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ENGINEERING DEPARTMENT  
CITY OF PHOENIX  
PROJECT SPECIFICATIONS AND CONTRACT DOCUMENTS  
(90 PERCENT SUBMITTAL)  
SQUAW PEAK PARKWAY  
SEGMENT NO. 5 B  
BETHANY HOME ROAD TO MYRTLE AVENUE

HNTB

|                                    |        |
|------------------------------------|--------|
| FLOOD CONTROL DISTRICT<br>RECEIVED |        |
| APR 26 '88                         |        |
| GR ENG                             | P & FM |
| DEF                                | HYDR   |
| ADMIN                              | LMGT   |
| FINANCE                            | FILE   |
| C & O                              |        |
| ENGR                               |        |
| REMARKS                            |        |



City of Phoenix  
Squaw Peak Parkway Coordinating Office

April 26, 1988

Mr. Edward A. Raleigh  
Maricopa County Flood  
Control District  
3335 West Durango  
Phoenix, AZ 85009

Dear Mr. Raleigh:

SQUAW PEAK PARKWAY  
SEGMENT V-B (BETHANY HOME ROAD TO MYRTLE AVENUE)  
(P-856344)

Transmitting one (1) set of preliminary Squaw Peak Parkway, Segment V-B  
(Bethany Home Road to Glendale Avenue) construction plans and specifications  
for your review.

Please return all review comments to our Coordinating Office no later than  
Friday, May 6, 1988.

If you have any questions, please contact our office at 262-7691.

Very truly yours,

RAMON F. MIGUEZ, CITY ENGINEER

For PETER A. JOHNSON, P.E.  
Squaw Peak Parkway Coordinator

PAJ/TM/ebl

c: Mr. Arthur  
Mr. Miguez

|                                    |        |
|------------------------------------|--------|
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| REMARKS                            |        |

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CALL FOR BIDS  
BIDS WILL BE OPENED  
TUESDAY, AT 4:00 P.M.

INDEX NO. 856344, AND ST-850891

Sealed bids will be received at the office of the City Engineer, Plaza Municipal Building, 125 East Washington Street, Phoenix, Arizona 85004 until the hour indicated for construction of the Squaw Peak Parkway Segment No. 5B Bethany Home Road to Myrtle Avenue including grading, drainage, storm sewer, paving, utility replacement and relocation, landscaping, noise walls, curbs, gutters, sidewalks, bridges at the Bethany Home, Maryland Avenue, Pedestrian Overpass, Arizona Canal and Glendale Avenue lighting, building demolition and incidental items necessary to the project.

Prospective bidders may examine and/or purchase plans, special provisions, and proposal pamphlets at the City Engineer's office. These documents may be purchased for \$50.00 per set. Only half-size plans will be available.

Pursuant to City of Phoenix Ordinance G-2772, on Prequalification of Contractors, all bidders must be prequalified to bid on this project.

Pursuant to City of Phoenix Ordinance G-1327, as amended, on Equal Employment Opportunity, all prime contractors and subcontractors are required to take affirmative action toward equal employment opportunity.

Pursuant to ARS 34-253, the lowest and/or best responsible bidder shall provide a noncollusion affidavit.

No proposal will be read unless accompanied by a proposal guarantee of cash, certified check, cashier's check or on the surety bond provided, for an amount not less than 5 percent of the amount bid.

The Council of the City of Phoenix reserves the right to award the contract to the lowest and/or best responsible bidder, or all bids will be rejected, as soon as practicable after the date of opening bids.

MARVIN A ANDREWS  
City Manager

By  
City Engineer

Published: Arizona Business Gazette

INFORMATION FOR BIDDERS

.01 REFUNDS FOR PLANS AND SPECIFICATIONS

No refunds will be made for the return of plans and/or specifications by prospective bidders--either before or after the bid opening date.

.02 PREQUALIFICATION OF CONTRACTORS

This project IS subject to the City of Phoenix Ordinance G-2772, Prequalification of Contractors. All bidders must be prequalified in one of the following categories to bid on this project.

CATEGORIES: C-4 OR C-6

NOTE:

Any bidders who are not prequalified, as stated above, will have their proposal rejected as a non-qualified proposal.

.03 SUBMITTING BIDS

No proposal will be read unless accompanied by a proposal guarantee of cash, certified check, cashier's check or on the surety bond provided, for an amount not less than 5 percent of the amount bid.

The entire Specification, containing the completed proposal with the 5 percent proposal guarantee shall be submitted in a sealed envelope. The outside, lower righthand corner of which shall be marked as follows:

Bid of (Firm's name, address and phone number)

For: Squaw Peak Parkway Segment 5B, Bethany Home Road to Myrtle Avenue

City of Phoenix Index No. 856344 and ST-850891

Sealed bids shall be delivered to Administrative Section Counter of the Engineering Department prior to the time and date specified for bid opening.

This project is subject to the City of Phoenix' Ordinance G-1327, as amended, pertaining to Equal Employment Opportunity. The Affirmative Action Requirements are included as a part of the Specification on pages B-1 and B-2.

.04 PRE-BID CONFERENCE AND QUESTIONS ON PLANS AND SPECIFICATIONS

A pre-bid conference will be held in the first floor Conference Room, Plaza Municipal Building, 125 East Washington Street, Phoenix, Arizona on: \_\_\_\_\_.

The purpose of this conference will be to discuss questions you may have on the project and clarify the plans and specifications.

Neither the Engineer nor the City of Phoenix shall be held responsible for any oral instruction. Any changes to the plans and specifications will be in the form of an addendum which will be furnished to all plan holders.

Should you desire additional information prior to submitting your bid, please call the following for questions on:

Plans, Technical/Special Provisions, or Proposal: Project Engineer, HNTB Consulting Engineer, Mr. Terry Weber, 602-954-7420, or City of Phoenix, Mr. Peter Johnson, 602-262-7691.

General Condition, Bid Bonds, Insurance, Payment and Performance Bonds and Contracts: Specifications, 602-262-4950.

Equal Employment Opportunities and Affirmative Action Programs: Human Relations Division, 602-262-6790.

Certified Minority/Women Business Enterprises (MBE's/WBE's): Minority Procurement Advisor, (602) 262-6790.

#### .05 RECORD DRAWINGS

The Contractor shall maintain a record set of plans at the job site. These shall be kept legible and current and shall show all changes or work added in a contrasting, reproducible color. When the project is substantially complete, the Contractor shall submit these plans to the Engineer for approval. The Engineer shall be the sole judge as to the acceptability of the record plans and receipt of an acceptable set is a prerequisite for final payment.

#### .06 NONCOLLUSION AFFIDAVIT

The lowest and/or best responsible bidder shall provide the attached noncollusion affidavit (page ABC-1), within 24 hours after bid opening.

#### .07 MBE PARTICIPATION

The successful bidder shall submit a "List of Minority and Non-Minority Subcontractors" pursuant to City of Phoenix Resolution #15629. The listing shall be made on a form provided with the contract documents and returned with the executed documents.

.08 PRE-CONSTRUCTION CONFERENCE

After completion of the Contract Documents, to include bonds, insurance and signature, and prior to the commencement of any work on the project, the Field Engineering Inspection Section (telephone 257-9599) will schedule a Pre-construction Conference. Normally, this will be held at the Field Engineering Building, 1034 East Madison, Phoenix, Arizona.

The purpose of this conference is to establish a working relationship between the contractor, utility firms and various City agencies. The agenda will include critical elements of the work schedule, submittal schedule, cost breakdown of major lump sum items, payment application and processing, coordination with the involved utility firms, emergency telephone numbers for all representatives involved in the course of construction and establishment of the Notice to Proceed date.

Minimum attendance by the contractor shall be a responsible company/corporate official, who is authorized to execute the sign documents on behalf of the firm, the job superintendent, and the contractor's safety officer.

.09 CASH FLOW

The contractor shall furnish to the City within 10 days of Notice to Proceed, an estimate of his monthly pay requests for the total project.

.10 ALLOCATION OF ADD/DEDUCT PROPOSAL ITEM

Determination of proportionate distribution of add or deduct will be calculated as follows and unit prices will be adjusted accordingly. Adjusted unit prices will be used to determine payment for all units of work completed under that item.

- A. Total sum of extended unit bid prices for Items \_\_\_\_\_.
- B. Divide extended unit bid prices for Item Nos. \_\_\_\_\_ and by the sum of these items to determine the percentage of the lump sum, add or deduct, adjustment which will be applied to the individual Bid Item Nos. \_\_\_\_\_ and \_\_\_\_\_.
- C. The new unit price for each affected item will be determined by adding or subtracting the lump sum adjustment for that item from the total extended amount listed in the bid for that item. This amount will then be divided by the number of "quantity units" listed in the bid proposal for that item to determine the new adjusted unit bid price for that item.
- D. Any minor deviation in total bid cost using new unit prices may be corrected by adjusting any one or more of the items to correct deviation.

**BID CONDITIONS  
AFFIRMATIVE ACTION REQUIREMENTS  
EQUAL EMPLOYMENT OPPORTUNITY**

**PART I:** *Policy of the City of Phoenix on nondiscrimination in employment by City contractors and subcontractors.*

Construction contracts involving funds in excess of ten thousand dollars (\$10,000) shall be awarded to contractors, subcontractors, or suppliers who adhere to a policy of equal employment opportunity and demonstrate an affirmative effort to recruit, hire and upgrade the position of employees regardless of race, color, religion, sex or national origin.

**PART II:** *Bidding Conditions*

The provisions of these bid conditions are such that no contractor, subcontractor or supplier will be eligible for award of a construction contract, his portions of which exceed \$10,000 on a City of Phoenix project unless they have submitted a written affirmative action plan embodying both (1) goals and timetables of minority manpower utilization and (2) specific affirmative action steps directed at increasing minority manpower utilization.

(1) **Goals and Timetables.** The plan must set forth, as minimum, the following ranges of goals for minority manpower utilization in each trade which is to be used:

2-28-77 until further notice - 20%

This percentage applies to man-hours worked by each work class, at all levels.

In no event may a contractor, subcontractor or supplier utilize goals, timetables, or affirmative action steps required by this section in such a manner as to cause or result in discrimination against any person on account of race, color, religion, sex or national origin.

The goals as established in this section may vary when a contractor, subcontractor or supplier recruits his labor force in a well defined labor area. Such variation shall reflect the ethnic composition of the particular area in relation to the State of Arizona ethnic composition.

(2) **Affirmative Action Steps.** The City of Phoenix shall establish standards to be met by contractors, subcontractors or suppliers in order to be eligible for award of City Construction Contracts. Contractors, subcontractors and suppliers shall execute such further forms and documentation at such times and as may be required by the appropriate awarding authority of the City of Phoenix.

(3) **Reporting Requirements.**

(a) All prime contractors and subcontractors bidding on City construction shall submit the following reports:

An EEO-1 or Phoenix Employer Information Report

An Equal Employment Questionnaire

An Affirmative Action Program

Failure to have the above listed reports on file prior to bidding will cause the proposal to be considered irregular and may be grounds for rejection by the City Council.

If, prior to awarding of the project, the prime contractor remedies the irregular submittal of the subcontractor by compliance with the reporting requirements set forth above, the City Council, in its discretion, may waive the original defect and accept the proposal.

(b) The Human Relations Commission shall transmit, to contractors and subcontractors who have submitted bids to the City, notification of their obligation to comply with the reporting requirements of this subsection, by certified mail, on at least an annual basis.

Before the City can invoke the enforcement provision of refusing to award a contract due to failure to comply with the reporting requirements of this subsection, the prime contractor and subcontractor must have received such a notice from the Human Relations Commission prior to the bid opening date.

(c) The contractor and each of the subcontractors and suppliers shall at the request of the City of Phoenix deliver to the City copies of any Affirmative Action Reports required by Federal or state agencies.

(d) In order to promote the effectiveness of meeting these requirements all reports received in compliance with these reporting requirements shall be deemed confidential.

#### *PART III: Compliance and Enforcement.*

Contractors are responsible for informing their subcontractors (regardless of tier) and suppliers as to their respective obligations under these Bid Conditions. The contractor, subcontractor or supplier shall carry out such sanctions and penalties for violation of the equal opportunity clause including cancellation, termination and suspension of existing subcontracts as may be imposed or ordered by the City, pursuant to Ordinance. Any contractor, subcontractor or supplier who shall fail to carry out such sanctions and penalties shall be deemed to be in noncompliance with these Bid Conditions and City Ordinance.

Violation of any substantial requirement by a contractor, subcontractor or supplier covered by these Bid Conditions including the failure of such contractor, subcontractor or supplier to make a good faith effort to meet its fair share of the trade's goals of minority manpower utilization, shall be deemed to be noncompliance by such contractor, subcontractor or supplier with the Equal Opportunity Clause of the contract, and shall be grounds for imposition of the sanctions and penalties provided in Chapter 18, Article IV, Section 18-18, Code of the City of Phoenix.

The City shall review its contractors', subcontractors' and suppliers' employment practices during the performance of the contract.

#### *PART IV: Compliance with City Ordinance.*

The contractor agrees to comply with Chapter 18, Article IV of the Code of the City of Phoenix entitled "Nondiscrimination in Employment by City Contractors and Subcontractors", and all applicable amendments thereto.

## SUPPLEMENTARY CONDITIONS

### .01 STANDARD SPECIFICATIONS AND DETAILS

Except as otherwise required in these specifications, construction of this project shall be in accordance with all applicable Maricopa Association of Governments' (MAG) Uniform Standard Specifications and Uniform Standard Details, latest revision, and the City of Phoenix Supplements, latest revision to the MAG Uniform Standard Specifications and Details.

### .02 PRECEDENCE OF CONTRACT DOCUMENTS

The city of Phoenix Supplements will govern over the MAG Standard Specifications and Details. In case of a discrepancy or conflict, plans will govern over both the City of Phoenix Supplements and MAG Standard Specifications and Details; Supplementary Conditions, Technical Provisions, Special Provisions, will govern over the City of Phoenix Supplements, the MAG Standard Specifications and Details and Plans.

### .03 SUSPENSIONS OF WORK

The engineer reserves the right to suspend the work wholly or in part if deemed necessary for the best interest of the City. This suspension will be without compensation to the Contractor, other than to adjust the contract time in accordance with Section 108.

### .04 HINDRANCE AND DELAYS

No charge or claim for damages shall be made by the contractor for any delays or hindrances from any cause during the progress of any portion of the work embraced by this contract. If any delay is caused by any act or omission on the part of the Contracting Agency or by any other Contractor working for the Contracting Agency, or if due to no fault or neglect of the Contractor, the Contractor will be granted an extension of time for the completion of the work sufficient to allow for the delay. The allowable extension of time due to such delays shall be determined by the Engineer, provided the Contractor has given the Engineer immediate notice in writing of the cause of such delay.

### .05 PARTIAL PAYMENTS

The Contracting Agency will make a partial payment to the Contractor on the basis of an estimate prepared by the Engineer for work completed and accepted through the preceding month. The Notice to Proceed date, which is designated for the specific project involved, will be used as the closing date of each partial pay period. Payment will be made no later than 20 days after mutual acceptance of the Engineer's Estimate.

Where feasible, quantities may be calculated for 5 days prior to the monthly closing date and projected for the remainder of the pay period.

.06 IDEMNIFICATION OF CITY AGAINST LIABILITY

The Contractor agrees to indemnify and save harmless the City of Phoenix, its officers, agents and employees, and any jurisdiction or agency issuing permits for any work included in the project, their officers, agents and employees, hereinafter referred to as indemnity, from all suits, including attorneys' fees and cost of litigation, actions, loss, damage, expense, cost or claims, of any character or any nature arising out of the work done in fulfillment of the terms of this contract or on account of any act, claim or amount arising or recovered under Workers' Compensation law, or arising out of the failure of the Contractor or those acting under Contractor to conform to any statutes, ordinances, regulation, law or court decree. It is the intent of the parties to this contract that the indemnity shall, in all instances, except for loss or damage resulting from the sole negligence of the indemnity, be indemnified against all liability, loss or damage of any nature whatever for or on account of any injuries to or death of person or damages to or destruction of property belonging to any person arising, out of or in any way connected with the performance of this contract, regardless of whether or not the liability, loss or damage is caused by, or alleged to be caused in part by the negligence, gross negligence or fault of the indemnity. It is agreed that Contractor will be responsible for primary loss investigation, defense and judgment costs where this contract of indemnity applies.

.07 CONTRACTOR'S INSURANCE REQUIREMENTS

Concurrently with the execution of the Contract, the Contractor shall furnish the City of Phoenix a Certificate of Insurance on a standard insurance industry ACORD form. The minimum limits of liability shall be \$1,000,000.00 for General Liability and Automobile Liability and \$100,000.00 for Workman's Compensation. The ACORD form shall be issued by an insurance company authorized to transact business in the State of Arizona, or one that is named on the List of Unauthorized Insurers maintained by the Arizona Department of Insurance.

The Contractor shall maintain during the life of the contract such public liability and property damage insurance, both general and automobile liability, as shall protect him and any subcontractor performing work under the contract from all claims for bodily injury, including accidental death, as well as for property damage arising from operations under the contract - whether such operations be by himself or by any subcontractor or by anyone

directly or indirectly employed by either of them. These policies shall not expire until all the work has been completed and the project has been accepted by the City of Phoenix. If a policy does expire during the life of the contract, the Contractor shall provide a renewal certificate of the required insurance coverage to the City of Phoenix not less than five (5) days prior to the expiration date. -

The City of Phoenix, a municipal corporation, its officers, agents and employees shall be names as additional insureds on all Public Liability and Property Damage Insurance and Builder's Risk/Course of Construction Insurance, when required, and this shall also be indicated on Certificates of Insurance issued to the City. The Contractor's coverage shall be primary for any and all losses arising out of the performance of this contract.

.08 MODIFICATION TO MAG UNIFORM STANDARD DETAIL 240 - VALLEY GUTTER

Reference Note 1 which reads "All concrete to be Class "B" unless otherwise approved. (Section 725)"

Change this note to read:

1. All concrete to be Class "A" unless otherwise approved. (Section 725).

.09 PRESSURE MANHOLE COVERS

Mag Detail 523, Change the Note (upper right corner) that reads "For a 30" M.H. opening. . . noted on the sheets" to read:

"For a 30" M.H. Opening, use the Std. watertight 30" M.H. Frame and Cover (Detail 423) and modify and install the frame and cover in accordance with Notes 1 through 12 listed below on this sheet."

.10 ALUMINUM MANHOLE COVERS

The Water and Wastewater Department has the following stated policy "MAG" Standard Detail 425 - 24" Aluminum Manhole Frame and Cover is not approved by the City of Phoenix."

.11 CLASS 35, MANHOLE COVERS AND FRAMES

ASTM A-48 Class 35, gray cast iron manhole frames and covers are approved for use on City's projects. The weight of the 30-inch frame and cover castings shall be no more than 2 percent less than 219 pounds for the frame and 207 pounds for the cover. The manufacturer shall provide certification that the product meets the required H-20 traffic loading.

.12 MODIFICATION TO MAG UNIFORM STANDARD DETAIL 522 - MANHOLE SHAFT

Reference Note 5 which calls for installation of manhole steps as required by agency. The Engineering Department has adopted the policy that manhole steps are NOT to be installed in any storm sewer manhole. If steps are provided, they shall be removed and the hole filled with Class "B" concrete.

.13 DISPOSAL OF SURPLUS MATERIAL

All surplus and/or waste material may be disposed of at the Contractor's discretion subject to the following conditions:

- A. If the City landfills are used, the Contractor shall pay the normal dumping fee.
- B. If private property within the City limits is used, the Contractor shall obtain written permission from the property owner and deliver a copy of this agreement to the Engineer prior to any hauling or dumping.

All disposal and grading shall be in strict conformance with the City of Phoenix Grading and Drainage Ordinance. The Contractor shall obtain and pay for the necessary permit(s).

- C. If the surplus material is disposed of outside the City limits, the Contractor shall comply with all applicable laws/ordinances of the agency concerned and be responsible for all cost incurred.

No measurement or direct payment will be made for the hauling and disposal of surplus and/or waste material, the cost shall be incidental to the cost of the project.

.14 CONTRACTOR'S MARSHALING YARDS

Contractors shall obtain approval of the City Engineer when using vacant property to park and service equipment and store material for use on City construction contracts.

- A. The Contractor shall notify adjacent property owners/residents of this proposed use.
- B. Any use of vacant property adjacent to or near the project for parking or servicing equipment and/or storing of material will require the Contractor to obtain written approval from the property owner. This approval shall contain any requirements which are a condition of this approval.

- C. A copy of the property owner's approval shall be submitted along with the Contractor's request to the City Engineer for approval for the use of the marshaling yard in connection with the project. An appropriate distance from adjacent property will be set by the City Engineer on a case by case basis based on the size and type of equipment to be used on the project.
- D. The yard shall be fenced and adequately dust-proofed in a manner such as to preclude tracking of mud onto paved City streets.
- E. Work in yard shall be scheduled so as to comply with the City Noise Ordinance.
- F. Equipment, materials, etc., shall be located so as to minimize impact on adjacent properties. A sound barrier may be required if deemed necessary by the City Engineer.
- G. The Contractor shall clean up property promptly upon completion of use.
- H. Contractor's request for approval shall specify in detail how he or she proposes to comply with D through G above.

.15 CITY OF PHOENIX SUPPLEMENT SUBSECTION 109.5.1 EQUIPMENT: IS MODIFIED TO ADD:

"Unless a prior written agreement has been made, the contracting Agency will not pay move-in/move out cost and standby equipment rates."

.16 REFERENCE CITY OF PHOENIX SUPPLEMENT SECTION 610 WATERLINE CONSTRUCTION, SUBSECTION 610.4.1 CONSTRUCTION WORK BY CITY FORCES, PARAGRAPH (A) DELETE THIS PARAGRAPH IN ITS ENTIRETY AND SUBSTITUTE THE FOLLOWING:

(A) City forces shall perform work on existing waterlines as indicated on the plans.

The Contractor shall coordinate with the Engineer to make the necessary arrangements to have the City forces perform the required work. There will be no charge to the Contractor for taps to existing waterlines, shut-downs for waterlines valve cut-in and waterline valve cut-in installation.

The Contractor will be responsible for paying for other shut-downs and the cost will be incidental to the job.

SQUAW PEAK PARKWAY  
SEGMENT NO. 5b  
GRAND CANAL TO INDIAN SCHOOL ROAD  
INDEX NUMBERS P-856344 AND ST-850891  
SPECIAL PROVISIONS  
TO  
UNIFORM STANDARD SPECIFICATIONS  
FOR  
PUBLIC WORKS CONSTRUCTION  
MARICOPA ASSOCIATION OF GOVERNMENTS, ARIZONA  
WITH  
CITY OF PHOENIX SUPPLEMENT

HOWARD NEEDLES TAMMEN & BERGENDOFF  
CONSULTING ENGINEERS  
PHOENIX, ARIZONA

July, 1988

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.01 GENERAL:

Construction contract specifications for this project shall conform to the requirements of the Uniform Standard Specifications for Public Works construction, and the City of Phoenix, Supplement (1987) sponsored and distributed by the Maricopa Association of Governments (latest Edition), except as noted below, including 1987 Revision and Corrections. In all cases, the City of Phoenix, Supplement to Maricopa Association of Governments, Uniform Standard Specifications (1987 Edition) shall supersede the MAG Uniform Standard Specifications. Special Provisions and Plan sheet notes, requirements and references to other specifications written for this Squaw Peak Parkway Segment 5b Project shall supersede the MAG Uniform Standard Specifications and the City of Phoenix Supplement.

The Contractor shall furnish at no separate payment, a mobile field office for use by City and Contractor personnel. The office shall be furnished with water, sewer, telephone and electric services and shall include air conditioning, toilet and washroom facilities.

The Contractor shall maintain local street lighting for the duration of this project.

.02 TRAFFIC REGULATIONS:

1. The following shall be considered major streets:

Bethany Home Road  
Glendale Avenue  
19th Street

2. All traffic and/or traffic control devices on this project shall be provided, maintained and/or controlled as specified in the City of Phoenix Traffic Barricade Manual, latest revision.
3. Permission to restrict City streets, sidewalks, and alleys (street closure permits) shall be requested as specified in Section III of the Traffic Barricade Manual.
4. Unless otherwise provided for in the following "Special Traffic Regulations" all traffic on this project shall be regulated as specified in Section IV of the Traffic Barricade Manual.

.03 SPECIAL TRAFFIC REGULATIONS:

Bethany Home Road at Squaw Peak Parkway

Bethany Home Road may be closed for construction of the structure. Bethany Home Road shall be opened to traffic as soon as possible after completion of the structure.

Maryland Avenue at 18th Street

Maryland Avenue shall maintain at least one traffic lane in each direction until Bethany Home Road is open to traffic following completion of the structure.

18th Street from Bethany Home Road to Maryland Avenue

18th Street shall maintain one traffic lane in each direction while Bethany Home Road is closed and during the reconstruction of 18th Street.

Glendale Avenue from 16th Street to 22nd Street (Storm Drain Installation)

A detour shall be provided as indicated on the plans during construction of the Glendale Avenue structure.

Glendale Avenue can be restricted to two lanes (one each way) from 9:00 p.m. to 6:00 a.m. Sunday through Thursday nights for asphalt concrete construction storm drain crossings and detour tie ins. Five lanes (3 westbound and 2 eastbound) shall be open at other times. At no time shall Glendale Avenue be completely closed.

19th Street between Osborn Avenue and Morten Avenue

19th Street can be closed when required for detour tie-ins, temporary signal changes, and traffic shifts. Under this closure, southbound traffic shall be detoured to 16th Street via Morten Avenue. Northbound traffic shall be directed to 16th Street from Glendale Avenue. Closure of 19th Street is allowed between 9:00 p.m. and 6:00 a.m., Sunday through Thursday nights. At all other times, 19th Street shall maintain traffic as shown in the plans.

Traffic on Glendale Avenue and 19th Street shall not be flagged or stopped between the hours of 7:00 - 8:30 a.m. and 4:00 - 6:00 p.m., weekdays.

Local streets can be closed to through traffic when construction requires. Local access shall be provided at all times.

After award of the contract, the Contractor shall submit for approval of the Traffic Engineering Department, a description of his proposed haul routes to and from the site for delivery and disposal of all materials (ie, fill, ABC, concrete, asphalt, pipe, etc.). The Contractor shall be restricted to use of the approved routes.

Police Officer Requirements (All Phases):

The Contractor shall provide one off-duty police officer at 19th Street and Glendale Avenue from 7:00 am to 6:00 pm weekdays and during all hours of night and weekend work whenever traffic is restricted through the intersection.

.04 CLEARING AND GRUBBING (SECTION 201):

201.5 PAYMENT, CLEARING AND GRUBBING:

Payment for clearing and grubbing will be for the job lump sum in accordance with Section 201, at the lump sum price stipulated in the proposal. At no additional payment, this item shall also include installation and maintenance of a temporary chain link fence eight feet high, on both sides and the ends of the parkway construction areas from the beginning of the project to the end of the project. Payment will include all items and materials included in Subsection 201.1 and not included in the plans and proposal as a "Remove" item.

201.8 REMOVAL AND DISPOSAL:

Items and materials separately listed by units and identified as "Remove..." on the plans and proposal shall be removed from the right-of-way and disposed of by the Contractor in accordance with the provisions of Section 201, except that fire hydrants shall be delivered to the City of Phoenix.

201.9 PAYMENT FOR REMOVAL AND DISPOSAL:

Payment for removal and disposal of items and materials will be on a unit price for each item or material measured, removed and disposed, in accordance with Section 201, at the unit price stipulated in the proposal.

.05 ROADWAY EXCAVATION (SECTION 205):

Roadway excavation shall conform to MAG Standard Specification Section 205. Blasting may be required and the attention of the Contractor is directed to the requirements of Subsection 107.8 Use of Explosives in the MAG Standard Specifications.

.06 BORROW EXCAVATION (SECTION 210):

Borrow shall conform to MAG Standard Specification Section 210.

Material has been stockpiled on the job site and is designated as "Local Borrow". Local Borrow has been stockpiled at a location north of Bethany Home Road as indicated on the plans.

There will be no direct payment for Local Borrow or Imported Borrow under Section 210, but borrow will be measured and paid for as fill construction in-place to the lines and grades indicated in the drawings.

.07 FILL CONSTRUCTION (SECTION 211):

Fill construction shall conform to MAG Standard Specification Section 211.

Compaction shall be not less than 95 percent in embankment, and under retaining wall footings from original ground level to top of embankment or bottom of footings.

Measurement will be by the cubic yard of fill in-place from local Borrow material. Measurement shall be determined by cross sections and average end area calculations of material at its' final location.

The local Borrow stockpile has not been compacted and shall be removed from areas requiring fill before fill construction of the engineered fill can proceed.

Payment will be made at the bid price shown in the Proposal for FILL CONSTRUCTION - LOCAL BORROW per cubic yard, and shall include all labor, materials, equipment, water, transport, compaction, and grading to the final grades indicated on the plans.

Top soil is a separate item to be measured and paid for under Section 425.

.08 EARTHWORK FOR OPEN CHANNELS (SECTION 215):

Earthwork for open channels shall conform to MAG Standard Specification Section 215, except no direct payment will be made for this item.

.09 SUBGRADE PREPARATION (SECTION 301):

The Engineer may require all or any part of the subgrade to be load tested for stability with Contractor's equipment prior to placement of asphalt or Portland Cement Concrete pavement. Unstable areas as determined by the Engineer shall be corrected by the Contractor at no increase in cost to the contract. The density requirements of Section 301.3, Relative Compaction, shall apply to the top one (1) foot of the existing subgrade.

Measurement and payment for subgrade preparation will be made for Asphalt Concrete pavements and Portland Cement Concrete pavements in streets and parkway roadway. Measurement for Portland Cement Concrete pavement shall include the area from lip of gutter to lip of gutter or from lip of gutter to edge of pavement where the pavement is under the concrete traffic barrier. Preparation of subgrade under miscellaneous paving, patching, and parking lots is not a pay item.

.10 AGGREGATE BASE COURSE (UNTREATED BASE) (SECTION 310):

GENERAL:

Aggregate Base Course (ABC) shall comply with the provisions of Subsection 310 and 702.

.11 ASPHALT CONCRETE PAVEMENT (SECTION 321)

All Asphalt Concrete shall comply with the Provisions of Subsections 321 and 710.

ASPHALT BASE AND SURFACE COURSE:

This item will include Preservative Seal for Asphalt Concrete for all finished surfaces of Asphalt Concrete C-3/4. Preservative Seal shall conform to the requirements of Section 334. The cost shall be included in the bid price for Asphalt Concrete C-3/4 and no separate payment will be made.

SURFACING TAPERS, TERMINATION AND RESIDENTIAL STREETS:

The surfacing shall consist of two inches compacted Type C-3/4 (or Type D-1/2) dense graded asphalt concrete laid in one course on six inches compacted aggregate base course.

ASPHALT CONCRETE REPLACEMENT:

Asphalt concrete shall be removed and replaced to match existing asphalt concrete frontage in back of new sidewalk, as detailed and noted on the plans and as directed by the Engineer. Existing asphalt concrete shall be trimmed and removed in accordance with Section 336.2.2. The new asphalt concrete shall be two inches of compacted, single course Type C-3/4 (or Type D-1/2) dense grade per Section 710.

Payment will be made at the bid price per ton for ASPHALT CONCRETE C-3/4 complete-in-place within the area as specified above, and shall include preservative seal, the removal and disposal of existing materials, not called out on plans, and subgrade preparation. Aggregate base materials, where required, will be paid under that proposal item.

.12 PORTLAND CEMENT CONCRETE STREET PAVEMENT (SECTION 324):

324.1 DESCRIPTION:

All Portland Cement Concrete Pavement shall comply with Section 324 of the Uniform Standard Specifications.

Pavement Joint Plans are included in the project plans for the purpose of establishing guide lines for construction of joints in Portland Cement Concrete Pavement. Lateral joints shown on the travelway lanes shall be extended through the adjoining PCCP shoulders, curb and gutter.

Adjustments in location and configuration of joints may be approved by the City upon submittal of a modified joint plan by the Contractor.

324.2.5 JOINT MATERIALS:

Delete the first sentence and the third paragraph and add the following:

Joint sealant material shall be a non-slumping paste, 1-part silicone, non-priming. The material shall be capable of 1000% elongation, expansion of 100% and compression of 50%. The joint sealer shall be DOW CORNING 888 Silicone Joint Sealant, or equal.

Before applying the material the sawcut joint shall be sand blasted and blown-out with air pressure equipment. The joint shall be free of all debris, soil, curing compound, laitance or other foreign material.

A representative of the sealant manufacturer shall be present at the site prior to and during start-up of the sealing operation to confirm proper joint preparation and application of sealant.

324.7 BASIS OF PAYMENT:

Payment for Portland Cement Concrete Pavement shall include all materials and construction for Portland Cement Concrete, steel reinforcement, dowel bars, joint construction, joint materials, curing, finishing and other associated items included in the plans and specifications. No separate payment will be made for these items.

.13 CHIP SEAL COAT (SECTION 330)

Chip seal shall conform to MAG Standard Specifications Section 330. Asphalt shall be AC-20, and chips shall be 1/4" nominal size pre-coated per table 716-1.

Measurement and payment will be per square yard.

.14 PRESERVATIVE SEAL FOR ASPHALT CONCRETE (SECTION 334)

Preservative seal for asphalt concrete shall conform to MAG Standard Specification Section 334, except no direct measurement and payment will be made for this item.

Asphalt preservative seal shall be applied on local streets where C-3/4 and D-1/2 asphalt surface is utilized.

.15 PAVEMENT MATCHING AND SURFACING REPLACEMENT (SECTION 336)

TEMPORARY PAVEMENT PATCHING:

After backfilling has been completed, a temporary pavement patch shall be applied in accordance with Section 336 to the surface of all excavations made because of the installation of new pipe, the removal of existing pipe or the removal of other structures at locations where the excavation encroaches into the existing pavement.

Temporary pavement patching will not be required on backfilled excavations for main storm sewers unless otherwise specified, except within the limits of major street intersections as designated on the plans or within these specifications.

The Engineer will delete temporary pavement patching when, in his opinion, subgrade preparation will follow sufficiently soon after backfilling to make patching unnecessary.

Backfilled excavations in existing pavement where patching is not required, shall be filled level with the existing pavement surface and maintained in a smooth dust-free condition to allow safe vehicular traffic at the posted speed limit.

No measurement or direct payment will be made for temporary pavement patching or maintaining unpatched pavements.

.16 CONCRETE TRAFFIC ISLAND, MEDIAN PAVING, BIKE PATH (SECTION 340):

340.1 DESCRIPTION:

All Concrete Traffic Islands, Concrete Median Paving, and bike path shall comply with Section 340 of the Uniform Standard Specifications.

BIKE PATH:

Bike path shall be constructed where shown and as detailed on the plans. The concrete shall be placed on compacted subgrade.

Bike path will be measured to the nearest square foot in place.

Bike path will be paid for at the unit price bid per square foot in the proposal. Such payment shall include full compensation for furnishing all labor, material, tools and equipment and accomplishing all work in conformance with the contract documents. The price per square foot shall be the same for all bike path (4" or 9") regardless of thickness.

.17 REMOVAL OF EXISTING IMPROVEMENTS (SECTION 350):

REMOVAL OF CONCRETE CURBING, SIDEWALK, DRIVEWAY, VALLEY GUTTER, CONCRETE SLABS, ASPHALT PAVEMENT, PIPE, BACKFILL AND COMPACT

The work under these items shall consist of the removal of existing concrete curbing, sidewalk, driveway, valley gutter, concrete slabs, asphalt pavement, and pipe, as specified in plans or as necessary. The work also consists of the disposal of all pipe, broken concrete, asphalt, and debris, and backfilling and compacting the void. Backfilling and compaction shall be in accordance with Sections 601 and 336.3. The Contractor may expose pipe and crush in-place where approved by the Engineer. Measurement and payment will be by the various units indicated in the Proposal.

REMOVAL OF STRUCTURES, BACKFILL AND COMPACT:

The work under this item shall consist of the removal of irrigation structures, stormwater inlets, headwalls, catch basins, swimming pools, ditch lining, and manholes at the locations designated on the plans and/or as necessary for the construction of this project and shall include the disposal of the broken concrete and debris, backfilling and compacting. Backfill and compaction shall be in accordance with Section 601 and 336.3. If any septic tanks and/or cess pools are discovered the Contractor shall notify the Engineer and the County Health Department.

The Contractor shall determine what items, if any, the City wants salvaged. Salvaged items shall be removed with care and delivered to a place to be determined by the City.

Payment will be made at the lump sum price quoted in the bid proposal for bid item "REMOVE STRUCTURES, BACKFILL AND COMPACT."

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.18 TRAFFIC SIGNAL MATERIAL AND CONSTRUCTION (SECTION 351):

Traffic signal material and construction shall conform to the requirements of Section 351 of the City of Phoenix Supplement to the Maricopa Association of Governments Uniform Standard Specifications.

.19 TRAFFIC CONTROL (SECTION 401)

1. Traffic detouring and construction sequencing on 19th Street and Glendale Avenue shall follow the general sequence shown on the Plans.
2. Any temporary retaining structures required to separate the detour road from the bridge structure or temporary fill shall be provided by the Contractor as part of traffic control. Details of any temporary retaining structure shall be submitted to the Engineer for approval.

3. After demolition on Glendale Avenue the Contractor will provide at least two weeks time for Arizona Public Service to install underground electrical service under the new roadway.
4. Add the following to MAG Subsection 401.7 PAYMENTS: Payment for Traffic Control will be paid for on a lump sum basis for Traffic Control Devices. The price bid shall include furnishing, placing, maintaining, and removing all temporary signs, temporary retaining structures, pavement markings, reflectors, drums, and miscellaneous traffic control devices required.

Separate measurement and payment will be made for furnishing, placing, maintaining and removing temporary concrete barriers as called for on the plans and shown in the Proposal per linear foot of Temporary Concrete Barrier.

.20 CONCRETE STRUCTURES (SECTION 505):

1. Catch Basins: Storm sewer catch basins shall be installed by type and at the locations indicated on the plans.

Storm sewer catch basins shall be constructed at the unit price bid for each type of catch basin, as represented by the respective bid item, regardless of dimensional or other differences occurring within a particular type. The unit price to be paid under these items shall be compensation in full for furnishing and placing catch basin structures as shown on the plans and as specified, including, when applicable, all removal and replacement of existing curb, gutter and sidewalk, concrete, reinforcing steel, forming, vibrating, finishing, curing, access opening frame and cover, embedded angles, grating, anchor bolts, structural excavation, backfill, compaction, pavement replacement, and any necessary modification of catch basin structures during construction.

2. Special Manhole: Special manholes with reinforced concrete square manhole risers built underground are shown on the plans and shall conform to MAG Specifications Section 505. Castings shall conform to Section 787. Steel shall conform to Sections 727 and/or 770

These special manholes will be paid for at the unit price bid in the Bid Proposal and shall be compensation in full for construction of the structure, including concrete, reinforcing steel, forming, vibrating, finishing, curing, excavation, backfill, compaction and any pavement replacement in excess of applicable pay widths.

3. Manholes and Transition Manholes: Manholes built underground as part of the storm sewer are shown on the plans and shall conform to Section 505. Castings shall conform to Section 787. Miscellaneous steel shall conform to Section 727 and/or 770.

