DIVISION 16 - ELECTRICAL

Section 16000 - General Discussion

Introduction

Refer any questions, clarifications regarding Division 16 to UA Facilities Design & Construction.

The electrical system is very important to the operation of many of the aspects of the operations of the University of Arizona. Many of the buildings have testing which need to go on continuously and if the electrical power goes out during the testing then millions of dollars of work and equipment can be destroyed. For this purpose it is very important to supply the most reliable electrical equipment system that can be designed. It is for this reason that many of the systems and specifications enclosed herein exceed the requirements of the National Electrical Code. In addition it must be understood that:

The National Electrical Code is a minimum standard of the quality of work that can be used and shall not be used as a maximum for the quality of the electrical system.

The DSS is a standard each Consultant, Builder and Project Manager needs to study as a standard for ALL University of Arizona renovations and new work.

The local lighting ordinances are exceeded.

Use of metal Halide light sources shall not be permitted without written approval of the Director of Facilities Design & Construction.

The University of Arizona is itself a small utility which maintains all of the secondary power distribution to all of the buildings on its campus at both 13.8KV and 4.16KV. The standards specified herein reflect the requirements of this "utility". Note that at some other locations interface with standard utility requirements will be required. In those cases only will these standards be overruled. Attention to fault current and how it affects systems must be observed. The system energy capacity increases on an ongoing basis, as the result of ongoing campus utility modifications.

ELECTRICAL SWITCHBOARD ROOMS

Whenever the design for a new building or major expansion of an existing building is to take place special consideration shall be made for providing an electrical distribution switchboard room which is sized adequately to house all of the major electrical switchboard items which would need to be installed on the project. This shall include the primary distribution switchboard (usually 480 volt), the Fire alarm panel, some of the secondary transformers and 120/208 volt distribution panelboards, the automatic transfer switch, the generator status panel, and the motor control center (where required). This room shall have built in at least 40% spare capacity to allow for installation of future equipment as necessary and storage of pertinent electrical maintenance items. There shall be a minimum of two exits from the room with at least a 6' aisle between rows of electrical equipment or between electrical equipment and the wall. In addition a separate area shall be made to house the primary distribution transformer, the standby / emergency generator, and any primary distribution switchgear required (such as a PMH switch). This area shall be located in an equipment yard just outside of the main building walls.

SERVICES

Existing electrical services will require specific attention with respect to replacement and expansion. Projects where the existing service equipment is not to be replaced, need to be evaluated for fault current, overload, deterioration, grounding and safety violations. Where this work is designed by consultants, reports will be required at the Schematic Phase and addressed with Project Managers and the University of Arizona Electrical Engineer.
SINGLE LINE DIAGRAM MINIMUM REQUIREMENTS

Single line diagrams shall be complete representations of the designed electrical systems. The goal is to allow the bidding and constructing contractor to bid the job using the correct equipment. The reviewer will require clear indications that all electrical parameters have been considered. Bidding and review shall not require tedious deciphering of keynotes. Nor shall the reader be burdened in flipping feverishly from sheet to sheet.

Single line representations shall include, but not be limited to, display of voltage levels, wye and delta configurations, bus sizing, sizes and types of main and feeder overcurrent devices, vertical bus sizes, horizontal bus sizes, pull sections, metering sections, grounding, spare bussing, bus extension provisions, transformer sizes, main breaker or lug locations for panelboards and switchboards, (bottom, top or feed through) fault levels, overcurrent device frame sizes and trip ratings, TVSS connections, TVSS overcurrent protection, feeder sizes, transformer sizes and housekeeping pads, primary cable conductor sizes and any other information necessary to provide a complete representation of the system.

The use of keynotes shall be minimized in the labeling of equipment and system components.

Switches, pull stations and automatic door closers in areas where the construction requires glass walls, glass doors and similar construction, shall require the architect to design mullions to accommodate orderly installation. Consultant shall coordinate these devices with the architect.

LIGHTNING PROTECTION

Lightning protection shall meet and exceed the requirements of NFPA 780 and the NEC.

Protection shall be provided where NFPA 780 calculation shows MODERATE conditions OR whenever directed by UA Facilities Design & Construction.

If available, UL MASTER LABELING shall be included.

Design shall be performed by the electrical registrant for the project, put on plan and sealed. It shall not be done as a requirement specification. The Consultant may feel free to seek the expertise of Lightning Protection Companies in preparing their (the Consultant's) design.

Attention shall be given to the Suppression Requirements of NEC for data, power and phone. Attention needs to be given to the material types and quality of lightning specific components and how they are fastened to the building. Mastics shall not be the primary method of attachment. Components shall be copper or bronze. Wire shall be copper. Down conductors shall be the braided UL approved copper product specifically designed for the application. Ground plates are allowed for existing buildings where grounding by other methods is not practical.

Examine the job site prior to completing your fee. Contact CCIT for suppression needs and methods. Determine such things as RF antenna on roofs, walls or parapets, "Add on" suppression for power shall be either APT OR CURRENT SYSTEMS products, not less than 180 ka per phase.

Firms having 3 dimensional capabilities shall include this graphic presentation

Consultants shall evaluate the need for lightning protection on all new buildings and building additions. Utilize the assessment criteria in NFPA 780. Risk factors in the highly moderate to severe category shall require lightning protection.

COORDINATION OF PROTECTIVE DEVICES AND STUDIES

Coordination studies, protective relay studies and adjustments shall be performed by registered electrical engineers skilled in this area of expertise.

The consultant shall design the system and perform key device coordination as part of his/her scope of work. This will require a basis of design "brand" in some cases. This in NOT to be an exhaustive Coordination Study. The consultant will give special attention to the sizing of busses, services transformers, motor control centers and distribution panelboards so as to assure clean system coordination. The upper device shall be the 13.8KV pad mounted switch fuse sized for less than 200 amperes. The Pad Mounted Switch (PMS) shall feed the service

transformer. The transformer shall have its own fusing to protect it.

The consultant shall submit selectivity curves in the design document and final construction documents show clean coordination of the devices aforementioned.

The consultant shall write the specifications to reflect the following:

Contractor shall submit equipment based on the basis of design or one of the approved equals. The contractor shall provide with the submittal, a coordination study based on the equipment submitted. The contractor shall be required to submit equipment equal in characteristics to the basis of design. That is to say the selectivity of the overcurrent devices shall be as clean in coordination as the basis of design devices.

Should the contractor submit a study, including related equipment submittal, that does not give clean coordination, the contractor shall be obligated to change components to allow clean coordination and selectivity, prior to getting approval for releasing equipment for manufacture at no cost to the Owner.

The contractor may utilize factory trained coordination engineers to prepare the study. However curves must be plotted on standard log-log paper, 11 in x 17 in.

References to clean coordination and selectivity shall be as defined in IEEE STD 192, as interpreted by the University of Arizona Electrical Engineer.

Coordination shall reflect all intentions of system planning per IEEE Std. 192.

TEMPORARY STANDBY POWER

Temporary standby power used to power existing critical (research not life safety) building loads shall require the presence of an approved generator technician for the duration of the outage.

Part 1 - General

- These electrical standards represent the minimum quality of workmanship and the minimum quality of equipment which are required for the projects which are to be constructed on this site. The general attitude about the equipment and materials to be supplied is that this University will be here for many years to come and the projects which we construct now shall be able to be in service for 10,15, 20, or more years without needing to be renovated due to the lack of quality of the electrical equipment or workmanship. In addition renovations will need to be made in the future to many of the areas which are under design today and for that reason spare capacity is to be built into the design to allow for a certain amount of flexibility for the future. Where the design engineer has some areas where he prefers to see an even higher level of quality than what

  is set by these standards he shall make the design to meet that level of quality as long as that design provides a cost effective design. Sometimes even though the design costs are considerably higher the actual costs including maintenance over the life of the product make it cost effective.

- Working In Confined Spaces

  - Whenever work is required within a confined space, e.g., utility vaults, utility tunnels, sumps, pits, sewers, etc., contact UA Risk Management and Safety Department for details and procedures on UA Confined Space Entry Program.

- *As-Builts*

  - *As-Builts shall be prepared by the Contractor and professionally hand drafted in a clear legible manner. These As-Built annotations will then be drafted on the reproducible Record Drawing by the Consultant. See Tab B-9.*

Part 2 - Products

- Specify the highest quality, best made type of equipment which is manufactured today. Balance this with maintaining quality while conserving cost. If there are materials which you know from working with them in the past which you know will not meet the requirements of this area of the specifications, then word your specifications to delete those items from being considered for use. Any types of material which by their very nature need to be looked at for meeting the quality that will be specified needs to be specified to be submitted upon prior to installation for review by both the Design Engineer and the Facilities Engineer at the University of Arizona. Single sourcing of a certain type of material shall be made only when other materials would not meet either the standard of the University or the required operation of the system for which it is specified. In most cases single sourcing will not be permitted. The use of one or two manufacturers which supply equipment which is known to meet the standards which are required for the particular operation which is specified shall be utilized. Other manufacturers which may not be known at the time of design or who in the past have manufactured equipment which is not the same quality as that which is specified then will have the ability to submit their equipment in accordance with the requirements of specification section 1300.

- When specifying equipment, attention shall be given to assure that if a particular manufacturer is specified, that all related equipment is specified with regards to the same manufacturer. For instance, if GE were specified for panelboards, regards should be given that disconnects, switchboards, motor starters and transformers be GE. Single sourcing already has been officially justified for fire alarm equipment, primary pad mounted switches and variable frequency drives. Prior approval is required for engine generators, transfer switches and primary cable deviations. There is no or equal to be considered after bidding where prior approval is required.

Part 3 - Execution

- It is the intent of the University to have all new work installed in a quality manner and in a way that it is accessible for future maintenance and expansion. The installation shall comply with both the requirements of OSHA, ADA Guidelines, NFPA, NESC and the NEC. In complying with OSHA regulations we wish to comply especially with the requirements of the lockout/ tagout regulations, and provide the personnel who have to work on the mechanical equipment serviced by the new electrical system with a completely maintainable system based on those regulations. As far as the quality of workmanship, we would like to have the electrical system installed in such a way that it both is functional, and looks like it has been installed in a professional manner.

End of Section 16000

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Coordination shall reflect all intentions of system planning per IEEE Std. 192.

- Selectivity curves shall be labeled with plain English nomenclature that identifies the devices on the project single line diagram, not some dapper reference file name. Each curve set shall have a l-line on the same page.

Consultants shall provide fault current levels for all new equipment required to have ARC FAULT labeling as required in NFPA 70E.

TEMPORARY STANDBY POWER

Temporary standby power used to power existing critical (research not life safety) building loads shall require the presence of an approved generator technician for the duration of the outage.

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- As-Builts

- As-Builts shall be prepared by the Contractor and professionally hand drafted in a clear legible manner. These As-Built annotations will then be drafted on the reproducible Record Drawing by the Consultant. See Tab B-9.

- Details
  - Consultant shall provide graph scales on all sheets.

- Misc.
  - When panel boards are replaced, replace respective feeders and feeder breakers
  - Designers shall coordinate motor service factors and efficiencies with mechanical trades and mechanical designers and bring this to the attention of the contractors.
  - The consultant shall make it clear to the contractor that deviations in design of major equipment shall not be a liberty that will be accepted. All equipment specified and supplied shall have been in the market place for a minimum of 2 years prior to bid date.

Part 2 - Products

- Specify the highest quality, best made type of equipment which is manufactured today. Balance this with maintaining quality while conserving cost. If there are materials which you know from working with them in the past which you know will not meet the requirements of this area of the specifications, then word your specifications to delete those items from being considered for use. Any types of material which by their very nature need to be looked at for meeting the quality that will be specified, needs to be specified to be submitted upon prior to installation for review by both the Design Engineer and the Facilities Engineer at the University of Arizona. Single sourcing of a certain type of material shall be made only when other materials would not meet either the standard of the University or the required operation of the system for which it is specified. In most cases single sourcing will not be permitted. The use of one or two manufacturers which supply equipment which is known to meet the standards which are required for the particular operation which is specified shall be utilized. Other manufacturers which may not be known at the time of design or who in the past have manufactured equipment which is not the same quality as that which is specified then will have the ability to submit their equipment in accordance with the requirements of specification section 1300.

- When specifying equipment, attention shall be given to assure that if a particular manufacturer is specified, that all related equipment is specified with regards to the same manufacturer. For instance, if GE were specified for panelboards, regards should be given that disconnects, switchboards, motor starters and transformers be GE. Single sourcing already has been officially justified for fire alarm equipment, intrusion detection equipment, telephone/data hardware, primary cable, primary pad mounted switches and variable frequency drives. Prior approval is required for engine generators, transfer switches and primary cable deviations. There is no or equal to be considered after bidding where prior approval is required.

Part 3 - Execution

- It is the intent of the University to have all new work installed in a quality manner and in a way that it is accessible for future maintenance and expansion. The installation shall comply with both the requirements of OSHA, ADA Guidelines, NFPA, NESC and the NEC. In complying with OSHA regulations we wish to comply especially with the requirements of the lockout/ tagout regulations, and provide the personnel who have to work on the mechanical equipment serviced by the new electrical system with a completely maintainable system based on those regulations. As far as the quality of workmanship, we would like to have the electrical system installed in such a way that it both is functional, and looks like it has been installed in a professional manner.

- Contractors shall be required to label all equipment with ARC FAULT labels as outlined and required in NFPA 70E.

End of Section 16000

DIVISION 16 - ELECTRICAL

Section 16050 - Basic Electrical Materials and Methods

Introduction

The design shall be set up such that all equipment shall be provided and installed with the highest degree of quality and workmanship in both the type of equipment installed and the quality of the equipment installed.

Part 1 - General

- All work associated with the installation of electrical equipment at this site shall be accomplished by skilled workmen which are experienced in the type of work for which they are to accomplish. The contractor shall be licensed to do commercial or industrial electrical work. Each work crew shall consist of a maximum of 1 helper for each journeyman electrician. For all work involving the installation of medium voltage (above 600v) equipment the work shall be accomplished by a contractor having a class A-17 license. The workers on medium voltage systems shall be journeyman electricians. The definition for a journeyman electrician will be that the electrician shall have completed a minimum of 5 years in a combination of training and education of electrical equipment installation under the direction of skilled journeymen electricians.

- The plans and drawings are complimentary and anything indicated by either shall be required to be installed as if it were indicated on both.

- All work shall be installed and coordinated with all other trades. Conflicts shall be solved through a joint decision by the trades and shall be presented to the University for their approval.

- It is the responsibility of the contractor to visit the site prior to bid, and familiarize himself with any and all site conditions.

- Laboratory panels shall be accessible to users, not locked in electrical/mechanical rooms.

- Use of the metal clad cable, special restrictions:

    - Metal Clad (MC) cable will be permitted under the following circumstances:

        - In walls, for electrical outlets, stud wall construction, dry locations.

        - Following strict procedures regarding the routing. Each wall may have the MC cable running horizontally to adjacent receptacles. The run of MC cable shall <u>not</u> run horizontally to adjacent walls. Instead, the run shall go up in the wall to a J-box in the interstitial ceiling space.

        - Horizontal runs of circuitry in the interstitial ceiling space shall be in EMT or GRC. Home runs shall be EMT or GRC.

    - Metal Clad (MC) cable shall meet the following:

        - It shall be steel with factory installed conductor, stranded copper wire, each conductor color coded.

        - The end fittings shall be Arlington Industries, SNAP 2 IT with insulated throats. Substitutions will not be considered.

    - All other wiring systems shall be as specified.

    - Elevators shall have their own direct feed feeders.

Part 2 - Products

- All products specified for use at this site shall be UL listed or CSA certified for the use specified herein.

- Provide submittals for all equipment as indicated in the section under which it is specified in accordance with the provisions of Division 01300.

- All equipment shall be protected from the elements between time of delivery to site and actual installation. No equipment shall be installed until it is obvious that no normal damage will occur to the equipment between the time of installation and the end of the contract. All equipment, whether installed or on site awaiting installation, remains the property of the contractor until the end of the contract.

- Conduit Sleeves / Concrete Walls & Floors Above Grade

    - Shall be schedule 40 steel
    - Sized for full dimensions of insulation and fire caulked where required
    - Install in all exterior walls, fire walls and floors
    - Floor sleeves to extend 1” above floor surface

- Conduit sleeves in non-rated, non-masonry walls or partitions. Provide 24 gage galvanized steel.

- **Part 3 - Execution**

- All work shall be accomplished in accordance with the latest NEC. A copy of the latest code book and project specifications shall be kept at the premises.

- Prior notice of any power shutdowns or any disruptions to existing facilities shall be coordinated by the contractor as directed by the Construction Project Manager.

- All work shall be inspected prior to covering and any work covered prior to inspection will be made available for inspection at the option of the Construction Project Manager. No additional fees will be provided to uncover work covered prior to inspection.

End of Section 16050

DIVISION 16 - ELECTRICAL

Section 16110 - Raceways

Introduction

The general attitude on conduit systems is that in the future any area which does not have surface mounted raceways in the area at present shall not have them in the future. New conduit in an existing gypsum board wall shall be either fished with steelflex or EMT caps, or shall have wall notched and then patched for installation of new conduits. In addition it is the intent of this section that conduits being installed now shall provide for additions in the future.

Reducing washers are prohibited except where approved by the UA Electrical Inspector or Electrical Engineer.

The minimum size of each conduit shall be 3/4" unless noted otherwise below.

The maximum number of circuits in a new conduit is 3. Remodels may add up to 6.

For homeruns a j-box shall be located above the lights in an accessible location to allow for future expansion. No home run shall terminate in a wall mounted device box. Use a separate J-Box.

For underground utility projects the information in section 16115 shall apply.

Do not substitute condulet fittings for pull boxes.

- ½" conduit shall be allowed where terminating to a one gang device box from an above ceiling J-box.
- Specific housing projects will permit ½" emt raceways in lieu of ¾" but homeruns shall be ¾".
- **Part 1 - General**
- Provide a submittal for conduit, wireways, and fittings.
- Reducing washers are prohibited except where specifically approved by the electrical inspector. A ground bushing will be required wherever reducing bushings are authorized.
- Stud to stud supports are required in all metal framing, in order to support boxes.
- Scrap conduit shall not be used for conduit supports.

Part 2 - Products

- EMT
  - Use steel compression type fittings, and couplings.
  - Connectors shall have insulated throat.
  - No factory emt bends allowed below 1".
  - No Condulet type fittings over 1 ½" unless approved by UA Electrical Inspector or Electrical Engineer.
- Galvanized rigid steel (GRC)
  - No running threads.
  - Use one piece couplings.
  - Use Ericsons only where approved by engineer.
  - Double locknuts and threaded insulated steel bushings at all boxes.
  - Minimum ¾".
  - No Condulet type fittings over 1 ½" unless approved by UA Electrical Inspector or Electrical Engineer.

- Steelflex
    - Minimum size ⅜" with #14 THHN wire. (For connection to an individual light fixture or with a single circuit)
    - No pre-wired raceways.
    - 1 screw compression or set screw connectors only.
    - Maximum 6' length.
    - No Aluminum flex.
    - No BX cable.
    - No MC unless approved by UA Electrical Inspector or Electrical Engineer.
    - Use integral insulated throat fittings.
- Liquid tight flexible conduit, steel core (LTFC)
    - Equal to Sealtight.
    - Minimum size ½". (For connection to a single motor or device with less than 5#12)
    - Use insulated throat compression type steel connectors.
    - Maximum length 6', minimum length 2'.
    - All device wiring shall be field wired by the electrical contractor. Suitcase type connectors shall not be used. Submit samples for evaluation by FDC Inspector.
- PVC
    - Schedule 40 minimum wall thickness.
    - Minimum size ¾".
- SURFACE MOUNTED RACEWAYS
    - Shall be as manufactured by Walkerduct or Wiremold.
    - Minimum size shall be equal to type 700 WM.
    - No PVC or plastic wiremold products will be permitted.
    - Utilize manufacturer's products for all transitions from conduit systems and for all bends, offsets, or otherwise appropriate situations. Minimize field modifications to the raceway.
- Conduit bodies allowed ¾" through 1 ¼" only.

Part 3 - Execution

- Conduit system must be complete prior to pulling cables.
- EMT
    - Use in gyp board walls, surface mounted in equipment rooms, and where not subject to moisture or damage. EMT to route vertically only in walls in areas with drop ceilings. No horizontal runs through walls unless specially approved by U of A, FDC Inspector and Electrical Engineer.
    - Condulets shall not be used indoors in place of pull boxes.
    - Route conduit not less than 1' above drop ceilings and no higher than 36” above unless approved by FDC.
- Galvanized Rigid Steel
    - Use above grade where subject to weather.
    - Use where subject to moisture.
    - Use where subject to damage.
    - Use for all bends and offsets in underground runs or in block walls.
    - Use within 5' of building walls, if penetrating the structure, in underground runs.

  - Use in all light pole bases.
  - All indoor runs larger than 4" except communications or special systems.
  - Underground or in concrete must be half lap wrapped with 10 mil PVC tape or painted with bitumastic compound.
  - Use in tunnel
  - Use at a height of 4' and below in all Electrical, Equipment and Mechanical Rooms or where subject to physical damage.

- Schedule 40 PVC

  - Use only below grade.
  - Use only with approved PVC supports.
  - Use inside of block walls, with solid grouted cells.
  - May be used as a sleeve inside of building for grounding or lightning protection wiring.
  - All bends and offsets shall be in rigid steel (GRC) elbows.
  - All stub ups shall be GRC.
  - See Section 16115 for installation requirements (dept, encasement, etc.).

- Steelflex.

  - Use only where permitted by Engineer or for feed to lights or smoke detectors in a t-bar ceiling.
  - Use where required for fishing existing stud walls to a single device.
  - Provide sufficient length for loop at bottom of flex. (Do not draw tight).
  - Use for dropping conduit down an existing wall with limited ceiling height.

- Liquid Tight Flexible Conduit (LTFC)

  - Use only where permitted by Engineer.
  - Use for final connection to all equipment.
  - It shall not be used to penetrate sheet metal enclosures.
  - Provide sufficient length for loop at bottom of flex. (Do not draw tight).

- Surface mounted raceways (Wiremold or approved equal)

  - Use in renovation projects where existing walls do not allow fishing or notching of walls. All other uses shall not be permitted without the approval of the Engineer.
  - Must use Wall box connection when connecting to a flush mounted wall box.
  - Must use center dividers when used for more than one system.
  - File all cuts smooth prior to installation.
  - Use factory manufactured cutters.

Support all conduits from structure minimum of 5' centers and within 18" of a box; connector, coupling or factory 90° bend and at closer intervals where required by NEC.

Reference Section 16190 for means of support.

End of Section 16110

DIVISION 16 - ELECTRICAL

Section 16115 - Underground Conduits And Distribution Duct Banks

Introduction

When preparing the layouts for new underground distribution for the electrical systems, future capacity shall be included to provide for expansion/modification of the services in an area. In this area common sense and a discussion with the University of Arizona Electrical Engineer and the FM Electrical shop shall be used in determining how many additional conduits shall be installed in a duct run above the number needed for actual work in the project. In addition it shall be the responsibility of the engineer doing the design to consult any and all of the as built documentation of an area prior to laying out the duct bank for a particular area. Any changes caused by the lack of proper investigation shall be fully documented by the engineer in the form of revised drawings and not notes added to the original drawings. Fully document and detail the drawings such that major obstructions and other utility services are clearly indicated on the drawings.

Part 1 - General

- Provide submittals for conduit, fittings, manholes, handholes, and all associated appurtenances.

Part 2 - Products

- UNDERGROUND CONDUIT AND DUCT BANKS
    - Use GRS (galvanized rigid steel) or PVC schedule 40 for underground conduit and duct bank installations. Installation parameters are prescribed in Table 1 below.
    - Where required concrete encasement shall be either 2000 psi or 3000 psi.
    - Red colored concrete encasement, where required, shall use a red pigment integrally mixed into the concrete. Dry shake or broadcast coloring agents are not to be used.
    - Use GRS (galvanized rigid steel) for all offsets and bends. Tape all underground GRS conduit with 10 mil PVC tape, half lapped or coat with a bitumastic compound.
    - For concrete encased conduits use manufactured PVC spacers and mounts for support and spacing of the conduits. Do not use concrete blocks or other means to support and space conduits that are to receive concrete encasement.
    - A metallic backed marking tape shall be installed 12” above all underground conduits and duct banks.
- MANHOLES AND HANDHOLES
    - Minimum 12" x 18" x 12" with solid nominal I.D. concrete bottom for power or lighting runs. For High Voltage work manhole shall be sized similarly to existing manholes on campus.
    - Shall be constructed out of 3000 PSI steel reinforced concrete.
    - Shall be traffic rated construction.
    - Cover shall indicate type of wiring enclosed within.
    - Shall include a securely mounted removable ladder when over 4' deep.

Part 3 - Execution

- UNDERGROUND CONDUITS AND DUCT BANKS
    - Install underground conduits and duct banks per Table 1, below, and locate a minimum of 1’ from other utility systems, including phone, steam, sewer, chilled water, etc.

