifications relative to repair and maintenance tools. Specifically, the letter shall include language that acknowledges the acceptance of the following:

1) 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 parameter 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 microprocessor system. The Owner shall not be required to sign licensing agreements related to the use of maintenance or repair tools.

2) It is the intention of the Owner to obtain competitive bids for all maintenance and repair services and material for the elevator provided. Accordingly, the use of proprietary equipment or equipment requiring the use of any proprietary items throughout the life of the equipment is unacceptable. In addition, 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.

6. All key switches used in the hallway or inside the elevator should be on the University 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).
7. Hydraulic Elevators

   A. Require double wall hydraulic piston casings on hydraulic elevators with waterproof seals at pit floor, and with waterproof, high pressure seal at bottom of casings.

   B. Jack cylinder shall be installed inside a PVC pipe. (The PVC jacket is helpful in preventing corrosion to the jack cylinder which shall be provided with dielectric protection. If the jack leaks underground, the PVC jacket helps to contain the hydraulic oil).

   C. Install piping above ground where possible. If necessary to route underground, cover with permanent protective wrapping before backfilling. Provide shut off valve in machine room for maintenance purposes. Underground hydraulic piping for elevators shall be schedule 80.

8. Control System:

   A. The elevator manufacturer / vendor shall provide a new control system with all required functions including, but not necessarily limited to call allocation, logic functions, door control, speed sensing / position, all with microprocessor operation. The control system shall not require the use of any proprietary or specialized manufacturer diagnostic tools for purposes of trouble shooting and / or repair. No hand held tools (data entry devices) will be acceptable for diagnostic or adjusting use. The manufacturer will turnover to the University all tools / devices required for the

maintenance of the elevator including equipment to reprogram software source codes at no extra cost to the University at the completion of the project.

B. All software, diagnostic, adjustment / tune-up manuals and documentation and any other documentation required for the maintenance of the elevator including tools or devices necessary to reprogram the software source codes shall be provided to the University for approval prior to commencement of the installation of the elevator equipment. Once provided, no substitution of the equipment described in the manuals and documentation will be acceptable.

C. All printed circuit boards shall be available to the University for purchase as spare parts in any quantity deemed reasonable by the University. Overnight delivery of printed circuit boards must be available for emergency repairs. Printed circuit boards will be accompanied by all pertinent documentation for installation and use. All components of the elevator must be commercially available from standard parts suppliers.

9. Warranty and Maintenance

A. Elevator manufacturers shall provide a one-year warranty for all service and maintenance during a one-year period after acceptance. Require the Contractor to submit monthly service reports to the University during warranty period.

B. Full maintenance shall be provided by skilled, competent employees of the elevator Installer for a period of 12 months following Date of Substantial Completion at no additional cost to the Owner. Full maintenance services to be included under this contract and at no additional cost to the Owner shall minimally include (1) monthly preventive maintenance performed during normal working hours, (2) repair or replacement of worn or defective parts or components, (3) lubricating, cleaning, and adjusting as required for proper elevator operation in conformance with specified requirements and (4) 24-hours-per-day, 7-days-per-week emergency callback service. Exclude only repair or replacement due to misuse, abuse, accidents, or neglect caused by persons other than Installer's personnel.

C. Response times:

a. Traps - 1 hour
b. Repairs – 2 hours

10. Install a ladder, stop switch, a light and a sump pit in the elevator pit. Sump pump (provided under Division 15) may be required where there is a problem with water.

11. Provide a malfunction signal to the controller which will indicate when the elevator is out of order. The University will take the responsibility of transmitting this signal from the controller to its emergency maintenance system. Auxiliary contacts shall be provided by the Contractor to achieve this function.

12. If the elevator is a hydraulic elevator, the motor starters shall be one size larger than recommended due to their frequent starting and stopping.

13. The design of hydraulic elevator machine rooms should be such as to provide for proper environmental conditions to prevent overheating or congealing of the oil.

14. When elevator machine rooms are adjacent to offices and/or classrooms, provide adequate sound insulation.

15. Provide security mirrors in all passenger elevator cabs.

16. Provide elevator access to penthouse mechanical spaces.

17. Contractor to provide cab protective pads.

18. Telephone

    A. All passenger elevators shall have an emergency speaker phone, as manufactured by Rath-Micro Tech or approved equal.

    B. The emergency telephone will be furnished by the Owner. A 6" x 8" recessed cabinet with door, between 19" and 48" above the cab floor, shall be indicated on the shop drawings. Conduit for the telephone shall be installed by the contractor.

    C. Provide conduit for analog telephone wiring from the telephone backboard to the elevator controller. Power for the elevator telephone must be on an emergency circuit.

19. Elevators shall be integrated with the fire detection system and contain both an ADA compliant visual alarm device, and an automatic return to lobby and shutdown feature in the event of fire detection.

20. Elevators shall have vandal resistant controls and finishes such as heavy-duty stainless steel finish on panel and hard-to-damage cab wall treatment. Residence Hall elevators shall have stainless steel cab interiors and vandal resistant hall call stations, light fixtures, car stations, position indicators, etc.

21. Prior to Owner acceptance of the installation, an inspection must be performed and acceptance tests must be witnessed by an independent elevator inspector to verify conformance of elevators and chair lifts with code requirements. The Owner shall employ the services of an independent elevator inspector. Any deficiencies shall be corrected by the contractor at no cost to the Owner. Owner requires three weeks notification prior to testing to schedule inspector.

22. Elevator equipment rooms shall not be used for access to roofs or other parts of the building unless elevator equipment is fenced or walled in.

23. Traction-type elevators shall have machinery located overhead.

24. Elevator pits shall have sump pumps and adequate drains to prevent the accumulation of water. Drains shall not be connected to building sewers.

25. Elevator cab floors shall be rubber floor tile with "lo-disc" raised circular design for a non-slip surface. Acceptable manufacturers include Roppe Rubber Co., Johnsonite and Musson Rubber Co.

26. Provide a sweep on the machine room door to provide of dust protection.

27. Provide all signage as required by applicable codes.

28. Elevators shall be provided with a full ray electronic door detection device. Devise shall project detection beams across the full car entrance from the floor to a 72 inch minimum height. When interrupted at any point, the device shall cause closing doors to stop and reopen and enact an alarm buzzer. The doors shall again attempt to close unless the detection beam is activated in which case the doors will reopen. The process shall repeat continuously until the obstruction is removed from the entrance. Provide a keyed switch in the car operating panel or a toggle switch in the service cabinet that will disconnect the electronic detection device.

14 40 00: Lifts

14 42 00: Wheelchair Lifts

Chairlifts shall require keys for operation.

End of Section

Division 21000: Fire Suppression

21 00 00: Fire Suppression

1. For information on Fire Extinguishers see Div. 10 44 00 Fire Protection Specialties.

2. In buildings with sprinklers, fire pumps and/or standpipes, separate water service for fire protection shall be provided, and shall not be through the domestic metered water service.

3. Provide water curtains in lieu of fire shutters.

4. Control Valves:

   A. 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.

B. 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).

C. 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.

D. Control valves shall not be installed, above or below ceilings in classrooms, offices, conference rooms or any dormitory living quarters.

E. Each control valve shall be supplied with a sign indicating the area of the building that is served by the valve.

5. Inspector Test Valves:

A. 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.

B. 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.

C. 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.

D. 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.

6. Drain Valves:

A. 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.

B. 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.

7. Main drains discharge shall be piped to the exterior of the building.
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.

8. All fire protection systems shall be approved by DEB and shall conform to Factory Mutual (FM) standards. All equipment shall bear a FM label where appropriate.

9. The A/E shall provide a complete set of drawings and specifications which can be approved for compliance with the Virginia Uniform Construction Code by the authority having jurisdiction. The A/E shall design the sprinkler system and provide FM and the University with all calculations.

10. Reference Standards: Installation of automatic sprinkler systems for fire protection shall comply with the following standards:

    A. NFPA No. 13, Installation of Sprinkler Systems

    B. Factory Mutual Data Sheet 2-8N, Installation of Sprinkler Systems

    C. BOCA National Building Code, the Virginia Fire Protection Subcode

11. Design Density:

    A. Design densities for hydraulically calculated sprinkler systems shall comply with the following standards (review with F.M. for any changes):

Classrooms and offices	0.15 gpm/sq. ft., 2000 sq. ft area
Laboratories	0.15 gpm/sq. ft., 2500 sq. ft area
Dormitories, Apartments	0.10 gpm/sq. ft., 3000 sq. ft area

    B. Hose stream allowances shall be provided for each system, and shall be not less than 150 gpm for interior hose stream and 250 gpm for outside hose stream. The interior hose stream location, for the purpose of hydraulic calculation, shall be at the hose valve nearest to the riser supplying that floor. In buildings not equipped with a combined fire standpipe/sprinkler riser, the interior hose stream allowance may be deleted.

12. Flow Velocity: The maximum permissible flow velocity through automatic sprinkler piping shall be 20.0 feet per second.

13. Minimum Pressure: The minimum starting pressure at the most remote sprinkler head shall be not less than 7 psi.

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. Equipment Type Acceptance: All sprinkler heads, valves, fittings and appurtenances shall be Factory Mutual approved types and shall bear the Factory Mutual acceptance label. All main control valves shall be provided with tamper contacts for connection to the building fire alarm system.

16. 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.

17. Inspections and Tests:

    A. All new systems shall be hydrostatically tested at not less than 200 psi pressure for 2 hours. The test pressure shall be read from a gauge located at the low elevation point of the individual system being tested. The inside sprinkler piping shall be installed in such a manner that there will be no visible leakage when the system is subjected to the hydrostatic pressure test.

    B. All sprinkler heads, valves, fittings and other appurtenances shall be installed prior to conducting the final hydrostatic test which shall be witnessed by the University Facilities Construction Inspector or authorized designee.

    C. A Contractor's Material and Test Certificate for Aboveground Piping shall be completed and submitted, by the Contractor, to the University Facilities Construction Office and Factory Mutual Engineering.

18. 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.

19. Hydrants: see section 02080.

20. Standpipes shall be wet type without hose cabinets. Provide 2 1/2" x 1 1/2' removable valve capped connection at each floor.

21. Where dry or preaction systems are required, use standard wall galvanized pipe as approved by Factory Mutual. Preaction systems shall be used only when approved by the GMU Fire Marshal. These systems are not preferred.

22. Fire pumps on low rise buildings (buildings less than 3 stories) should not be used.

23. Buildings covered by BOCA high rise code in seismic areas shall be designed with a secondary source of water (10,000 gallon capacity or as required) and shall be as approved by Factory Mutual.

24. All fire pumps and sprinkler supplies from city water services shall be installed per city requirements. A/E must contact and coordinate with city officials and design all installations in accordance with their requirements.

25. Do not provide fire hoses. Also, all fire extinguishers will be provided by GMU.

26. Plain end pipe couplings should not be used in systems unless they are the positive locking type specifically approved by Factory Mutual for above ground sprinkler piping.

27. The design area for gridded sprinkler systems shall be the hydraulically most demanding "rectangular area" having a dimension parallel to the branch lines equal to 1.4 times the square root of the area of sprinkler operation corresponding to the density used.

28. To facilitate flushing of the sprinkler system, the ends of all cross mains should be provided with a threaded flushing connection no more than 2" in diameter.

29. Pipe hanger installation shall be in accordance with Factory Mutual Data Sheet 2-8N (NFPA #13).

30. A permanent placard should be provided at the base of each riser stating the design criteria of the system for hydraulically designed systems.

End of Section

Division 22000: Mechanical

RECENT REVISIONS:

22 00 00, #16 Mech. Gen'l Rqmts …..	Added flexible coupling requirements
22 05 16, #4 to 6 Expansion Comp....	Added piping expansion and contraction provisions.
22 05 23, #10 General Duty Valves …	Added grooved end valve section.
22 05 23, #13 General Duty Valves…	Added balancing valve specifications.
22 05 29, #5 Hangers and Supports ...	Added rigid and flexible coupling requirements.
22 11 13, #2 Pipes and Tubes …….	Added grooved pipe system use.
22 11 13, #5 Pipes and Tubes …..…..	Added grooved joint pipe specification.

22 00 00: Mechanical General Requirements

1. See the Construction and Professional Services Manual (CPSM) section 715.

2. 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.

3. Energy and resource conservation effectiveness shall be considered and documented. The GMU 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 tied into this system.

4. 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.

5. 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 on mylar with a CAD file.

6. The A/E shall be responsible for preparation and follow-up correspondence for all permitting required for fuel burning equipment.

7. Supply Air Requirements: At a minimum, outside air must be supplied to occupied spaces in accordance with ASHRAE 62-1989, Ventilation for Acceptable Indoor Air Quality. All laboratories, shops and studios where hazardous materials are used must be maintained under negative pressure with respect to areas of lower hazard (e.g. corridors, offices). Exhaust air from these areas of higher hazard must not be recirculated, and must be exhausted directly to the outdoors. Air intakes must be located in areas where they not introduce air pollutants into the building (e.g. away from loading docks, high traffic areas, emergency generator exhaust and exhaust from other buildings, etc.)

8. No roof top mechanical equipment shall be located closer than 10'-0" to a roof edge unless adequate guardrail protection (rail or parapet) is provided.

9. HVAC - Temperature Design Standards: see the Construction and Professional Services Manual (CPSM) section 715.A.2.

	Winter	Summer
Arlington	7^{o} F DB	91^{o} F DB/77^{o} F WB
Fairfax	7^{o} F DB	91^{o} F DB/77^{o} F WB
Prince William	10^{o} F DB	93^{o} F DB/77^{o} F WB

For cooling towers, use 78^{o} F WB design.

10. Sealants shall not take the place of welding of metal ducts.

11. Access for mechanical device installation, operation, and future maintenance is essential. Provide access doors for all VAV boxes. When access doors are specified, check with the Project Manager for need of locks.

12. Field verify HVAC system CFM values in existing buildings prior to renovation designs.

13. Encase all cleanouts and valve boxes located in lawn areas in a 1' x 1' x 6" concrete pad.

14. Provide piping to drain from WYE strainer blow down, backflow preventers, pressure reducing valves and any other equipment that automatically will release liquid or that requires regular flushing of debris.

15. Use flexible fittings at all piping connections to equipment such as pumps, AHU coils, VAV reheat, etc...

16. Victaulic Style 75 or 77 flexible couplings may be used in lieu of flexible connectors for vibration isolation at equipment connections. Three (3) couplings, for each connector, shall be placed in close proximity to the source of vibration (for temperatures to 230 deg F).

17. All suspended mechanical equipment shall have vibration isolation.

22 05 00: Common Work Results for Plumbing

15120: Piping Specialties

Sleeves

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 16: Expansion Compensation

1. Avoid using expansion compensators on Secondary Heating Water if possible. Use expansion bends (calculated) for pipe flexibility situations. If space is limited, bellows type can be used if approved by GMU.
2. Do not use bellows type expansion joints on HTHW. Flanged, slip type expansion joints are preferred.
3. Preferred manufacturer: Advanced Thermal Systems, Inc.
4. 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.
5. Install Victaulic in-line expansion joints in water piping systems that are installed in enclosures where pipe bends or loops cannot be applied:

a. 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®.
b. 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 19: Meters and Gages

1. Use bimetallic temperature indicators in 5" diameter case. Orient gage so that special flexible joint is not needed.

2. Use materials compatible with service for pressure indicators, temperature indicators and flow meters. Use diaphragm where needed.

3. Water Meters shall be included in the contract and installed in accordance with the City of Fairfax specifications.

22 05 23: General-Duty Valves for Plumbing Piping

1. USA made materials are preferable.

2. Include sufficient zone isolation/shut off valves in cold/hot water, heating hot water, chilled water, steam and other service piping to allow maintenance and replacement of terminal equipment without shutting down entire building.

3. Install valves on all lines that penetrate the floor from below.

4. Install valves on all branch lines off of main lines.

5. Install valves on all lines at locations such that each floor can be isolated independent of main building.

6. 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.

7. Install control valves where they can be reached from the floor where possible.

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

9. OS&Y valves are preferred.

10. Victaulic Grooved End Valves:

    A. Butterfly Valves

        1. 2" through 12" Sizes: 300 psi CWP at 250 deg F, suitable for bidirectional and dead-end service at full rated pressure. Body shall be grooved end black enamel coated ductile iron conforming to ASTM A536. Disc shall be electroless nickel plated ductile iron with blowout proof 416 stainless steel stem. Disc shall be offset from the stem centerline to allow full 360 degree seating. Seat shall be pressure responsive [EPDM] [Lubricated Nitrile] [Fluoroelastomer]. Valve bearings shall be TFE lined fiberglass, and stem seals shall be of the same grade elastomer as the valve seat. Valve shall be complete with ISO flange for actuation mounting. Valve operators shall be lever handle, gear operator with handwheel or automated with electric, pneumatic, or hydraulic operators. Victaulic Vic®-300 MasterSeal™.

        2. 14" through 24" Sizes: 300 psi CWP at 230 deg F, AGS grooved ends, polyphenylene sulfide (PPS) coated ductile iron body ASTM A-536, PPS coated ductile iron disc (ASTM A-536), and two piece 17-4 PH S/S stem design. Seat and seal material to suit intended service. Reinforced PTFE bearings and gear operator with handwheel or automated with electric, pneumatic, or hydraulic operators. Seat tested to MSS-SP-67. Bubble tight, dead-end, or bi-directional service. With memory stop for throttling, metering or balancing service. Victaulic AGS Vic®-300.

    B. Check Valves:

        1. 2” through 4” Sizes Horizontal Swing: Horizontal installation, ductile iron body, ASTM A-536, Grade 65-45-12, and Type 316 stainless steel clapper. Synthetic rubber bumper & bonnet seals suitable for intended service, stainless steel wetted parts, 300 psi CWP. Victaulic Series 712.

        2. 2-1/2” through 12” Sizes Spring-Loaded: Non-slam, silent type check valve with ductile iron body, ASTM A-536, Grade 65-45-12, aluminum bronze or elastomer coated ductile iron disc, PPS coated or welded-in nickel seat, 300 psi CWP. Victaulic Series 716 or Series 779 with venturi taps.

        3. 14” through 24” Sizes Dual Disc Design: Spring-loaded check valve with ductile iron body, ASTM A536, Grade 65-45-12, stainless steel disc, spring and shaft with EPDM seat bonded to the valve body, 230 psi CWP, AGS grooved ends. Victaulic Series W715.

11. Valves for high Temperature Water:

A. 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.

B. 1-1/2” and Smaller: Shall be 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.

C. 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.

D. 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.

E. 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.

F. 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 7500F. Valves shall be 1/2" size, Crane Co. or approved equal.

G. 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.

H. 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 7500F. Crane Co. or approved equal.

I. 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.

J. Control Valves
- HTHW – 2-way Flanged 300 lb. cast steel, 316 stainless steel trim, Fisher Type ES body, high pressure pneumatic actuator with positioner, if required.
- 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.
- HTHW – Control valve should be on Supply side for better temperature control.

- Use equal percentage contour plug. Preliminary sizing shall be based on 20 psi. pressure differential (verify with Project Manager).
- Valves shall be capable of closing off against a 100 psi pressure difference.