For all Manholes where indicated on the plans the Contractor shall construct and install a complete manhole including the base, shaft, reinforced concrete rings, frames and covers, concrete caps, frame and adjustment to grade, etc., as shown on the plans and Standard Details.

Storm sewer manholes will be paid for at the unit price for each type, as represented by the respective bid item, regardless of dimensional or other differences occurring within a particular type. The unit price to be paid under these items shall be compensation in full for furnishing and placing manhole structures as shown on the plans and as specified, including concrete, reinforcing steel, forming, vibrating, finishing, curing, cast iron manhole frame and cover, frame adjustment to grade, structural excavation, backfill, compaction, and any pavement replacement in excess of the applicable pay widths assigned to the adjacent pipes.

4. Permanent Pipe Support: Permanent Pipe Supports shall conform to MAG Std. Det. 403. This work shall include all items necessary to complete this item as specified on the plans and in the Details.

Permanent Pipe Supports will be paid for at the unit price bid for each unit installed regardless of dimensional or other differences occurring within a particular type. The unit price shall be compensation in full for furnishing and placing permanent pipe supports, installing concrete, reinforcing steel, forming, vibrating, grouting, curing, and required earthwork necessary to complete the work as prescribed.

.21 WATERLINE CONSTRUCTION (SECTION 610):

610.2 GENERAL:

Waterline Construction shall conform to the requirements of MAG Specifications Section 610 "Waterline Construction." All metal pipe, fittings and valves shall receive the polyethylene corrosion protection per Section 610.5.

610.3 MATERIALS:

Waterline Pipe: All 4 to 12 inch pipe shall be per MAG Standard Specifications. Where called for on the plans, pipe shall be Ductile Iron Pipe, Thickness Class 52 per Section 750.2 with fittings per Section 750.4.

610.3 MATERIALS: modify (B) to read:

- B. Pipe eighteen (18) inches and larger may be either ductile iron, or concrete pressure pipe - steel cylinder type.

610.4 CONSTRUCTION METHODS: is modified to add:

When concrete pressure pipe - steel cylinder type is installed the following shall apply:

1. The Contractor shall mortar the inside and outside of all pipe joints. The mortar shall be applied in the field on the inside joints such that the mortared surface is flush with the adjacent pipe mortar lining. The outside of the joints shall be mortar coated by the diaper method.

The mortar shall be a Type "M" mortar per MAG 776 using Type II, low alkali cement.

2. All non-mortar coated steel, including flanges, shall be covered with a minimum of two (2) inches of hand-packed mortar. Wire mesh shall be used to hold the mortar in place. Mortar shall be the same as applied to the joints. Field-applied coal tar coatings will not be accepted in lieu of mortar. Except, coal tar enamel in accordance with AWWA C-203 shall be applied to the non-mortar coated steel and flanges on the 24" side outlets in access manholes.

3. Joint restraints shall be provided by means of welded joints. The extent of welded joints shall be as shown on the pipeline and layout drawings, and shall in no case be less than that shown on the plan drawings. Where welded joints are required, the weld shall be continuous about the entire circumference of the pipe joint. Welds shall be made intermittently, in short section of about six (6) inches, to avoid overheating the gaskets on joints where a gasket is used. Welds shall conform to that shown on the approved shop drawings and calculations.

For mains eighteen (18) inches and larger the following shall apply:

1. Backfill and compaction for the full distance encompassed by welded/restrained joints shall be completed prior to testing.

2. All mainline valves shall be covered with a minimum of two (2) inches of hand-packed mortar. Wire mesh shall be used to hold the mortar in place. Field applied coal tar coatings will not be accepted in lieu of mortar. Portions of valve within manholes shall not be mortar coated.

The mortar shall be a Type "M" mortar per MAG 776 using Type II, low alkali cement.

3. Where plans call for welding joints and ductile iron pipe is furnished, the Contractor shall restrain the joints by a Water and Wastewater Department approved joint restraint method.

610.6 VALVES:

Four to 12 inch valves shall be furnished by the Contractor. They shall be of one of the types specified in Section 630 at the Contractor's option.

Measurement and payment for valves shall be as outlined in Sections 630.8 and 630.9 of the MAG Specifications, except that valve boxes and covers shall be measured and paid for as separate pay items.

610.7 MANHOLES AND VAULTS:

Relocation of fire 8" detector valve and vault shall be for the job lump sum and shall include salvage and reinstallation of the detector valve, new pipe and fittings, new vault, excavation, installation, backfill, compaction, and repair of all disturbed surface features.

610.8 FIRE HYDRANTS:

The City of Phoenix shall furnish all fire hydrants as per Subsection 610.8 of the City of Phoenix Supplement to the MAG Specifications.

PROCEDURE:

New mains shall be connected to the water system by the Contractor as detailed on the plans. City crews will provide the Contractor with a shutdown upon application and payment of shutdown fees. The Contractor shall be ready to make the connection when the water line is shut down. A maximum of two hours will be allowed for the shutdown unless prior written authorization is obtained from the Engineer or the Water Department. The Contractor shall be responsible for notifying customers to be affected by the shutdown in accordance with MAG Specifications Section 610.9.

WATER SERVICE PIPE:

New water service pipe, connections, and fittings shall conform to MAG Specifications Section 631 and City of Phoenix Standard Detail P-1342. Existing size and type of each present service shall be determined and replaced by the Contractor at the locations indicated on the plans.

Measurement and payment for water service pipe will be made at the bid price per linear foot. The unit price to be paid under this item shall be compensation in full for furnishing all materials, and for preparation and placement of these materials, and for all labor, equipment, excavation, compaction, testing and incidentals necessary to complete this work as prescribed.

FIRE HYDRANT REMOVAL:

Where noted on the plans Fire Hydrants shall be carefully removed, salvaged, and delivered to the Water Distribution offices at 3045 South 22nd Avenue (telephone 262-5077).

.22 SEWER LINE CONSTRUCTION (SECTION 615)

Sanitary sewer line construction shall conform to the requirements of Section 615 of the Uniform Standard Specifications and the City of Phoenix Supplement.

.23 STORM SEWER CONSTRUCTION WITH PRECAST CONCRETE PIPE (SECTION 618):

1. Construction shall conform to MAG Standard Specification Section 618, except as modified herein.
2. MAG Subsection 601.2.3 Trench Grade is modified to add:  
"The initial foundation for all pipe 12 inches or larger shall be select material Type B per MAG Section 702 or aggregate base course material."
3. MAG Subsection 601.4.2 Bedding is modified to add:  
"For all pipe 12 inches or larger, bedding material shall be aggregate base course material per MAG Section 310 and 702."
4. City of Phoenix Supplement 618.3.3 Leakage Test: is not required for Precast Concrete Pipe.
5. Concrete Pipe Collar: There shall be no measurement or payment for construction of pipe collars for pipe.
6. Pipe Plugs: Pipe plugs shall be paid for at the unit price bid for each unit installed regardless of dimensional or other differences occurring within a particular type. The unit price bid shall be compensation in full for furnishing and placing pipe plugs, included brick work, concrete, reinforcing steel, forming, vibrating, grouting, curing, and any required earthwork.

No free outfall for this storm sewer is available for some time; therefore, Corrugated Steel Pipe is not an approved pipe material for mainline 90", 84", 78", 72", and 60" storm sewer pipe.

Where the new storm sewer undercrosses A.C.P. waterlines (12 inches or smaller excluding water service lines) and the Engineer has determined that the A.C.P. waterlines can be shut down, the Contractor shall contact and coordinate with Water Distribution at 262-4711 or 262-4712 at least one week in advance for the purpose of replacing the crossing line with ductile iron pipe and fittings or removing the crossing line from service by closing existing or new valves. A replacement section shall extend at least five feet beyond the mainline trench wall. Water Distribution shall determine the need for new valve installation.

The Contractor will be paid for the ductile iron pipe at the unit price bid per each crossing under the bid schedule item WATERLINE REPLACEMENT. This item shall also include trench excavation, backfill, compaction and surface restoration.

Where catch basin connector pipes conflict with existing water mains (2" through 12"), the Contractor shall realign the water main per the requirements of Standard Detail 370.

The Contractor will be paid for the realignment at the unit price bid per each crossing under the bid schedule item VERTICAL REALIGNMENT OF WATER MAINS. This item shall include all pipe, fittings, thrust blocks, trench excavation, backfill, compaction and surface restoration.

Backfill replacement on all storm sewer connector pipes in the roadway shall be Type B backfill, Standard Detail 200. The cost of the Type B backfill for the Roadway Connector pipes shall be included in the cost of the connectors pipe and no additional payment will be made. The cost of the Type B backfill for the storm sewer connector pipes shown with the storm sewer plans will be paid for separately as provided in the City of Phoenix Supplement.

.24 STORM SEWER CONSTRUCTION WITH CAST-IN-PLACE CONCRETE PIPE (SECTION 620):

Construction shall conform to MAG Standard Specification 620.

Cast-in-Place pipe will only be allowed in the areas designated on the Alternate Pipe Chart.

.25 IRON WATER PIPE AND FITTINGS (SECTION 750)

750.2 Ductile Iron Water Pipe: is modified to add:

Ductile Iron Pipe eighteen (18) inches and larger - A manufacturer's pipeline layout shall be submitted showing the line layout with each fitting specified and detailed. Numbering of each standard joint is not required.

Manufacturer's specifications and details on the proposed joint restraint method shall be submitted for review with the line layout. In all cases, the proposed method shall comply with the design requirements shown on the plans and be approved by the Water and Wastewater Department.

Where tangential outlets are shown on the plans tangential outlets shall be furnished.

Weld-on boss outlets are not acceptable.

.26 CONCRETE PRESSURE PIPE-STEEL CYLINDER TYPE (SECTION 758)

758.1 General: is modified to add:

All pipe shall be designed for 150 psi working pressure, test pressure 188 psi.

The pipe shall be designed to support the earth cover over the pipe as shown by the pipeline profiles on the plans. Where the earth cover over the pipe is less than eight (8) feet, the design shall be based on eight (8) feet minimum cover. When the plans show both existing and future surface profile, the critical cover shall be used for design purposes.

Earth loads on pipe shall be calculated assuming the pipe is installed in a positive projecting embankment condition. The loading for positive projecting embankment condition shall be derived using a product of the projection ratio and the settlement ratio of 0.5. The Ku factor shall be 0.150. The soil unit weight shall be 140 pounds per cubic foot.

Pipe reinforced with ring stiffeners will not be permitted.

Dimensions of fittings and specials shall conform to AWWA C-208.

Field joints for specials and fittings shall be as called for on the plans. Flanges shall be Class "D" steel ring flanges in accordance with AWWA C-207.

758.1 (A): change second paragraph to read:

Reinforced concrete pressure pipe may be furnished in pipe diameters of eighteen (18) inches through forty-two (42) inches.

758.1 (A): is modified to add:

The pipe shall be designed for the maximum stress to be encountered in place as indicated on the plans, whether it be internal pressure, external backfill load, H-20 truck load on the backfill, or any combination of loading.

The pipe shall be designed to limit the deflection of the pipe, in inches, under the external loads specified to not more than the square of the diameter of the pipe in inches divided by 4,000. Deflection shall be calculated by "Spangler's" formula using a bedding constant (K) of 0.100 and a modulus of soil reaction (E') of 1,000.

The pipe shall be designed for external loading based on a H-20 truck loading and impact factors recommended by AASHTO for highway truck loads in "Standard Specifications for Highway Bridges."

Immediately after the cement-mortar coating has been placed, the ends of each section of pipe shall be tightly capped with waterproof covers to prevent the escape of moisture when water curing. When steam curing, waterproof covers may not be necessary until completion of cure, provided prompt application of steam is begun. The waterproof covers shall become a component part of the completed pipe section, to protect the interior of the pipes, and shall remain on the pipe until it is installed in the trench.

758.1 (B): is modified to add:

Pipe may be either lined cylinder type or embedded cylinder type. Stress analysis of pipe shall be made using "Olander's" coefficients for a 120 degree bedding angle.

Except as otherwise provided in this Section, fabricated steel plate fittings and specials shall be designed for internal pressure only. The internal pressure design shall be based upon a design stress of 15,000 psi. The minimum steel plate thickness shall be 1/4 inch.

1. Outlets, where specified on the plans, with an internal diameter of less than one-half the diameter of the mainline pipe shall be installed on prestressed concrete cylinder pipe. Outlets with an internal diameter greater than one-half the diameter of the mainline pipe or thirty-six (36) inches shall be designed and manufactured as a separate fabricated steel plate fitting.
2. The exterior of fabricated steel plate fittings and specials shall not be mortar coated but shall be shop painted as provided in this Section.
3. All fabricated steel plate fittings and specials shall be encased in reinforced concrete as shown on the details in the plans.

At mainline valves where a steel plate section is required to comply with plans and/or attach a companion flange for connection to the valve, the following shall apply to such plate sections:

1. Design shall limit deflection to the square of the diameter in inches divided by 4,000 for pipe diameters less than sixty (60) inches. For pipe diameter sixty (60) inches and greater deflection is limited to one and one-half (1-1/2) percent of the diameter.
2. Unless otherwise specified, plate sections shall not be longer than one (1) foot.
3. Plate sections shall comply with all other applicable provisions, MAG Specifications, Phoenix Supplement to MAG and AWWA Standards.

758.2 Manufacture: is modified to add:

An affidavit of compliance as specified in Section 1.10 of AWWA C-301 and Section 1.11 of C-303 shall be furnished to the Engineer.

Cement used in manufacture of pipe shall conform to ASTM C-150, Type II, low alkali.

No concrete admixture shall be used except as approved in writing by the Engineer.

Liquid membrane-forming compounds shall conform to ASTM C-309, Type I, and shall be of such composition that after drying they will not impart taste or odor to water flowing through the pipe, nor will they contain any toxic materials. The use of such compounds shall be subject to the approval of the Engineer.

Rust inhibitors used for preventing rust on steel surfaces at holdbacks of mortar lining and/or coating shall be quick-drying material with good bonding properties to the steel, and shall be tack-free and smooth within four (4) hours after applying.

All joints shall be the Carnegie Bell and Spigot type with rubber gaskets. The joint rings for spigot ends for rubber gasket joints shall be Carnegie Shape M-3516, M-3818 or M-3836.

Openings, connections, and outlets shall be cement mortar lined and concrete coated as detailed on the plans.

### 758.3 Material Drawings: New Subsection

The Contractor shall furnish the Engineer with six (6) copies of shop drawings, pipe layout diagrams, manufacturer's catalog data, and detailed information, in sufficient detail to show complete compliance with all specified requirements, covering but not limited to the following items:

fabricated pipe and specials; design calculations; field closures; reinforcing steel and concrete mix designs.

The manufacturer's complete design calculations shall be submitted to the Engineer for review prior to the Joint Detail submittal.

The procedure outlined in American Water Works Association Manual M-9 will be used in determining the length of pipe requiring welded joints. Joint restraints design shall be based on test pressures. Shop drawing submittals shall include calculations showing the length of welded joints, tensile stress to be resisted by, and design welds and pipe longitudinal reinforcement. Minimum design parameters shall be as follows: Soil unit weight = 110 pounds per cubic foot, soil friction coefficient = .3, height of backfill over pipe = maximum four (4) feet or as shown on the plans; if less than four (4) feet. Throat thickness of welds shall be based on an allowable stress of 8,800 pounds per inch per inch of throat thickness using an E60 low-hydrogen electrode. The allowable stress in the steel cylinder shall not exceed 15,000 psi.

#### Shop Drawings and Line Layout

1. The manufacturer's pipeline layout shall be furnished together with standard details for review. The line layout shall show each standard pipe joint and each special joint or fitting by number. Manufacturer's standard details shall be furnished in sufficient detail to assure that the detail design of the pipe and specials will comply with the design concept and structural requirements of the project as presented in the Contract Documents. Full details of reinforcement, concrete, cement, mortar, joint dimensions, etc., for the straight pipe, specials and connections shall be furnished. Layout drawings shall show stations and the invert elevations of the pipeline.
2. Manufacturer's shop drawings shall be furnished for fabrication, inspection and record purposes in accordance with the "General Conditions". The manufactured pipe and specials shall conform to the approved standard details and shall meet all specified requirements unless otherwise approved in writing.

3. Valves and fittings to be incorporated in the pipeline shall be considered when preparing the pipeline layout.

758.4 Shop Inspection and Tests: New Subsection

A. Inspection

1. The City and its representatives shall have access to the work wherever it is in preparation or progress, and the Contractor shall provide proper facilities for access and for inspection during the manufacturing process.
2. Inspection by the City or its representatives, or failure of the City or its representatives to provide inspection, shall not relieve the Contractor of his responsibility to furnish materials and to perform work in accordance with this specification.
3. Material, fabricated parts, and pipe which are discovered to be defective or which do not conform to the requirements of this specification, will be subject to rejection at any time prior to final acceptance. Rejected material and pipe shall promptly be removed from the site of the work.

B. Test and Materials

1. In advance of manufacture of the pipe, the Contractor shall furnish the Engineer three (3) copies of the mill test certificate for all steel products incorporated in the pipe. Three (3) copies shall be furnished of mill test reports on each heat from which the steel is rolled.
2. Methods of Tests for Cement Mortars and Concrete

a. Mortar Lining

The mortar for all mortar lined pipe shall be sampled and molded by the following procedure:

The mortar sample shall be taken directly from the transfer bucket between the mixer and the charging trough which injects the mixed mortar into the spinning pipe. A sufficient amount shall be extracted to make four (4) 6" x 12" cylinders, and shall be placed in a wheelbarrow or other suitable container. The mortar sample material shall then be transported to the location at which the cylinder cans are to remain without moving for the next 24 hours.

The mortar shall be thoroughly mixed immediately prior to pouring into the cylinders in order to prevent segregation. After the mortar has been thoroughly mixed, it shall be poured in a continuous stream into the cylinder cans. The cans shall immediately be capped and allowed to remain without disturbing for twenty-four (24) hours.

b. Mortar Coating

Mortar for all mortar coated pipe shall be sampled by molding four (4) cylinders for compressive tests of the representative material being used to coat the pipe. The mortar sample shall be molded in 6" diameter cylinder in accordance with applicable provisions of ASTM D-558.

c. Curing of Test Cylinders

The curing of concrete, lining and coating cylinders for the first twenty-four (24) hours shall be the same as that for the pipe, except that the mortar for coating cylinders shall be covered with a piece of damp burlap to retard the drying out of the low moisture content of the mortar coating. At the end of twenty-four (24) hours, the cylinders shall be transported to a moist curing cabinet and cured in acceptance with ASTM C-192.

3. Strength of Cement Mortar Lining, Coating, Concrete and Steel

a. Mortar Lining

The average compressive strength, as per Section C below, of cylinders for mortar lining for the several types of pipe shall be as follows:

1. Semi-Rigid Pipe

Steel pipe and steel cylinder pipe, single wrap, pretensioned, the average compressive strength of cylinders shall be not less than 3000 psi at seven days and 4500 psi at twenty-eight days.

2. Rigid Pipe

Steel cylinder pipe prestressed, the average compressive strength of cylinders shall be not less than 3000 psi at seven days and 4500 psi at twenty-eight days.

b. Mortar Coating and Concrete Prestressed Pipe

1. Semi-Rigid Pipe

Steel pipe and steel cylinder pipe, single wrap, pretensioned, the average compressive strength of cylinders shall be not less than 3000 psi at seven days and 4500 psi at twenty-eight days.

- c. To conform to these requirements ("a" and "b" above), the average of any five (5) consecutive strength tests of the laboratory cured specimens shall be equal to or greater than the specified strength, and not more than 20% of the strength test shall have values less than the specified strength. If any one cylinder falls below 80% of the specified strength at seven days, an extra cylinder from the same batch shall then be broken, and if the strength of this cylinder also falls below 80% of the specified strength, then the entire production represented by these cylinders will not be accepted for use until the results of the twenty-eight day test is known, and if it also falls below 80% of the specified strength, the above non-acceptance will become final. The expense of the required tests of cylinders and of testing the welds shall be borne by the Contractor and shall be performed by the Engineer or his duly authorized representative. The cost of cutting and matching metal test specimens shall be borne by the Contractor.

d. Testing of Steel Pipe Cylinders (Hydrostatic Pressure Test)

Each steel pipe cylinder, prior to embedment in cement mortar, or concrete, shall be hydrostatically tested under a water pressure which stresses the steel to a unit stress of at least 22,000 psi after the bell and spigot ends have been welded in place. The tests shall be performed with rubber gaskets in place, utilizing companion bell and spigot test heads. While under this stress, the welded seams shall be hammered vigorously at one foot intervals with a one pound sledge hammer, and shall be thoroughly inspected.

All parts of the cylinder showing leakage shall be marked for rewelding. After rewelding, such cylinders shall be subjected to another hydrostatic test as stipulated above. The costs of hydrostatic pressure test shall be at the Contractor's expenses.

e. Testing of Fitting and Specials

The seams in angle pipe, short-radius bends and special fittings shall be welded in two or more passes, and each weld tested for tightness by the air-soap method or by the dye-penetrant method. However, if the fitting is fabricated from cylinders which have been previously tested hydrostatically, no further test is required for seams so tested. Hydrostatic testing of fittings to 150% of design operating pressure may replace the tests described above. Any defect revealed under any of the alternate test methods shall be rewelded, and the weld tested again. The cost of these tests shall be at the Contractor's expense.

758.5 Marking, Handling and Delivery: New Subsection

A. Marking

Identification markings, for each type of water pipe as specified herein, shall be placed on the pipes. These markings shall show the proper location of the pipe or special in the line by reference to layout drawings. All bends shall be marked on the ends with the angle of deflection and the plane through the axis of the pipe. All beveled pipe shall be marked with the amount of the bevel, and the point of maximum bevel shall be marked at the end of the spigot.

B. Handling and Delivery

All pipe shall be manufactured, handled, loaded, shipped, unloaded and stored at the job site in such a manner as to prevent any damage to the pipe. Any pipe section that becomes damaged shall be repaired as directed by the Engineer if, in his opinion, a satisfactory repair can be made. Otherwise, it shall be replaced with an undamaged section, at the Contractor's expense. Lifting from the inside of the pipe will not be permitted.

.27 RECOMMENDED CONSTRUCTION PHASING AND SEQUENCING:

A recommended sequence of construction and phasing is shown on the project plans. If the Contractor plans to deviate from the phasing and sequencing shown, he shall submit his plan in writing to the Engineer and shall not proceed until such plan is approved by the Engineer.

Work in any phase may be done in sequential manner and simultaneously with other phases upon written approval of the Engineer.

.28 UTILITY CONFLICTS:

DESCRIPTION:

In the event of an unanticipated conflict with underground utilities during construction, the conflict shall be resolved in accordance with MAG Subsection 105.6 and City of Phoenix Supplements Subsections 610.4.1, 610.4.2, and 615.6.

Where sanitary sewer lines (vitrified clay pipe 12 inches or smaller) cross the mainline construction, the Contractor shall permanently support the sanitary sewer line per MAG Detail 403.

Any waterline shutdowns requested by the Contractor for the Contractor's convenience, shall be paid for by the Contractor at the prevailing rate set by the Water and Wastewater Department. This is a non-pay item. This work shall be coordinated with Water Distribution, 262-4711. The Contractor must apply and pay for shutdowns at Water and Wastewater Technical Services, at 455 North 5th Street.

.29 CONCRETE BARRIER:

DESCRIPTION:

The work under this section shall consist of furnishing all materials and constructing Portland Cement Concrete barriers at the locations shown on the project plans and in accordance with the details shown on the plans and the requirements of Section 910 of the State of Arizona Department of Transportation, Standard Specifications for Road and Bridge Construction, Edition of 1987.

MEASUREMENT AND PAYMENT:

Measurement and payment for this item will be per linear foot of barrier installed in accordance with the plans and details including barrier markers, as detailed on the plans, reinforcing steel and anchoring into the shoulder portland cement concrete pavement. Impact attenuators will be paid for separately.

.30 IMPACT ATTENUATORS:

DESCRIPTION:

The work under this item shall consist of furnishing all materials and constructing Impact Attenuators at the locations shown on the plans and in accordance with the Details shown on the plans and the requirements of (or equal to) the G.R.E.A.T. System Guard Rail Energy Absorbing Terminal with Hex-foam Cartridge as described in the G.R.E.A.T. System Design Manual and Addendum, and the manufacturer's detail drawings, published by Energy Absorption Systems, Inc., 860 South River Road, West Sacramento, California,

95691, (916) 371-3900. The Contractor shall submit shop drawings for approval. The impact attenuator may require minor changes or adjustments in the field. The cost for these adjustments shall be included in the unit price bid.

MEASUREMENT AND PAYMENT:

Impact Attenuators shown on the plans and in the proposal will be measured as one unit per total installation including concrete pad under the attenuator. Adjacent Valley gutters will be paid for separately. Payment will be made in accordance with the unit prices set forth in the proposal.

.31 NOISE BARRIER WALL:

DESCRIPTION:

The work under this section shall consist of furnishing all materials and constructing noise barrier walls at the locations shown on the plans in accordance with the details shown on the plans and the requirements of this Section.

Concrete shall be Class A conforming to the requirements of MAG Standard Specifications for Section 505, Reinforcing steel shall conform to the requirements of MAG Standard Specifications for Section 727. Rustication shall be as specified in the drawings.

ALTERNATE DESIGN:

The noise barrier walls as shown in the plan and described in these Special Provisions are for a cast-in-place concrete wall. If the Contractor elects, he may submit to the City for approval an alternate design for a pre-cast concrete wall.

The alternate design shall be in accordance with the requirements of the MAG Standard Specifications and City of Phoenix Supplement, and in accordance with the requirements for load factor design, 1983 AASHTO Specifications and interim specifications through 1986.

In addition to the requirements as specified above, the additional requirements for the alternate design shall meet the following criteria:

1. Design wind load 100 MPH wind velocity.
2. Design to withstand 10 KIP impact load at 2.8 feet above ground line.
3. Ground line differential loading of maximum 4-1/2 feet.

The alternate design shall be submitted to the City 30 days prior to commencing work on the noise barrier wall.

Factors to be evaluated in review and approval or disapproval by the City of an alternate design will include, but not be limited to: cost, compatibility with surroundings, input from the Squaw Peak Parkway Ad Hoc Citizen Review Committee and effects on noise barrier wall design for other segments of the parkway. If an alternate design is approved, any additional design and construction costs to modify other project items such as landscaping, landscape irrigation, etc., will be paid by the Contractor.

MEASUREMENT AND PAYMENT:

Measurement of this work will be made by the Square foot of noise barrier wall constructed and will be measured longitudinally along the front face of wall and vertically from the top of footing to top of wall.

Payment for this work will be made at the contract price per square foot, which price shall be full compensation for the items complete, including necessary excavating, backfilling and footings, as described and specified herein and on the project plans.

.32 WROUGHT IRON FENCE:

DESCRIPTION:

Wrought iron fence shall consist of furnishing all materials and constructing fence and gates of steel, including posts and foundations. Wrought iron fence shall be fabricated, installed and painted black in color in accordance with the details shown on the plans and these specifications.

FABRICATION:

Prior to beginning any work on the fabrication of the fencing, the Contractor shall submit shop drawings for approval, showing complete fencing details including gates line, terminal and gate post locations and spacing.

Materials furnished for wrought iron fence shall be square steel tubing and shall conform to ASTM standards for tubular sections of hot rolled mild steel. The following minimum sizes shall be used:

| <u>Item</u>           | <u>Outside Dimension</u> | <u>Wall Thickness</u> |
|-----------------------|--------------------------|-----------------------|
| Line Posts            | 2" x 2" Galvanized       | 14 Gauge              |
| Terminal & Gate Posts | 2" x 3" Galvanized       | 11 Gauge              |
| Fence Rails           | 2" x 2" Black            | 14 Gauge              |
| Pickets               | 1" x 1" Black            | 16 Gauge              |

Line, terminal and gate posts shall be galvanized in accordance with the requirements of MAG Standard Specifications Section 771 unless otherwise specified.

Each post, rail, picket and section shall be:

- (1) Cleaned of oil, grease, etc., using Del Chemical's "Del's Grime Fighter" or approved equal.
- (2) Primed with Lupton Zinc Chromate Primer #171 or approved equal. Minimum dry film thickness - 2 MLS.
- (3) Painted by dipping in a dip tank containing Lupton Satin Black #170 or approved equal. Minimum dry film thickness - 1.8 MILS.

All painting shall be performed in conformance with MAG Standard Specification Section 530.

Gates shall be double-swing gates providing a clear opening of 12-feet. A heavy duty padlock hasp shall be provided near the center of each gate. Padlocks will be furnished by the City.

Welding shall be performed by the electric arc process and shall be done in conformance with Specifications for Welded highway and Railway Bridges of the American Welding Society. All but welds on exposed surfaces shall be ground flush with adjacent surfaces.

Fence panels shall be straight and true to dimensions.

ERECTION:

The wrought iron fence shall be carefully erected, true to line and grade. Posts, pickets and rails shall be vertical and parallel from the vertical for the full height of the panel not exceeding 1/8-inch. After erecting the fence, any abrasions or exposed steel shall be repaired in accordance with MAG Standard Specification Section 771 or Section 530.

MEASUREMENT AND PAYMENT:

- (1) The wrought iron fence will be measured by the linear foot from end to end along the face of the railing including gates and terminal sections.
- (2) The price paid per linear foot for fence shall include full compensation for furnishing all labor, materials, tools, and equipment and doing all work involved, including foundations, in constructing the fence in place as shown on the plans and as specified herein.

.33 TRAFFIC MARKINGS AND STRUCTURES:

DESCRIPTION:

The work under this section shall consist of furnishing all materials and constructing the following items:

- Sign Installation
- Painted Marking
- Thermoplastic Marking
- Preformed Plastic Pavement Markings
- Pavement Markers
- Obliterate Pavement Marking
- Remove Pavement Markers

The items shall be at the locations shown on the project plans and in accordance with the details, requirements and referenced specifications shown on the plans, or to the requirements of Sections 606, 608, 609, 701, 704, 705, and 706 of the State of Arizona, Department of Transportation (A.D.O.T.) Highways Division Standard Specifications for Road and Bridge Construction, Edition of 1987. Sign Panels (A.D.O.T. 608) will be furnished by the city and installed by the Contractor.

MATERIALS

Pavement Marking Paint

Paint for striping shall be white or yellow as called for on the project plans.

Paint shall be produced by a manufacturer who is recognized as being regularly engaged in the production of paint specifically formulated for use in striping pavement.

If at any time the Engineer determines that certain characteristics of the paint, such as weight per gallon, viscosity, or drying time are such that singly, or in combination, the paint is not acceptable, he will order the contractor to furnish paint which will produce striping which is satisfactory.

Glass beads for use with pavement marking paint shall conform to the requirements of the current ADOT Specifications for Glass Reflectorizing Beads.

#### Adhesive for Pavement Markers

Adhesive for pavement markers shall be a bituminous adhesive especially made for installing raised pavement markers as approved by the Engineer.

Epoxy adhesive shall not be used.

#### MEASUREMENT AND PAYMENT:

Measurement and payment for this work shall be on the basis of units called out in the proposal and as described below for completion of the work as indicated in the project plans, details and all referenced requirements and specifications.

#### (A) Sign Installation: (A.D.O.T. 606)

- 1) Overhead and ground mount sign structures will be measured by the unit of each type or types of sign structures furnished and erected.

Foundations for the sign structures will be measured by the unit of each type or types of foundations constructed.\

- 2) The accepted quantities of various types of overhead and ground mount sign structures and foundations, measured as provided above, will be paid for at the contract unit prices complete in place.

The contract unit price paid per unit for each type and size of sign structure designated in the bidding schedule shall include full compensation for furnishing all labor, materials, tools, equipment and incidentals, and for doing all the work involved in furnishing and erecting the sign structures complete in place, including painting, galvanizing if necessary, furnishing and placing nonshrink grout, installation of City furnished sign panels,

furnishing tapered tube sign mounting brackets, decorative cover plates and all necessary hardware except for anchor bolts which are considered as part of the foundations, all as shown on the plans and as specified in these specifications.

The contract unit price paid per unit for each type of sign structure foundation designated in the bidding schedule shall include full compensation for furnishing all labor, materials, tools, equipment and incidentals, and for doing all the work involved in constructing foundations, complete in place, including steel reinforcement, furnishing and installing anchor bolts, all necessary excavation and disposing of excess excavated material, all as shown on the plans and as specified in these specifications.

(B) Painted Marking: (A.D.O.T. 701)

- 1) Painted pavement stripes will be measured by the linear foot along the centerline of the pavement stripe and will be based on a four inch wide stripe. Measurement for striping with a plan width greater or less than the basic four inches as shown on the plans or directed by the Engineer will be made by the following method:

$$\frac{\text{Plan Width of Striping (inches)} \times \text{Linear Feet}}{4 \text{ (inches)}}$$

No measurement will be made of the number of linear feet of skips in the dashed line.

- 2) The accepted quantities of painted pavement markings of the type specified in the bidding schedule, measured as provided above, will be paid for at the contract unit price, complete in place, including pavement surface preparation.

(C) Thermoplastic Marking: (A.D.O.T. 704)

- 1) Thermoplastic pavement stripes will be measured by the linear foot along the centerline of the pavement stripe and will be based on a four inch wide stripe. Measurement for striping with a plan width greater or less than the basic four inches as shown on the plans or directed by the Engineer will be made by the following method:

$$\frac{\text{Plan Width of Striping (inches)} \times \text{Linear Feet}}{4 \text{ (inches)}}$$

No measurement will be made of the number of linear feet of skips in the dashed line.

Thermoplastic pavement symbols and legends will be measured by each unit applied. Each pavement symbol and each legend, as shown on the plans, will be considered a unit.

- 2) The accepted quantities of thermoplastic pavement markings of the type specified in the bidding schedule, measured as provided above, will be paid for at the contract unit price, complete in place, including pavement surface preparation.

(D) Preformed Plastic Pavement Markings: (A.D.O.T. 705)

- 1) Measurement of preformed reflectorized plastic pavement arrows and legends will be made for each arrow or legend, as shown on the plans, furnished and applied in accordance with the requirements specified herein and on the plans.

Measurement of preformed reflectorized plastic pavement lines will be made by the linear foot along the centerline of the pavement line and will be based on a four inch wide stripe. Measurement for pavement lines with a plan width greater or less than the basic four inches will be made by the following method:

$$\frac{\text{Plan Width of Striping (inches)} \times \text{Linear Feet}}{4 \text{ (inches)}}$$

- 2) The accepted quantities of preformed reflectorized plastic pavement markings, measured as provided above, will be paid for at the contract unit price for the type specified in the bidding schedule, which price shall be full compensation for the item completed in place, including necessary pavement cleaning.

(E) Pavement Markers: (A.D.O.T. 706)

- 1) Pavement markers of the type specified on the project plans will be measured as a unit for each marker furnished and placed.
- 2) The accepted quantities of pavement markers, measured as provided above, will be paid for at the contract unit price, for the type designated in the bidding schedule, complete in place, including the bituminous adhesive and surface preparation.

(F) Obliterate Pavement Markings: (A.D.O.T. 701)

- 1) Obliterate Pavement Marking, will be measured by the linear foot of marking obliterated regardless of width.

2) Obliterate Pavement Marking, measured as provided above, will be paid for at the contract unit price per linear foot which price shall be full compensation for the item including furnished all labor and equipment required and restoring the pavement surface to a condition deemed suitable by the Engineer.

(G) Remove Pavement Markers: (A.D.O.T. 701)

1) Remove Pavement Markers will be measured by the linear foot of markers removed regardless of type, measured from the center of the last marker removed along any continuous segment. A space of more than 10-feet between markers will render any segment as noncontinuous. A single marker by itself will be considered as 1-foot long.

2) Remove Pavement Markers, measured as provided above, will be paid for at the contract unit price per linear foot, which price shall be full compensation for the item including furnished all labor and equipment required and restoring the pavement surface to a condition deemed suitable by the Engineer. Epoxy residue shall not be allowed to remain over 1/8-inch above the pavement surface. If removal of the markers causes pitting or spalling of the pavement surface deeper than 1/4-inch, the Contractor shall patch the pavement to the satisfaction of the Engineer.

.34 COLOR COATING

DESCRIPTION

A color coating shall be applied above one foot below finished ground surface to all exposed surfaces of concrete structures, that can be seen by the traveling public, pedestrians and neighborhood residents. These surfaces shall includes both sides and the top of noise walls and the sides and bottoms of concrete bridge box girders, piers, ramps, walls and abutments. Roadway surface, curbs, gutters, curb openings, islands and sidewalks are excluded.

MATERIALS

The color coating shall be a semi-opaque colored toner containing only methyle methacrylate-ethyl acrylate copolymer resins, inorganic oxide toning pigments suspended in solution at all times by a chemical suspension agent and solvent, and shall conform to the following:

|           |  |
|-----------|--|
| Solids    | Not less than 21 percent by volume.                        |
| Viscosity | 150 to 500 cps when tested in accordance with ASTM D 2196. |

Solvent                      Hydrocarbon base tested by MIR infrared spectrograph.

Water Content              Not more than 1.00 percent by volume.

There shall be no settling or color variation. Use of vegetable or marine oils, paraffin materials, stearates or organic pigments in any part of coating formulation will not be permitted. The coating material shall weigh at least 8.3 pounds per gallon.

The color coating shall approximate that of paint No. 20318 as specified by Federal Standard 595a or alternate color as directed by the Engineer.

The recessed patterns on the facia of the bridges at Osborn Road and Indian School Road shall receive a darker color coating than the other concrete surfaces throughout the job. The color shall approximate that of paint no. 20059 as specified by Federal Standard 595a or alternate color as directed by the Engineer.

#### SAMPLES

The Contractor shall furnish a preliminary sample of concrete with the required colored coating applied. The sample shall be 2 feet by 2 feet and the concrete shall have a surface similar in pattern and texture of that to be used on the work. The coating shall be applied by the same methods as will be used to coat the wall panels on the work.

After a preliminary sample has been approved, a final sample shall be furnished measuring at least 4 feet by 10 feet. It shall be prepared as specified hereinbefore for the preliminary sample and shall be placed at the project site and left for three weeks for observation. No work shall be accomplished until a final sample has been approved by the Engineer.

All concrete shall be finished and cured in accordance with the requirements of the specifications prior to the application of the coating material.

Within 24 hours before the coating material is to be applied, the concrete surfaces to be coated shall be lightly sandblasted to remove dirt, curing agents, form release agents, or other foreign substances which could be detrimental to coating penetration or color. All concrete surfaces to be coated shall be clean, completely dry, and free of frost or other foreign substances at the time of the application of both the first coat and the second coat.

The coating material shall be applied in two coats by spray, brush, or roller, at the option of the Contractor. Each application shall be at the approximate rate of one gallon per 150 square feet. The second coat shall not be applied until thorough solvent release has been achieved for the first coat.

The coating material shall be applied at an ambient temperature of from 40 degrees F. to 90 degrees F. Should ambient temperatures consistently exceed 90 degrees F., manufacturer's recommendation for application at higher temperatures shall be followed.

#### MEASUREMENT AND PAYMENT

No separate measurement will be made for this work. Payment will be included in the contract price for retaining wall, concrete noise walls and the bridges.

