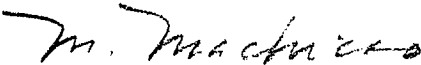
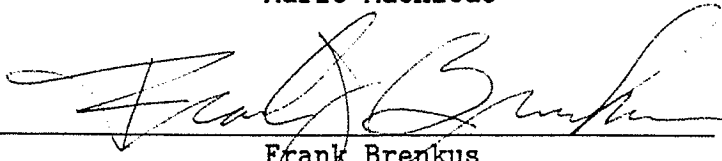
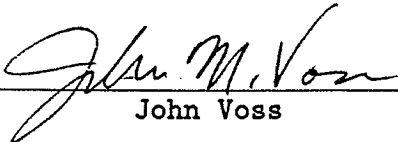


TECHNICAL SPECIFICATIONS  
FOR  
SSRL 3GEV INJECTOR  
SUBSTATION 515 INSTALLATION  
IS-439-720-01-R0

Prepared by  Plant Engineering  
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Issue Date: DEC 15 1988

TECHNICAL SPECIFICATIONS  
FOR  
SSRL 3GEV INJECTOR  
SUBSTATION 515 INSTALLATION  
IS-439-720-01-RO

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## DIVISION 1

GENERAL REQUIREMENTS

The following Specification broadly outlines the requirements to install one 12.47 KV air interrupter switchgear, one 1000 KVA transformer, underground 12.47 KV ducts and cables, and low voltage conduits and wiring.

SECTION 01100 -- STATEMENT OF WORK1.1 LOCATION

Perform the work outlined in this specification at the Stanford Linear Accelerator Center, 2575 Sand Hill Road, Menlo Park, San Mateo County, California. The construction site is located near Shelter 140, see Dwg. SK-MM-11-10-88.

1.2 SCOPE OF WORK

The intent of the specifications is to prescribe the details for the construction and completion of the work which the Subcontractor undertakes to perform in accordance with the terms of the Subcontract. Where the plans or specifications describe portions of the work in general terms, but not in complete detail, it is understood that only the best general practice is to prevail and that only materials and workmanship of the first quality are to be used, based upon submittals provided by the Subcontractor and subject to the approval of the University. Unless otherwise specified, the Subcontractor shall furnish all labor, materials, tools, equipment and incidentals, and do all the work involved in executing the Subcontract in a satisfactory and workmanlike manner.

The Subcontractor shall verify all dimensions and quantities in the field and shall furnish all construction surveys required for correct location and installation of all work.

### 1.3 DRAWING LIST

All work covered by this specification shall be in strict accordance with the following subcontract drawings:

<u>Number</u>	<u>Title</u>
ID-439-720-01-RO	SSRL 3GEV Injector Substation 515 Plan and Details
ID-439-720-02-RO	SSRL 3GEV Injector Substation 515 Equipment Anchor & Conduit Details
SK-MM-11-10-88	Campus and Research Area Site Plan

### 1.4 TENTATIVE SCHEDULE

1.	January 12, 1989	Award
2.	January 23, 1989	Notice to Proceed
3.	February 6, 1989	Commencement of On-site Work
4.	March 31, 1989	Completion, excluding only final connection in the high voltage box.
5.	June 30, 1989	Final connection in high voltage box on or before this date as directed by the University. See Section 01330-1.2.

SECTION 01310 -- GENERAL REQUIREMENTS: SAFETY,  
SECURITY, PROTECTION, AND CLEANUP

1.1 SAFETY, SECURITY, PROTECTION, AND CLEANUP - RELATED CLAUSES

See General Conditions clauses titled "Safety and Health", "Cleanup", "Sanitary Conditions", and "Codes and Standards".

All work shall be done in accordance with the requirements of the California Administrative Code, Title 8, Division of Industrial Safety, Safety Orders, and Department of Labor Safety and Health Regulations for Construction (Part 1518) and the U.S. Department of Energy.

All materials and processes used must conform to the applicable Bay Area Air and Water Pollution requirements.