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

13. Balancing Valves are to be used as needed.
    A. 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.

    B. 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.

    C. Install a Series 78U union port fitting and Series 78Y strainer/ball valve combination to complete terminal hookup at coil outlet.

22 05 29: Hangars and Supports for Plumbing, Piping, and Equipment

1. 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.

2. All piping with insulation shall be supplied with saddles and rigid insulation at pipe hanger locations.

3. Seismic requirements must be considered as required.

4. Provide extra pipe supports for sterilizer piping.

5. 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.

22 05 53: Identification for Plumbing Piping and Equipment

1. Mark location of air handlers, fan coil units, mixing boxes, 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

Sleeves

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 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. For High Temperature Hot Water insulation (greater than 400^{o} F.) use 4" calcium silicate.
   a. For interior piping: canvas wrap, coated with Fosters 81-42w or equal and painted to match existing supply and return piping.
   b. For tunnel piping: wrap with an approved non-flammable moisture barrier. Aluminum jacket preferred.

5. Insulation specification shall describe what systems and services are to be insulated.

6. Internal insulation or lining of ductwork is prohibited unless approved by GMU.

7. Chilled water piping at the Central Heating and Cooling Plant (CHCP) shall be canvas wrapped.

8. For condensation control on interior Chilled water Supply and Return piping use the following thicknesses: Pipe sizes 1-1/2" and smaller use 1-1/2" insulation, pipe sizes greater than 1-1/2" use 2" insulation.

9. Condensate drains shall have 1" of insulation.

22 10 00: Plumbing Piping and Pumps

1. All welding of high temperature water systems shall be performed by welders certified in accordance with ASME Boiler and Pressure Vessel Code, for pressure piping, latest edition.

2. 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.

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'.

4. See Part V – Standard Details, HTHW Tunnel Detail, Fairfax Campus, HTHW Tunnel Top Details, HTHW Manhole Detail for information on HTHW tunnel and piping clearances.

5. Encase all key crocks, for chilled water building isolation, in a 1' x 1' x 6" concrete pad.

6. Do not run plumbing piping above telecommunication racks.

22 11 00: Facility Water Distribution

22 11 13: Pipes and Tubes

1. USA made materials are preferable.
2. "Victaulic" pipe will be allowed for heating hot water, condenser water and chilled water distribution piping and equipment connections in lieu of welded, threaded, or flanged methods. All grooved components and grooving tools shall be of one manufacturer.

   A. Pipe: Carbon Steel, A-53B/A-106B - Roll or cut grooved-ends as appropriate to pipe material, wall thickness, pressures, size and method of joining. Pipe

ends to be grooved in accordance with Victaulic current listed standards conforming to ANSI/AWWA C-606.

1. Victaulic Mechanical Couplings 2" through 12": Manufactured in two segments of cast ductile iron, conforming to ASTM A-536, Grade 65-45-12. Gaskets shall be pressure-responsive synthetic rubber, conforming to ASTM D-2000. Mechanical Coupling bolts shall be zinc plated (ASTM B-633) heat treated carbon steel track head conforming to physical properties of ASTM A-183 and A-449, minimum tensile strength 110,000 psi (758450 kPa) as provided standard Victaulic.

    a. Rigid Type: Coupling housings with offsetting, angle-pattern bolt pads shall be used to provide system rigidity and support and hanging in accordance with ANSI B31.1, B31.9, and NFPA 13.
        1) 2" through 6": Victaulic Style 107 QuickVic™ "Installation Ready" rigid coupling designed for direct "stab" installation onto grooved end pipe without prior disassembly of the coupling. Grade "EHP" with red color-code designed for temperatures to 250 deg. F.
        2) 2" through 12": Victaulic Style 07 (Zero-Flex®) standard rigid coupling with Grade "E" gasket with green color-code designed for temperatures to 230 deg F.
    b. Flexible Type: Use in locations where vibration attenuation and stress relief are required. Flexible couplings may be used in lieu of flexible connectors for vibration isolation at equipment connections. Three (3) couplings, for each connector, shall be placed in close proximity to the vibration source. Victaulic Style 75 or 77.

2. Victaulic Mechanical Couplings, 14" through 24": Manufactured in two segments of ductile iron conforming to ASTM A536, 65-45-12 cast with a wide key profile and flat bolt pads for metal-to-metal contact. Gasket shall be wide-width, pressure-responsive synthetic rubber of a FlushSeal® design, with plated steel bolts and nuts.

    a. Rigid Type: Provides a rigid joint that corresponds with support spacings as defined by ASME B31.1 and B31.9. Victaulic Style W07.
    b. Flexible Type: Allows for linear and angular movement, vibration attenuation and stress relief. Victaulic Style W77.

3. Victaulic standard and AGS grooved end fittings shall be ductile iron conforming to ASTM A536 or fabricated carbon steel conforming to ASTM A53, with factory grooved ends designed to accept Victaulic standard or AGS "W" series couplings.

4. Grooved Joint Flange Adapters: ASTM A536 ductile iron casting, flat faced, for incorporating flanged components with ANSI Class 125, 150 and 300 bolt-hole patterns to a grooved system. Victaulic Style 741, W741, or 743.

3. Materials for High Temperature Water Systems:

A. 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

B. 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.

C. Flanges (all sizes): 300 pound class, forged steel, welding neck type, ASA B 16.5 ASTM A 181 Grade I.

D. 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.

E. Strainers (all sizes): Y-type; same size as pipe in which they are installed. Strainers shall have cast steel bodies suitable for 425^{o} 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.

F. 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.

G. 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.

H. 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.

4. Dielectric waterway fittings shall be used with connecting piping of dissimilar metals.

5. Grooved joint piping systems shall be installed in accordance with the manufacturer's (Victaulic) guidelines and recommendations. The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service as specified. Gaskets shall be supplied by Victaulic. Grooved end shall be clean and free from indentations, projections and roll marks in the area from pipe end to groove. A Victaulic factory trained field representative shall provide on-site training to contractor's field personnel in the installation of grooved piping products. Factory trained representative shall periodically review the product installation. Contractor shall remove and replace any improperly installed products.

22 11 16: Domestic Water Piping

Provide frost proof wall hydrants every 50' on exteriors of new buildings. Model B65 series as made by Woodford Manufacturing. Inc. or approved equal.

22 13 00: Facility Sanitary Sewerage

22 13 16: Sanitary Waste and Vent Piping

1. Do not use plastic pipe materials above ground.

2. Hubless cast iron pipe is acceptable above grade (not acceptable below grade).

3. Install floor drains in all restrooms, centrally located with floor slightly sloped toward drain, 6" inlet with 2" outlet, chrome plated brass or nickel bronze.

4. Drain and waste lines in laboratories shall be selected for chemical resistance **and** for resistance where steam is used as a laboratory medium.

5. Encase all cleanouts and valve boxes located in lawn areas in a 1’ x 1’ x 6” concrete pad.

22 14 00: Facility Storm Drainage

22 14 13: Storm Drainage Piping

1. Provide at least 2 roof drains per section of reel. See Uniform Construction Code for additional requirements.

2. Encase all cleanouts located in lawn areas in a 1’ x 1’ x 6” concrete pad.

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. Other heating media shall be as approved by GMU.

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 Supply side for better temperature control.

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. Plumbing fixtures and fittings for laboratory furniture shall be provided by the laboratory furniture manufacturer.

4. See Division 11 53 33 for eyewash and safety showers.

22 42 16: Commercial Lavatories and Sinks

Service Sink

Locate sink in custodial closet. Floor mounted, cast iron or steel with baked enamel covering, acid/chemical resisting plastics, concrete or stone construction material with back splash; 28" maximum height from floor to rim, 24" x 24" (minimum size) with back splash; Faucet - vacuum breaker, integral stops, spout with pail hook and nose end, top single brace, renewable units and valve seats, equal to Eljer.

22 47 00: Drinking Fountains and Water Coolers

22 47 13: Drinking Fountain

1. Not recessed, wall mounted, surface mounted.

2. Provide "lead free" materials certification from drinking fountain manufacturer prior to installation.

End of Section

Division 23000: Heating Ventilating and Air Conditioning

Recent Revisions:

23 05 93, Testg Adjustg, & Balancg …Revised and added balancing requirements.

23 09 00, Instrumentation.& Control ...Revised and added instrumentation and controls requirements.

23 21 23, #4 HVAC Pumps …… Added pump suction diffuser requirements.

23 52 00, #4 Heating Boilers …….. Eliminated use of electric boilers.

23 65 00, # 9 Pckgd. Cooling Towers ..Added requirement for piping cooling tower drains to the sanitary sewer per code.

23 00 00: Heating, Ventilating, and Air Conditioning (HVAC)

23 05 00: Common Work Results for HVAC

23 05 93: Testing, Adjusting, and Balancing

1. In accordance with the submittal specifications and 01810, submit a synopsis of the testing, adjusting, and balancing procedures and proposed agenda.

2. In accordance with the submittal specifications, submit sample forms, if other than those standard forms prepared by the AABC or NEBB are proposed.

3. 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.

4. 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.

5. Report Contents:

a. 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.

b. 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.

6. 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.

7. Pre-balancing Conference: Prior to beginning the testing, adjusting, and balancing procedures, 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.

23 06 00: Schedules for HVAC

23 06 80: Unitary Air Conditioning Equipment

Window Air Conditioners

Window air conditioning units are not preferred by GMU and should be avoided. 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 Commissioning Office, Building Automation and Energy Management shops during the design phase.

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. 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.

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.

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 with Sitrans flow meters, demand control ventilation and provide peak demand limiting routines as determined by Owner. Monitor and alarm selected conditions for temperature, Pressure, Flow, damper position, cw/hw valve position, 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).

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 Sitrans 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.

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. VFDs will communicate remotely with the EMCS system via P1 communications and added to the EMCS with the proper unbundled points for control.

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:

   a. System name.

   b. List of devices with brief description of functional purpose of each.

   c. A description of the expected signal values transmitted by the sensor.

d. A description of the expected signal values transmitted by the controller to the control device or actuator.

e. A description of the expected signal values of the control device over its operating range.

f. A description of the instrumentation required to test the system.

g. A detailed description of the test.

h. 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.

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

    a. Verify the operation of the microcomputer operating system of the field panels. Demonstrate proper automatic restart of equipment after power restoration.

    b. 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

    c. Verify the operation through the use of a laptop connected to the Siemens Field Panel.

    d. 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.

    e. Verify the operation of the clock routine in the field panel.

    f. Demonstrate changing of default values of sensors by the use of a laptop connected to the Siemens Field Panel.

    g. Demonstrate proper system operation while set points and data are being modified.

    h. Verify operation of all terminal equipment controllers.

    i. Verify all graphics for accuracy and that they meet GMU 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

   a. 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.

   b. 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.

   c. 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.

Guarantee and Service

1. Instrumentation and control equipment shall be guaranteed in writing against defects in workmanship and defective materials for a period of one year after acceptance by the University.

2. Provide one year free repair or replacement on all instrumentation and control equipment and components during the guarantee period to include all material, programming, and color.

3. Emergency service: Mason will initiate service calls when the control system is not functioning properly. Qualified personnel shall be available to provide service to the completed control system. Siemens will furnish Mason with a telephone number where the service supervisor can be reached at all times. Service personnel shall be at the site within 4 hours after receiving a request for emergency service and remain on-site until the control system is restored to prior operating condition.

4. The contractor shall diagnose/troubleshoot via remote web access at no additional cost during the warranty period.

5. Response time for notification of problem shall be as follows: 2 hour remote web access diagnostics, 4 hour on-site assistance.

23 10 00: Facility Fuel Systems

23 11 00: Facility Fuel Piping

1. Use # 2 fuel oil type systems.

2. University gas systems are natural gas.

23 20 00: HVAC Piping and Pumps

23 21 00: Hydronic Piping and Pumps

23 21 13: Hydronic Piping

1. For chemical cleaning of all hydronic piping please use our term contractor,
   Water Chemistry, Inc
   3404 Aerial Way Dr.
   Roanoke, VA 24016
   540-343-3618
2. Medium temperature water systems are designed at 190^{o} F. Use 150# AISI design standards.

3. High Temperature Hot Water systems are designed at 400^{o} F. and 350 psig. Use 300 Lb. ANSI design standards and a 100 ^{o} F delta.

4. Chilled Water systems are designed at 42^{o} F to 55^{o} F. nominal temperatures. Use a 14^{o} F. delta and provide a 2-way flow control valve on the building main, located in the main mechanical room.

5. Dual temperature systems shall be designed for 100-190^{o} F., winter and 42^{o} F to 55^{o} F summer. Use A. O. Smith "green thread" or approved equal.

6. 4-pipe systems are preferable.

7. GMU prefers diaphragm-type compression tanks.

8. Triple duty valves are not acceptable.

9. Steel and copper pipe can be used for hydronic piping. Do not use plastic piping.

10. Flexible connection shall be installed at pumps only when directed by GMU or when acoustic consultant recommendations are accepted by GMU.

11. Hanger spacing for copper pipe shall be as follows:

Pipe Size	Hanger Spacing
1"	6 ft.
1-1/2"	8 ft.
2"	9 ft.
3"	10 ft.
4"	12 ft.

12. Do not use butterfly valves for throttling hydronic systems.

23 21 23: HVAC Pumps

1. Consult with GMU about pump selection philosophy. Limit speed to 1750 RPM. Any pumps handling HTW shall be selected with GMU's input. Industrial pumps may be required.

A. For small flows and low heads, in-line circulators may be used, this application is limited to zoned residential-type (or similar) systems and may include systems intended to prevent cold freeze-up. Typical limits are 80 GPM at 25 feet TDH.

B. Vertical in-line pumps may be used for systems similar to those described in the paragraph above where a larger system head exists. Typical limits are 3", 7-1/2 HP.

C. Base-mounted close coupled and separately controlled, end suction pumps shall be used when flows are between 100 and 500 GPM. The suction connection should be less than 4". Close coupled pumps should not exceed 10 HP and should not exceed 15 HP for the separately coupled pump. Base mount or separately coupled pumps should be of the back pull-out type.

D. Base-mounted, separately coupled double-suction, horizontal split-case type pumps should be used for connections 4" and larger. B&G VSC may be used. Consider vertical pumps, such as Aurora 413, where space is at a premium.

E. Selection should be made for high efficiency. Consideration of life cycle cost study of variable speed pumping should be made.

F. 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).

2. Vibration control is usually not needed when pumps are mounted on basement slab. All vibration controls need to be carefully examined. Pads, isolated from the slab may be acceptable. Inertia blocks need to be considered when the pump room is below an acoustically important room. Flexible connectors should also be minimized in use.
3. Secondary pumping of the HTHW and Chilled water at the building is not required as our Central Plant is designed to provide these services without additional pumping.

4. 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.

23 22 00: Steam and Condensate Piping

1. Steam system shall be designed for low pressure (15 psig or less) unless otherwise approved by the University. When steam is obtained from a HTW 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 HTW. 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 electrically driven steam generator that can be separately metered (electrically) can be considered.

2. Steam for user-required humidification should be generated by unitary humidifiers, approved by the University, as manufactured by Armstrong, Sarco, Carnes, Herr, Nortec or approved equal.

3. Use bimetallic element traps only with GMU approval.

4. Hot Water is preferred heating medium.

5. Use steel pipe conforming to ASTM A 53, Grade B. Use of copper pipe shall be subject to approval by GMU. If copper pipe is used, modify fittings accordingly.

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

7. Steel piping 1" or less for low-pressure steam shall be Schedule 80.

8. Do not use butterfly valves for throttling steam systems.

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

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

23 30 00: HVAC Air Distribution

1. Insure ducts are free of debris before filters are replaced at project close-out.

2. For fume hood duct design and construction, see 11 53 00.

23 34 00: HVAC Fans

1. In-line or tubular fans are not preferred and such use shall be approved by GMU.

2. Centrifugal fans (especially for fume hoods) shall be direct drive if possible.

3. 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 the GMU's preferred vertical discharge stackhead.

4. Fume hood fans shall be nonsparking and Teflon P coated. Wheels and scrolls may be heresite coated for corrosion protection. Use explosion proof motors when required.

5. Exhaust 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.

6. 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.

7. Do not use backdraft dampers on laboratory fume hood fans unless specifically approved by GMU.

23 36 00: Air Terminal Units

1. Fan powered terminal boxes are only allowed to be used for conditioning atrium areas.
   a. Located in an area accessible from an 8' ladder for maintenance.
   b. Inductive type fan speed controllers are not allowed.

2. Reheat coils are required on all air terminal units serving interior spaces as well as spaces on the building perimeter.

23 40 00: Air Cleaning Devices

Duct Cleaning shall be based upon the National Air Duct Cleaners Association (NADCA) specification.

23 50 00: Central Heating Equipment

23 51 00: Breechings, Chimneys, and Stacks

1. 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.

2. GMU may require an analysis of effluent flume shape and dispersion by a specialist in air wake analysis. Specialist shall be approved by GMU. Such analysis is typical for all discharge stacks such as laboratory fume hood or other laboratory discharges.

23 52 00: Heating Boilers

1. Modular type 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 GMU for use of dual-fuel burners for type of burner to use, turn-down desired and type of control to use.

3. Boilers shall be operating at pressures 15 psig or less.

4. Do not use electric boilers.

5. Water treatment should be discussed with GMU.

23 53 00: Heating Boiler Feedwater Equipment

Consult GMU's engineers concerning feedwater equipment.

23 55 00: Fuel-Fired Heaters

Do not use without permission of GMU. If so, use less 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 GMU. For glycol exchangers, consult with GMU. 30% glycol solution should provide adequate freeze protection; consult with GMU 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.

5. HW for heating shall be 190^{o} F (or 200^{o} F if approved by GMU).

23 60 00: Central Cooling Equipment

1. Warranty: 5 year parts and labor on all components including the compressor, fan motors, structural components, etc.

23 63 00: Refrigerant Condensers

1. Use only on very small projects, with GMU 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. GMU requires as efficient a unit as possible. Refrigerant type to be approved by GMU. Centrifugal chillers shall not be located outside of the building. A/E shall indicate pipe rupture disk discharge to a safe point.

2. If the unit is pre-purchased, the A/E shall obtain pre-purchase specifications from GMU.

3. 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 GMU.

23 65 00: Packaged Cooling Towers

1. GMU prefers cooling towers with propeller fan, packaged, cross flow (induced draft) with stainless steel pan. Use a Marley selected for low horsepower, or approved equal. Towers shall have metal Balance Clean Chambers.

2. Centrifugal fan, forced draft towers are to be reviewed with GMU prior to consideration.

3. Winterizing requirements shall be discussed with GMU. The appropriate design shall be reviewed prior to such application.

4. Fan motors shall be variable speed, controlled and sequenced to obtain the condenser water temperatures needed. Size of conduits to starter located in Mechanical Room shall take this into account.

5. Fan shall be shaft driven.

6. Provide handrail, ladder and cage for access.

7. Provide flow control valves for all outlets. 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.

8. Float type Water level control is preferable. EP, BD and chemical pump should have H-O-A- selection switch.

9. 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.