#### .35 DEMOLITION OF BUILDINGS

The Contractor shall demolish the existing buildings shown on drawings at the location designated.

The Contractor shall accept the premises as found. The City of Phoenix shall assume no responsibility for the condition of the buildings on the site or continuation in condition existing at the time of Proposal Invitation or thereafter. The Contractor shall assume all risk regarding damage or loss, whether by reason of fire, theft, or other casualty or happening to the specified buildings from the "Notice to Proceed" date and thereafter. No such damage or loss shall relieve the Contractor from his contract obligations to complete the work.

The Contractor shall plug all sanitary sewer lines leading from the buildings to be demolished. The Contractor shall contact the Water Department (262-6365) to turn off water services and to remove water meters. The Contractor shall contact the appropriate utility companies to disconnect gas, electric and telephone services.

The Contractor shall promptly remove all building materials and debris resulting from demolition as it accumulates. Material shall not be stored on site or in the right-of-way. Any salvaging operations must be performed at another site away from the demolition/construction area. No burning of any debris will be allowed on site. If the Contractor fails to remove excess debris promptly, the Engineer reserves the right to cause same to be removed at Contractor's expense.

Particular attention and adherence must be made to applicable portions of Part 13 of the City of Phoenix, Construction Code, as amended. The method of demolition must be approved by the Building Official and the Engineer.

A general description of the building at the site is as follows:

Measurement and payment shall be for the job and shall include complete demolition of all existing buildings, including floor slabs, basement structures, footing, pipes etc., plugging sewer taps, clearing the site at the area designated on the plans, including all fences, walls, planter boxes and complete removal of all miscellaneous structures and debris from the site.

.36 WATERLINE RELOCATION

Excavation, Backfill, and Compaction for Waterline Relocation and/or Adjustment.

In the event of an unanticipated conflict with existing waterlines, excavation and backfill for relocating waterlines by the Water and Wastewater Department shall be a contingency item. Payment will be made only for the lengths of trench excavated and backfilled for relocated waterlines at the unit price set in the Bid Proposal.

.37 STORM SEWER PIPE SIZE OPTION

The Contractor may substitute the next larger multiple of 6-inch size storm sewer pipe for the intermediate 3-inch size pipes shown on this project at his discretion. The cost of the increase in size shall be borne by the Contractor. The intermediate 3-inch size pipe will remain in the proposal as the required size. If the Contractor elects to use the next larger multiple of 6-inch size pipe he shall be responsible for any utility or any other conflict caused by the increase in the size of the pipe. There shall be no extension of time granted for any delay caused by these conflicts.

.38 STORM SEWER CONSTRUCTION MATERIAL AND LAYOUT SUBMITTALS

Prior to the manufacturing of the pipe, the Contractor shall submit material and layout drawings to the Engineer in accordance with the procedures contained in the City of Phoenix Supplement, latest edition.

Submittals shall show layout, stationing, laying length of all pipe, D-load or gauge thickness, detailed drawings of any pipe used to construct a curve, and other pertinent data. Fabrication drawings shall be submitted for concrete pipe. Catch basin connector pipe need not be included in the pipe layout, however, pipe stubs shall be included. In lieu of including catch basin connector pipe in the pipeline layout, a list of catch basin connector pipe shall accompany the layout. The connector pipe list shall contain the following information:

- A. Inside diameter and type of material to be used. (R.C.P., C.S.P.)
- 1) If R.C.P. is used for connector pipe, the D-load rating shall be shown.
  - 2) If C.S.P. is used for connector pipe, the gauge shall be shown.
- B. Station at which pipe joins mainline.
- C. Number of sections of pipe and laying length of sections.

.39 STORM SEWER CROSSING UNDER - INCH AND - INCH WATERMAINS

Storm sewers cross under large transmission watermains at locations tabulated below which must remain in service.

| <u>Storm Pipe Crossing Station</u> | <u>Approximate Watermain Skew</u> | <u>Watermain Size</u> | <u>StormSewer Size</u> |
|------------------------------------|-----------------------------------|-----------------------|------------------------|
|                                    | (need locations)                  |                       |                        |

The Contractor shall support the exposed watermain in a manner that will not disrupt operations and construct a pipe support system during backfill operations as called for on the drawings.

As an option, at no change in price, the Contractor may elect to jack and bore under the watermain for an appropriate length depending on trenching conditions.

The Contractor shall submit shop drawings of the support system for the watermain or jack and bore procedure and length depending on trench conditions encountered for approval by the Engineer, prior to ordering material or implementing the work.

There shall be separate measurement and payment for each of these crossings. Measurement shall be for the job lump sum over and above the price per linear foot for the storm sewer installation to install the storm sewer under the watermain including the permanent utilities support as called for on the plans.

Payment will be made at the lump sum price for STORM SEWER UNDERCROSSING STATION as shown in the proposal for the job complete including excavation, backfill, compaction, pipe supports (temporary and permanent), all labor and materials to install the storm sewer under the watermain without disturbing watermain operation.

The undercrossing of all other pipes while maintaining their function shall remain the responsibility of the Contractor. The costs of the undercrossing of all other existing pipes and utilities shall be included in the bid price of the new pipe installation in accordance with the MAG Standard Specifications.

.40 TEMPORARY TRAFFIC SIGNALS AND STREET LIGHTING:

Description:

This work shall consist of furnishing, installing, maintaining, and removing three temporary traffic signal and temporary lighting installations as shown on the project plans at the following intersection location:

o 19th Street/Glendale Avenue

The work shall include relocation of the traffic signal controller and cabinet, wood poles, foundations as required, span wire and tether wire with accessories, signal heads, street lighting luminaires, mast arms, electrical service, pull boxes, all cable and wiring as necessary.

A new controller and cabinet will be supplied by the City of Phoenix and installed for temporary signal #3.

Materials:

Poles:

Wood poles shall conform to subsection 731-2.03 of the A.D.O.T. Standard Specifications.

Mast arms to support luminaires and their connections to the wood poles shall be submitted to the Engineer for approval.

The poles shall be erected at locations shown on the plans.

Span Wire and Tether Wire:

The span wire shall be of 3/8 inch nominal diameter, 7-strand, zinc-coated steel wire conforming to ASTM A 475, utilities grade, having a minimum breaking strength of 11,500 pounds. The tether wire shall be 1/4-inch nominal diameter. The span and tether wire shall be installed in accordance with the details shown in the project plans.

Span Wire Accessories:

The components of span wire accessories shall meet the following requirements, and with the exception of nylon cable hanger, shall be galvanized in accordance with AASHTO M 232:

Thimble-eye Bolts, Nuts and Washers. The thimble-eye bolts and nuts shall be 5/8 inch nominal diameter and conform to ASTM A 307.

3-Bolt Clamps. The 3-bolt clamps shall have a minimum breaking strength of 11,500 pounds.

Split Clamps with Thimble-eye Connections. Split clamps with thimble-eye connections shall have a minimum breaking strength of 11,500 pounds.

Split Clamps with S-Hook Connections. Split clamps with S-hook connections shall have a minimum breaking strength of 5,000 pounds.

Automatic Compression Type Clamps. Automatic compression type clamps for 3/8" diameter span wires shall have a minimum capacity of 11,500 pounds. Automatic compression clamps for 1/4" inch diameter tether wires shall have a minimum capacity of 5,000 pounds.

Dead Ends. The dead-ends shall be made of the same materials and shall have at least the same minimum breaking strength as the span wire or tether wire to which they are attached.

Cable Hangers. The cable hangers shall be made of nylon or steel.

The span wire accessories shall be assembled and installed in accordance with the details shown in the project plans.

Traffic and Pedestrian Indications and Accessories:

The signal indications and mounting assemblies shall conform to the requirements of the A.D.O.T. Standard Specifications.

All signal and pedestrian heads shall be equipped with necessary mounting equipment.

All pedestrian signal heads shall be neon type - 20 watt.

All pedestrian signals shall display international "Hand/Man" symbols.

Traffic Signal Controller/Cabinet and Load Center Cabinet:

The existing controller/cabinet and load center cabinet at the project intersection (19th Street/Glendale Avenue) shall be utilized for temporary traffic signals #1 and #2. The contractor shall modify the controller to provide the operation specified by the Engineer to conform with construction activities. No modifications shall be done without the written permission of the Engineer. The contractor shall coordinate with the Engineer on all such work.

Luminaires:

The luminaires shall conform to the Requirements of Section 736 of the A.D.O.T. Standard Specifications and these special provisions.

The luminaires shall be 250 watt, high pressure sodium luminaires of the horizontal burning type. The light distribution shall be Type III cutoff. The lighting circuits shall be connected to the existing load center circuitry and photo cell.

#### Construction Requirements:

At the preconstruction conference the contractor shall submit detailed drawings indicating location, construction details and type of equipment proposed for use, for approval by the Engineer.

After written approval has been issued by the City of Phoenix, the contractor shall install temporary signals and highway lighting as required to meet the construction schedule. The contractor shall notify the Engineer at least 48 hours in advance when the temporary signal and highway lighting installation is ready to be energized. Upon approval of the installation by the Engineer, the maintenance of the temporary signal and street lighting installation, including all energy charges, shall become the responsibility of the contractor until removal is directed by the Engineer.

The contractor shall be responsible for maintaining the signals and street lighting in proper operating condition. Any damage to the temporary traffic signal and street lighting installation from any cause whatsoever shall be repaired by the contractor at his own expense. If, at any time, the contractor fails to perform any work deemed necessary by the Engineer to keep the temporary traffic signals and street lighting in proper operating condition, the Engineer may have the needed work performed by others. The cost of such work will be deducted from the amount due the contractor.

The contractor shall remove the temporary traffic signal and temporary street lighting installation when notified to do so by the Engineer. All salvageable material such as the controller and cabinet, signal heads, luminaires, mast arms, poles and hardware shall become the property of the City of Phoenix and shall be removed without damage, and shall be stored by the contractor as directed by the Engineer. The contractor shall be held responsible for the safekeeping of all salvageable materials until they are received by the City of Phoenix. The contractor shall repair or replace at his own expense any material or equipment damaged, stolen or otherwise lost prior to receipt by the City of Phoenix. The contractor shall be responsible for proper disposal of unusable material. Any holes resulting from removal of the poles shall be backfilled and compacted by the contractor.

#### Method of Measurement and Basis of Payment:

The three signal installations will be paid at the contract lump sum price for TEMPORARY TRAFFIC SIGNALS AND HIGHWAY LIGHTING, which price shall be full compensation for the item complete, including maintenance, energy costs and removal when directed, all as described and specified herein and on the project plans.

.41 SALT RIVER PROJECT IRRIGATION RELOCATIONS

.42 SPECIFICATION FOR HIGHWAY LIGHTING

Additional specifications (HL series) for highway lighting are included in these contract documents.

.43 SPECIFICATIONS FOR LANDSCAPING

Additional specifications (LI series) for landscaping are included in these contract documents.

.44 SPECIFICATIONS FOR GENERATOR AND PUMP CONTROL BUILDING AND STORM WATER PUMP STATION

Additional specifications (GPS series) for generator and pump control building and storm water pump station are included in these contract document.

.45 SPECIFICATION FOR BRIDGES

Additional specifications (BR series) for bridges are included in these contract documents.

**SQUAW PEAK PARKWAY  
SEGMENT 5B  
LIGHTING  
SPECIAL PROVISIONS**

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CHAPTER 1

LIGHTING SPECIFICATIONS FOR SQUAW PEAK PARKWAY

1.0 Scope of Work

General:

The work as specified herein and shown on the Project Plans shall consist of furnishing all materials, labor, and services to complete a functional highway and area lighting systems. Included is the furnishing and installation of conduit, pull boxes, conductors, foundations, load centers, poles, mast arms, luminaires, junction boxes, and all appurtenances necessary for the operations of highway and ramp lighting, underdeck lighting, area lighting, pedestrian tunnel lighting and electrical services to irrigation controllers.

All materials shall be new.

All work shall be done in compliance with applicable codes and regulations, these Special Provisions and the Arizona Department of Transportations (ADOT) Standard Specifications for Road and Bridge Construction 1987 Edition.

1. Scope:

BETHANY HOME ROAD OVERPASS PORTION OF WORK

1. Install junction boxes, conduit conductors, anchor bolts, mounting bracket and fixtures for underdeck lighting for Bethany Home Road.
2. Install conduits, junction boxes, and anchor bolts for traffic signals.
3. Install conduits, junction boxes, conductors, anchor bolts, poles, mast arms, fixtures and all else which is necessary for mainline lighting on this structure.
4. Make all necessary connections and install in-line fuses.
5. Payments: All items cast in concrete on this structure will be included in the cost of the structure (conduit, J-Boxes, Anchor Bolts) all other items will be included under their respective bid items.

CANAL BRIDGE PORTION OF WORK

1. Install junction boxes, conduit, conductors, anchor bolts, mounting bracket, fixtures, and other miscellaneous electrical gear necessary to light the north maintenance road.

2. Install conduits, conductors, anchor bolts, junction boxes, poles, mast arm, fixtures and all else that is necessary for mainline roadway lighting which is necessary on this structure.
3. Make all necessary connections and install all in-line fuses.
4. Payment: All items cast in concrete on this structure will be included in the cost of the structure, all other items will be paid for under their respective bid items.

GLENDALE AVENUE UNDERPASS

1. Install junction boxes, conduit, conductors, anchor bolts and fixtures necessary for all the underdeck lighting of the mainline. Make all necessary connections and install in-line fuses.
2. Install conduit, hangers and expansion fittings for Arizona Public Service Street Lighting conduit crossing of the structure on Glendale Avenue.
3. Install conduits, hangers, anchor bolts, junction boxes and expansion fittings for traffic signals and lighting on Glendale Avenue structure.
4. Payment: All items cast in concrete on this structure will be included in the cost of the structure. All other items will be paid for under their respective items.

PEDESTRIAN TUNNELS PORTION OF WORK

1. There are three pedestrian tunnels on this Projects Maryland, South of Canal Bridge (South Maintenance Road and Equestrian Trail) and Myrtle Wash Trail. Each tunnel will be illuminated 24 hours a day.
2. Install all conduits, junction boxes, anchor bolts, conductors, fixtures, cabinets, and electrical gear necessary for the lighting and electrical service for each pedestrian tunnel.
3. The fixtures for the Myrtle Wash Tunnel shall be waterproof.
4. All inside lighting and electrical work for these three pedestrians tunnels will be paid for under a lump sum price item, one for each tunnel.

## MAINLINE LIGHTING

1. Install all conduit, junction boxes, pull boxes, conductors foundations, poles, mast arms, fixtures, load centers and other miscellaneous items necessary for the lighting of the Squaw Peak Parkway from just south of Bethany Home Road to just north of Myrtle Wash.
2. Perform all necessary tests of conductors and fixtures.
3. Energize circuits.
4. All mainline lighting items will be paid for under their respective payment items except for those items cast in concrete structure (bridges) or foundations in retaining walls, soundwalls, and Jersey Barrier.

## OTHER LIGHTING WORK

1. Install all conduits, conductors, pull boxes, foundations, poles, mast arms and fixtures necessary for all area lighting on this project.
2. Install all conduits, pull boxes and conductors necessary to provide electrical service to the irrigation controller.
3. Install all conduits, pull boxes, ground rods and special backfill for APS Street Lighting. APS will supply pull boxes.

## 2. QUALITY OF MATERIALS

1. Electrical equipment and luminaires shall meet the standard and bear labels of Underwriter Laboratories (UL) and the National Electrical Manufacturer's Association (NEMA).
2. All materials shall conform to Division VII "Traffic Control Facilities" of the ADOT Standard Specifications for Road and Bridge Construction, 1987 Edition.
3. Equipment and apparatus installed in an outdoor application shall have NEMA 3K Rating unless specified otherwise.
4. Workmanship shall be from craftsmen in their trade, use of unskilled labor shall be considered grounds for rejection of the work.

## CHAPTER 2

### HIGHWAY LIGHTING

#### 2.01 GENERAL SPECIFICATIONS FOR HIGHWAY LIGHTING

All materials and equipment shall conform to these specifications, Sections 730 and 737 of ADOT Standard Specifications plans and special provisions. The poles, hardware, lighting fixtures, ballasts and all other items shall be manufactured and tested in accordance with: ASTM, ASA, AWS, UL, NEC, and NEMA.

a. Anchor Bolts:

1. Anchor bolts shall conform to Section 731-2.02(G) on page 454 of ADOT Specifications.

b. Slip-Away Base:

1. Slip base shall conform to Section 731-2.02(E).

c. Lighting Poles and Mast Arms:

1. Lighting poles and mast arms shall conform to all applicable requirements of Section 731 - Structural Supports and Foundations for Traffic Signal and Highway Lighting of ADOT Standard Specifications.

d. Pole Installation:

1. Poles shall not be erected until the foundation concrete has set at least 14 days. The pole shall be plumbed or raked as directed by the Engineer.

#### 2.02 SPECIFICATIONS FOR LOAD CENTER CABINETS

- a. General - The cabinet(s) covered in this section shall be used to house the lighting equipment. All cabinets shall be designed and installed as shown on the plans. Cabinet wiring shall be as shown on the plans, specified in these specifications and per requirement of Sections 736-2.01 and 736-2.03 of ADOT Standard Specifications, except for cabinet painting (refer to pages 555, 556 and 560).
- b. Door Requirements - All doors shall have neoprene gaskets installed so that when the doors are closed a raintight and dusttight seal is made. All door hinge pins shall be made of stainless steel. Door stop(s) will be required.
- c. Locks - All doors shall be equipped with a keyed tumbler lock, the self locking type.

d. Installation - All cabinets shall be plumbed and leveled. Cabinets on concrete foundations shall have an approved caulking compound placed between the foundation and the base of the cabinet.

e. Cabinet Wiring

1. All cabinet wiring shall be neat and firm. Wires shall be bound together with TY Wrap or equivalent.
2. A minimum of six copies of the wiring diagram shall be furnished with each cabinet. Each cabinet shall be furnished with a plastic envelope to house one or more prints of the cabinet wiring diagram.
3. All switches shall be of sufficient size and rating to perform the functions required.

## 2.03 HIGH PRESSURE SODIUM LUMINAIRES

- a. General - The following high pressure sodium luminaires shall be used on this project:
  1. For mainline Squaw Peak and Ramp Lighting: General Electric M-400 A/Z Medium Cut-off Type III Cobra Head with either 250 Watt (for ramps) or 400 Watt (for mainline) lamps. Each fixture shall be equipped with individual photo-electric controls.
  2. For underdeck lighting at Bethany Home Road and Glendale Avenue: Holophane Modul 600 shall be used with either 150 watt or 100 watt lamps.
  3. All luminaries shall conform to the applicable requirements of Section 736 Highway and Sign Lighting of ADOT Standard Specifications.
- b. Testing Procedures and Data Required
  1. The manufacturer shall furnish the Contractor complete photometric data on each type of luminaire. The Contractor shall then furnish the City of Phoenix with three copies of this information. The Contractor shall also furnish the Engineer with two sets of adjusting and aiming instructions, as described above, and the Contractor shall furnish three sets of these same instructions to the City of Phoenix Streets and Traffic Department.
  2. Upon request of the City of Phoenix, the Contractor shall furnish sample(s) of the proposed lighting equipment for testing. Test procedures shall conform to the Illumination Engineering Society Standards.
- c. Housing
  1. All luminaire housing (except for the underdeck luminaires) shall be a medium duromic bronze color and shall match the pole and mast areas.
  2. Housing for the color heads shall conform to Subsection 736-2.01(1) of ADOT Standard Specifications.
- d. Optical Assembly and Gasket (Reflector, Refractor, Lamp Socket, and Lamps).
  1. The optical assembly and gaskets for the cobra heads shall conform to Subsection 736-2.01(2) of ADOT Standard Specifications.
  2. All lamps shall conform to Subsection 736-2.01(C) of ADOT Standard Specifications.

2.04 SPECIFICATIONS FOR BALLAST

1. Ballast for cobra heads, shoe boxes and underdeck lights shall conform to Subsection 736-2.01(A)(3) of ADOT Standard Specifications.

2.05 PHOTOELECTRIC CONTROLS AND AUXILIARY CONTRACTOR

a. General

1. Photoelectric controls, of types as specified in this section, shall be furnished and installed on each lighting fixture.
2. The supply voltage rating shall be 465-495 volts, 60 Hertz AC as required.
3. The operating temperature range shall be from -20 degrees to +150 degrees F. A time delay shall be incorporated into the circuit to prevent the street lights from being turned off at night by transient lights which might be focused on the control.
4. When the north sky illumination in the area falls to pre-set value, the lighting load shall be turned on.
5. A switch to permit manual operation of the lighting circuit shall be provided for each photoelectric control.

b. Photoelectric Control

1. The photoelectric control circuitry shall be solid state, except the control relay. The control relay shall be operated by direct current voltage through a full-wave bridge rectifier.
2. The photoelectric control shall have a built-in type lightning arrester with a spark-over value of 2,250 volts on a 1.5x40 microsecond wave and interrupts up to 1,000 amperes of Hertz power-follow current, without affecting the operating characteristics.
3. The photoelectric control shall meet the following electrical requirements:

|                 |  |
|-----------------|--|
| Supply Voltage  | 480 volt; 60 Hz., AC                       |
| Photo cell coil | 480 volts, AC                              |
| Inrush current  | 3.75 amperes at 480 volts,<br>Single Phase |
| Relay contacts  | Single pole, single throw                  |

|                    |                   |
|--------------------|-------------------|
| Operating level:   |                   |
| Turn on            | 1.0 foot candle   |
| Turn off           | 6.0 foot candle   |
| Maximum Difference | 10.0 foot candles |
| Minimum Difference | 0.5 foot candles  |

## CHAPTER 3

### PULL BOXES, CONDUIT, CABLE, CONDUCTORS, WIRING PROCEDURES, SERVICE STRUCTURES AND FOUNDATIONS

#### 3.01 PURPOSE

The purpose of this chapter is to present the specifications used by the City of Phoenix in procuring materials, work and equipment related to or a part of pull boxes, conduit, cable, conductors, wiring procedures, service structures and foundations.

#### 3.02 SPECIFICATIONS FOR PULLBOXES

1. All pull boxes and extensions shall conform to Section 732 - Electrical Underground Material of ADOT Specifications (Refer to page 472-475).

#### 3.03 SPECIFICATIONS FOR CONDUIT

1. All conduit, fittings, and installation shall conform to Section 732 - Electrical Underground Material of ADOT Specifications (refer to pages 471-476 and 480 for Method of Measurement).
2. Trenching and backfilling for APS or SRP service connections and conduit for street lighting shall be to their specific requirements.
3. Trenching and backfilling for all other conduits shall conform to Section 732 - Electrical Underground Material of ADOT Specifications (refer to pages 471-475).
4. The necessary trenching and backfilling cost for all conduit installations shall be included in the contract bid price for the respective conduit item.

#### 3.04 CABLE AND CONDUCTORS

1. All conductors shall be as specified under Section 732 - Electrical Underground Material of ADOT Specifications (refer to pages 467-472).
2. Conductors will be paid for by the linear foot which price shall include the cost for all connections and in-line fuses.
3. All wiring, bonding, grounding, tagging, splices, testing and service system components shall conform to the requirement under Section 732 - Electrical Underground Material of ADOT Specifications (refer to pages 476-479).

4. All poles on structure shall be grounded to the structures rebar.
5. All conductors shall be "hi-pot" (Meggar) tested in place prior to energization. Results of Meggar testing shall be recorded and documented with copies delivered to the City of Phoenix.

3.05 LIGHT POLES, MAST ARMS, AND FOUNDATIONS

1. All poles and mast arms shall conform to Section 731 - Structural Supports and Foundations for Traffic Signal and Highway Lighting of ADOT Specifications (refer to pages 452-454, 464-467).
2. All poles shall be equipped with a cable hook welded on the inside of the pole near the top. The hook shall be accessible from the removable cap. A cable support grip shall be included.
3. The Contractor shall provide the engineer with actual mill certifications which verify that all poles and mast arms are manufactured of domestic steel and meet all applicable ASTM Standards for steel grades.
4. All welding shall be in accordance with the requirements of Subsection 604-3.06 of ADOT Standard Specifications.

SQUAW PEAK PARKWAY  
SEGMENT 5B  
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LANDSCAPING

PALM TREE TRANSPLANTING

TREE RELOCATION OTHER THAN PALM TREES

INTERLOCKING PAVER STONES

SPRINKLER IRRIGATION SYSTEM

LANDSCAPING:

All landscape construction shall conform to the 1979 MAG Uniform Standard Specifications or as superseded by Sections 430, 431, 432 and 795 of the 1987 City of Phoenix Supplement or as modified herein.

Subsection 430.2 General (Phoenix):

Add the following paragraphs: "Trees and plants to remain in the field have been identified on the project plans. Contractor shall create an irrigation berm around all trees and plants to remain. The berms shall be 8" high with a 16" base with a minimum diameter of 12'. All remaining plants shall be protected with a 5' lath fence secured to at least 6 flanged metal fence posts driven adequately into the ground to support the fence material for the duration of the project. The area protected by the fence shall include the irrigation berm.

The contractor shall flood irrigate the plants from his Notice-to-Proceed till permanent irrigation is supplied to the tree. Each tree shall be watered daily during the spring and summer months and twice a week in the fall and winter or as required to maintain the plants in a healthy, vigorous condition. Contractor shall keep the irrigation berm area free of weeds, trash and debris. Irrigation berm is to remain after final landscape installation has been made.

Subsection 430.4.1 Decomposed Granite Areas (Phoenix):

Delete the sentence beginning "the area shall be treated with..."

Add the following sentences: "After fine grading has been completed and prior to the placement of granite, a pre-emergent weed control, such as SURFLAN or equal, shall be applied over the entire area in accordance with the manufacturers recommendations. Incorporate the pre-emergent into the ground surface. Make a second application of pre-emergent after placement of the granite"

Subsection 430.8 Plant and Lawn Guarantee and Maintenance (Phoenix):

Delete this subsection in its entirety and substitute the following:

"Section 430.8 PLANT ESTABLISHMENT GUARANTEE AND MAINTENANCE:

The contractor shall insure that all plant materials are in a sound, healthy, vigorous condition free from insects, bark abrasions, or other objectionable disfigurement and shall immediately replace any plant which is unacceptable at any time up to and including final acceptance of the project or completion of the plant establishment prior whichever occurs later.

Unless otherwise authorized by the Engineer, the Contractor shall maintain all landscaped areas on a continuous basis as they are completed during the course of work and until the final Plant Establishment Guarantee and Maintenance acceptance. Maintenance shall include keeping the landscape areas free of debris on a weekly basis, chemical control of weeds and fertilization as needed, and cultivating and make any necessary repairs regardless of cause to assure a complete operational system as originally designed and constructed. Chemical mixing and method of application for weed control shall be done in the presence of the Engineer.

The Contractor shall provide adequate personnel to accomplish the required maintenance. Pruning and restaking is to include removal off any growth conflicting with vehicular traffic or pedestrian movement.

The Contractor shall request an inspection by the Engineer whenever completion of the planting and related work has been accomplished. After this initial inspection, and subject to his approval of the work, the Engineer will issue a written field notification to the Contractor setting the effective beginning date for Plant Establishment Guarantee and Maintenance Period which will last for 6 months. Inspections shall occur monthly, the date being the same as the effective beginning date for the Plant Establishment Guarantee and Maintenance Period. The 6 month Plant Establishment Guarantee and Maintenance Period is subject to extension by the Engineer if the landscape areas are improperly maintained, if appreciable plant replacement is required or other corrective work becomes necessary.

At the end of the Plant Establishment Guarantee and Maintenance Period a final acceptance inspection of the planted areas will be made by the Engineer. Any plants which need to be replaced, regardless of the cause, shall be replaced prior to final acceptance. Payment for Plant Establishment Guarantee and Maintenance Period shall be 6 equal prorated payments for the item Plant Establishment Guarantee and Maintenance Period based on monthly inspections subject to extensions where the Contractor fails to comply with previously stated requirements. Payments may or may not be supplemental to final project payment."

Subsection 430.9 Plant and Lawn Establishment Period (Phoenix):

Delete this subsection in its entirety. Refer to revised Subsection 430.8 PLANT ESTABLISHMENT GUARANTEE AND MAINTENANCE herein.

Subsection 431.1 Description (Phoenix):

Add the following: "Contractor shall confirm that palms identified for transplanting on project plans exist in the field. If palms are nonexistent or undesirable for transplanting, the Contractor shall provide palms of like kind and size as indicated with no

change in the Contract amount. Responsibility for proper disposal of unacceptable palms shall be borne by the contractor."

The contractor shall have the option of storing palms designated for transplanting in either an approved on-site location(s) or off of the project site. If the contractor selects to store the palms on the project site, he shall take appropriate steps necessary to ensure the survivability of the transplanted materials. The steps would include but are not limited to, providing all labor equipment and materials to instal a secure 6' cyclone fence around the storage area, install a temporary poly tube emitter system for all plant material, pruning as required, apply Vitamin B1 root stimulants once a week as per the manufacturers recommendations, protection from weather disturbances, maintain the storage area in a weed-free condition, and daily monitoring the area and correcting damage and/or problems caused by natural or man-made activities.

The storage area maintenance activities will be required from the Notice-to-Proceed to the acceptance of the Parkway landscape installation (except for the storage area location). At the direction of the Engineer demolition of the storage area can take place. Materials shall be removed from site and properly disposed of by the contractor. The effective beginning date for the Plant Establishment Guarantee and Maintenance Period for the storage area will be considered separate from the other portions of the Parkway landscaping unless agreed upon by the Engineer.

Payment for water, fees, permits and/or meters necessary to supply water to the storage area will be the responsibility of the Contractor. Water meters will be required where City of Phoenix Water sources are utilized. Protection from health safety hazards to the storage area facility shall also be borne by the Contractor.

Plams stored off-site shall be located in a facility appropriate for such activities. The requirements shall be the same as those identified for palms stored on the project site."

Subsection 432.2 Equipment (Phoenix):

Delete the first paragraph.

Add the following: "All trees indicated on the project plans are to be moved by boxing the sides and bottom of the rootball."

Subsection 432.3 Tree Relocation Other Than Palm Trees (Phoenix):

Delete the paragraph beginning "approximately two to four weeks"

Add the following paragraphs:

"Contractor shall determine the accessibility, timing and digging conditions prior to any excavation. Coordinate with the Engineer. Conditions which would adversely affect transplanting such as rocky, hardpan or sandy soils shall be brought to the attention of the Engineer. Contractor shall ensure that trees to be relocated are properly watered from the Notice-to-Proceed until relocation from their original project location.

At least 1 week prior to initiating the boxing operation the trees shall be pruned to remove all dead, diseased or weakened growth plus sufficient vigorous growth to remove 30-40% of the tree foliage. Pruning shall not alter the typical form, visual character and/or growth potential of the species being transplanted. Trees shall be dug in a manner to minimize root ball jarring and damage. Roots shall be cut cleanly to avoid tearing or stripping the root tissue. Box size shall be determined by the size of the tree trunk and remaining foliage and shall be approved by the Engineer.

After the box sides have been placed and secured, the root ball shall be packed and thoroughly watered. Bracing may be applied as necessary to support the tree. Boxed trees shall remain in this condition for at least four weeks before undercutting and placement of the bottom of the box unless otherwise directed by the Engineer. Maintain and water during this period.

Undercutting and removal from the original location shall be done with care. Avoid damage to the tree or root ball. Proper equipment and procedures shall be utilized to transport the trees to the storage area. Refer to Subsection 431.1 PALM TREE TRANSPLANTING as modified herein for storage requirements.

Do not replant trees that appear to be weakened, stressed or show signs of disease as a result of the transplanting operation. Engineer shall approve trees to be replanted. Trees other than palms which are rejected for replanting shall be replaced with like kind from 36" box containers."

#### Section 342 Interlocking Paver Stoness

Concrete paver stones shall be supplied and installed as per the project plans. Match direction of pavement pattern to Squaw Peak Parkway Segment 5B (south of Bethany Home Road). Joint spacing shall be 1/8" maximum. Broom sand into joints.

#### Section 440 Sprinkler Irrigation System Installation

Construction of the sprinkler irrigation system shall conform to the requirements of MAG Standard Specification Section 440.

Subsection 795.2 Topsoil (Standard)

Delete the paragraph beginning "Topsoil shall be".

Add to the following paragraphs:

"Topsoil shall be fertile, friable soil obtained from well-drained arable land which has or is producing healthy crops or other vegetation. It shall be free draining, non-toxic and capable of sustaining healthy plant growth. Topsoil shall be free of calcium carbonate, roadway subbase, subsoil, refuse, roots, heavy clay, clods, noxious weed seeds such as Dallas, Johnson and Bermuda grass, phytotoxic materials, coarse sand, large rocks, sticks, brush, litter, pesticides, chemicals and other deleterious substances.

Topsoil shall be from a source approved by the Engineer. At least 10 days prior to delivery of topsoil to the site, the Contractor shall furnish the Engineer, at no additional cost, with a soil sample from each source for analysis and testing. Prior to excavation of topsoil, all plants, grass, weeds, brush, stumps, loose rock, and other objectionable material shall be removed from the surface of the area from which the topsoil is to be removed."

## SECTION 0.45

### SPECIFICATIONS FOR GENERATOR AND PUMP CONTROL BUILDING AND STORM WATER PUMP STATION - STRUCTURAL, PLUMBING, ELECTRICAL

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| 0.45-44 | NOT INCLUDED                         |     |     |
| 0.45-45 | LEVEL PROBE SYSTEM                   | GPS | 177 |
| 0.45-46 | NOT INCLUDED                         |     |     |
| 0.45-47 | STANDBY POWER GENERATOR SYSTEMS      | GPS | 180 |
| 0.45-48 | OVERCURRENT PROTECTIVE DEVICES       | GPS | 199 |
| 0.45-49 | EXTERIOR LIGHTING FIXTURES           | GPS | 202 |
| 0.45-50 | MEASUREMENT AND PAYMENT              | GPS | 206 |

SECTION 0.45-1 - GENERAL REQUIREMENTS

SUMMARY:

Section 0.45 of the specifications outlines the provisions of the contract work dealing with the Structural, Plumbing, and Electrical Sections for the Generator and Pump Control Building and the Storm Water Pump Station.

The work consists of the complete construction of a pump station, including but not limited to, all excavation and backfilling; masonry, concrete, reinforcement and structural steel; roofing; pumps and controls, generators, pipes and valves; hatches; fuel storage; plumbing work; electrical work; painting, site improvements and all appurtenances and other items of work as specified herein, and as indicated on the plans, including all items necessary to complete the pump station at the location shown on the project plans.

PERMITS:

Unless otherwise provided in the Contract Documents, the Contractor shall secure and pay for the building permit and other permits and governmental fees, licenses, and inspections necessary for proper execution and completion of the work.

SHOP DRAWINGS:

Refer to MAG Section 105.2.

LIST OF EQUIPMENT:

At the preconstruction conference the Contractor shall submit in duplicate for the Engineer's approval a complete list of all equipment he proposes to furnish for the Pump Stations. The equipment list shall include a complete description of all components with catalog cuts and drawings as necessary for in-depth evaluation of each unit and its interaction with the total system.

SUBSTITUTIONS:

Refer to MAG Section 106.4.

WARRANTY AND SUPPLEMENTAL PERFORMANCE BOND:

The Contractor shall guarantee his workmanship and materials for a period of one year from the date of acceptance by the Engineer and shall leave the work in perfect order at completion. Should defects develop within the guarantee period, the Contractor shall, upon written notice of same, remedy the defects and reimburse the Owner for all damage to the other work, whether caused by the defects or the work of correcting same. A Supplemental Generator

and Pump Control Building and Storm Water Pump Station Performance Bond furnished by the Contractor as a part of this Contract shall remain in effect until the expiration of the guarantee period as assurance of the Contractor's obligation to meet the guarantee herein stipulated. See Supplementary Conditions Section .14. Guarantees, if any, extending beyond said one year period shall be specifically provided for in the Contract and may be fulfilled by assignment of the Bond or written warranty of the manufacturer.

OPERATION AND MAINTENANCE MANUALS:

Prior to or with the delivery of all systems and equipment, the manufacturer shall provide six copies of an operation and maintenance manual including storage, installation, start-up, operating and maintenance instructions, and a complete parts list and recommended spare parts list.

CUTTING AND PATCHING:

The Contractor shall be responsible for cutting, fitting, or patching required to complete the work or to make its parts fit together properly.

Do not cut-and-patch work exposed to view (exterior and interior) in a manner resulting in noticeable reduction of aesthetic qualities and similar qualities, as judged by Engineer.

Do not cut-and-patch structural work in a manner resulting in a reduction of load-carrying capacity or load/deflection ratio. Submit proposal and request and obtain Engineer's approval before proceeding with cut-and-patch of structural work.

Use materials for cutting and patching that are identical to existing materials. If identical materials are not available, or cannot be used, use materials that match existing adjacent surfaces to the fullest extent possible with regard to visual effect. Use materials for cutting and patching that will result in equal-or-better performance characteristics.

Patch with seams which are durable and as invisible as possible. Comply with specified tolerances for the work.

Restore exposed finishes of patched areas and where necessary extend finish restoration into retained adjoining work in a manner which will eliminate evidence of patching and refinishing.

SECTION 0.45-2 - STRUCTURE EXCAVATION, BACKFILL AND EMBANKMENTS:

DESCRIPTION:

The Contractor shall provide the excavation, backfilling, and embankments necessary to accommodate the structures as shown on the plans and as specified in MAG Section 206 and modified herein.

BACKFILL AND EMBANKMENTS:

Placement. No fill shall be placed covering other work until such work has been inspected and approved. Where fill is required on both sides of a foundation or wall, the fill shall be placed simultaneously on each side. Fill against building walls shall not be placed until the first floor slab has been poured and set, unless otherwise approved by the Engineer. Fill against other work shall be in a manner and at such time as not to endanger the stability or damage the work. No fill shall be placed against water bearing walls until they have been tested for watertightness.

Compaction. All fill at the Generator Building and Pump Station shall be compacted as specified herein, unless otherwise shown.

Backfill. Backfill shall be placed in 6 inch loose layers and each layer compacted to not less than 95 percent of maximum dry density; the moisture content shall be not greater than 3 percentage points above optimum as determined by ASTM D698.

Embankments. Embankment fill shall be placed in 6 inch loose layers and each layer compacted to not less than the percent of maximum dry density specified herein; the moisture content shall be not greater than 3 percentage points above optimum as determined by ASTM D698.

| <u>Maximum Dry Density</u><br><u>lbs/cu ft</u> | <u>Compaction</u><br><u>Percent Maximum</u><br><u>Dry Density</u> |
|--|---|
| 90-104.9                                       | 102   |
| 105-119.9                                      | 100   |
| 120 and more                                   | 98  |

Subgrade. All pavement subgrades shall be compacted in accordance with MAG Section 301.

GRANULAR BACKFILL:

Material. Granular material shall be gravel, crushed slag, or crushed stone meeting the grading specified herein.