1.2 HAZARD COMMUNICATION STANDARD

THE SUBCONTRACTOR'S ATTENTION IS SPECIFICALLY DIRECTED TO THE FEDERAL O.S.H.A. "HAZARD COMMUNICATIONS" STANDARD (29 CODE OF FEDERAL REGULATION 1910.1200).

The Subcontractor is required to comply with this STANDARD in all respects, including, but not limited to furnishing to the University and appropriate posting at the job site, copies of the Material Safety Data Sheets (MSDS) for all hazardous materials brought onto the University premises.

Copies of the Material Safety Data Sheets shall be furnished to the Contract Administrator and approved by the Environmental Safety Office prior to any such materials being brought to the job site.

1.3 SUBCONTRACTOR RESPONSIBLE FOR SAFETY

It is the Subcontractor's responsibility to provide protection for SLAC property, SLAC personnel, other personnel and visitors, other Government property, and private property.

The Subcontractor is solely responsible for safe working methods and shall insure that SLAC workers and other personnel or visitors inside the buildings and out are not exposed to safety hazards.

#### 1.4 NOISE CONTROL

The Subcontractor shall make use of latest techniques for abatement of construction noise. All construction equipment shall be contained in sound reducing enclosures and shall be fitted with mufflers as required so the noise level within 3 feet of the equipment does not exceed levels recommended by EPA for construction sites in occupied areas. Use pneumatic or electric tools designed for quiet operation.

#### 1.5 PROTECTION OF EXISTING FACILITIES AND WORK IN PROGRESS

Existing facilities, including but not limited to buildings, equipment, materials, surfaces, pipes, conduits and appurtenances which are damaged by any operations under this Subcontract, shall be replaced or repaired, neatly patched and refinished, all as may be necessary to restore the damage to the original condition and to leave the work in a thoroughly complete, operable and finished condition.

Work and materials shall be protected against damage due to construction operations, weather, or other hazards. The Subcontractor shall provide suitable covering of all exposed trenches, excavations, and equipment to protect the work from damage.

Storm drains shall be used for clean water only.

See also General Conditions clauses titled "Protection of Existing Installations, Materials and Work", "Protection of Trees", and "Assumption of Risk Until Final Acceptance".

#### 1.6 SECURITY

The Subcontractor is responsible for the safe keeping of all his materials, tools and equipment.

1.7 CLEANING UP

Each day, the Subcontractor will remove any material tracked, or otherwise introduced into SLAC buildings or other property by the Subcontractor's personnel. If not performed timely, the University will arrange for cleaning services and backcharge the Subcontractor. At the end of each work-day, the Subcontractor shall clean the work areas and remove all loose debris.

All areas used by the Subcontractor shall be restored to their original condition and the area left in a clean condition.

SECTION 01320 -- OTHER GENERAL REQUIREMENTS1.1 VISIT TO THE CONSTRUCTION SITE

All prospective bidders should plan to visit the work site prior to submission of bids. A pre-bid conference will be held at SLAC and all bidders should plan to attend. See Invitation for Bids for time and date. See Instructions to Bidders clause titled "Conditions Affecting the Work" and General Conditions clause titled "Site Investigations and Representations".

1.2 WORKING HOURS

The Subcontractor will be permitted to work in the work areas, and delivery of materials may be made, during normal working hours (7:30 am to 4:30 pm Monday through Friday) and, when authorized in advance by the Contract Administrator, after hours, on holidays, or weekends.

1.3 COOPERATION WITH OTHER SUBCONTRACTORS AND SLAC PERSONNEL

Other Subcontractors and SLAC technicians may be working in or occupying the area within and adjacent to the Subcontractor's work area. The Subcontractor shall cooperate with others in the scheduling of work to avoid undue inconveniences to all concerned.

The Subcontractor shall confine his activity to the areas designated. Other SLAC areas shall not be visited without specific permission and under no circumstances will the Subcontractor's personnel cause interruption of normal SLAC activities in other areas.

See also General Conditions clauses titled "Operations", "Other Work", and "Use and Possession Prior to Completion".