10. Warranty: 5 year parts and labor on all components including the fan motors, structural components, etc.

23 70 00: Central HVAC Equipment

23 73 00: Air Handling Units

1. HW and CHW coils shall have no more than 120 fins per foot of tube length, where possible. 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. HW coil temperature drop should be high (50^{o} to 100^{o} F.) with an entering water temperature of 190^{o} F. CHW temperature delta should be 14^{o} F. with an entering temperature of 42^{o} F. For 100% outside air applications, a higher delta T maybe used with GMU permission.

2. Use of factory automatic temperature controls may be considered.

3. Do not use electric heat without specific permission of GMU.

4. 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.

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

6. 30% Filters shall be installed in manufactured filter frames. Precede higher efficiency filters with roughing filters. Use HEPA or other high efficiency filters when required or directed. Provide pressure differential gage to monitor filter performance on all major air handling units.

7. Condensation drain pans will be stainless steel. Secondary drain pans are required by IMC 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.

8. Access doors on the return side to open outward. Supply side doors to open inward and be removable if space is limited inside the unit.

9. 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.

10. 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.

11. Preferred Manufacturers are:

    - Trane
    - Carrier

12. Relief Fan configurations are not acceptable. Please use Return Fan configuration as all buildings, except one which have had frequent problems with, have return fan configuration.

23 74 00 Packaged Outdoor HVAC Equipment

Rooftop Heating and Cooling Units

2. These may be used only with GMU approval. When used, the only acceptable types are:

    - Trane
    - McQuay
    - Carrier

3. 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.

4. As an alternative, the equipment may be located on an approved ground slab.

5. Coils shall be fully drainable from valve with hose connection.

6. 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 GMU approval.

7. Relief Fan configurations are not acceptable. Please use Return Fan configuration as all buildings, except one which have had frequent problems with, have return fan configuration.

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

The university encourages investigating water-source heat pumps for feasibility. Use only after detailed life cycle cost analysis and approval of GMU.

End of Section

Division 25 00 00: Integrated Automation

End of Section

Division 26 00 00: Electrical

26 00 00: General Requirements

1. Provide Digital Electric Meters (DEM) for all new buildings.

2. Electrical closets and distribution shall be centrally located throughout the building.

3. In atriums or other multi-story open areas, accessibility and maintenance should be a consideration when mounting lights.

4. Access doors to crawl spaces should be located as close as possible to electrical equipment under floor.

5. Provide separate electrical and telecommunications closets. Custodial closets shall not be used to house electrical or telecommunications equipment.

6. Corridor wall receptacles (primarily used for floor cleaning equipment) shall be circuited separate from interior office/classroom receptacles.

7. Electrical wiring system shall be designed and installed with as much flexibility as practical and reasonable.

8. In demolition associated with renovations, all wire shall be removed back to the panel board and all accessible conduits shall be removed.

9. For back-up power, emergency generators are preferred to battery systems.

10. Emergency Light and Power (see also 16530):

    a. During the design development phase of any facility, the extent of emergency lighting and power required shall be determined in order to establish the alternate power source. The total requirement shall dictate the use of engine generator, local battery or central battery stand-by sources. Location of the generator exhaust outlet must not be located where it would affect building occupants.

    b. Buildings requiring only emergency lighting should be handled through local battery or central battery system based on total load and economic of system.

    c. Buildings requiring operation of motor driven equipment, and/or elevator as well as emergency lighting shall use engine generator unit as the standby source.

    d. For emergency generator, see 16230.

    e. 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.

11. Electrical provisions for elevators: see 14200.

12. For cathodic protection, see 13110.

26 05 00: Basic Electrical Materials and Methods

26 05 19: Low-Voltage Electrical Power Conductors and Cables

1. All conductors 300 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. Secondary Distribution

   a. Wire for low voltage (600 volts and below) circuits shall be single conductor stranded copper of not less than 98% conductivity with 600 volt, Type THHN/THWN insulation. Type XHHW may be used for sizes #2AWG and larger.

   b. 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.

   c. All conductors shall be color-coded throughout 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

   d. Branch Circuit Feeders: The design shall be for acceptable voltage drop and capacity for 20% load growth above initial design.

   e. Branch Circuits: These circuits shall not be loaded to more than 80% of panel breaker ratings. Not more than six unassigned general use duplex convenience outlets shall be on any one 20 ampere branch circuit.

   f. Feeder sizes and protections shall not be such a large percentage of the main that coordination of devices cannot be achieved.

g. Use two wire circuits with individual neutral conductors for all branch receptacle circuits in administrative, office, computer laboratory and classrooms, and general laboratory areas.

3. Primary Distribution:

   a. Provide testing of the feeder cables per NETA-ATS and furnish GMU with a copy of the completed test report prior to equipment startup.

   b. 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.

   c. 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.

   d. High voltage cables shall be terminated in accordance with the cable manufacturer's recommendations using terminators specifically recommended by the type of cable specified.

   e. 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.

   f. Cables shall be identified in manholes as to source and destination.

   g. 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 GMU with a copy of the completed test report prior to equipment startup.

2. Drawings shall show ground systems, protective conduit sizes, and relative locations. Specifications and drawings shall include detailed requirements of the grounding system. A reference only to the NEC and/or specifying requirements only referencing the code are not acceptable.

3. Service grounding electrode shall be on the street side of cold water valve and also provide a made grounding system. A reference only to the NEC and/or specifying requirements only referencing the code are not acceptable.

4. 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.

5. Grounding conductor in metallic conduits 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.

6. The complete electrical installation shall be permanently and effectively grounded per NEC. 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.

7. Convenience outlets shall have a wired ground for continuity of ground path from the device grounding pole.

8. Provide a 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.

9. A system ground shall be provided for each separately derived system including service entrance, each voltage level, and generators per NEC.

10. 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 insulated ground conductor per NEC.

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:

    a. 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.

b. Interior high voltage runs.

c. Exposed exterior raceways.

d. Any raceway in hazardous areas.

e. 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:

   a. Interior branch circuits that are exposed.

   b. Interior exposed feeders.

   c. Interior exposed motor circuit wiring.

   d. Interior exposed control, Fire alarm, signal and sound wiring.

   e. Use compression fittings only. Set screw type fittings are unacceptable.

5. Rigid Plastic Conduit, Schedule 40 PVC, can be used for the following:

   a. 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.

   b. Underground telephone service ductbank encased in concrete.

   c. Lightning protection down leads, and individual ground conductors.

   d. Interior branch circuits that are exposed in wet or caustic environments.

   e. 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. Marker tape shall be standard metallic lined, permanent, bright red colored continuous printed plastic tape for direct burial service, not less than 6 inches wide by 4 mils thick, and printed, "caution electric line buried below." 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 to be recessed 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.

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. For underground service see section 33 70 00.

26 10 00: Medium-Voltage Electrical Distribution

26 11 00: Substations

1. Design Engineer will provide the final trip setting for the Main Breaker prior to equipment star-up.

2. 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:

    a. 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.

    b. 208Y/120 volt 3 phase 4 wire 60 HZ for buildings with small power loads that can be readily served by this voltage.

    c. Buildings requiring almost equal quantities of both a. and b. above should be served by two unit substations, one for each low voltage service.

3. Type and Location of Building Substations:

    a. 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.

    b. 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.

c. Selection of a. or b. above will depend on site location of new facility, indoor space availability for mechanical and electrical equipment, etc. and shall be determined by discussions with the University.

d. 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.

4. Secondary Distribution Systems: 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 application, and over sizing of distribution panel neutrals by 200% as well as the neutral conductors of the system feeding these panels.

26 18 00: Medium-Voltage Circuit Protection Devices

26 18 39: Medium-Voltage Motor Controllers

1. Motor voltages: Motors 3/4 HP and larger shall be 3 phase 60 Hz, 208 volt or 460 volt based on system secondary distribution. Motors under 3/4 HP shall be single phase 60 Hz, 115 volt or 208 volt.

2. Size all motors to run at no more than 80% of FLA at normal load conditions.

3. All single phase motors shall have a local lockable means of disconnect that provides over current protection.

26 20 00: Low-Voltage Electrical Distribution

1. One line diagram of electrical system shall be posted in the switchgear room or in vicinity of main distribution panel.

2. Panelboards shall be flush mounted only in areas with grid type ceilings or open ceilings. Do not locate panelboards in custodial closets.

3. Distribution panelboard shall be provided complete with all mounting hardware for mounting any size breaker that the panel will accept and breakers shall be plug-in type.

4. Provide a minimum of one 100 ampere, 30 pole panelboard per laboratory.

5. Provide 10% spare breakers in each distribution panel in all new buildings. Provide 10% spare breakers in each panelboard. Also an addition 20% breaker space for future connection in both panelboards and distribution panels

6. All panelboard indices shall identify all equipment served by each circuit, (i.e. Rcpt - Rooms 111, 112, 115), Spaces and Spares.

7. Any panelboard spaces shall be fully bussed.

8. Include power circuit for card key door locking hardware.

9. Provide power circuit(s) for automatic door openers.

26 24 00: Switchboards and 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 GMU 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. Panelboards shall be initially designed so that they are not loaded more than 75%. Provide spare breakers and spare space.

4. Panels shall consist of factory completed dead-front assemblies of sheet steel cabinets, main buses, over-current and switching units and sheet steel trim.

5. 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.

6. 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.

7. 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.

8. 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.

9. 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.

10. 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.

11. Multiple section panels shall have feed-thru lugs with full capacity taps to adjacent panel sections.

12. 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.

13. 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.

14. Motor starters (Individual), Magnetic Type:

    a. 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.

    b. 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.

    c. 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.

15. 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.

    a. 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.

    b. 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.

c. 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.

d. 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.

e. 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.

    1) The engaged position - Stabbed on the vertical bus.

    2) 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.

f. 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.

g. 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.

h. Engraved nameplates shall be provided for each unit of the motor control center as well as the assembly.

16. 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.

17. Provide a motor disconnect switch within sight of motor.

26 27 00: Low-Voltage Distribution Equipment

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, ivory, 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 within 3' of water basin or sink shall be GFCI.

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 15 or 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:

    a. 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.

    b. 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.

26 28 00: Low-Voltage Circuit Protective Devices

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.

26 30 00: Facility Electrical Power Generating and Storing Equipment

26 32 00: Packaged Generator Assemblies

26 32 13: Engine Generator Assemblies

1. 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.

2. Provide load bank for generators to use when cycling for maintenance. At a minimum, provide a connection for a portable load bank.

3. Consider emergency generator exhaust path in relation to make-up air and building openings.

4. Provide grounding system for generator per NEC.

5. Generator shall provide operational status to the Fire Alarm Annunciator.

26 41 00: Facility 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. should 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 a U.L. master label.

26 42 00: Cathodic Protection

Underground steel pipe systems shall be cathodically protected using Pikotec or approved equal.

26 50 00: Lighting

1. Light Fixtures:

    a. 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.

    b. 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.

    c. 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.

2. 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.

3. Owner 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/xl series.

4. 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/classrooms when possible. Ceiling mounted occupancy sensors shall be provided in conference rooms and classrooms. Wall switches also be provided in conference rooms and classrooms such that lights may be controlled by switches when space is occupied.

5. Locate light fixture schedule on drawings. Schedule shall contain a description fixture, not simply a model number.

6. Use of fluorescent dimming systems is discouraged. When approved, the ballasts shall have a dimming range of 100% to 1%.

7. Provide dimming capability for classrooms to allow note taking while viewing a projection screen.

8. Specify standard lamps not requiring special order or premium price.

9. The following illumination levels are recommended by GMU. 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. See also the Construction and Professional Services Manual section 716C.

Area / Room Name	**Maintained Foot Candles**

Offices & Secretarial Areas	55 -60
Laboratories	75 - 80
Study Areas & Classrooms	50 - 60
Conference Rooms & Meeting Rooms	40 - 50
Lecture Hall Auditorium / Multi Purpose	35 - 50
Corridors & Stairwells	15 - 20
Reception / Lobby, Lounge	30 - 35
Mechanical, Electrical Rooms	25
Telephone & Elevator Machine Rooms	25
Receiving Areas	30
Storage Areas	10 – 15
Rest & Locker Rooms	25 – 30
Critical Work areas such as tissue labs, Culture plate areas, Instrument Rooms, etc.	90 – 100
Temporary site lighting for Security purposes	1 – 3
Walkways for pedestrian Safety	2 - 2.5
Parking Lots	1 - 1.5
Parking Decks	5

a. Provide fixtures that comply with the requirements of our Energy Savings Performance Contract (ESPC).

b. 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.

c. 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 fixtures 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.

d. Fluorescent ballasts shall be electronic type with following features:

- High frequency solid state electronic
- High power factor (90% or higher)
- Class P thermally protected
- Have a harmonic distortion of less than 15% and comply with all current ANSI standards
- Super - quiet operating sound level of 2 dB above a 16 dB ambient
- Meet FCC requirements governing electromagnetic and radio frequency interference
- Comply with all applicable State & Federal ballast efficiency standards
- Listed & Approved by U. L.
- Designed for use with T8 OCTIC type (265 ma) rapid start lamps

Ballast manufacturers to be Advance, Universal or EBT.

e. Fluorescent lamps shall be T8 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.

f. Incandescent lamps when required shall be rated 130 volt for 120 volt circuits.

g. 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.

h. 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.

10. Exterior Lighting:

a. Lighting for the entire site development of a building shall be included in the building contract documents.

b. LED fixtures shall be used for exterior lighting of parking lots, walkways, roadways, and building perimeter security lighting. These fixtures shall be mounted on suitable standards and/or building for site lighting. Walkways, pathways, and sidewalks shall

use LED fixtures, BETA LED, or approved equal. Roadways and parking lots shall use LED fixtures, BETA LED, or approved equal.

c. Street and parking lot poles shall be round, tapered, brushed aluminum. Mounting height shall be 25'-30'. Heads shall be semi-cutoff, cobra type with glass drop lens and 400 Watt High Pressure Sodium lights. Concrete bases shall be 18 inch diameter minimum, six feet below ground and set 30" above top of curb/lot surface. Concrete shall be minimum 4000 psi with steel reinforcement.

d. Path and sidewalk lighting shall be non-tapered square dark brown, steel. Mounting height shall be 12'-14'. Lights shall be 150 Watt High Pressure Sodium. Concrete bases shall be 18 inch diameter minimum, four feet below ground and set 12" above walkway. Concrete shall be 4000 psi with steel reinforcement.

e. Lens control shall be provided on all exterior lighting fixtures. Vandal proof fixtures shall be used if fixtures are mounted 10' or less off the ground.

f. Fixtures shall be located so that dark voids and excessive glare in windows are eliminated. Accessibility for servicing and spillage onto adjacent facilities must be considered.

g. For covered walkways use metal halide or mercury vapor H.I.D. downlights or wall mounted type fixtures depending on application.

h. Include temporary security site lighting of the construction area.

11. Lighting Control:

a. Photo-electric control shall be used for all entrance and site lighting.

b. 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 & electrical rooms, and any other area where a safety hazard may be created by lights going off automatically.

c. 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.

d. All exterior and security lighting shall be powered from one location in the building, namely the main electrical room.

e. 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 GMU Project Manager 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.

f. Remote switching by means of central control shall be evaluated for special areas.

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.

End of Section

Division 27 00 00: Communications

27 00 00: General Communications Provisions (Communications)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 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.

1.3 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.

1.4 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.

1.5 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

1.6 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.

1.7 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.

1.8 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.

1.9 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. 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.

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)

END OF SECTION 27 00 00

27 05 00 – Common Work for Communications

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 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.

1.3 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.

B. NBR: Acrylonitrile-butadiene rubber.

C. Wiring: Cable and/or wire installed in Raceway.

1.4 SUBMITTALS

A. Product Data: For sleeve seals.

1.5 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.

1.6 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.

1.7 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.

1.8 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.

1.9 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

2.1 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).

2.2 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.

2.3 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

3.1 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."

3.2 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.

3.3 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.

3.4 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.

3.5 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.

3.6 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.

3.7 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.

3.8 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.

END OF SECTION 27 05 00

27 05 26 —Grounding and Bonding fo rTelecomunications Systems

PART 1 - GENERAL

1.1 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.

1.2 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 — "General Requirements"
   2. Division 27 Section — "Communications"

1.3 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)*

1.4 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.

1.5 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.

1.6 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.

1.7 SEQUENCING

1.8 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

2.1 GENERAL

A. Materials shall consist of busbars, supports, bonding conductors and other incidentals and accessories as required.

2.2 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

3.1 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.

3.2 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!"

END OF SECTION 27 05 26

27 05 28 — Conduit and Back Boxes for Communications Systems

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 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"

1.3 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)*

1.4 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.

1.5 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.

1.6 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 GMU 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.

1.7 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.

1.8 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.

1.9 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

2.1 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.

2.2 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.

2.3 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.

2.4 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:

    a. Brady: Bradymaker Wire Marking Labels WML-511-292 (or approved equal)

3.1 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.

3.2 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.

3.3 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 GMU-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.

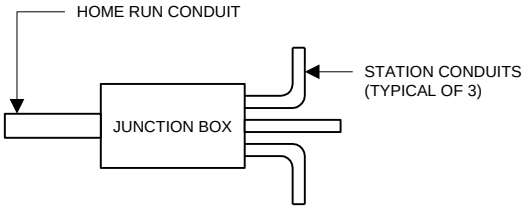
5. Install hinged-cover enclosures and cabinets plumb, and supported at each corner.

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.

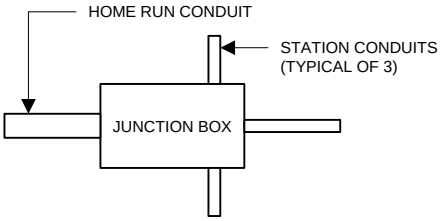
a. Where a junction box is installed in a ceiling space, coordinate with other trades to provide full access to the junction box door and adequate working room for both the installation personnel and for proper looping of cable during installation.

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:



CORRECT INSTALLATION



INCORRECT INSTALLATION

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).

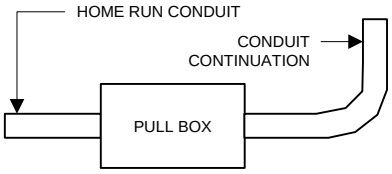
5. Install hinged-cover enclosures and cabinets plumb, and supported at each corner.

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).

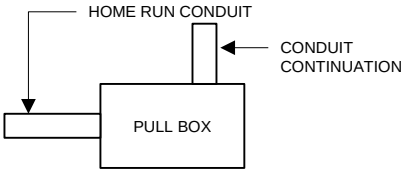
   a. Where a pull box is installed in a ceiling space, provide full access to the junction box door and adequate working room for both the installation personnel and for proper looping of cable during installation.

   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:



CORRECT INSTALLATION



INCORRECT INSTALLATION

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.

3.4 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.

3.5 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.

3.6 CLEANING

1. 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.

END OF SECTION 27 05 28

27 05 36 — Cable Tray for communications systems

PART 1 - GENERAL

1.1 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.

1.2 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 7 Section — "Firestopping"

2. Division 10 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"

1.3 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)*

1.4 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.

1.5 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.