Grading.

| <u>Sieve</u>      | <u>Total Percent Passing</u> |
|-------------------|------------------------------|
| 2 1/2 inch        | 100                          |
| 1 inch            | 70-100                       |
| No. 4 (3/16 inch) | 25-100                       |
| No. 40            | 10-50                        |
| No. 200           | 5-15                         |

Placement. Granular fill shall be placed where shown. Granular fill under slabs shall be placed after the subgrades have been leveled and cleared of all debris and immediately prior to pouring of the slab. The subgrade shall be shaped at all walls, floors, and drains so that the required thickness of the slab and granular fill can be maintained.

Compaction. Granular material shall be placed in 8 inch loose layers and each layer compacted to not less than 98 percent of maximum dry density; the moisture content shall be not greater than 3 percentage points above optimum as determined by ASTM D698.

POROUS BACKFILL:

Porous backfill, where shown, shall be gravel, crushed slag, or crushed stone meeting the requirements of ASTM D448, No. 4 size coarse aggregate.

SECTION 0.45-3 - CONCRETE:

Codes and Standards: ACI 301 "Specifications for Structural Concrete Buildings"; ACI 318, "Building Code Requirements for Reinforced Concrete"; comply with applicable provisions except as otherwise indicated.

Construction shall conform to the requirements of MAG Section 505, these specifications, and the plans. Concrete shall be Class A; minimum  $f'c = 3000$  psi. except the minimum cement content shall be 564 pounds per cubic yard.

Related Materials:

Waterstops: Flat dumbbell or centerbulb type, size to suit joints, of either rubber (CRD C 513) or PVC (CRD C 572).

Vapor Barrier: Clear 8-mils thick polyethylene.

Reinforcing Materials:

Deformed Reinforcing Bars: ASTM A 615, Grade 60, unless otherwise indicated.

Welded Wire Fabric: ASTM A 185.

Reinforcement: Position, support and secure reinforcement against displacement. Locate and support with metal chairs, runners, bolsters, spacers and hangers, as required. Set wire ties so ends are directed into concrete, not toward exposed concrete surfaces.

Install welded wire fabric in as long lengths as practicable, lapping at least one mesh.

Joints: Provide construction, isolation, and control joints as indicated or required. Locate construction joints so as to not impair strength and appearance of structure. Place isolation and control joints in slabs-on-ground to stabilize differential settlement and random cracking as indicated on Plans.

Installation of Embedded Items: Set and build into work anchorage devices and other embedded items required for other work that is attached to, or supported by cast-in-place concrete. Use setting diagrams, templates and instructions provided by others for locating and setting.

Concrete Placement: Comply with ACI, placing concrete in a continuous operation within planned joints or sections. Do not begin placement until work of other trades affecting concrete is completed.

Concrete Finishes:

Exposed-to-view Surfaces: Provide a smooth finish for exposed concrete surfaces and surfaces that are to be covered with a coating or covering material applied directly to concrete. Remove fins and projections, patch defective areas with cement grout, and rub smooth. NOTE: Special exterior finishes and color are required for this project as specified in Section 0.22 and the Plans.

Slab Trowel Finish: Apply trowel finish to monolithic slab surfaces that are exposed to view or are to be covered with resilient flooring, paint or other thin film coating. Consolidate concrete surfaces by finish troweling, free of trowel marks, uniform in texture and appearance.

SECTION 0.45-4 - UNIT MASONRY:

Standards: Comply with recommendations of Brick Institute of America (BIA), and National Concrete Masonry Association (NCMA).

Submittals: Submit product data for masonry units, cementitious products for mortar and grout, coloring pigments, and masonry accessories. Submit samples of exposed masonry units and colored pigmented mortar.

Masonry Units, General: Provide units of size indicated and in special shapes for applications where forms, size or finish cannot be produced from standard shapes.

Units shall be free of iron and other substances that will stain plaster or paint. Aggregate shall not contain more than 1.5 mg of ferric oxide per 200 grams when tested in accordance with ASTM C331.

All concrete masonry units shall be cured in a moisture controlled environment or an autoclave with high-pressure steam at 125 to 150 psi pressure and at a temperature of 350 degrees F. Moisture content in the units at time of delivery to job site shall not exceed 30 percent maximum absorption unit.

All exterior exposed concrete masonry units shall contain an integral water repellent and colorant.

Provide uncured or unfrogged units with all exposed surfaces finished for sills, caps and similar applications exposing surfaces otherwise concealed from view.

Concrete Block: Provide Grade N loadbearing units complying with the following requirements:

Type I, Moisture Controlled

Exposed Interior Faces: Manufacturer's standard color and texture, unless otherwise indicated.

Exposed Exterior Faces: Slum block finish.

Hollow Block: ASTM C 90.

Weight Classification: Normal weight.

Solid Block: ASTM C 145.

Weight Classification: Normal weight.

Integral Water Repellent: Provide units manufactured with integral water repellent equivalent to:

"Dry Block System"  
Forrer Chemical Co.  
Milwaukee, Wisconsin

Colorant for Concrete Mix: Provide units manufactured using a manufacturer's standard colorant additive to produce a Desert Tan Color.

The Engineer will select the exact color from a minimum of four color samples which shall be furnished by the Contractor.

Mortar Materials and Mixes: Provide mortar complying with ASTM C 270, Proportion Specification, for materials and mortar types of composition indicated below:

Cementitious Material: Portland cement, Type I, natural color as required to produce mortar color indicated; per ASTM C150.

Hydrated Lime: Type S, per ASTM C207.

Water = Potable.

Aggregate: Natural or manufactured sand; per ASTM C144.

Use Type S mortar for reinforced masonry where indicated.

Do not add admixtures unless otherwise indicated.

Grout for Bond Beams and Reinforced Concrete Masonry shall be in compliance with ASTM C476, and grout for setting lintel beams and similar items shall be composed of one part Portland cement and two parts fine aggregate with sufficient lime putty added to form a quick set.

Water Repellent Mortar Additive: All mortar use for exterior masonry work shall contain the recommended amount of mortar admix for water-repellency and to assure proper bond strength (ASTM E 72-74). The recommended amount is one quart of admix per bag of Portland cement when mixed at the job site with lime; with not more than 6 cubic feet of masonry sand.

Reinforcement: Deformed bars of grade indicated complying with ASTM A 615, except as otherwise indicated.

Submittals: Besides steel producer's mill certificate for reinforcement, submit shop drawings for fabrication, bending, and placement of reinforcement complying with ACI 315.

Place reinforcement accurately at spacing shown, secured against displacement, and spliced by lapping unless otherwise indicated, at locations shown.

Provide temporary formwork and shores as required of reinforced masonry elements.

Use grouting technique and type of grout appropriate to masonry construction indicated and as recommended in referenced standards and the following:

For brick masonry comply with recommendations of Brick Institute of America (BIA).

For concrete masonry comply with recommendations of NCMA.

Joint Reinforcement, Ties and Anchoring Devices: Comply with requirements indicated below for basic materials and with those indicated under each item.

Hot-Dip Galvanized Wire: ASTM A 82 for uncoated wire, ASTM A 153, Class B2, zinc coating applied after prefabrication.

Joint Reinforcement: Welded-wire units prefabricated with deformed continuous side rods and plain cross rods into straight lengths of not less than 10 feet and of widths to fit wall thicknesses indicated, with prefabricated corner and tee units, and as follows:

Wire Size for Side Rods: No. 9 gauge.

Wire Size for Cross Rods: No. 9 gauge.

For single and multi-wythe masonry provide truss design with single pair of side rods. Butt welded to side rods.

All reinforcing units for corners and abutting and intersecting walls shall be factory fabricated.

Miscellaneous Masonry Anchors: Fabricated from 16-gage steel sheet or 3/8 inch steel rod, 1.5 ounce hot-dip zinc coating after fabrication.

Flexible Anchors: Where masonry is to be anchored to structural framework with flexible anchors, two-piece anchors which will permit horizontal and vertical movement of masonry shall be provided. These flexible anchors will provide lateral restraint and shall be factory fabricated.

Concealed Flashing Materials: Provide materials as follows:

Copper Masonry Flashing: ASTM B 370, H100 temper (cold-rolled), 10-ounce sheet, deformed for 2-direction mechanical bond wherever used as thru-wall flashing.

Control Joint Filler: Shall be factory-extruded solid section of rubber conforming to ASTM D2000 2AA-805 with durometer hardness of 80 when tested in conformance with ASTM D2240. The shear section shall not be less than 5/8 inch thick and the flanges not less than 5/15 inch thick.

Expansion Joint Filler: Shall be composed of cork granules in a binder conforming to ASTM D 1752.

Weepholes: Polyethylene plastic tubing, 1/4" x 4".

Install masonry units in the bond pattern indicated, or if none is indicated, in running bond.

Cut exposed masonry units, where necessary, with a power saw.

Avoid the use (by proper layout) of less-than-half-size units.

Bond intersecting walls with masonry units or provide anchors spaced 2'-0".

Hold uniform joint sizes to suit modular size of masonry units.

Cut joints flush and tool slightly concave, unless otherwise indicated.

Reinforce horizontal joints with continuous masonry joint reinforcement, spaced 16 inches vertically; except spaced 8 inches in parapet walls, and immediately above and below openings, for a distance of 2 feet beyond jambs of opening. Do not bridge control and expansion joints in the wall system. Lap reinforcement not less than 6 inches.

Install vertical reinforcement where indicated and in poured grout studs which are formed by the vertically aligned cells of the unit masonry.

Provide control and expansion joints at locations shown, and keep clean of mortar droppings. Install joint fillers where indicated and in accordance with manufacturer's installation instructions.

Provide concealed flashing in exterior masonry work as indicated.

Except as otherwise shown, provide flashing under copings and sills, through wall at counterflashing locations, and above elements of structural support for masonry.

Build other work into the masonry work as shown, fitting masonry units around other work, and grouting for secure anchorage.

Place mortar and grout within one hour after mixing. Place mortar on unit bearing surfaces in a manner such that the unit being installed is bonded to the bearing surface next below, and to the surface of the previously installed unit in the same course as the unit being installed; furrowing of mortar will not be permitted. Pack mortar under and around joint reinforcement before the unit is installed.

Provide reinforced lintels using special lintel blocks over head openings where indicated on the Plans. Fill lintel with concrete and reinforce with steel rods. Provide at least 8-inch bearing at ends.

Tool joints and retool after initial set. Use concrete masonry units of uniform thickness. Joint between masonry and steel members shall be finished with sealant material and backing. Control joints shall be raked out 3/4 inch deep and finished with sealant material. Defective joints shall be raked out the full depth and patched with mortar to match adjacent joints.

Protect newly laid masonry from exposure to precipitation, excessive drying, freezing, soiling, backfill and other harmful elements.

Dry-brush masonry work at end of each day's work.

Final Cleaning: After mortar is thoroughly set and cured clean masonry as follows:

Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.

Test cleaning methods on sample panels before proceeding with cleaning of entire masonry work.

Clean concrete unit masonry to comply with masonry manufacturer's directions and applicable NCMA "Tek" bulletins.

SECTION 0.45-5 - STRUCTURAL STEEL:

Codes and Standards: AISC "Code of Standard Practice for Steel Buildings and Bridges"; AISC "Specifications for the Design, Fabrication, and Erection of Structural Steel for Buildings" including "Commentary"; AWS "Structural Welding Code - Steel"; comply with applicable provisions except as otherwise indicated.

Shop Drawings: Show complete details and schedules (if required) for fabrication, assembly and erection. Furnish anchor bolts required for installation in other work; furnish templates for bolt installation.

Steel Plates, Shapes, Bars: ASTM A 36.

Fasteners: High-strength bolts and nuts, ASTM A 325.

Shop Paint: FS TT-P-86, Type II; or, SSPC-Paint 2.

Fabrication: Comply with AISC "Specifications" and final shop drawings. Mark and match-mark units for field assembly.

Connections: As shown on final shop drawings. Use high-strength bolts for field connections.

Comply with AWS Code for procedures, appearance, and quality of welds.

Provisions for Other Work: Fabricate structural steel members to provide holes for securing other work and for passage of other work through steel framing as indicated.

Shop Painting: Paint structural steel work, except members or portions of members embedded in concrete or mortar, and contact areas to be welded or bolted. Clean steel free of loose mill scale, rust, oil and grease. Apply prime paint to provide a minimum dry film thickness of 2.0 mils. All painting shall comply with MAG Section 530.

Erection: Comply with AISC Code and Specifications, and maintain work in safe and stable condition during erection. Provide temporary bracing and shoring as required; remove when final connections placed.

Set base plates on cleaned bearing surfaces, using wedges or other adjustments as required. Solidly pack open spaces with bedding mortar, consisting of 1 part portland cement to 3 parts sand and only enough water for packing and hydrations or use commercial nonshrink grout material at Erector's option.

Touch-up prime paint after erection. Clean field welds, bolted connections and abraded areas, and apply same type paint as used in shop.

SECTION 0.45-6 - STEEL JOISTS AND JOIST GIRDERS:

Codes and Standards: SJI "Standard Specifications, Load Tables and Weight Tables for Steel Joists and Joist Girders" for types of joists indicated; comply with applicable provisions except as otherwise indicated.

Shop Drawings and Data: Show complete details and schedules (if required) for fabrication and erection, including layout, special connections, jointing and accessories. Locate anchor bolts for installation in other work; furnish templates for bolt installation by others.

Steel: ASTM A 36, or other per SJI, "Specifications."

Fasteners: High-strength bolts and nuts, ASTM A 325 or A 490.

Shop Paint: Comply with SJI "Specifications" for materials and application.

Fabrication: Comply with SJI "Specifications" and final shop drawings.

Provisions for Other Work: Provide holes to accommodate other work to be secured to joists as indicated on final shop drawings.

Extended and Special Ends: Provide where indicated, complying with SJI "Specifications."

Header Units: Provide header units to support tail joists at openings in floor or roof system not framed with steel shapes.

Bridging: Comply with SJI "Specifications" for type of joists and installation requirements. Provide bridging anchors for ends of bridging lines terminating at walls or beams.

End Anchorage: Comply with SJI "Specifications" unless otherwise indicated.

Erection: Comply with SJI "Specifications", and maintain work in safe and stable condition during erection. Do not apply construction loads until bridging and anchorages are completed.

SECTION 0.45-7 - METAL DECKING:

Shop Drawings and Data: Show complete details and schedules (if required) for layout and types of deck panels, anchorage, supplementary framing, cut openings, and accessories.

Codes and Standards: AISI "Specification for the Design of Cold-Formed Steel Structural Members"; AWS "Structural Welding Code"; SDI "Design Manual for Floor Decks and Roof Decks"; comply with applicable provisions except as otherwise indicated.

Steel for Galvanized Units: ASTM A 446, Grade A.

Steel Shapes: ASTM A 36.

Sheet Metal Accessories: ASTM A 526, galvanized.

Galvanizing: ASTM A 525, G60.

Galvanizing Repair Paint: MIL-P-21035 (Ships).

Fabrication: Form deck units in lengths to span at least three supports; flush, telescoped, or nested 2 inch end laps; nested or interlocked side laps, unless otherwise indicated.

Roof Deck: Comply with SDI "Roof Deck Specifications," 22 gauge; width and depth indicated.

Manufacturers:

Bowman/E.G. Smith, Div. Cyclops Corp.  
Consolidated Systems, Inc.  
Epic Metals Corp.  
Inryco, Inc.  
Roll Form Products, Inc.  
United Steel Deck, Inc.  
Vulcraft/Div. Nucor Corp.  
Wheeling Corrugating Co.  
Wolverine Deck Co.

Accessories: Provide cover plates, closure strips, roof sump pans, cant strips, as required; use deck manufacturer's standard unless otherwise shown.

Installation: Place deck units and secure to adjacent framing by fusion welding 12 inches o.c. to supports, with a minimum of two welds at each support, unless otherwise indicated.

Secure roof deck units at ends and side laps at spacings recommended by deck manufacturer to provide resistance for gross uplift of 45 psf at eave overhang and 30 psf for other roof areas.

Place accessory units in accordance with manufacturer's recommendations unless otherwise shown.

Touch up shop paint after application. Clean field welds and abraded areas, and apply same type paint as used in shop. Use galvanizing repair paint to correct damaged galvanized surfaces.

SECTION 0.45-8 - COLD-FORMED METAL FRAMING:

Types of cold-formed metal framing units for project include the following:

"C" shaped steel studs.

"C" shaped steel joists.

Shop Drawings and Data: Submit shop drawings for special components and installations not fully dimensioned or detailed in manufacturer's product data.

Include placing drawings for framing members showing size and gage designations, number, type, location and spacing. Indicate supplemental bracing, splices, accessories, and details as required for proper installation.

Component Design: Calculate structural properties of studs and joists in accordance with AISI "Specification for the Design of Cold-Formed Steel Structural Members."

Manufacturers:

Standard:

Versarof Framing System by Decks International, Inc. of Northbrook, Illinois or Equal products as manufactured by:

Alabama Metal Industries Corp.  
Bostwick Steel Framing Co.  
Dale Industries, Inc.  
Milcor Div., Inryco, Inc.  
Marino Industries Corp.  
U.S. Gypsum Co.

System Components: With each type of metal framing required, provide manufacturer's standard steel runners (tracks), blocking, lintels, clip angles, shoes, reinforcements, fasteners, and accessories as recommended by manufacturer for application indicated, as needed to provide a complete metal framing system.

Materials and Finishes:

For 18-gage and lighter units, fabricate metal framing components of commercial quality steel sheet with a minimum yield point of 33,000 psi; ASTM A 446, A 570, or A 611.

Provide galvanized finish to metal framing components complying with ASTM A 525 for minimum G 60 coating.

"C" Shape Studs: Manufacturer's standard load-bearing steel studs of size, shape, and gage indicated, with 1.625" flange and flange return lip.

Joists: Manufacturer's standard C-shape sections of size, shape, and gage indicated.

Electrodes for Welding: Comply with AWS Code.

Galvanizing Repair Paint: High zinc dust content paint for repair of galvanized surfaces damaged by welding, complying with M.I. Spec. MIL-P-21035.

Prefabrication: Structural framing components may be prefabricated into panels prior to erection. Fabricate panels plumb, square, true to line and braced against racking with joints welded. Perform lifting of prefabricated panels to prevent damage or distortion.

Fabricate panels in jig templates to hold members in proper alignment and position and to assure consistent component placement.

Fastenings: Attach similar components by welding. Attach dissimilar components by welding, bolting, or screw fasteners, as standard with manufacturer.

Wire tying of framing components is not permitted.

Fabrication Tolerances: Fabricate panels to a maximum allowable tolerance variation from plumb, level, and true to line of 1/8 inch in 10'-0".

Installation: Install metal framing systems in accordance with manufacturer's printed or written instructions and recommendations, unless otherwise indicated.

Install continuous tracks sized to match studs. Secure tracks as recommended by stud manufacturer for type of construction involved.

Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar requirements.

Install supplementary framing, blocking and bracing in metal framing system wherever walls or partitions are indicated to support fixtures, equipment, services, casework, heavy trim and furnishings, and similar work.

Secure studs to top and bottom runner tracks by either welding or screw fastening at both inside and outside flanges.

Install horizontal stiffeners in stud system, spaces (vertical distance) at not more than 4'-6" o.c. Weld at each intersection.

Installation of Joists: Install level and plumb, complete with bracing and reinforcing as indicated. Provide not less than 1-1/2 inch end bearing.

Reinforce ends with end clips, steel hangers, steel angle clips, steel stud section, end grain wood block, or as otherwise recommended by joist manufacturer.

SECTION 0.45-9 - METAL FABRICATIONS:

General:

Structural Performance:

Provide the following assemblies capable of withstanding loadings indicated:

Handrails and Toprails: Concentrated load of 200 lbf applied at any point in any direction and a uniform load of 50 lbf per linear foot applied simultaneously in both vertical and horizontal directions.

Guards: Intermediate rails, balusters and panel fillers; uniform load of 25 lbf per square foot of gross area of guard including open areas.

Submittals: In addition to product data, submit the following:

Shop drawings showing details of fabrication, assembly and installation including templates for anchor bolt placement.

Samples of materials and finished products as may be requested by Engineer.

Materials/Fabrication:

General: For work exposed to view use materials selected for their smoothness and freedom from surface blemishes.

Steel Plates, Shapes, and Bars: ASTM A 36.

Steel Tubing: ASTM A 500 or ASTM A 501.

Structural Steel Sheet: ASTM A 570 or ASTM A 611, Class 1; of grade required for design loading.

Galvanized Structural Steel Sheet: ASTM A 446, of grade required for design loading; coating designation G90 or as indicated.

Steel Pipe: ASTM A 53, type and grade as required for design loading (if applicable), black finish unless galvanizing indicated; standard weight unless otherwise indicated.

Aluminum: Alloy and temper recommended by aluminum producer or finisher for use intended and finish indicated, and with strength and durability of alloy listed below:

Extruded Bar and Shape: ASTM B 221, 6063-T6.

Extruded Pipe and Tube: ASTM B 429, 6063-T6.

Plate and Sheet: ASTM B 209, 6061-T6.

Castings: ASTM B 26, 356-T6.

Gray-Iron Castings: ASTM A 48, Class 30.

Concrete Inserts: Threaded or wedge type; galvanized ferrous castings, either galvanized ferrous castings, malleable iron, cast steel; with steel bolts, washers and shims; hot-dip galvanized.

Steel Bar Gratings: ASTM A 569 hot dip galvanized per ASTM A 123.

Heavy-Duty Steel Grating: ASTM A 36 hot dip galvanized per ASTM A 123, designed for AASHTO H-20 wheel load.

Nonshrink Nonmetallic Grout: CE CRD-C621, nonstaining, noncorrosive, nongaseous; recommended by manufacturer for types of applications indicated.

Fasteners: Provide bolts, nuts, lag bolts, machine screws, wood screws, toggle bolts, masonry anchorage devices, lock washers as required for application indicated and complying with applicable Federal standards. Hot-dip galvanize fasteners for exterior applications to comply with ASTM A 153.

Shop Painting: Apply shop primer to surface of metal fabrications except those embedded in concrete or galvanized; comply with SSPC-PA1 and requirements indicated below.

Shop Primer: Fabricator's standard, fast-curing, lead-free, "universal" primer complying with performance requirements of FS TT-P-645.

Galvanizing: ASTM A 386 for assembled products; ASTM A 123 for rolled, pressed and forged steel shapes, plates, bars and strip 1/8 inch and thicker; galvanizing repair paint: MIL-P-22035 or SSPC-Paint-20.

Fabrication, General: Use materials of size and thickness shown or, if not shown, of required size, grade and thickness to produce strength and durability in finished product. Shop-paint all items not specified to be galvanized after fabrication.

Weld corners and seams continuously; grind exposed welds smooth and flush.

Form exposed connections with hairline, flush joints; use concealed fasteners where possible.

Rough Hardware: Furnish custom-fabricated bolts, plates, anchors, hangers, dowels, and other miscellaneous steel and iron shapes for framing.

Galvanize, unless otherwise indicated.

Ladders: Fabricate ladder for locations shown, with dimensions, spacings, and anchorages as indicated. Comply with the requirements of ANSI A14.3, unless otherwise indicated.

Railings: Steel railings shall be ASTM A53 Gr.B or ASTM A 501, 1-1/2 inch Schedule 40 pipe. All fittings shall be welded and ground to final shapes for a tight, flush fit. All fasteners shall be Type 307 galvanized steel, set flush or hidden.

Chains: Chains, where shown, shall be a double row of 1/4 inch, Type 304, all welded stainless steel. Chains shall come complete with stainless steel swivel safety snap at each end and a stainless steel eye bolt anchored to the railing or wall.

Loose Bearing Plates: Provide for steel items bearing on masonry or concrete, as indicated. Drill plates to receive anchor bolts.

Galvanize after fabrication.

Loose Steel Lintels: Fabricate to sizes indicated.

Galvanize after fabrication.

Miscellaneous Framing and Supports: Provide as required to complete work and not included with structural steel framework. Fabricate of welded construction in as large units as possible; drill and tap as required to receive hardware and similar items. Include required anchors for building into other work; spaced not more than 24 inches o.c.

Miscellaneous Steel Trim: Fabricate to shapes and sizes as required for profiles shown; continuous welded joints and smooth exposed edges. Use concealed field splices wherever possible. Provide cutouts, fittings, and anchorages; coordinate assembly and installation with other work.

Security Grille: The security screen and the grille at soffit indicated on the Plans shall be Orsogril Sterope type as manufactured by A&T Iron Works, Inc., of New Rochelle, New York, or approved equal.

Framing Bar. 31/32" x 5/32".

Vertical Bars. 31/32" x 1/8" at 2-7/16" o.c.

Horizontal Tie. 3/16" O at 5-3/16" o.c.

Casting. Hot dipped galvanized and electrically coated with thermosetting polyurethane resin, with color to be selected by the Engineer.

Bolts and Nuts. Anti-thief, 3/8" diameter x 1", stainless steel.

Wheel Guards: Hollow core, gray-iron castings, filled with 3,000 psi concrete after installation.

Safety Climb Device: Provide complete safety climb fall prevention system for ladders in wet well. Safety rail shall be tubular steel notched every six inches with hot-dipped galvanized finish. Provide all materials and components as required to furnish a complete fall prevention system including one safety belt. System shall meet all applicable Federal Specs and conform to OSHA requirements. Approved manufacturers are: Norton Company, Cerritos, CA and DHV, Antenna Products Division, Mineral Wells, TX or approved equal.

Installation: Perform cutting, drilling and fitting required for installation; set work accurately in location, alignment and elevation, measured from established lines and levels. Provide anchorage devices and fasteners where necessary for installation to other work.

Set loose items on cleaned bearing surfaces, using wedges or other adjustments as required. Solidly pack open spaces with bedding mortar, consisting of 1 part portland cement to 3 parts sand and only enough water for packing and hydration, or use commercial nonshrink grout material.

Touch-up shop paint after installation. Clean field welds, bolted connections and abraded areas, and apply same type paint as used in shop. Use galvanizing repair paint on damaged galvanized surfaces.

SECTION 0.45-10 - ROUGH CARPENTRY:

General:

Submittals: Submit the following:

Material certificates for dimension lumber indicated for compliance with selected minimum design values.

Wood treatment data including treatment plant's certification of compliance with indicated requirements.

Products:

Lumber, General: Manufacture lumber, S4S and grade stamped, to comply with PS 20 and applicable grading rules of inspection agencies certified by ALSC's Board of Review.

Provide seasoned lumber with 19 percent moisture content at time of dressing and shipment, for sizes 2 inches or less in thickness.

Dimension Lumber: Provide lumber of the following product classification in grade and species indicated:

Light-Framing (2 to 4 inches thick, 2 to 4 inches wide).

Standard.

Any species of grade indicated:

Lumber for Miscellaneous Uses: Unless otherwise indicated, provide Standard grade lumber for support of other work, including rooftop equipment and support bases, cant strips, bucks, nailers, blocking, furring, grounds, stripping and similar members.

Fasteners and Anchorages: Of size, type, material and finish suited to application shown. Provide metal hangers and framing anchors of size and type recommended for intended use by manufacturer. Hot-dip galvanize fasteners and anchorages for work exposed to weather, in ground contact and high relative humidity to comply with ASTM A 153.

Preservative pressure treat lumber and plywood with water-borne preservatives to comply with AWPB C2 and C9, respectively, and with requirements indicated below:

Wood for Ground Contact Use: AWPB LP-22.

Wood for Above-Ground Use: AWPB LP-2.

Treat cants, nailers, blocking, stripping and similar items in conjunction with roofing, flashing, vapor barriers, and water proofing.

Treat sills, sleepers, blocking, furring, stripping and similar items in direct contact with masonry or concrete.

Installation:

Install rough carpentry work to comply with "Manual of House Framing" by National Forest Products Assoc. (NFPA), unless otherwise indicated. Set carpentry work to required levels and lines, with members plumb and true and cut to fit.

Securely attach carpentry work to substrates and supporting members including metal roof deck using fasteners of size that will not penetrate members where opposite side will be exposed to view or receive finish materials. Where fastening to metal deck penetrating of deck is acceptable. Install fasteners without splitting wood; fasten panel products to allow for expansion at joints unless otherwise indicated.

SECTION 0.45-11 - BITUMINOUS DAMPPROOFING:

Submittals:

Product Data: Submit manufacturer's technical product data, installation instructions, and recommendations for each damp proofing material required. Include data substantiating that materials comply with requirements.

Job Condition:

Substrate: Proceed with dampproofing work section only after substrate construction and penetrating work have been completed.

Weather: Proceed with dampproofing work only when existing and forecasted weather conditions will permit work to be performed in accordance with manufacturer's recommendations.

Hot-Applied Asphalt Dampproofing:

Asphalt Primer: Asphalt cut-back type; ASTM D 41.

Dampproofing Asphalt: ASTM D 449, Type 1.

Manufacturers:

Bird & Son, Inc.  
Celotex Corporation  
Certainteed Corporation  
Flintkote/Genstar Roofing Products Co.  
GAF Corporation  
Manville Building Materials Corporation  
Owens-Corning Fiberglass Corporation  
Tamko Corporation

Installation: Except as otherwise indicated, and whether or not shown on drawings, apply dampproofing to all exterior below-grade surfaces of exterior underground walls in contact with earthwork or other backfill, in any situation where space of any kind is enclosed on opposite side.

Extend vertical dampproofing down walls from finished grade line to top of footing, extend over top of footing and turn down minimum of 6 inches over outside face of footing. Extend 12 inches onto intersecting walls, and footings but do not extend onto surfaces which will be exposed to view when project is completed.

Comply with manufacturer's instructions, except where more stringent requirements are shown or specified, and except where project conditions require extra precautions or provisions to ensure satisfactory performance of work.

Mask or otherwise protect adjoining work to prevent spillage or migration of dampproofing materials onto other surfaces of work. Do not allow dampproofing materials to enter drains or conductors.

Install 2 x 2 cant strip of bituminous grout at base of vertical dampproofing where it meets horizontal surface.

Fill voids, seal joints, and apply bond breakers (if any) as recommended by prime materials manufacturer, with particular attention at construction joints.

Install separate flashings and corner protection stripping as recommended by prime materials manufacturer, where indicated to precede application of dampproofing. Comply with details shown and manufacturer's recommendations. Give particular attention to requirements at building expansion joints, if any.

Apply dampproofing compound to comply with indicated below for minimum rate of application and minimum uniform dry film thickness.

Hot-applied bitumen: 2.5 gal./100 s.f.; min. 30 mils thick.

SECTION 0.45-12 - PREFORMED ROOFING:

Performance Requirements: Provide preformed panel systems which comply with performance requirements indicated based on pretesting of installed panels using the following methods.

Air Infiltration: ASTM E 283

Water Penetration: ASTM E 331

Structural Properties: ASTM E 72

Structural Design Requirements: Provide panels which comply with structural requirements indicated based on design procedures of AISI "Specifications for the Design of Cold-Formed Steel Structural Members".

Fire-Resistance: Provide preformed panel systems with fire-resistance ratings, based on assemblies tested and listed by testing and inspection organization acceptable to authority having jurisdiction.

Submittals: Submit manufacturer's product data describing preformed roofing and siding panels and structural support system.

System shop drawings showing layout of panels on roofs and walls, and details of special and typical conditions.

Submit samples of each exposed finish material.

Submit certification by manufacturer that products have been pretested and comply with performance requirements indicated.

Products:

Mansard Roof: The roof of the mansard shall be similar or equal to SBS-18/Structural Batten System as manufactured by AEP/SPAN Metal Corporation of San Diego, California. The batten system shall be fabricated from 20 gauge sheet metal. The system shall have a UL Rating of 90.

The soffit shall be perma panels, 22 gauge, 6, G-90 as manufactured by AEP/SPAN Metal Corporation, or approved equal.

Steel for Painting/Coating: Hot-dip zinc coated steel sheet, ASTM A 446, Grade A, except as otherwise indicated, G90 zinc coating,, surface treated for maximum coating performance.

Internal Panel Framing: Manufacturer's standard.

Fasteners: Manufacturer's standard, with heads gasketed where exposed on exterior.

Accessories: Provide manufacturer's standard and accessories as required for a complete installation including trim, copings, cap flashings, fascia, gravel stops, mullions, sills, flashing, corner units, ridge closures, clips, seam closures, battens, gutters, downspouts, louvers, gaskets, sealants, and similar items.

Metal Finishes: Apply coatings indicated either before or after forming and fabricating panels, as required by coating process or for maximum coating performance. Provide colors or color matches as indicated or, if not otherwise indicated, as selected by Engineer from manufacturer's standard colors.

Fluoropolymer Coating: Baked-on fluoropolymer coating system consisting of epoxy or urethane primer and fluoropolymer topcoat formulated with "Kynar 500 resins, with dry film thickness of not less than 0.2 mil for primer and 1.0 mil for topcoat.

Fabricate and finish panels and accessories at factory to greatest extent possible, by manufacturer's standard procedures and processes to produce panels of the type indicated and to comply with indicated profiles, and to dimensional performance requirements indicated.

Installation:

Comply with panel manufacturer's instructions for anchorage, joint sealers, flashing and trim for the proper and permanent installation of panels, with provisions for thermal expansion, erected in panel pattern indicated.

Conceal fasteners by use of laps and joint clips.

SECTION 0.45-13 - BUILT-UP COAL TAR ROOFING SYSTEM:

General:

Built up roofing shall consist of four-ply felts, gravel surfaced, tar saturated roofing felt on tapered foamglass insulation.

Roofing system manufacturer's recommendations for components of roofing materials not listed in this Specification shall be complied with.

The roofing system shall be Kopper's Specification No. 220 as manufactured by Koppers Company, Inc. of Pittsburgh, Pennsylvania or an approved equivalent meeting the following requirements:

Classification: UL Class A rating.

Classification: FM "Class I" or "Noncombustible," and complying with zoned wind resistance of I-60 Zone.

Classification: UL "Fire-Classified," and complying with "Class 30" wind uplift resistance.

Manufacturer's Guarantee/Warranty: Manufacturer's standard 10-year guarantee.

Roofing Warranty: Provide "Roofing Contractor's" standard 2-year roofing guarantee; MRCA form 1970A, or equivalent form.

Roofing Warranty: 2-year warranty, in accordance with terms and conditions of form attached at end of this section.

Certification: After the roofing system has been installed, the Contractor shall require the roofing manufacturer to inspect and certify that the roofing system has been furnished and installed in accordance with the roofing manufacturer's materials and installation procedures, and approved modifications. A copy of the certificate shall be furnished and filed with the Engineer.

Aggregate-Surfaced Coal-Tar Bitumen Built-Up Roofing:

Insulation Board: The roof insulation shall be tapered Foamglass Board 1/4" per foot as manufactured by Pittsburgh Corning Corporation of Pittsburgh, Pennsylvania, or equal, as follows:

- (1) Thickness - 1-1/2", minimum.
- (2) Thermal Conductivity - 0.32, ASTM C518.
- (3) Compressive Strength - 100 psi, ASTM C165, C240.
- (4) Water Absorption (Volume %) - 0.2, ASTM C240.

4-courses of ply sheets, each mopped down with 23 pounds (+25 percent) of coal-tar bitumen (ASTM D 450, Type III; or Koppers Co. "Coal Tar Bitumen").

Ply Sheets: No. 15 coal-tar saturated organic felt, perforated (ASTM D 227, FS HHR B Type 15C, Style A.).

Steep Asphalt: ASTM D312, Type III.

Aggregate surfacing course of 75 pounds (+25 percent) of coal-tar bitumen, plus 500 pounds of gravel or crushed stone or 400 pounds of slag, cast in hot, fluid bitumen. Provide aggregate complying with ASTM D 1863; or if unavailable, provide aggregate complying with ASTM D 448 gradation, 6, 7, or 67 and with max. 3 percent moisture content and meeting all other requirements of ASTM D 1863.

Cant Strip: Foamglass as manufactured by Pittsburgh Corning Corporation or approved equal.

Plastic Cement: FS SS C-153, Type I, PC88 adhesive.

Roof Curb: Model CRC as manufactured by Custom Curb Company of Chattanooga, Tennessee, or approved equal with similar appearance. Height must allow minimum 8" above membrane surface and accommodate tapered insulation of varying thickness.

Flashing Material: Kopper's Specification No. 108 or equal.

Composition Flashing and Stripping: Provide composition flashing and stripping at edges and interruptions of roofing as shown and including the following:

Two piles of glass fiber fabric (ASTM D 1688), each set in and coated over with heavy coating of roofing cement (ASTM D 2822). Apply at metal flanges set on roof membrane at penetrations; set flanges in a bed of roofing cement.

At roof drains which do not have a metal flashing sheet, add two plies of glass fiber fabric and roofing cement. Extend stripping into clamping rings of drains.

For cap-sheet type roofing, substitute one ply of cap sheet for last ply of flashing or stripping, and omit final coating of roofing cement.

Counter Flashing: Type MA Springlock Flashing by Fry Reglet Corp., stainless steel Type 302.

Traffic Pads: 12" x 24" x 1/2", preformed slab or planking of asphalt fibers and fillers, by Manville Corp.

Installation:

Insulation:

Install insulation in accordance with the manufacturer's installation instructions.

Install insulation using approved mechanical fasteners, metal with metal washers, at minimum of 1 per 4 square feet.

Shingle successive plies of roofing, unless otherwise required by felt manufacturer's instructions. Lap base felts four inches at sides and six inches at ends.

Nailing: Where nailing is indicated and on nailable substrates, comply with felt manufacturer's recommendations, and with FM and UL requirements, for nailing of roofing to substrate.

On sloping substrates (sloping more than 3/8 inch for coal-tar bitumen, 3/4 inch for asphalt with asbestos felts, or 1 inch for asphalt with other felts) comply with NRCA "Roofing Manual" for nailing plies of BUR to substrate or to nailers in the substrate, and comply with composition roofing manufacturer's instructions for nailing composition roofing.

Bitumen Mopping: Apply interply and surface moppings of bitumen in accordance with the "EVT Method" as recommended by NRCA. Determine proper EVT for bitumen being applied either from manufacturer's data or bitumen container or from certification accompanying bulk bitumen.

Substrate Moisture: Do not install roofing on wet insulation or other moist substrates. Do not apply hot bitumen under a condition which would cause foaming (due to moisture).

Cant Strips: Provide cellular glass cant strips where edges of roofing adjoin vertical surfaces, to raise edges of roof membrane above main surface.

Tapered Edge Strips: Provide tapered edge strips where possible, where edges of roofing do not adjoin a vertical surface, to raise edges of roof membrane above main roof surface.

Nail edges of roofing where possible (without causing leaks), and nail composition flashing to vertical surfaces at edges and penetrations of roofing.

Seal edges of built-up roofing to prevent flow of bitumen into building and drains. Provide envelope of roofing felt, or, where envelope is not possible, provide large beads of roofing cement.

SECTION 0.45-14 - FLASHING AND SHEET METAL:

Fabricated Sheet Metal, General:

Conform to profiles and sizes shown, and comply with "Architectural Sheet Metal Manual" by SMACNA, for each general category of work required.

Metal flashing and counter flashing.

Gutters and downspouts (rain drainage).

Gravel stops, fascia units and trim.

Zinc-Coated Steel Sheet: ASTM A 526, 0.20 percent copper, 26 gage (0.0179 inch); ASTM A 525, designation G90 hot-dip galvanized, mill phosphatized.

Fabricate sheet metal with flat-lock seams; solder with type solder and flux recommended by manufacturer, except seal aluminum seams with epoxy metal seam cement and, where required for strength, rivet seams and joints.