#### 1.4 DIMENSIONS AND CONTROL POINTS

Reference General Provisions clause titled "Specifications and Drawings" and General Conditions clauses titled "Subcontract Drawings and Specifications" and "Base Line and Grades": The Subcontractor shall furnish all construction surveys required for correct location and installation of all work. The drawings are diagrammatic and indicate the general arrangement of the work. Drawings shall not be scaled for dimensions. Control points and dimensions shown on the drawings or otherwise furnished by the University shall be verified in the field by the Subcontractor. The Subcontractor shall be responsible for properly fitting materials and equipment at locations indicated without substantial alterations.

#### 1.5 SUBMITTALS

Shop drawings and other submittals shall be provided to the University for review as required by the various sections of this specification and shall conform to the requirements of the General Conditions clauses titled "Specifications and Standards" and "Materials and Equipment".

Submittals are required for all specified items, as well as for "or equal" items proposed by the Subcontractor. See also the clause titled REQUEST FOR SPECIFIED ITEM SUBSTITUTE below.

A minimum of six (6) complete sets (or other number as specified elsewhere herein) of all submittals, including cover letters, transmittal letters, attachments, etc., shall be provided to the Contract Administrator.

The Subcontractor shall thoroughly review all submittals, including those from lower tiers, for conformance to Subcontract requirements prior to submittal for approval. This review shall include but shall not be limited to confirmation of conformance to dimensional, qualitative, and utilization requirements.

#### 1.6 SUBMITTALS REQUIRED PRIOR TO ISSUANCE OF THE NOTICE TO PROCEED

Within five (5) calendar days, or other time period specified elsewhere herein, after award, and prior to issuance of the Notice to Proceed, the Subcontractor shall provide the Subcontract Agreement and acceptable Insurance Certificates, and, for Subcontracts over \$25,000, Performance and Payment Bonds.

1.7 TIMELY SUBMISSION OF SUBCONTRACT AGREEMENT, INSURANCE CERTIFICATES, AND PERFORMANCE & PAYMENT BONDS

No time extension will be granted for late submission of the Subcontract Agreement, Insurance Certificates, or Performance or Payment Bonds. In the event that any of the above items are received after the time frame specified, the University, at its sole option, may elect to issue the notice to proceed at that time. In such case, and notwithstanding any other provision in this Subcontract to the contrary, the specified performance period shall be increased by the time frame specified in the Subcontract for submission of these items. THE REQUIRED COMPLETION DATE SHALL THEN BE DETERMINED BY ADDING THE EXTENDED PERFORMANCE PERIOD TO THE AWARD DATE, RATHER THAN TO THE NOTICE TO PROCEED DATE. Nothing herein shall be construed to limit the rights of the University under the Subcontract clauses related to Default or Termination, or any other right of the University under the Subcontract or otherwise.

1.8 SUBMITTALS REQUIRED PRIOR TO INCEPTION OF ON-SITE WORK

Prior to inception of on-site work, the Subcontractor shall submit the following at or before the Project Kickoff Meeting:

1. Name of the Subcontractor's full-time on-site Superintendent.
2. List of Sub-Subcontractors and names of all persons who will be working within the Research Areas or after hours. (The purpose of this list is for issuing badges.)
3. Bar chart schedule showing projected start and finish dates for major milestones. The purpose of this schedule is to provide a basis for planning and coordination as well as a history of progress of the project. The number of milestones and level of detail is subject to the approval of the University.
4. In the event that the Subcontractor intends to request Progress Payments, he shall submit a price breakdown showing items of work and value for each item. The level of detail and value of each item is subject to the approval of the University for the purpose of determining whether the amount requested is commensurate with the progress of the work.

1.9 SUBMITTALS REQUIRED AFTER INCEPTION OF ON-SITE WORK

1. The Subcontractor shall update and resubmit the list of Sub-Subcontractors and individuals whenever personnel are assigned to or reassigned from the project.
2. At the request of the University representative, the Subcontractor shall update the schedule showing actual start date, actual milestone dates to date, projected milestone dates, and projected finish date.
3. The Subcontractor shall revise the number and level of detail of the milestones as indicated by the University representative as being necessary to fulfill the stated purpose of the schedule.
4. Weekly payroll reports.