Table 1

Underground Conduit and Duct Bank Installation Requirements			
	Above 600V	600 V and Below	Other Systems
Below Building Slabs	PVC or GRS, 36" deep, red concrete encasement, 3000 psi	PVC or GRS, 18" deep, no concrete encasement required	PVC or GRS, 24" deep, no concrete encasement required
Outside of Bldg.	PVC or GRS, 36" deep, red concrete encasement, 3000 psi	GRS, 36" deep, no encasement, or PVC, 24" deep with 2000 psi concrete encasement, plain	GRS, 36" deep, no encasement, or PVC, 24" deep with 2000 psi concrete encasement, plain
Outside of Bldg. Min. depth requirement cannot be met	Special permission required, Contact FDC Inspection		

- Install not less than 4- #4 reinforcing bars tied to a square cage at 8' centers for conduits in bank under roadways.
- Concrete encased with a minimum envelope of 3" around each conduit where encasement is required.
- Minimum 3" spacing between outer diameter of conduits.
- Conduits to be used for high voltage cable shall be installed by journeyman electricians having minimum of five years experience in the installation, splicing, and testing of high voltage wiring. Contractor shall have class A-17 license for minimum of 2 years prior to work.
- Use bell adapters where conduits enter manholes.
- Concrete shall be red dyed utilizing red dye mixed into the concrete for a minimum of 5 minutes prior to pouring. Minimum of 1 bag of dye per 1 yd of concrete.
- For 4" diameter and larger GRS conduit bends, minimum bending radius shall be 48". Standard factory bends may be used for 3-1/2” diameter and smaller GRS conduit bends.
- Tie banks down and stake using rebar at each support.
- Spacers and supports to be at 5' centers.
- Conduits shall be cleaned and tested for continuity prior to installation of cables as follows:

    - A steel sectional mandrel shall be pulled through the conduit. The mandrel outer diameter shall not be less than .5" less than the inside diameter of the conduit.
    - Should the mandrel become stuck in the conduit then the length of conduit where the mandrel was stuck shall be condemned and replaced to the satisfaction of the U of A Electrical Engineer.
    - The conduit shall then be swabbed out by pulling through a brush and/or rags which remove any additional debris from the conduit.
    - Spare conduits shall receive a pull strong and be capped at both ends. Spare conduit shall be identified as to other end. Spare conduit where subject to weather shall be sealed using a coupling and steel insert.

- MANHOLES AND HANDHOLES

    - Ring and lid shall be installed above grade so that water drains away from them.
    - Shall be installed on a bed of gravel (minimum of 12" deep) with a drain hole to allow for water to drain out of them.
    - Shall be installed with cover flush on sidewalks.
    - Shall be installed with top of cover minimum 2" above grade in landscaped areas.
    - For handholes use cover appropriate to the area located.

- For manholes use traffic rated cast steel outer cover with an inner lid which can be padlocked from above. The inner lid shall be welded to the manhole ring.
- Provide a ¾ " x 10' ground rod driven into the bottom of the manhole near one of the sides for grounding of wires and cables.
- Provide pulling irons opposite potential duct entrances.
- Have inset unistrut to allow for cable racks in manholes.
- HV Cable racks shall have porcelain insulators. Loop high voltage feeders around the inside of the manhole tied to the insulators.
- Manhole covers shall be manufactured with inscriptions for “Electrical” and “Communications” and be weld-bead inscribed with U of A. This welding shall be performed by a certified MIG (GMAN) welder with the proper approved skills.
- Manhole steel rings, frames and covers shall be “NIKKO”. No exceptions.

End of Section 16115

DIVISION 16 - ELECTRICAL

Section 16120 - Wire and Cable

Introduction

All wire to be in conduit UNLESS APPROVED BY UA Electrical Inspector or Electrical Engineer.

Design is to make conduit system available for use in future.

Maximum of three circuits in each conduit for all new installations. Remodels may have six.

Where more than one 20 amp circuit is installed in a conduit with a common neutral, size neutral conductor to #10.

Part 1 – General

- Wiring of different system voltages shall be in separate raceways separated gutter compartments required.
- Wiring color coding to be as indicated under Section 16195.
- Grounding and grounded conductors to be identified at all visible points.
- In order to provide for future wiring when calculating box fill maximum fill shall be 70% of code fill requirements.
- All power and lighting conduits shall contain a ground conductor sized per NEC 250-95.
- All wire shall be new.
- All wire removed from conduit shall be discarded.

Part 2 - Products

- 600 volt insulation minimum on all cables unless specified otherwise.
- All wiring to be minimum #12 AWG stranded copper conductors. Only exception is for fire alarm circuits where #14 solid copper conductors shall be used.
- All wire is to be new and brought to the job site in unopened packages.
- Use THHN/THWN for all sizes between #12 and #4 AWG. Use XHHW-2 for all sizes #2 and larger. Do not use #3.
- Control cabling for instrumentation shall be twisted shielded pair No. 18 ga. Minimum copper conductors with overall foil shield where used for 4 to 20ma or 1 to 10 volt control signals. For 120 volt control signals use minimum of No. 14 ga. Stranded copper.
- For wire sizes #6 and smaller as appropriate for the devices, wiring may be connected using wire nut type of wiring connectors. Twist wires together before applying wire nut. *Interior of nuts shall be metallic. Submit samples for approval.*
- Joints in cables #6 and larger shall be made with solderless connectors. Either compression type connectors or split bolt connectors and a combination of rubber and plastic “Scotch 33” type of tape shall be used.

- Connections at terminal strips shall be made using either compression type of terminals or a ring or spade connector must be installed on the wire before connecting to a screw terminal. Wrapping stranded wire at a screw terminal is not permitted.

- *Suitcase type connectors are disapproved.*

Part 3 - Execution

- Wire shall be color coded throughout its length. Wires #8 and smaller shall be color coded using colored insulation. Wires #6 and larger shall be identified with multiple rings or spirals of color coding tape at each box or piece of equipment.

- Use fire alarm manufacturers standard color coding for fire alarm circuits.

- Conduit system shall be complete prior to pulling in wires.

- Use only UL approved wire lubricant. No grease or silicon which could damage the insulation of the cable shall be used.

- Any run of conduit which does not permit conductors to be pulled in readily shall be condemned and replaced to the satisfaction of the Engineer.

- When pulling in cables for feeders use power operated pulling equipment only where specifically approved by Engineer.

- Protect wires at all locations where exiting from conduits.

- Carefully cable all wires in panelboards, gutters, and wireways. Use tie wraps where needed.

- Do not use tape to cable wires either for pulling into conduits, or for cabling in panels, gutters, or wireways.

- Do not combine systems of various voltages or circuits from separate sources in the same conduit system.

    - Exceptions

        - Readily identifiable low voltage conductors for lighting system control may be run in the same conduit as the power conductors for a terminal drop to a light switch or to a single light fixture.
        - Motor control wires (not including control wiring for a VFD) may be installed in the same conduit as the power wiring if they can be installed without damaging the smaller wiring.

End of Section 16120

DIVISION 16 - ELECTRICAL

Section 16122- PRIMARY POWER CABLES

Introduction (Refer to Appendix For Approved Master Spec.)

The goal at this site is to provide looped power distribution to all buildings on the main campus power system. In addition in the future we would also like to change the service to the University to eliminate all of the 4160 volt distribution and replace with 13.8 KV distribution. All new designs should reflect that plan. All cables should be capable of connecting to either 13.8 KV or 4160 volt systems. The cable should be either tied to an existing looped system with PMH switches or to a new looped distribution system as per the U of A Electrical Engineer. All cable should be shielded and run in duct banks out of the existing (or new) tunnel system.

Part 1 - General

- Incorporate attached specification as applicable into your specification.

Part 2 - Products

- Incorporate attached specification as applicable into your specification.

Part 3 - Execution

- Incorporate attached specification as applicable into your specification.

End of Section 16122

DIVISION 16 - ELECTRICAL

Section 16130 - Boxes

Introduction

Types of boxes - outlet and receptacle boxes, and metal junction and pull boxes. Underground concrete boxes or manholes are discussed in underground distribution systems.

Boxes are to be left in such a manner that they are both accessible for future access, and that spare space (per NEC) is available for working with additional conductors.

Part 1 - General

- DEVICE BOXES
    - NEW WORK minimum size to be 4"sq. x 2 1/8" deep with adequate space for devices, wires, and 30% spare fill capacity except as approved by Owner.
    - REMODEL use flush mounted boxes in existing walls (notch GWB walls if necessary). Use 4" sq. boxes.
- JUNCTION BOXES
    - NEW WORK minimum size 4 11/16" sq x 2 1/8" *with ½" and ¾" knockouts on each side*. For conduits 1" and larger use boxes 6 x CS (conduit size) X 8 x CS, x 4" minimum or as per NEC 370-28. Provide for 30% spare fill capacity in all junction boxes. Extension boxes are not permitted.
    - All home runs shall have a j-box located in an accessible location *above the ceilings (in interstitial ceiling spaces).*
    - All existing junction boxes in an area remodeled shall be left accessible or relocated to an accessible location.
    - All j-boxes 4 11/16" sq. x 2 1/8" sq. or smaller shall have both ¾" and ½" knockouts on all sides.
    - Ground tails shall be installed in boxes prior to rough-in.

Part 2 - Products

- DEVICE BOXES
    - Shall be galvanized steel one piece boxes. No more than one plaster ring shall be utilized with each box. Gangable boxes or handy boxes shall not be used without prior approval of the engineer.
- JUNCTION BOXES
    - Shall be galvanized steel or metal with baked enamel. Where used outdoor boxes shall be NEMA 3R rated. Where subject to corrosion shall be NEMA 4X SS.
    - For new work no extension boxes will be permitted.

Part 3 - Execution

- DEVICE BOXES
    - No Madison clips used as supports.

- Rigidly supported to structure independent of conduit system support.
- Flush mounted shall not have more than 1/8" gap.
- No back to back devices or boxes in walls unless approved. Offset all boxes *in* non-fire rated walls minimum of 6". For fire rated walls provide minimum 24” separation or use approved fire assembly.
- Where transitioning from flush mounted j-box to surface mounted raceway, horizontally mount the plaster ring so that the proper type of wall box connection may be utilized with the surface mounted raceway.
- Surface mounted boxes shall be 4" square boxes, with industrial raised device plates. These shall be only used in equipment rooms or where specifically approved by the U of A Electrical Engineer.
- Cut in boxes may be used in remodel applications where conduit is fished down existing stud walls.

- JUNCTION BOXES
  - Shall be rigidly supported to structure independent of conduit system.
  - Shall be accessible.
  - Runs between junction boxes shall not exceed 90'.
  - Shall be identified per Section 16195.
  - Shall not be located more than 3' or less than 1’ above a drop ceiling.
  - Covers shall be attached with machine screws only. NO self tapping screws or wood screws shall be utilized in attaching the cover.
  - Reference 16190 for supports and anchors.
  - Shall not have concentric knockouts unless specifically approved by the U of A Electrical Inspector or FDC Engineer.
  - Use grounding bushings on all enclosures having concentric and eccentric knockouts where such knockouts are approved by the University of Arizona Inspector.
  - No powder actuated, plastic or lead fasteners. Install boxes with machine screw type fasteners.

End of Section 16130

DIVISION 16 - ELECTRICAL

Section 16140 - Devices

Introduction

The design should take into account not only what type of equipment is to be connected to the device but also what type of loading will occur on the circuit when determining the number of receptacles on each circuit.

- Designers shall provide at least one outlet on each wall unless construction with doors and walls prevent sensible construction.
- Minimum of 1 convenience circuit shall be installed in each individual office.
- Maximum of 6 receptacles on each circuit for office areas.
- Dedicated circuit for copiers.
- Dedicated circuit for laser printers.
- Dedicated circuit for microwave.
- Hallway receptacles shall be connected to circuits which are independent of the office or other room receptacles.
- Wall switches shall be on the latch side of doors according to the architectural plans. Where two level switching is used switches shall be in the same J-box. Motion sensors with override button shall only be installed in specific situations approved by UA Electrical Inspector or Electrical Engineer.

Part 1 - General

- Due to the rough treatment of devices at this facility industrial quality heavy duty specification grade devices and receptacles are used.

Part 2 - Products

- Pass & Seymour, Arrowhart, Leviton, and Hubbell are approved manufacturers. Hubble shall be the basis of design.
    - All devices shall be heavy duty specification grade, back & side wired minimum 20 A rated devices. Included here are standard wall outlets, light switches, GFCI, and IG receptacles.
    - Receptacles shall have a one piece brass strap and grounding system.
    - Back wire through a hole with clamp type screw. Tightened assembly suitable for stranded wires.
    - Color of devices shall match the existing for main campus modifications, and ivory for AHSC and all new construction.
    - Devices used for emergency power shall be red.
    - Isolated ground devices shall be orange.
    - All wall plates shall be stainless steel, satin finish, minimum of .035" thick. Sierra Brand, to match plates specified in 16700.

- Exterior device plates shall have separate covers for each section of the device. Plate shall be constructed of either polycarbonate or cast aluminum. The unit shall be rain tight with plug in use.

- Lighted toggle switches shall be used in all electrical, mechanical, equipment rooms and in tunnels. Color shall be white or clear. Wire so that they glow when the power is off.

Part 3 - Execution

- Install receptacles with the ground stab up in vertical mounting or neutral stab up in horizontal mounting.

- Install such that devices are either perpendicular or parallel to the floor or adjacent walls.

- All devices shall be pigtail connected and not used as a terminal strip or feed through connector for devices down line.

- Receptacles shall be mounted at 18" above finished floor to center.

- Lab receptacles shall mount minimum of 6" above counter top. (Except where using countertop mounted devices, manufactured for that purpose.)

- Light switches shall mount at +46" above finished floor to center.

- All receptacles shall be identified per Section 16195.

- Install wiring under back wiring clamp without use of Stak-ons or crimp terminals except at ground terminals.

- Receptacles not installed in back splashes can be installed vertical above counters.

- Provide samples for approval.

End of Section 16140

DIVISION 16 - ELECTRICAL

Section 16160 - Cabinets and Enclosures

Introduction

Since this is typically a special item used only on specific items this section shall be as specified for the particular project and shall be worked out between the Design Engineer and the U of A Electrical Engineer.

Part 1 - General

No discussion.

Part 2 - Products

No discussion.

Part 3 - Execution

No discussion.

End of Section 16160

DIVISION 16 - ELECTRICAL

Section 16170 -Motor Starters

Introduction

All motors shall be protected by motor starters (except for fire pump systems or where motor has internal motor protection) .

Where available use 480 volt 3 phase power for all motors rated above 1/2 hp. These motors should be protected by three phase motor starters with overloads on all three phases. Where 480 volts is not available utilize 3 phase power at 208 volts.

All motors 1/2 hp and smaller shall be 120 volt.

All motors 1 hp and larger shall utilize magnetic type of motor starters. All motors controlled through the use of control systems shall utilize magnetic type motor starters.

Where five or more starters are required in the same area utilize a motor control center arrangement.

Where both a starter and a disconnecting means are required at the same location use a combination starter. When using automatic controls associated with the motor use a magnetic type starter. When no automatic type of control is needed use a manual motor starter.

Motor starters shall be supplied and installed by the electrical contractor. It shall be required for the Electrical design engineer to coordinate all of the sizes of the motors and indicate the sizes of the motors on the drawings. Where motor sizes shall change due to design changes by the mechanical contractor he shall coordinate the same with the electrical contractor at no additional cost to the University of Arizona.

Part 1 - General

- Acceptable manufacturer's shall be Allen Bradley, General Electric, *Cutler Hammer, Square D* or prior approved equal.

Part 2 - Products

- All motor starters shall be NEMA size starters. No IEC type starters shall be utilized.

- Manual motor starters shall be heavy duty, rated minimum of NEMA size 0, and shall have separate replaceable thermal type overload relays.

- Magnetic motor starters shall be heavy duty, rated minimum of NEMA size 0, and shall have separate replaceable thermal type overload relays, one per phase.

- Combination type motor starters shall utilize type FRN rejection Full size fuses rated minimum of 600 volts. With magnetic motor starter as per above, separate 120 volt control transformer, hand- off-auto switch, red and green pilot lights, and minimum of two sets of auxiliary contacts. If an external control source is used then an auxiliary disconnect device is to be added to the starter to disconnect this when disconnecting power for the starter.

- Enclosures shall be NEMA 1 for indoors, NEMA 3R *gasketed* or the equivalent for outdoor, and NEMA 4X SS where subject to corrosion. *The basis for outdoor design/construction is Cutler Hammer NEMA 3R/12.*

Part 3 - Execution

- Motor starters shall be installed at an accessible location. All motor starters shall be identified in accordance with Section 16195.
- Clearances as specified in NEC 110-16 shall be provided.
- Maximum height shall be +72" aff.

End of Section 16170

DIVISION 16 - ELECTRICAL

Section 16175 – Elevator Power and Controls

Introduction

There are unique University requirements. Refer to sample specification in the Appendix Section.

Part 1 - General

- Consultants shall provide details on plans, clearly reflecting the requirements within. The consultant shall not specify pre-manufactured equipment for machine room shunt trip and control requirements. Specifically note on the plans that the pre-manufactured items are not acceptable.

- POWER
  - The consultant shall specify generous circuitry that accommodates circuit sizing requirements by vendors notorious for requiring over sizing. Provide notations that require the contractor to provide system upgrades when elevator equipment requires larger capacity system components in excess of that shown on the construction documents. The consultant shall explicitly state in the specifications that these upgrades shall be performed without additional cost to the University. The consultant is directed to Intentionally size feeders for worse case conditions.

  - Provide a minimum elevator machine room size of 100 square feet, exclusive of the area above the hoistway (for traction elevators), and without any odd corners, narrow passages or structural interferences.

  - Main electrical elevator feed should employ a molded case shunt trip breaker and a suitably sized enclosure. Larger enclosures for electronic type breakers are to be avoided as they take up too much room in an already cramped service space. Requirements for electrical coordination to be accomplished upstream of the main elevator feed. Engineers will feed the elevator breaker from the building's main switchboard, so as to maintain a 4 to 1 separation in current trip settings between the elevator breaker and the switchboard main breaker. This is to be done regardless of the convenience of any closer distribution points that cannot afford the 4 to 1 separation.

  - Ancillary electrical elevator equipment shall be fed from a separate, solely dedicated, elevator electrical LOAD CENTER 120/208V, 3 phase, 4 wire. This elevator load center shall only be used for elevator related equipment and devices .It will provide the required means to lockout the equipment for service. Required characteristics of elevator electrical Load center are: surface mounted, copper bus, no door, dead front, 14 inches wide, lockable (lockout) breakers and a maximum size of 12 full size breaker spaces. Additional spaces are authorized only where the number of elevator related loads increases above 12 spaces. Unused breaker spaces shall not have any spare breakers installed. Ancillary elevator equipment to be fed from this panel may be, but is not limited to, the following:

    - Shunt trip control feed
    - Machine room lights/receptacles
    - Elevator car lights
    - Elevator pit lights/GFI receptacle
    - Elevator pit sump pump
    - Machine room A/C
    - Elevator Fan (A/C)
    - Hydraulic oil cooler

- Power for the machine room load center shall be on the life safety engine generator, when available.

Part 2 – Products

- SHUNT TRIP AND RELATED CONTROLS
    - The machine shunt trip breaker shall be enclosed in a HOFFMAN ENCLOSURE having a dust tight hinged door with external disconnecting handle for the breaker. The breaker shall be electronic type with LSI features, including short time adjustment. It shall have on N.O. and one N.C. contact for future use.
    - The enclosure shall be oversized to accommodate the neat field wiring and installation of controls and relays associated with the requirements of all applicable codes.
    - Terminal/barrier strips shall be 20 ampere rated, bakelite, industrial grade.
    - Provide load center as described in Part 1, above.
    - Provide 120 Volt control system with switch, Neon Pilot and Current Limiting (CL) fuse.
    - Provide a schematic diagram and parts list for mounting within the enclosure.

Part 3 - Execution

Refer to drawing Fire Alarm Specification & related drawings in Appendix 16720

End of Section 16175

DIVISION 16 - ELECTRICAL

Section 16190 - Supports

Introduction

This section covers support requirements for conduits, light fixtures, and all other electrical equipment.

Supports as specified herein are more strict than those required by the NEC due to the increased accessibility to areas by U of A maintenance personnel.

Part 1 - General

- *All materials shall be corrosion resistant (supports, fasteners, misc. hardware).*

- Minimum support requirements shall be as specified in the NEC for electrical equipment. Where specified herein as more stringent the more stringent shall apply.

Part 2 - Products

- CONDUIT SUPPORTS shall be as follows:

    - Width of structural strut trapeze shall not exceed 12”.

    - Where individual conduits are run on walls and where appropriate one hole straps may be used. Where more than two conduits are run in parallel or where conduits are 1 1/2" or larger, support using approved structural strut members fastened to the structure at minimum of two points. Minimum strut length is 12 inches.

    - Single conduits trapeze above ceiling use 1/4" all thread and conduit hangers up to 1 1/2". For 2" and above use strut rack and minimum of 2 - 3/8" or larger all thread rods.

    - Wire shall not be used as a method to fasten conduits above ceilings. Conduit hangers or straps as appropriate shall be used to rigidly support the conduits in each situation. 18 gauge or larger galvanized tie wire may be used to tie conduits inside of metal stud walls.

    - Conduits above drop ceilings shall be supported independent of wire supports for drop ceilings, and shall not be supported on wires. Caddy #812MB18 box and conduit supports or equal may be used.

    - *Fixture whips, however, shall be permitted to be supported by the fixtures seismic wire utilizing approved clips*

    - All fasteners shall be steel threaded inserts or steel expansion shield anchors for location used. One hole straps shall be either connected to the wall studs using appropriate screws or to the wall using expansion bolts. In hollow masonry walls steel toggle bolts may be used. Plastic or lead expansion anchors shall not be used. No powder actuated fasteners shall be used. All fasteners shall be screw in type fasteners.

    - *Sheet rock screws of any type shall not be used.*

    - Fastening methods shall be subject to approval by Owner representative.

    - One hole conduit straps shall be Mineralac Med series or equal.

- LIGHT FIXTURE SUPPORTS in drop ceilings

    - Small incandescent or down lights to have one support wire.

- 2 x 2 or 2 x 4 fluorescent to have (2) support wires and earthquake clips.
- Support wires to be not less than 12 gauge galvanized steel.
- Deflection on support wires to be not more than 30% except where approved by Owner.
- All support wire connected to structure.
- Anchors in concrete to be not less than ¼" diameter. Use only drill in type anchors.
- All other fixtures shall be rigidly supported from the structure.

Part 3 - Execution

- CONDUITS
  - Support on 5' centers and within 18" of boxes connector, couplings or equipment.
  - Support from structure.
  - Use strut frame or angle iron frame when no wall system is available.
- LIGHT FIXTURES
  - Support from structure.
  - Support independent of ceiling grid.
  - Earthquake clips.
  - Support from structure to a 500% safety factor
- SAFETY SWITCHES, MOTOR STARTERS, PANELBOARDS
  - Use strut backing when more than 1 is surface mounted in an area.

End of Section 16190

DIVISION 16 - ELECTRICAL

Section 16195 - Electrical Identification

Introduction

To provide ready identification of power source for maintenance personnel.

Part 1 - General

- The following items are to be identified as to source of power:

  Receptacles
  Safety Switches
  Motor Starters
  Junction boxes
  Snap Switches on inside of plate with indelible felt-tip marker

- The following items are to be identified as to what they service.

  Safety Switches
  Motor Starters
  Panelboards
  Switchboards
  Time Clocks

- The following items are to be identified to match the identification indicated on the drawings:

  Panelboards
  Switchboards
  Transformers

- Other items which require identification will be identified in the section pertaining to them.

Part 2 - Products

- For panelboards, safety switches, motor starters, switch boards use black on white plastic engraved identification signs attached using #6 self tapping screws.

- For receptacles use acrylic labels self-adhesive by “Brother P-Touch” Equip. or approved equal.

- For wires use vinyl impregnated cloth tags.

- For color coding cables use vinyl marking tape.

- For j-boxes write in large letters on cover using an indelible magic marker. Where exposed, identification is to be on inside face of cover.

- Panelboards shall have typewritten directories indicating actual room numbers and any other pertinent information for the circuit served. (I.E. COPIER ROOM 131, EF-3, NW CORNER OF ROOF, RECEPTACLES E & W WALLS RM 242). Verify room numbers with CPM *and Space Management, prior to typing the directories. Use proper room numbers. Note new room numbers on as-built drawings.*

Part 3 - Execution

- Require that *the new typewritten* panel directories be *installed* after each project *or remodel*, updated to reflect all changes Removed panel schedules shall be returned to the *construction project manager*.

- J-boxes for fire alarm circuits shall be painted RED and labeled using an indelible black marker "Fire Alarm".

- Identify ground wires and neutral conductors at all j-boxes, pull boxes, or wherever wires are accessible. Spiral tape continuous where accessible. Ground wires and neutral conductors size #8 and below will have colored insulation.

- COLOR CODES for new work shall be as follows:

POWER WIRING

PHASE	**120/208 VOLTS 4160/13800 VOLTS**	***277/480* VOLTS**
A	BLACK	BROWN
B	RED	ORANGE
C	BLUE	YELLOW
NEUTRAL	WHITE	GRAY
GROUND	GREEN	GREEN

CLOCK AND BELL

A	BLUE
B	BLACK
C	ORANGE
BELL HOT	RED
BELL NEUTRAL	WHITE

FIRE ALARM WIRING

Refer to Section 16720 (pg. 16720-7)

End of Section 16195

DIVISION 16 - ELECTRICAL

Section 16310 - Primary Switching Station
Introduction

The goal of the electrical department is to provide a looped power distribution system at both 4160 volts and 13.8 KV which can be upgraded in the future to 13.8 KV. Each basic loop is a 400 A loop with available capacity to be able to handle all of the load on the loop from either of two main disconnects at the main distribution system. At present the PMH switch is the point where each building is to be disconnected from the loop.