Coat back-side of fabricated sheet metal with 15-mil sulfur-free bituminous coating, FS TT-C-494 or SSPC-Paint 12, where required to separate metals from corrosive substrates including cementitious materials, wood or other absorbent materials; or provide other permanent separation.

Provide for thermal expansion of running sheet metal work, by overlaps or expansion joints in fabricated work. Where required for water-tight construction, provide hooked flanges filled with polyisobutylene mastic for 1 inch embedment of flanges. Space joints at intervals of not more than 50 feet for steel, 24 feet for copper or stainless steel, or 30 feet for zinc alloy or aluminum. Conceal expansion provisions where possible.

Finish: Where adjoining metal roofing, provide finish and color to match roofing.

Installation Requirements:

Anchor work in place with noncorrosive fasteners, adhesives, setting compounds, tapes and other materials and devices as recommended by manufacturer of each material or system. Provide for thermal expansion and building movements. Comply with recommendations of "Architectural Sheet Metal Manual" by SMACNA.

Seal moving joints in metal work with elastomeric sealants, complying with FS SS-T-00227, -00230, or 001543.

Clean metal surfaces of soldering flux and other substances which could cause corrosion.

Nail flanges of expansion joint units to substrates at spacing of 6" o.c.

Composition Stripping: Cover flanges (edges) of work set on bituminous substrate with 2 courses of glass fiber fabric (ASTM D 1668) set in and covered with roofing cement, FS SS-C-153.

Performance: Water-tight/weatherproof performance of flashing and sheet metal work is required.

SECTION 0.45-15 - ROOF ACCESSORIES:

Standards: Comply with SMACNA "Architectural Sheet Metal Manual" details for fabrication of units, including flanges and cap flashing to coordinate with type of roofing indicated. Comply with "NRCA Roofing and Waterproofing Manual" details for installation of units.

Roof Accessory Materials Miscellaneous Units:

Sheet Metal: Except as otherwise indicated, 16 ounce lead-coated copper (ASTM B 101) with 0.076 pound lead coating on exposed surfaces.

Fasteners: Match metal and finish of metal work, or provide nonmagnetic stainless steel, unless another type fastener is recommended by manufacturer of accessory unit.

Roofing Cement: FS SS-C-153, type which is compatible with roofing, and nominally free of sulfur.

Bituminous Coating: 15 mil bituminous mastic coating, FS TT-C-494, or SSPC-Paint 12, nominally free of sulphur.

Mastic Sealant: Polyisobutylene type.

Prefabricated Roof Hatches:

General: Provide units of sizes indicated, with integrally insulated curbs and hatch doors, 1 inch thick glass fiber sandwiched insulation, sponge neoprene gaskets; hardware including self-lifting mechanism, hold-open devices, padlock hasp and exterior latch handle; metal counterflashing; fabricated from the following materials:

Zinc-coated steel sheet, prime painted.

Roof Hatch: Roof hatch to be Type S as manufactured by the Bilco Co. or approved equal products of:

Bohem Manufacturing Co., Inc.; West Conshohocken, Pa  
Bristol Fiberlite Industries; Santa Ana, CA  
Dur-Red Products; Cudahy, CA  
Hillsdale Industries, Inc; Knoxville, TN  
Naturalite, Inc.; Garland, TX  
Milcor Div./Inryco, Inc.; Milwaukee, WI  
Wasco Products, Inc.; Sanford, ME

Special Fabricated Roof Hatches: Provide hatches as described on the drawings. Install on integrally insulated curbs. All framing, sheet steel, and lifting lugs shall be galvanized.

Installation:

Seal waterproof expansion joints between roof accessory units with concealed pockets of mastic sealant.

Where flanges and bases of units set directly on roof or deck construction, set in bed of roofing cement or mastic sealant.

Anchor units securely to supporting structure, except for small accessory items which are embedded and stripped into roofing for support.

Coordinate installation with deck construction, vapor barrier (if any), insulation, roofing and flashing work, to provide waterproof and weatherproof installations, in accordance with Construction Details of NRCA Roofing and Waterproofing Manual.

Separate dissimilar metals by coating surfaces with bituminous coating or other permanent separation.

SECTION 0.45-16 - JOINT SEALERS:

General:

Preconstruction Joint Sealer-Substrate Tests: Submit substrate materials representative of actual joint surfaces to joint sealer manufacturer for laboratory testing of joint sealers for adhesion to primed and unprimed substrates and for compatibility with secondary seals, if required.

Preconstruction Field Tests: Prior to installation of joint sealers, field-test their adhesion to joint substrates as recommended in ASTM C 962.

Submittals: In addition to product data submit the following:

Samples of each type and color of joint sealer required.

Certified test reports for joint sealers evidencing compliance with requirements.

Products:

Compatibility: Provide joint sealers, joint fillers and other related materials that are compatible with one another and with joint substrates under service and application conditions, as demonstrated by testing and field experience.

Colors: Provide color of exposed joint sealers indicated or, if not otherwise indicated, as selected by Engineer from manufacturer's standard colors.

Elastomeric Sealant Standard: Provide manufacturer's standard chemically curing, elastomeric sealant of base polymer indicated, complying with ASTM C 920 requirements.

Two-Part Nonsag Polysulfide Sealant: Type M; Grade NS; Class 12 1/2; Uses NT, M, G, A and, as applicable to joint substrates indicated, O.

Multi-Part Nonsag Urethane Sealant: Type M, Grade NS, Class 25 uses NT, M, A and O as applicable to joint substrates indicated.

Two-Part Nonsag Low-Modulus Urethane Sealant: Type M, Grade NJS, Class 25, uses NT, M, A and O; with additional capability to withstand an increase and decrease of 50 percent of joint width as measured at time of application and remain in compliance with other requirements of ASTM C 920.

Bituminous Fiber Joint Filler: Preformed strips of composition below, complying with ASTM D 1751:

Asphalt saturated fiberboard.

Sealant Backings, General: Nonstaining; compatible with joint substrates, sealants, primers and other joint fillers; approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.

Plastic Foam Joint-Fillers: Preformed, compressible, resilient, nonwaxing, nonextruding strips of plastic foam of material indicated below, and of size, shape and density to control sealant depth and otherwise contribute to producing optimum sealant performance.

Open-cell polyurethane foam, flexible.

Elastomeric Tubing Joint Fillers: Neoprene, butyl or EPDM tubing complying with ASTM D 1056, nonabsorbent to water and gas, capable of remaining resilient at temperatures down to -26 degrees Fahrenheit ( $^{\circ}$  F.) (-15 degrees Celsius [ $^{\circ}$  C.]). Provide products with low compression set and of size and shape to provide a secondary seal, to control sealant depth and otherwise contribute to optimum sealant performance.

Bond-Breaker Tape: Polyethylene tape or other plastic tape as recommended by sealant manufacturer for preventing bond sealant and joint filler or other materials at back (3rd) surface of joint.

Primer: Type as recommended by joint sealer manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint sealer-substrate and field tests.

Execution:

General: Comply with joint sealer manufacturer's printed installation instruction applicable to products and applications indicated.

Elastomeric Sealant Installation Standard: Comply with ASTM C 962.

SECTION 0.45-17 - STEEL DOORS AND FRAMES:

Standards: In addition to other specified requirements, comply with Steel Door Institute "Recommended Specifications for Standard Steel Doors and Frames" (SDI-10), for the following classifications:

Exterior Doors: SDI-100, Grade III, extra heavy-duty, Model 2, minimum 16-gage faces and shall be hot dip galvanized.

Minimum door thickness 1-3/4". Honeycomb core.

Submittals: With manufacturer's standard details and specifications for steel doors and frames, submit shop drawings showing application to project, as required.

Manufacturer: One of the following:

Allied Steel Products, Inc.  
Amweld/Div. American Welding & Mfg. Co.  
Ceco Corp.  
Curries Mfg., Inc.  
Dittco Prod. Div.  
Fenestra Corp.  
Mesker Industries, Inc.  
Pioneer Bldrs. Products Corp./Div. CORE Industries, Inc.  
Steelcraft/Div. American Standard Co.  
Trussbilt, Inc.  
Republic Builders Products Corp./Subs. Republic Steel

Materials: Steel doors and frames; hot-rolled, pickled and oiled per ASTM A 569 and A 568; cold-rolled per ASTM A 366 and A 568.

Galvanized sheets, ASTM A 526 with ASTM A 525, G 90 zinc coating, not lighter than 16 gage, mill phosphatized (FS TT-C-490).

Anchors and Accessories: Manufacturer's standard units. Use galvanized items for units built into exterior walls, complying with ASTM A 153.

Fabrication: Fabricate units to be rigid, neat in appearance, and free from defects, warp or buckle. Weld exposed joints continuously, grind, dress, and make smooth, flush and invisible. Close top and bottom edges as integral part of door construction or by addition of inverted steel channels.

Prepare steel doors and frames to receive mortised and concealed finish hardware, including cutouts, reinforcing, drilling and tapping, complying with ANSI A 115 "Specifications for Door and Frame Preparation for Hardware."

Reinforce units to receive surface-applied finish hardware to be field applied.

Minimum thickness of hardware reinforcing plates shall be:

Hinge & pivot - 7 gage 1'4" x 10" minimum size  
Strike - 12 gage  
Flush Bolt - 12 gage  
Closer - 12 gage

Locate finish hardware as indicated or, if not indicated, per DHI "Recommended Locations for Builder's Hardware".

Shop paint exposed surfaces of doors and frame units, including galvanized surfaces, using manufacturer's standard baked-on rust inhibitive primer.

Doors: Comply with SDI-100, of the types and styles indicated, for materials quality, metal gages, and construction details.

Frames: Comply with SDI-100, of the types and styles indicated, for materials quality, metal gages, and construction details. Gage not less than 16 and hot dip galvanized.

Provide standard hollow metal frames for doors, transoms, sidelights, borrowed lights, and other openings as indicated.

Prepare frames to receive two silencers on strike jambs.

Provide 26-gage steel plaster guards or mortar boxes, welded to frame, at back of hardware cutouts where installed in concrete, masonry or plaster openings.

Protect inside faces of frames in masonry wall construction which are placed with anti-freeze additives, using high-build fibered asphalt emulsion coating.

Hardware:

Hinges: 4-1/2 x 4-1/2 standard weight, two ball bearing, solid stainless steel, US32D with nonremovable pins, as manufactured by Stanley, Hager, Lawrence, or approved equivalent, except as noted.

Locksets: Corrosion resistant mortise locks with 3/4 throw US323D, as manufactured by Sargent (8700 Series), Russwin (3000 Series), Yale (8000 Series), or approved equivalent (FS FF-H-06106 B Series).

Cylinders: Removable core cylinder US32D. All cylinders to be manufactured to fit a template key that will be provided by the Engineer.

Closers: Primed, Sargent (154 Series) LCN (4010 Series) or approved equivalent.

Thresholds: Extruded aluminum 4 inches wide with accommodation to fit 1/2" offset per drawings.

Door Stops: Stainless steel and rubber tip type, as applicable.

Weatherstrip: Provide weatherstripping at jambs and heads of all doors. Provide drip sweep at bottom.

Installation: Install hollow-metal units in accordance with manufacturer's instructions, final shop drawings and these Specifications. Fit doors to frames and floors with clearances specified in SDI-100. Install hardware per manufacturer's instructions.

Frames shall be set accurately in position plumb, aligned and braced securely until permanent anchors are set. The bottom of the frames will be anchored to floors with expansion bolts or with power fasteners if required. Build-in wall anchors shall be used to secure to adjoining construction as indicated. Backfill frames shall be built into masonry construction as wall construction proceeds.

Doors shall be hung where indicated and in a manner which will ensure smooth and easy operations, and which will eliminate binds, warps and squeaks. Adjust and lubricate hardware to operate properly. Fully seat screws and fasteners.

A prime coat touch-up shall be applied immediately after installation: sanding, smoothing and touching up with same primer as applied at the factory, all rust and all areas where prime coat has been damaged shall be carefully done. Touch up shall not be obvious.

SECTION 0.45-18 - ACCESS DOORS:

Submittals: Manufacturer's standard details and specifications.

Manufacturers: One of the following:

Bar-Co., Inc.  
J.L. Industries  
Karp Associates, Inc.  
Milcor Div.; Inryco-Inc.  
Nystrom, Inc.

Frames: 16-ga. steel, factory primed.

Fabricate frame with exposed flange nominal 1 inch wide for access doors located in the following construction:

Exposed masonry; also furnish adjustable masonry anchors.

Flush Panel Doors: Factory primed 14-gage steel or heavier with manufacturer's standard hinges for access doors located in the following construction:

Exposed masonry.

Locking Devices: Flush, screwdriver-operated, cam type locks as required for panel size.

Key operated mortise cylinder with interior latch release mechanism as shown on the plans. All locks to be manufactured to fit a template key provided by the Engineer.

Installation: Coordinate installation with work of other trades and locate accurately. Comply with manufacturer's instructions for secure attachment, proper relation to adjacent finished surfaces and proper operation.

SECTION 0.45-19 - LOUVERS AND VENTS:

Performance Standards: For performance-rated louvers, provide units whose ratings have been determined in compliance with AMCA Standards 500.

SMACNA Standards: Comply with "Architectural Sheet Metal Manual" recommendations for fabrication, construction and installation procedures.

Field Measurements: Verify size, location and placement of louver units prior to fabrication, where possible.

Preassemble units in shop to greatest extent possible.

Submittals: In addition to manufacturer's product data, submit the following:

Shop drawings for assemblies not completely described in product data.

Samples of each type of metal finish.

Manufacturer: Subject to compliance with requirements to provide units as manufactured by one of the following:

Airline Products Co.  
The Airolite Co.  
American Warming and Ventilating Co.  
Construction Specialties, Inc.  
Industrial Louvers, Inc.  
Ruskin Mfg. Co.

Galvanized Sheet Steel: ASTM A 526, G90, mill phosphatized.

Cold-Rolled Sheet Steel: ASTM A 366, Class I, matte finish.

Aluminum Sheet: ASTM B 209, Alloy 3003, or 5005 with temper as required for forming and to provide required finish.

Aluminum Extrusions: ASTM B 221, Alloy 6063-T52.

Fastenings: Use same material as metal fastened except use hot-dipped galvanized for exterior steel units and stainless steel for exterior aluminum units.

Bituminous Paint: SSPC-Paint 12 (cold-applied asphalt mastic).

Fabrication, General: Provide louvers and accessories of design, materials, sizes, depth, arrangement, and metal thicknesses indicated or required for performance and use intended. Fabricate frames, including sills and sill flashing to suit adjacent construction.

Join frame members to one another and to blades by welding, except where indicated otherwise, or field-bolted assembly is required.

Provide stiffener bar to connect louver blades and provide concealed (inside) vertical mullion if span of louver blades exceeds manufacturer's required standard.

Stationary Extruded Aluminum Wall Louvers: Provide horizontal drainable blade louvers with extrusions not less than 0.081 inch thick. Basis of design is Model LE-49, Type 3.SILL as manufactured by American Warming and Ventilating, Inc.

Louver Screens: On inside face of exterior louvers, provide 1/2 inch square mesh anodized aluminum wire (minimum 0.0625") birdscreens mounted in removable frames of same metal as louvers.

Metal Finishes: Comply with NAAMM "Metal Finishes Manual" to provide uniformly finished products.

Provide color or color matches as indicated or, if not otherwise indicated, as selected by Engineer from manufacturer's standard colors.

Colored Aluminum Finish: AA-C-22A42 (medium matte etched finish with 0.7 mil min. thick colored anodic coating).

Installation: Locate and place louver units plumb, level, in proper alignment with adjoining work, and in accordance with manufacturer's instructions.

Use nonferrous metal or galvanized anchors and inserts for exterior installations and elsewhere where required for corrosion resistance.

Protect aluminum surfaces from corrosion when in contact with dissimilar metals and concrete or masonry by coating contact surfaces with zinc chromate primer or bituminous paint.

Provide concealed gasket, flashings and joint fillers as indicated, and as required to make installation weathertight.

Repair damaged finishes so that that is no evidence of corrective work.

SECTION 0.45-20 - PAINTING:

Submittals: Prior to beginning work, Engineer will furnish color chips for surfaces to be painted. In addition to manufacturer's data, application instructions, and label analysis for each coating material, submit samples for Engineer's review of color and texture only. Resubmit samples if requested until required sheen, color and texture is achieved.

On 12" x 12" hardboard, provide two samples of each color and material, with texture to simulate finish conditions.

On concrete masonry, provide two 4 inch square samples of masonry for each type of finish and color, defining filler, prime and finish coats.

On actual wall surfaces and other building components, duplicate painted finishes of acceptable samples, as directed by Engineer.

Description of Work: Painting and finishing of interior and exterior items and surfaces, unless otherwise indicated:

Includes field painting of bare and covered pipes and ducts (including color coding), and hangers, exposed steel and iron work, and primed metal surfaces of equipment installed under mechanical and electrical work.

Paint exposed surfaces, except as otherwise indicated, whether or not colors are designated. If not designated, colors will be selected by Engineer from standard colors available for the coatings required.

Work Not Included: Unless otherwise indicated, shop priming of ferrous metal items and fabricated components are included under their respective trades. Unless otherwise indicated, painting not required on surfaces of concealed areas except for piping, equipment and other such items within the concealed spaces. Finished metals such as anodized aluminum, stainless steel, bronze, baked enamel sheet metal, and similar metals will not be painted. Do not paint any moving parts of operating units, or over any equipment identification, performance rating, name or nomenclature plates or code-required labels.

Delivery and Storage: Deliver materials to job site in new, original and unopened containers bearing manufacturer's name, trade name, and label analysis. Store where indicated in accordance with manufacturer's instructions.

Job Conditions: Do not apply paint in snow, rain, fog or mist or when relative humidity exceeds 85 percent. Do not apply paint to damp or wet surfaces.

Protection: Protect work of other trades. Correct any painting related damages by cleaning, repairing or replacing, and refinishing, as directed by Engineer.

Coordination: Provide finish coats which are compatible with prime paints used. Provide barrier coats over incompatible primers where required. Notify Engineer in writing of anticipated problems using specified coatings with substrates primed by others.

Surface Preparation: Perform preparation and cleaning procedures in strict accordance with coating manufacturer's instructions for each substrate condition.

Remove hardware and accessories, machined surfaces, plates, lighting fixtures and similar items in place and not to be finish-painted or provide surface-applied protection. Reinstall removed items and remove protective coverings at completion of work.

Prepare cementitious surfaces of concrete, concrete block and similar materials to be painted by removing efflorescence, chalk, dust, dirt, grease and oils, and by roughing to remove glaze. Determine alkalinity and moisture content of surfaces to be painted before beginning painting. Do not paint over surfaces where alkalinity or moisture content exceeds manufacturer's recommendations.

Clean ferrous surfaces which are not galvanized or shop-coated. Remove oil, grease, dirt, loose mill scale and other foreign substances by solvent or mechanical cleaning. Touch up shop-applied prime coats wherever damaged.

Clean galvanized surfaces free of oil and surface contaminants with nonpetroleum based solvent.

Material Preparation: Mix, prepare, and store painting and finishing materials in accordance with manufacturer's directions.

Application: Apply painting and finishing materials in accordance with manufacturer's directions. Use applicators, and techniques best suited for material and surfaces to which applied.

Apply additional coats when undercoats, stains or other conditions show through final paint coat, until paint film is of uniform finish, color and appearance.

Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Paint surfaces behind permanently fixed equipment or furniture with prime coat only before equipment is installed.

Paint interior surfaces of ducts, where visible through registers, grilles, or louvers, flat, nonspecular black.

Paint back sides of access panels, and removable or hinged covers to match exposed surfaces.

Finish exterior doors on tops, bottoms and edges same as exterior faces, unless otherwise indicated.

Sand lightly between succeeding enamel or varnish coats.

Omit first coat (primer) on metal surfaces which have been shop-primed and touch-up painted, unless otherwise specified.

Apply prime coat to material which is required to be painted or finished, and which has not been prime coated by others.

Apply each material at not less than manufacturer's recommended spreading rate to provide a total dry film to thickness of not less than 4.0 mils for entire coating system of prime and finish coats for 3-coat work.

Completed Work: Match approved samples for color, texture and coverage. Remove, refinish or repaint work not in compliance with specified requirements.

Paint Schedule:

All finish painting shall be semi-gloss unless noted otherwise.

Proprietary names used are those of DAVIS PAINT CO. This is intended to establish a standard of quality, and does not imply that referenced products are required to the exclusion of equivalent products or other approved manufacturer's. Equivalent products of the following manufacturers are approved, provided acceptable colors and products are available:

Benjamin Moore  
Davis Paint Co.  
Glidden  
Iowa Paint  
Martin Senour  
Pittsburgh Paint Co.  
Pratt & Lambert Co.  
Sherwin-Williams  
Valspar

Provide undercoat paint produced by the same manufacturer as the finish coats. Use only thinners approved by the paint manufacturer, and use only within recommended limits.

EXTERIOR PAINT SYSTEMS:

Provide the following paint systems for the various substrates, as indicated. The abbreviation "ics" means "in color selected".

Concrete:

1st coat - Hold-Tite Primer  
2nd coat - Super Hold-Tite acrylic emulsion Satin (ics)  
3rd coat - Super Hold-Tite acrylic emulsion Satin (ics) Same color.

Concrete Masonry Units (Not integral colored units):

1st coat - #4273 Latex Block Filler  
2nd coat - Super Hold-Tite acrylic emulsion Satin (ics)  
3rd coat - Super Hold-Tite acrylic emulsion Satin (ics) Same color.

Ferrous Metal:

1st coat - #2714 Rust Inhibitive Red Oxide Primer  
2nd coat - Super Hold-Tite acrylic emulsion Satin (ics)  
3rd coat - Super Hold-Tite acrylic emulsion Satin (ics) Same color.

First coat may be used for touch-up only on items delivered shop primed.

Zinc Coated Metal:

1st coat - Universal First Coater or Industrial Galvanized Metal Pr. 4-1010  
2nd coat - Industrial acrylic emulsion enamel (ics)  
3rd coat - Industrial acrylic emulsion enamel (ics) Same color.

INTERIOR PAINT SYSTEMS:

Concrete:

1st coat - Kwik-Kote Latex Primer  
2nd coat - Da-Tex Alkyd Satin Enamel (ics)  
3rd coat - Da-Tex Alkyd Satin Enamel (ics) Same color.

Concrete Masonry Units:

1st coat - #4273 Latex Block Filler  
2nd coat - Da-Sheen Satin Latex (Semi-gloss finish)  
3rd coat - Da-Sheen Satin Latex (Semi-gloss finish)

Ferrous Metal:

1st coat - #2714 Rust Inhibitive Red Oxide Primer  
2nd coat - Da-Tex Alkyd Enamel (Semi-gloss finish) (ics)  
3rd coat - Da-Tex Alkyd Enamel (Semi-gloss finish) (ics) Same Color.

First coat may be used for touch-up only on items delivered shop primed. Not less than 3 mils DFT, excluding primer.

Zinc Coated Metal:

- 1st coat - Universal First Coater or Industrial Galvanized Metal  
Pr. 4-1010
- 2nd coat - Da-Tex Alkyd Satin Enamel (Semi-gloss finish) (ics)
- 3rd coat - Da-Tex Alkyd Enamel Satin (Semi-gloss finish) (ics) Same  
Color.

Not less than 3 mils, DFT, excluding primer.

Concrete Floors:

- 1st coat - Tuff-Thane Urethane Concrete coat 4-9149 with Saf-Step  
added to prevent slipping.

Mechanical Items to be Identified:

Mechanical items to be color code painted or tag identified shall conform to ANSI Z-53.1 latest revision, "Safety Color Code for Marking Physical Hazards".

SECTION 0.45-21 - PLUMBING:

DESCRIPTION:

The Contractor shall furnish and install the plumbing as shown on the plans and as specified herein.

GENERAL:

Coordination: The Contractor shall be responsible for coordinating this work with other trades. Furnish and locate all sleeves, wall pipes, hangers, and appurtenances as required for this work.

Permits: The Contractor shall obtain all permits and inspections required by all laws, ordinances, rules, regulations, and public authority having jurisdiction and shall obtain certificates of such inspections and submit same to the Engineer, and shall pay all fees, charges, and expenses in connection therewith.

Codes: All work shall be installed in full accordance with all rules, regulations, and safety requirements of all state and local authorities having jurisdiction over the premise. All work shall be inspected as the work progresses, and a certificate of approval issued by the appropriate authority before estimates are submitted.

APPROVAL DRAWINGS:

Shop drawings shall be submitted to the Engineer for approval. Shop drawings shall include detailed, single line piping layouts at a scale of 1/4 inch equals 1 foot. The piping layouts shall be dimensioned and show all the connected equipment with a reference to the equipment shop drawings. Data sheets shall show details of construction, sizes, materials, cuts of equipment, capacities, controls, wiring, and finish. Fabrication and installation shall be in accordance with the approved shop drawings.

PIPING, FITTING AND ACCESSORIES:

Plant Water Piping: Piping 1-1/2 inches and smaller shall be copper with sweat type fittings. Pipe 2 inches and larger shall be copper or Schedule 40 yoloy.

Exposed Copper: Exposed copper piping shall be Type L hard copper.

Buried Copper: Buried copper piping shall be Type K copper.

Dielectric Fittings: Dielectric fittings shall be used at all junctions of dissimilar metals.

Shock Absorbers: Install shock absorbers in all runs to fixtures and where shown on the plans.

Roof Drainage Piping: Piping shall be Schedule 40 yolooy or as shown on the plans. Fittings shall be malleable iron with threaded joints.

Roof Drains: Roof drains shall be cast iron with round flanges, lacquer finish, nonpuncturing flashing clamp and gravel stop, deck clamp if required, sump receiver, and cast aluminumdome. Roof drains shall be Zurn, Josam, Wade, Smith, or equal. Roof drains shall be of the size and type shown on the plans.

Cleanouts: Cleanouts shall be installed at the base of each stack and where shown on the plans. Cleanouts shall be easily accessible for rodding.

Unions: Unions shall be installed adjacent to all valves and equipment.

Joints: All joint shall be made watertight.

Pipe Hangers: All pipe shall be properly supported by substantial hangers and wall straps. Pipe hangers shall be adjustable, wrought iron, clevis type, spaced as required by the size and type of piping so as to produce no undue strain or bending. All copper pipe shall be completely isolated from hangers and/or straps if or dissimilar metal.

Sleeves: Where lines pass through interior walls, floor, or ceilings, they shall be provided with Schedule 40 galvanized steel or PVC sleeves set flush having a diameter 3/4 inch larger than the pipe passing through. All sleeves shall be packed solid with jute or hemp rope, sealed, and capped with escutcheon plates on each end.

GATE VALVES:

Gate valves shall be 125 pound, all bronze, non-rising stem, double disc or wedge type, with handwheel. Gate valves shall be installed adjacent to all equipment and where shown on the plans.

GLOBE VALVES:

Globe valves shall be 125 pound, all bronze, non-rising stem, with handwheel.

CHECK VALVES:

Check valves shall be 125 pound, all bronze, swing type, with bronze disc.

#### SOLENOID VALVES:

Solenoid valves shall be two way, spring loaded, 115 volt, 60 hertz, single phase, capable of being mounted in any position. Solenoids shall be of a material compatible or resistant to the liquid handled. Valves shall open when energized and close when deenergized. Solenoids shall be Asco, Valcor, Ross, or equal.

#### NEEDLE VALVES:

Needle valves shall be heavy union bonnet type, all bronze, threaded ends with back seats to permit repacking under pressure.

#### HOSE BIBBS:

Hose bibbs shall be heavy brass compression type, 150 pound working pressure with renewable seats and vacuum breaker. Hose bibbs shall have 3/4 inch supply with 3/4 inch hose connections.

#### REDUCED PRESSURE BACKFLOW PREVENTER:

Backflow preventers shall be of the reduced pressure type meeting American Society of Sanitary Engineers (ASSE) Standard 1013 and come complete with gate valves, test cocks, and suitable type connections. They shall be made of corrosion resistant materials, conforming to AWWA C506, and be Watts Model 900, Febco, or equal.

#### PRESSURE GAUGES:

Pressure gauges shall be bourdon type, Type 316 stainless steel, plastic window, 4-1/2 inch dial. Gauges shall be capable of reading from 0 to the specified pressure in pounds per square inch (psi) with a plus or minus 1/2 degree accuracy. Gauges shall come complete with pulsation damper, pigtail siphon, brass tee handle cock, and back connections, Ashcroft Duragauge Marsh, or equal.

#### STRAINERS:

Strainers shall be "Y" pattern, 125 pound, with Type 316 stainless steel strainer basket and body of the same material as the adjoining pipe.

#### ELECTRICAL WORK:

The furnishing and mounting of all motor starting switches and all power wiring through to all motors, controls and switches, and any manual disconnects required by code and not included as an integral part of the specified equipment shall be performed under Section 0.45-48."

SECTION 0.45-22 - PIPE AND FITTINGS INSIDE STRUCTURES:

DESCRIPTION:

The Contractor shall furnish and install the pipe and fittings inside structures as shown on the plans and as specified herein.

APPROVAL DRAWINGS:

Shop drawings shall be submitted to the Engineer for approval. Shop drawings shall show materials and their properties, types, sizes, coatings and linings, connections, layouts, and locations. Shop drawings shall include detailed piping layouts at a scale of 1/4 inch equals 1 foot. Piping 4 inches and smaller may be shown as single lines. The piping layouts shall be dimensioned and show all connected equipment with a reference to the equipment shop drawings. Fabrication and installation shall be in accordance with the approved shop drawings.

MATERIAL:

Gray (Cast) Iron:

Pipe: Gray iron pipe shall conform to ANSI A21.6 (AWWA C106), with the following exceptions: Ends of pipe shall be designed for type of joints shown on the plans and permissible under these specifications. Unless otherwise noted on the plans, the minimum thickness of the barrel of the gray iron pipe shall be Class 22.

Fittings: Gray iron fittings shall conform to ANSI A21.10 (AWWA C110) for short bodied fittings or ANSI B16.1 for special fittings. Unless otherwise noted on the plans, fittings shall be suitable for a minimum working pressure of 150 pounds per square inch (psi). Ductile iron fittings may be used in lieu of gray iron fittings.

Ductile Iron:

Pipe: Ductile iron pipe shall conform to ANSI A21.51 (AWWA C151). The chemical constituents shall meet the physical property recommendations of ASTM A536 to ensure that the iron is suitable for satisfactory drilling and cutting. Unless otherwise noted on the plans, the minimum thickness of the barrel of the pipe shall be not less than Class 53.

Fittings: Ductile iron fittings shall conform to ANSI A21.10 (AWWA C110). Flanged fittings shall be suitable for a minimum working pressure of 250 psi, all other fittings shall be suitable for a minimum working pressure of 350 psi, except sizes 30 inches in diameter and larger shall be suitable for a minimum working pressure of 250 psi.

Polyvinyl Chloride (PVC):

Pipe: PVC pipe shall conform to ASTM D1785, PVC 1120, Schedule 80 for a working pressure of 150 psi, unless otherwise noted on the plans.

Fittings: PVC fittings shall conform to ASTM D2467, PVC 1120, Schedule 80 for a minimum working pressure of 150 psi.

Fiberglass Reinforced Plastic (FRP): FRP pipe and fittings shall consist of a glass fiber reinforced epoxy or polyester resin. Resin shall be as recommended by the manufacturer for the service required. All fittings shall be factory fabricated. Pipe and fittings shall be filament wound and shall be suitable for a working pressure of 125 psi unless otherwise noted on the plans.

Black and Galvanized Steel:

Pipe: Steel pipe shall conform to ASTM A120, Schedule 40, for a working pressure of 150 psi, unless otherwise noted on the plans.

Fittings: Steel fittings, unless otherwise shown, shall be malleable iron suitable for a minimum working pressure of 150 psi and conforming to ANSI B16.3.

Stainless Steel: Stainless steel pipe and fittings shall conform to AISI Type 316, all welded, solution annealed and pickled. Unless otherwise shown on the plans, the minimum thickness shall be Schedule 10.

Pipe Hangers: Pipe hangers, unless otherwise shown, shall be of the heavy duty clevis type consisting of a top yoke, bottom strap, bolt with nut and supporting rod, nuts, and washers. Hangers shall be sized for the pipe being supported.

Joint Lubricant: Lubricant shall be nontoxic, not support the growth of bacteria, have not deteriorating effects on the gasket, pipe, or fitting, and shall not impart a taste or odor to the liquid being carried in the pipe.

JOINTS:

Flanged: Flanged joints for iron pipe shall meet the requirements of ANSI A21.15 (AWWA C115) or ANSI B16.1, Class 125, unless otherwise noted.

Gaskets: All flanged joints shall be furnished with 1/8 inch thick full face red rubber or full face asbestos fiber gaskets, except air and gas piping shall be provided with full face asbestos fiber gaskets only.

Bolts: Bolts shall have American Standard heavy unfinished hexagonal head and nut dimensions conforming to ANSI B18.2. For bolts of 1-3/4 inch in diameter and larger, bolt studs with a nut on each end are recommended. Material for bolts and nuts shall conform to ASTM A307, Grade B.

Push-on and Mechanical: Push-on and mechanical joints for iron pipe and fittings shall conform to ANSI 21.11 (AWWA C111). Bolts shall be high strength cast iron tee head with hex nuts.

Bell and Spigot: Bell and spigot joints for iron pipe and fittings shall conform to ANSI A21.6 (AWWA C106).

Grooved and Shouldered: Grooved and shouldered joints shall conform to AWWA C606. Rigid joints shall be provided, unless otherwise noted.

Welded:

Steel: In conformance with AWWA C206.

Plastic: As per the manufacturer's recommendations.

Threaded and Coupled: In conformance with American Standard Taper Pipe thread ANSI B2.1.

COATINGS AND LININGS:

Paint: The outside of all ferrous pipe and fittings, except plastic coated pipe and fittings, shall be shop primed as specified under Section 0.45-20, "Painting".

Bituminous and Coal Tar: The inside of ferrous pipe and fittings, except plastic, glass, or cement lined pipe and fittings, shall be coated with a bituminous material in accordance with ANSI A21.6 (AWWA C106) for iron pipe, asphaltic material in accordance with ANSI A21.4 (AWWA C104) for ductile iron pipe, and with a coal tar in accordance with AWWA C203 for steel pipe.

Glass: A glass lining, when required, shall be a minimum of two coats, fired separately, for a total thickness of not less than 0.008 inch, have a hardness of five to six on the MOHS scale with a density of 2.5 to 3.0 grams per cubic centimeter. Glass lining shall be capable of withstanding a thermal shock of 350 degrees Fahrenheit (°F.), solutions with pH range of 3 to 10 and no visible loss of surface gloss after immersion in an 8 percent sulfuric acid solution at 148°F. for 10 minutes. In addition, the lining, when tested according to ASTM C283, shall show a weight loss of not more than 3 milligrams per square inch. Lining shall be Ervite Type SG-14 by the Ervite Corporation, the Glass Lined Pipe Company, or equal.

Plastic: A plastic coating and/or lining, when required, shall be not less than 60 mils thick, be corrosion and abrasion resistant, and be a vinyl polymer conforming to ASTM F491 or a polyethylene copolymer conforming to ASTM F546.

Cement: When required, pipe and fittings shall be lined with cement mortar and seal coated in accordance with ANSI A21.4 (AWWA C104).

#### INSTALLATION:

General: Proper and suitable tools and appliances for the safe and convenient handling and placing of the pipe and fittings shall be used. Great care shall be taken to protect the pipe, coating, and lining from damage. All pieces shall be carefully examined for defects and no piece shall be installed which is known to be defective. If any defective piece shall be discovered after having been installed, it shall be removed and replaced with a sound piece in a manner satisfactory to the Owner by the Contractor at his own expense. The pipe and fittings shall be kept clean until they are accepted in the completed work and when installed shall conform accurately to the lines and grades given.

Pipe Cutting: The cutting of pipe shall be done in a neat and workmanlike manner without damage to the pipe, coating, or lining. The end shall be smooth and at right angles to the axis of the pipe. Flame cutting of metal pipe shall not be permitted. All pipe cutting shall be at the Contractor's expense.

Flanged Joints: Prior to assembling a flanged joint, care shall be taken to ensure that the flange faces are clean and that the gasket is in place. Flanged joints shall be fitted so that the contact faces bear uniformly on the gasket and then are made up with relatively uniform bolt stress. Special attention shall be given to the installation of wall pipes to ensure proper alignment with the connecting flanges.

Mechanical Joints: Mechanical joints for metal pipe require that the spigot be centrally located in the bell. The surfaces with which the rubber gasket comes in contact shall be thoroughly cleaned just prior to assembly. These clean surfaces shall then be brushed with a special lubricant just prior to slipping the gasket over the spigot and into the bell. The lubricant shall also be brushed over the gasket prior to installation to remove the loose dirt and lubricate the gasket as it is forced into its retaining space.

Bolt Torques: The normal range of bolt torques to be applied to standard cast iron bolts in a joint are:

| <u>Size</u> | <u>Range of Torque<br/>in Foot-pounds</u> |
|-------------|---|
| 5/8"        | 40 - 60                                   |
| 3/4"        | 60 - 90                                   |
| 1"          | 70 - 100                                  |
| 1-1/4"      | 90 - 120                                  |

Push-on Joints: The surfaces with which the rubber gasket comes in contact shall be thoroughly cleaned just prior to assembly. The gasket shall then be inserted into the groove in the bell. Before starting joint assembly, a liberal coating of special lubricant shall be applied to the spigot end. With the spigot and centered in the bell, the spigot end is pushed home.

Lead Joints: In joining pipes, the spigot of each piece shall be properly seated in the bell of the next adjacent piece and adjusted so as to give a uniform joint space around the entire circumference of the pipe. Joints shall be made with twisted jute or braided hemp packing and soft pig lead. Sterilized hemp or jute shall be used on all joints for lines carrying potable water. Where possible, each joints shall be made in one pouring. The joints shall be thoroughly caulked by competent mechanics and in such manner as will ensure the construction of a tight joint without overstraining the bells. All lead used shall be of the best quality subject to the approval of the Engineer. No jointing compound will be permitted. The packing shall be thoroughly driven into the bell so that the lead, after having been caulked, shall have a depth a follows:

| <u>Pipe Size</u> | <u>Depth of Lead</u> |
|------------------|----------------------|
| 3" - 20"         | 2-1/4"               |
| 24" - 30"        | 2-1/2"               |
| 36" and larger   | 3"                   |

Pipe Supports, Hangers, and Blocking: The Contractor shall furnish And install, whether shown on the plans or not, all required supports, hangers, and blocking. Thrust blocking shall be provided at all bends and tees, where changes in pipe diameter occur at reducers or in fittings, at all dead ends, and at pipes which are tapped or plugged. Pipe supports, hangers, and thrust blocks shall be of the size, shape, and quantities as shown on the plans or as required. All proposed hangers, supports, and blocking must be approved before placement. Spacing of supports and hangers shall not exceed the manufacturer's recommendations for the type and class of pipe and temperature of liquid being carried.

TESTING:

All pipe and fittings shall be installed with watertight joints. The Contractor shall test all pump discharge piping by filling the lines with water to 150 psi and all other lines to 50 psi and maintaining the pressure for 6 hours. Any leakage shall be corrected by the Contractor at no cost to the Owner.