1.10 SUBMITTALS REQUIRED PRIOR TO PROCESSING PROGRESS PAYMENT REQUESTS

All submittals cited above or required elsewhere herein shall be up to date. See especially General Conditions clause titled "Reports", subclauses titled "Progress Schedule" and "Purchase Orders".

1.11 SUBMITTALS REQUIRED PRIOR TO PROCESSING FINAL PAYMENT

1. Completion of the work
2. Final Inspection Report
3. Final Release and Waiver of Lien
4. As-Built Drawings and other submittals, if required elsewhere herein
5. Guarantee
6. Warranty documents for any equipment
7. Manuals and spare parts lists for any equipment
8. Payroll reports
9. Dosimeter Badges
10. Final Invoice

1.12 REQUEST FOR SPECIFIED ITEM SUBSTITUTE

Any proposed substitution shall be clearly identified as such on all submittals.

In addition, the Subcontractor shall submit a written request for approval of each proposed substitution via letter separately from the related submittal(s). The request must show clearly what is proposed, and must include:

1. Product specifications in the same level of detail or greater than that provided in the specifications,
2. Certifications and other submittals otherwise required for the specified item,
3. Additional information and rationale as necessary to establish that the quality of the proposed substitution and that it is equal to the item specified, without recourse to other information.

This implies no right of the Subcontractor to use other materials or methods unless approved in advance in writing by the University. The determination of the University shall govern as to whether the proposed item is equivalent to that specified, but the burden of proof shall be upon the Subcontractor. See also General Provisions clause titled "Materials and Workmanship".

1.13 MATERIALS AND WORKMANSHIP

Reference General Provisions clauses titled "Materials and Workmanship" and "Inspection and Acceptance".

Only quality workmanship will be accepted. Haphazard or poor practice will be cause for rejection of the work by the University.

Materials and equipment:

1. Must be new, first quality commercial stocks.
2. Shall be free from structural, visual, or operational defects upon completion of the work.
3. Of the same types and kinds shall be essentially the standard product of the same manufacturer throughout the work.
4. Shall be fabricated and installed in accordance with the applicable standards referred to throughout this speci-

ation, or where standards are not specified, in accordance with best commercial practice.

5. For which detailed specifications or installation instructions are not established hereby but which are required to meet the intent of the work shall be provided by the Subcontractor based on University approval of a submittal by the Subcontractor of proposed items and methods of the class, grade, and type proper for the work.

Each component of a system under this Subcontract shall be compatible with the other parts of component products and with operating conditions as shown, specified, or encountered.

Work noted as deficient during Final Inspection must be repaired and corrected by the Subcontractor, and made ready for reinspection, within five (5) working days, but not later than the required Subcontract completion date.

#### 1.14 MATERIALS ACCESS

Access to the work site for delivery of materials and equipment shall be through the Main Gate at 2575 Sand Hill Road east of the intersection with Interstate Highway 280.

No material deliveries will be accepted by the University on behalf of Subcontractors. All deliveries shall be properly labeled or identified as follows:

--- (Subcontractor) ---  
c/o SLAC Jobsite, near Shelter 140  
2575 Sand Hill Road  
Menlo Park, CA 94025

See also SECTION 01310 -- SAFETY, SECURITY, PROTECTION, AND CLEANUP, clause titled HAZARD COMMUNICATION STANDARD.

#### 1.15 DISPOSAL OF WASTE MATERIAL

Waste material shall be disposed of by the Subcontractor off the SLAC site. See also General Conditions clause titled "Trash Disposal". Clean fill may be dumped on site near Sector 21 if inspected and approved by the University representative.

1.16 UTILITIES

Water and electricity are available near the work area at no cost to the Subcontractor. See General Conditions clause titled "Utilities".

The Subcontractor shall provide and install all necessary wire, piping, etc. between the source of the utility and the work area(s). Routing and method of transmission shall be subject to the approval of the University.

1.17 UTILITY AND EQUIPMENT OUTAGES

Reference Section 01330, clause titled UTILITY OUTAGES.

All required utility outages, including power, domestic water, fire protection, sanitary sewer, gas, ventilation, air conditioning, etc., shall be scheduled 72 hours in advance. Certain electrical outages may require additional notice. All outage requests shall be scheduled and coordinated through the Contract Administrator.