Where located as part of a new construction system the PMH switch is to be located at a point that is accessible as far as future connections and for future replacement if necessary. Where for redistribution to an existing system the switch is to be located at a point that is limited in access to the general public, and accessible for future connections.

The designer shall coordinate the medium voltage design with the University of Arizona, Electrical Engineer.

PMH switch should be mounted on a concrete pad with a minimum of 6' clearance in front of all doors, an accessible exit (when the doors are open), and minimum 3' of clearance on both sides for easy access to control switches. The concrete pad shall extend to a minimum of 3' in front of all doors. The concrete pad should contain a grounding ring composed of a 3/4" x 10' copperweld or copperclad ground rod on each corner, connected by minimum of 3/0 ground wire. This ground shall be connected to the ground pad of the PMH switch exothermically.

Specify stub-outs for all unused compartments.

Specify 24" bases under all switches.

Specify fuse sizes.

Part 1 - General

- Refer to Appendix Section 16310 and incorporate into project.

Part 2 - Products

- Refer to Appendix Section 16310 and incorporate into project.

Part 3 - Execution

- Refer to Appendix Section 16310 and incorporate into project.

End of Section 16310

Section 16310 PRIMARY SWITCH STATION

PART 1 GENERAL

1.01 Description of Work

A. The pad-mounted gear shall be in accordance with the one-line diagram, and shall conform to the following specification. This gear shall be type PMH-9 as manufactured by S&C Corporation or approved equal in Federal Pacific.

B. The pad-mounted gear shall consist of a single self-supporting enclosure, containing interrupter switches and power fuses with the necessary accessory components, all completely factory-assembled and operationally checked.

C. NOTE: It is the intent of the University to use equipment rated for 13.8 KV ungrounded systems on 4160 volt at this time to allow for conversion to 13.8 KV ungrounded systems in the future.

1.02 Ratings

A. The ratings for the integrated pad-mounted gear shall be as designated below:

KV, Nominal 14.4	
KV, Maximum Design	17.0
KV, BIL	95
Main Bus Continuous, Amperes	600
Three Pole Interrupter Switches	
Continuous, Amperes (Source/Feeder)	600/600
Live Switching, Amperes (Source/Feeder)	600/600
Two-Time Duty-Cycle Fault-Closing	
Capability, Amperes Rms Asymmetrical	22,400
Fuses with Integral Load Interrupter	
Maximum, Amperes	200
Live Switching, Amperes	200
Two-Timing Duty-Cycle Fault-Closing	
Capability, Amperes Rms Asymmetrical	13,000
Short-Circuit Ratings	
Amperes, Rms Symmetrical at	12,500
Mva Three-Phase Symmetrical at	
Rated Nominal Voltage	310

B. The momentary and two time duty cycle fault closing ratings of switches and bus, interrupting ratings of fuses, and one-time duty-cycle fault-closing capabilities of the fuses with integral load interrupters shall equal or exceed the short-circuit ratings of the pad-mounted gear.

1.03 Certification of Ratings

A. The manufacturer shall be completely and solely responsible for the performance of the basic switch and fuse components as well as the complete integrated pad-mounted gear assembly as rated.

B. The manufacturer shall furnish with the bid certification of ratings of the basic switch and fuse components and the integrated pad-mounted gear assembly consisting of the switch and fuse components in combination with the enclosure.

1.04 Compliance with Standard and Codes

A. The pad-mounted gear shall conform to or exceed the applicable requirements of the following standards and codes:

1. Applicable safety and health standards promulgated pursuant to Federal Occupational Safety and Health Act of 1970 which are in effect 30 days prior to the date of quotation or bid.

2. Article 710-21(e) Circuit Interrupting Devices (Load Interrupters) in the 1984 National Electrical Code, which specifies that the interrupter switches in combination with power fuses shall safely withstand the effects of closing, carrying, and interrupting all possible currents up to the assigned maximum short-circuit rating.

3. All portions of ANSI, IEEE, and NEMA standards applicable to the basic switch and fuse components.

1.05 Enclosure Design

A. To ensure a completely coordinated design, the pad-mounted gear assembly shall be constructed in accordance with the minimum construction specifications of the fuse and/or switch manufacturer to provide adequate electrical clearances and adequate space for fuse handling.

B. In establishing the requirements for the enclosure design, consideration shall be given to all relevant factors such as controlled access and tamper resistance. Provide padlock and penta head fasteners, in addition to manufacturer's normal controls.

PART II PRODUCTS AND EXECUTION

2.01 Insulators

A. The interrupter-switch and fuse-mounting insulators shall be of a cycloaliphatic epoxy resin system with characteristics and restrictions as follows:

1. Operating experience of at least 10 years under similar conditions.
2. Ablative action to ensure nontracking properties.
3. Adequate leakage distance established by test per IEC Publication 507, First Edition, 1975.
4. Adequate strength for short-circuit stress established by test.
5. Conformance with applicable ANSI standards.
6. Homogeneity of the cycloaliphatic epoxy resin throughout each insulator to provide maximum resistance to power arcs. Ablation due to high temperatures from power arcs shall continuously expose more material of the same composition and properties so that no change in mechanical or electrical characteristics takes place because of arc-induced ablation. Furthermore, any surface damage to insulators during installation or maintenance of the pad-mounted gear shall expose material of the same composition and properties so that insulators with minor surface damage need not be replaced.

2.02 High-Voltage Bus

A. Bus and interconnections shall consist of copper bar.

B. Bus and interconnections shall withstand the stresses associated with short circuits up through the maximum rating of the pad-mounted gear, including proper allowance for transient conditions.

C. All current carrying parts shall be copper or bronze.

2.03 Ground-Connection Pads

A. A ground-connection pad shall be provided in each compartment of the padmounted gear.

B. The ground-connection pad shall be constructed of steel, 3/8" thick for use with 600 ampere main bus which shall be copper clad and welded to the enclosure, and shall have a short-circuit rating equal to that of the integrated assembly.

C. Ground-connection pads shall be coated with a uniform coating of an oxide inhibitor and sealant prior to shipment.

2.04 Enclosure

A. The pad-mounted gear enclosure shall be of unitized monocoque (not structuralframe-and-bolted-sheet) construction to maximum strength, minimize weight, and inhibit internal corrosion.

B. The basic material shall be 11-gauge hot-rolled, pickled, and oiled steel sheet.

C. All structural joints and butt joints shall be welded, and the external seams shall be ground flush and smooth.

1. The gas-shielded short-circuiting transfer welding process shall be employed to eliminate alkaline residues and to minimize distortion and spatter.
2. Any welds made by other than this method shall be ground and sanded (wire brushed if internal) to remove all scale and alkaline residues formed during welding.

D. To guard against unauthorized or inadvertent entry, enclosure construction shall not utilize any externally accessible hardware.

E. The base shall consist of continuous 90-degree flanges, turned inward and welded at the corners, for bolting to the concrete pad. The flanges shall be formed from double-thickness folded edges for strength and rigidity, with the sheared edges folded back into the inside of the enclosure to minimize exposure to corrosive attack.

F. The door openings shall have 90-degree flanges, facing outward, that shall provide strength and rigidity as well as deep overlapping between doors and door openings to guard against water entry.

G. Roof edges shall be formed to create a mechanical maze with the top flanges of the enclosure which shall allow free-flow ventilation to help keep the enclosure interior dry while discouraging tampering or insertion of foreign objects.

H. A heavy coat of insulating "no-drip" compound shall be applied to the inside surface of the roof to prevent condensation of moisture thereon.

I. Insulating interphase and end barriers of fiberglass-reinforced polyester shall be provided for each interrupter switch and each set of power fuses where required to achieve BIL ratings. Additional insulating barriers of the same material shall separate the front compartments from the rear compartments and isolate the tie bus (where furnished).

J. Models containing source switches rated 600 amperes continuous shall have full-length steel barriers separating adjoining compartments.

K. Lifting tabs shall be removable. Sockets for the lifting tab bolts shall be blind-tapped. A resilient material shall be placed between the lifting tabs and the enclosure to prevent the tabs from scratching the enclosure finish. To help retard corrosion, this material shall be closed-cell neoprene to prevent moisture from being absorbed and held between the tabs and the enclosure.

L. Interrupter switches shall be provided with dual-purpose front barriers. These barriers, in their normal hanging positions, shall guard against inadvertent contact with live parts. It shall also be possible to lift these barriers out and insert them into the open gap when the switch is open. A window panel shall be provided to allow viewing of the switch position without removing the barriers. These barriers shall meet the requirements of Section 381 .G of the National Electrical Safety Code (ANSI Standard C2).

M. Each fuse shall be provided with a dual-purpose front barrier. These barriers, in their normal hanging positions, shall guard against inadvertent contact with live parts. It shall also be possible to lift these barriers out and insert them into the open gaps when the fuses are in the disconnect position. These barriers shall meet the requirements of Section 381.G of the National Electrical Safety Code (ANSI Standard C2).

N. A (steel-compartmented) base spacer shall be provided to increase the elevation of live parts in the pad-mounted gear above the mounting pad by 24 inches.

2.05 Doors

A. Doors shall be constructed of 11 gauge hot-rolled, pickled, and oiled steel sheet.

B. Door-edge flanges shall overlap with door-opening flanges and shall be formed to create a mechanical maze that shall guard against water entry and discourage tampering or insertion of foreign objects, but shall allow free-flow ventilation to help keep the enclosure interior dry.

C. Doors shall have a minimum of three stainless steel hinges and hinge pins. The hinge pins shall be welded in place to guard against tampering.

D. In consideration of controlled access and tamper resistance, each door (or set of double doors) shall be equipped with a positive-action three-point latching system.

E. Each door (or set of double doors) shall be provided with a recessed stainless steel door handle. The door handle shall be padlockable and shall incorporate a hood to protect the padlock shackle from tampering. The handle shall be provided with a recessed penta head bolt for additional security.

F. Doors providing access to solid-material expulsion-type power fuses shall have provisions to store spare refill units.

G. Each door shall be provided with a galvanized-steel door holder located above the door opening. These holders shall be hidden from view when the door is closed, and it shall not be possible for the holders to swing inside the enclosure.

H. Doors shall automatically self lock open.

2.06 Ventilation System

A. Ventilation system shall be provided along the bottom and top at each side of the enclosure.

B. Each vent shall have an inside baffle to protect against insertion of foreign objects, or shall be so constructed as to prevent insertion of foreign objects.

2.07 Finish

A. During fabrication, the areas of structural parts which may later become inaccessible, such as folded edges and overlapping members, shall be given a phosphatizing bath and an iron-oxide zinc-chromate anti-corrosion primer to ensure that all surfaces are protected.

B. Any welds made by other than the gas-shielded short-circuiting transfer welding process shall be ground and sanded (wire brushed if internal) to remove all scale and alkaline residues formed during welding.

C. Full coverage at joints and blind areas shall be achieved by processing enclosures independently of components such as doors and roofs before assembly into the utilized structures.

D. All exterior seams shall be filled and sanded smooth for neat appearance.

E. To remove oils and dirt, and to form a chemically and anodically neutral conversion coating to improve the finish-to-metal bond, and to retard underfilm propagation of corrosion, all surfaces shall undergo a thorough pretreatment process before any protective coatings are applied.

F. After pretreatment, protective coatings shall be applied that shall help resist corrosion and protect the steel enclosure. To establish the ability of the finishing system to resist corrosion and protect the enclosure, representative test specimens shall satisfactorily pass the following tests:

1. 1000 hours of exposure to salt-spray testing per ASTM B 11 7-73 with loss of adhesion from bare metal not to extend more than 1/8" and underfilm corrosion not to extend more than 1/32" from the scribe.
2. 1000 hours of humidity testing per ASTM D 2247 with the formation of no more than #6 medium blisters as evaluated per ASTM D 714-56.
3. 500 hours of accelerated weather testing per ASTM G 53-77 with no more than 25% reduction of paint gloss.
4. Crosshatch adhesion testing per ASTM D 3359 Method B with no loss of paint.
5. 160 inch-pound impact adhesion testing per ASTM D 2794-69 with no paint chipping or cracking.

6. Certified test abstracts substantiating such capabilities shall be furnished with the bid.

G. The finishing system shall be applied without sags or runs for a pleasing appearance.

H. After the finishing system has been properly applied and cured, welds along the enclosure bottom flange and around the door hinges shall be coated with a wax-based anti-corrosion moisture barrier to give these areas added corrosion resistance. Weld studs within the enclosure that are not covered by nuts shall be coated with an oxide-inhibiting compound to help guard against corrosion starting on the exposed threads.

I. After the enclosure is completely assembled and the components (switches, fuses, bus, etc.) are installed, the finish shall be inspected for scuffs and scratches. Blemishes shall be carefully touched up by hand to restore the protective integrity of the finish.

J. The finish shall be white. *Contractor shall sand finish with #220 grit dual action Sander Prime with duPont Vari Prime #815/8165 and apply 3 wet coats of duPont catalyzed #817 acrylic enamel.*

2.08 Corrosion

A. To guard against corrosion, all hardware (including door fittings, fasteners, etc.), all operating-mechanism parts, and other parts subject to abrasive action from mechanical motion shall be of either non-ferrous materials, or galvanized, or zinc-plated ferrous materials. Cadmium-plated ferrous parts shall not be used.

2.09 Tamper Resistance

A. In consideration of tamper resistance, the enclosure shall withstand a prying leverage of 75 foot-pounds applied to all joints, crevices, hinges, seams and locking means. All such openings shall prevent insertion of number 10 AWG hard-drawn copper wire after the prying leverage has been applied.

2.10 Interrupter Switches

A. Interrupter switches shall have a two-time duty-cycle fault-closing rating equal to or exceeding the short-circuit rating ability to close the interrupter switch twice against a three-phase fault with asymmetrical current in at least one phase equal to the rated value, with the switch remaining operable and able to carry and interrupt rated current. Tests substantiating these ratings shall be furnished with the bid.

B. Interrupter switches shall be operated by means of an externally accessible 3/4 inch hex switch-operating hub. The switch-operating hub shall be located within a recessed pocket mounted on the side of the pad-mounted gear enclosure and shall accommodate a 3/4 inch deep-socket wrench or a 3/4 inch shallow-socket wrench with extension. The switch-operating hub pocket shall include a pad lockable access cover that shall incorporate a hood to protect the padlock shackle from tampering. Stops shall be provided on the switch operating hub to prevent over travel and thereby guard against damage to the interrupter switch quick-make, quick-break mechanism.

C. Interrupter switches shall utilize a quick-made, quick-break mechanism installed by the switch manufacturer. The quick-make, quick-break mechanism shall be integrally mounted

on the switch frame, and shall swiftly and positively open and close the interrupter switch independent of the switch independent of the switch-operating hub speed. Switches shall be the air break type.

D. Each interrupter switch shall be completely assembled and adjusted by the switch manufacturer on a single rigid mounting frame. The frame shall be of welded steel construction such that the frame intercepts the leakage path which parallels the open gap of the circuit when the interrupter switch is in the open position.

E. Interrupter switch contacts shall be of silver-to-silver construction for optimum current transfer, and shall be backed up by stainless steel springs to provide constant high contact pressure.

F. Interrupter switches shall be provided with a single blade per phase for circuit closing including fault closing, continuous current carrying, and circuit interrupting. Spring-loaded auxiliary blades shall not be permitted. Interrupter switch blade supports shall be permanently molded in place in a unified insulated shaft constructed of the same cycloaliphatic epoxy resin as the insulators.

G. Circuit interruption shall be accomplished by use of an interrupter which is positively and inherently sequenced with the blade position. It shall not be possible for the blade and interrupter to get out of sequence. Circuit interruption shall take place completely within the interrupter, with no external arc or flame. Any exhaust shall be vented in a controlled manner through a deionizing vent.

H. Interrupter switches shall have a readily visible open gap when in the open position to allow positive verification of correct switch position.

I. Each interrupter switch shall be provided with a folding switch-operating handle. The switch-operating handle shall be secured to the inside of the switch-operating hub pocket by a brass chain. The folded handle shall be stored behind the closed switch-operating-hub access door.

J. Key interlocks shall be provided between each fuse-compartment door and all switches to guard against opening fuse-compartment door(s) unless all switches are locked open.

K. Grounding studs shall be provided at all switch terminals. Grounding studs shall also be provided on the ground pad in each interrupter switch compartment and on terminals and ground pads in any cable-termination compartment. The momentary rating of the grounding studs shall equal or exceed the short-circuit ratings of the pad-mounting gear.

L. Mounting provisions shall be provided to accommodate one three-phase fault indicator with three single-phase sensors in each switch compartment on units with more than one switch position.

2.11 Fuses

A. Fuses shall be disconnect style, solid-material power fuses, and shall utilize refill-unit-and-holder construction. The refill unit or fuse unit shall be readily replaceable and low in cost.

1. Fusible elements shall be non-aging and non-damageable so that it is unnecessary to replace unblown companion fuses on suspicion of damage following a fuse operation.

2. Fusible elements for refill units, rated 10 amperes or larger, shall be helically coiled to avoid mechanical damage due to stresses from surges.
3. Fusible elements shall be supported in air to allow cooling after current surges to help prevent damage.
4. Each refill unit shall have a single fusible element to eliminate the possibility of unequal current sharing in parallel current paths.
5. Power fuses shall have melting time-current characteristics that are permanently accurate to within a total of 10% in terms of current. Time current characteristics shall be available which permit coordination with protective relays, automatic circuit reclosers, and other fuses.
6. Power fuses shall be capable of detecting and interrupting all faults whether large, medium, or small (down to minimum melting current), under all realistic conditions of circuitry, with line-to-line or line-to-ground voltage across the power fuse, and shall be capable of handling the full range of transient recovery voltage severity associated with these faults.
7. All arcing accompanying power fuse operation shall be contained within the fuse, and all arc products and gases evolved during fuse operation shall be vented through an exhaust control device that shall effectively control fuse exhaust.
8. Power fuses shall be equipped with a blown-fuse indicator that shall provide visible evidence of fuse operation while installed in the fuse mounting.
9. Fuses shall be S&C type SML-4Z units which accept type SM-4 refill units.

B. Fuse-mounting jaw contacts shall incorporate an integral load interrupter that shall permit live switching of fuses with a hook stick.

1. The integral load interrupter housing shall be of the same cycloaliphatic epoxy resin as the insulators.
2. The integral load interrupter shall be in the current path continuously. Auxiliary blades or linkages shall not be used.
3. Live switching shall be accomplished by a firm, steady opening pull on the fuse pull ring with a hook stick. No separate load-interrupting tool shall be required.
4. The integral load interrupter shall require a hard pull to unlatch the fuse to reduce the possibility of an incomplete opening operation.
5. Internal moving contacts of the integral load interrupter shall be self-resetting after each opening operation to permit any subsequent closing operation to be performed immediately.
6. Circuit interruption shall take place completely within the integral load interrupter with no external arc or flame.
7. The integral load interrupter and the fuse shall be provided with separate fault-closing contacts and current-carrying contacts. The fuse hinge shall be self-guiding and, together with the fault-closing contacts, shall guide the fuse into the current-carrying contacts during closing operations. Circuit-closing inrush currents and fault currents shall be picked up by the fault-closing contacts, not by the current-carrying contacts or interrupting contacts.
8. Integral load interrupters for power fuses shall have a one-time duty-cycle fault-closing capability equal to the interrupting rating of the fuse, and a two-time duty-cycle fault-closing capability of 1 3,000 amperes RMS asymmetrical at 14.4 KV or 25 KV. The duty-cycle fault-closing capability defines the level of available fault current into which the fuse can be closed the specified number of times (once or twice), without a quick-make mechanism and when operated vigorously through its full travel with6ut hesitation at any point, with the integral load interrupter remaining operable

and able to carry and interrupt remaining operable and able to carry and interrupt currents up to the emergency peak-load capabilities of the fuse.

C. Fuse terminal pads shall be provided with a two-position adapter. This adapter shall accommodate a variety of cable-terminating devices.

D. Grounding studs shall be provided at all fuse terminals. One grounding stud shall also be provided on the ground pad in each fuse compartment. The momentary rating of the grounding study shall equal or exceed the short-circuit ratings of the pad-mounted gear.

E. A full set of fuses, plus a full set of spare fuse refills, shall be provided for each fuse position as shown on the one line diagram.

2.12 Warning Signs

A. All external doors shall be provided with permanent "Caution - High Voltage -Keep out" signs.

B. The inside of each door shall be provided with "Danger - High Voltage -Qualified Persons Only" signs (Bilingual English, Spanish *and Japanese*).

C. The inside each door providing access to interrupter switches shall be provided with warning signs indicating that "Switch Blades May Be Energized In Any Position".

D. The inside of each door providing access to power fuses shall be provided with permanent warning signs indicating that "Fuses May Be Energized in Any Position".

E. All warning signs shall be provided in both English and Spanish.

2.13 Rating Nameplates and Connection Diagrams

A. The outside of each door (or set of double doors) shall be provided with nameplates indicating the manufacturer's name, catalog number, and model number.

B. The inside of each door (or set of double doors) shall be provided with nameplates indicating the following: voltage ratings (kv, nominal; kv, maximum design; and kv, BIL); main bus continuous rating (amperes); short-circuit ratings (amperes, RMS symmetrical and Mva three-phase symmetrical at rated nominal voltage); the type of fuse and its ratings (amperes, one-time/two-time duty-cycle fault-closing capability); and interrupter switch ratings (amperes, continuous; amperes, live switching - load splitting and load dropping; amperes, fault-closing, duty-cycle, two-time RMS symmetrical, RMS asymmetrical, and one-second symmetrical).

C. A three-line connection diagram showing interrupter switches, fuses with integral load interrupter, and bus along with the manufacturer's model number shall be provided on the inside of the front and rear doors (or set of double doors), and on the inside of each switch-operating-hub access cover.

2.14 Auxiliaries

A. Holders, and refill units for original installation, as well as one spare fuse unit or refill unit for each fuse mounting shall be furnished.

B. A fuse handling tool as recommended by the fuse manufacturer shall be furnished.

C. One bolted connector per phase accommodating NO.2 solid through 500 MCM stranded copper or aluminum conductor shall be furnished for all switch and fuse positions.

2.15 Three-Phase Fault Indicator

A. A three-phase fault indicator shall be provided and installed with three single phase sensors in each switch compartment on all units.

B. Fault indicators shall be provided at switching points on distribution circuits and unfused taps. A fault indicator shall be provided for each phase. Trip setting shall be as required for the given circuit. Reset shall be automatic and initiated by normal current. Fault indicators shall be type CR (10) manufactured by RTE Corporation, Waukesha, Wisconsin, or approved equal.

PART 3 INSTALLATION

3.00 Installation

A. The switch assembly shall be mounted securely on a concrete pad minimum of six inches in thickness, designed adequately for the weight of the switch. The pad shall extend a minimum of 3' from the front of each set of doors. The switch shall be securely anchored to the pad per the manufacturer's recommendations. A ground loop shall circle the switch and provisions for grounding the switch and landing any grounds or shields shall be provided for within the enclosure. During installation all internal shields shall be left inside of the switch and shall not be left out of the cabinet or subject to exposure to the elements. Any shield which has been damaged due to neglect or exposure to the elements shall be replaced to the satisfaction of the University of Arizona Electrical Engineer.

End of Appendix Section 16310

DIVISION 16 - ELECTRICAL

Section 16320 - Transformers (high voltage)

Introduction

The goal at this site is to remove all of the 4160 volt distribution system and replace it with a 13,800 volt distribution system. In the long run this system would be more cost effective both to maintain and operate. In the interim all new transformers which are installed on the 4160 volt system should be dual rated 13.8 KV/4160 volts except where utilized on 13.8 KV systems.

Transformers should be mounted on a raised concrete pad a minimum of 4" above the finished floor.

At each transformer a ground ring should be supplied with a 3/4" x 10' copper weld or copper clad ground rod at each corner tied together with a 3/0 copper ground conductor. This shall supply a grounding electrode for the transformer. Exothermic weld grounding electrode conductor to transformer ground pad.

Part 1 - General

- Refer to Appendix Section 16320 and incorporate into project.

- Coordinate new building design to allow for easy removal of distribution transformers from building interiors.

- Transformers shall first be considered for outdoor placement. When indoor placement is approved, provide permanent hoisting and dolly apparatus with egress pathway for easy replacement. Utilize station transformers with a primary knife switch.