1.6 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.

1.7 SEQUENCING

1.8 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

2.1 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

2.2 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.

2.3 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.

2.4 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

3.1 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.

3.2 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.

3.3 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.

3.4 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.

3.5 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.

3.6 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.

3.7 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.

3.8 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!”

END OF SECTION 27 05 36

27 05 43 — Underground ducts and raceways for communications systems

PART 1 — GENERAL

1.1 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.

1.2 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"

1.3 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) ACI 301: Structural Concrete for Buildings

2) ACI SP-66: American Concrete Institute - Detailing Manual

3) ANSI/ASTM A82: Cold Drawn Steel Wire for Concrete Reinforcement

4) ANSI/AWS D1.4: Structural Welding Code for Reinforcing Steel

5) ANSI/AWS D12.1: Reinforcing Steel Welding Code

6) ASTM A615: Deformed and Plain Billet Steel Bars for Concrete Reinforcement

7) AWS D12: Welding Reinforcement Steel, Metal Inserts and Connections in Reinforced Concrete Construction

b. Cast-in-Place:

1) ACI 212.3R: Chemical Admixtures for Concrete

2) ACI 301: Structural Concrete for Buildings

3) ACI 304: Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete

4) ACI 305R: Hot Weather Concreting

5) ACI 306R: Cold Weather Concreting

6) ASTM C33: Concrete Aggregates

7) ASTM C39: Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens

8) ASTM C94: Ready-Mixed Concrete

9) ASTM C150: Portland Cement

10) ASTM C143: Standard Test Method for Slump of Hydraulic Cement Concrete

11) ASTM C173: Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method

12) ASTM C231: Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method

13) ASTM C260: Air Entraining Admixtures for Concrete

14) ASTM C309: Standard Specifications for Liquid Membrane Forming Compound for Curing Concrete

15) ASTM C494: Chemical Admixtures for Concrete

c. Pre-Cast:

1) ASTM C478: Standard Specification for Precast Reinforced Concrete Manholes Sections

2) ASTM C857: Standard Practice for Minimum Structural Design Loading for Underground Precast Utility Structures

3) ASTM C858: Standard Specification for Underground Precast Concrete Utility Structures

4) ASTM C891: Standard Practice for Installation of Underground Precast Concrete Utility Structures

5) ASTM C1037: Standard Practice for Inspection of Underground Precast Concrete Utility Structures

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

1.4 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)

1.5 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.

1.6 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.

1.7 SEQUENCING

1.8 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

2.1 GENERAL

A. Materials shall consist of fill, topsoil, concrete formwork, concrete, raceway, maintenance holes, handholes and other incidentals and accessories as required.

2.2 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

2.3 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.

2.4 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:

a. 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

2.5 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.

2.6 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.

1.

2.7 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)

2.8 LANDSCAPING:

A. Topsoil: Imported from off construction site.

PART 3 — EXECUTION

3.1 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.

3.2 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.

3.3 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) 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.

3.4 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.

3.5 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.

END OF SECTION 27 05 43

27 10 00: Structured Cabling

27 15 00: Inside Plant Structured Cabling system for residential buildings

PART 1 – GENERAL

1.1 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.

1.2 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 7 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

1.3 REFERENCES

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 - 455: *Fiber Optic Test Standards*
    b. ANSI/TIA/EIA - 526: *Optical Fiber Systems Test Procedures*
    c. ANSI/TIA/EIA - 568-B: *Commercial Building Telecommunications Cabling Standard*
    d. ANSI/TIA/EIA - 569: *Commercial Building Standard for Telecommunication Pathways and Spaces*
    e. ANSI/TIA/EIA - 606: *The Administration Standard for the Telecommunications Infrastructure of Commercial Buildings*

f. ANSI/TIA/EIA - 607: *Commercial Building Grounding and Bonding Requirements for Telecommunications*

g. ANSI/TIA/EIA -TSB67: *Transmission Performance Specifications for Field Testing of Unshielded Twisted Pair Cabling Systems*

h. ANSI/TIA/EIA -TSB75: *Additional Horizontal Cabling Practices for Open Offices*

i. NECA/FOA 301-1997: *Standard for Installing and Testing Fiber Optic Cables*

j. NECA/BICSI 568-2001: *Standard for Installing Commercial Building Telecommunications Systems*

k. IEEE 802.3 (series): *Local Area Network Ethernet Standard, including the IEEE 802.3z Gigabit Ethernet Standard*

l. ISO/IEC IS 11801: *Generic Cabling for Customer Premises*

m. BICSI: *BICSI Telecommunications Cabling Installation Manual*

n. BICSI: *BICSI Telecommunications Distribution Methods Manual* (TDMM)

3. 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

1.4 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.

1.5 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 ISO/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…) .

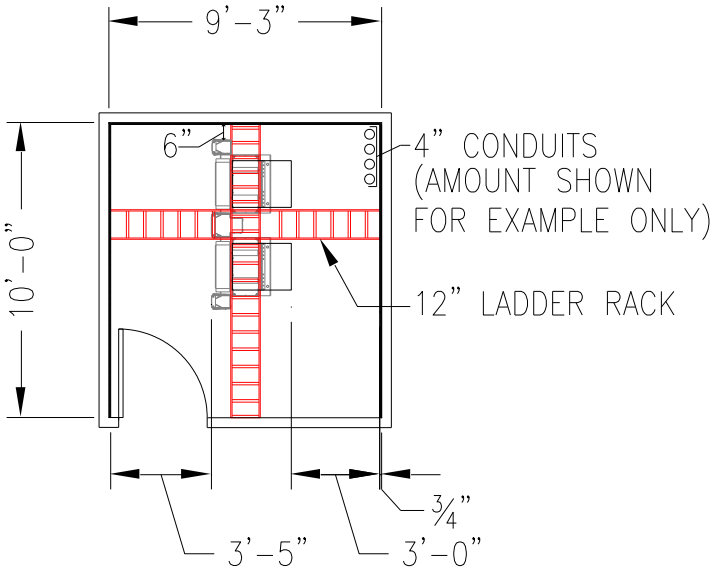
8. Floors shall be VCT tile or sealed concrete, carpet is prohibited. The rated distribution floor loading should be greater than 250 psf. The rated concentrated floor loading should be greater than 1000 lbs.

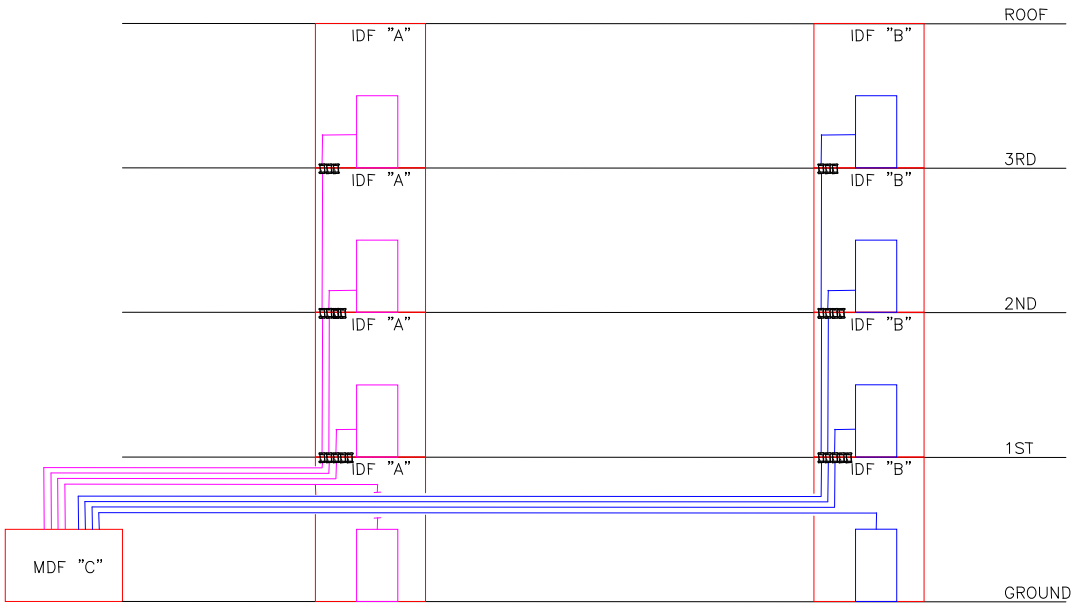
9. Telecommunications rooms will not have a suspended ceiling. The recommended minimum ceiling height is 8' 6".

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

1.6 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.

1.7 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.

1.8 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.

1.9 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

2.1 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.

2.2 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.

2.3 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).

2.4 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.

2.5 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

2.6 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".

2.7 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

2.8 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

2.9 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:

a. SUTTLE SE-630AD4, or approved equal.

F. Surface Device Boxes: Surface mount device boxes shall be:

a. 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:

   1. Each Multimode Fiber shall be/have:

      a) Graded-index optical fiber wave-guide with nominal 50/125μm-core/cladding diameter.

      b) Comply with the latest revision of ANSI/EIA/TIA-4920000.

      c) Attenuation measured in accordance with ANSI/EIA/TIA-455-46, 53 or 61.

      d) Information transmission capacity measured in accordance with ANSI/EIA/TIA-455—204 for overfilled launch.

      e) The measurements performed at 23 degrees C +/- 5 degrees.

      f) Maximum attenuation dB/Km @ 850/1300 nm: 3.5/1.5

      g) Bandwidth: > 1500 MHz-km @ 850nm for overfilled launch,

      h) Bandwidth 500 MHz-km @ 1300nm.

      i) Bandwidth 2000 MHz-km characterized using FOTP 220

      j) Optical Fiber laser optimized and guaranteed for
      10 Gigabit Ethernet distances of 300m/300m for 850nm and 1300nm respectively

      k) Optical Fiber laser optimized and guarantee
      Gigabit Ethernet distances of 1000m/600m for 850nm and 1300nm respectively

Physical Characteristics:

a) Shall be rated for environment being distributed.

b) Shall have 900μm tight-buffered construction

c) Shall be available with a fiber stand count range from 6 to 144.

d) Shall have an UL-OFNR/FT4 Flame Rating.

e) Strength members shall be aramid yarn.

f) Tight buffered fibers shall be color coded in accordance with EIA/TIA 598 with an overall orange jacket.

g) Suitable for operation between -20° to 75° C.

h) Shall comply with ICEA S-83-596

l) 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

2. Each Single-mode Fiber shall be:

a) Class IVa dispersion - unshifted single mode optical fibers with Low Water Peak complying with ANSI/EIA/TIA-492BAAA492CAAB-2000.

b) 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.

c) 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.

d) Transmission Characteristics:

e) Maximum cabled attenuation dB/km @ 1310/1550 nm: 1.0/1.0

f) The cabled cutoff wavelength shall be ≤1260 nm when measured in accordance with ANSI/EIA/TIA-455-80-C

g) Distance vs. bandwidth using a Laser transmitter operating at a 1310 nm wavelength

2. Physical Characteristics:

a) Shall be rated for environment being distributed.

b) Shall be available with a fiber strand count range from 6 to 144.

c) Bundled cable constructions shall have a sub-unit core size of 5.2mm for 12 fibers and 4.5mm for 6 fibers.

d) Shall have and be marked with an UL-OFNR and OFN FT4 Flame Rating.

e) Shall comply with Telcordia GR-409.

f) Shall comply with the requirements of ICEA S-83-596.

g) Strength members shall be dielectric and may be either FGE/aramid/yarn.

h) Buffered fibers shall be color coded in accordance with EIA/TIA-598 with an overall

yellow jacket.

i) Shall have a ripcord for overall jacket.

j) Suitable for operation between -20°C to +75°C

k) Shall be of an all dielectric design

l) Cables containing Single-mode shall have a YELLOW jacket

m) 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.

2 Copper (UTP) patch cords shall:

1. be a Category 5E Clarity patch cord.

2. use 8 position connector with impedance matched contacts and designed using dual reactance.

3. 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.

4. meet TIA category 5E component specifications in ANSI/TIA/EIA-568-B

- 100% factory tested to meet category 5E performance and

- ETL or any other nationally recognized 3rd party verification

5. be center tuned to category 6 performance specifications by using paired bi-level contact array

6. be capable of universal T568A or T568B wiring schemes.

7. Modular connector shall maintain the paired construction of the cable to facilitate minimum untwisting of the wires.

8. have a performance marking indelibly labeled on the jacket (by the manufacturer).

9. have the ability to accept color-coded labels and icons to comply with ANSI/TIA/EIA-606-A labeling specifications.

10. have “snagless” protection for the locking tab to prevent snagging and to protect locking tab in tight locations and provide bend relief

11. be available in three standard colors

12. be available in 3 foot, 5 foot, 7 foot, 9 foot, and 15 foot standard lengths

13. be backwards compatible to Category 3 and 5

14. be manufactured by an ISO 9001 registered company.

15. be manufactured by the selected SCS Manufacturer

3 Optical Fiber patch cords shall:

1. contain two (2) multi-mode optical fibers.
2. use multi-mode, graded-index fibers with a 850 nm Laser Optimized 50.omicron core.
3. be capable of transmission at both 850 nm and 1300 nm wavelengths.
4. include listing of actual loss of patchcord when packaged
5. 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.
6. be manufactured by an ISO 9001 registered company.
7. 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

3.1 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.

3.2 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.

3.3 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

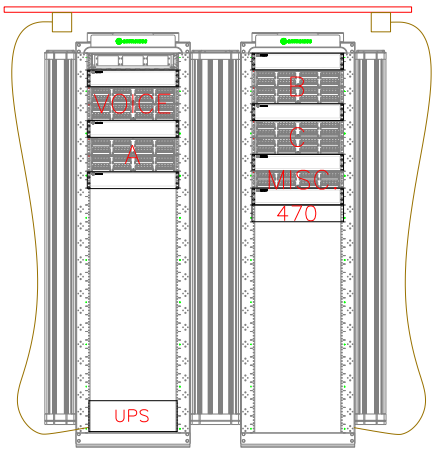
sample installations, manufacturer's recommendations, local fire and building authorities, and applicable codes and standards referenced in PART 1 – REFERENCES. Apply of sealing material in a manner acceptable to the local fire and building authorities.

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.

3.4 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.

3.5 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.

3.6 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.

3.7 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.

3.8 CONNECTORS

A. Copper Connectors (modular jacks):

1. For Horizontal Distribution:

a. Terminate Category 5E cable using the T568B wiring pattern.

3.9 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. 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. 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 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.

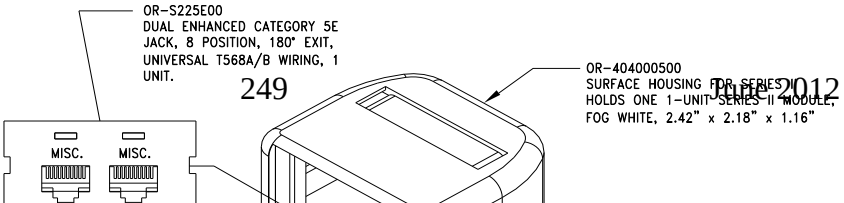
B. Faceplates shall be level and plumb.

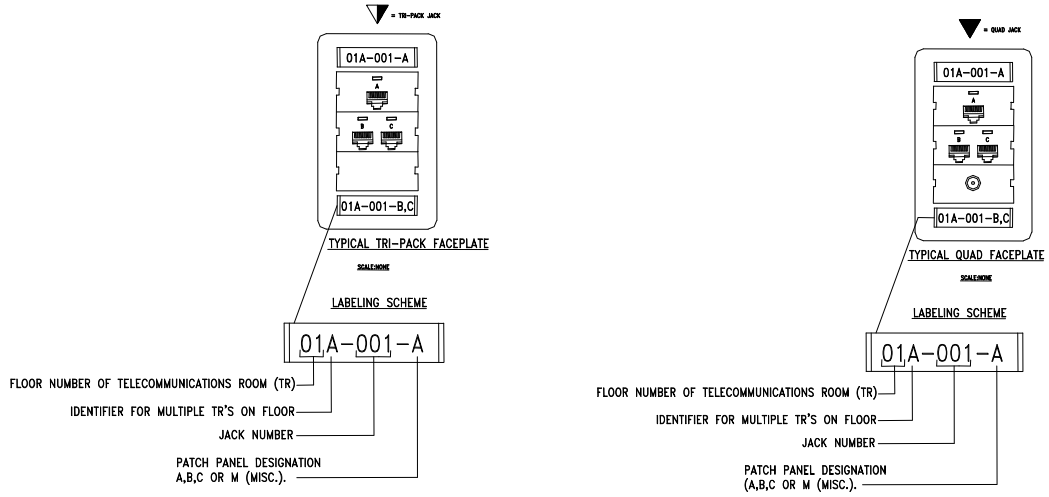
C. Faceplate Mounting Brackets: Provide faceplate mounting brackets as required and as shown for flush mounted communications outlets.

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.





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 Category5E and coaxial cable for TV Distribution, terminate Category 5E 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 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.

c) 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.END OF SECTION

27 15 00 — Inside Plant Structured Cabling system for NON-residential buildings

PART 1 – GENERAL

1.10 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.

1.11 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 7 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 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

1.12 REFERENCES

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 - 455: *Fiber Optic Test Standards*
    b. ANSI/TIA/EIA - 526: *Optical Fiber Systems Test Procedures*
    c. ANSI/TIA/EIA - 568-B: *Commercial Building Telecommunications Cabling Standard*
    d. ANSI/TIA/EIA - 569: *Commercial Building Standard for Telecommunication Pathways and Spaces*
    e. ANSI/TIA/EIA - 606: *The Administration Standard for the Telecommunications Infrastructure of Commercial Buildings*
    f. ANSI/TIA/EIA - 607: *Commercial Building Grounding and Bonding Requirements for Telecommunications*
    g. ANSI/TIA/EIA -TSB67: *Transmission Performance Specifications for Field Testing of Unshielded Twisted Pair Cabling Systems*
    h. ANSI/TIA/EIA -TSB75: *Additional Horizontal Cabling Practices for Open Offices*
    i. NECA/FOA 301-1997: *Standard for Installing and Testing Fiber Optic Cables*
    j. NECA/BICSI 568-2001: *Standard for Installing Commercial Building Telecommunications Systems*
    k. IEEE 802.3 (series): *Local Area Network Ethernet Standard, including the IEEE*

802.3z Gigabit Ethernet Standard

l. ISO/IEC IS 11801: *Generic Cabling for Customer Premises*

m. BICSI: *BICSI Telecommunications Cabling Installation Manual*

n. BICSI: *BICSI Telecommunications Distribution Methods Manual* (TDMM)

3. 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

1.13 DEFINITIONS

H. "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.

I. "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.

J. "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.

K. "TBB" shall mean *Telecommunications Bonding Backbone*. The TBB is a conductor used to connect TMGBs to TGBs.

L. "UTP" shall mean *Unshielded Twisted Pair* cable.

M. "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).

N. "TR" or "IDF" shall mean Intermediate Distribution Frame. The IDFs are the floor level rooms where horizontal cable terminates.

1.14 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 ISO/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…).