1.18 PROPOSED CHANGES

Reference General Provisions clause titled "Changes": The Subcontractor shall furnish an itemized price breakdown in conjunction with any proposed modification of the Subcontract price or performance period.

The breakdown shall specifically identify cost data sources and shall be in sufficient detail to permit independent verification and analysis of all quantities and unit prices of all labor, material, equipment, Subcontract, and other direct costs, overhead and other indirect costs, and profit, and shall cover all work involved to accomplish the modification, whether deleted, added, or changed.

Sufficient detail shall normally be the same level of detail used in the preparation of the initial bid. A formal presentation format is not required; legible copies of worksheets, from which totals and subtotals cited in the proposal for modification were derived, are acceptable as a basis for evaluation of the proposal for modification.

If the proposal for modification includes a time extension, a rationale therefore shall be furnished and shall specify the projected impact on any final critical path.

Any amount claimed for Sub-Subcontracts shall be supported by a similar price breakdown.

SECTION 01330 -- SPECIAL REQUIREMENTS

1.1 SUBCONTRACTOR RESPONSIBLE FOR SAFETY

Reference Section 1310 clause titled SUBCONTRACTOR RESPONSIBLE FOR SAFETY:

Flagmen, signs, barricades, fences, lights, fire extinguishers, and similar precautions shall be the responsibility of and shall be provided by the Subcontractor to assure public safety and properly guard against personal injury or property damage.

Special care must be taken when working around the high-voltage cables in the high-voltage splicing box.

1.2 UTILITY OUTAGES

Reference Section 01320 clause titled UTILITY AND EQUIPMENT OUTAGES:

There are no live exposed parts in the high voltage splice box near H-frame. The 12 KV cables shall be pulled, terminated and tested while the cables and connectors in the box are energized. The power system will not be shut down during the construction period. Final connection shall be made on a Saturday, during the second quarter of 1989. Exact date to be determined later.

1.3 SUBMITTALS REQUIRED PRIOR TO INCEPTION OF ON-SITE WORK

Reference Section 01320 clause titled SUBMITTALS REQUIRED PRIOR TO INCEPTION OF ON-SITE WORK:

Materials listed specified in Section 16100, Part II - PRODUCTS, except, conduit, conduit fittings, and 600V conductors.



1.4 SUBMITTALS REQUIRED AFTER INCEPTION OF ON-SITE WORK

Reference Section 01320 clause titled SUBMITTALS REQUIRED AFTER TO INCEPTION OF ON-SITE WORK:

As-built drawings (red-lined blueprints) are required.

The Subcontractor shall maintain two complete sets of Subcontract documents at the job site showing all as-built conditions. As the work progresses, the Subcontractor shall record on the drawings in red pencil the actual locations of all items where there is a variance from the drawings.

Approval must be received from the University before any item is relocated. Upon the completion of the work, the Subcontractor shall forward the as-builts to the University.

1.5 UTILITIES

Reference Section 01320 clause titled UTILITIES:

Water is available at the fire hydrant near the work area at no cost to the Subcontractor.

120/208 Volt construction power will be made available at no cost to the Subcontractor.

1.6 TOILET FACILITIES

Toilet facilities are available in Shelter 140.

1.7 DOSIMETER BADGES

Reference General Conditions clause titled "Identification of Employees": Dosimeter badges that measure exposure to ionizing radiation will be issued by the University to all Subcontractor personnel working in the Research Areas. Although no personal radiation exposure above natural background radiation is anticipated, the badges are required for compliance with Department of Energy regulations and for site security. These badges will be issued at the Sector 30 Gate by the guard on duty. Radiation dosimeters are to be carried at all times while inside the Research Areas. Persons entering the area will be required to show their badge to the guard at the gate house.

The Subcontractor shall maintain a list of badgeholders. A copy of the list shall be submitted to the University representative whenever a change is made.

The Subcontractor is responsible for the return of each dosimeter to the guard at the Sector 30 Gate when each individual completes his activity under this Subcontract. All badges must be returned or otherwise accounted for in writing prior to final payment.