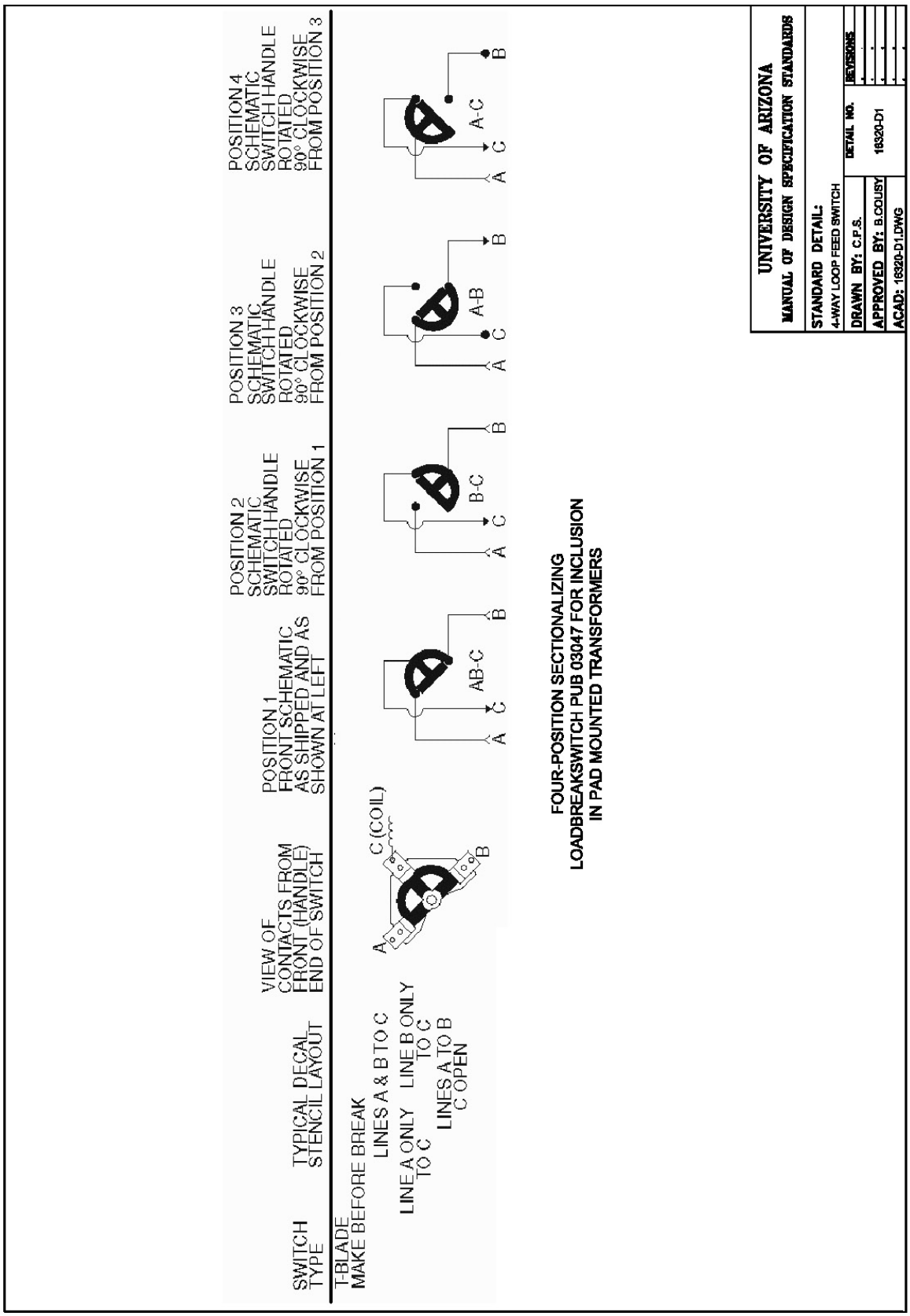
- Transformers shall be loop feed with 4-way load break switch. Mount arrestors on the spare bushings. See detail 16320-D1

Part 2 - Products

- Refer to Appendix Section 16320 and incorporate into project.

Part 3 - Execution

- Refer to Appendix Section 16320 and incorporate into project.
- All 4160 Volt & 13.8 KV equipment not utilized or in use inside or outside a building and its associated wiring shall be removed all the way back to the tunnel where it originates.



End of Section 16320

DIVISION 16 - ELECTRICAL

Section 16390 - Primary Grounding

Introduction

This section applies to the main building grounding electrode system. In general this applies to new building construction or major building expansions only and is not applicable to general renovation projects.

Ground system shall be considered to be separate from the lightning protection system and its associated counterpoise but must be attached to each other. *(Typically below grade).*

Part 1 - General

- On the Main campus and at AHSC the wiring in the facility becomes a separately derived system as it relates to the distribution system supplied by the power company any time we have a local 4160 volt or 13,800 volt primary transformer. The design of this system should be based on that fact. Grounding shall be per article 250 of the NEC.

Part 2 - Products

- Provide a minimum *50'* size 3/0 stranded bare copper conductor in the footing to provide for a base conductor or Concrete Encased Electrode ("UFER") ground for the electrical system. At each end bond out to a 3/4" x 10' copper clad or copper weld ground rod. At each of these points provide an inspection or test point.

Part 3 - Execution

- All primary and secondary service ground connections shall be made using an exothermic welding such as Cadweld.
    - Ground shall be bonded in at least one location to any underground metal water mains or copper water mains.
    - Ground shall be bonded to building structural steel at least one location and per the NEC.
    - The building ground system shall be bonded to any ground ring for lightning protection.
    - Bond to fire protection.
    - Bond to gas.

End of Section 16390

DIVISION 16 - ELECTRICAL

Section 16420 - Service Entrances

Introduction

Service entrance type panelboards and switch gear shall be used wherever the service enters into the facility from the utility serving the facility or where connected to a transformer served from the U of A plant power distribution network.

All new buildings should utilize service entrance switchboards sized for the load indicated. All Service entrance switchboards should utilize 100% rated power breakers.

200 – 600 Ampres; electronic with LSI
800 Ampres and up; insulated case with LSI, add G per NEC
1600 Ampere and up; consider use of Pringle bolted pressure switches

Metering at the service entrance shall be as specified by the utility providing the service. For buildings connected to plant power distribution this shall be as specified under division 16430.

At the Main Switchboard or at the service entrance main disconnect switch the neutral conductor should be bonded to the building or facility grounding electrode system. This system shall be as specified in section 16390 Primary Grounding.

Part 1 - General

- Per NEC 230 for under 600 volts and per NEC 710 for over 600 volts.

- *Consultant shall choose major protective device schemes that are easy to coordinate. Consultant shall write into the specifications in **BOLD TYPE** the requirement that a completed coordination study be submitted with the switchboard submittals/service submittals if not in conformance with the basis of design.*

  Examples:

  Do not protect 75 KVA transformers with 100 amp fuses, use 200 amp switches fused at 125 amperes.

  Allow 4 to 1 ratios between motors, motor control centers and upstream devices.

  Do not size transformers for demand. Downstream main devices must clear before transformer fuses.

  Refer to IEEE Standard 141 regarding the art of planning systems.

- *Switchboard entries shall utilize pull sections that allow main devices to be top line, bottom load.*

Part 2 - Products

- Products should be the same as those specified for other divisions of these specifications except that they should meet the requirements of having a means of installing a bonding jumper between the neutral bus and the ground bus. Note that the ground bus should be bonded to the enclosure.

Part 3 - Execution

- The bonding jumper must be a one piece jumper with no splices.

- The service entrance switchboard must be connected to the grounding electrode system. The minimum size of the connection should be per NEC 250-*66*.

End of Section 16420

DIVISION 16 - ELECTRICAL

Section 16425 – Motor Control Centers, Controllers and Contactors

Introduction

Part 1 - General

- Refer to Appendix Section 16425 and incorporate into project.
- Provide a comprehensive specification.
- Include the following in performing the design and specification:
    - Minimum vertical bussing shall be 600 amperes.
    - Centers shall be 3 phase 4 wire.
    - Center shall have main disconnecting devices.

Part 2 - Products

- Refer to Appendix Section 16425 and incorporate into project.
- Subject to submittal approval, products known to meet the University's requirements are Cutler Hammer, G.E., Siemens and Allen Bradley.

Part 3 - Execution

- Refer to Appendix Section 16425 and incorporate into project.

End of Section 16425

DIVISION 16 - ELECTRICAL

Section 16430 - Metering

Introduction

Metering shall be provided at the location where each building receives its service. In general the metering shall be located at the main switchboard for the building.

Metering shall consist of a separate meter for each building with local plain language annunciation at the switchboard.

Metering shall be through the use of potential transformers and 3 current transformers located in the main switch board at the building.

Metering shall have the capability of being tied into a separate system where all meters can be monitored from a separate remote control system.

For all new buildings the meters shall be tied into the existing Building Control System.

Part 1 - General

- Metering system shall have the capability of reading KWH, KVA, KVARS, Volts, Current, THD Voltage, THD Current frequency and power factor in the same system with the capability of transmitting that data to a central system where that data can be read at a central control station.

Part 2 - Products

- Provide a 1" conduit between the meter and MDF.

- New Switchboard Construction

    - New boards shall be equipped with cold sequence metering. Metering section shall utilize factory installed CT's, PT's and meter. Meter shall be equal to Cutler Hammer IQ DP6000. Additionally, the board will be fitted with cold sequence CT's, contractor purchased from VERIS INDUSTRIES, switchboard manufacturer installed. The factory metering compartment shall be factory fitted by contractor purchased VERIS INDUSTRIES Hawkeye 8163 Meter and H 8163-CB Communication Board. Contractor shall provide rigid/emt raceway from metering compartment to the building MDF telephone terminal board. Provide com cable between switchboard meter section and TTB. Provide new RS 485 jack at TTB. Meter compartment shall be dead-front with lunged swing out panel cover. Interior shall have mounting board in place.

      New and existing building services without switchboards shall be equipped with the VERIS system described for switchboard systems. Where existing space will allow, provide a CT com. On new construction provide a CT com.

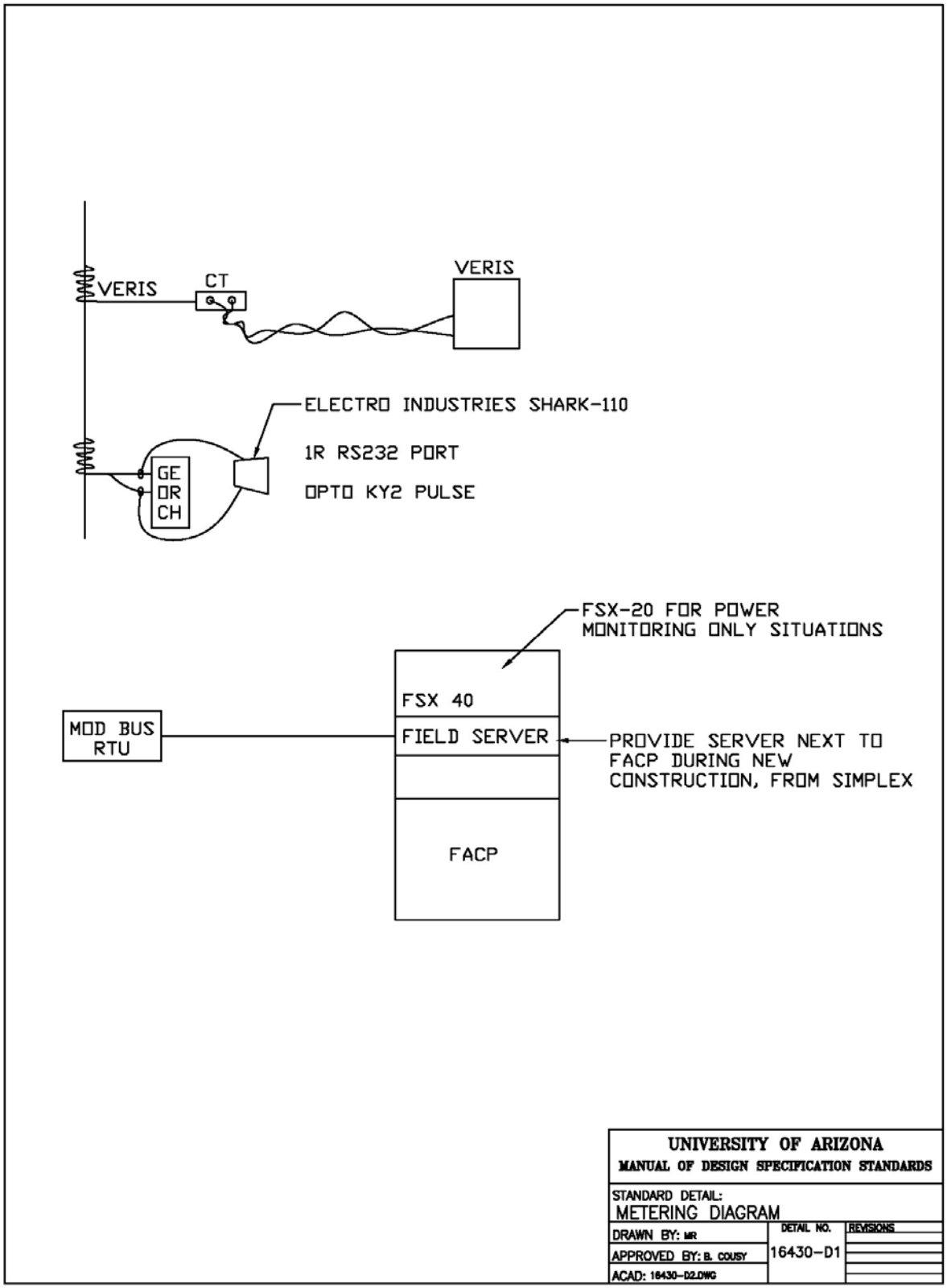
Part 3 - Execution

- Metering shall be located in the main switchboard, at an elevation of somewhere between 5' and 6' above finished grade, and in a readily accessible location.

- All programming for setup of meters shall be supplied and accomplished as a part of the contract.

- An identification tag shall indicate any and all multipliers at each meter. Tag shall be an engraved tag with minimum of 1/4" high letters and secured to switchboard using either screws or rivets.

- Incorporate the following diagram, 16430-D1, into the project drawings.



End of Section 16430

DIVISION 16 - ELECTRICAL

Section 16435 – Switchboards

Introduction

There are no unique University requirements.

Part 1 - General

- Refer to Appendix Section 16435 and incorporate into project.

    - Provide a comprehensive specification.
    - Include the following in performing the design and specifications.
        - Pull sections shall be required.
        - Top of main device shall be line side.
        - Sections shall have steel barriers or galactic barriers between each section.
        - Metering shall be cold sequence.
        - Metering shall be Veris as specified in the Metering Section of the Design Specification Standards.
        - Suppressor shall be hard bussed and mounted in it's own cubicle.
        - Areas next to last section shall be planned and marked on the floor for future extension. Provide the housekeeping pad now.
        - Integrated switchboard design is discouraged unless required by the University of Arizona, Facilities Design & Construction, Electrical Engineer.
        - Bussing and system design will address coordination of devices. Designer shall provide 4 to 1 separation on motor feeder devices and transformer feeder devices, when referenced to the upstream device.
        - Transformer feeder breakers shall be electronic, and coordinated to the transformer and its inrush.
        - Consultant shall base initial coordination on Cutler Hammer, General Electric or Square D.
        - Provide electronic type breakers on devices below 200 amperes whenever clean coordination cannot be achieved, including elevator feeder breakers.

Part 2 - Products

- Refer to Appendix Section 16435 and incorporate into project.
- Approved manufacturers, subject to submittal review are Cutler Hammer, GE and Square D.

Part 3 - Execution

- Refer to Appendix Section 16435 and incorporate into project.
- Edit carefully, as required for the project.

End of Section 16435

DIVISION 16 - ELECTRICAL

Section 16440 - Disconnect Switches

Introduction

Disconnect switches shall be used where required to meet OSHA standards for a disconnecting means within line of sight and no more than fifty feet of the actual piece of equipment being controlled.

All disconnect switches shall be heavy duty motor rated switches.

All disconnect switches required for compliance with OSHA shall be lockable.

A disconnect switch is not to be used as a substitute for a motor starter but should be used in conjunction with all motor starters where required as a disconnecting means.

Part 1 - General

- Acceptable manufacturer's should include GE, Square D, Cutler Hammer, Allen Bradley and approved equal.

Part 2 - Products

- Safety switches shall be heavy duty motor rated with fuses provided to protect downline equipment where required.
- NEMA 3R Environments shall be specified as NEMA 3R/12 gasketed.

Part 3 - Execution

- The maximum mounting height for safety switches should be 6'0" to the top. Safety switches should be rigidly mounted in place.
- Must be *readily* accessible per NEC
- Label per Section 16195

End of Section 16440

DIVISION 16 - ELECTRICAL

Section 16450 - Secondary Grounding

Introduction
This section shall cover all grounding from the secondary of the main supply transformer OR service entrance main disconnect and all wiring downstream of that point. All systems where the possibility of shock exists due to the lack of grounding shall be grounded.

ALL CONDUITS CONTAINING WIRING TO BE ENERGIZED AT OVER 90 VAC SHALL CONTAIN A SEPARATE GROUNDING CONDUCTOR SIZED PER NEC.

Part 1 - General

- As a minimum per NEC 250.
- Use grounding bond bushings for all *feeder* conduits at panelboards, switchboards, wireways, bus ducts, transformers, generators, transfer switches and any other distribution equipment.
- At panelboards only line conduits shall be required to be bonded. Load conduits for subfeed panels will also need to be bonded at each panel.
- *Wherever grounding requirements are stated in specifications, consultant shall insert requirement that contractor shall submit variance requests in writing and receive approval prior to proceeding with the variance.*
- *Refer to Drawing 16450-D1 on page 3 of this Section.*

Part 2 - Products

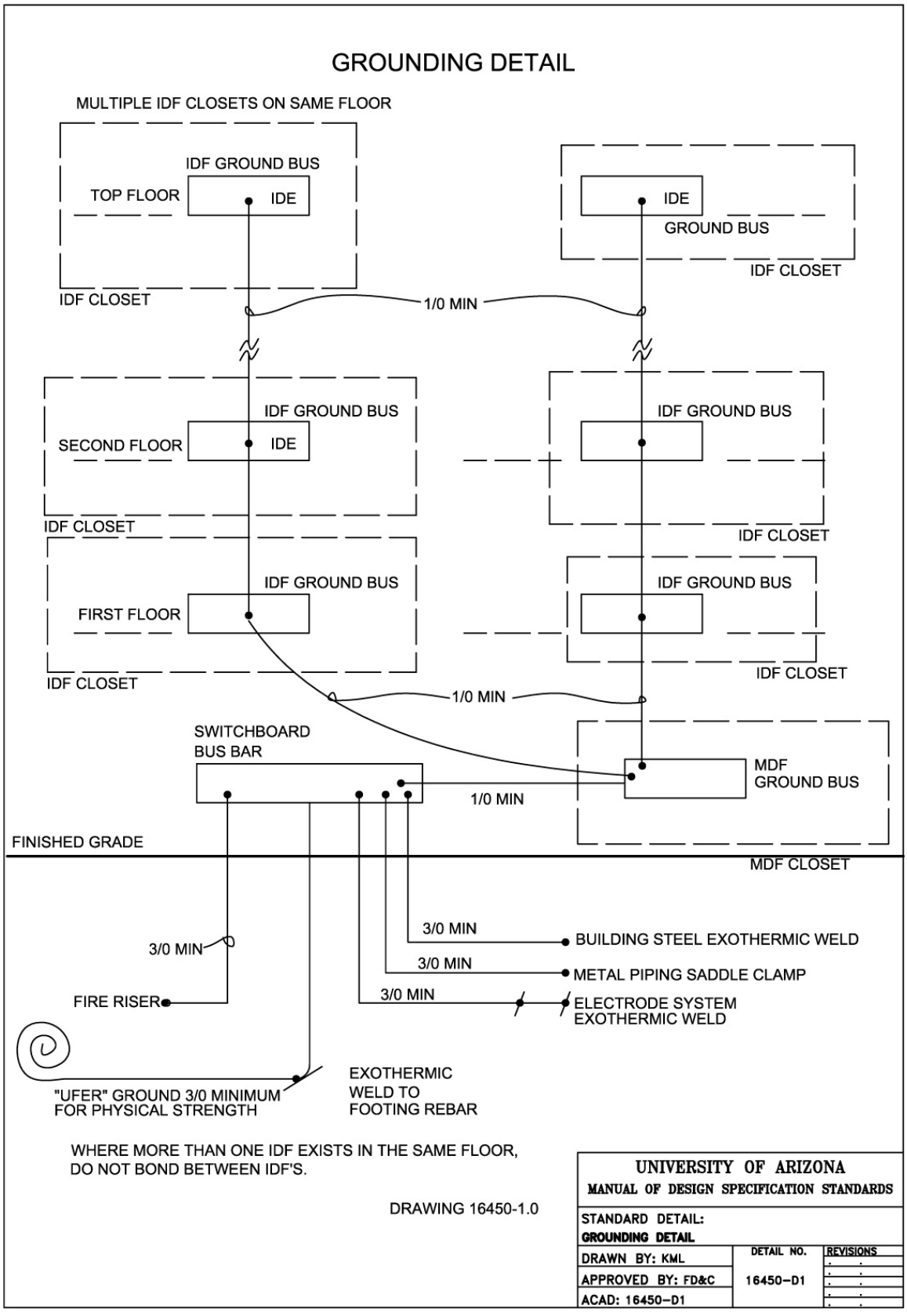
- All grounding conductors shall be stranded *insulated* copper wire *except factory tails*.
- Minimum size ground conductor to be #12. Size to be as per NEC.
- All busducts shall contain a separate copper ground bus. This shall be bonded to the enclosure.
- *Receptacle or switch bonding jumpers may be factory crimped stranded assemblies or field assembled with #12 insulated solid conductor.*

Part 3 - Execution

- All grounding conductors shall be color coded green. This must be visible at all visible locations such as in panelboards, cabinets, enclosures, boxes, wireways, etc.
- Isolated grounding conductors shall be green with an orange *or yellow* tracer.
- All light fixtures shall be grounded via a ground screw in the body of the fixture. The ground screw shall not be attached to a removable entrance fitting.
- All enclosures shall be grounded.
- All j-boxes shall be grounded.
- All panelboards shall contain separate isolated neutral and ground busses. An additional isolated ground bus shall be provided where required.
- All enclosures shall be connected to the grounding conductor.

- All conduit systems shall be connected to the grounding conductor.

- Bond transformer neutral to ground at the secondary of the transformer. Do not bond at any other location. An additional ground from the building ground system shall be supplied with the size as per NEC.



End of Section 16450

DIVISION 16 - ELECTRICAL

Section 16460 - Transformers (low voltage)

Introduction

This section covers transformers with primary voltages to 480 volts and secondary voltages to 120/208.

Locate transformers in an area where they are accessible for inspection on a periodic basis. All transformers are to have both secondary and primary circuit protection.

Final connection to transformers shall be in sealtight or steelflex. Minimum length shall be 3'. Conduit shall be left with an ample vibration loop.

Transformer 30 KVA and larger are to be mounted on ground level with a 4" concrete housekeeping pad.

Part 1 - General

- Transformers are to be as manufactured by PowerSmith, or approved equal.
- Contact FDC for current listing of approved transformers.
- All approved units shall have been in normal production for a period of two years prior to bid date.

Part 2 - Products

- All windings shall be copper.
- Provide 4 - 2 ½ % taps on each transformer 10 KVA and above. Two above rated voltage and two below rated voltage.
- Transformers shall be harmonic mitigating type. 3rd harmonic removal shall be considered in design. UA will consider other types of equipment to accomplish 3rd harmonic removal.
- 80°C rise transformers.
- Noise levels shall be 3 db below NEMA Standards, using he lower level NEMA parameter.
- Products shall be energy conserving type TP-1, or better.

Part 3 - Execution

- Ground transformer neutral to building steel or approved grounding electrode system where building steel is not available.
- Bond frame of transformer.
- When transformers are wall mounted they are to be mounted using factory constructed support assemblies or prior approved supports.

End of Section 16460

DIVISION 16 - ELECTRICAL

Section 16465 - Busduct

Introduction

Busduct should be used where it can effectively replace wire and cable at a competitive rate, or where it is needed to give an area a flexible distribution system.

Part 1 - General

- Acceptable manufacturers are GE, Cutler Hammer, or approved equal.

Part 2 - Products

- All busducts shall be copper bus with a steel, nonventilated enclosure.
- Shall include full size neutral.
- Shall include a half size copper ground. The duct case shall not be the system ground bus.

Part 3 - Execution

- Support on 5' centers and within 18" of any change in direction, to building structure.
- Support at Tap box or terminal box connection.

End of Section 16465

DIVISION 16 – ELECTRICAL

Section 16470 - Panelboards

Introduction

Typically we would like to see panelboards installed here in a manner that they are expandable for future requirements. For this reason no panel (as a part of the original design) should have more than 60% of the panel filled.

Panelboards shall be readily accessible where located for use by the maintenance personnel.

Wherever possible we would like to see them isolated from view of the general population in localized electrical closets so that unauthorized persons can not operate the breakers.

The general size and construction of the panelboard should be per the required load of the area plus at least 30% spare capacity (calculated).

Minimum AIC ratings for the panel should be 10,000 AIC for 120/208 volt panels, and 14,000 AIC for 277/480 panelboards.

No Load centers.

Must be readily accessible.

Do not install in doorways.

All circuits from multi pole breakers shall terminate in a single device or piece of equipment. Do not tie more than one receptacle from a multi pole breaker.

Main Breakers shall be fully electronic LSI type. Equal to Cutler Hammer digitrip OPTIMA.

Part 1- General

- Submittals will be required on all panelboards. Suggested manufacturers are GE, Cutler Hammer, Siemens or approved equal.