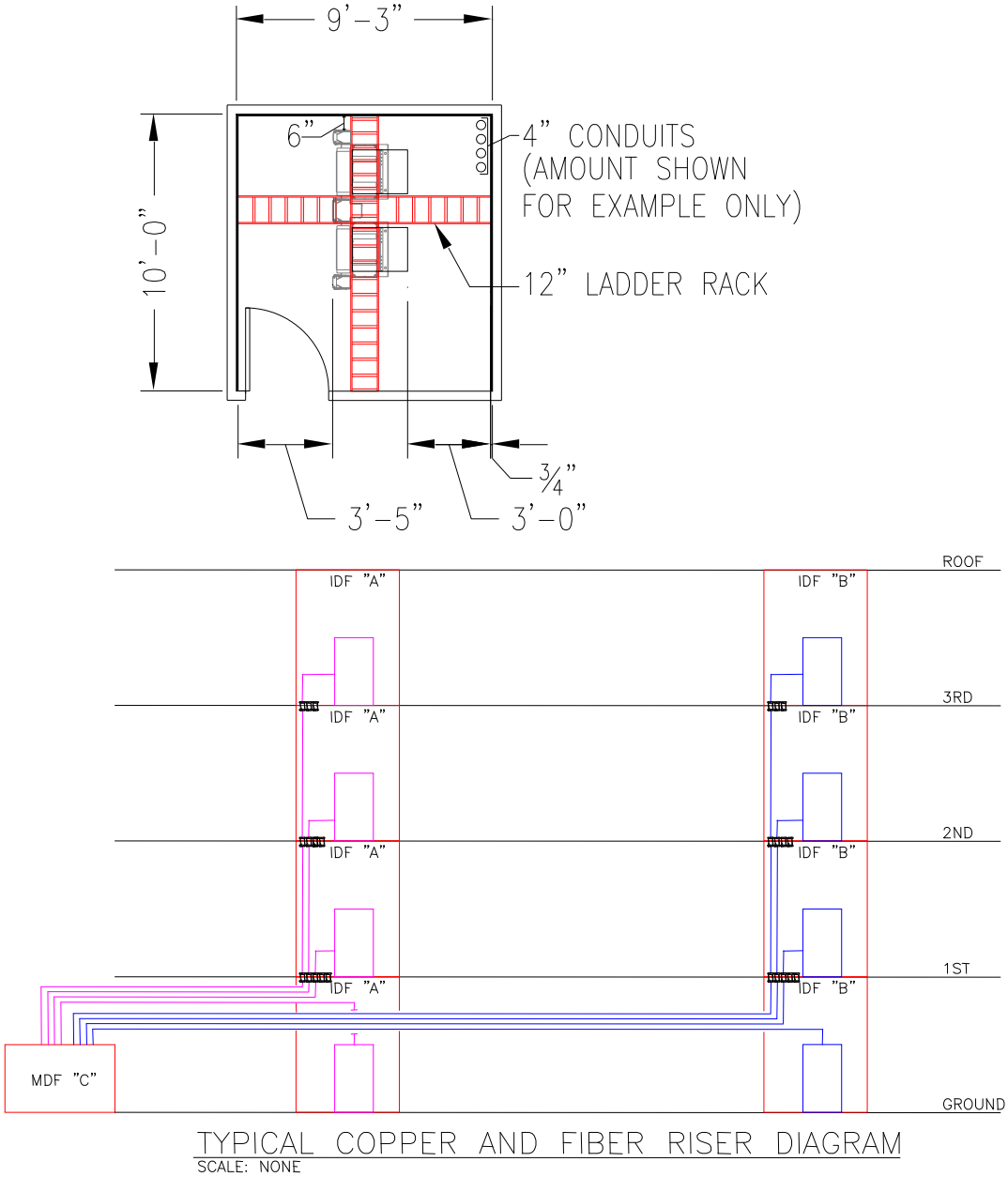
8. Floors shall be VCT tile or sealed concrete, carpet is prohibited. The rated distribution floor loading should be greater than 250 psf. The rated concentrated floor loading should be greater than 1000 lbs.

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

1.15 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.

1.16 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.

1.17 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.

1.18 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

2.14 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.

2.15 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.

2.16 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).

2.17 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.

2.18 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

2.19 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”.

2.20 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 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

2.21 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.

2.22 RISER COPPER TERMINATION BLOCKS

A. Krone

1. Series II, 10 Pair blocks, type 105 can

2.23 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:
6. be a low profile assembly,
7. incorporate a mechanism for storage of cable and fiber slack needed for termination,
8. position the fiber optic couplings to face downward or at a downward angle to prevent contamination and,
9. incorporate a shroud that protects the optical couplings from impact damage.
10. be available as single-gang or dual-gang.
11. provide easy access for adds, moves, and changes by front removal of jack modules.
12. possess recessed designation windows to facilitate labeling and identification.
13. include a clear plastic cover to protect labels in the designation window.
14. have mounting screws located under recessed designation windows.
15. comply with ANSI/TIA/EIA-606-A work area labeling standard.
16. allow for the UTP modules to be inverted in place for termination purposes.
17. 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:

a. SUTTLE SE-630AD4, or approved equal.

F. Surface Device Boxes: Surface mount device boxes shall be:

a. Wiremold

2.24 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.

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:

a) Graded-index optical fiber wave-guide with nominal 50/125μm-core/cladding diameter.

b) Comply with the latest revision of ANSI/EIA/TIA-4920000.

c) Attenuation measured in accordance with ANSI/EIA/TIA-455-46, 53 or 61.

d) Information transmission capacity measured in accordance with ANSI/EIA/TIA-455—204 for overfilled launch.

e) The measurements performed at 23 degrees C +/- 5 degrees.

f) Maximum attenuation dB/Km @ 850/1300 nm: 3.5/1.5

g) Bandwidth: > 1500 MHz-km @ 850nm for overfilled launch,

h) Bandwidth 500 MHz-km @ 1300nm.

i) Bandwidth 2000 MHz-km characterized using FOTP 220

j) Optical Fiber laser optimized and guaranteed for
10 Gigabit Ethernet distances of 300m/300m for 850nm and 1300nm respectively

k) Optical Fiber laser optimized and guarantee
Gigabit Ethernet distances of 1000m/600m for 850nm and 1300nm respectively

Physical Characteristics:

a) Shall be rated for environment being distributed.

b) Shall have 900μm tight-buffered construction

c) Shall be available with a fiber stand count range from 6 to 144.

d) Shall have an UL-OFNR/FT4 Flame Rating.

e) Strength members shall be aramid yarn.

f) Tight buffered fibers shall be color coded in accordance with EIA/TIA 598 with an overall orange jacket.

g) Suitable for operation between -20° to 75° C.

h) Shall comply with ICEA S-83-596

i) 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

3. Each Single-mode Fiber shall be:

a) Class IVa dispersion - unshifted single mode optical fibers with Low Water Peak complying with ANSI/EIA/TIA-492BAAA492CAAB-2000.

b) 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.

c) 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.

d) Transmission Characteristics:

e) Maximum cabled attenuation dB/km @ 1310/1550 nm: 1.0/1.0

f) The cabled cutoff wavelength shall be ≤1260 nm when measured in accordance with ANSI/EIA/TIA-455-80-C

g) Distance vs. bandwidth using a Laser transmitter operating at a 1310 nm wavelength

3. Physical Characteristics:

a) Shall be rated for environment being distributed.

b) Shall be available with a fiber strand count range from 6 to 144.

c) Bundled cable constructions shall have a sub-unit core size of 5.2mm for 12 fibers and 4.5mm for 6 fibers.

d) Shall have and be marked with an UL-OFNR and OFN FT4 Flame Rating.

e) Shall comply with Telcordia GR-409.

f) Shall comply with the requirements of ICEA S-83-596.

g) Strength members shall be dielectric and may be either FGE/aramid/yarn.

h) Buffered fibers shall be color coded in accordance with EIA/TIA-598 with an overall yellow jacket.

i) Shall have a ripcord for overall jacket.

j) Suitable for operation between -20°C to +75°C

k) Shall be of an all dielectric design

l) Cables containing Single-mode shall have a YELLOW jacket

m) Single-mode shall be tight buffered and manufactured by the selected SCS Manufacturer

2.25 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

e) 100% factory tested to meet Category 6 performance and

f) ETL or any other nationally recognized 3rd party verification

g) be center tuned to Category 6 performance specifications by using paired bi-level contact array

h) be capable of universal T568A or T568B wiring schemes.

i) Modular connector shall maintain the paired construction of the cable to facilitate minimum untwisting of the wires.

j) have a performance marking indelibly labeled on the jacket (by the manufacturer).

k) have the ability to accept color-coded labels and icons to comply with ANSI/TIA/EIA-606-A labeling specifications.

l) have "snagless" protection for the locking tab to prevent snagging and to protect locking tab in tight locations and provide bend relief

m) be available in three standard colors

n) be available in 3 foot, 5 foot, 7 foot, 9 foot, and 15 foot standard lengths

o) be backwards compatible to Category 3, 5 and 5E

p) be manufactured by an ISO 9001 registered company.

q) 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

2.26 Copper Jumper Wire: Category 5 (for cross connects)

A. LABELING AND ADMINISTRATION

1. Labels:

a. 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.

b. For Station Cable:

1) Brady: Bradymaker Wire Marking Labels WML-511-292 (or approved equal)

c. For Backbone Cable:

1) Panduit Marker Tie (or approved equal)

2. Hand-carried label maker:

a. Brady: ID Pro Plus (or approved equal).

PART 3 - EXECUTION

3.1 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.

3.2 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.

3.3 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.

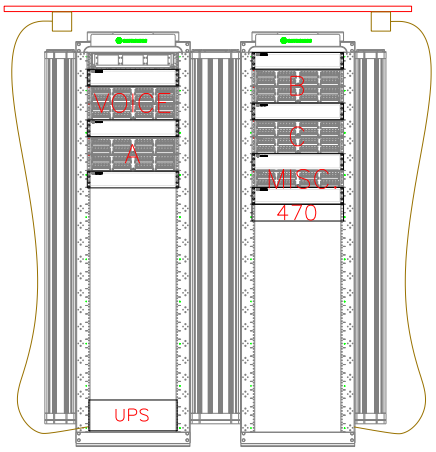
3. Install firestops in accordance with fire test reports, fire resistance requirements, acceptable sample installations, manufacturer's recommendations, local fire and building authorities, and applicable codes and standards referenced in PART 1 – REFERENCES. Apply of sealing material in a manner acceptable 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.

3.4 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.

3.5 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.

3.6 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.

3.7 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.

3.8 CONNECTORS

A. Copper Connectors (modular jacks):

1. For Horizontal Distribution:

a. Terminate Category 6 cable using the T568B wiring pattern.

3.9 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. 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. 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.

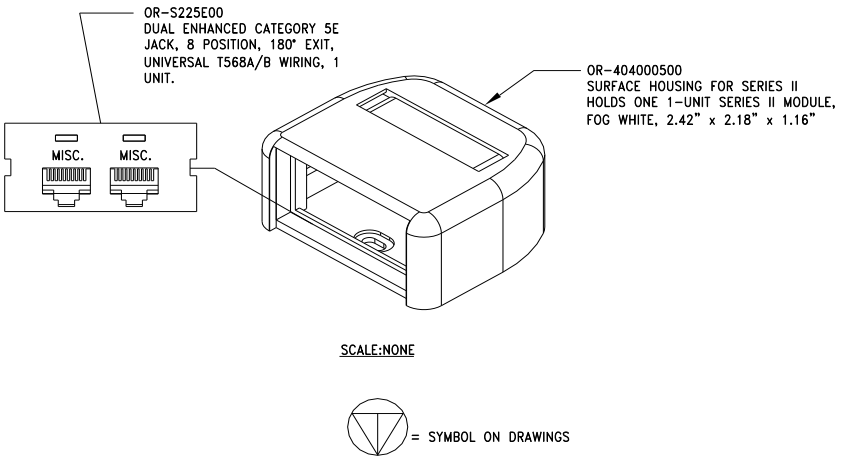
B. Faceplates shall be level and plumb.

C. Faceplate Mounting Brackets: Provide faceplate mounting brackets as required and as shown for flush mounted communications outlets.

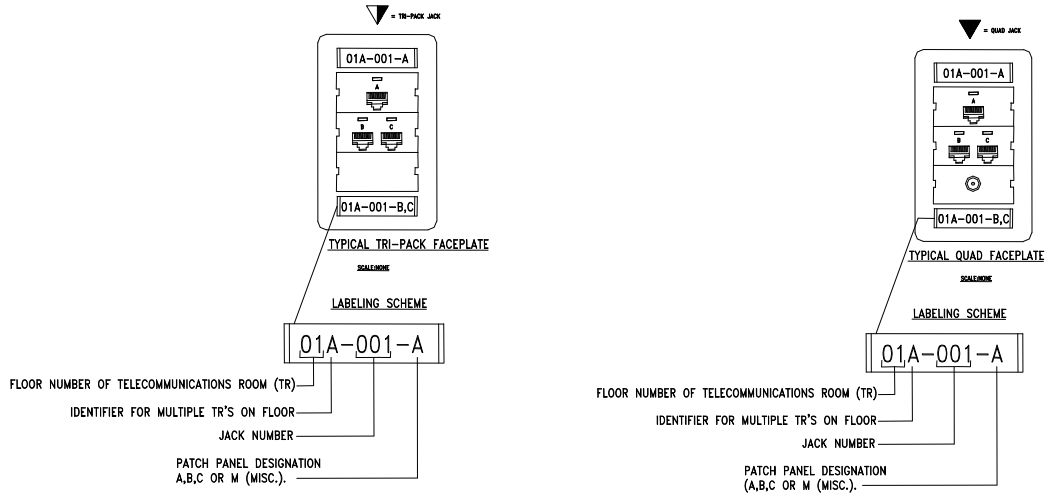
D. Surface Device Boxes: Provide surface mount device boxes as required and as shown for surface mounted communications outlets.

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.



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:

    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:

5. First character – The floor designator, 1.

6. Second character – Telecommunications Room Designator, A.

7. Third, fourth, and fifth character – a three-digit number identifying each outlet, numbered sequentially.

8. 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:

            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.

            c) 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 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.

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.

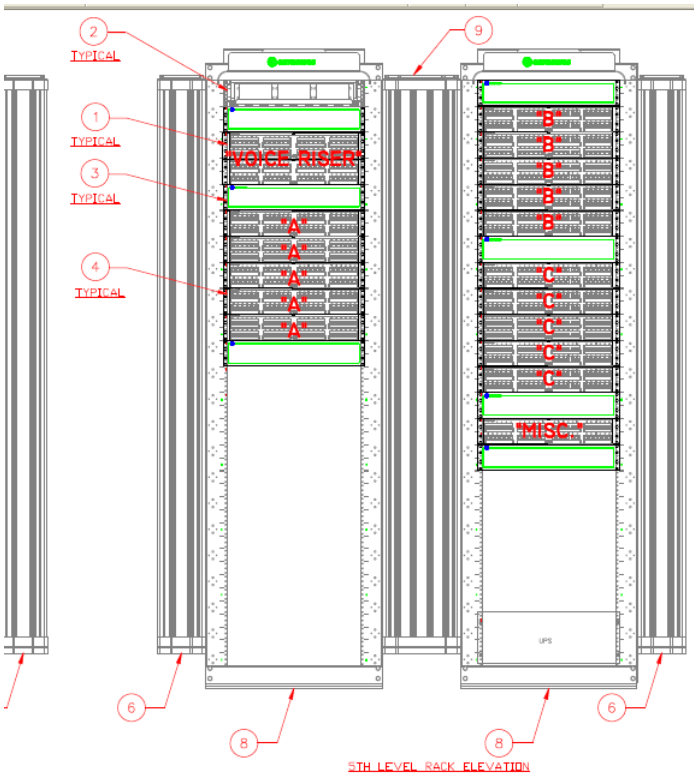
d. If a cable which occupies the same innerduct or conduit (if not in innerduct) as a damaged cable is damaged by the extraction and installation process, replace the cable at no additional expense to the Owner.

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.

END OF SECTION



KEYED NOTES:

1. OR-401004789
   BLANK FILLER PANEL, 2 RU.
2. CORNING CCH-02U
   2 RU. FIBER HOUSING WITH PANEL
3. (2) TWO OR-PHA66U48
   ANGLED "CLARITY" CATEGORY 6, MODULAR TO 110
   PATCH PANEL, W/6 PORT MODULES,
   96 PORTS, HIGH DENSITY, T568 A/B, 4 RU.
4. OR-PHA66U48
   ANGLED "CLARITY" CATEGORY 6, MODULAR TO 110
   PATCH PANEL, W/6 PORT MODULES,
   48 PORTS, HIGH DENSITY, T568 A/B, 2 RU.
5. OR-MM6VMD806
   MIGHTY MO 6 VERTICAL CABLE MANAGEMENT CAGE WITH HINGED DOORS,
   INCLUDES FOUR SPOOLS AND 12 BEND LIMITING CLIPS, 6" x 8" x 8'
   51 RACK UNITS
6. OR-MM6VMD706
   MIGHTY MO 6 VERTICAL CABLE MANAGEMENT CAGE WITH HINGED DOORS,
   INCLUDES FOUR SPOOLS AND 12 BEND LIMITING CLIPS, 6" x 8" x 7'
   45 RACK UNITS
7. OR-MM6810
   MIGHTY MO 6 CABLE MANAGEMENT RACK, 10.5" CHANNEL DEPTH, x 7'TALL,
   51 RACK UNITS
8. OR-MM6710
   MIGHTY MO 6 CABLE MANAGEMENT RACK, 10.5" CHANNEL DEPTH, x 7'TALL,
   45 RACK UNITS
9. OR-MM6VMD710
   MIGHTY MO 6 VERTICAL CABLE MANAGEMENT CAGE WITH HINGED DOORS,
   INCLUDES FOUR SPOOLS AND 12 BEND LIMITING CLIPS, 10" x 13" x7'
10. OR-401004788
    BLANK FILLER PANEL, 1 RU.

End of Section

Division 28 00 00: Electric Safety and Security

RECENT REVISIONS:

28 31 53, # 4, Fire Alarm Systems ….. Added Edwards as an acceptable provider.

28 30 00: Electronic Detection and Alarm

28 31 00: Fire Detection and Alarm

28 31 53: Fire Alarm Systems

1. Ensure compatibility with the existing system(s).

2. 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.

3. It is the intention of the University to obtain competitive bids for maintenance and repair services and material for the fire alarm system provided. Accordingly, the use of proprietary equipment or equipment requiring the use of any proprietary items throughout the life of the equipment is unacceptable. In addition, 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.

4. GMU will accept the following systems:

    a. Notifier

    b. FCI (Fire Control Instruments)

    c. Simplex

    d. Edwards

5. The main FACP shall be located in a secured area such as the Main electrical room.

6. Remote Annunciator:

a. Description: Duplicate annunciator functions of the FACP, including acknowledging, silencing, resetting, smoke evacuation system, testing, alarm, supervisory, and trouble indications.