1.8 HISTORICAL AND SCIENTIFIC SPECIMENS

All articles of historical or scientific value, including but not limited to fossils and archaeological artifacts which may be uncovered by the Subcontractor during the progress of the work, shall become the property of the University. Such findings shall be reported immediately to the University Representative who will determine the method of removal, where necessary, and the final disposition thereof.

## DIVISION 16

ELECTRICALSECTION 16100 -- ELECTRICAL WORKPART I -- GENERAL16.1 REQUIREMENTS

This section of the specification describes the requirements to furnish all labor, equipment, material and tools, to provide all transportation, services and operations and to perform all work required as shown on the drawings and outlined in this technical specification.

16.2 STATEMENT OF WORK

The work covered by this Division of the specification shall include, but shall not necessarily be limited to the following:

1. Saw cut the existing slab and excavate the necessary trenches for the installation of underground ducts.
2. Backfill trenches and restore concrete slab.
3. Install one government furnished 3 bay, 12 KV air interrupter switchgear.
4. Install one government furnished 1000 KVA dry type power transformer.
5. Furnish and install a 350 MCM, 12 KV feeder from an existing junction box to the new 12 KV switchgear.
6. Furnish and install one 12 KV feeder from the 12 KV switchgear to the 1000 KVA transformer.

7. Furnish and install conduits and wiring for auxiliary power and control circuitry.
8. Furnish and install underground conduits for a future circuit breaker.
9. Furnish and install stress relief termination for 12 KV cables.
10. Ground and anchor switchgear and transformer.
11. Test cables, 1000 KVA transformer, and 12 KV switchgear.
12. Dispose off site all waste material.
13. Install housekeeping pads for switchgear and transformer.
14. Ground transformer neutral.

### 16.3 WORK NOT INCLUDED

The University will provide rigging service to move the 12 KV switchgear and transformer to their final locations under the supervision and direction of the Subcontractor. Rigging service requires 72-hour notice.

### 16.4 APPLICABLE DOCUMENTS

#### A Electrical Codes

The electrical work shall be installed in accordance with the applicable provisions of the State of California Electrical Safety Orders, and the National Electric Code. All materials shall be Underwriters' Laboratories, Inc. listed and shall bear their label or approval. Where any conflict occurs between the provisions of the State of California Electrical Safety Orders and the National Electric Code, the document giving the greatest protection shall govern.

#### B United States Department of Labor

Part 1910, Occupational Safety and Health Standards.

#### C Standards and Specifications

Reference to federal, state, association (ANSI, ASTM and NEMA) standards and specifications, hereinafter contained in this speci-

fication, shall be construed to mean the latest edition thereto unless specifically stated otherwise.

#### 16.5 GOVERNMENT-FURNISHED EQUIPMENT AND MATERIAL

- A One 1000 KVA, 12,477-480/277 V dry type power transformer.
- B One 12.47 KV, 600 A, air interrupter switchgear assembly.

### PART II -- PRODUCTS

#### 16.6 MATERIALS AND EQUIPMENT

##### A General

1. Materials shall be new, first quality commercial stock.
2. Materials and equipment shall be free from structural, visual or operational defects upon completion of the work.
3. Electrical materials and equipment covered by the regular inspection service of Underwriters' Laboratories, Inc., shall be U.L. approved and listed in the "Electrical Construction Materials List" and shall be U.L. labeled.
4. Other materials and equipment shall be fabricated and installed in accordance with the applicable standards referred to throughout the specifications.
5. In addition to the provisions of Section 01320, substitute products may be used only if similar and equal in design, quality, and performance when approved by the University. Dimensional as well as qualitative equivalence of any proposed substitutes for specified equipment shall be investigated before seeking approval.

##### B Materials Lists and Shop Drawings

Manufacturer's descriptive literature, material lists, equipment data and shop drawings shall be submitted for University approval in accordance with the General Requirements.

##### C Conduit and Fittings

1. Rigid steel conduit (RSC) and fittings for 480 volt circuits shall be hot-dipped, galvanized or sherardized and shall conform to F.S. W-C-575A, minimum size.