Part 2 - Products

- All busses shall be full capacity copper.
- Full capacity neutral bus.
- Computer rooms or areas with intensive (200% rated) electronic equipment shall use oversized neutral bus.
- Ground bus isolated from ground.
- Door in door piano hinged front panel.
- Factory installed main breaker with bolted connections to the enclosed bus bars.
- Main circuit breaker required where source is not within line of sight.
- 20" wide minimum cabinets.
- Cans shall be galvanized steel with blank end walls. Knockouts to be field punched.

- 120/208 volt panels shall have plug in circuit breakers.
    - 100 A panels should be 30 circuit.
    - 150 to 225 A panels or larger should be minimum of 42 circuit.
    - Panel sizes shall be based on full size breakers.
    - Back fed mains are unacceptable.
- 277/480 panels and distribution panelboards, 400 ampere and larger shall have bolt on type circuit breakers.
- Use plated bus in NEMA 3R applications.
- Multi pole breakers shall be manufactured for that purpose and shall not be single pole breakers tied together.
- All main and secondary breakers shall be 100% rated.
- Series rated equipment shall not be used unless approved by UA Electrical Engineer.
- Distribution panelboards shall utilize fully electronic circuit breakers, LSI for sizes 100 amperes and larger.

Part 3 - Execution

- Support to 500% safety factor.
- For panels mounted flush in walls provide 1 spare 1" conduit per each 3 spare circuits or spaces. Route spare conduits to above lights or to an accessible location.
- Provide Plastic Laminate Label per Section 16195.
- Mount flush wherever possible if not in electric room or equipment room. When installing in an existing building either cut into existing wall and properly support or fir out the wall.
- Maximum mounting height 6'7" to highest breaker (center line).

End of Section 16470

DIVISION 16 - ELECTRICAL

Section 16475 - Overcurrent Protective Devices

Introduction

The general philosophy regarding the application of protective devices is that the circuit breaker or fuse at the source must be sized to protective the wiring. The motor protective device overloads on a motor starter) should be sized to protect the motor (except where permitted under other sections of the NEC). Where a combination motor starter is used, it is preferred that a fused disconnect be utilized rather than motor circuit protectors. (Both for single units and motor control centers).

Wiring should be always sized to be adequate to serve the load served. The maximum rating of the protective device upstream of the wiring should never be higher than the 75°C column of Table 310-16 of the NEC or as appropriate for the actual equipment being utilized.

The AIC rating of the protective device must be adequate for the available short circuit of the devices being used. Therefore it is imperative that with each design where the primary distribution to a building is being modified that a proper short circuit calculation be made and applied to the design. Where the short circuit rating of downstream devices is not adequate for the available short circuit current then either the downstream devices must be replaced with higher AIC rated devices or current limiting devices must be used.

The load analysis for the building should be calculated each time a modification to the building loading is done so that a general building overload or a feeder circuit overload will not occur due to inattention to this detail. Should the new loads introduce a situation which would cause either a building or a feeder overload then the Engineer should discuss the situation with the U of A Project Manager and the U of A Electrical Engineer.

On new facilities all circuit breakers from the main to the 120/208 volt panelboards shall be coordinated and a copy of the coordination study provided to the U of A engineer during the construction of the facility.

Part 1 - General

- Circuit breakers should be of the same manufacturer as that of the panelboard or switchboard in which it is manufactured.
- For new equipment circuit breakers shall be either GE, Cutler Hammer, Siemens, or prior approved equal.
- Fuses shall be as manufactured by BUSS, Littlefuse, or prior approved equal.

Part 2 - Products

- Circuit breakers should be appropriate for the equipment in which they are being installed.
- 10,000 AIC minimum for 120/208 volt systems.
- 14,000 AIC minimum for all 277/480 volt systems.
- The actual ratings should be as per the short circuit analysis for the appropriate building.
- Circuit breakers for new 120/208 volt panelboards shall be plug in type.
- Circuit breakers for new 277/480 volt panelboards shall be bolt on type.
- Fuses shall be dual element time delay type fuses.
- Minimum AIC rating for fuses to be 200,000 AIC.

- Panelboard main breakers, panelboard branch breakers 100 amperes and larger, distribution panelboard breakers, and switchboard breakers shall be fully electric type. These breakers shall have at least 5 levels of adjustment, equal to Cutter Hammer “Digitrip OPTIM”. Where 5 levels are not sufficient for CLEAN coordination, the 10 levels of adjustability of the Digitrip OPTIM – 1050 is required. Enhanced thermal magnetic breakers are not to be used and will not be considered. This paragraph shall be included in all specifications prepared by engineering consultants. This information shall also be passed on to bidders in situations where contractors, such as CM at risk contractors, are formulating budgets during the early stages of project development.

- All switchboards shall have electronic interlocks for selective tripping.

- All fuses for new equipment shall be rejection type fuses with approved rejection pins at all disconnects.

Part 3 - Execution

- Where multiple breakers are indicated on the drawings they shall be provided with a common trip and not as separate breakers “strapped” or “tied” together.

- Fuses shall be installed in such a manner that the fuse rating can be read from the front of the panel or switch without having to remove or rotate the fuse.

End of Section 16475

DIVISION 16 - ELECTRICAL

Section 16485 - Lighting Controls and Contactors

Introduction

Lighting contactors are to be generally used for *the* control of outdoor lighting or special effect lighting. Lighting contactors should generally be controlled via a combination of an *auto rewind* time clock and a photocell. *This is* for areas which require lighting up to a certain time and after the building is no longer in use and do not need to be on. For lighting in areas *requiring all night illumination control shall be a photocell on and off*.

Part 1 - General

- Provide submittals for contactors and associated time clocks and photocells.

Part 2 - Products

- *Photocells are the preferred control and should be adequate for the loading required where used for only one or two fixtures. Where used for more than two fixtures tie control through a contactor.*

- *Photocells shall have override switch.*

- *Time clocks shall be electronic astronomical programmable units with capacitor back up. Clock shall not need to be reprogrammed in case of a power outage. Time clocks shall have adjustable longitude and override switch.*

- Use NEMA size contactors rated for the size and type of loads required. Contactors shall be electrically held. Approved manufacturers are GE, Allen Bradley, Cutler Hammer, Square D, or prior approved equal.

Part 3 - Execution

- Locate time clocks and contactors in accessible locations in the appropriate electric room where the equipment served is located.

- Photocells should be located such that the light from the controlled lights will not cause the photocell to operate. Photocells should be located at a readily accessible location.

End of Section 16485

DIVISION 16 - ELECTRICAL

Section 16510 - Lighting Design

Introduction

Lighting utilizes approximately 40% of the electrical energy consumed here at the university. In order to conserve the energy it is very important that the lighting design be energy efficient.

Consideration for maintenance of the light fixtures needs to be taken into account also. If a lamp is known to have a short life or a fixture manufacturer is known for having problems with his equipment make sure to eliminate them from consideration as a manufacturer. Use linear type fixtures whenever possible. Recessed compacts are to be minimized.)

Light levels should be appropriate for the task and per the following guide in Part 1 - General.

Design Guidelines

- Lighting design shall comply with current IESNA guidelines and application notes, with selection of the median illuminance as the target optimum, not the minimum. In all areas designated higher than IESNA category C, specified illuminance shall be on task, with ambient illuminance generally task/3. In all areas, lighting targets shall be achieved by the most current energy efficient technology which meets the requirements of this Section 16510.
- Incorporation of natural daylight, and daylight-supplementing artificial light.
- Area lighting by high-CRI linear tube fluorescent with specular reflectorized interior luminaire. For applications which do not involve frequent switching, use fully electronic instant start parallel-circuit ballasts.
- Task lighting by 13 watt lamps (or smaller), with laterally offset placement so as not to cause direct or veiling glare.
- Conference room dimming: provide continuous architectural-dimming (to 10%) with linear fluorescent luminaries in place of incandescent can downlights.
- Reflectorized technologies for interior luminaries.
- Areas with visible daylight may use continuous-dimming photocell-controlled variable light output devices except those controlled by non-defeatable occupancy sensors. Daylighting contribution to be considered in calculation of IESNA target illuminance.
- Whenever possible fluorescent lamps shall meet the Federal TCLP mercury limit of 0.05mg./L

Prohibited technologies include:

- Tungsten filament incandescent except quartz-halogen
- T12 fluorescent
- VHO and SHO lamps
- Mercury vapor lamps
- U-shaped lamps (except for CFLs)
- Small-cell paracube grates and large cell paracube fixtures where the lamp is not centered into the cell
- Magnetic fluorescent ballasts
- Series-circuit ballasts
- Indirect lighting in restrooms, corridors, and utility areas
- Neon systems of any type

Occupancy Sensors shall be specified and installed in accordance with EPA Green Lights guidelines, with control technology appropriate to the application. Areas with video display terminals shall be primarily illuminated by task lighting, use of overhead luminaries in each space to be evaluated for Visual Comfort Probability. Visual acuity factors are to be treated as minus weighting factors.

Discouraged Practices

- Indirect cone and soffit lighting
- Fixtures inaccessible from a landing.

Two level Lighting control should be provided in areas where multi use of the area would require various levels of light control. Where a greater variation on the lighting is required then the use of linear fluorescent fixtures with electronic dimming ballasts is preferable as far as energy consideration than the use of incandescent fixtures with dimmers. Motion sensors with override button shall only be installed in specific situations approved by UA Electrical Inspector or Electrical Engineer.

Minimize the use of incandescent and quartz halogen type light sources since they are both expensive to operate (in both energy and heat gain) and maintain. Prior approval from the U of A electrical engineer must be obtained prior to design using either of these light sources.

Where remodeling is being done in an area it shall be considered to be part of the scope of work to bring the existing lighting in the area into compliance with this section.

Indirect type lighting sources may be used but only when it is used for special area lighting such as special conference areas, and in computer type labs.

In both new lighting and remodeling type lighting projects it shall be required to perform lighting calculations for the proposed systems and to submit point to point, area and lighting density calculations. Provide cut sheets for the fixtures proposed as a part of the schematic design of the project.

For new classroom or classroom remodel projects the fixtures shall be 2 lamp parabolic with electronic ballasts, and high reflectivity mirrored internal reflector 18 cell reflectors minimum 3" deep. One lamp is to be controlled via dimmable ballast and a second lamp by a standard electronic ballast. Ballast to allow for dimming down to 10% of rated wattage. Where wiring is required to go into podiums for light control utilize low voltage relay control such as that manufactured by GE or Douglas.

Use T5 Systems in lieu of HID in interior applications for high ceilings et.al.

Part 1 – General

- Contractor to provide submittals of all light fixtures, with actual ballast type when applicable, and lamp types utilized.

- **Lighting Levels**

  The following information shall be used by the designer in developing a lighting system for each specific project based on IES recommended practices, codes and ordinances, life safety requirements and good engineering practices. Major deviations due to engineering decisions shall be documented in writing and discussed with the Project Manager and University Electrical Engineer during the design development stage or schematic design stage. When in doubt, call for a presentation by the University.

- **University Lighting Standards**

  Lighting levels at desk or tables tops shall be:

  Hallways: 25 foot-candles average maintained foot-candles
  Public areas: 30 foot-candles average maintained foot-candles.
  Offices: 50 foot-candles average maintained foot-candles.
  Reading rooms: 50 foot-candles average maintained foot-candles.
  Classrooms: 50 foot-candles average maintained foot-candles.
  Laboratories: 70 foot-candles average maintained foot-candles.
  Machine Shops/Workshop: 100 foot-candles average maintained foot-candles.

  Minimum lighting standards shall be defined as average maintained foot-candles (within the range of -10% to +25%) over the life of the lamps, unless otherwise pre-approved by the University of Arizona.

- **Preferred Lighting Densities**

The maximum lighting power density (LPD) for any building may be calculated by either the Complete Building Method (Table 2.1) or the Area Category Method (Table 2.2)

Table 2.1
Complete Building Method

Building Type	Max. Lighting Power Density (W/sf)	
	Goals	Max *
General Commercial or Industrial Work Buildings	0.8	
Grocery Stores	1.2	
Industrial or Commercial Storage Buildings	0.5	
Medical Buildings and Clinics	1.0	A.R.
Office Buildings	1.0	1.8
Religious Worship, Auditorium/Convention Centers	1.3	A.R.
Restaurants	1.0	
Retail and Wholesale Stores	1.3	A.R.
Schools	1.2	
Theaters	1.0	
All Others	0.5	

*AR means “as required”

Table 2.2
Area Category Method

Area Type	Max. Lighting Power Density (W/sf)	
	Goals	Max *
Auditorium	1.3	A.R.
Bank and ATM’s	1.2	1.8
Classrooms	1.3	1.8
Convention/Conference/Meeting Centers	1.0	2.0
Corridors, Restrooms, Support Areas	0.5	
Dining	0.8	
Exhibit	1.5	2.0
General Commercial and Industrial Work	0.8	A.R.
Grocery	1.3	A.R.
Hotel Function	1.5	
Industrial and Commercial Storage	0.4	1.8
Kitchen	1.5	
Lobbies: Hotel Lobby	1.5	
Main Entry Lobby	1.0	
Malls, Arcades, and Atria	0.8	
Medical and Clinical Care	1.2	A.R.
Office	1.0	1.8
Precision Commercial and/or Industrial Work	1.3	A.R.
Religious Worship	1.4	
Retail Sales, Wholesale Showrooms	1.4	
Theaters: Motion Picture	0.7	
Performance	1.0	A.R.

* AR means “as required”

Part 2 – Products

- Light fixtures are to be the product of a manufacturer of high quality light fixtures generally used in an industrial or commercial type setting. Fixtures shall be UL or CSA listed and certified.

- Fluorescent fixtures shall utilize electronic ballasts (not hybrids). Ballasts shall be Advance, Universal/Magnetec or prior approved equal as manufactured. All ballasts shall be fused with glass tube fuses type HLR/GLR. All ballasts shall be CBM certified. Crest factor shall be not greater than 1.7. Harmonic distortion shall be less than 10%.

- Linear fluorescent lamps for 4' or 8' fixtures shall be type T8 32 watt 4 ft. lamps (tandem 4' lamps in 8' fixtures) energy saving lamps and shall be compatible with the type of ballasts supplied (and must be certified as such by both the manufacturer of the lamps and the manufacturer of the ballasts).

- Lamps shall be 4100°K with a CRI of 85. New buildings shall utilize 4100°K lamps. Lamps shall be rated for 24,000 hrs. minimum. Lamps shall be non-hazardous and disposable by normal means.

- For smaller than 4' lamps it is recommended that compact biax lamps be utilized rather than the use of u-tube type lamps. (36 watts and higher wattage Biax are not approved.) (48" U tubes are not permitted.)

- Ballasts should be installed such that they are contained within the fixture. Where this is not possible the ballast should be installed clear of any combustible material and in an accessible location. Ballasts for recessed non-linear type fixtures shall be located between the fixture housing and the junction box.

- Where HID type fixtures are used utilize ballasts without igniters and specify that the igniter be integral with the lamps.

- All ballasts for HID fixtures shall be high power factor/low noise/low emf type ballasts.

- Compact flurescent ballasts shall be highest quality, HPF, minimum THD and maximum efficiency.

Part 3 – Execution

- Light fixtures shall be installed so that they are accessible for maintenance.

- Reference 16190 for supports.

- Fixtures mounted in a plaster or drywall type ceiling shall be rigidly supported in an approved manner using channels connected to the ceiling support system

- Provide plaster frames for all fixtures requiring them.

- Light fixtures mounted flush in fire rated walls or ceilings shall be rated to the wall/ceiling rating.

- 3/8" light fixture whips may be utilized when fixture whip comes from the factory attached to the fixture via a steel box connection. Wire size shall not be less than #14 THHN. Box connectors must have a locknut, i.e., pop in type connectors will not be permitted. Lengths shall not exceed 6'0". (Tandem whips may be longer with University approval.)

- Removable snap in entrance fittings shall be secured to the fixture body using a #8 (minimum) self tapping screw.

- 2x2; 2x4; 1x4; 1x6 and 1x8 types of light fixtures including recessed can type fixtures installed in grid ceilings shall be supported using not less than #12 gauge steel galvanized support wire and earthquake clips shall be installed. Each rectangular or square type fixture shall have a minimum of two support wires attached at opposite corners. Each recessed can type fixture shall have a minimum of one support wire. Support wires shall be secured attached directly and independently to the building structure with minimum size ¼" galvanized steel anchors (use expansion type anchors when in concrete). Wires shall have a minimum of

three twists (turns) at each attachment point. Deflection on the support wires shall not exceed 10-degrees from plumb. Refer to Section 16190 – Supports – LIGHT FIXTURE SUPPORTS.

End of Section 16510

DIVISION 16 - ELECTRICAL

Section 16530 - Site Lighting

Introduction

When designing site lighting for the University two areas of major concern arise. The first and most prominent is that of safety for the students and faculty members. Since many times students need to be out and around the facility at late hours it is important to provide lighting such that they can see well enough to feel safe when they are traveling from one building to another.

The second area of concern is to minimize site lighting so as to meet within the guidelines for both Kitt Peak and Mt. Hopkins Observatories.

Lighting design should be in keeping with IES Lighting Standards *and the Pima County Lighting Ordinance. Follow the ordinance. Special situations may receive a variance. Submit written requests to FDC for written approval.*

As a part of the design we expect to see details of both bollard and light pole foundations. *Foundation designs* shall be sealed by a Structural Engineer.

Metal halide shall not be used unless approved by UA, FDC Electrical Engineer or UA, FDC Electrical Inspector*.*

Low pressure sodium sources are not to be used. High pressure sodium, fully shielded is the preferred source.

Whenever rework in the existing series street lighting is accomplished we should make an aim to eliminate the 2300 volt circuit and rewire to be powered by the nearest building. In addition label each pole base inside as to the source of the power.

Light fixtures should be located in such a manner that they can be easily maintained using standard equipment. Where fixtures can not be easily accessed the use of hinged poles shall be required. All exterior building light fixtures and poles shall able readily accessible and not restricted by other site improvements.

The design should be made in a manner such that is both energy efficient and cost effective as well as meeting the requirements for the local regulations.

The design should be flexible for both the field installation for expansion and for maintenance.

Where large areas are involved provide handholes for maintenance use to trouble shoot the underground wiring when needed, and to allow for easier expansion if required in the future.

As part of the design development phase provide cut sheets and point to point design calculations for all site lighting.

Where site lighting is to be designed either on the fringes of campus or off campus, insure that no light trespass occurs.

Part 1 - General

- Provide submittals on all fixtures, including poles, bases, and ballasts.

Part 2 - Products

- Provide high quality products which are both architectural in nature and have an efficient lighting design.
- Use enough fixtures to provide adequate light especially in exterior corridors or areas between buildings to allow proper levels for personnel safety.
- Where available match fixtures in surrounding areas to be able to allow some continuity with the lighting in a general area.
- Light poles need to be designed for a minimum of a 100 mph wind loading. (80 mph + 1.3 gust factor)
- All fixtures with ballasts shall be fused.
- Pole mounted fixtures shall have fuses in base of pole with handhole access.
- **Part 3 - Execution**
- Include requirements for aligning light fixtures, light poles, and bollards to be both level and uniform in layout and light distribution.

End of Section 16530

DIVISION 16 - ELECTRICAL

Section 16535 - Emergency Lighting

Introduction

Provisions for emergency lighting should take into consideration the requirements for location of emergency exit lights in accordance with the new ADA and the requirements of the NFPA for exit lights.

In general for new buildings it is required that all emergency lighting be supplied through the use of an electric generator. Each floor should have its own emergency panel and all emergency lights should be supplied from that panel.

On existing buildings where an emergency generator exists, all new emergency lights should be connected to that system. On buildings without an emergency generator system utilize 2 hour emergency battery packs in fixtures where required.

Do not wire light fixtures with power from two different emergency power systems.

For corridor emergency/night light circuits consider using florescent fixtures with PL type lamps at either 13 or 26 watt levels.

Emergency lights located in classrooms or labs where a fully lit fixture would cause problems with the capability to darken the room (where a dark room is necessary for the room's operation) shall be switched via a lighted red toggle switch.

Part 1 - General

- Provide submittals on all emergency light fixtures.

Part 2 - Products

- Emergency or exit lights shall be the LED type low power use.
- Clear plexiglass exit signs, if used, shall have factory backings to prevent reading the words backwards.
- Battery packs should use the Nicad type batteries with a minimum of 10 year life.
- Where emergency lights contain battery packs the emergency ballast shall be as manufactured by Iota or approved equal.
- Fluorescent fixtures with 4 ft. lamps shall utilize 1000 lumen battery packs when battery packs are permitted.

Part 3 - Execution

- Where used in classroom situations it is generally considered that all emergency lights should be capable of being turned off via normal light switches. However in case of an emergency or loss of power, and where possible they should all be energized to illuminate the means of egress. Emergency lights should be supported by the same criteria as normal light fixtures.

End of Section 16535

DIVISION 16 - ELECTRICAL

Section 16580 - Theatrical Lighting

Introduction

Since theatrical lighting is a very specialized lighting system it should be left to be designed by experts in this field of lighting. On projects such as this it is required that the engineer responsible for this area of design be experienced in this type of design and should provide documentation in the form of past projects engineered which would back up his claim.

Documentation required on this type of design would be providing a minimum of two proposals for the type of design proposed. Each should include back up information such as type of equipment planned (including cut sheets), typical life expectancy of equipment (including bulbs and ballasts where applicable), and cost estimates for each type of lighting system.

Design should take into account the requirements of maintenance on the system and the reliability of the equipment. For this reason we would expect to have included in the design high quality equipment by the top manufacturer's of this type of equipment.

Theater design should include design calculations and computer printouts on a point to point basis. Cut sheets of intended products shall be provided at the design development phase.

The electrical consultant shall supervise the lighting design and seal the plans.

Part 1 - General

- Complete submittals of all equipment proposed should be provided.
- Maintenance and operational manuals should be provided (minimum of 4 sets) at completion of project.

Part 2 - Products

- All products should be the product of top quality manufacturers and should be designed for the purpose for which it is used.
- All products should be U.L. listed or certified.

Part 3 - Execution

- All equipment should be independently supported to a minimum of a 200% safety factor to the building structure.
- All equipment should be located such that it is accessible for maintenance or can be made available for maintenance through normally available methods.

End of Section 16580

DIVISION 16 - ELECTRICAL

Section 16610 - Uninterruptable Power Supply Systems

Introduction

The design of UPS systems is normally associated only with specialized computer room distribution systems. At the present most of these systems are not associated with the renovation of any building or facility, but rather a piece of equipment that would be provided by the user as a separate item. However where they are to be provided by the contractor as a part of the construction package the following guidelines should be taken into account for the design.

- A minimum of a 20 minute battery backup should be used.
- Only static UPS units should be used.
- Design should provide for a minimum of 30% spare capacity.
- Design should be based on top quality static UPS systems such as those supplied by Liebert, and similar manufacturers.
- Design for the electric service to the unit should take into account the losses for the system.
- Since these units generate a large amount of heat and are usually somewhat noisy it is recommended that they be located in a room where the general public will not normally be working, where there is adequate air conditioning for the required heat load, and where the walls provide a good deal of noise attenuation.

Should this section be required for an actual project please consult with the U of A electrical engineer.

Part 1 - General

- All systems must be UL listed.

- Provide complete submittals on UPS system including operations and maintenance manuals (minimum of 4 copies).

- Provide for two years of preventative maintenance as a part of the cost of the UPS.

Part 2 - Products

- To be determined at time of design. Suggested manufacturers to be Liebert or approved equal.

Part 3 - Execution

- Install units in an area where they are fully accessible for maintenance, and with adequate ventilation.

End of Section 16610

DIVISION 16 - ELECTRICAL

Section 16620 - Standby Power Generator Systems

Introduction

The design for emergency power generation takes on two separate designs at this campus. For the typical building at the main campus it is generally used only to provide power to emergency lighting and similar building maintenance type pieces of equipment. In some other buildings additional loads are added for such things as freezers or other types of mechanical equipment which need to be on due to worry about losses of expensive equipment (including some valuable experiments) which are stored in the freezers. However the design for expansions on the AHSC campus sometimes take on a different flavor since it may include areas which could someday become part of the hospital. For this reason it will be necessary to discuss in great detail the design of the emergency generation system with the Engineer, prior to the proposal of the system. As a part of the design the following items should be taken into account:

- In general we *require* the use of Natural Gas to fuel the generators due to *local emissions requirements and ordinances,* ease of delivery of the fuel *and elimination of the need for fuel* storage. With the constant construction around this campus, areas which were once very accessible for delivery of fuel are now very difficult to access. In addition the designer should verify that the source of natural gas which has been designed for the building is adequate for the additional volume of natural gas that will be required during the full load operation of the generator.

- Make sure that the generator will be adequately cooled in case of loss of power to the general building system. It may be necessary to provide additional capacity for the generator just to cover an additional fan coil unit to provide cooling to the generator room if it is located inside of a closed room in the building.

- Provide for adequate exhaust from the building in a location where the fumes will not be sucked into the building air conditioning system during normal or emergency conditions.

In addition it may be decided that some of the emergency generator systems will in the future be used for peak shedding. For this reason it is important that the generator provided be of a top brand of manufacture and designed for more than just an occasional run emergency operation. Engine generators shall be site tested for rated output plus 10% for 1 continuous hour, connected for temperature, based on capability to operate continuously at 115°C ambient. (Refer to base specification.)

As a part of the design development documents, provide a load calculation which is used for providing the basis for the sizing of the emergency generator. Take into account that at least 30% spare capacity shall be provided for in the design of the emergency generator.