DISINFECTION:

Pipelines designed to carry water for domestic consumption shall be thoroughly cleaned, flushed, and disinfected before being put in service and before acceptance by the Owner. Disinfection shall be done by the addition of suitable amounts of chlorine in the form of liquid chlorine or high test hypochlorite of lime. The application shall be as approved by the Owner and in accordance with AWWA C651. Tests for efficacy of disinfection shall be carried out by the Contractor when required at no cost to the Owner.

SECTION 0.45-23 - PUMPS, GENERAL:

DESCRIPTION:

The Contractor shall furnish and install the pumps as shown on the plans and as specified herein.

GENERAL:

The pumping equipment shall be heavy duty, suitable for continuous, efficient, and dependable service under the operating conditions imposed by the installation. All pumps of a given type shall be of the same manufacturer. See the Equipment Schedule for capacity, head, speed, and other pertinent data.

Castings: All castings shall be free of warp, fins, gas and pit holes, and other defects that might impair strength or appearance. Cast iron castings shall have a minimum tensile strength of 30,000 pounds per square inch (psi) and conform to the applicable ASTM standard.

Steel: All steel shall conform to the applicable ASTM standard. All welding shall be in accordance with the standards of the American Welding Society.

Painting: See Section 0.45-20, "Painting."

Electrical: See Section "Electrical, General" and Section "Electrical, Detailed."

PERFORMANCE DATA:

Performance data and curves shall be submitted to the Engineer for preliminary approval of the pumping equipment to be furnished. Such data shall be based on actual tests of similar equipment and include sufficient data to demonstrate suitability of both the pump and driver for the conditions specified. Prior to shipment the pump manufacturer shall provide the Engineer with certified copies of the pump curves.

APPROVAL DRAWINGS:

Shop drawings shall be submitted to the Engineer for approval. Shop drawings shall show dimensional layouts, anchor bolts, sectional views of pump construction, driver specifications, and a bill of materials. Fabrication and installation shall be in accordance with the approved shop drawings.

MOTORS:

Motors, unless otherwise noted, shall be continuous duty, constant speed, normal starting torque, squirrel cage, induction type, Class F insulation, full voltage starting, and shall meet the requirements of the applicable NEMA standard. Motors shall have 1.15 service factor rating. The brake horsepower (BHP) shall not exceed the nameplate horsepower under the operating conditions as listed in the applicable Equipment Schedule. Motors shall be designed to operate at the highest efficiency and power factor. Motors shall be of standard manufacture, Westinghouse, General Electric or equal.

PUMP TEST:

All pumps shall be inspected and tested as follows and written certification provided prior to shipment:

(1) Impeller, motor rating and electrical connections shall first be checked for compliance to the customer Purchase Order.

(2) A motor and cable insulation test for moisture content or insulation defects shall be made.

(3) Prior to submergence, the pump shall be run dry to establish correct rotation and mechanical integrity.

(4) The pump shall be run for 30 minutes submerged, a minimum of 6 feet under water.

(5) After operational test 4, the insulation test 2 is to be repeated.

(6) One pump shall be performance tested per Hydraulic Institute Standards.

SPARE PARTS:

The spare parts shall be tagged for positive identification and stored on the site where directed.

OPERATION AND MAINTENANCE MANUALS:

Four operation and maintenance (O&M) manuals shall be submitted to the Engineer prior to delivery of the equipment. The O&M manuals shall include instructions on storage, installation, start-up, and operation and maintenance, together with a complete parts list and a recommended spare parts list.

MANUFACTURER'S REPRESENTATIVE:

A qualified representative of each equipment manufacturer shall inspect the completed installation, service the equipment, operate the equipment under all design conditions, instruct the Owner's personnel in proper operating and maintenance procedures, and provide the Owner with a written certificate of approval. Each representative shall spend at least 1 day performing the required services.

SECTION 0.45-24 - PUMPS, SUBMERSIBLE NONCLOG SEWAGE:

GENERAL:

Submersible non-clog sewage pumps shall be furnished as shown on the Plans in accordance with the requirements of Section 0.45-23, "Pumps, General", and as modified herein.

Each unit shall be fitted with a stainless steel lifting cable and sufficient power cable, seal chamber probe cable and thermal lead cables to permit raising and lowering the pumps.

The pumps shall be capable of handling stormwater. The discharge connection elbow shall be permanently installed in the wet well along with the discharge piping. The pumps shall be automatically connected into place, and shall be easily removed for inspection or service. There shall be no need for personnel to enter the wet well. Sealing of the pumping unit to the discharge connection elbow shall be accomplished by a simple linear downward motion of the pump. A sliding guide bracket shall be part of the pump unit. The entire weight of the pump unit shall be guided by two guide bars, and seal tightly against the discharge connection. The pump with its appurtenances and cables shall be capable of continuous submergence without loss of watertight integrity to a depth of 50 feet.

Motor and pump shall be designed to permit no less than 10 starts per hour without exceeding insulation class or affecting the service life of the unit.

Each unit shall be provided with an adequately designed heat dispersion system.

TYPE:

Pumps shall be centrifugal, nonclog sewage type meeting the requirements for NEMA Class 1, Division 1, Group D Service, hazardous location (explosion proof).

CASINGS:

Pump and motor casings shall be cast iron with "O" ring gaskets at all casing and motor cover joints. The casing shall be provided with replaceable wearing rings of stainless steel.

IMPELLERS:

The impellers shall be single suction, one or two vane, enclosed type designed with large, smoothly contoured passages capable of passing the solid size as listed in the Equipment Schedule. Impellers shall be cast iron, accurately machined, and dynamically balanced. They shall be provided with repelling vanes on the back of the shroud to prevent collection of solids and to reduce the

pressure on the seals. Impellers shall be secured to shafts with a key and nut arrangement to permit easy removal and to prevent backing off. The impeller shall be provided with replaceable wearing rings of stainless steel alloy dissimilar to the casing wearing rings.

BEARINGS:

Bearings shall be properly lubricated, antifriction type, and shall withstand all radial and thrust loads.

SEALS:

The pump shall be equipped with two independent mechanical seals separated by an oil reservoir. The lower seal shall be tungsten carbide.

SHAFTS:

Shafts shall be of stainless steel AISI Type 304 designed for the maximum operating load.

MOTORS:

The pump motors shall be housed in a watertight casing and be submersible. The motors shall be NEMA design B rated 155 degrees Celsius (°C.) maximum with Class F insulated moisture resistant windings, thermal protection, and shall be wired for 460 volt, 60 hertz, 3 phase current. The power cable junction box and motor shall be separated by a terminal board which shall isolate the motor from any water or solids gaining access through the pump top. The power cable entry shall be watertight.

POWER CABLE:

The pump motor cable shall be suitable for submersible pump application with P122-Mine Safety Health Act approval. This shall be indicated by a code or legend permanently embossed on the cable. Cable sizing shall comply with NEC Specification for pump motors. The pump shall be provided with a 4-conductor motor cable (3 phases and ground) of sufficient length to connect to the receptacle without splicing. The pump motor cable end shall be provided with a 100 amp, 480 volt, 3 pole, 4 wire plug.

THERMAL SENSORS:

Thermal sensors shall be used to monitor stator temperatures. The stator shall be equipped with three thermal switches, one in each phase, embedded in the end coils of the stator winding. These shall be used in conjunction with and supplemental to external motor over-load protection and wired to the control panel.

The installed thermal sensor cable shall be suitable for submersible pump application with P122-Mine Safety Health Act approval. This shall be indicated by a code or legend permanently embossed on the cable. Cable sizing shall comply with NEC Specifications. Cables shall be of sufficient length to connect to the terminal boxes as shown on the plans.

COATINGS:

Exterior coating shall be manufacturer's standard system for sewage.

ACCESSORIES:

Access Doors:

Pump removal hatches shall be double leaf steel door type capable of supporting AASTHO H-20 loading and provided with guide bar and cable fixture holders. Final hatch size and design shall be coordinated with the pump supplier to insure proper installation of guide bar holders and cable fixture holders. Channel frame shall be steel with an anchor flange around the perimeter. Doors shall be provided with spring operators and an automatic hold-open arm with release handle and galvanized safety chains. A lock, as approved by the Engineer, with removable handle shall be provided. Drainage shall be to wet well. Ferrous hardware shall be cadmium plated. A bituminous coating shall be applied to the exterior of the frame. The unit shall be factory prime coated with red oxide paint. Final finish shall be as approved by the Engineer.

Guide Bars: A guide bar system shall be provided for each pump. The guide bars shall be of adequate length to extend from the pump discharge elbow to the access opening. Guide bars shall be galvanized or epoxy coated to prevent corrosion and to maintain a smooth sliding surface.

Guide bars shall be of the size recommended by the pump manufacturer and as approved by the Engineer. The guide bars shall not support any portion of the weight of the pump when it is in operating position. Guide bar holders, seal chamber probe cable, level sensor cable and power cable holders shall be furnished and installed.

Mounting Assembly: A cast iron discharge base elbow shall be leveled, grouted, and bolted to the floor and have a quick disconnect flange on the inlet side and a Class 125 ANSI flanged outlet. The assembly shall include means of anchoring and aligning the guide rails to ensure a positive automatic connection between pump and elbow.

Lifting Cable: Each pump shall be furnished with a stainless steel cable of sufficient strength and length to completely raise and lower the pump.

Moisture Sensor: A moisture sensor shall be provided in the seal oil reservoir.

SPARE PARTS:

Spare parts shall include one spare set of seals for each pump.

PUMP WARRANTY:

The pump manufacturer shall warrant the units being supplied to the owner against defects in workmanship and material for a period of five (5) years or 10,000 hours under the Municipal Wastewater-Permanent Installation Warranty Policy, under normal use, operation and service. The warranty shall cover parts and labor and shall be in printed form and apply to all units.

EQUIPMENT SCHEDULE:

The pumped liquid is storm water.

| <u>DESCRIPTION</u> | <u>QUANTITY</u> | <u>CAPACITY</u> |                |
|--------------------|-----------------|-----------------|----------------|
|                    |                 | <u>PER PUMP</u> | <u>TDH(FT)</u> |
|                    |                 | <u>GPM</u>      |                |
| Glendale Avenue    | 3               | 4600            | 38'            |
| Pump Station       |                 | 5700            | 31'            |

All points, as stated above, shall fall within the selected pump operating curve and shall not overload the pump motor at any point on the curve.

Solids Size = 4 inches  
Maximum Speed = 1200 RPM

## SECTION 0.45-25 - BASIC ELECTRICAL MATERIALS AND METHODS

### RELATED DOCUMENTS:

Drawings and general provisions of Contract, including General and Supplementary Conditions and Section 0.45-1 apply to work of this section.

### SUMMARY:

This Section specifies the basic requirements for electrical installations and includes requirements common to all Sections 0.45-25 through 0.45-049. It expands and supplements the requirements specified in Section 0.45-1.

### ROUGH-IN:

Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.

Refer to equipment specifications in Sections 0.45-2 through 0.45-24 for rough-in requirements.

### ELECTRICAL INSTALLATIONS:

Coordinate electrical equipment and materials installation with other building components.

Verify all dimensions by field measurements.

Arrange for chases, slots, and openings in other building components to allow for electrical installations.

Coordinate the installation of required supporting devices and sleeves to be set in poured in place concrete and other structural components, as they are constructed.

Sequence, coordinate, and integrate installations of electrical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing-in the building.

Coordinate the cutting and patching of building components to accommodate the installation of electrical equipment and materials.

Where mounting heights are not detailed or dimensioned, install electrical services and overhead equipment to provide the maximum headroom possible.

Install electrical equipment to facilitate maintenance and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.

Coordinate the installation of electrical materials and equipment above ceilings with suspension system, mechanical equipment and systems, and structural components.

Coordinate connection of electrical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.

The contractor, except as otherwise specified, shall furnish, fabricate, deliver, erect, install and test electrical material, and equipment specified herein and as shown on the plans so as to constitute a complete and operating electrical system.

The contractor shall furnish and install the various systems of electrical work specified and indicated on the plans. The specifications and plans are not intended to cover every equipment detail. The contractor shall, however, furnish and install all devices and appurtenances which are necessary to fully complete the entire work even if said details are not shown or are not specified in detail.

The ventilation and pumping equipment, the UPS, the solenoid operated valves, the tank level gauges, the pump control equipment and other equipment that shall be furnished and installed under other items of work, shall be connected as part of the work under this subsection, unless otherwise indicated.

Operating limits of electrical apparatus, whether furnished under this subsection or in other sections of the Specifications, shall be adjusted in the field to meet operating conditions. This shall include settings of all overcurrent and trip devices, load balancing on panel buses, transformer tap selection, timer and control device adjustments, etc.

The horsepower ratings shown on the plans are approximate. Actual motor horsepower and motor full load amperes shall be determined in the field from motor nameplate. Feeder sizes and overload protection shall be selected and furnished in accordance with the requirements of the NEC, based on the actual nameplate data.

The contractor shall furnish, install and maintain all temporary power and lighting systems needed for construction in accordance with the requirements of the utility company involved. This temporary system shall include weatherproof panel(s) for the main breakers and distribution system. Ground fault interrupting equipment shall be installed. All connections shall be watertight with wiring installed using Type SO portable cable. After construction is completed, the contractor shall remove all temporary power equipment and devices.

The project plans indicate generally the location of outlets, fixtures, equipment, conduits, wiring, etc., and the general details necessary for the complete electrical installation. It shall be the contractor's responsibility to install all electrical work in a neat and workmanlike manner. The contractor shall cooperate with other trades to permit the installation of all the work without interferences. If changes become necessary to avoid interference with other work being installed, the contractor shall submit to the Engineer for review the proposed changes and, upon review by the Engineer, proceed with the installation of such changes without additional cost to the Department.

The contractor shall not perform any electrical work until shop drawings for such work are completed, reviewed by the Engineer and returned to the contractor. Any such work installed by the Contractor prior to this review will be the responsibility of the Contractor and any modification of the electrical work necessary to meet the equipment requirements shall be made without additional compensation.

The total system shall be coordinated to provide matched pumps, motor controllers and power generation equipment.

It is the intent of this specification that the Contractor shall furnish, install and place in successful operation a comprehensive automatic Pump Control and Protective System.

The pumping station is designed to provide a broad flow of stormwater pumping using combinations of constant-speed pumps. Particular care shall be taken to assure flexibility and allow alternate pump combinations and that each pump will be provided with its full complement of protective auxiliaries.

All of the motor control equipment and automatic control equipment is to be supplied by one manufacturer. It shall be factory assembled, wired, tested and covered by complete electrical drawings and operation and maintenance instructions.

Any system varying from these specifications as to results achieved will not be accepted.

The pump control operation shall be based on wet well level sensing utilizing a submersible level sensor and a microprocessor based programmable controller. The programmable controller (PLC) shall be furnished as part of the motor control center.

All electrical and control equipment supplied shall be capable of operating in an ambient temperature of 122°F.

All necessary components and circuitry shall be provided to make the monitoring/protective/alarm sub-systems of each pump and associated equipment complete and effective. These shall include moisture-sensing and winding temperature-responsive systems as

required where each condition shall be displayed and abnormal condition alarms or shut-down indicated by an appropriate light and remote alarm system actuation. All pump sensing-elements associated with such sub-systems shall be specifically approved by the pump manufacturer to make the equipment warranties fully effective. A separate contact for each pump, indicating pump failure, shall be provided as an input to the radio communications link.

A wet well level-responsive automatic pump control system shall be furnished and installed which optimizes available wet well storage capacity by using a multi-step, programmed pump operation. The pumps and generators shall be operated in an additive/subtractive/substitutional basis program based on wet well level. The pumping program shall minimize the starting frequency of each pump and generator. The programs shall minimize starting frequency and shall not allow simultaneous starting of pumps and generators.

#### ELECTRICAL COORDINATION DRAWINGS:

Prepare and submit a set of coordination drawings showing major elements, components, and systems of electrical equipment and materials in relationship with other building components. Prepare drawings to an accurate scale of 1/4"=1'-0" or larger. Indicate the locations of all equipment and materials, including clearances for servicing and maintaining equipment. Indicate movement and positioning of large equipment into the building during construction.

Prepare floor plans, reflected ceiling plans, elevations, sections, and details to conclusively coordinate and integrate all installations. Indicate locations where space is limited, and where sequencing and coordination of installations are of importance to the efficient flow of the Work, including (but not necessarily limited to) the following:

Equipment room layouts;

Specific equipment installations, including, but not limited to the following:

- Substations;
- Main switchgear;
- Motor control centers;
- Generator set and automatic transfer switches;
- Transformers;
- Switchboards and panelboards;
- Equipment connections;
- Control panels.

Wiring diagrams: indicating field installed electrical power and control wiring and cabling layouts, overcurrent protective devices, equipment, and equipment connections.

Work in pipe spaces, chases, trenches, and tunnels;

Exterior wall penetrations;

Ceiling plenums which contain piping, ductwork, or equipment in congested arrangement;

Exterior underground lines;

CUTTING AND PATCHING:

This Article specifies the cutting and patching of electrical equipment, components, and materials to include removal and legal disposal of selected materials, components, and equipment. The Contractor shall be responsible for cutting, fitting, or patching required to complete the work or to make its parts fit together properly.

Do not endanger or damage installed Work through procedures and processes of cutting and patching.

Arrange for repairs to restore other work, because of damage caused as a result of electrical installations.

No additional compensation will be authorized for cutting and patching Work that is necessitated by ill-timed, defective, or non-conforming installations. Perform cutting, fitting, and patching of electrical equipment and materials required to:

uncover Work to provide for installation of ill-timed Work;

remove and replace defective Work;

remove and replace Work not conforming to requirements of the Contract Documents;

remove samples of installed Work as specified for testing;

install equipment and materials in existing structures;

upon written instructions from the Engineer, uncover and restore Work to provide for Engineer observation of concealed Work.

Cut, remove and legally dispose of selected electrical equipment, components, and materials as indicated, including, but not limited to removal of electrical items indicated to be removed and items made obsolete by the new Work.

Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.

Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.

Locate, identify, and protect electrical services passing through remodeling or demolition area and serving other areas required to be maintained operational. When transit services must be interrupted, provide temporary services for the affected areas and notify the Owner prior to changeover.

ELECTRICAL SUBMITTALS:

Refer to the Conditions of the Contract (General and Supplementary) and Section 0.45-1: SHOP DRAWINGS for submittal definitions, requirements, and procedures.

Submittal of shop drawings, product data, and samples will be accepted only when submitted by The Contractor. Data submitted from subcontractors and material suppliers directly to the Engineer will not be processed.

PRODUCT OPTIONS AND SUBSTITUTIONS:

Refer to the Instructions to Bidders and the Section 0.45-1 Section "PRODUCTS AND SUBSTITUTION" for requirements in selecting products and requesting substitutions.

PRODUCT LISTING:

Prepare listing of major electrical equipment and materials for the project.

Provide all information requested.

Submit this listing as a part of the submittal requirement specified in the Section 0.45-1: PRODUCTS AND SUBSTITUTION.

When two or more items of same material or equipment are required they shall be of the same manufacturer. Product manufacturer uniformity does not apply to raw materials, bulk materials, wire, conduit, fittings, sheet metal, steel bar stock, welding rods, solder, fasteners, motors for dissimilar equipment units, and similar items used in Work, except as otherwise indicated. Provide products which are compatible within systems and other connected items.

NAMEPLATE DATA:

Provide permanent operational data nameplate on each item of power operated equipment, indicating manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and similar essential data. Locate nameplates in an accessible location.

DELIVERY, STORAGE, AND HANDLING:

Deliver products to project properly identified with names, model numbers, types, grades, compliance labels, and similar information needed for distinct identifications; adequately packaged and protected to prevent damage during shipment, storage, and handling.

Store equipment and materials at the site, unless off-site storage is authorized in writing. Protect stored equipment and materials from damage.

Coordinate deliveries of electrical materials and equipment to minimize construction site congestion. Limit each shipment of materials and equipment to the items and quantities needed for the smooth and efficient flow of installations.

RECORD DOCUMENTS:

Refer to the Section 0.05: RECORD DOCUMENTS for requirements. The following paragraphs supplement the requirements of Section 0.05.

Mark Drawings to indicate revisions to conduit size and location both exterior and interior; actual equipment locations, dimensioned from column lines; concealed equipment, dimensioned to column lines; distribution and branch electrical circuitry; fuse and circuit breaker size and arrangements; support and hanger details; Change Orders; concealed control system devices.

Mark Specifications to indicate approved substitutions; Change Orders; actual equipment and materials used.

OPERATION AND MAINTENANCE DATA:

Refer to the Section 0.45-1: OPERATION AND MAINTENANCE DATA for procedures and requirements for preparation and submittal of maintenance manuals.

In addition to the information required by Section 0.45-1 for Maintenance Data, include the following information:

Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of all replaceable parts.

Manufacturer's printed operating procedures to include start-up, break-in, routine and normal operating instructions; regulation, control, stopping, shut-down, and emergency instructions; and summer and winter operating instructions.

Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.

Servicing instructions and lubrication charts and schedules.

#### WARRANTIES:

Refer to Section 0.45-1 under WARRANTIES for procedures and submittal requirements for warranties and for minimum requirements. Refer to individual equipment specifications for additional warranty requirements.

Compile and assemble the warranties specified in Section 0.45-25 through 0.45-49, into a separated set of vinyl covered, three ring binders, tabulated and indexed for easy reference.

provide complete warranty information for each item to include product or equipment to include date of beginning of warranty or bond; duration of warranty or bond; and names, addresses, and telephone numbers and procedures for filing a claim and obtaining warranty services.

#### CLEANING:

Clean all light fixtures, lamps and lenses prior to final acceptance. Replace all inoperative lamps.

#### LISTING AND LABELING

All electrical equipment shall be U.L., E.T.L., or other third party nationally recognized testing laboratory listed and labeled. Wherever U.L. compliance is mentioned in the specifications, the above alternatives shall be understood to apply to all listing and labeling requirements.

#### SCHEDULE OF WORK AND RESPONSIBILITY

The work specified in this and the following sections relates to the proposed pump control system for the stormwater pumps at the Highland Avenue and 18th Street pump station buildings as shown on plans.

The equipment specified herein in these specifications shall be furnished by a single electrical contractor or supplier who shall be responsible for furnishing, installation, and testing of the motor control center, level control equipment, uninterruptible power supply, the engine generator and generator switchgear, etc., as a complete system.

SECTION 0.45-26 - RACEWAYS

PART 1 - GENERAL RELATED DOCUMENTS:

Drawings and general provisions of Contract, including General and Supplementary Conditions and Section 0.45-1 apply to work of this section.

This part is a Section 0.45-25 Basic Electrical Materials and Methods section, and is part of each Section 0.45-26 through 0.45-49 making reference to electrical raceways specified herein.

DESCRIPTION OF WORK:

Extent of raceway work is indicated by drawings and schedules.

Types of raceways specified in this section include the following:

- Electrical metallic tubing (EMT).
- Flexible metal conduit.
- Intermediate metal conduit.
- Liquid-tight flexible metal conduit.
- Underground plastic utilities duct.
- Rigid metal conduit.
- Rigid nonmetallic conduit.
- Surface metal raceways.
- Overhead metal raceways.

QUALITY ASSURANCE:

Manufacturers: Firms regularly engaged in manufacture of raceway systems of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

Installer's Qualifications: Firm with at least 3 years of successful installation experience of projects with electrical raceway work similar to that required for this project.

Codes and Standards:

NEMA Compliance: Comply with applicable requirements of NEMA Standards Publications pertaining to raceways.

UL Compliance and Labeling: Comply with applicable requirements of UL Safety standards pertaining to electrical raceway systems. Provide raceway products and components which have been UL-listed and labeled.

NEC Compliance: Comply with applicable requirements of NEC pertaining to construction and installation of raceway systems.

## SUBMITTALS:

Product Data: Submit manufacturer's technical product data, including specifications and installation instructions, for each type of raceway system required. Include data substantiating that materials comply with requirements.

Shop Drawings: Submit dimensioned drawings of raceway systems showing layout of raceways and fittings, spatial relationships to associated equipment, and adjoining raceways, if any. Show connections to electrical power panels and feeders.

Samples: Submit 6 inch length of exposed type surface raceways with required finish, in accordance with requirements of Section 0.45-1.

Maintenance Data: Submit maintenance data and parts lists for each type of raceway system installed, including furnished specialties and accessories. Include this data, product data, and shop drawings in maintenance manual; in accordance with requirements of Section 0.45-1.

## PART 2 - PRODUCTS

### METAL CONDUIT AND TUBING:

General: Provide metal conduit, tubing and fittings of types, grades, sizes and weights (wall thicknesses) for each service indicated. Where types and grades are not indicated, provide proper selection determined by Installer to fulfill wiring requirements, and comply with applicable portions of NEC for raceways.

Rigid Aluminum Conduit: Provide rigid aluminum 6063 Alloy, T41 temper, conforming to FS WW-C-540, ANSI C80.5 and UL 6.

Provide factory-applied, closed-end thread protectors.

Rigid Steel Conduit: Provide rigid steel, zinc-coated, threaded type conforming to FS WW-C-581, ANSI C80.1 and UL 6.

Provide zinc coating fused to inside and outside walls.

Intermediate Steel Conduit: Rigid intermediate grade (IMC) hot-dip galvanized conforming to FS WW-C-581 and UL 1242.

PVC Externally Coated Rigid Steel Conduit: Rigid steel zinc-coated with additional external coating of PVC conforming to ANSI C80.1 and NEMA RN 1.

Flexible Metal Conduit: FS WW-C-566 and UL 1. Formed from continuous length of spirally wound interlocked zinc-coated strip steel.

Liquid-Tight Flexible Metal Conduit: Provide liquid-tight flexible metal conduit; construct of single strip, flexible, continuous, interlocked, and double-wrapped steel; galvanized inside and outside; coat with liquid-tight jacket of flexible polyvinyl chloride (PVC).

Rigid Metal Conduit Fittings: Cast malleable iron, galvanized or cadmium plated, conforming to FS W-F-408.

Use Type 1 fittings for raintight connections.

Use Type 2 fittings for concrete tight connections.

Use Type 3 fittings for other miscellaneous connections.

Properly sealed explosion-proof conduit seals and fittings for Class I, Division I, Group D hazardous areas shall be furnished and installed in conduits used for the installation of explosion-proof equipment. The wet well shall be by definition a Class I, Division I, Group D hazardous area and all work shall be installed per NEC Article 500.

Flexible Metal Conduit Fittings: Provide conduit fittings for use with flexible steel conduit of threadless hinged clamp type.

Straight Terminal Connectors: One Piece body, female end with clamp and deep slotted machine screw for securing conduit, and male threaded end provided with locknut.

45 degrees or 90 degrees Terminal Angle Connectors: Two-piece body construction with removable upper section, female end with clamp and deep slotted machine screw for securing conduit, and male threaded end provided with locknut.

Liquid-Tight Flexible Metal Conduit Fittings: FS W-F-406, Type 1, Class 3, Style G. Provide cadmium plated, malleable iron fittings with compression type steel ferrule and neoprene gasket sealing rings, with insulated, or noninsulated throat.

Electrical Metallic Tubing (EMT): FS WW-C-563, ANSI C80.3 and UL 797.

PVC Externally-Coated EMT: ANSI C80.3 and NEMA RN 1.

EMT Fittings: FS W-F-408.

Use Type 1 fittings for raintight connections.

Use Type 2 fittings for concrete tight connections.

Use Type 3 fittings for miscellaneous connections.

NONMETALLIC CONDUIT AND DUCTS:

General: Provide nonmetallic conduit, ducts and fittings of types, sizes and weights for each service indicated. Where types and grades are not indicated, provide proper selection determined by Installer to fulfill wiring requirements which comply with provisions of NEC for raceways.

Bituminous Fiber Duct and Fittings: NEMA BC 1, Class 600, for encased or direct burial, Class 1200 for direct burial in heavy traffic areas, Class 2000 for extremely heavy traffic area.

Asbestos-Cement Conduit and Fittings: ASTM C 875, Class C, Type 1.

Electrical Plastic Tubing (EPT): NEMA TC 2, Type 1, for encasement in concrete.

Electrical Plastic Conduit:

Heavy Wall Conduit: Schedule 40, 90 C, UL-rated, construct of polyvinyl chloride and conforming to NEMA TC-2, for direct burial, or normal above ground use, UL-listed and in conformity with NEC Article 347.

Extra Heavy Wall Conduit: Schedule 80, UL-rated, construct of polyvinyl chloride compound C-200 PVC, and UL-listed in accordance with NEC Article 347 for direct burial, or above ground use.

Thin Wall Conduit: Type A, UL-rated for concrete encasement underground, construct of polyvinyl chloride compound C-2000, and UL-listed in accordance with NEC Article 347.

PVC Conduit and Tubing Fittings: NEMA TC 3, mate and match to conduit or tubing type and material.

Underground PVC Plastic Utilities Duct: NEMA TC 6, Type 1 for encased burial in concrete, Type II for direct burial.

PVC and ABS Plastic Utilities Duct Fittings: NEMA TC 9, mate and match to duct type and material.

Conduit and Tubing Accessories: Provide conduit, tubing and duct accessories of types, sizes, and materials, complying with manufacturer's published product information, which mate and match conduit and tubing.

Conduit Bodies: Provide galvanized cast-metal conduit bodies of types, shapes and sizes as required to fulfill job requirements and NEC requirements. Construct conduit bodies with threaded conduit-entrance ends, removable covers, either cast or of galvanized steel, and corrosion-resistant screws.

Available Manufacturers: Subject to compliance with requirements, manufacturers offering conduit bodies which may be incorporated in the work include, but are not limited to, the following:

Appleton Electric; Div of Emerson Electric Co.  
Arrow-Hart Div.; Crouse-Hinds Co.  
Bell Electric Div.; Square D Co.  
Gould Inc.  
Killark Electric Mfg. Co.  
O-Z/Gedney Div.; General Signal Co.  
Spring City Electrical Mfg. Co.

WIREWAYS:

General: Provide electrical wireways of types, grades, sizes, and number of channels for each type of service as indicated. Provide complete assembly of raceway including, but not limited to, couplings, offsets, elbows, expansion joints, adapters, holddown straps, end caps, and other components and accessories as required for complete system.

Lay-in Wireways: Construct lay-in wireways with hinged covers, in accordance with UL 870 and with components UL-listed, including lengths, connectors, and fittings. Select units to allow fastening hinged cover closed without use of parts other than standard lengths, fittings and connectors. Construct units to be capable of sealing cover in closed position with sealing wire. Provide wireways with knockouts.

Connectors: Provide wireway connectors suitable for "lay-in" conductors, with connector covers permanently attached that removal is not necessary to utilize the lay-in feature.

Finish: Protect sheet metal parts with rust inhibiting coating and baked enamel finish. Plate finish hardware to prevent corrosion. Protect screws installed toward inside of wireway with spring nuts to prevent wire insulation damage.

Raintight Wireway: Construct raintight lay-in wireways with hinged covers, in accordance with UL 870 and with components UL-listed, including lengths, connectors and fittings. Design units to allow fastening hinged cover closed without use of parts other than standard lengths, fittings and connectors. Construct units to be capable of sealing cover in closed position with sealing wire. Providing wireway units with knockouts only in bottom of troughs.

Raintight Troughs: Construct in accordance with UL 870, with components UL-listed.

Construction: 16-gage galvanized sheet metal parts for 4" x 4" to 6" x 6" sections, and 14-gage parts for 8" x 8" and larger sections. Provide knockouts only in bottom of troughs, with suitable adapters to facilitate attaching to other NEMA 3R enclosures. Do not use gasketing that can rip or tear during

installation, or would compromise raintight capability of the trough. Do not use cover screws that will protrude into the trough area and damage wire insulation.

Finish: Provide 14-gage and 16-gage galvanized sheet metal parts with corrosion-resistant phosphate primer and baked enamel finish. Plate hardware to prevent corrosion.

J.I.C. Wireway: Construct wireway in accordance with UL 870. Manufacture to J.I.C. standards for Oiltight and Dusttight Lay-in Wireway, and to NMTBA standards for Industrial Control Equipment.

Lengths and Fittings: Manufacture from 14-gage steel, provide straight lengths with hinged covers with gasketing. Hold covers closed with external latches. Installation of Knockouts in either lengths or fittings are to be avoided.

Connections: Provide wireway that is suitable for "lay-in" conductors and with joint hardware assembly with each piece. Provide gasketed joint assembly, attached in such a manner that it does not have to be removed to utilize the lay-in feature.

Finish: Provide sheet metal parts with inhibiting phosphate coating and baked enamel finish.

Installation: Fasten wireway joint connections with use of slotted hex head screws. Gasket each joint for oil-tight seal where lengths are joined.

#### SURFACE METAL RACEWAYS:

Type 1 Raceway: Multi-outlet assembly for prewired outlets, lengths as indicated. Provide 3-wire, single circuit with outlets on 18 inch centers.

Type 2 Raceway: Multi-outlet assembly for prewired outlets, lengths as indicated. Provide 4-wire, double circuit with outlets on 18 inch centers. Provide green covered ground as fourth wire.

Type 3 Raceway: Two-piece type with single compartment, length as indicated. Provide nominal 2 3/4" x 1 7/16" with flush, snap-on cover. Install devices as indicated in raceway.

Type 4 Raceway: Two-piece type, divided for power and communication use, lengths as indicated. Provide nominal 4 3/4" x 1 3/4" with two 2 3/8-inch compartments.

Type 5 Raceway: Surface mounted type for power use, lengths as indicated. Provide nominal 3/4 inch wide, depth as required, single piece type.

Type 6 Raceway: Two-piece type with single compartment, length as indicated. Provide nominal 4 3/4" x 3 9/16" with flush, snap-on cover. Install devices as indicated in raceway.

Boxes for Surface Raceways: Designed, manufactured and supplied by raceway manufacturer for use with specified raceway.

Available Manufacturers: Subject to compliance with requirements, manufacturers offering surface metal raceways which may be incorporated in the work include, but are not limited to, the following:

B-Line Systems, Inc.  
Midland-Ross Corp.  
Power-Strut Civ.; Youngstown Sheet and Tube Co.  
Johnson Plastic Civ.; Johnson Rubber Co.  
Square D Company  
Versa-Tech Corp.  
Walker/Parkersburg Div.; Textron, Inc.  
Wiremold Company.

OVERHEAD METAL RACEWAYS:

General: Provide overhead metal raceways of size, types, capacities, and for type services indicated; construct of 19-gage steel sheet with snap-on covers. Provide fittings indicated and/or required for complete installation, including cover plates, transition fittings, hangers and retaining clips which mate and match with raceway. Coat raceways with manufacturer's standard corrosion-resist finish.

Type 1 Raceway: Multi-outlet assembly for prewired outlets, lengths as indicated. Provide 3-wire, single circuit with outlets on 24 inch centers, with special, 277 volts outlets.

Type 2 Raceway: Multi-outlet assembly for prewired outlets, lengths as indicated. Provide 4-wire, double circuit with outlets on 24 inch centers, with special, 277 volts outlets.

Type 3 Raceway: Multi-outlet assembly for prewired outlets, lengths as indicated. Provide multi-wire, 2 circuit, one each of 120 volts and one each of 277 volts, with outlets on 24 inch centers. Provide green covered conductor for ground, with special, 120 volts, 277 volts outlets.

Available Manufacturers: Subject to compliance with requirements, manufacturers offering overhead metal raceways which may be incorporated in the work include, but are not limited to, the following:

3M Company  
Walker Div.; Textron, Inc.  
Wiremold Co.

## PART 3 - EXECUTION

### INSPECTION:

Examine areas and conditions under which raceways are to be installed, and substrate which will support raceways. Notify Contractor in writing of conditions detrimental to proper completion of the work. Do not proceed with work until satisfactory conditions have been corrected in manner acceptable to Installer.

### INSTALLATION OF RACEWAYS:

General: Install raceways as indicated; in accordance with manufacturer's written installation instructions, and in compliance with NEC, and NECA's "Standards of Installation." Install units plumb and level, and maintain manufacturer's recommended clearances.

Coordinate with other work including wires/cables, boxes, and panel work, as necessary to interface installation of electrical raceways and components with other work.

### INSTALLATION OF CONDUITS:

General: Install concealed conduits in new construction work, either in walls, slabs, or above hung ceilings. Run conduits concealed in existing work where practicable. Where conduits can not be concealed in finished areas, use surface metal raceways.

Mechanically fasten together metal conduits, enclosures, and raceways for conductors to form continuous electrical conductor. Connect to electrical boxes, fittings and cabinets to provide electrical continuity and firm mechanical assembly.

Avoid use of dissimilar metals throughout system to eliminate possibility of electrolysis. Where dissimilar metals are in contact, coat surfaces with corrosion inhibiting compound before assembling.

Install miscellaneous fittings such as reducers, chase nipples, 3-piece unions, split couplings, and plugs that have been specifically designed and manufactured for their particular application. Install expansion fittings in raceways every 200 foot linear run or wherever structural expansion joints are crossed.

Use roughing-in dimensions of electrically operated unit furnished by supplier. Set conduit and boxes for connection to units only after receiving review of dimensions and after checking location with other trades.

Provide nylon pull cord in empty conduits where indicated. Test conduits required to be installed, but left empty, test with ball mandrel. Clear any conduit which rejects ball mandrel. Pay costs involved for restoration of conduit and surrounding surfaces to original condition.

Conduit Installation: Provide rigid steel zinc-coated conduit where embedded in concrete, masonry, earth, or installed outdoors. Follow minimum requirements in other areas as follows:

Use rigid steel zinc-coated conduit in mechanical equipment rooms, electrical equipment rooms, penthouses, crawl spaces, service splines, ceiling plenum areas, kitchens or cafeterias, and in warehouse spaces below 18'-0" height, and for main feeder circuits.

Use steel zinc-coated EMT, or aluminum conduit in offices, corridors, toilets, lunchroom areas, lab areas, and in warehouse spaces above 18'-0" height.

Use flexible conduit in movable partitions and from outlet boxes to recessed lighting fixtures, and final 24" of connection to motors, or control items subject to movement or vibration, and in cells of precast concrete panels.

Use liquid-tight flexible conduit where subjected to one or more of the following conditions:

Exterior location.

Moist or humid atmosphere where condensate can be expected to accumulate.

Corrosive atmosphere.

Subjected to water spray or dripping oil, water or grease.

Cut conduits straight, properly ream, and cut threads for heavy wall conduit deep and clean.

Field-bend conduit with benders designed for purpose so as not to distort nor vary internal diameter.

Size conduits to meet NEC, except no conduit smaller than 3/4 inch shall be embedded in concrete or masonry.

Fasten conduit terminations in sheet metal enclosures by two locknuts, and terminate with bushing. Install locknuts inside and outside enclosure.

Conduits are not to cross pipe shafts, or ventilating duct openings.

Keep conduits a minimum distance of 6 inches from parallel runs of flues, hot water pipes or other sources of heat. Wherever possible, install horizontal raceway runs above water and steam piping.

Support riser conduit at each floor level with clamp hangers.

Use of running threads at conduit joints and terminations is prohibited. Where required, use 3-piece union or split coupling.

Complete installation of electrical raceways before starting installation of cables/wires within raceways.

#### Concealed Conduits:

Metallic raceways installed underground or in floors below grade, or outside are to have conduit threads painted with corrosion inhibiting compound before couplings are assembled. Draw up coupling and conduit sufficiently tight to ensure watertightness.