2. Bends for 1-1/4" and larger shall be factory elbows.

D 600 Volt Conductors

1. Wires and cables noted herein shall be furnished and installed by the Subcontractor.
2. All insulated wire shall conform to the latest requirements of NEC and shall meet all ASTM specifications. All wire shall be new and have the size, grade of insulation, voltage and manufacturer's name permanently marked on the outer covering at intervals not exceeding 2'. Conductors shall be standard American Wire Gauge sizes, soft-drawn copper. Conductors 8 AWG and larger shall be stranded. Type THWN/THHN insulated wire shall be furnished for feeder conductors. Type THWN/THHN or THW 600 Volt insulated wire shall be furnished for ground conductors.
3. All conductors shall be color-coded in accordance with PART III, Section 16.10.
4. Conductors shall be installed in the conduits in accordance with the drawings.

E Terminal Lugs

Solderless type lugs shall be used for all terminations. Lugs shall be Burndy "Q1KLUG" or equal.

F 12 KV Conductors And Accessories

1. H.V. Cables

The cables shall be single conductor, 15 KV, shielded, EPR 133% insulation, 220 mils shield, PVC jacket. Uncoated copper conductor, Class B stranded per ASTM B-8. Conductor size as shown on the drawings. The cable shall be Okoguard-Okoseal type MV-90 or equal.

Cable splicing shall not be allowed.

2. Stress Relief Material

Stress relief terminations shall be made with "Raychem," kit series HVT-150 or equal.

G Separable Insulated Connectors

Cable termination and connection inside the High Voltage splice box shall be made with Elastimold 650 BLR elbow connectors, 600 CP connector plug, appropriate spade connector, cable adapter and grounding adapter for metallic tape shield.

The Subcontractor shall verify existing Elastimold part numbers in the H.V. box to insure compatability.

#### H Concrete for Underground Conduit

All concrete for encasing conduit shall be colored a distinctive red by adding 10 pounds of Millers red pigment (or approved equal) per cubic yard of concrete. Concrete strength shall be 2,500 psi minimum allowable compression strength at 28 days, maximum slump 3 inches. Transit mix concrete shall be used and this shall conform to ASTM C94-81.

### PART III -- EXECUTION

#### 16.7 INSTALLATION

##### A General

The electrical system layouts, as indicated on the drawings, are generally diagrammatic and the locations of equipment are approximate. The exact routing of all conduit, cabling and wiring shall be governed by the physical and structural conditions or obstructions encountered in the work. Such adjustments shall be made as required to insure a properly conditioned installation.

##### B Conduits and Ducts

###### Steel Conduits:

1. All conduits shall be installed in accordance with the best standards of practice. Conduit shall be installed with large radius bends and with not more than three (3) 90 degree bends between outlets or terminals unless otherwise approved by the University Representative. Conduit shall be tightly corked and shall be otherwise well protected during construction. Conduit shall be blown out and swabbed before wires are pulled. All conduit ends shall be reamed after cutting. Running threads are prohibited. Where necessary for connecting conduit, approved conduit unions shall be installed.
2. Exposed vertical runs of conduit shall be supported independently of the cabinets or switches to which they run, by means of pipe clamps or other approved supports. All conduits entering panelboards, pull boxes or outlet boxes shall be secured by locknuts on the inside and outside of the box, and a bushing on the end of the conduit. Exposed conduit shall be run parallel or at right angles to the center lines of columns or beams. Conduits entering an exposed conduit

area from a concealed area shall be equipped with escutcheon plates at the points of entry through the wall.

3. Sleeves shall be provided for duct or conduit penetrating floors and walls. All arrangements for the installation of these items shall be made sufficiently in advance of construction to prevent cutting. Such cutting as may be required for the proper installation shall be included as part of the work of this section. All repairing and patching shall be done in a manner satisfactory to the University.

#### 16.8 CONDUCTORS - 600 VOLT CLASS

A When required, only the lubricant as recommended by the cable manufacturer shall be used when pulling wires. No conductors shall be pulled in until outlet boxes and cabinets have been thoroughly cleaned of plaster and debris, and conduits are dry and clean.