As part of the plans design make sure that the required circuits for the battery charger and the engine oil and manifold heaters are shown and provided.

Remote control or annunciation panels shall be shown on the drawings with all wiring required.
Show ATS (automatic transfer switch) and all associated wiring on the plans. Fire alarm shall monitor generator run and report to Fire Safety Shop *thru the FACP.*

For your use a copy of an existing specification for an emergency generator specification and an automatic transfer switch have been provided. (See attached appendix specification sections 16620 and 16622). As a minimum all of the areas covered in this specification should be covered. This specification can be provided on disk for your use, however it is still the responsibility of the engineer to provide a complete specification for this design.

Where a building EMCS system is available connect the following items to the system. Building power off, generator power on, generator alarm (a common alarm of all generator alarm functions).

Part 1 - General

- Provide complete submittals on the emergency generator, including at least 4 copies of all operations and maintenance manuals. Submittal information shall include documentation of fuel efficiency based on a KW per pound of gas. This should be provided for evaluation by the engineer prior to approving the use of any brand of emergency generator set.

Part 2 - Products

- The generator should be the product of top quality generator manufacturers such as Caterpillar or Waukesha. Other manufacturers may be considered based on submittal information. The manufacturer should certify that the generator is capable of providing the necessary power for all of the load as designed, including the spare capacity.

- *Engine Generator System shall have a 5 year extended warranty. Whenever the transfer switch manufacturer offers an extended warranty, it shall be included,*

- *The contractor shall provide (2) complete sets of parts and repair manuals for all engine, generator and transfer switch systems and components.*

Part 3 - Execution

- The generator shall be mounted on a housekeeping pad and if in a building shall have a containment area built around to contain any oil or antifreeze spills. The generator shall be installed and connected to meet with the requirements of the manufacturer.

- Provide a resistive load bank test of all generators prior to acceptance. Minimum tests should show all required control options of the generator and transfer switch as well as a one hour load bank test at 80% load and an additional one hour load bank test at 110% load, corrected for temperature of 115° C. Generator shall also be tested in a full load live situation test prior to acceptance.

End of Section 16620

DIVISION 16 - ELECTRICAL

Section 16622 Automatic Transfer Switch

Introduction

The intent of this section is to require that at each location where an emergency generator system is utilized an automatic transfer switch (ATS) *or bypass isolation transfer switch shall* be utilized.

Since more and more equipment is being added to the system which is "protected" by the emergency generator system it is important that a top quality transfer switch be utilized. In addition it has been found that though many of the manufacturer's of emergency generators can provide a switch in conjunction with the emergency generator that these are usually of a lower overall quality and more subject to breakdown. Therefore we would suggest that the ATS be of similar quality to that in the accompanying specification.

The ATS should be sized to meet both the maximum short circuit current available from the combined sources (in case of a direct fault during transfer), and for 125% of the available current from either the normal or emergency power source *with a 3 cycle rating in excess of UL 1008*.

Since the ATS generally contains electronic items make sure that the location of the transfer switch is compatible (i.e. adequate cooling and minimum dust) with the transfer switch.

A sample specification (see attached Appendix Section 16622) has been provided for your use outlining all of the standard requirements necessary for new installations here. As a minimum all of the items outlined in this specification should be included.

Whenever GFI is used, provide 4 pole switches.

Transfer switch shall have programmable auto exercising feature for once a week

Part 1 - General

- Complete submittals and operational manuals shall be provided as a part of the system.
- The warranty shall be the same as that of the emergency generator that it is associated with.
- Complete maintenance manuals and spare parts lists be provided as a part of the project close out documents.

Part 2 - Products

- Russelectric, or *prior* approved equal. *Zenith and ASCO may be specified after first documenting proof of third party testing for a 3 cycle rating. (Prior to completing contract documents submit proof at design development stage of design).*

Part 3 - Execution

- Startup and check out to be by a manufacturer's certified technician.

End of Section 16622

DIVISION 16 - ELECTRICAL

Section 16650 - Electromagnetic Shielding Systems

Introduction

Electro magnetic shielding is only required when due to the type of testing going on in a building that high levels of electro magnetic fields (EMF) are generated in an area. Typically if personnel are being exposed to levels of EMF higher than 100 mg then electro magnetic shielding should be provided or special consideration should be taken to lower the EMF.

Sometimes it will be necessary to build a specially shielded room for personnel involved in the testing of special systems so as to minimize the amount of EMF and RF (radio frequencies) which would enter the test space.

The design of such a system in either case shall be done only by personnel who are experienced in design of shielded rooms or special shielding facilities. Special grounding systems shall be taken into account to facilitate complete draining of all EMF energies into the ground and thus protect personnel.

Part 1 - General

- Provide complete submittals for the design whether by the engineering firm or a design build concept is used.

Part 2 - Products

- All grounding parts shall be copper. Copper shielding shall be utilized in the design. Where required for personnel protection the entire system shall be UL certified.

Part 3 - Execution

- The installation of the system shall only be accomplished by personnel experienced in the construction of Electromagnetic shielding systems. Following the construction of the system it shall be the requirement of the installer to have the entire system tested to verify that it complies with the minimum design constraints set up prior to the design of the system.

- Foil systems utilizing foil stapled to walls is unacceptable design.

- Consult University of Arizona Engineer for test/compliance of these facilities during design.

End of Section 16650

DIVISION 16 - ELECTRICAL

Section 16660 - Ground Fault Protection Systems

Introduction

All building main distribution systems shall have a ground fault protection system as a part of the secondary main disconnect at the building. This is required per the NEC for services of 1000 amps and larger.

GFI receptacles shall be used for drinking fountains and wherever a receptacle is within 5' of a sink or an emergency shower and where otherwise required by the NEC or good engineering practice.

GFI receptacles shall not be feed through type. Each location required shall have its own GFI receptacle.

It may be necessary to add GFI protection to services where an adequate ground is not available and where danger of electrocution is possible. An example of this would be an overhead crane where only a three wire system has been connected to the service and where the danger of electrocution is greater than the possible danger from loss of power to the overhead crane.

Part 1 - General

- Provide complete submittals for all devices supplied under this section.

Part 2 - Products

- GFI relays provided as a part of a main switchboard shall be as recommended by the manufacturer of the switchboard.

- GFI receptacles shall be heavy duty specification grade receptacles similar to Hubbell 5362 GFI.

Part 3 - Execution

- Install all devices in accordance with the manufacturer's recommendations. For service entrance systems the device shall be tested following installation in accordance with NETA testing standards.

- Each GFI receptacle shall be tested for proper operation following installation.

End of Section 16660

DIVISION 16 - ELECTRICAL

Section 16680 - Variable Speed Drive Systems

Introduction

There has been some confusion as to who should specify variable speed drives. Since they are electrical in nature and are maintained by the U of A Electric shop we would like to see them in the electrical specification section in the future.

Since there are some concerns as to what type of drives are recommended for use on this campus we would like to provide the attached sample specification (Section 16680) for your review as to what areas are necessary for inclusion in this specification and also the level of quality which is recommended for use on this campus.

Note that it will be necessary to interface with the mechanical or instrumentation engineer as to what required connections are necessary for the tie into the EMCS or other control system.

Do not locate drive inside of air handling units.

Part 1 - General

- Require complete submittals including wiring diagrams and recommended spare parts at the submittal.
- Require submission of complete operation and maintenance manuals at time of completion of contract prior to conducting the “training session”. Operation and maintenance manual shall contain a complete copy of the submittal documents.
- Require a factory representative startup and training on site four hour minimum training session to be scheduled after the VFD is in service and fully operational.

Part 2 - Products

- ABB or prior approved equal meeting the aforementioned specification, type ACH 401.
- Indoor enclosures shall be NEMA 12. Outdoor shall be NEMA 4.
- Fully transistorized PWM type drives.
- Match type of drive to actual load driven (i.e. variable torque or constant torque)
- Coordinate use of VFD rated motors with mechanical trade.

Part 3 – Execution

- Utilize Mechanical section 15870 in coordination with the mechanical trade and /or engineer.
- Limit length of feeder from VFD or AFC (adjustable frequency controllers) to motor as per recommendations of the manufacturer. If possible locate drive near motor.
- Feeder must be in steel conduit.
- Control wiring in separate steel conduit. Speed signal wiring to be in twisted shielded pair, minimum of 18 ga. copper.
- Install AY.

End of Section 16680

DIVISION 16 - ELECTRICAL

Section 16700- TELECOMMUNICATIONS

Part 1 - General

- The scope of this project includes providing all material and labor to install a complete telecommunication system. The systems shall include building entrance cables, riser cables, station wiring, terminations, and termination devices and grounding.
- In any case where the specifications or drawings are not perfectly clear to contractors submitting a proposal, it is the responsibility of the contractor to obtain clarification from UITS-NTS Engineering. The drawings are diagrammatic and are not complete in every detail. The contractor shall be responsible for determining how to perform indicated work under the scope of the project and shall not make any additional charges for any work or material required for a complete installation. The drawings and specifications are complementary, and what is called for on one shall be binding as if called for by both.
- Coordinate size and location of communication rooms with the architect to be in compliance with this document and NEC Art. 800 © (2002).
- In projects where “Blue Light” emergency phones are required, refer to Section 16705, Blue Light Phones.
- Refer to project plans and specifications for grounding and power requirements.

- General Requirements

  - Codes & License Compliance: The completed installation shall be in compliance with all applicable electrical and fire codes and ordinances, the Williams-Steiger Occupational Safety and Health Act of 1970, and University Standards. Telecommunications contractor must have a current L67 Low Voltage Communications Systems license, and have held the license for a minimum of 4 years, and be listed by the University as an approved telecommunications cabling contractor.
  - New & Listed Materials: All materials shall be new and shall be listed as being suitable for the purpose by Underwriters Laboratories, Inc. or equivalent testing agency known to and approved by the University.
  - Workmanship: All work shall be executed according to these specifications in a workmanlike manner and shall present a neat mechanical appearance when complete.
  - Quality Assurance: At least one person directly employed by the prime contractor shall monitor the daily activities of workers to assure the quality of the work performed.
  - Acceptance Inspection: All work must pass functional and workmanship inspections prior to acceptance. The contractor shall make all required corrections, at no additional cost, before the system is put into service.
  - Clean up & Repair: Contractor shall be responsible for clean up and repair of job site. Damaged false ceilings, pencil or chalk marks, hand prints, gouges and tool makers, plaster dust, etc. shall be repaired, cleaned, removed, or painted as required. Penetrated fire barriers shall be resealed in an approved manner.
  - Submittal: (5 copies required). Complete materials lists, manufacturer’s literature, required drawings, and other required information shall be submitted for approval no less than 10 working days before such materials are required to be ordered for the work. UITS-NTS Engineering must approve submittal prior to starting the installation. Submit thru the Construction Project Manager.
  - Guarantee: Upon completion of the work and acceptance by the University, the contractor shall submit his warranty effective for one year guaranteeing to replace without additional cost to the University any work or material which develops defects.
  - As-Built Drawings & Documents: The contractor shall maintain daily up to date specifications and drawings. The contractor shall submit to UITS-NTS a complete set of As-Built drawings showing the location and identification number of all jacks installed as part of the project. As-Built drawings shall be submitted in both hard-copy and AutoCAD format.
  - Changes: No changes shall be made from the work as called for by these specifications and drawings, except by a written order approved by the project Construction Project Manager, Architect, and UITS-NTS Engineering.
  - Splicing: All cable splicing must be done by a qualified cable splicer, with a minimum of 5 years experience splicing large pair count copper cables. The cable splicer’s name and qualifications must be

submitted to UITS-NTS Engineering for verification and approval prior to any splicing work. Provide a minimum of 48 hours advance notice to UITS-NTS prior to performing any splicing to existing campus cabling infrastructure.
- Coordinate grounding requirements with Specification 16450.

Part 2 - Description of Work

- Building Entry Cable: Supply, install, splice, and terminate the required multi-pair building entrance cable and or fiber optic cable routed as shown on drawings. Supply and install station protectors and grounding in accordance with NEC requirements.

- Entrance Facilities:

  - Vertical cable runs are to be supported at a maximum of 5 ft. centers. Horizontal cable runs are to be supported at a maximum of 3 ft. centers.
  - Copper entrance cables shall terminate on a rack mounted protector panel. Optical fiber entrance cables shall terminate on a rack mounted optical fiber enclosure (LIU).
  - Supply and install 4' x 8' x 3/4" A-C plywood backboards in communications equipment rooms as shown on drawings. All walls within the telecommunications rooms shall be covered with plywood. **Plywood shall be treated on all sides with at least two coats of** white paint. Paint shall be fire resistant type if plywood is not.
  - Terminal blocks shall be permanently marked with pair count numbers for entry cable terminations Horizontal station cable termination's shall be marked with final University room numbers. Obtain entry cable and riser cable pair count information from UITS NTS Engineering.
  - Entry cables are to be terminated starting with lowest pair count, left to right, top to bottom. Horizontal station cables are to be terminated starting with the lowest room number, left to right, top to bottom.
  - Metal closed loop D-rings (2, 4, and 6 inch as required) shall be installed in quantities sufficient to produce an orderly quality cable and wire installation. Distributing posts are not acceptable.
  - Cables shall be routed in such a way as to minimize interference with cross connect wiring and future equipment additions. D-rings shall be utilized to route cable away from the top and bottom of the terminal blocks. Entrance cable shall be routed to and terminated to the bottom group of termination blocks. Horizontal distribution cables shall be routed to and terminated to the top group of termination blocks.
  - Cable management D-rings, brackets, and horizontal and vertical cable managers shall be installed to maintain an orderly appearance for cable or wires running between backboards or to common equipment.
  - Transition splice cases and riser cable splice cases are not considered part of a TTB, and shall be located so as not to interfere with backboards or common equipment.
  - All wall mounted equipment shall be securely fastened to the TTB/DTB. Suspension by connection to other equipment is not acceptable.
  - Complete telecommunication room layout drawings shall be included as part of the project submittal. Layout shall be designed to allow all four walls of the telecommunications room to be used for mounting telecommunications equipment.
  - All fiber optic connectors shall be ST ceramic tip type.
  - All fiber optic cable splicing shall be done using the fusion splice method.

- Station Wiring:

  - Provide a quad frame for each outlet, with blank inserts provided for unused openings. A standard outlet shall consist of a quad frame with two jacks horizontally aligned, and two blank inserts.
  - HORIZONTAL STATION WIRING MUST BE IN COMPLIANCE WITH EIA/TIA-568B HORIZONTAL WIRING DISTANCE SPECIFICATIONS. The maximum horizontal cable length shall be 90 meters (295 ft). This is the cable length from the mechanical termination of the media in the telecommunications closet to the telecommunications outlet in the work area. The distance maximum includes all wiring that is part of the horizontal wiring. Provide 12 in. of cable slack at each outlet, plus an additional 10 ft. of slack in the telecommunications room, neatly arranged in a loop above (not on) the TTB.
  - Station wiring and termination equipment shall be rated Category 6.

- Outlet jack shall be an eight position modular jack meeting the specifications of FCC Regulations Part 68.500. All jacks shall be wired according to the T568B wiring schematic.
- Station cable must not be spliced. Cable runs are to be direct home runs to the IDF and shall not pass through any other station outlet box. The cable bend radius for station cabling shall not be less than four times the outside diameter of the cable.
- Install cables in conduit, and raceways as specified and supplied and installed by the electrical contractor. All conduits and sleeves shall have insulated bushings installed to protect wire and cables from damage. Installed cables shall not be bundled together.
- Station cable and wiring shall comply with EIA/TIA 568B, standards. (UTP Category 6)
- Install and terminate fiber optic cable as shown on drawings.
- All network outlets shall terminate in the IDF that is on the same floor level as the outlets.

- Wiring Practices:

  - Station cables shall terminate on a rack mounted patch panel, in a single unified field (no separate voice and data fields).
  - Cable and wire above ceiling shall be run parallel or perpendicular to the walls. Diagonal runs will not be accepted. Riser cables shall be run parallel to riser system. Do not install cables in close proximity to fixtures or equipment that may cause RFI or EMI. To reduce the effects of EMI, the following minimum distances shall be adhered to:
    - 5” from power lines of 2kVA or less.
    - 18” from high voltage lighting (including fluorescent).
    - 39” from transformers, motors, and power lines of 5kVA or greater
  - Cables and wire shall not be attached to conduit, pipes, ceiling grid/hanger wire, light fixture hangers, HVAC duct work, etc.
  - All horizontal UTP cable shall be pulled by hand. During pulling operation, an adequate number of workers shall be present to allow cable observation at all points of raceway entry and exit, as well as the point at which cable is “payed out” from the box or reel.
  - Pull cables in accordance with manufacturer's recommendations and ANSI/IEEE C2 Standards. Manufacturer recommendations shall be part of cable submittal. Recommended pulling tensions and bend radius shall not be exceeded. Any cables bent or kinked to radius less than recommended dimensions are not allowed and shall be replaced at no expense to the owner.
  - Cables that show signs of being bent or kinked beyond recommendations then straightened are also not allowed and shall be replaced at no expense to the owner.
  - Cables that show damage to the jacket in any manner shall be replaced at no expense to the owner.
  - Cable and wire above ceiling shall be suspended from approved hangers as required and be routed as close to upper ceiling as practical. Supports shall be installed at a maximum of 3 ft. centers. Metal “J” hangers are the approved hanger type.
  - Ground entrance cable shield to an approved provable ground as close to the entrance as possible.
  - All telephone boards and cabinets must have a No. 6 AWG minimum copper wire from an approved ground as specified on the drawings to the telephone backboard or cabinet. Terminate ground wire to a 6 inch copper buss bar which has provisions for additional ground connections.
  - Conduit fill: In new installations, conduit fill shall not exceed 50%. In retrofit installations, conduit fill may exceed 50% provided that the necessary pulling tension does not exceed the cable rating, and that compression of the cable jacket does not occur. **Note:** Fill requirement does not apply to outside cable plant or building entrance cable installation.
  - All conduits and sleeves must have UL approved insulated end bushings installed prior to installation of cables or station wire.
  - All riser sleeves/conduits and penetrations of fire rated partitions shall be fire stopped using approved methods and materials.
  - All cables shall be installed in compliance with manufacturers pull tension and bend radius specifications. Station cable (voice & data), shall have individual pair twists preserved to point of termination. Cable jacket and inter-pair twists shall be continuous to within ½” of termination. Cables should not be routed in tightly cinched bundles. Avoid over-tensioning or twisting cable during installation.

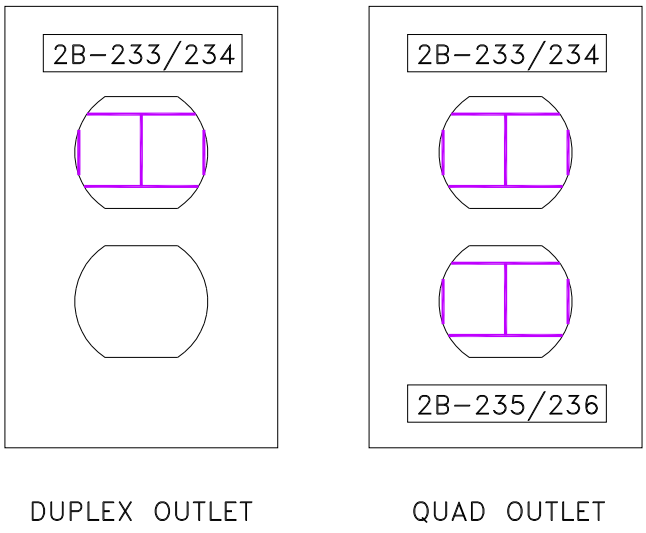
- Wall boxes shall be flush mounted, standard metal 4 inch square, deep type, with a single gang plaster ring.

Conduit from the wall box shall be concealed and stubbed out above accessible ceiling, to riser closet, or to the telecommunications cable tray. Conduit shall be 1" minimum. Conduit end shall be fitted with a UL approved insulated bushing.

- Any additional service requirements that will not operate over the standard University building telephone/data wiring shall use a completely separate conduit and wall outlet.

- Labeling:

  - All labels shall be machine generated (printer or handheld label machine).
  - All cables shall be permanently identified at both ends.
  - The labeling for outlets shall consist of three components: (1) a unique sequential numeric designation for each jack/cable, (2) an alpha-numeric designation for the telecommunications room serving the outlet, and (3) the final University room number. At the station end, the faceplate of each outlet shall be labeled with the alpha-numeric telecommunications room identifier, plus the sequential numeric jack/cable identifier, as shown on the diagram below. At the telecommunications room end, the patch panel shall be labeled with the final University room number, plus the sequential jack/cable identifier. A label with the sequential jack/cable identifier shall be applied to each end of the station cable within 6 inches of the termination.



Faceplate Labeling Diagram

  - Fiber optic riser cables shall be labeled utilizing a unique sequential numeric designation for each strand within a given building. Couplers and coupling panels shall be grouped by type of fiber, adjacent to each other either vertically or horizontally depending on make up of LIU, with a designation indicating "SM" for single mode and "MM" for multimode. Each LIU in an IDF shall be labeled with the unique numeric strand designations, and labeled with the originating end Equipment/BET Room designation (alpha-numeric identifier). The LIU(s) in the Equipment/BET Rooms shall be labeled with the unique numeric strand designations, plus each group of fibers shall be labeled with the remote end IDF Room designation (alpha-numeric identifier).
  - **Prior approval of final labeling scheme must be received from UITS-NTS. Labels shall be applied at the time of cable acceptance testing.**

Part 3 - Products

- Materials List:

All items not specifically covered in these specifications must have the concurrence of the University UITS-NTS Engineering Department before placement or implementation.

- Building entry cable shall be 24 AWG solid, REA color code, number of pairs as required. Lucent spec "ANMW", ASP type underground cable. (Transition splice to non-filled cable required prior to BET termination.)
- Station wire: 4 pair, solid conductor, REA color code, plenum rated, UL Listed type "CMP" w/FEP insulation. Cable must comply with EIA/TIA 568B. NOTE: Cables not having FEP insulation on all four pairs are not acceptable. Approved station cables are: Belden 7882A Cat. 6, Berk-Tek LanMark1000 Cat. 6, Superior Essex DataGain Cat. 6. Cable jacket shall be violet in color.
- Cable hangers: Caddy Category 5 CableCat "J" hangers.
- Splice Case: as required and approved by submittal.
- Termination blocks: rack mount, Cat. 5e, Panduit #P110B100R2.
- Patch panels for station cabling: angled modular patch panels, Panduit #DPA24688TGY (24 port), Panduit #DPA48688TGY (48 port).
- Patch panels for riser cabling: flat, modular snap-in type, Panduit #CPPLAWBL, populated with violet Cat. 6 jacks.
- "D" Rings: Lucent 13A (2 in.), 13B (4 inc.), 13C (6 in.) (for use in telecom rooms for vertical cable management only).
- Cable runway: 12" minimum gray tubular steel, with associated mounting, support, junction, and splice hardware. Chatsworth Products Inc. #10250-12 or equal.
- Cross connect wire: 2 pair, 24 awg, solid, copper, REA color code, polyethylene or PVC insulation. NOTE: Must be rated category 5e
- Connecting blocks: Cat. 5e: Panduit P110CB4, P110CB5
  Cat. 6: Panduit GPCB4
- Telephone/Data outlets: Cat. 6: Panduit CF1064EI frame, with CMBEI blank modules and CJ688TGVL jacks. All jacks shall be violet in color.
- Outlet cover plate: all cover plates shall be stainless steel, Pass & Seymour #SS8 (single gang), #SS82 (double gang).
- Wall telephone outlet: Panduit, KWP6P stainless steel phone plate with Giga-TX style CAT 6 keystone jack module
- Surface mount jack enclosure- use for bluelight phone jacks, wireless access points: Panduit #CBX2.
- Blank cover plate: Pass & Seymour #SS14 (single gang), #SS24 (double gang).
  NOTE: Blank telephone style cover plate shall not be used.
- Cable Protector: Circa #1900A1-100 with cable stubs in/out (100 pr.).
- Plug in Protectors : Avaya (Systimax) 4B1EW
- Fire Stop – sleeves shall be STI EZ-Path, Wiremold FlameStopper, or prior approved equivalent. Caulks and sealants shall be as manufactured by STI, 3M, Nelson, or approved equivalent.
- Cable shield connector: 3M Scotchlock #4460, 4460-S
- Bonding & Ground cable/wire: Ground Wire - No.6 AWG minimum, Bonding Cable - No.6 AWG rated Flexible braid with eyelets. Insulated ground wire shall have insulation that is green in color.
- Splice case filling compound, re-enterable type: 3M 4442.
- Heat Shrink Tubing: Highly Flame Resistant, semi rigid, polyvinylidene fluoride (Kynar).
- Cable Ties: Plenum type where required by code – Panduit hook and loop type.
- Fiber Optic enclosures: All associated hardware shall be provided, including ground clamp, labels, vertical troughs, horizontal troughs, connector panels, blank panels, etc.
  - Fiber Optic Connector: ST type with ceramic tip 3M 6100 (MM), 3M 8100 (SM)
  - Fiber Optic Riser Cable shall be OFNR or OFNP, tight buffered. Multimode shall be 62.5/125 micron, with minimum guaranteed gigabit Ethernet performance distance of 300m at 850nm and 550m at 1300nm. Singlemode shall be 8.2/125 micron, 900 micron, with maximum attenuation of 1.0dB/km at 1310nm and 0.75dB/km at 1550nm. Approved cables are Corning Cable Systems MIC series, Optical Cable Corp. DX series and Commscope Premises Riser Distribution series. All singlemode optical fiber cable shall use Corning SMF28e glass. Riser cables shall be terminated in rack mount enclosures, Panduit FRME Series, with FAP6WST (multimode) and FAP6WSTZ (singlemode) adapter panels.