For floors-on-grade, install conduits under concrete slabs.

Install underground conduits minimum of 24" below finished grade.

#### Conduits in Concrete Slabs:

Place conduits between bottom reinforcing steel and top reinforcing steel.

Place conduits either parallel, or at 90 degrees, to main reinforcing steel.

Separate conduits by not less than diameter of largest conduit to ensure proper concrete bond.

Conduits crossing in slab must be reviewed for proper cover by Engineer.

Embedded conduit diameter is not to exceed 1/3 of slab thickness.

Install conduits as not to damage or run through structural members. Avoid horizontal or cross runs in building partitions or side walls.

#### Exposed Conduits:

Install exposed conduits and extensions from concealed conduit systems neatly, parallel with, or at right angles to walls of building.

Install exposed conduit work as not to interfere with ceiling inserts, lights or ventilation ducts or outlets.

Support exposed conduits by use of hangers, clamps, or clips. Support conduits on each side of bends and on spacing not to exceed following: up to 1": 6'-0"; 1 1/4" and over: 8'-0".

Run conduits for outlets on waterproof walls exposed. Set anchors for supporting conduit on waterproof wall in waterproof cement.

Above requirements for exposed conduits also apply to conduits installed in space above hung ceiling, and in crawl spaces.

#### Nonmetallic Conduits:

Make solvent cemented joints in accordance with recommendations of manufacturer.

Install PVC conduits in accordance with NEC and in compliance with local utility practices.

Conduit Installation: Provide rigid steel zinc-coated conduit where embedded in concrete, masonry, earth, or installed outdoors. Follow minimum requirements in other areas as follows:

Use rigid steel zinc-coated conduit in mechanical equipment rooms, electrical equipment rooms, penthouses, crawl spaces, service splines, ceiling plenum areas, kitchens or cafeterias, and in warehouse spaces below 18'-0" height, and for main feeder circuits.

Use steel zinc-coated EMT, or aluminum conduit in offices, corridors, toilets, lunchroom areas, lab areas, and in warehouse spaces above 18'-0" height.

Use flexible conduit in movable partitions and from outlet boxes to recessed lighting fixtures, and final 24" of connection to motors, or control items subject to movement or vibration, and in cells of precast concrete panels.

Use liquid-tight flexible conduit where subjected to one or more of the following conditions:

Exterior location.

Moist or humid atmosphere where condensate can be expected to accumulate.

Corrosive atmosphere.

Subjected to water spray or dripping oil, water or grease.

Cut conduits straight, properly ream, and cut threads for heavy wall conduit deep and clean.

Field-bend conduit with benders designed for purpose so as not to distort nor vary internal diameter.

Size conduits to meet NEC, except no conduit smaller than 3/4 inch shall be embedded in concrete or masonry.

Fasten conduit terminations in sheet metal enclosures by two locknuts, and terminate with bushing. Install locknuts inside and outside enclosure.

Conduits are not to cross pipe shafts, or ventilating duct openings.

Keep conduits a minimum distance of 6 inches from parallel runs of flues, hot water pipes or other sources of heat. Wherever possible, install horizontal raceways runs above water and steam piping.

Support riser conduit at each floor level with clamp hangers.

Use of running threads at conduit joints and terminations is prohibited. Where required, use 3-piece union or split coupling.

Complete installation of electrical raceways before starting installation of cables/wires within raceways.

#### Concealed Conduits:

Metallic raceways installed underground or in floors below grade, or outside are to have conduit threads painted with corrosion inhibiting compound before couplings are assembled. Draw up coupling and conduit sufficiently tight to ensure watertightness.

For floors-on-grade, install conduits under concrete slabs.

Install underground conduits minimum of 24" below finished grade.

#### Conduits in Concrete Slabs:

Place conduits between bottom reinforcing steel and top reinforcing steel.

Place conduits either parallel, or at 90 degrees, to main reinforcing steel.

Separate conduits by not less than diameter of largest conduit to ensure proper concrete bond.

Conduits crossing in slab must be reviewed for proper cover by Engineer.

Embedded conduit diameter is not to exceed 1/3 of slab thickness.

Install conduits as not to damage or run through structural members. Avoid horizontal or cross runs in building partitions or side walls.

#### Exposed Conduits:

Install exposed conduits and extensions from concealed conduit systems neatly, parallel with, or at right angles to walls of building.

Install exposed conduit work as not to interfere with ceiling inserts, lights or ventilation ducts or outlets.

Support exposed conduits by use of hangers, clamps, or clips. Support conduits on each side of bends and on spacing not to exceed following: up to 1": 6'-0"; 1 1/4" and over: 8'-0".

Run conduits for outlets on waterproof walls exposed. Set anchors for supporting conduit on waterproof wall in waterproof cement.

Above requirements for exposed conduits also apply to conduits installed in space above hung ceilings, and in crawl spaces.

#### Nonmetallic Conduits:

Make solvent cemented joints in accordance with recommendations of manufacturer.

Install PVC conduits in accordance with NEC and in compliance with local utility practices.

#### Conduit Fittings:

Construct locknuts for securing conduit to metal enclosure with sharp edge for digging into metal, and ridged outside circumference for proper fastening.

Bushings for terminating conduits smaller than 1-1/4 inches are to have flared bottom and ribbed sides, with smooth upper edges to prevent injury to cable insulation.

Install insulated type bushings for terminating conduits 1-1/4" and larger. Bushings are to have flared bottom and ribbed sides. Upper edge to have phenolic insulating ring molded into bushing.

Bushing of standard or insulated type to have screw type grounding terminal.

Miscellaneous fittings such as reducers, chase nipples, 3-piece unions, split couplings, and plugs to be specifically designed for their particular application.

INSTALLATION OF RACEWAYS AND WIREWAYS:

General: Mechanically assemble metal enclosures, and raceways for conductors to form continuous electrical conductor, and connect to electrical boxes, fittings and cabinets as to provide effective electrical continuity and rigid mechanical assembly.

Avoid use of dissimilar metals throughout system to eliminate possibility of electrolysis. Where dissimilar metals are in contact, coat all surfaces with corrosion inhibiting compound before assembling.

Install expansion fittings in all raceways wherever structural expansion joints are crossed.

Make changes in direction of raceway run with proper fittings, supplied by raceway manufacturer. No field bends of raceway sections will be permitted.

Properly support and anchor raceways for their entire length by structural materials. Raceways are not to span any space unsupported.

Use boxes as supplied by raceway manufacturer wherever junction pull or devices boxes are required. Standard electrical "handy" boxes, etc. shall not be permitted for use with surface raceway installations.

SECTION 0.45-27 - ELECTRICAL BOXES AND FITTINGS

PART 1 - GENERAL RELATED DOCUMENTS:

Drawings and general provisions of Contract, including General and Supplementary Conditions and Section 0.45-1 apply to work of this section.

This part is a Section 0.45-25 Basic Electrical Materials and Methods section, and is a part of each Section 0.45-26 through 0.45-49, sections making reference to electrical wiring boxes and fittings specified herein.

DESCRIPTION OF WORK:

Extent of electrical box and associated fitting work is indicated by drawings and schedules.

Types of electrical boxes and fittings specified in this section include the following:

- Outlet boxes.
- Junction boxes.
- Pull boxes.
- Floor boxes.
- Poke-throughs.
- Bushings.
- Locknuts.
- Knockout closures.

QUALITY ASSURANCE:

Manufacturers: Firms regularly engaged in manufacture of electrical boxes and fittings, of types, sizes, and capacities required, whose products have been in satisfactory use in similar service for not less than 3 years.

Installer's Qualifications: Firm with at least 3 years of successful installation experience on projects utilizing electrical boxes and fittings similar to those required for this project.

NEC Compliance: Comply with NEC as applicable to construction and installation of electrical wiring boxes and fittings.

UL Compliance: Comply with applicable requirements of UL 50, UL 514-Series, and UL 886 pertaining to electrical boxes and fittings. Provide electrical boxes and fittings which are UL-listed and labeled.

NEMA Compliance: Comply with applicable requirements of NEMA Stds/Pub No.'s OS1, OS2 and Pub 250 pertaining to outlet and device boxes, covers and box supports.

Federal Specification Compliance: Comply with applicable requirements of FS W-C-586, "Electrical Cast Metal Conduit Outlet Boxes, Bodies and Entrance Caps."

SUBMITTALS:

Product Data: Submit manufacturer's data on electrical boxes and fittings.

Shop Drawings: Submit layout drawings of electrical floor, junction and pull boxes showing accurately scaled box layouts and their spatial relationship to associated equipment.

PART 2 - PRODUCTS

FABRICATED MATERIALS:

Outlet Boxes: Provide galvanized flat rolled sheet-steel outlet wiring boxes, of shapes, cubic inch capacities, and sizes, including box depth as indicated, suitable for installation at respective locations. Construct outlet boxes with mounting holes, and with cable and conduit-size knockout openings in bottom and sides. Provide boxes with threaded screw holes, with corrosion-resistant cover and grounding screws for fastening surface and device type box covers, and for equipment type grounding.

Outlet Box Accessories: Provide outlet box accessories as required for each installation, including box supports, mounting ears and brackets, wallboard hangers, box extension rings, fixture studs, cable clamps and metal straps for supporting outlet boxes, which are compatible with outlet boxes being used to fulfill installation requirements for individual wiring situations. Choice of accessories is Installer's code-compliance option.

Device Boxes: Provide galvanized coated flat rolled sheet-steel nongangable device boxes, of shapes, cubic inch capacities, and sizes, including box depths as indicated, suitable for installation at respective locations. Construct device boxes for flush mounting with mounting holes, and with cable-size knockout openings in bottom and ends, and with threaded screw holes in end plates for fastening devices. Provide cable clamps and corrosion-resistant screws for fastening devices. Provide cable clamps and corrosion-resistant screws for fastening cable clamps, and for equipment type grounding.

Device Box Accessories: Provide device box accessories as required for each installation, including mounting brackets, device box extensions, switch box supports, plaster ears, and plaster board expandable grip fasteners, which are compatible with device boxes being utilized to fulfill installation requirements for individual wiring situations. Choice of accessories is Installer's code-compliance option.

Available Manufacturers: Subject to compliance with requirements, manufacturers offering outlet boxes which may be incorporated in the work include, but are not limited to, the following:

Manufacturers: Subject to compliance with requirements, provide interior outlet boxes of one of the following:

Adalet-PLM Div., Scott Fetzer Co.  
Appleton Electric; Emerson Electric Co.  
Bell Electric; Square D Company.  
Eagle Electric Mfg. Co., Inc.  
Midland-Ross Corp.  
OZ/Gedney; General Signal Co.  
Pass and Seymour, Inc.  
RACO Div.; Harvey Hubbell, Inc.  
Thomas & Betts Co.

Raintight Outlet Boxes: Provide corrosion-resistant cast-metal raintight outlet wiring boxes, of types, shapes and sizes, including depth of boxes, with threaded conduit holes for fastening electrical conduit, cast-metal face plates with spring-hinged watertight caps suitably configured for each application, including face plate gaskets and corrosion-resistant plugs and fasteners.

Available Manufacturers: Subject to compliance with requirements, manufacturers offering raintight outlet boxes which may be incorporated in the work include, but are not limited to, the following:

Manufacturers: Subject to compliance with requirements, provide raintight outlet boxes of one of the following:

Appleton Electric; Emerson Electric Co.  
Arrow-Hart Div.; Crouse-Hinds Co.  
Bell Electric; Square D Company.  
Eagle Electric Mfg. Co., Inc.  
Gould, Inc.  
Harvey Hubbell, Inc.  
OZ/Gedney; General Signal Co.  
Pass and Seymour, Inc.

Junction and Pull Boxes: Provide galvanized code-gage sheet steel junction and pull boxes, with screw-on covers; of types, shapes and sizes, to suite each respective location and installation; with welded seams and equipped with stainless steel nuts, bolts, screws and washers.

Available Manufacturers: Subject to compliance with requirements, manufacturers offering junction and pull boxes which may be incorporated in the work include, but are not limited to the following:

Manufacturers: Subject to compliance with requirements, provide junction and pull boxes of one of the following:

Adalet-PLM Div., Scott Fetzer Co.  
Appleton Electric; Emerson Electric Co.  
Arrow-Hart Div.; Crouse-Hinds Co.  
Bell Electric; Square D Company.  
GTE Corporation  
Keystone Columbia, Inc.  
OZ/Gedney Co.; General Signal Co.  
Spring City Electrical Mfg. Co.

Floor Boxes: Provide cast-iron raintight adjustable floor boxes as indicated, with threaded-conduit-entrance ends, and vertical adjusting rings, gaskets, brass floor plates with flush screw-on covers with ground flange and stainless steel cover screws.

Floor Box Accessories: Provide flush type two-pole, three-wire, grounded-pole, 125-volts, 20-amperes, floor-type receptacles with flanges.

Poke-Throughs: Provide factory prewired poke-through units, suitable for power and communication work, with UL fire resistance rating of 3 hours. Construct integral fire-stop with cold smoke barrier to prevent passage of smoke where heat is not present. Provide units with separation barrier between power and communication compartments, and with above-floor fittings of contoured die-cast aluminum with satin chrome finish covers. Provide poke-throughs with a single divided through-floor conduit, of proper length for floor thickness indicated, and a 4 11/16" square x 2 9/16" deep junction box, which is self supporting without attachment of above-floor fitting.

Available Manufacturers: Subject to compliance with requirements, manufacturers offering floor boxes which may be incorporated in the work include, but are not limited to, the following:

Arrow-Hart Div.; Crouse-Hinds Co.  
Harvey Hubbell, Inc.  
Midland-Ross Corp.  
Nelson Electric; General Signal Co.  
Payle-National Co.  
Spring City Electrical Mfg. Co.  
Square D Company.

Bushings, Knockout Closures and Locknuts: Provide corrosion-resistant box knockout closures, conduit locknuts and malleable iron conduit bushings, offset connectors, of types and sizes, to suit respective installation requirements and applications.

Available Manufacturers: Subject to compliance with requirements, manufacturers offering bushings, knockout closures, locknuts and connectors which may be incorporated in the work include, but are not limited to, the following:

Adalet-PLM Div; Scott Fetzer Co.  
AMP, Inc.  
Arrow-Hart Div.; Crouse-Hinds Co.  
Appleton Electric Co.; Emerson Electric Co.  
Bell Electric; Square D Co.  
Midland-Ross Corp.  
Midwest Electric; Cooper Industries, Inc.  
OZ/Gedney Co.; General Signal Co.  
RACO Div.; Harvey Hubbell, Inc.  
Thomas & Betts Co., Inc.

### PART 3 - EXECUTION

#### INSTALLATION OF ELECTRICAL BOXES AND FITTINGS

General: Install electrical boxes and fittings as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation," and in accordance with recognized industry practices to fulfill project requirements.

Coordinate installation of electrical boxes and fittings with wire/cable, wiring devices, and raceway installation work.

Provide weathertight outlets for interior and exterior locations exposed to weather or moisture.

Provide knockout closures to cap unused knockout holes where blanks have been removed.

Install electrical boxes in those locations which ensure ready accessibility to enclosed electrical wiring.

Avoid installing boxes back-to-back in walls. Provide not less than 6 inch (150 mm) separation.

Avoid installing aluminum products in concrete.

Position recessed outlet boxes accurately to allow for surface finish thickness.

Set floor boxes level and flush with finish flooring material.

Avoid using round boxes where conduit must enter box through side of box, which would result in difficult and insecure connections when fastened with locknut or bushing on rounded surfaces.

Fasten electrical boxes firmly and rigidly to substrates, or structural surfaces to which attached, or solidly embed electrical boxes in concrete or masonry.

Provide electrical connections for installed boxes.

Subsequent to installation of boxes, protect boxes from construction debris and damage.

GROUNDING:

Upon completion of installation work, properly ground electrical boxes and demonstrate compliance with requirements.

SECTION 0.45-28 - ELECTRICAL CONNECTIONS FOR EQUIPMENT

PART 1 - GENERAL RELATED DOCUMENTS:

Drawings and general provisions of Contract, including General and Supplementary Conditions and Section 0.45-1 apply to work of this section.

This part is a Section 0.45-25 Basic Electrical Materials and Methods section, and is part of each Section 0.45-23 through 0.45-49 sections making reference to electrical connections for equipment specified herein.

DESCRIPTION OF WORK:

Extent of electrical connections for equipment is indicated by drawings and schedules. Electrical connections are hereby defined to include connections used for providing electrical power to equipment.

Applications of electrical power connections specified in this section include the following:

To resistive heaters.

From electrical source to motor starters.

From motor starters to motors.

To lighting fixtures.

To converters, rectifiers, transformers, inverters, rheostats, and similar current adjustment features of equipment.

To grounds including earthing connections.

To master units of communication, signal, alarm, clock, public address, sound, and video systems.

Electrical connections for equipment, not furnished as integral part of equipment, are specified in Sections 0.45-23 through 0.45-49, and are work of this section.

Motor starters and controllers, not furnished as integral part of equipment, re specified in applicable Sections 0.45-23 through 0.45-49, and are work of this section.

Refer to Sections 0.45-23 and 0.45-24 for motor starters and controllers furnished integrally with equipment; not work of this section.

Junction boxes and disconnect switches required for connecting motors and other electrical units of equipment are specified in applicable Sections 0.45-25 through 0.45-49, and are work of this section.

Electrical identification for wire/cable conductors is specified in Section 0.45-35, "Electrical Identification," and is work of this section.

Raceways and wire/cables required for connecting motors and other electrical units of equipment are specified in applicable Sections 0.45-25 through 0.45-49 and are work of this section.

Refer to other Sections 0.45-25 through 0.45-49 for junction boxes and disconnect switches required for connecting motors and other electrical units of equipment; not work of this section

Refer to Sections 0.45-23 and 0.45-24 for control system wiring; not work of this section.

Refer to other Sections for specific individual equipment power requirements, not work of this section.

#### QUALITY ASSURANCE:

Manufacturers: Firms regularly engaged in manufacture of electrical connectors and terminals, of types and ratings required, and ancillary connection materials, including electrical insulating tape, soldering fluxes, and cable ties, whose products have been in satisfactory use in similar service for not less than 5 years.

Installer's Qualifications: Firms with at least 2 years of successful installation experience with projects utilizing electrical connections for equipment similar to that required for this project.

NEC Compliance: Comply with applicable requirements of NEC as to type products used and installation of electrical power connections (terminals and splices), for junction boxes, motor starters, and disconnect switches.

IEEE Compliance: Comply with Std 241, "IEEE Recommended Practice for Electric Power Systems in Commercial Buildings" pertaining to connections and terminations.

ANSI Compliance: Comply with applicable requirements of ANSI/NEMA and ANSI/EIA standards pertaining to products and installation of electrical connections for equipment.

UL Compliance: Comply with UL Std 486A, "Wire Connectors and Soldering Lugs for Use With Copper Conductors" including, but not limited to, tightening of electrical connectors to torque values indicated. Provide electrical connection products and materials which are UL-listed and -labeled.

ETL Compliance: Provide electrical connection products and materials which are ETL-listed and -labeled.

SUBMITTALS:

Product Data: Submit manufacturer's data on electrical connectors for equipment products.

DELIVERY, STORAGE, AND HANDLING:

Deliver electrical connection products wrapped in proper factory fabricated type containers.

Store electrical connection products in original cartons and protect from weather, construction traffic and debris.

Handle electrical connection products carefully to prevent breakage, denting, and scoring finish.

PART 2 - PRODUCTS

ACCEPTABLE MANUFACTURERS:

Available Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include, but are not limited to, the following:

Adalet-PLM Div., Scott and Fetzer Co.  
Allen-Stevens Conduit Fittings Corp.  
AMP Incorporated.  
Appleton Electric Co.  
Arrow-Hart Div., Crouse-Hinds Co.  
Atlas Technologies, Inc.  
Bishop Div., General Signal Corp.  
Burndy Corporation.  
Eagle Electric Mfg. Co., Inc.  
Electroline Mfg. Co.  
Gardner Bender, Inc.  
General Electric Co.  
Gould, Inc.  
Harvey Hubbell, Inc.  
Ideal Industries, Inc.  
Pyle National Co.  
Reliable Electric Co.  
Square D Company.  
Thomas and Betts Corp.

## MATERIALS AND COMPONENTS:

General: For each electrical connection indicated, provide complete assembly of materials, including but not necessarily limited to, pressure connectors, terminals (lugs), electrical insulating tape, electrical solder, electrical soldering flux, heat-shrinkable insulating tubing, cable ties, solderless wire-nuts, and other items and accessories as needed to complete splices and terminations of types indicated.

### Metal Conduit, Tubing and Fittings:

General: Provide metal conduit, tubing and fittings of types, grades, sizes and weights (wall thicknesses) indicated for each type service. Where types and grades are not indicated, provide proper selection as determined by Installer to fulfill wiring requirements and comply with NEC requirements for raceways. Provide products complying with Section 0.45-26 "Raceways," and in accordance with the following listing of metal conduit, tubing and fittings:

- Rigid steel conduit.
- PVC externally-coated rigid steel conduit.
- Rigid metal conduit fittings.
- Flexible metal conduit.
- Flexible metal conduit fittings.
- Liquid-tight flexible metal conduit.
- Liquid-tight flexible metal conduit fittings.

### Wires, Cables, and Connectors:

General: Provide wires, cables and connectors complying with Section 0.45-30 "Wires and Cables."

Wires/Cables: Unless otherwise indicated, provide wires/cables (conductors) for electrical connections which match, including sizes and ratings, of wires/cables which are supplying electrical power. Provide copper conductors with conductivity of not less than 98 percent at 20 degrees Celsius ( $^{\circ}$  C.) (68 degrees Fahrenheit [ $^{\circ}$  F.]).

Connectors and Terminals: Provide electrical connectors and terminals which mate and match, including sizes and ratings, with equipment terminals and are recommended by equipment manufacturer for intended applications.

Electrical Connection Accessories: Provide electrical insulating tape, heat-shrinkable insulating tubing and boots, electrical solder, electrical soldering flux, wirenuts and cable ties as recommended for use by accessories manufacturers for type services indicated.

PART 3 - EXECUTION

INSPECTION:

Inspect area and conditions under which electrical connections for equipment are to be installed and notify Contractor in writing of conditions detrimental to proper completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

INSTALLATION OF ELECTRICAL CONNECTIONS:

Install electrical connections as indicated, in accordance with equipment manufacturer's written instructions and with recognized industry practices, and complying with applicable requirements of UL, NEC and NECA's "Standard of Installation" to ensure that products fulfill requirements.

Coordinate with other work, including wires/cables, raceway and equipment installation, as necessary to properly interface installation of electrical connections for equipment with other work.

Connect electrical power supply conductors to equipment conductors in accordance with equipment manufacturers written instructions and wiring diagrams. Mate and match conductors of electrical connections for proper interface between electrical power supplies and installed equipment.

Maintain existing electrical service and feeders to occupied areas and operational facilities, unless otherwise indicated, or when authorized otherwise in writing by Owner, or Engineer. Provide temporary service during interruptions to existing facilities. When necessary, schedule momentary outages for replacing existing wiring systems with new wiring systems. When that "cutting-over" has been successfully accomplished, remove, relocate, or abandon existing wiring as indicated.

Cover splices with electrical insulating material equivalent to, or of greater insulation resistivity rating, than electrical insulation rating of those conductors being spliced.

Prepare cables and wires, by cutting and stripping covering armor, jacket, and insulation properly to ensure uniform and neat appearance where cables and wires are terminated. Exercise care to avoid cutting through tapes which will remain on conductors. Also avoid "ringing" copper conductors while skinning wire.

Trim cables and wires as short as practicable and arrange routing to facilitate inspection, testing and maintenance.

Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturers published torque tightening values for equipment connectors. Accomplish tightening by utilizing proper torquing tools, including torque screwdrivers, beam-type torque wrench, and ratchet wrench with adjustable torque settings. Where manufacturer's torquing requirements are not available, tighten connectors and terminals to comply with torquing values contained in UL's 486A.

Provide PVC-coated conduit and fittings as indicated for highly-corrosive atmospheres.

Provide flexible conduit for motor connections, and other electrical equipment connections, where subject to movement and vibration.

Provide liquid-tight flexible conduit for connection of motors and other electrical equipment where subject to movement and vibration, and also where connections are subjected to one or more of the following conditions:

Exterior location.

Moist or humid atmosphere where condensate can be expected to accumulate.

Corrosive atmosphere.

Water spray.

Dripping oil, grease, or water.

Fasten identification markers to each electrical power supply wire/cable conductor which indicates their voltage, phase and feeder number in accordance with Section 0.45-35 "Electrical Identification" Affix markers on each terminal conductor, as close as possible to the point of connection.

FIELD QUALITY CONTROL:

Upon completion of installation of electrical connections, and after circuitry has been energized with rated power source, test connections to demonstrate capability and compliance with requirements. Ensure that direction of rotation of each motor fulfills requirements. Correct malfunctioning units at site, then retest to demonstrate compliance.

SECTION 0.45-29 - WIRES AND CABLES

PART 1 - GENERAL RELATED DOCUMENTS:

Drawings and general provisions of Contract, including General and Supplementary Conditions and Section 0.45-1 apply to work of this section.

This part is a Section 0.45-25 Basic Electrical Materials and Methods section, and is part of each Section 0.45-23 through 0.45-49 making reference to electrical wires and cables specified herein.

DESCRIPTION OF WORK:

Extent of electrical wire and cable work is indicated by drawings and schedules.

Types of electrical wire, cable, and connectors specified in this section include the following:

- Copper conductors.
- Copper-clad aluminum conductors.
- Copper-sheathed cable.
- Fixture wires.
- Flat conductor cable.
- Service-entrance cable.
- Shielded nonmetallic-sheathed cable.
- Switchboard wires. Tap type connectors.
- Split-bolt connectors.
- Wirenut connectors.

Applications of electrical wire, cable, and connectors required for project are as follows:

- For power distribution circuits.
- For lighting circuits.
- For appliance and equipment circuits.
- For motor-branch circuits.

QUALITY ASSURANCE:

Manufacturers: Firms regularly engaged in manufacture of electrical wire and cable products of types, sizes, and ratings required, whose products have been in satisfactory use in similar service for not less than 5 years.

Installer's Qualifications: Firm with at least 3 years of successful installation experience with projects utilizing electrical wiring and cabling work similar to that required for this project.

NEC Compliance: Comply with NEC requirements as applicable to construction, installation and color coding of electrical wires, cable and connectors.

UL Compliance: Comply with applicable requirements of UL Std 83, "Thermoplastic-Insulated Wires and Cables," and Std 486A, "Wire connectors and Soldering Lugs for Use with Cooper Conductors."

UL Compliance: Provide wiring/cabling and connector products which are UL-listed and labeled.

ETL Compliance: Provide wiring/cabling and connector products which are ETL-listed and labeled.

NEMA/ICEA Compliance: Comply with NEMA/ICEA Std Pub/No.'s WC 5, "Thermoplastic-Wire and Cable for the Transmission and Distribution of Electrical Energy," and WC-30, "Color Coding of Wires and Cables," pertaining to electrical power type wires and cables.

IEEE Compliance: Comply with applicable requirements of IEEE Stds 82, "Test Procedures for Impulse Voltage Tests on Insulated Conductors," and Std 241, "IEEE Recommended Practice for Electric Power Systems in Commercial Buildings" pertaining to wire systems.

ASTM Compliance: Comply with applicable requirements of ASTM B1, 2, 3, 8 and D-753. Provide cooper conductors with conductivity of not less than 98 percent at 20 degrees Celsius ( $^{\circ}$  C) (68 degrees Fahrenheit [ $^{\circ}$  F]).

FS Compliance: Comply with Federal Specifications J-C-30, "Electrical Cable and Wire, (Power, Fixed, Installation)," and W-S-610, "Splice Conductor."

FAA Compliance: Comply with FAA Stds L-824, "Underground Electrical Cable for Airport Lighting," and L-846, "Electrical Wire for Wiring Circuits for Installation in Airport Pavement."

SUBMITTALS:

Product Data: Submit manufacturer's data on electrical wires, cables and connectors.

DELIVERY, STORAGE, AND HANDLING:

Deliver wire and cable properly packaged in factory-fabricated type containers, or wound on NEMA-specified type wire and cable reels.

Store wire and cable in clean dry space in original containers. Protect products from weather, damaging fumes, construction debris and traffic.

Handle wire and cable carefully to avoid abrasing, puncturing and tearing wire and cable insulation and sheathing. Ensure that dielectric resistance integrity of wires/cables is maintained.

## PART 2 - PRODUCTS

### ACCEPTABLE MANUFACTURERS:

Available Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include, but are not limited to the following:

#### Wire and Cable:

Apex Wire and Cable Corp.  
American Insulated Wire Corp.  
American Wire and Cable Co.  
Anaconda-Ericsson Inc.; Wire and Cable Div.  
Belden Div.; Cooper Industries  
Brand-Rex Div.; Pyle National Co.  
Cerro Wire and Cable Corp.  
Cleveland Insulated Wire Co.  
General Cable Corporation.  
Helix Wire Corporation.  
Hitemp Wires, Inc.  
Indiana Insulated Wire, Inc.  
Madison Wire and Cable Corp.  
Phelps Dodge Cable and Wire Co.  
Pirelli Cable Corp.  
Radix Wire Co.  
Rome Cable Corp.  
Southwire Company.  
Triangle PWC, Inc.

#### Connectors:

AMP, Inc.  
Appleton Electrical Co.; Emerson Electric Co.  
Burndy Corporation  
Brand-Rex Div., Pyle National Co.  
Electrical Products Div.; Midland-Ross Corp.  
General Electric Co.  
Gould, Inc.  
Ideal Industries, Inc.  
Leviton Mfg. Company.  
3M Company  
O-Z/Gedney Co.  
Southport Industries, Inc.  
Square D Company.  
Thomas and Betts Corp.

## WIRES, CABLES AND CONNECTORS:

General: Provide electrical wires, cables, and connectors of manufacturer's standard materials, as indicated by published product information; designed and constructed as recommended by manufacturer, for a complete installation, and for application indicated. Except as otherwise indicated, provide copper conductors with conductivity of not less than 98 percent at 20° C. (68°F).

Building Wires: Provide factory-fabricated wires of sizes, ampacity ratings, and materials for applications and services indicated. Where not indicated, provide proper wire selection as determined by Installer to comply with project's installation requirements, NEC and NEMA standards. Select from the following UL types, those wires with construction features which fulfill project requirements:

Type RHH: For dry locations; max operating temperature 90° C. (194°F.). Insulation, heat resistant rubber; outer covering, moisture-resistant, flame-retardant, nonmetallic covering; conductor, annealed copper.

Type RHW: For dry and wet locations; max operating temperature 75°C. (167°F.). Insulation, moisture and heat resistant rubber; outer covering, moisture-resistant, flame-retardant, nonmetallic covering; conductor, annealed copper.

Type RUH: For dry locations; max operating temperature 75°C. (167°F.). Insulation 90% unmilled, grainless rubber, outer covering, moisture-resistant, flame retardant, nonmetallic covering; conductor, annealed copper.

Type RUW: For wet and dry locations; max operating temperature 60°C. (140°F.). Insulation, 90 percent unmilled, grainless rubber; outer covering, moisture-resistant, flame-retardant, nonmetallic covering; conductor, annealed copper.

Type THW: For dry and wet locations; max operating temperature 75° C. (167°F.). Insulation, flame-retardant, moisture- and heat-resistant, thermoplastic; conductor, annealed copper.

Type THWN: For dry and wet locations; max operating temperature 75° C. (167° F.). Insulation, flame-retardant, moisture and heat-resistant, thermoplastic; outer covering, nylon jacket; conductor, annealed copper.

Type TW: For dry and wet locations; max operating temperature 60° C. (140° F.). Insulation, flame-retardant, moisture-resistant thermoplastic; conductor, annealed copper.

Type XHHW: For dry locations; max operating temperature 90 degrees C. (194 degrees F.). Insulation, flame-retardant, cross-linked synthetic polymer; conductor, annealed copper.

Type TBS: For switchboard wiring only; max operating temperature 90° C. (194° F.). Insulation, thermoplastic; outer covering, flame-retardant, nonmetallic covering; conductor, annealed copper.

Type MI: For wet and dry locations; max operating temperature 85° C. (185° F.). Insulation, magnesium oxide; outer covering, copper sheath; conductor, annealed copper.

Cables: Provide UL-type factory-fabricated cables of sizes, ampacity ratings, and materials and jacketing/sheathing as indicated for services indicated. Where not indicated, provide proper selection as determined by Installer to comply with installation requirements, NEC and NEMA standards. Select from the following types, those cables with construction features which fulfill project requirements.

Type MI: Mineral-insulated, metal-sheathed (copper) cable; used for services, feeders, and branch circuits in hazardous locations; underground, indoors, or outdoors. Not used where exposed to destructive corrosive conditions.

Type AVL: Asbestos-varnished-cambric insulation, with outer asbestos braid covered with lead sheath. Provides good heat resistant insulation, used for low-voltage installation.

Type MC: Metal-clad cable; used for wet or dry locations; exposed or concealed; suitable for cable tray usage.

Type AC: Armored cable; used in dry locations for under-plaster extentions. Not for direct burial in earth.

Connectors:

General: Provide UL-type factory-fabricated, metal connectors of sizes, ampacity ratings, materials, types and classes for applications and for services indicated. Where not indicated, provide proper selection as determined by Installer to comply with project's installation requirements, NEC and NEMA standards. Select from the following, those types, classes, kinds and styles of connectors to fulfill project requirements:

Type: Pressure  
Type: Crimp.  
Type: Threaded.

Class: Insulated.  
Class: Noninsulated.

Kind: Aluminum (for Al to Al connection).  
Kind: Copper (for Cu to Cu connection).  
Kind: Aluminum-copper (for Al to Cu connection).

Style: Butt connection.  
Style: Elbow connection.  
Style: Combined "T" and straight connection.  
Style: "T" connection.

Style: Split-bolt parallel connection.  
Style: Tap connection.  
Style: Pigtail connection.  
Style: Wirenut connection.

### PART 3 - EXECUTION

#### INSTALLATION OF WIRES AND CABLES:

General: Install electrical cables, wires and wiring connectors as indicated, in compliance with applicable requirements of NEC, NEMA, UL, and NECA's "Standard of Installation," and in accordance with recognized industry practices.

Coordinate wire/cable installation work including electrical raceway and equipment installation work, as necessary to properly interface installation of wires/cable with other work.

Install UL Type SE cable for aboveground service-entrances.

Install UL Type UF cable with nonmetallic outer jacketing, for underground feeders.

Install UL Type FCC cable for under carpeting.

Install UL Type THW wiring in conduit, for feeders and branch circuits.

Pull conductors simultaneously where more than one is being installed in same raceway.

Use pulling compound or lubricant, where necessary; compound must not deteriorate conductor or insulation.

Use pulling means including fish tape, cable and basket weave wire/cable grips which will not damage cables or raceways.

Install exposed cable, parallel and perpendicular to surfaces, or exposed structural members and follow surface contours, where possible.

Keep conductor splices to minimum.

Install splices and tapes which possess equivalent-or-better mechanical strength and insulation ratings than conductors being spliced.

Use splice and tap connectors which are compatible with conductor material.

Tighten electrical connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Std 486A and B.

FIELD QUALITY CONTROL:

Prior to energization of circuitry, check installed wires and cables with megohm meter to determine insulation resistance levels to ensure requirements are fulfilled.

Prior to energization, test wires and cables for electrical continuity and for short-circuits.

Subsequent to wire and cable hook-ups, energize circuitry and demonstrate functioning in accordance with requirements. Where necessary, correct malfunctioning units, and then retest to demonstrate compliance.

SECTION 0.45-30 - CONTROL/SIGNAL TRANSMISSION MEDIA

PART 1 - GENERAL RELATED DOCUMENTS:

Drawings and general provisions of Contract, including General and Supplementary Conditions and Section 0.45-1 apply to work of this section.

This part is a Section 0.45-25 Basic Electrical Materials and Methods section, and is part of each Section 0.45-23 through 0.45-49 sections making reference to control/signal transmission media specified herein.

DESCRIPTION OF WORK:

Extent of control/signal transmission media work is indicated by drawings and schedules.

Types of control/signal transmission media in this section include the following:

- Coaxial cable.
- Twinaxial cable.
- Shielded cable.
- Unshielded cable.
- Plenum cable.
- Video pair cable.

Applications of control/signal transmission media required for project are as follows:

For data communication systems:

- Electronic cash registers.
- Data processing peripherals.
- Video display screens.
- Local area networks.

For security systems:

- Burglar alarm systems.
- Closed-circuit TV surveillance equipment.

For communications systems:

- Background music systems.
- Intercom networks.
- Telephone systems.
- Television systems.
- Energy management systems.

QUALITY ASSURANCE:

Manufacturers: Firms - regularly engaged in manufacture of control/signal transmission media products of types, sizes, and characteristics required, whose products have been in satisfactory use in similar service for not less than 3 years.

Installer's Qualifications: Firm with at least 3 years of successful installation experience with projects utilizing control/signal transmission media work similar to that required for this project.

NEC Compliance: Comply with NEC requirements as applicable to construction, installation and color coding of both power type wires/cables and control/signal transmission media.

UL Compliance: Comply with applicable requirements of UL Stds 83, "Thermoplastic-Insulated Wires and Cables"; 486A, "Wire Connectors and Soldering Lugs for Use with Copper Conductors"; and UL 910, "Test Method for Fire and Smoke Characteristics of Cables Used in Air-Handling Spaces." Provide products which are UL-listed and labeled.

NEMA/ICEA Compliance: Comply with NEMA/ICEA Stds Pub/No.'s WC 5, "Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy," and WC 30, "Color Coding of Wires and Cables," pertaining to control and signal transmission media.

NEMA/ICEA Compliance: Comply with NEMA/ICEA Stds Pub/No. WC 41, "Coaxial Communication Cable."

ASTM Compliance: Comply with applicable requirements of ASTM B1, 2, 3, 8, 33, D2219 and D2220. Provide copper conductors with conductivity of not less than 98 percent at 20 degrees Celsius (° C.) (68 degrees Fahrenheit [° F.]).

IMSA Compliance: Comply with applicable requirements of International Municipal Signal Association (IMSA) standards 19-2 and 20-2 pertaining to signals, control,s and communications.

MIL-SPEC Compliance: Comply with MIL-C-3093, "Telephone Cable; Inside Distribution Wiring." MIL-C-55021, "Twisted-Pair and Triplet Cables; Hook-ups General Specifications," and MIL-C-17/29, "Radio Frequency Coaxial Cables, 75 Ohms."

SUBMITTALS:

Product Data: Submit manufacturer's data on control/signal transmission media.

DELIVERY, STORAGE, AND HANDLING:

Deliver wire and cable properly packaged in factory-fabricated type containers, or wound on NEMA-specified type wire and cable reels.

Store wire and cable in clean dry space in original containers. Protect products from weather, damaging fumes, construction debris and traffic.

Handle wire and cable carefully to avoid abrasing, puncturing and tearing wire and cable insulation and sheathing. Ensure that dielectric resistance and characteristic impedance integrity of transmission media are maintained.