#### B Splices

1. Wire and cable splices shall be made using solderless connectors. In no case shall the insulation of the joint be less than that of the corresponding insulation of the wire. All splices in outlet boxes shall be made up leaving at least 6" of correctly color-coded tails protruding from the box.
2. Splice joints shall be taped using 3M Brand, Scotch No. 33 Plastic Electrical Tape, or approved equal, applied in an approved manner. All joints shall be taped with a covering of tape equal in thickness to the insulation.

#### 16.9 HIGH VOLTAGE CABLE INSTALLATION

A Only qualified craftsmen, experienced in handling and using the specialized materials, equipment and techniques required, shall be employed on the work. Care shall be taken to train the cables in a manner so that movement due to load cycling will have minimum detrimental mechanical effect on the cable. The cable shall be handled throughout installation procedures so that it is never bent more sharply than a radius of twelve (12) times the cable diameter. When required, no lubricant other than that recommended by the cable manufacturer shall be used for pulling cables.

B Pulling tension shall not exceed maximum values recommended by the cable manufacturer. Only plain manila rope will be permitted for pulling. Pulling hardware shall fasten to both cable core conductor and sheath.



- C Terminations shall be made with stress relief cones in accordance with the cable manufacturer's instructions and by certified power cable splicers.

#### 16.10 PHASE LOCATION, ROTATION AND COLOR CODING

- A Standard phase rotation shall be C-B-A. The phase identification for all buses and connections as viewed from the front or operating face shall be as follows:

1. Phase A shall be at the top, left, or front position.
2. Phase B shall be in the middle position.
3. Phase C shall be in the bottom, right, or rear position.
4. The neutral shall be unique and readily identifiable.

- B The phases shall be clearly marked at each major location or bus where branch or feeder circuits emanate. All conductors shall be color-coded. Conductors Size #4 and smaller shall have colored insulation coded as follows. Conductor Size #2 and larger shall be identified by colored tape or equivalent.

<u>120/208V</u>	<u>480/277V</u>	<u>12,470 V</u>
Phase A - Black	Brown	Black
Phase B - Red	Orange	Red
Phase C - Blue	Yellow	Blue
Neutral - White	Grey	--
Ground - Green	Green	Green

#### 16.11 IDENTIFICATION AND LABELING

- A Respective names, circuit and wire numbers shall be as indicated on the drawings.
- B Where any changes in the work are made, for whatever reason, the respective identification shall be changed accordingly.

#### 16.12 TESTS

- A All tests shall be made in the presence of the University Representative. The application or interruption of power shall have the approval of the University. Standard forms for electrical testing work will be furnished by the University, and shall be filled in completely, signed and dated, and returned to the University. Submit to the University five (5) copies of all test results, certified in writing, witnessed, signed and dated, imme-

diately upon completion of the work. Any unsatisfactory condition revealed by these test results, or unsatisfactory methods of tests and/or testing apparatus and instruments shall be corrected to the satisfaction of the University.

B Continuity and Clearance

The Subcontractor shall ring out all devices, power cables and wires promptly after installation and shall check and test them for continuity, short circuits and grounds, and correct them as required.

C 600V Insulated Conductors

The insulation resistance test of all 600 V rated conductors shall be performed with a 1000 volt megger.

D Transformer Test

The insulation resistance of the primary windings to ground shall be measured with a 1000 V megger. The secondary windings shall be shorted and grounded during this measurement.

The insulation resistance of the secondary windings to ground shall be measured with a 500 volt megger. The secondary bus terminals shall be jumpered and the primary bushings grounded.

The test report shall include transformer winding temperature and ambient humidity.

E Transformer Turns Ratio

The transformer turns ratio test shall be performed with an instrument specifically designed for that purpose. The test report must include instrument model and manufacturer.

F High Voltage Cables

The 15 KV cables shall be given a 50 KV D.C. potential test. The potential shall be applied in 16.6% steps, with each step held for a duration of one minute. Following the fifth step, the voltage shall be brought to the 50 KV (hold) value for a duration of 5 minutes. During the test, the leakage current of each step shall be recorded. The leakage current of hold period shall be recorded every 15 seconds. At the conclusion of the five minute hold period, the source of DC high potential shall be shut off and the applied charge shall be allowed to discharge over a period of five minutes.