- Fiber Optic Entrance Cable: Entrance cables shall be Corning Cable Systems Altos Armored loose tube gel-free, interlocking armored cables, indoor/outdoor riser rated, singlemode 8.2/125 Micron, 900 Micron buffered with a minimum LED bandwidth 1500/500 Mhz*km (singlemode). Entrance fiber shall be terminated on a rack mount enclosure, Panduit #FT124MC with CMSTEI and CMSTZBU adapters.

- Surface raceway: Steel or aluminum only. Wiremold 2100 or approved equal is the minimum size acceptable; larger sizes may be required based on the size and number of cable and jacks to be accommodated.
- Two post equipment racks: provide 7 ft. x 19" freestanding steel equipment rack, B-Line #SB-506-084-U-TG or approved equal.
- Vertical cable managers: freestanding equipment racks shall be provided with 7' high, double-sided cable mangers 6" or 10" as indicated on the drawings, Chatsworth MCS Series.
- Horizontal cable managers shall be provided as shown on the drawings. High capacity cable managers shall be Panduit #NCMHAEF4. Standard size cable managers shall be Panduit #NCMHF1. Small cable managers shall be Panduit #NCMHF1.
- Blank filler plates for equipment racks shall be Panduit #CPAF1BLY, provided one per freestanding equipment rack as indicated on the drawings.
- Four post equipment racks shall be 7 ft. high, 19" EIA width, 29" depth, Chatsworth #50120-X03.

Part 4 - Telecommunications Room

- General Requirements:
  - Equipment racks, cable runway and other conductive equipment shall be grounded with a minimum #6 AWG connection to the ground bus in each
  - Install floor tile or seal the concrete floor to avoid dust.
  - The minimum recommended ceiling height is 8 feet, 6 inches.
  - When ceiling distribution systems are used, design the closets with adequate conduit or openings through beams or other obstructions into the accessible ceiling space.
  - Design doorway opening with a minimum opening of 3 ft. wide and 6 ft. 8 inches high.
  - Hinge door to open outward.
  - Closet shall not have a false ceiling.
  - Locate the closets in areas above the threat of flooding.
  - Provide a No. 6 AWG minimum ground wire in each closet. Terminate ground wire to a 6 inch copper buss bar which has provisions for additional ground connections.
  - Design lighting to provide a minimum equivalent of 50 foot candles measured at 1 meter AFF.
  - Closets shall be keyed to the restricted campus telecommunications key plan and be accessible only to authorized personnel.
  - If possible locate riser closet in the center of the building or within 150 feet of each tenant space. Multiple riser closets may be required on each floor.
  - Provide fire stops for raceway and pathway systems as required by code. Putty type fire stop material is to be used as required for all conduits and sleeves.
  - In a multi-floor building the closets shall be aligned vertically. Locate closets so building structure beams and other trades equipment does not interfere with placing riser sleeves/conduits within six inches from wall.
  - Minimum size for floor (IDF) riser closets shall be 9 ft. x 11 ft.
  - Minimum size for main (BET) Building Entrance room shall be 10 ft. x 12 ft.
  - Line all walls with 3/4 inch, 4 ft. X 8 ft. A-C grade plywood. Plywood shall be treated on all sides with at least two coats of fire resistant paint (white).
  - Provide a minimum of one 20A/120V duplex receptacle on each wall of each telecommunications room. Provide a minimum of two 20A/208V L6-20R and one 30A/208V L6-30R receptacles in each telecommunications room. In telecommunications rooms containing more than 192 station cable terminations, provide two additional 20A/208V L6-20R and one 30A/208V L6-30R receptacles. **NOTE:** In buildings with emergency power systems, half of the 120V equipment outlets, half of the 20A/208V outlets, and all the 30A/208V outlets are to be connected to building emergency power.
  - Locate riser sleeves/slots on the immediate left side of the closet. This will enhance the use of wall space

from left to right.

- Riser sleeves/slots shall be aligned vertically from floor to floor.
- Riser sleeves/slots shall be: (4) 4 inch sleeves or 4 in. by 16 in. slots. Additional sleeves may be required in large buildings. All riser sleeves shall have bushings installed for cable protection. Sleeves shall extend 4 inches AFF.

- Provide fire stops for cable tray system and riser system as required by code. Putty type fire stop material is to be used as required for all conduits and sleeves. Pillow type fire stops are only acceptable for cable tray penetrations.
- Closets shall be dedicated to telecommunications equipment and shall not be used as a passageway to other utility rooms. Energy management systems, fire alarm, sound systems, and HVAC control systems equipment shall not be located in the telecommunications closet.
- Closets are not to be used for HVAC, plumbing, or electrical risers systems.
- Closets shall not be used for storage or for janitorial equipment.
- User equipment requiring an attendant, monitoring, or frequent attendance shall not be placed in equipment rooms.
- All telecommunications rooms shall be served by the building HVAC system. Temperature with telecommunications rooms that will house active equipment shall be maintained within the range of 64 to 75 degrees F, at 30-50% relative humidity. Telecommunications rooms shall have dedicated environmental controls, providing conditioning 24 hours a day, 7 days a week.

Part 5 - Acceptance Testing

- End-to-end testing of all cable pairs, optical fiber strands, and coax cables shall be performed after completion of installation and termination. UTP Category 6 station wiring shall be in compliance with the EIA/TIA 568B standard. Cat. 6 systems shall be tested to Level III accuracy. Labels shall be applied at the time acceptance testing is performed.
- Cable testing shall be performed using Fluke DSP-4000 Series or Fluke DTX series test equipment.
- Copper station cable tests shall be “Permanent Link” tests, performed with the appropriate test adapters/cords. “Basic Link” and “Channel” tests are not acceptable.
- End-to-end attenuation testing of each optical fiber strand shall be made using an optical power meter and optical light source. Multimode fibers shall be tested at 850 and 1300nm. Singlemode fibers shall be tested at 1310 and 1550nm. Attenuation tests shall be performed in both directions. Outside plant backbone cables that are greater than 100m in length shall also be tested with an OTDR.
- UITS-NTS must approve test documentation. Documentation shall be submitted in Fluke LinkWare Database electronic format.
- Test result documentation shall indicate the final cable/outlet number assigned to each item tested, as well as identify the project and the telecommunications room serving each item tested. The test result submittal shall be organized by telecommunications room, with the test results in sequential order based on jack id. Test results that are incomplete or that are not organized in sequential order will not be accepted.

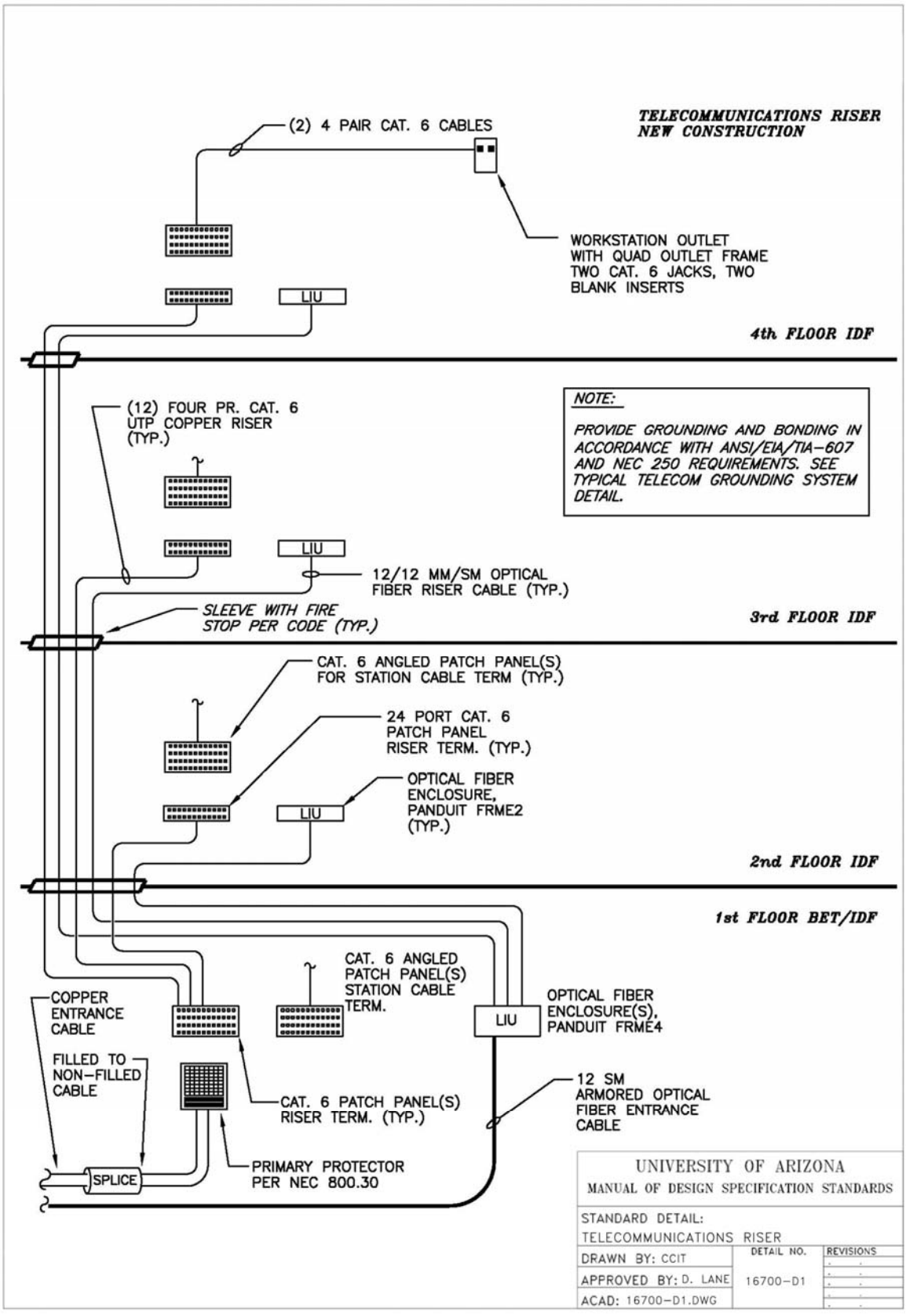
Part 6 - Cable Tray System Design Guide Minimum Requirements

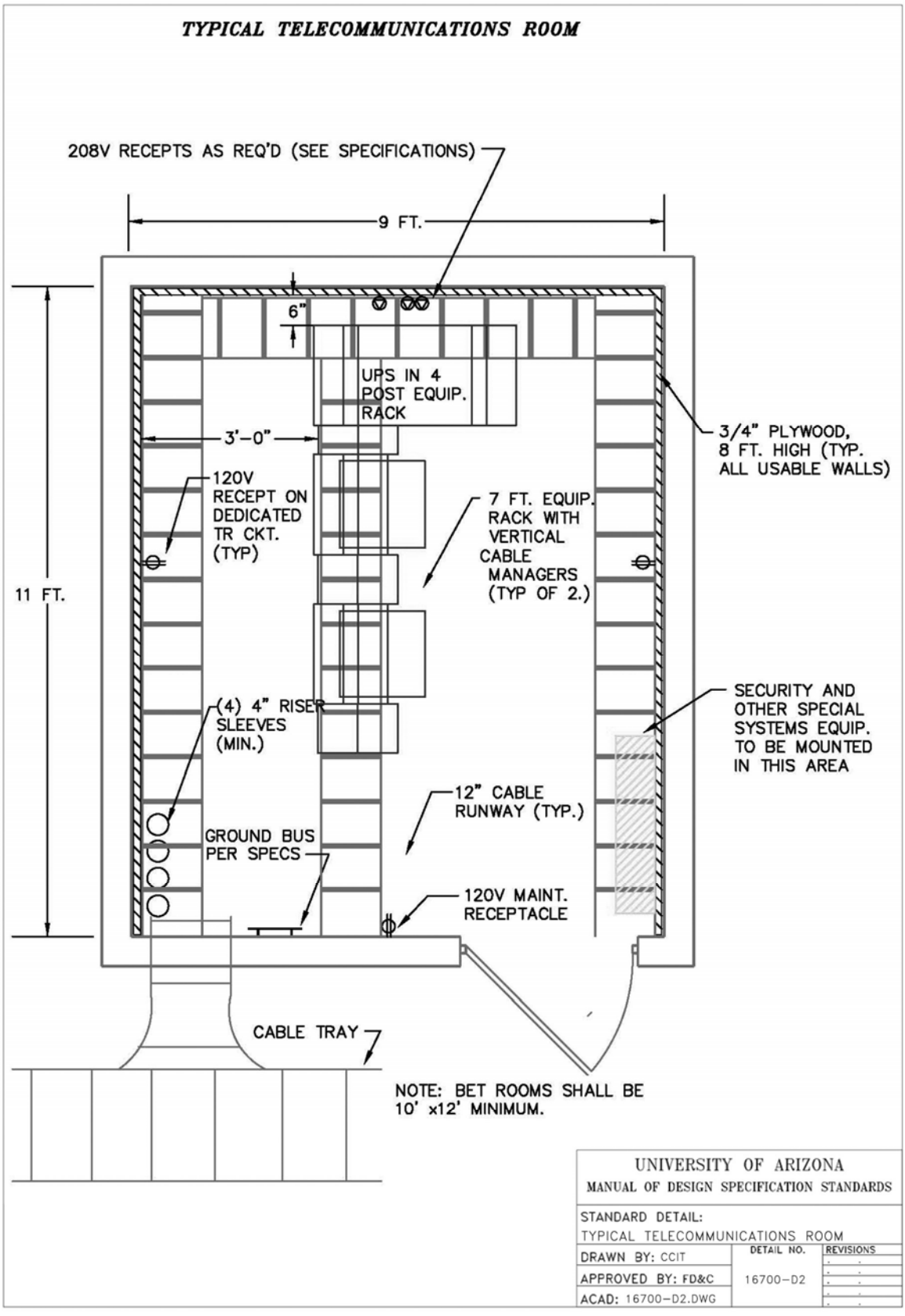
- Cable trays are for the containment of telecommunications cables and shall be installed in accordance with applicable electrical codes. Cable tray shall be bonded to ground.
- System shall be designed and installed to allow accessibility for adds, moves, and changes.
- A standard prefabricated ladder type cable tray consisting of solid side panels and side rails connected by individual transverse members, or an approved wire basket type tray shall be used. The approved wire basket type trays are Cablofil EZTray and GS Metals Flextray.
- Ladder type trays shall use standard prefabricated elbows, reducers, crossovers, tees, and elevation change tray sections as required.
- Trays may be supported by cantilever brackets, trapeze, or individual rod suspension. Supports shall be installed on five foot centers maximum. A support shall be placed within two feet on each side of any connection to a fitting. Center hung supports shall be used only with prior approval from CCIT-NTS Engineering.

- The inside of the cable tray shall be free of burrs, sharp edges, and projections that can damage cable insulation.
- A minimum of 12 inch access headroom shall be provided and maintained above the complete cable tray system. Cable trays must have adequate side access for initial cable installation and for future cable adds, moves, and changes.
- Cable tray “tees” and 90’s shall have wide radius junctions.
- Care should be taken to ensure that other building components do not restrict access to the cable tray.
- Cable tray shall be level and have supports if required to prevent horizontal movement.
- System shall be designed and installed to allow compliance with EIA/TIA-568B horizontal wiring distance standards.
- Fire wall penetrations must be sealed with an approved design tested fire-stopping system installed in accordance with manufacturer’s instructions. Use of pillow type fire stop material is acceptable only for cable tray penetrations.

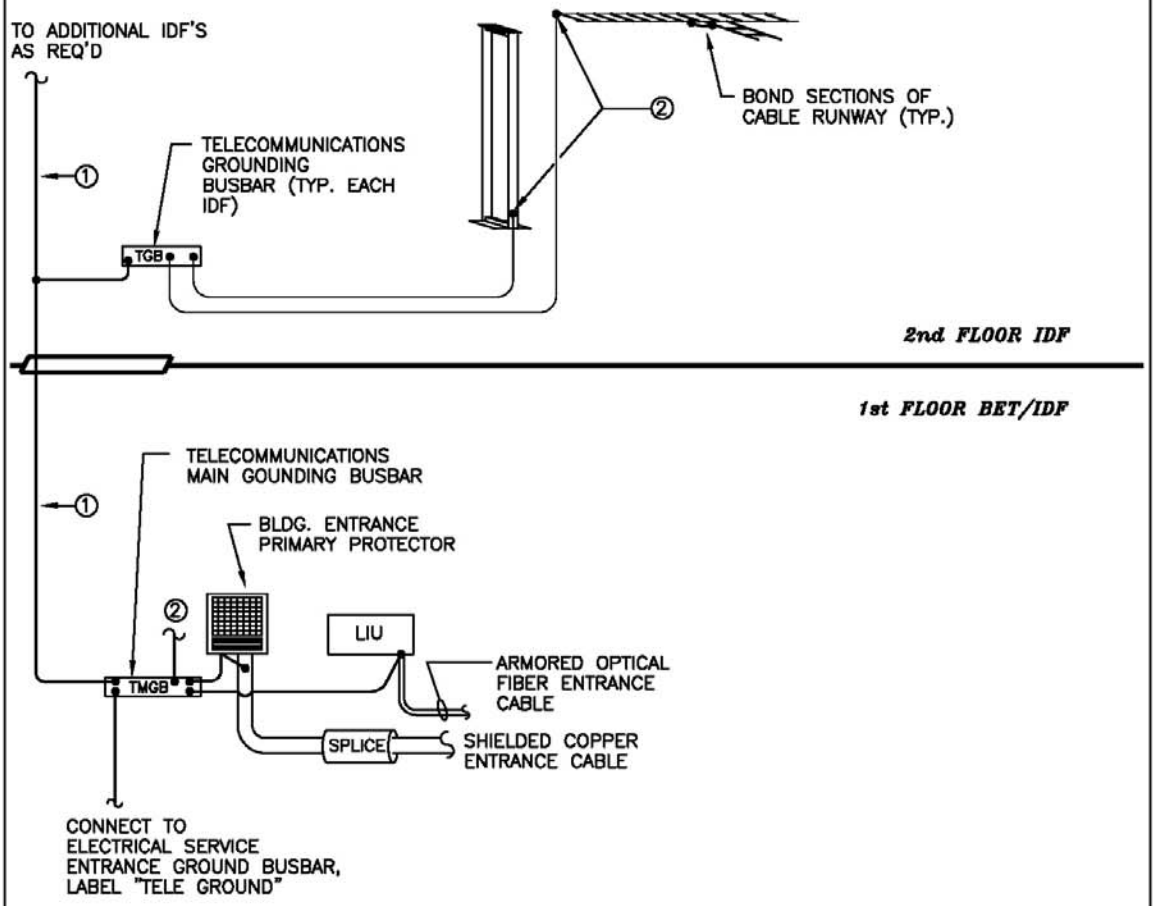
Part 7 – Demolition

- All abandoned cables within a project’s boundaries shall be completely removed back to the termination block.
- Tele/data outlets shown on demolition drawings to be removed shall be removed completely including outlet and wiring to the originating IDF termination point. Termination labels shall be revised to reflect all changes.


TELECOMMUNICATIONS RISER
NEW CONSTRUCTION
(2) 4 PAIR CAT. 6 CABLES
WORKSTATION OUTLET
WITH QUAD OUTLET FRAME
TWO CAT. 6 JACKS, TWO
BLANK INSERTS
LIU
4th FLOOR IDF
NOTE:
PROVIDE GROUNDING AND BONDING IN ACCORDANCE WITH ANSI/EIA/TIA-607 AND NEC 250 REQUIREMENTS. SEE TYPICAL TELECOM GROUNDING SYSTEM DETAIL.
(12) FOUR PR. CAT. 6
UTP COPPER RISER
(TYP.)
LIU
12/12 MM/SM OPTICAL
FIBER RISER CABLE (TYP.)
SLEEVE WITH FIRE
STOP PER CODE (TYP.)
3rd FLOOR IDF
CAT. 6 ANGLED PATCH PANEL(S)
FOR STATION CABLE TERM (TYP.)
24 PORT CAT. 6
PATCH PANEL
RISER TERM. (TYP.)
OPTICAL FIBER
ENCLOSURE,
PANDUIT FRME2
(TYP.)
LIU
2nd FLOOR IDF
1st FLOOR BET/IDF
CAT. 6 ANGLED
PATCH PANEL(S)
STATION CABLE
TERM.
COPPER
ENTRANCE
CABLE
LIU
OPTICAL FIBER
ENCLOSURE(S),
PANDUIT FRME4
FILLED TO
NON-FILLED
CABLE
CAT. 6 PATCH PANEL(S)
RISER TERM. (TYP.)
12 SM
ARMORED OPTICAL
FIBER ENTRANCE
CABLE
SPLICE
PRIMARY PROTECTOR
PER NEC 800.30
UNIVERSITY OF ARIZONA
MANUAL OF DESIGN SPECIFICATION STANDARDS
STANDARD DETAIL:
TELECOMMUNICATIONS RISER
DRAWN BY: CCIT
APPROVED BY: D. LANE
ACAD: 16700-D1.DWG
DETAIL NO.
16700-D1
REVISIONS


TYPICAL TELECOMMUNICATIONS ROOM
208V RECEPTS AS REQ'D (SEE SPECIFICATIONS)
9 FT.
6"
UPS IN 4 POST EQUIP. RACK
3'-0"
3/4" PLYWOOD, 8 FT. HIGH (TYP. ALL USABLE WALLS)
120V RECEPT ON DEDICATED TR CKT. (TYP)
7 FT. EQUIP. RACK WITH VERTICAL CABLE MANAGERS (TYP OF 2.)
11 FT.
(4) 4" RISER SLEEVES (MIN.)
SECURITY AND OTHER SPECIAL SYSTEMS EQUIP. TO BE MOUNTED IN THIS AREA
12" CABLE RUNWAY (TYP.)
GROUND BUS PER SPECS
120V MAINT. RECEPTACLE
CABLE TRAY
NOTE: BET ROOMS SHALL BE 10' x12' MINIMUM.
UNIVERSITY OF ARIZONA
MANUAL OF DESIGN SPECIFICATION STANDARDS
STANDARD DETAIL:
TYPICAL TELECOMMUNICATIONS ROOM
DRAWN BY: CCIT
APPROVED BY: FD&C
ACAD: 16700-D2.DWG
DETAIL NO.
16700-D2
REVISIONS

TELECOMMUNICATIONS GROUNDING SYSTEM



○ KEYNOTES

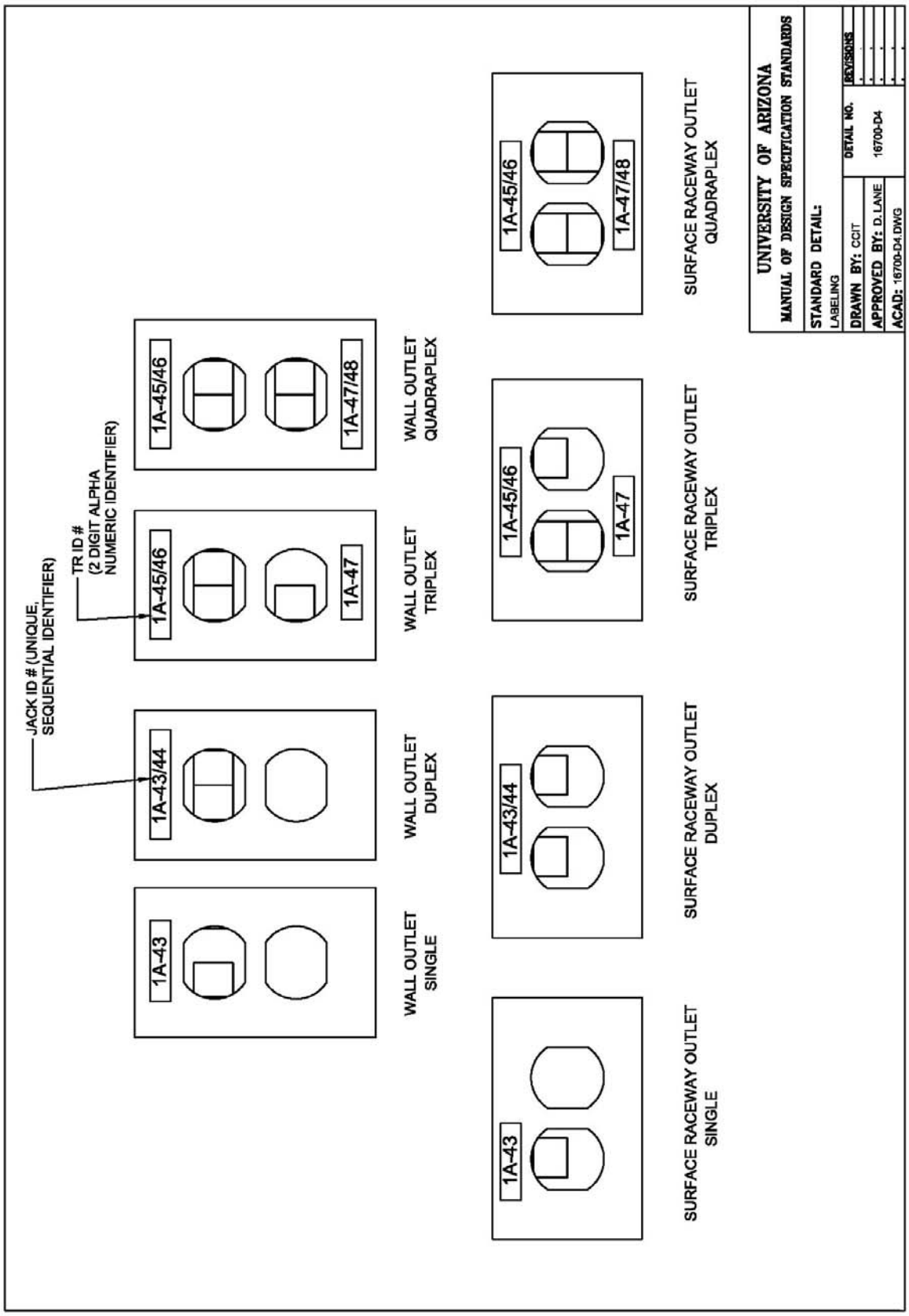
① TELECOMMUNICATIONS BONDING BACKBONE. SIZE PER ANSI J-STD-607A; #4 AWG MINIMUM XHHW.