7. All smoke detectors shall be photo-electric type including all HVAC duct smoke detectors

8. HVAC duct smoke detectors should maintain power during HVAC equipment shutdown.

9. Smoke Dampers are not required in any building, on any campus, of George Mason University.

10. Please ensure the Fire Alarm system is compatible for future radio transmitter. GMU is looking at using the AES 7750 w/ IntelliTap 7068 in the future.

11. Emergency Generator shall report operational status to Fire Alarm annunciator panel.

End of Section

Division 31 00 00: Earthwork

RECENT REVISIONS:

31 25 00, Erosion Ctrls …….... Added Erosion and Sedimentation Controls/Storm Water Pollution section.

31 10 00: Site Clearing

Topsoil shall be stripped to the depth determined by the Soils Engineer, usually not less than 4". Topsoil shall be stockpiled in accordance with the requirements of the Soil Conservation District in locations as directed by the A/E, or elsewhere on University property. Under no circumstances shall topsoil be removed from University property. Topsoils shall not be mixed with subsoils or other site debris.

31 20 00: Earth Moving

The Contractor shall give notification to the appropriate Soil Conservation district, 3 days prior to start of work on the site.

31 23 00: Excavation and Fill

1. All excavation for GMU 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. Please contact Miss Utility prior to excavation.

2. Require the Contractor to hire a Soils Engineer approved by the A/E to perform inspection and testing of all earthwork. Soils Engineer shall be a Professional Engineer licensed in the Commonwealth of Virginia and possess professional liability insurance in the minimum amount of $500,000. Soils Engineer shall provide all field and laboratory services required to:

   A. Test and evaluate all samples of proposed fill materials to determine optimum moisture density relationship in accordance with ASTM D 1557.

   B. Test all samples to assure compliance with gradation requirements of this Specification. Grain size analysis shall be performed in accordance with ASTM D 422.

   C. 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 has not produced desired finished lawns around new facilities.

   D. Inspect all proof rolling and determine the presence of any local soft pockets.

   E. Inspect excavation in natural soil to determine if bearing stratum meets design criteria.

   F. Inspect and test compacted fill to determine compliance with these Specifications. Field densities shall be determined by ASTM D 1556M, ASTM D 2167 or ASTM D 2922.

   G. Keep written records of all tests and field instructions, and summaries of these reports shall be mailed weekly to A/E, University, University Code Official, and Contractor. Final written summaries shall be provided upon completion of work.

31 25 00: Erosion and Sedimentation Controls / Storm Water Pollution

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.

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.

End of Section

Division 32 00 00: Exterior Improvements

RECENT REVISIONS:

32 06 10, #1 Bases Ballasts and Pavg.	Added note regarding acceptance of cracked concrete.
32 06 10, # 2 Bases Ballasts and Pavg	Changed size on rebar chair from 3" to 2".
32 16 13, Concrete Curbs & Gutters	Added note regarding acceptance of cracked curbs.
32 80 00, #3 Irrigation ……....	Added 6" size requirement for down spouts.
32 91 19.13, Topsoil Plcmt, & Gradg .	Added note for 4"-6" topsoil compacted at 85%.
32 92 00, #2 Turfs and Grasses …….	Added note to require sod use.
32 92 00, #4 Turfs and Grasses …….	Added clarification that note applies to sodded areas.

32 06 00: Schedules for Exterior Improvements

32 06 10: Schedules for Bases, Ballasts, and Paving

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.

2. GMU's standard sidewalk is minimum 6' wide, 4" slab constructed of 3000 psi 4 – 6% air entrained concrete reinforced with 6 x 6 #10 welded plain cold drawn steel flat panel wire mesh, with broom finish. Wire mesh shall be supported by, and attached to, 2" rebar chairs that are spaced adequately to ensure support of the mesh during the concrete pour. A 6mil. vapor barrier shall be used on compacted base of naturally or artificially graded mixture of natural or crushed gravel, crushed stone, crushed slag, natural or crushed sand. Aggregate used within the sidewalk shall be rounded.

3. Install 6'-minimum turning radius at all sidewalk intersections for electric carts.

4. Install ramps where sidewalks intersect roads for electric cart access.

5. Transverse control joints shall occur 6' - 0" on center for 6' - 0" wide sidewalks. Transverse contraction joints with premolded joint fillers shall occur 48' - 0" on center. Premolded joint fillers shall be 1/2" thick asphalt impregnated fiber board 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 of the sidewalk.

6. Use non-slip finish on sidewalks, steps, and metal grates where a slipping hazard may exist.

32 10 00: Bases, Ballasts, and Paving

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 should be determined by tests. Require the Contractor to remove any areas not meeting the required bearing capacity which he may encounter during subgrade preparation. Those areas will be filled and compacted with suitable material to achieve the required CBR. During preparation of the subgrade, specify that the Contractor perform CBR tests as necessary, but in no case less than one test for each 1000 S. Y. of paved area.

VALUE PAVEMENT TYPE	MIN. CBR TYPE	TYPE & THICKNESS OF BASE COURSE	TYPE & THICKNESS OF SURFACE COURSE
TYPE A Sidewalks, play areas, bike paths, bus stops	10	Mix I-4, 4" Surface to be as tight as possible	Single Lift
Type B Driveway which caries	10	Mix I-2, 4"	Mix I-5, 1-1/2"

only passenger cars and passenger car parking lots			
Type C Local roads which carry passenger cars and light trucks	10	Mix I-2, 4-1/2”	Mix I-5, 1-1/2”
Type D Feeder roads which carry bus & truck traffic and bus & truck parking lots	10	Mix I-2, 5”	Mix I-5, 2”
Type E * Arterial roads and service roads with heavy truck & bus traffic	10	Mix I-2, 6”	Mix I-5, 2”
Type F Heavy duty bus & truck roads and service drives	10	Mix I-2, 7”	Mix I-5, 2”

* Shall also include all sidewalks used for service and emergency vehicular access.

2. Fire lanes shall be a minimum of 18’ wide.

32 16 00: Curbs and Gutters

32 16 13: Concrete Curbs and Gutters

Concrete curbs shall be formed of minimum 4000 psi concrete. Voids will not be accepted in the back of curbs. Cracked curbs will not be accepted.

32 17 00: Paving Specialties

32 17 23: Parking Space Marking

Non-handicap parking stalls shall normally be 8’-6” wide and 18’-0” deep with a 22’-0” aisle. Stall line markings shall be 4” wide single line, white color. If required include directional arrows in the contract.

32 30 00: Site Improvements

32 31 00: Fences and Gates

Fencing is required around all climbing hazards and grade installed mechanical and electrical equipment (i.e. cooling towers, emergency generators, etc.).

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" conduit with pull rope to a point 5' outside the building, 3' - 0" 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.

2. New buildings shall also be provided with outside water access. Turn-on valves must fit a standard four way universal water key with hose connections sized for a standard garden hose.

3. Where down spouts are utilized, these should be tied into adjacent storm drainage. All down spouts are required to be 6" or larger.

32 90 00: Planting

Provide a Planting Schedule that specifies the types, number, and sizes of plants and trees.

32 91 00: Planting Preparation

Subgrade

Preparation of Subgrade: Specify that subsoil shall be loosened to a depth of 5" and graded to remove all ridges and depressions so that it will be parallel to proposed finished grade. Remove stones over 1" in any dimension, sticks, rubbish and other extraneous matter.

32 91 19: Landscape Grading

32 91 19.13: Topsoil Placement and Grading

Specify that all topsoil shall be tested against the following Specifications:

Physical Analysis (Soil Texture)

Quantity Percent by oven dry weight	Size Fraction inches	Range of Particle Diameter mm
Less than 2% gravel	larger than 1	25
Less than 3% gravel	1/4 to 1	6-25
Less than 10% gravel	2/25 to ¼	2-6
40% to 65% sand	1/500 to 2/25	.05-2.0

25% to 60% silt	1/12,500 to 1/500	.002-.05
Less than 20% clay	small 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"-6" compacted 85%.

Chemical Analysis

- Organic matter content (% oven 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. All new lawns and plantings shall have an underground irrigation system. See Section 02810.

2. Sod is always to be used, especially near building perimeters. Seeding is acceptable for Erosion and Sediment Controls but must be replaced with topsoil. Hydroseeding is not preferred. GMU will indicate the type of lawn treatment that will prevail.

3. Preferred sod shall be turf type tall fescue. Sod should be ½"-1" 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" 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 the 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" in diameter or greater and spaced at 4' 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 2' intervals.

Seed Mixtures

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% Chewings 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

Inspections

1. Inspections will be made at completion of the following tasks:

   A. At completion of the soil loosening phase to insure that the minimum depths have been achieved.

   B. At completion of the removals and /or screening phase to insure that specified dimension material has been removed.

   C. At completion of the top soiling phase to insure that full depth of cover has been achieved.

   D. At completion of the fine grading phase to insure that specified slopes, uniformity and positive drainage have been achieved.

   E. At completion of the seeding and mulching phase to insure adequate coverage.

   F. At the end of the 60 Day Maintenance Period to insure adequate percentage of growth and coverage as specified has been achieved.

2. 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 must be corrected at Contractor's expense before beginning next phase tasks.

32 93 00: Plants

Warranty

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 GMU, has been destroyed through root damage, loss of branches, bark damage, etc. shall be replaced by the Contractor at no cost to the Owner. 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 additional 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 Owner and promptly report to the Owner 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 Owner'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

Shade trees adjacent to parking lots shall have all limbs removed to a point 7'-0" above grade.

32 94 00: Planting Accessories

32 94 13: Landscape Edging

A Mowing Edge shall be installed at all trees and around perimeter of the Building

32 94 33: Planters

Install drainage in outdoor plant boxes.

Division 33 00 00: Utilities

33 00 00: Utilities

Underground steel pipe systems shall be cathodically protected using Pikotec or approved equal.

Pipeline Marker

1. All underground piping runs, both mechanical and plumbing shall be protected with buried pipeline marker. Marker to be 6 mil thick, 3" wide, florescent yellow polyethylene. Tape to be imprinted to read "Caution- buried pipe below".

2. Tape to be placed 1' 0" directly above top of pipe, over entire length of run.

3. Tape to be placed on top of 4" deep x 6" wide layer of clean white sand.

4. 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 Rutgers, prior to backfilling.

33 10 00: Water Utilities

1. Major water mains shall be ductile iron, cement lined, mechanical joint with thrust or rod as necessary. Cover exterior pipes per Factory Mutual requirements (or minimum 3'-6").

2. Reference Standards: Installation of underground fire protection mains shall comply with the following standards:

   A. NFPA No. 24, Private Fire Service Mains and their Appurtenances

   B. Factory Mutual Data sheet 3-10, Fire Service Mains

3. Piping: Shall be listed for fire protection service and comply with AWWA standards. Underground mains shall be cement lined ductile iron.

4. Depth of Cover: The depth of cover over fire protection water mains shall be not less than 4 1/2 feet, measured from the top of the pipe to finished grade.

5. Pipe Joints: All bolted joint assemblies shall be cleaned and thoroughly coated with asphalt or other corrosion-retardant material after installation of the assembly and prior to inspection and backfilling.

6. Anchoring: Mechanical joints shall be utilized on all tees, plugs, hydrant branches and bends. These joints on underground pipe shall be restrained against movement. Restraint shall be via thrust blocks, and/or rods and clamps.

7. Thrust Blocks: Thrust blocks shall be provided at all tees, plugs, caps, bends and hydrants and shall be of concrete mix having not less than 2,000 psi strength at 28 days. Thrust blocks shall be poured between the underground pipe and undisturbed earth, leaving the pipe joint accessible for inspection and repair, and not obstructing the fire hydrant drain ports. Thrust blocks shall be sized in accordance with table 8-6.2.7 of NFPA-24.

8. Flushing: Underground mains and lead-in connections to system risers shall be flushed thoroughly before connection is made to sprinkler, standpipe, or other fire protection system piping in order to remove foreign materials which may have entered the pipe during the course of the installation. The minimum rate of flow shall be not less than the demand rate of the system or the following rates, which ever is the greater:

Pipe Size	Flow Rate
4"	400 gpm
5"	600 gpm
6"	750 gpm
8"	1000 gpm

9. Fire Hydrant: The hydrant shall contain one 4-1/2" National Standard Fire Hose Thread (NST) pumper outlet and two 2-1/2" NST hose outlets. The pumper outlet shall be adjusted to face in the direction prescribed by the University, and such adjustment, if necessary, shall be made by the installing contractor prior to acceptance of the installation by the University.

   A. All fire hydrants shall be set on a gravel bed of at least 12" deep, minimum to ensure quick drainage from the ports provided near the base of the hydrant barrel.

   B. The center of the pumper connection shall be not less than 12" above final grade.

10. Inspections and Tests: No underground fire protection pipe assembly or fire hydrant shall be backfilled prior to inspection and approval of the installation by the University.

    A. A hydrostatic test shall be performed on the underground fire protection pipe assembly upon completion of the installation. All components, such as valves, fittings, hydrants, etc. shall be installed prior to the final test. The Contractor may conduct preliminary testing for his benefit, however the University will not accept such preliminary testing in lieu of the final required inspections and tests. The hydrostatic test shall be performed for not less that two hours, and shall be witnessed by the University.

    B. A contractor's material and test certificate for Underground Pipe shall be completed and submitted, by the Contractor, to Factory Mutual Engineering and the University on an approved form. The contractor shall provide a hydraulic design placard at the main riser base.

11. The contractor will be required to provide water meters per Fairfax County specifications. See 15120.

33 30 00: Sanitary Sewerage Utilities

Minimum cover under roads for Sanitary Sewer systems shall be 3'-6" and minimum slope shall be 1" in 15'-0" (.55% slope).

33 40 00: Storm Drainage Utilities

33 41 00: Storm Drainage

1. Trench type storm drains are to be avoided.

2. Road grates shall be Campbell Foundry Company #2617, or approved equal. These grates are bicycle safe grates.

3. The top of lawn grates shall be set 1/2" below finished grade level to facilitate drainage. Lawn grates shall be round.

4. Specify that Contractor shall clean interior of piping after installation.

5. Manholes: Specify precast concrete, 4000 psi minimum with rubber gasket joints. Wall to be 5" thick with aluminum drop front ladder rungs, 12" o.c. Base, as a minimum, shall be 6" thick with #4 bars 12" o. c. both ways. Manhole openings shall be 30" diameter with roadway type frame and cover by Campbell or Neenhah Foundries, or approved equal. Entire interior concrete surface shall receive 2 coats "Drycon" as manufactured by I. P. A. Systems, Inc.

33 60 00: Hydronic and Steam Energy Utilities

See High Temperature Hot Water Tunnel clearance detail in Part V – Standard Details.

33 70 00: Electrical Utilities

1. 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. Marker tape shall be standard metallic lined, permanent, bright red colored continuous printed plastic tape for direct burial service, not less than 6 inches wide by 4 mils thick, and printed, "caution electric line buried below."

2. Service runs from existing manholes and/or buildings to new buildings shall be run in duct banks. Duct banks shall use 4" minimum PVC schedule 40 ducts supported on approved spacers and encased in red concrete, and located a minimum of 30" below grade to top of bank. Runs under traffic areas shall be reinforced. Duct bank runs shall be no greater than 300 feet long, unless otherwise approved, and run into manholes as needed to serve the facility.

3. Service runs to outdoor or indoor building unit substations shall be underground conduits two 4" schedule 40 PVC runs minimum; use four 4" PVC if for loop feed service; and encase in red concrete. Low voltage service runs to buildings shall be sized per load being served and shall include a minimum of 2 spare ducts.

4. Duct run terminations shall be made using rigid galvanized steel conduit. Slope duct runs into manholes to drain, and runs shall be essentially straight between manholes. Ducts shall be run below gas lines, and where ducts cross high temperature water lines a minimum separation of 3 feet shall be maintained, and a minimum of 6" thick foamglass type insulation extending at least 4 feet in both directions of crossing shall be used.

5. Electric Manholes:

    a. Construction: Electric manholes shall be a minimum of 6 feet square and 7 feet deep at the inside dimensions. Hardware shall include pulling eyes and inserts, and cable racks. Concrete 4000 psi at 28 days, with re-bar reinforcement. Precast manholes are preferred.

    b. Drains: Manholes shall be provided with a drain to the storm sewer that will not backwash shall have a sump cast into the floor next to the ladder into which a portable sump pump can be installed. Floor shall slope to sump.

    c. Covers: Manhole covers shall be round, having a standard manhole frame and cover. The cover shall be 30" in diameter and have the word ELECTRIC or TELEPHONE cast into it. Install frame and cover assembly on at least 4 courses of brick or precast concrete rings to allow adjustments to surrounding finish grade. Manholes shall be labeled as confined spaces.

    d. Ground: A copperweld ground rod shall be installed in each manhole for bonding of hardware and cable sheaths.

Telecommunications Service Entrance

1. Identify communications manhole to be used on the building plans. Telecommunications Staff will specify. Provide new manhole and underground path to the building if the existing manhole is not available. Distance between manholes should not exceed 600'. The total number of bends in a conduit run shall not exceed two 90^{o} bends or equivalent of sweeps and radius bends. Each bend will have a minimum radius in accordance with existing standards (10 times the I.D. minimum for the bend radius).

2. Install four (4) - Four (4) inch diameter polyvinyl chloride PVC schedule 40 conduits from existing and/or new manholes to the building shear line. The conduits will be installed at a minimum depth of 30" and backfilled with select material. An orange warning tape will be placed in conduit trench approximately 12" below the surface. Encase conduits in concrete (2,500 PSI), except when terminating at a pole. When terminating at a pole, clamp the conduit(s) rigidly to the field side of the pole at a 90^{o} separation from power.

3. Galvanized steel conduits should be used from the inside of the, building to undisturbed earth to Prevent a "shearing point" at the building edge. Conduits terminating inside a building will be installed so that the conduit extends four (4) inches beyond the surface from which it emanates. Conduits shall be plugged with inserts to ensure that foreign matter does not enter the building. The ends of metallic conduit shall be reamed, bushed and grounded according to the National Electric Code. All conduits are to be installed with a minimum 200 lb. test noncorrosive graduated pull tape.

   (* Minimize routing of conduits under the building foundation.)

4. Provide and install the 6'W X 12'L X 7'D in-line manholes allowing two splicing bays and 7'W X 9'L X 7'D auxiliary manholes as needed. Prefabricated manholes preferred whenever possible. Manholes should be equipped with cable racks, pulling irons, 8" sump hole, frame, cover and ladder. A 6'-6" galvanized straight steel ladder is required when the chimney height is 12 inches or less. When the chimney height is 12 inches or more, a hooked ladder is required and manhole steps are to be provided at 12 inch intervals. The frame shall have a nominal opening of 27 inches and the cover is to be marked with a "C"; "Communications", or "T"; "Telephone".

5. Terminating Space for the service entrance shall have a 3/4' trade size A-C plywood. 8 ft. High X 4' Wide. The terminating space shall include a two 11O V, 20 -amp AC Power outlets and lighting equivalent to 50 foot-candles 3 feet above the floor. A #6 ground should be provided at the terminating space.

End of Section

Division 34 00 00: Transportation

End of Section

Division 35 00 00: Waterway and Marine Construction

End of Section

Division 40 00 00: Process Integration

RECENT REVISIONS:

40 92 49..... Updated VFD requirements.