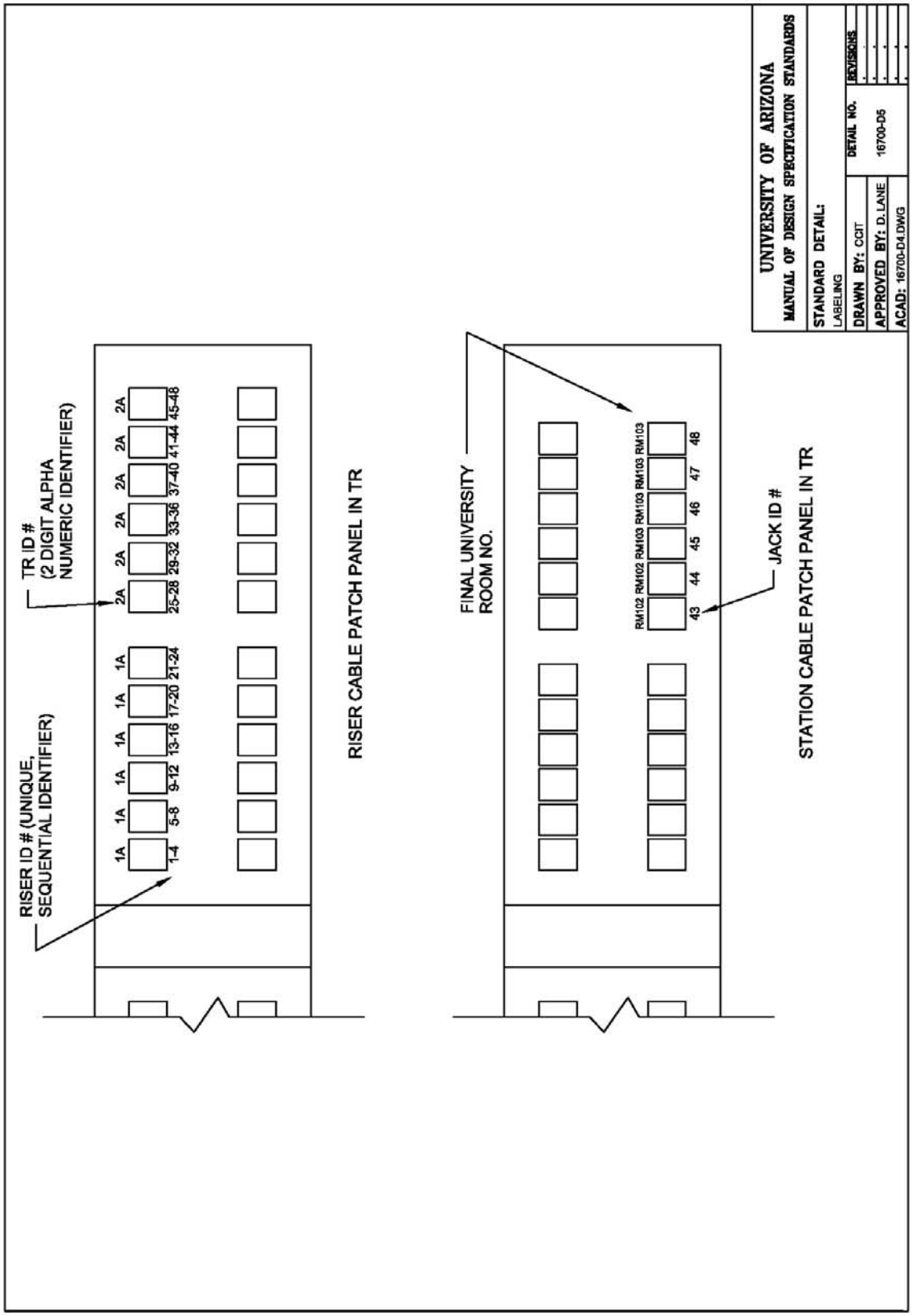
② BOND TO EQUIPMENT RACKS, CABLE RUNWAY, CABLE TRAY, ETC. #6AWG MINIMUM, TYP. OF ALL IDF'S AND BET

NOTE:

GROUNDING AND BONDING SHALL BE IN ACCORDANCE WITH ANSI/EIA/TIA-607 AND NEC 250 REQUIREMENTS.

UNIVERSITY OF ARIZONA MANUAL OF DESIGN SPECIFICATION STANDARDS		
STANDARD DETAIL: TELECOMMUNICATIONS GROUNDING SYSTEM		
DRAWN BY: CCIT	DETAIL NO.	REVISIONS
APPROVED BY: D. LANE	16700-D3	
ACAD: 16700-D3.DWG		


JACK ID # (UNIQUE, SEQUENTIAL IDENTIFIER)
TR ID # (2 DIGIT ALPHA NUMERIC IDENTIFIER)
1A-43
1A-43/44
1A-45/46
1A-47
1A-47/48
WALL OUTLET SINGLE
WALL OUTLET DUPLEX
WALL OUTLET TRIPLEX
WALL OUTLET QUADRAPLEX
SURFACE RACEWAY OUTLET SINGLE
SURFACE RACEWAY OUTLET DUPLEX
SURFACE RACEWAY OUTLET TRIPLEX
SURFACE RACEWAY OUTLET QUADRAPLEX
UNIVERSITY OF ARIZONA
MANUAL OF DESIGN SPECIFICATION STANDARDS
STANDARD DETAIL:
LABELING
DRAWN BY: CCIT
APPROVED BY: D.LANE
ACAD: 16700-D4.DWG
DETAIL NO.
16700-D4
REVISIONS



End of Section 16700

DIVISION 16 - ELECTRICAL

Section 16705 – Blue Light Phones

Introduction

Auxiliary Systems and Communications related support systems.

Part 1 - General

- This section must be incorporated into each project and coordinated with related sections. These areas include:
  - "Blue Light" emergency phones
  - Telecommunications grounding

- In projects where "Blue Light" emergency phones are required, the installation of the emergency phone unit and mounting pole or wall-mount housing shall be included in the scope of work. Conduit and power shall also be provided for each emergency phone. Electrical outlet shall be installed inside pole for proper disconnect requirements.

Part 2 - Products

- The following are the part numbers for the Blue Light Phones commonly used at the University of Arizona (include verbal descriptions and verify catalog numbers, require submittals):

  Hands-Free Emergency Phone: Talk-a-Phone #ETP-400
  Mounting Tower (pedestal): Talk-a-Phone #ETP-MT
  Wall-mount Enclosure: Talk-a-Phone #ETP-WM

  Authorized Product:

  TALK-A-PHONE Co.
  5013 North Kedzie Avenue
  Chicago, Illinois 60625-4988
  Phone: (773) 539-1100
  Fax: (773) 539-1241
  Email: info@talkaphone.com http://www.talkaphone.com

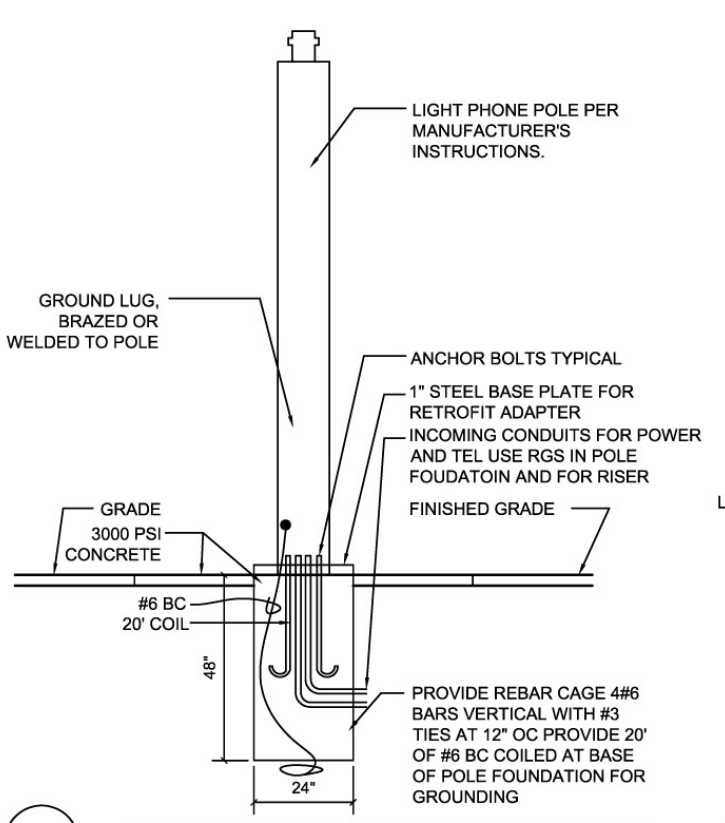
Part 3 – Emergency "Blue Light" Phone Systems

- Blue phones shall be mounted on steel pedestals with concrete bases, or in wall-mount enclosures as directed by the project manager with #6 ground ring.
- Instruments shall be "Talk-A-Phone Co.", Model ETP-400, with blue light mounted above. Refer to University Standard details.
- "Blue Light" phones shall be cabled and terminated at the closet IDF closet. Provide station protectors at the phone unit where required by NEC 800.30. Final cross-connections and phone programming will be provided by U of A, CCIT-Telecommunications.

Consultant to coordinate locations with University Risk Management department.

- Refer to Drawings 16705-D1 and 16705-D2.

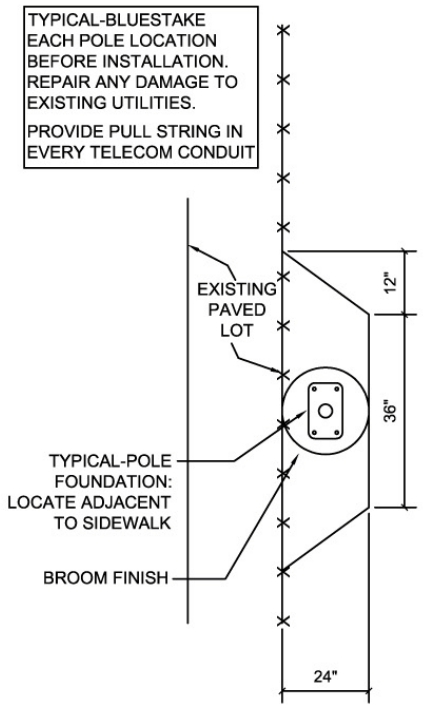
BLUE LIGHT PHONE PEDESTAL DETAIL



E4 POLE INSTALLATION DETAIL, NEW TOWER, NEW FOUNDATION
NOT TO SCALE

TYPICAL-BLUESTAKE EACH POLE LOCATION BEFORE INSTALLATION. REPAIR ANY DAMAGE TO EXISTING UTILITIES.

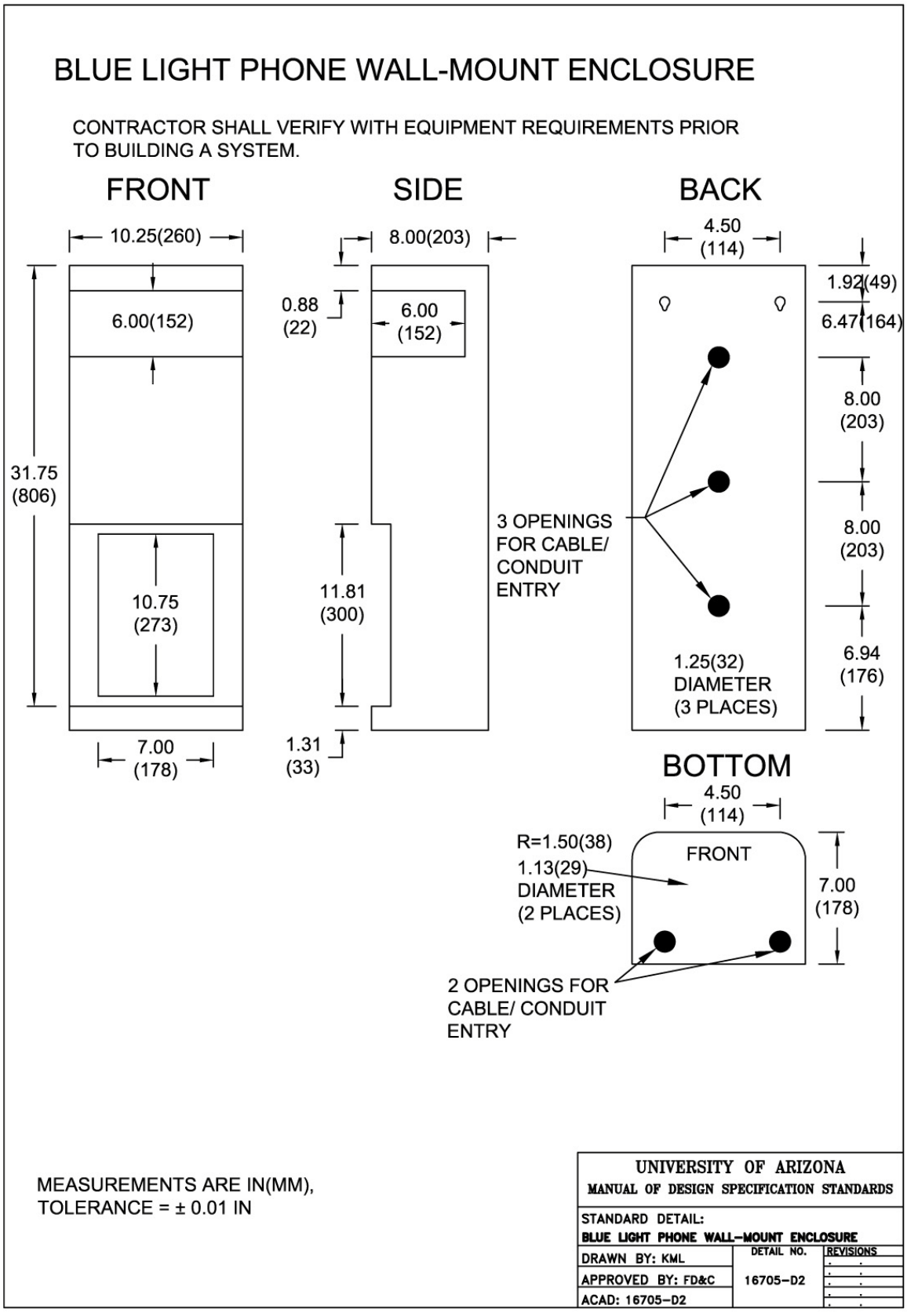
PROVIDE PULL STRING IN EVERY TELECOM CONDUIT



TYPICAL-FOR ADA ACCESSIBILITY POUR 4" SLAB AT GRADE TO DIMENSIONS SHOWN AT EACH LOCATION WHERE SIDEWALK EXISTS.

E4 ADA ACCESSIBILITY DETAIL
NOT TO SCALE

UNIVERSITY OF ARIZONA MANUAL OF DESIGN SPECIFICATION STANDARDS		
STANDARD DETAIL: BLUE LIGHT PHONE PEDESTAL DETAIL		
DRAWN BY: KML	DETAIL NO.	REVISIONS
APPROVED BY: FD&C	16705-D1	
ACAD: 16705-D1		



End of Section 16705

DIVISION 16 - ELECTRICAL

Section 16720 - Fire Alarm Systems

Introduction

The fire alarm systems here at the University are integrated together into a single reporting system which reports to the U of A police department. To maintain system integrity it has been decided that all systems shall be manufactured by Simplex and shall be compatible with the 4120 addressable multiplexed system as manufactured by Simplex. To maintain and insure system integrity with new projects, the University has developed a guide form specification, which must be edited by the engineer in charge of each particular project. Each fire alarm system specification must be evaluated on an item by item basis and the specification edited to be project specific. For example some projects by the nature of the type of building and its occupancy will be required to have a voice evacuation signal. For most projects the standard horns and strobes *no longer* will suffice. Smaller projects will not require the complexity of the design that the larger ones will require, and thus some of the specification may be deleted.

For new projects it will be necessary to connect the system back into the central reporting system loop. This loop is composed of a series of cables routed through the existing tunnel network. During the preliminary design it will be necessary for the engineer to discuss with the University Fire Safety representative as to the exact location of the point of connection to this loop.

For existing buildings the system interconnection should be intact, and it will be necessary only to tie the new system into the existing loop at the point of connection.

Where only a few devices are required it will be necessary for the engineer to delete all non applicable portions of the guide form specification and make it project specific.

Typically the fire alarm systems are to be considered a higher quality system than what is normally used in a facility of this type. All new systems are to be fully addressable systems with horns and strobes throughout and in compliance with ADA and NFPA requirements. Smoke detectors are to be used in all corridors, with duct smoke detectors on all AHU's over 2000 cfm per the Uniform Mechanical Code. All conference rooms and classrooms are to have alarm indicators, with A/V's to be used in larger lecture halls. Strobes are to be used in all restrooms. Pull stations are to be used at all exits from a floor on multistory buildings and at any and all building exits. In addition provide pull stations where required by the NFPA 72. All mechanical rooms shall be protected using heat detectors. All electrical rooms, telecommunications rooms, storerooms, and janitor closets shall be protected using smoke detectors.

Elevators shall have shunt trip detectors installed whenever a sprinkler head is located in the shaft or equipment room. To activate the shunt trip system a heat detector must be installed within 18” of each sprinkler head, and must be coordinated with the sprinkler head such that the heat detector will operate at a lower temperature than the sprinkler head. The heat detectors will notify the system of a problem, which will activate the shunt trip detector through a ZAM module. Elevator recall shall be activated through smoke detectors located at each floor or at the top of the shaft. It may be necessary based on state elevator codes to have both items, side by side, in a shaft. Where the elevator recall function is not available all equipment and programming for a future modification to the elevator shall be provided.

Utilize Class A wiring to all devices on the system. Color codes shall be in accordance with University standards. All conduits shall run concealed unless no other option is available. Conduit, wiring, j-boxes, etc. shall be installed in compliance with other areas of this standard. Conduits shall have a minimum separation of 6’. This is the University’s decision and standards requirement.

All fire alarm systems designed and installed throughout the University shall be capable of being expanded easily and readily. In order to make this easier we would like to require that both alarm and mapnet loops have at least 30% spare capacity.

For all new projects it has been decided that the University will require the new system to be up and fully operational for a minimum of 5 days prior to having the fire marshall do his final inspection. At the point in time that the contractor believes that the system is ready to begin the 5 day "burn in" the supplier will certify to the owner that the system is fully operational. Until receipt of this letter the acceptance test will not be considered to have begun. During the acceptance test no modifications to the system can be made. The contractor may be permitted to remove or demolish the existing system where applicable and where permitted by the owner prior to acceptance of the new system by the owner.

Part 1 - General

- Provide in accordance with the standards set forth in the guide form specification and instructions from the FDC Electrical Engineer during the pre-design conference.
- *Design shall confirm to NFPA 72, the requirements of the State Fire Marshal and the Uniform Fire Code.*
- *The consultant shall complete comprehensive plans, and single line diagrams based on the system described in the App-16720 Section of this DSS.*
- *The consultant shall perform voltage drop calculations as part of the Construction Document Submittal for looped signal circuiting. Signal circuits shall not exceed 70% loading in order to accommodate future system changes.*
- *Provide heat detectors in elevator shafts, machine rooms. Set 20°F lower than sprinkler heads, to signal the FACP to shut down the elevators.*
- *The consultant shall show the following supervisory functions on plans and single line diagrams. All conductors shall be in metal conduit.*
- *Phone circuit from FACP, with jack, to telephone terminal board.*
- *Monitoring circuit from each elevator control monitoring circuit (in machine rooms) to the FACP.*
- *Monitoring circuit from Engine Generator to the FACP, to monitor generator running.*
- *Circuit from switchboard meter to FACP.*
- *The consultant shall provide emergency lighting in the vicinity of the FACP.*
- *Generally speaking, graphic annunciation is not utilized.*

Part 2 - Products

- Provide in accordance with the standards set for the in the guide form specification Section 16720, as discussed in the introduction to this section, *and as directed*.
- Where pull stations are susceptible to nuisance vandal pulling, a protective local alarm type covering device shall be provided.

Part 3 - Execution

- Provide in accordance with the standards set for the in the guide form specification Section 16720 and as discussed in the introduction to this section.
- Wiring color codes shall be as specified in division 16195. J-boxes shall be identified as per division 16195.
- Testing. Insert the following language at this Section:
  - "The fire alarm system shall be 100% complete, operational and free from trouble or alarm conditions prior

to testing by the Owner. After the Owner has tested and verified operation of the fire alarm system the system shall go through a 5 day burn in time, during which the system shall operate under normal conditions with no modifications by the contractor. At the end of this period the fire alarm system shall be tested and approved by the State Fire Marshall who shall issue a letter of acceptance. Only upon receipt of approval by the Fire Marshall shall this system be considered complete."

End of Section 16720

DIVISION 16 - ELECTRICAL

Section 16730 - Clock and Program Systems

Introduction

Clock systems shall be provided for all new buildings. The University has a master clock system which receives a signal from the National time standard located in Colorado. All campus clocks are synchronized to this signal from the master clock. Therefore it is imperative that the specification and drawings include requirements for connecting the new buildings to the plant distribution system.

Signal systems shall be provided for all new classroom type buildings and construction. The signal system shall be programmable through the building master clock system.

Bell system wiring shall be run with the clock system.

Each new or renovated system shall incorporate a building submaster clock to isolate each building in case of a fault on the main campus master clock.

Part 1 - General

- Provide complete submittals on all new clock systems including complete maintenance and operation manuals for each new system installed.

Part 2 - Products

- Compatible with the present Master time system which is manufactured by Simplex Time Recorder Company.
- Any substitute must prove that it is compatible with this system.
- The existing system is a 24 vdc impulse system with a 24 vdc 3 wire correction. All clocks should be semiflush mounted. Each clock shall have an integral two lobe 5 minute catch up cam.
- Wiring color code should be in accordance with section 16195.

Part 3 - Execution

- For rearrangement type projects final tie-in of clocks to building system will be by the University Facilities Management Electric Shop.
- Final tie in of new building systems with the campus systems will be by the University Facilities Management Electric Shop.
- Testing for new facilities shall be done with factory trained representative of the manufacturer, the U of A Electric Shop, and the Engineer.

End of Section 16730

DIVISION 16 - ELECTRICAL

Section 16950 - Testing

Introduction

Testing for all areas shall be listed under this section and referenced back to the appropriate Section.

Testing shall be done in accordance with NETA standards.

Part 1 - General

- Written documentation shall be provided to the U of A electrical engineer for all testing accomplished under this section.
- Although NETA test standards are referenced herein for brevity it is required that the engineering firm, rewrite the test standards for application to the specific project.
- All the required testing shall be fully spelled out in the specifications.
- Cable shall be 5kv megger tested on their respective reels.
- Cable shall be high potential tested with terminations in place after assembly.

Part 2 - Products

- A partial list of equipment to be tested shall include:
  - wire and cables
  - high voltage switchgear
  - transformers
  - panelboards
  - switchboards
  - emergency generator
  - ups type systems.
  - 50 Hp and larger motors - absorption - polarization index
- Testing of medium voltage cables (5KV or 15KV), transformers, and switchgear shall be by a third party testing firm which has all of the equipment and capabilities for performing the specified tests.
- All other testing shall be accomplished by the electrical contractor doing the work.

Part 3 - Execution

- All medium voltage rated cable shall be tested in accordance with NETA testing standards.
- Medium voltage transformers, cable, and switchgear shall be tested in accordance with NETA testing standards, with a complete written report provided to the U of A prior to completion of the project. All testing of this equipment shall be accomplished in the presence of the Engineer or a representative of the University Facilities Management Electric Shop.
- For actual requirements of each area, verify testing requirements with the Engineer.
- All wire and cable utilized on the 120/208 and 480/277 volt systems shall be meggar tested utilizing a 1000 volt rated tester.

- All panelboards and switchboards shall be meggar tested prior to energizing.

- All connections inside of switchboards, panelboards, motor control centers, and similar equipment shall be torqued and tested prior to energizing the equipment.

End of Section 16950