40 90 00: Instrumentation and Control for Process Systems

40 92 00: Primary Control Devices

40 92 49: Variable Frequency Drives (VFD)

Manufacturer Preference

1. Yaskawa is the preferred manufacturer.
2. ABB
3. Trane

All VFDs shall be provided with a manual or automatic type constant speed bypass circuit. The bypass circuit shall be provided in the drive enclosure. A harmonic analysis shall be performed by the drive manufacturer based on the system documentation. Provide this information as a part of the submittal. Provide isolation transformers in a separate enclosure. VFDs shall include input line reactor.

Electrical output for variable speed drives shall not exceed 10% THD.

End of Section

Division 41 00 00: Material Processing and Handling Equipment

This section is under construction.

End of Section

Division 42 00 00: Process Heating, Cooling, and Drying Equipment

This section is under construction.

End of Section

Division 43 00 00: Process Gas and Liquid Handling, Purification and storage Equipment

This section is under construction.

End of Section

Division 44 00 00: Pollution Control Equipment

This section is under construction.

End of Section

Division 45 00 00: Industry-Specific Manufacturing Equipment

This section is under construction.

End of Section

Division 48 00 00: Electrical Power Generation

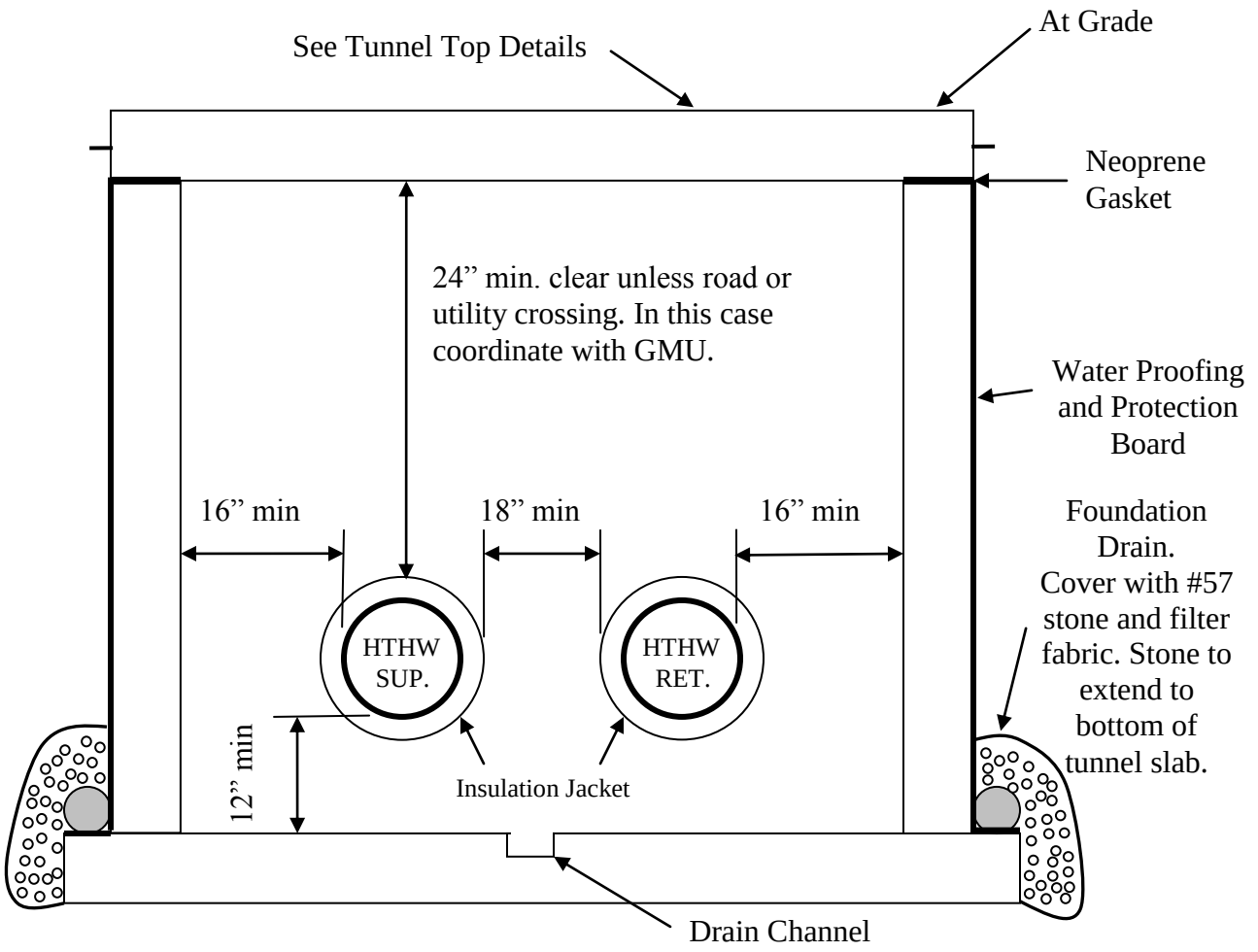
This section is under construction.

End of Section

PART V - STANDARD DETAILS

HTHW Tunnel Detail, Fairfax Campus

BACK to Div. 33 60 00 ** NOT TO SCALE ** **BACK to Div. 03 31 00**

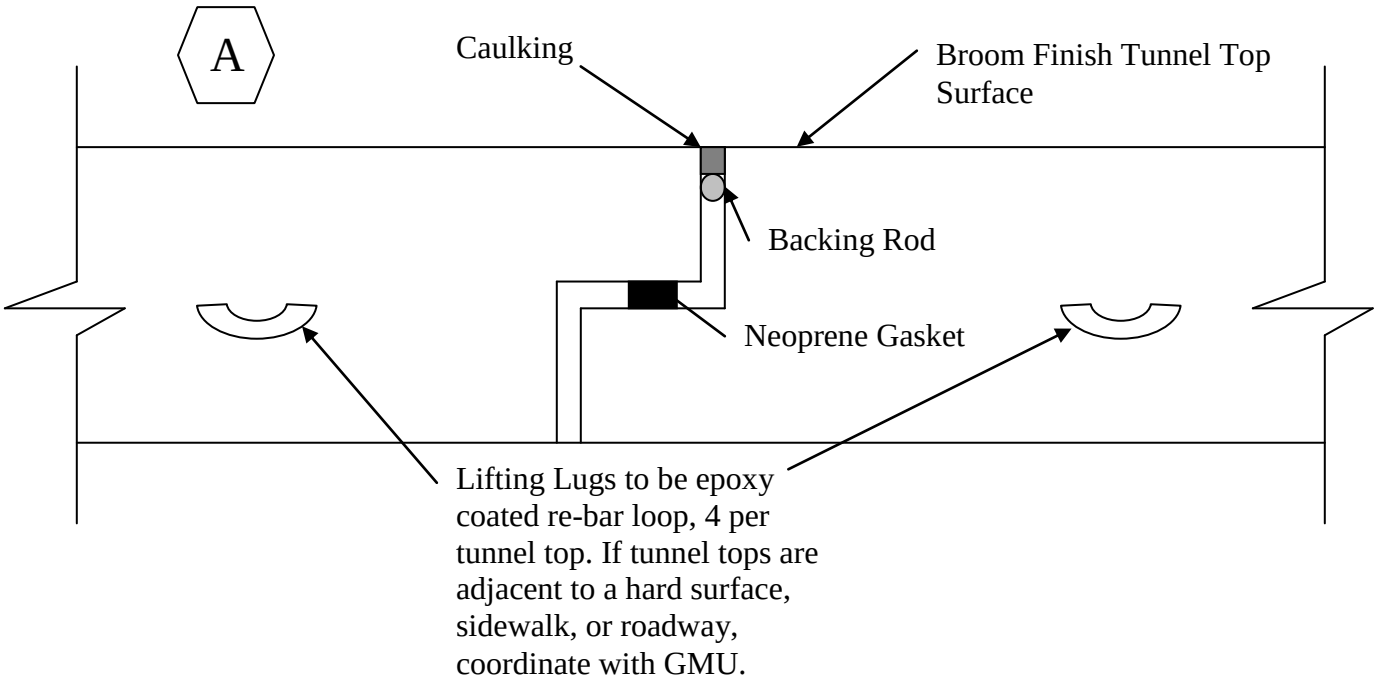


Notes:

1. Manholes, tunnel and piping to be designed by a Virginia registered 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. Provide 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. clearance.

HTHW Tunnel Top Details:

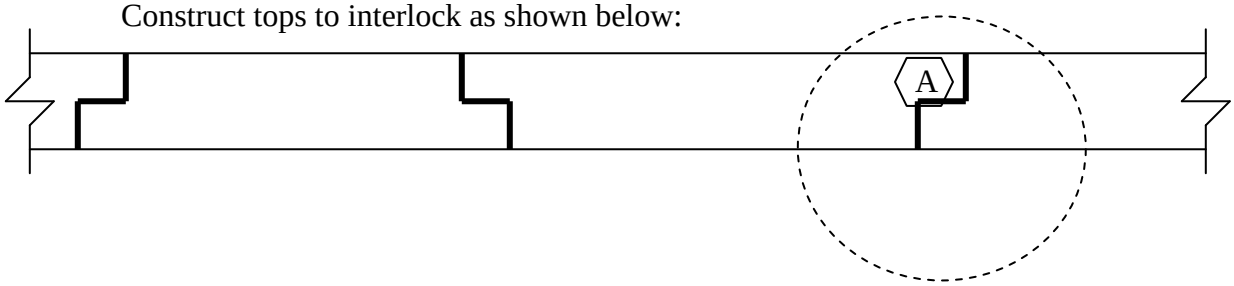
BACK to Div. 33 60 00 NOT TO SCALE **BACK to Div. 03 31 00**



Notes:

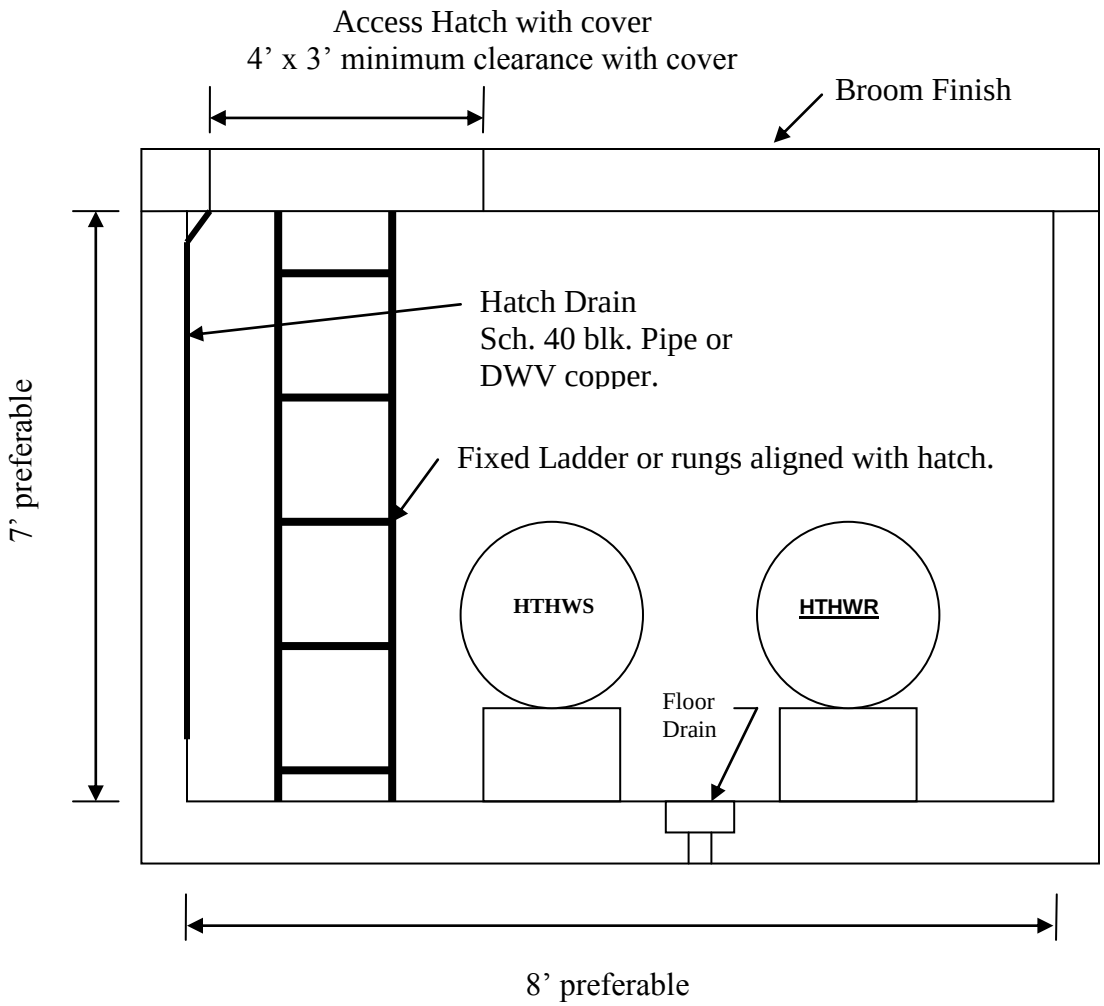
1. Construct tunnel and tops for H-20 loading.
2. Tops at grade unless precluded by abrupt grade changes, road crossing or other obstruction.
3. Tunnel tops not to exceed 4,500 pounds each.

Construct tops to interlock as shown below:



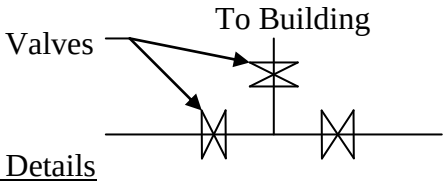
HTHW Manhole Detail

BACK to Div. 33 60 00 NOT TO SCALE **BACK to Div. 03 31 00**



Notes:

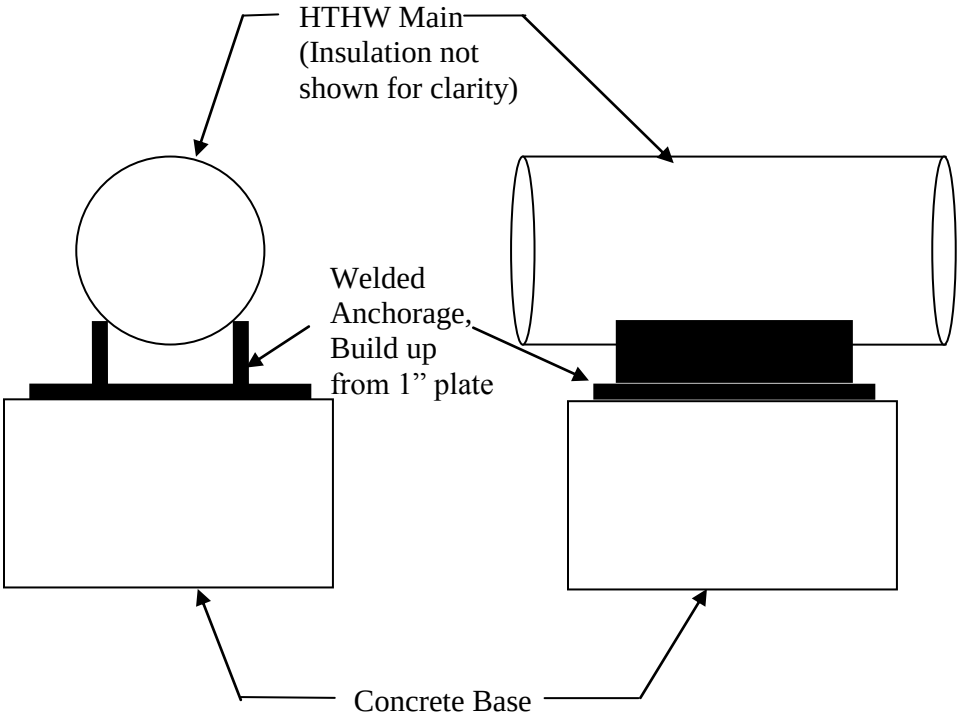
1. Construct Manhole for H-20 loading.
2. Manholes are required at building take-offs and valve locations only.
3. Floor drain to be piped to Storm Sewer.
4. At lowest Manhole in the piping run include HTHWS & R drains piped to a tempering tank, to be discharged into sanitary sewer.
5. If a sump pump 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:



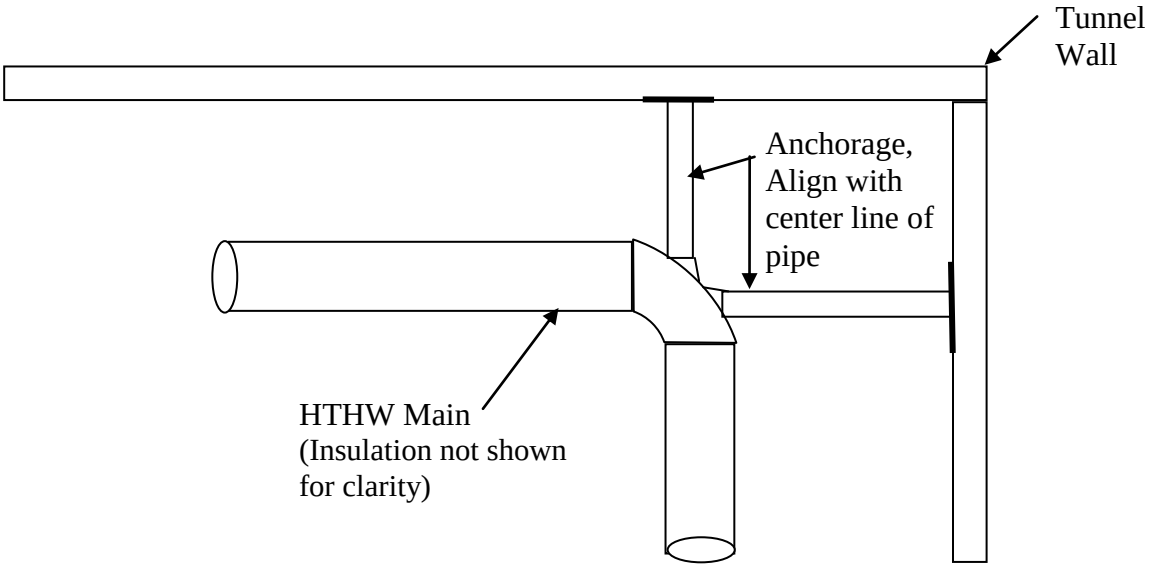
HTHW & Chilled Mains

HTHW Main, Preferred Anchorage Details

**NOT TO SCALE **



Preferred Corner Anchorage: **** NOT TO SCALE ****



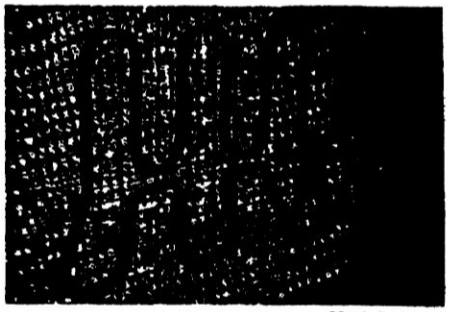
THE RIBBON® RACK by brandir

IMPORTANT CONSIDERATIONS

COLORS (Painting/Coating)—Painting or coating the rack will result in a maintenance problem, as no coating will withstand the abuse of the bicycles *Powder coating cannot be maintenanced; an enamel finish will chip* A A A RIBBON® Rack Co has the best solution where color is essential Please contact us to find out how to achieve an appropriate color with a minimum of maintenance

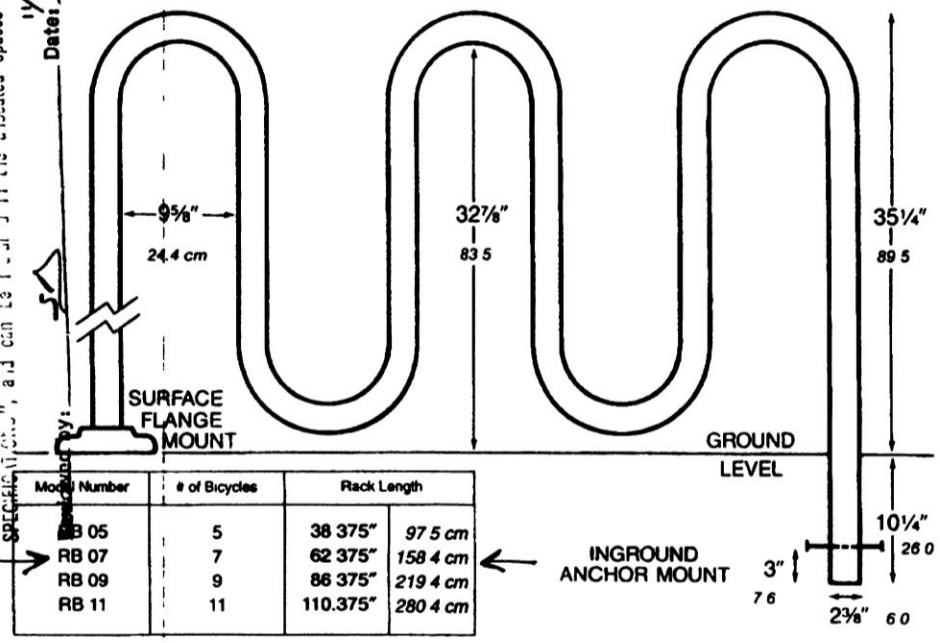
MATERIALS—Steel tubing or aluminum are not suitable materials for a bicycle rack Pre-galvanized material will flake and crack during manufacture A A A RIBBON® Rack Co, uses heavy-duty steel pipe, hot-dipped galvanized after fabrication to provide security and durability

MANUFACTURE—Hydraulic bending with a mandrel, as used by A A A RIBBON® Rack Co insures smooth and aesthetic curves on The RIBBON® Rack. Dress bending leaves an indentation, other methods flatten outer curves and crimp inner curves.



Model RB 09

"THE RIBBON® RACK — IDSA NATIONAL DESIGN AWARD WINNER"



Model Number	# of Bicycles	Rack Length	
RB 05	5	38 375"	97 5 cm
RB 07	7	62 375"	158 4 cm
RB 09	9	86 375"	219 4 cm
RB 11	11	110.375"	280 4 cm

General

'RIBBON' and the Brandir International Inc logo are trademarks of **Brandir International Inc** used exclusively by **A A A RIBBON® Rack Co**

Delivery time Six weeks or sooner from receipt of order

or prices and information contact
A A A RIBBON® RACK CO , INC
Division of
BRANDIR INTERNATIONAL, INC
521 Fifth Avenue 17th Floor
New York, NY 10175 USA
212 505 6500 Fax 212 505 6813

Specifications

All standard units made from ASTM A53 SCHEDULE 40 steel pipe (2 375" OD × 154 wall) hydraulically bent with a mandrel, hot-dipped galvanized after fabrication

Installation methods
inground anchor mount (standard)
freestanding mount } (optional & extra)
surface flange mount }

The RIBBON® RACK is available in ASTM A312 SCHEDULE 40 TP 304 stainless steel, satin #4 finish (optional and extra)

Specifying / Estimating / Ordering

Please use the following notation

Quantity
RIBBON®
05, 07, 09, 11 — Model Number (# of bicycles)
F — Freestanding Mount
I — Inground Anchor Mount
S — Surface Flange Mount
G — Galvanized
S — Stainless Steel

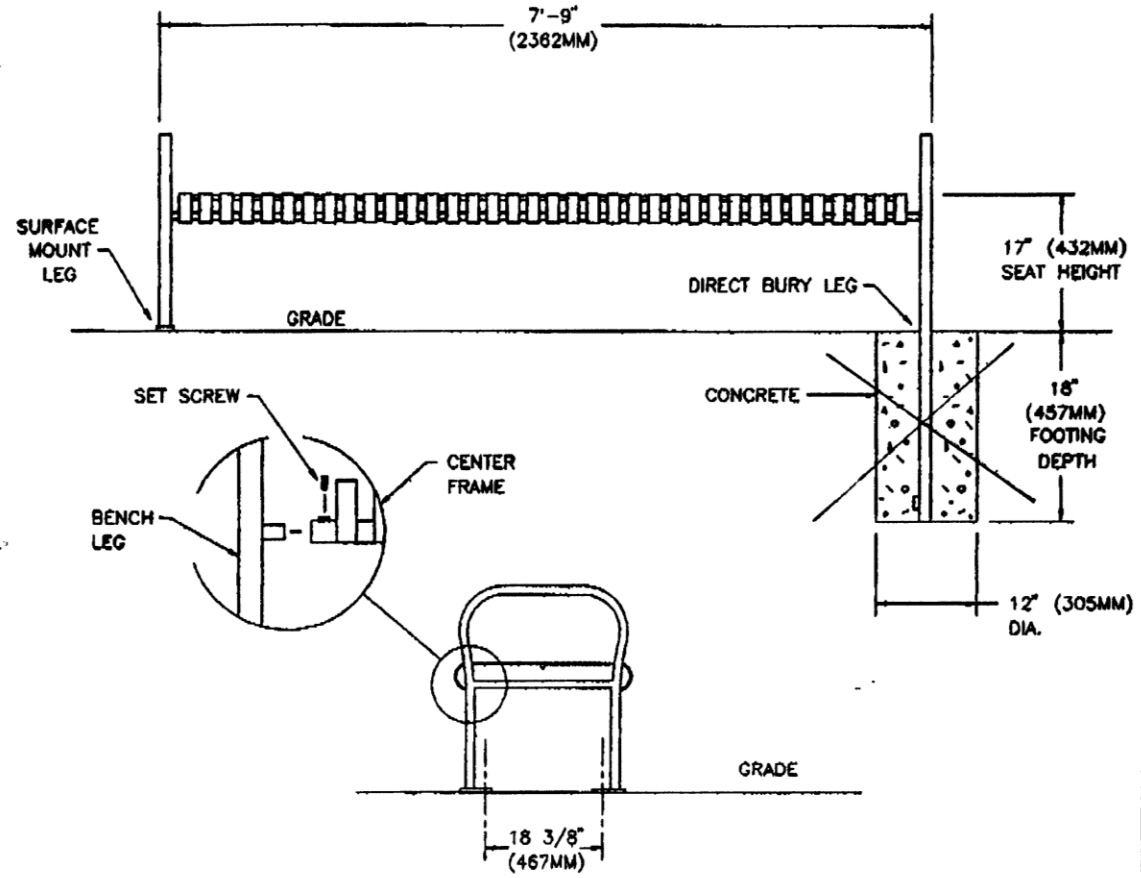
RB

Back cover photo / Joanne Gere

Printed in U S A.

1995 Brandir International Inc

CUSTOM STRUCTURES, INC
670 MERCER ROAD – P O BOX 1888
BUTLER, PA 16003–1888
PHONE (412)282–2712 FAX (412)283–4713



SPECIFICATIONS

STEEL

CENTER FRAME
1 5/8" O D
H S TUBING
11 GAUGE
&
3/8 X 1 1/2" FLAT
&
1/2" SOLID
ROUND ROD

BENCH LEGS
1" SQ SOLID BAR
&
3/8 X 1 1/2" FLAT

FINISH
POWDER COATED

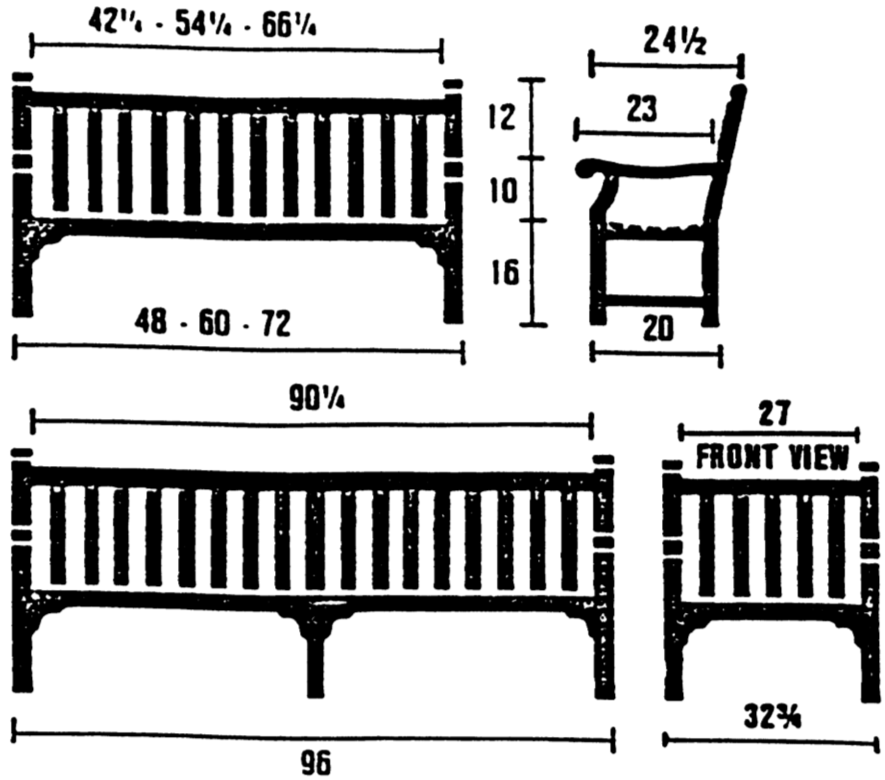
HARDWARE
3/8" X 3/8" SET SCREWS

DRAWN BY	D W R
DATE	2–3–94

PULLMAN SERIES BENCH W/O BACK
ELEVATIONS & ASSEMBLY DETAIL
P18S – (8'–0" SURFACE) ~~P18B – (8'–0" BURY)~~

ARCH, PLEASE PROVIDE CUSTOM COLOR

<u>Outdoor Benches, Arlington Campus</u>



All dimensions are shown in inches.

The equipment and material shown and marked in this submittal is to be incorporated into this Project is in compliance with the Contract drawings and specifications unless otherwise shown in bold face type or lettering and listed on a page or pages headed "DEPARTURES FROM DRAWINGS AND SPECIFICATIONS", and can be installed in the allocated spaces

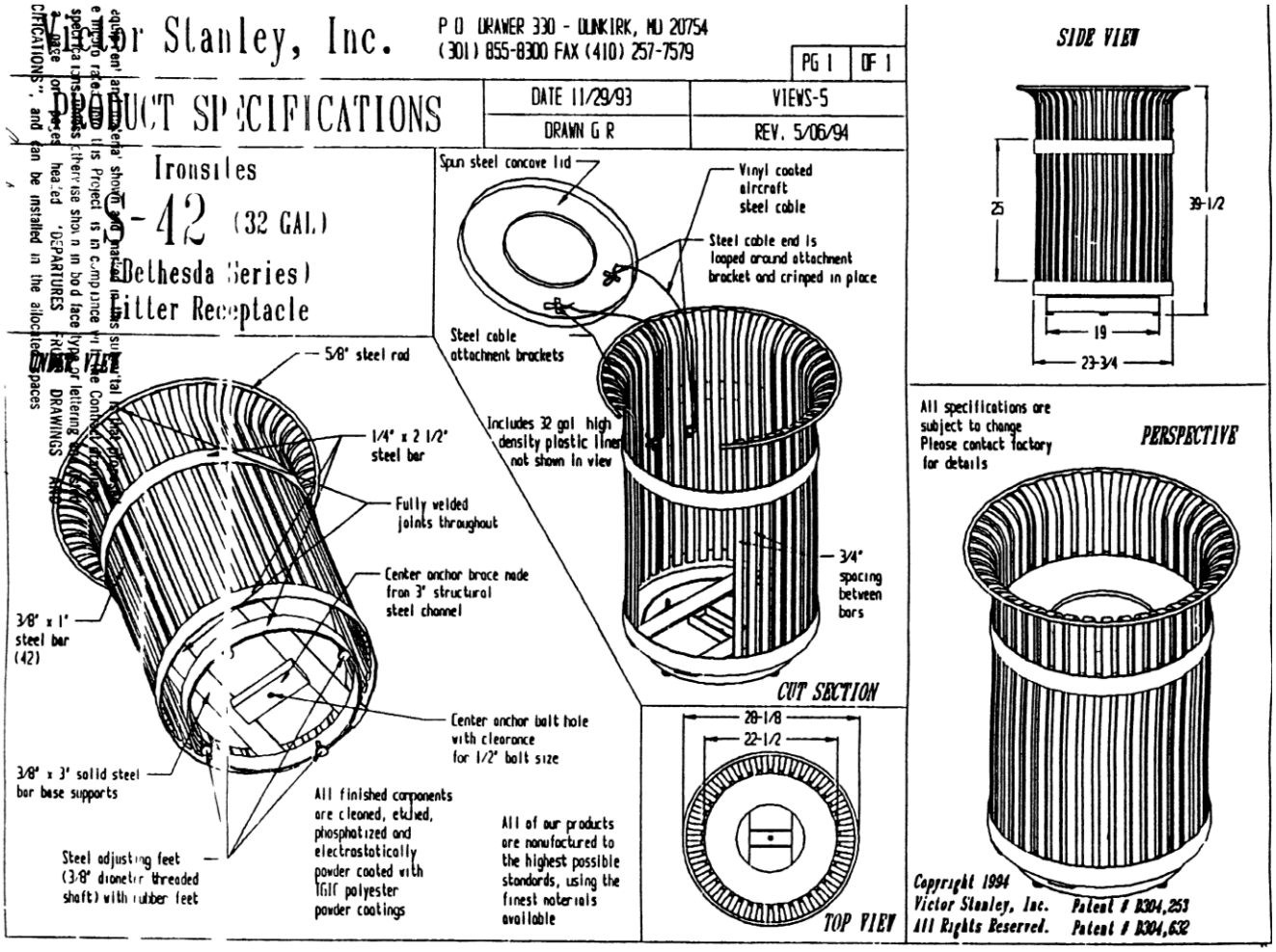
Reviewed by: Lou Thomas **Date:** 8/17/94

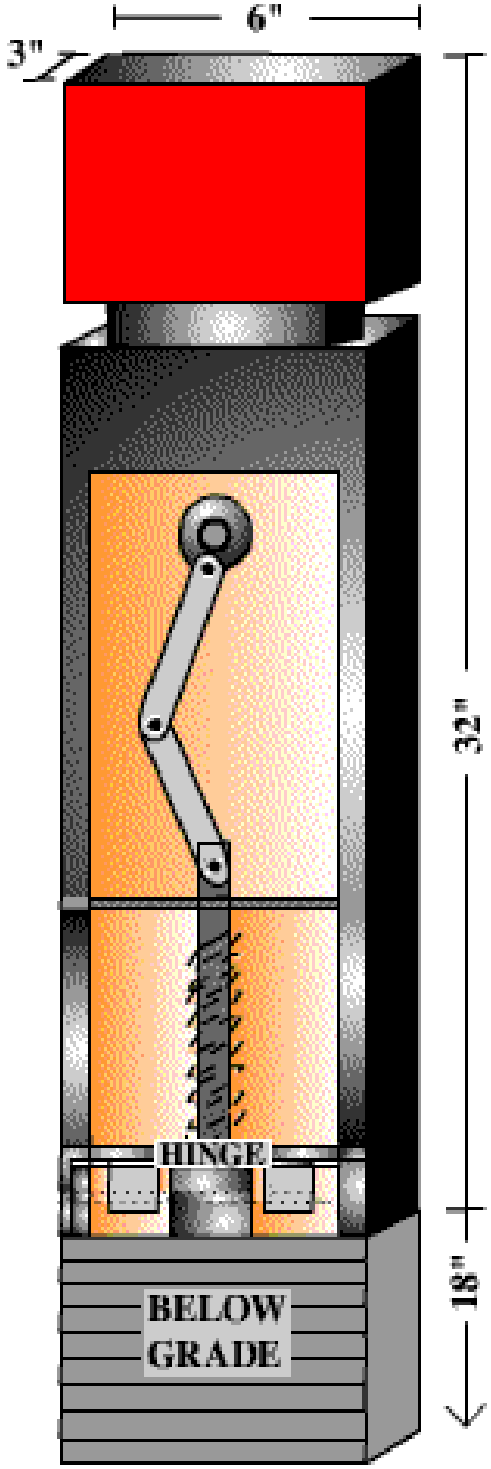
2870-1

Victor Stanley, Inc.

P.O. Box 144 (301) 855-8300
Dunkirk, Maryland 20754

"DUNKIRK"	Date 6-86	Scale	SHT. 1
	Dwn.	Rev.	OF 1


Victor Stanley, Inc.
P O DRAWER 330 - DUNKIRK, MD 20754
(301) 855-8300 FAX (410) 257-7579
PG 1 OF 1
PRODUCT SPECIFICATIONS
DATE 11/29/93
VIEWS-5
DRAWN G R
REV. 5/06/94
Ironsides
S-42 (32 GAL)
(Bethesda Series)
Litter Receptacle
SIDE VIEW
25
39-1/2
19
23-3/4
All specifications are subject to change Please contact factory for details
PERSPECTIVE
Spun steel concave lid
Vinyl coated aircraft steel cable
Steel cable end is looped around attachment bracket and crimped in place
Steel cable attachment brackets
Includes 32 gal high density plastic liner not shown in view
3/4" spacing between bars
CUT SECTION
5/8" steel rod
1/4" x 2 1/2" steel bar
Fully welded joints throughout
Center anchor brace made from 3" structural steel channel
3/8" x 1" steel bar (42)
Center anchor bolt hole with clearance for 1/2" bolt size
3/8" x 3" solid steel bar base supports
Steel adjusting feet (3/8" dionetir threaded shaft) with rubber feet
All finished components are cleaned, etched, phosphatized and electrostatically powder coated with TGIC polyester powder coatings
All of our products are manufactured to the highest possible standards, using the finest materials available
28-1/8
22-1/2
TOP VIEW
Copyright 1994
Victor Stanley, Inc.
All Rights Reserved.
Patent # D304,253
Patent # D304,632



BACK