PART 2 - PRODUCTS

ACCEPTABLE MANUFACTURERS:

Available Manufacturers: Subject to compliance with requirements, manufacturers offering control/signal transmission media products which may be incorporated in the work include; but are not limited to, the following:

Alpha Wire Corporation.  
American Insulated Wire Corp.  
ARI Industries, Inc.  
Belden Div.; Cooper Industries.  
Berk-Tek Company.  
Brand-Rex Div.; Pyle National Co.  
Comm/Scope Company.  
DeKoron Div.; Eaton Corp.  
General Cable Corporation.  
Hitemp Wires, Inc.  
Markel Corporation.  
Phelps Dodge Cable and Wire Co.  
Rome Cable Corp.  
Southwire Company.  
Thomas & Betts Corporation.  
3M Company.

CONTROL/SIGNAL TRANSMISSION MEDIA:

General: Provide control/signal transmission media of manufacturer's standard materials, as indicated by published product information; designed and constructed as recommended by manufacturer, for a complete installation, and for applications indicated. Except as otherwise indicated, provide copper conductors with conductivity of not less than 98 percent at 20° C. (68° F.).

Wires: Provide factory-fabricated wires of sizes, ampacity ratings, and materials as indicated for applications indicated.

Where not indicated, provide proper wire selection as determined by Installer to comply with project's installation requirements, and NEC and NEMA standards. Select from the following UL types, those wires with construction features which fulfill project requirements.

Type RUW: For wet and dry locations; max operating temperature 60° C. (140° F.). Insulation, 90 percent unmilled, grainless rubber; outer covering, moisture-resistant, flame-retardant, non-metallic covering; conductor, annealed copper.

Type THW: For dry and wet locations; max operating temperature 75° C. (167° F.). Insulation, flame-retardant, moisture- and heat-resistant, thermoplastic; conductor, annealed copper.

Type THWN: For dry and wet locations; max operating temperature 75 degrees C. (167 degrees F.). Insulation, flame-retardant, moisture and heat-resistant, thermoplastic; outer covering, nylon jacket; conductor, annealed copper.

Type TW: For dry and wet locations; max operating temperature 60° C. (140° F.). Insulation, flame-retardant, moisture-resistant thermoplastic; conductor, annealed copper.

Type XHHW: For dry locations, max operating temperature 90° C. (194° F.). Insulation, flame-retardant, cross-linked synthetic polymer; conductor, annealed copper.

Cables: Provide factory-fabricated cables of sizes, characteristics, ratings, materials, and jacketing/sheathing as indicated for applications indicated. Select from the following types, those cables with construction features which fulfill project requirements.

Coaxial:

RG-6A/U; Coaxial single conductor, 75-ohms characteristic impedance, with solid polyethylene core, 97 percent copper braid shield coverage, with black polyethylene jacket, 100 percent swepttested 5-450 MHz.

RG-8/U; Coaxial single conductor, 50-ohm characteristic impedance, with solid polyethylene core, 60 percent tin coated copper braid shield coverage, with PVC jacket.

RG-58/U; Coaxial single conductor, 50-ohm characteristic impedance, with cellular polyethylene core, 97 percent bare copper braid shield coverage, with black PVC jacket.

RG-59/U; Coaxial single conductor, 75-ohms characteristic impedance, with polyethylene low-density dielectric core, constructed in compliance with MIL-C-17/29, and 100 percent sweep tested 5-300 MHz.

Twin Lead: Bare copper covered steel, 2 conductor parallel, 300-ohm characteristic impedance, orange polyethylene insulation and web between conductors, cellular polyethylene oval brown jacket.

Twisted-Pair: Multi-paired cable, unshielded, with quantity of twisted-pairs indicated, minimum 14-gage tinned copper conductors, color coded, with PVC insulation, and chrome PVC jacket.

Direct Burial: Coaxial single conductor cable, 75-ohm characteristic impedance, with center conductor 18-gage copper-clad steel; dielectric, solid natural polyethylene; outer conductor shield, 34-gage bare copper braid, 95 percent coverage; with black polyvinyl chloride jacket; and 100 percent sweep tested.

Aerial: Coaxial single conductor cable, 75-ohm characteristic impedance; with center conductor 18-gage copper-clad steel; dielectric, cellular expanded polyethylene; outer conductor 34-gage bare copper braid, 95 percent coverage; with black polyvinyl chloride jacket; and 100 percent sweep tested.

Plenum: RG-11/U coaxial single conductor cable, 75-ohm characteristic impedance, with center conductor solid bare copper; dielectric, foamed teflon; outer conductor, tinned copper double braid, 100 percent shield coverage, with black tint teflon jacket.

Plenum: RS-232-C multi-conductor cable with six pairs of teflon insulated 24-gage, 7 strand tinned conductors, with 100 percent overall shield of aluminum/polyester, and 22-gage tinned copper drain wire. Teflon jacketed.

Video Pair: Balanced pair coaxial cable, 125-ohm characteristic impedance, with 16-gage soft drawn bare copper conductors twisted to form pairs; core insulation, expanded polyethylene, covered with copper shielding tape and with expanded polyester film.

### PART 3 - EXECUTION

#### INSTALLATION OF CONTROL/SIGNAL TRANSMISSION MEDIA:

General: Install control/signal transmission media as indicated, in accordance with manufacturer's written instructions, and in compliance with applicable requirements of NEC, and in accordance with recognized industry practices.

Coordinate transmission media installation work, as necessary to properly interface installation of media with other work.

Use extreme care in handling, fishing, and pulling-in transmission media to avoid damage to conductors, shielding and jacketing/cladding. Avoid excessive and sharp bends. Ensure medium manufacturer's recommended pulling tensions are not exceeded.

Pull conductors simultaneously where more than one is being installed in same raceway.

Use pulling compound or lubricant, where necessary; compound used must not deteriorate conductor or insulation.

Use pulling means including, fish tape, cable, rope, and basket weave wire/cable grips which will not damage media or raceway.

Install exposed cable, parallel and perpendicular to surfaces, or exposed structural members, and follow surface contours, where possible.

Avoid splices in media runs.

Use splice and tap connectors which are compatible with media material.

Tighten connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Std 486A and B.

#### FIELD QUALITY CONTROL:

Prior to usage, test control/signal wires and cables for electrical continuity and for short-circuits. Correct malfunctions, if any.

Subsequent to control/signal transmission media hook-ups, demonstrate proper functioning in accordance with requirements. Where necessary, correct malfunctioning units, and then retest to demonstrate compliance.

SECTION 0.45-31 - WIRING DEVICES

PART 1 - GENERAL RELATED DOCUMENTS:

Drawings and general provisions of Contract, including General and Supplementary Conditions and Section 0.45-1 apply to work of this section.

This part is a Section 0.45-25 Basic Electrical Materials and Methods section, and is a part of each Section 0.45-25 through 0.45-49 making reference to wiring devices specified herein.

DESCRIPTION OF WORK:

The extent of wiring device work is indicated by drawings and schedules. Wiring devices are defined as single discrete units of electrical distribution systems which are intended to carry but not utilize electric energy.

Types of electrical wiring devices in this section include the following:

- Receptacles.
- Ground-fault circuit interrupters.
- Switches.
- Wall plates.
- Dimmer.
- Plugs and connectors.
- Floor service outlets.
- Poke-through assemblies.
- Telephone/power poles.

QUALITY ASSURANCE:

Manufacturers: Firms regularly engaged in manufacture of electrical wiring devices, of types, sizes, and ratings required, whose products have been in satisfactory use in similar service for not less than 3 years.

Installer's Qualifications: Firms with at least 2 years of successful installation experience on projects utilizing wiring devices similar to those required for this project.

NEC Compliance: Comply with NEC as applicable to installation and wiring of electrical wiring devices.

UL Compliance: Comply with applicable requirements of UL 20, 486A, 498 and 943 pertaining to installation of wiring devices. Provide wiring devices which are UL-listed and labeled.

IEEE Compliance: Comply with applicable requirements of IEEE Std 241, "Recommended Practice for Electric Power Systems in Commercial Buildings," pertaining to electrical wiring systems.

NEMA Compliance: Comply with applicable portions of NEMA Stds Pub/No. WD 1, "General-Purpose Wiring Devices," WD 2, "Semiconductor Dimmers for Incandescent Lamps," and WD 5, "Specific,-Purpose Wiring Devices."

FS Compliance: Comply with FS W-C-596 (Series) and FS W-S-896 (Series) pertaining to electrical power connectors and toggle switches.

SUBMITTALS:

Product Data: Submit manufacturer's data on electrical wiring devices.

PART 2 - PRODUCTS

ACCEPTABLE MANUFACTURERS:

Available Manufacturers: Subject to compliance with requirements, manufacturers offering wiring devices which may be incorporated in the work include, but are not limited to, the following:

Adalet-PLM, Scott and Fetzer Co.  
Allen-Bradley Co.  
AMP Products Corp.  
Appleton Electric Co.  
Arrow-Hart Div., Crouse-Hinds Co.  
Bryant Electric Co.  
Cutler-Hammer, Inc.  
Eagle Electric Mfg. Co.  
Furnas Electric Co.  
General Electric Co.  
GTE Products Corp.  
Harvey Hubbell, Inc.  
Ideal Industries, Inc.  
Leviton Mfg. Co.  
Pass and Seymour, Inc.  
Slater Electric Co.  
Square D Company.  
Thomas and Betts Corp.  
Warker Parkersburg Div.; Textron, Inc.  
Wiremold Company.

FABRICATED WIRING DEVICES:

General: Provide factory-fabricated wiring devices, in types, colors, and electrical ratings for applications indicated and which comply with NEMA Stds Pub/No. WD 1. Provide brown color devices and wallplates except as otherwise indicated; color selection to be verified by Contractor with Engineer.

## Receptacles:

General-Duty Duplex: Provide duplex general-duty type receptacles, 2-pole, 3-wire, grounding, with green hexagonal equipment ground screw, ground terminals and poles internally connected to mounting yoke, 15-amperes, 125-volts, with metal plaster ears; design for side and back wiring with spring loaded screw activated pressure plate, with NEMA configuration 5-15R unless otherwise indicated.

General-Duty Simplex: Provide single general-duty type receptacles, 2-pole, 3-wire, grounding, with green hexagonal equipment ground screw, 20-amperes, 125-volts, with metal plaster ears; design for side and back wiring with spring loaded, screw activated pressure plate, with NEMA configuration 5-20R unless otherwise indicated.

General-Duty Clock Simplex: Provide single general-duty type receptacles, 2-pole, 3-wire, grounding, 15-amperes, 125-volts, with recessed male plug which permits clock to be mounted flush with wall and cover outlet, with metal hook for supporting clock, side wiring, with NEMA configuration 5-15R.

Heavy-Duty Duplex: Provide heavy-duty duplex receptacles, 2-pole, 3-wire, grounding, 15-amperes, 125-volts, with metal plaster ears, design for side and back wiring with spring loaded, screw activated pressure plate, with NEMA configuration 5-15R unless otherwise indicated.

Ground-Fault Interrupter: Provide "feed-thru" type groundfault circuit interrupters, with heavy-duty duplex receptacles, capable of protecting connected downstream receptacles on single circuit, and of being installed in a 2 3/4 inch deep outlet box without adapter, grounding type UL-rated Class A, Group 1, rated 20-amperes, 120-volts, 60 Hz; with solid-state ground-fault sensing and signaling; with 5 milliamperes ground-fault trip level; equip with NEMA configuration 5-20R.

## Plugs and Connectors:

Plugs: Provide 15-amperes, 125-volts, 3-wire grounding, armored cap plugs, parallel blades with cord clamp, and 0.4 inch cord hole; match NEMA configuration with power sources.

Duplex Snap: Provide general-duty flush double-pole AC quiet switches, 15-amperes, 120-277 volts, with mounting yoke insulated from mechanism, equip with plaster ears, switch handles, side-wired screw terminals, with break-off tab features, which allows wiring with separate or common feed.

Three Way: Provide general-duty flush 3-way AC switches, 15-amperes, 120-277 volts, with mounting yoke insulated from mechanism, equip with plaster ears, lock type switch handles,

side-wired screw terminals, with break-off tab features, which allows wiring with separate or common feed.

Four Way: Provide general-duty flush 4-way AC quiet switches, 15-amperes, 120-277 volts, with mounting yoke insulated from mechanism, equip with plaster ears, switch handles, side-wired screw terminals, with break-off tab features, which allows wiring with separate or common feed.

Touch Snap: Provide soft touch-snap switches, capable of effortless-fingertip operation; single-pole AC quiet, with lighted rocker switch handles; side-wire screw terminals for connecting copper-clad aluminum wire, 20-amperes, 120-277 volts rating. Equip with plaster ears.

Combination Devices: Provide general-duty 3-way quiet switch, 20-amperes, 120-277 volts AC, with toggle switch handle, and 3-wire grounding receptacle, 20-amperes, 120-volts, equip with plaster ears, and with break-off tab feature which allows wiring with separate or common feed, with NEMA configuration 5-20R.

Incandescent Lamp Dimmers: Provide branch lighting solid-state AC dimmer controls for incandescent fixtures; wattage as indicated, 120-volts, 60 Hz, with continuously adjustable rotary dimmer, anodized aluminum face, single-pole, with soft-tap ON/OFF switch. Equip with electromagnetic filters to eliminate noise, RF and TV interference, and with 5-inch wire connecting leads.

Fluorescent Lamp Dimmers: Provide single-pole, full-wave semiconductor modular type AC dimmers for fluorescent fixtures; with 60 Hz, wattage and voltage as indicated, and with electromagnetic filters to reduce noise, RF and TV interference to minimum. Construct with continuously adjustable trim potentiometer for adjustment of low and dimming; and with anodized heat sinks. Provide 5-inch wire connecting leads.

#### WIRING DEVICE ACCESSORIES:

Wall Plates: Provide wallplates for single-switch and combination wiring devices, of types, sizes, and with ganging and cutouts as indicated. Select plates which mate and match wiring devices to which attached. Construct with metal screws for securing plates to devices; screw heads colored to match finish of plates; wall plates colored to match wiring devices. Provide wall plates possessing the following additional construction features:

Material and Finish: Steel plate with wrinkled finish, baked-on white insulating enamel.

Material and Finish: 0.04 inch thick, type 302 satin finished stainless steel.

Material and Finish: 0.04 inch thick brass, brushed.

Material and Finish: 0.04 inch thick brass, satin chrome plated.

Material and Finish: 0.05 inch thick aluminum, anodized.

Material and Finish: Steel plate, galvanized.

Material and Finish: Plastic, ribbed.

Material and Finish: Plastic, smooth.

Floor Service Outlets: Provide floor service receptacle outlets and fittings of types and ratings indicated. Construct of die cast aluminum, satin finish, with 20-amperes, 125-volts, back-to-back gray duplex receptacles, NEMA configuration type 5-20R. Provide with 1 inch NPT, 1 inch long, locking nipple for installation.

Poke-Through Assembly Devices: Provide factory-assembled poke-through assembly devices, with power-rated 15-amperes, 125-volts, single pole, 3-wire, grounding, duplex NEMA configuration 5-15R receptacles capable of maintaining fire floor rating of 3-hours. Construct for installation in concrete floor 3-inches thick, with center tube, fire-stop wafers, spreader plate, service fitting base plate, and 4-11/16 inch conduit box. Provide floor service fitting base with alignment adjustment screws.

Telephone/Power Poles: Provide factory-assembled telephone/power poles of types, sizes and ratings indicated; for use with telephone and power systems installed above suspended ceilings. Construct with provisions for one telephone cable, cable size 50 pairs, and with two, 15-amperes, 125-volts, 3-wire receptacles. Isolate power section from telephone compartment with separating steel enclosure. Extend wiring from receptacles to junction box at top of pole where connections are made above suspended ceiling. Provide pole foot and carpet pad; also provide pole with ceiling tile trim pad.

### PART 3 - EXECUTION

#### INSTALLATION OF WIRING DEVICES:

Install wiring devices as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation," and in accordance with recognized industry practices to fulfill project requirements.

Coordinate with other work, including painting, electrical boxes and wiring work, as necessary to interface installation of wiring devices with other work.

Install wiring devices only in electrical boxes which are clean; free from excess building materials, dirt, and debris.

Install galvanized steel wall plates in unfinished spaces.

Install wiring devices after wiring work is completed.

Install wall plates after painting work is completed.

Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for wiring devices. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Stds 486A and B.

PROTECTION OF WALL PLATES AND RECEPTACLES:

Upon installation of wall plates and receptacles, advise Contractor regarding proper and cautious use of convenience outlets. At time of Substantial Completion, replace those items which have been damaged, including those burned and scored by faulty plugs.

GROUNDING:

Provide equipment grounding connections for wiring devices, unless otherwise indicated. Tighten connections to comply with tightening torques specified in UL Std 486A to assure permanent and effective grounds.

TESTING:

Prior to energizing circuitry, test wiring devices for electrical continuity, and for short-circuits. Ensure proper polarity of connections is maintained. Subsequent to energization, test wiring devices to demonstrate compliance with requirements.

SECTION 0.45-32 - CIRCUIT AND MOTOR DISCONNECTS

PART 1 - GENERAL

RELATED DOCUMENTS:

Drawings and general provisions of Contract, including General and Supplementary Conditions and Section 0.45-1 apply to work of this section.

Section 0.45-25 Basic Electrical Materials and Methods, apply to work of this section.

DESCRIPTION OF WORK:

Extent of circuit and motor disconnect switch work is indicated by drawings and schedules.

Types of circuit and motor disconnect switches in this section include the following:

- Equipment disconnects.
- Appliance disconnect.
- Motor-circuit disconnect.

Wires/cables, raceways, and electrical boxes and fittings required in connection with circuit and motor disconnect work are specified in other Sections 0.45-25 through 0.45-49.

Refer to other Sections 0.45-26 through 0.45-49 for wire/cables, raceways, and electrical boxes and fittings work required in connection with circuit and motor disconnect work; not work of this section.

QUALITY ASSURANCE:

Manufacturers: Firms regularly engaged in manufacture of circuit and motor disconnect switches of types and capacities required, whose products have been in satisfactory use in similar service for not less than 3 years.

Installer's Qualifications: Firm with at least 3 years of successful installation experience with projects utilizing circuit and motor disconnect work similar to that required for this project.

NEC Compliance: Comply with NEC requirements pertaining to construction and installation of electrical circuit and motor disconnect devices.

UL Compliance: Comply with requirements of UL 98, "Enclosed and Dead-Front Switches." Provide circuit and motor disconnect switches which have been UL-listed and labeled.

NEMA Compliance: Comply with applicable requirements of NEMA Stds Pub NO. KS 1, "Enclosed Switches" and 250, "Enclosures for Electrical Equipment (1000 Volts Maximum).

SUBMITTALS:

Product Data: Submit manufacturer's data on circuit and motor disconnect switches.

Shop Drawings: Submit shop drawings of electrical circuit and motor disconnect switches which have ratings of 100 amperes and larger, showing accurately scaled switches, their layouts, and proximity to associated equipment.

Wiring Diagrams: Submit power and control wiring diagrams for circuit and motor disconnects including connections to power and control panels, and feeders.

PART 2 - PRODUCTS

ACCEPTABLE MANUFACTURERS:

Available Manufacturers: Subject to compliance with requirements, manufacturers offering circuit and motor disconnects which may be incorporated in the work include, but are not limited to, the following:

Crouse-Hinds Co.  
Cutler-Hammer, Inc.  
Federal Pacific Electric Co.  
Furnas Electric Co.  
General Electric Co.  
General Switch Corp.  
GTE Sylvania, Inc.  
Square D Company  
Westinghouse Electric Corp.

FABRICATED SWITCHES:

General-Duty Disconnect Switches: Provide surface-mounted, general-duty type, sheet-steel enclosed switches, of types, sizes, and electrical characteristics indicated; rated 240 volts, 200 amperes, 60 Hz, with 3-blades, 3-poles; and incorporating spring assisted, quick-make, quick-break switches which are so constructed that switch blades are visible in OFF position with door open. Equip with operating handle which is integral part of enclosure base and whose operating position is easily recognizable, and is capable of being padlocked in OFF position. Construct current carrying parts of high-conductivity copper, with silver-tungsten type switch contacts, and stamped enclosure knockouts. Provide NEMA Type 1 enclosure.

Heavy-Duty Safety Switches: Provide surface-mounted, heavy-duty type, sheet-steel enclosed safety switches, of types, sizes and electrical characteristics indicated; fusible type, rated 600 volts, 400 amperes, 60 Hz, 3-blades, 4-poles, solid neutral; and incorporating quick-make, quick-break type switches, so that switch blades are visible in OFF position with door open. Equip with operating handle which is integral part of enclosure base and whose operating position is easily recognizable and is padlockable in OFF position; construct current carrying parts of high-conductivity copper, and silver-tungsten type switch contacts; and positive pressure type reinforced fuse clip. Provide NEMA Type 3R enclosure.

Fuses: Provide fuses for safety switches, as recommended by switch manufacturer, of classes, types, and ratings needed to fulfill electrical requirements for service indicated.

### PART 3 - EXECUTION

#### INSTALLATION OF CIRCUIT AND MOTOR DISCONNECT SWITCHES:

Install circuit and motor disconnect switches as indicated, complying with manufacturer's written instructions, applicable requirements of NEC, NEMA, and NECA's "Standard of Installation," and in accordance with recognized industry practices.

Coordinate circuit and motor disconnect switch installation work with electrical raceway and cable work, as necessary for proper interface.

Install disconnect switches for use with motor-driven appliances, and motors and controllers within sight of the controller position unless otherwise indicated.

#### GROUNDING:

Provide equipment grounding connections, sufficiently tight to assure a indicated.

#### FIELD QUALITY CONTROL:

Subsequent to completion of installation of electrical disconnect switches, energize circuitry and demonstrate capacity and compliance with requirements. Where possible, correct malfunctioning units at project site, then retest to demonstrate compliance; otherwise remove and replace with new units and retest.

SECTION 0.45-33 - SUPPORTING DEVICES

PART 1 - GENERAL RELATED DOCUMENTS:

Drawings and general provisions of Contract, including General and Supplementary Conditions and Section 0.45-1 apply to work of this section.

This part is a Section 0.45-25 Basic Electrical Materials and Methods section, and is a part of each Section 0.45-26 through 0.45-49 making reference to electrical supporting devices specified herein.

DESCRIPTION OF WORK:

Extent of supports, anchors, sleeves and seals is indicated by drawings and schedules and/or specified in other Sections 0.45-26 through 0.45-49.

Types of supports, anchors, sleeves and seals specified in this section include the following:

- Clevis hangers.
- Riser clamps.
- C-clamps.
- I-beam clamps.
- One-hole conduit straps.
- Two-hole conduit straps.
- Round steel rods.
- Lead expansion anchors.
- Toggle bolts.
- Wall and floor seals.

Supports, anchors, sleeves and seals furnished as part of factory-fabricated equipment, are specified as part of that equipment assembly in other Sections 0.45-26 through 0.45-49.

QUALITY ASSURANCE:

Manufacturers: Firms regularly engaged in manufacture of supporting devices, of types, sizes, and ratings required, whose products have been in satisfactory use in similar service for not less than 3 years.

Installer's Qualifications: Firm with at least 3 years of successful installation experience with projects utilizing electrical supporting device work similar to that required for this project.

NEC Compliance: Comply with NEC requirements as applicable to construction and installation of electrical supporting devices.

MSS Compliance: Comply with applicable MSS standard requirements

pertaining to fabrication and installation practices for pipe hangers and supports.

NECA Compliance: Comply with National Electrical Contractors Association's "Standard of Installation" pertaining to anchors, fasteners, hangers, supports, and equipment mounting.

UL Compliance: Provide electrical components which are UL-listed and labeled.

FS Compliance: Comply with Federal Specification FF-S-760 pertaining to retaining straps for conduit, pipe and cable.

#### SUBMITTALS:

Product Data: Submit manufacturer's data on supporting devices including catalog cuts, specifications, and installation instructions, for each type of support, anchor, sleeve and seal.

Shop Drawings: Submit dimensioned drawings of fabricated products, indicating details of fabrication and materials.

#### PART 2 - PRODUCTS

##### MANUFACTURED SUPPORTING DEVICES:

General: Provide supporting devices which comply with manufacturer's standard materials, design and construction in accordance with published product information, and as required for complete installation; and as herein specified. Where more than one type of supporting device meets indicated requirements, selection is Installer's option.

Supports: Provide supporting devices of types, sizes and materials indicated; and having the following construction features:

Clevis Hangers: For supporting 2 inch rigid metal conduit; galvanized steel; with 1/2 inch diameter hole for round steel rod; approximately 54 pounds per 100 units.

Riser Clamps: For supporting 5 inch rigid metal conduit; black steel; with 2 bolts and nuts; and 4 inch ears; approximately 510 pounds per 100 units.

Reducing Couplings: Steel rod reducing coupling, 1/2" x 5/8"; black steel; approximately 16 pounds per 100 units.

C-Clamps: Black malleable iron; 1/2 inch rod size; approximately 70 pounds per 100 units.

I-Beam Clamps: Black steel, 1 1/4" x 3/16" stock, 3/8 inch cross bolt; flange width 2"; approximately 52 pounds per 100 units.

One-Hole Conduit Straps: For supporting 3/4 inch rigid metal conduit; galvanized steel; approximately 7 pounds per 100 units.

Two-Hole Conduit Straps: For supporting 3/4 inch rigid metal conduit, galvanized steel; 3/4 inch strap width; and 2 1/8 inches between center of screw holes.

Hexagon Nuts: For 1/2 inch rod size; galvanized steel; approximately 4 pounds per 100 units.

Round Steel Rod: Black steel; 1/2 inch diameter; approximately 67 pounds per 100 feet.

Offset Conduit Clamps: For supporting 2 inch rigid metal conduit; black steel; approximately 200 pounds per 100 units.

Anchors: Provide anchors of types, sizes and materials indicated; and having the following construction features:

Lead Expansion Anchors: 1/2 inch, approximately 38 pounds per 100 units.

Toggle Bolts: Springhead; 3/16" x 4"; approximately 5 pounds per 100 units.

Available Manufacturers: Subject to compliance with requirements, manufacturers offering anchors which may be incorporated in the work include, but are not limited to, the following.

Abbeon Cal, Inc.  
Ackerman Johnson Fastening Systems, Inc.  
Elcen Metal Products Co.  
Ideal Industries, Inc.  
Joslyn Mfg and Supply Co.  
McGraw Edison Co.  
Rawlplug Co., Inc.  
Star Expansion Co.  
U.S. Expansion Bolt Co.

Sleeves and Seals: Provide sleeves and seals, of types, sizes and materials indicated, with the following construction features:

Wall and Floor Seals: Provide factory-assembled watertight wall and floor seals, of types and sizes indicated; suitable for sealing around conduit, pipe, or tubing passing through concrete floors and walls. Construct seals with steel sleeves, malleable iron body, neoprene sealing grommets and rings, metal pressure rings, pressure clamps, and cap screws.

Conduit Cable Supports: Provide cable supports with insulating

wedging plug for non-armored type electrical cables in risers; construct for 2 inch rigid metal conduit; 3-wires, type wire as indicated; construct body of malleable-iron casting with hot-dip galvanized finish.

U-Channel Strut Systems: Provide U-channel strut system for supporting electrical equipment, 12-gage hot-dip galvanized steel, of types and sizes indicated; construct with 9/16 inch diameter holes, 8 inches o.c. on top surface, with standard green finish, and with the following fittings which mate and match with U-channel:

- Fixture hangers.
- Channel hangers.
- End caps.
- Beam clamps.
- Wiring stud.
- Thinwall conduit clamps.
- Rigid conduit clamps.
- Conduit hangers.
- U-bolts.

Available Manufacturers: Subject to compliance with requirements, manufacturers offering channel systems which may be incorporated in the work include, but are not limited to, the following:

- Allied Tube and Conduit Corp.
- B-Line Systems, Inc.
- Elcen Metal Products Co.
- Greenfield Mfg. Co., Inc.
- Midland-Ross Corp.
- OZ/Gedney Div.; General Signal Corp.
- Power-Strut Div.; Van Huffel Tube Corp.
- Unistrut Div.; GTE Products Corp.

FABRICATED SUPPORTING DEVICES:

Pipe Sleeves: Provide pipe sleeves of one of the following:

Sheet-Metal: Fabricate from galvanized sheet metal; round tube closed with snaplock joint, welded spiral seams, or welded longitudinal joint. Fabricate sleeve from the following gages metal: 3 inches and smaller, 20-gage; 4 to 6 inches, 16-gage; over 6 inches, 14-gage.

Steel-Pipe: Fabricate from Schedule 40 galvanized steel pipe; remove burrs.

Iron-Pipe: Fabricate from cast-iron or ductile-iron pipe; remove burrs.

Plastic-Pipe: Fabricate from Schedule 80 PVC plastic pipe; remove burrs.

Sleeve Seals: Provide sleeve seals for piping which penetrates foundation walls below grade, or exterior walls. Caulk between sleeve and pipe with nontoxic, UL-classified calking material to ensure watertight seal.

Sleeve Seals: Provide modular mechanical type seals, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between pipe and sleeve, connect with bolts and pressure plates which cause rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

### PART 3 - EXECUTION

#### INSTALLATION OF SUPPORTING DEVICES:

Install hangers, anchors, sleeves and seals as indicated, in accordance with manufacturer's written instructions and with recognized industry practices to insure supporting devices comply with requirements. Comply with requirements of NECA and NEC for installation of supporting devices.

Coordinate with other electrical work, including raceway and wiring work, as necessary to interface installation of supporting devices with other work.

Install hangers, supports, clamps and attachments to support piping properly from building structure. Arrange for grouping of parallel runs of horizontal conduits to be supported together on trapeze type hangers where possible. Install supports with spacings indicated and in compliance with NEC requirements.

Torque sleeve seal nuts, complying with manufacturer's recommended values. Ensure that sealing grommets expand to form watertight seal.

SECTION 0.45-34 - ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

RELATED DOCUMENTS:

Drawings and general provisions of Contract, including General and Supplementary Conditions and Section 0.45-1 apply to work specified of this section.

Section 0.45-25 Basic Electrical Materials and Methods apply to work specified in this section.

DESCRIPTION OF WORK:

Extent of electrical identification work is indicated by drawings and schedules.

Types of electrical identification work specified in this section include the following:

Buried cable warnings.

Electrical power, control and communication conductors.

Operational instructions and warnings.

Danger signs.

Equipment/system identification signs.

QUALITY ASSURANCE:

Manufacturers: Firms regularly engaged in manufacture to electrical identification products of types required, whose products have been in satisfactory use in similar service for not less than 3 years.

Installer's Qualifications: Firm with at least 3 years of successful installation experience with projects utilizing electrical identification work similar to that required for this project.

NEC Compliance: Comply with NEC as applicable to installation of identifying labels and markers for wiring and equipment.

UL Compliance: Comply with applicable requirements of UL Std 969, "Marking and Labeling Systems," pertaining to electrical identification systems.

ANSI Compliance: Comply with applicable requirements of ANSI Std A13.1, "Scheme for the Identification of Piping System."

NEMA Compliance: Comply with applicable requirements of NEMA Std No's. WC-1 and WC-2 pertaining to identification of power and control conductors.

SUBMITTALS:

Product Data: Submit manufacturer's data on electrical identification materials and products.

Samples: Submit samples of each color, lettering style and other graphic representation required for each identification material or system.

PART 2 - PRODUCTS

ACCEPTABLE MANUFACTURERS:

Available Manufacturers: Subject to compliance with requirements, manufacturers offering electrical identification products which may be incorporated in the work include, but not limited to, the following:

Alarm Supply Co., Inc.  
Brady, W.H. Co.  
Calpico, Inc.  
Cole-Flex Corp.  
Direct Safety Co.  
George-Ingraham Corp.  
Griffolyn Company.  
Ideal Industries, Inc.  
LEM Products, Inc.  
Markal Company.  
National Band and Tag Co.  
Panduit Corp.  
Radar Engineer Div.; EPIC Corp.  
Seton Name Plate Co.  
Tesa Corp.

ELECTRICAL IDENTIFICATION MATERIALS:

General: Except as otherwise indicated, provide manufacturer's standard products of categories and types required for each application. Where more than single type is specified for an application, selection is Installer's option, but provide single selection for each application.

Color-Coded Conduit Markers:

General: Provide manufacturer's standard pre-printed, flexible or semi-rigid, permanent, plastic-sheet conduit markers, extending 360 degrees around conduits; designed for attachment to conduit by adhesive, adhesive lap joint of marker, matching adhesive plastic

tape at each end of marker, or pretentioned snap-on. Except as otherwise indicated, provide lettering which indicates voltage of the conductor(s) in conduit. Provide 8 inch minimum length for 2 inches and smaller conduit, 12 inch length for larger conduit.

Colors: Unless otherwise indicated or required by governing regulations, provide white markers with black letters.

Color-Coded Plastic Tape:

General: Provide manufacturer's standard self-adhesive vinyl tape not less than 3 mils thick by 1 1/2 inches wide.

Colors: Unless otherwise indicated or required by governing regulations, provide orange tape.

Underground-Type Plastic Line Marker:

General: Manufacturer's standard permanent, bright-colored, continuous-printed plastic tape, intended for direct-burial service; not less than 6 inches wide x 4 mils thick. Provide tape with printing which most accurately indicates the type of service of buried cable.

Cable/Conductor Identification Bands:

General: Provide manufacturer's standard aluminum wrap-around cable/conductor markers, of size required for proper application, and numbered to show circuit identification.

General: Provide manufacturer's standard vinyl-cloth self-adhesive cable/conductor markers of the wrap-around type; either pre-numbered plastic coated type, or write-on type with clear plastic self-adhesive cover flap; numbered to show circuit identification.

Plasticized Tags:

General: Manufacturer's standard pre-printed or partially pre-printed accident-prevention and operational tags, of plasticized card stock with matt finish suitable for writing, approximately 3 1/4" x 5 5/8", with brass grommets and wire fasteners, and with appropriate pre-printed wording including large-size primary wording, e.g., DANGER, CAUTION, DO NOT OPERATE.

Self-Adhesive Plastic Signs:

General: Provide manufacturer's standard, self-adhesive or pressure-sensitive, pre-printed, flexible vinyl signs for operational instructions or warnings; of sizes suitable for application areas and adequate for visibility, with proper wording for each application, e.g., 208V, EXHAUST FAN, RECTIFIER.

Colors: Unless otherwise indicated or required by governing regulations, provide white signs with black lettering.

Baked Enamel Danger Signs:

General: Provide manufacturer's standard "DANGER" signs of backed enamel finish on .20-gage steel; of standard red, black and white graphics; 14" x 10" size except where 10" x 7" is the largest size which can be applied where needed, and except where larger size is needed for adequate vision; with recognized standard explanation wording, e.g., HIGH VOLTAGE, KEEP AWAY, BURIED CABLE, DO NOT TOUCH SWITCH.

Engraved Plastic-Laminate Signs:

General: Provide engraving stock melamine plastic laminate, complying with FS L-P-387, in sizes and thicknesses indicated, engraved with engraver's standard letter style of the sizes and wording indicated, black face and white core plies (letter color) except as otherwise indicated, punched for mechanical fastening except where adhesive mounting is necessary because of substrate.

Thickness: 1/16 inch, except as otherwise indicated.

Thickness: 1/8 inch, except as otherwise indicated.

Thickness: 1/16 inch, for units up to 20 square inches or 8 inch length; 1/8 inch for larger units.

Fasteners: Self-tapping stainless steel screws, except contract-type permanent adhesive where screws cannot or should not penetrate the substrate.

LETTERING AND GRAPHICS:

General: Coordinate names, abbreviations and other designations used in electrical identification work, with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of the electrical systems and equipment. Comply with ANSI A13.1 pertaining to minimum sizes for letters and numbers.

PART 3 - EXECUTION

APPLICATION AND INSTALLATION:

General Installation Requirements:

Install electrical identification products as indicated in accordance with manufacturer's written instructions, and requirements of NEC.

Coordination: Where identification is to be applied to surfaces which requires finish, install identification after completion of painting.

Regulations: Comply with governing regulations and requests of governing authorities for the identification of electrical work.

Conduit Identification:

General: Where electrical conduit is exposed in spaces with exposed mechanical piping which is identified by color-coded method, apply color-coded identification on electrical conduit in manner similar to piping identification. Except as otherwise indicated, use white as the coded color for conduit.

Underground Cable Identification:

General: During backfilling/topsoiling of each exterior underground electrical, signal or communication cable, install a continuous underground-type plastic line marker, located directly over buried line at 6 to 8 inches below finished grade. Where multiple small lines are buried in a common trench and do not exceed an overall width of 16 inches, install a single line marker.

Limit use of line markers to direct-burial cables.

Install line marker for every buried cable, regardless of whether direct-buried or protected in conduit.

Cable/Conductor Identification:

General: Apply cable/conductor identification, including voltage, phase and feeder number, on each cable/conductor in each box/enclosure/cabinet where wires of more than one circuit or communication/signal system are present, except where another form of identification (such as color-coded conductors) is provided. Match identification with marking system used in panelboards, shop drawings, contract documents, and similar previously established identification for project's electrical work.

Operational Identification and Warnings:

General: Wherever reasonably required to ensure safe and efficient operation and maintenance of the electrical systems, and electrically connected mechanical systems and general systems and equipment, including the prevention of misuse of electrical facilities by unauthorized personnel, install self-adhesive plastic signs or similar equivalent identification, instruction or warnings on switches, outlets and other controls, devices and covers of electrical enclosures. Where detailed instructions or explanations are needed, provide plasticized tags with clearly written messages adequate for the intended purposes.

Danger Signs:

General: In addition to installation of danger signs required by governing regulations and authorities, install appropriate danger signs at locations indicated and at locations subsequently identified by Installer of electrical work as constituting similar dangers for persons in or about project.

High Voltage: Install danger signs wherever it is possible, under any circumstances, for persons to come into contact with electrical power of voltages higher than 110 to 120 volts.

Critical Switches/Controls: Install danger signs on switches and similar controls, regardless of whether concealed or locked up, where untimely or inadvertent operation (by anyone) could result in significant danger to persons, or damage to or loss of property.

Equipment/System Identification:

General: Install an engraved plastic-laminate sign on each major unit of electrical equipment in the building; including central or master unit of each electrical system including communication/control systems, unless unit is specified with its own self-explanatory identification or signal system. Except as otherwise indicated, provide single line of text, 1/2 inch high lettering on 1 1/2 inch high sign (2 inches high where two lines are required), white lettering in black field. Provide text matching terminology and numbering of the contract documents and shop drawings. Provide signs for each unit of the following categories of electrical work:

Panelboards, electrical cabinets and enclosures.

Access panel/doors to electrical facilities.

Major electrical switchgear.

Electrical substations.

Motor control centers.

Power transfer equipment.

Transformers.

Inverters.

Rectifiers.

Frequency converters.

Battery racks.

Power generating units.

Telephone switching equipment.

Clock/program master equipment.

Call system master station.

TV/audio monitoring master station.

Fire alarm master station.

Security monitoring master station.

Install signs at locations indicated or, where not otherwise indicated, at location for best convenience of viewing without interference with operation and maintenance of equipment. Secure to substrate with fasteners, except use adhesive where fasteners should not or cannot penetrate substrate.

SECTION 0.45-35 - SERVICE ENTRANCE

PART 1 - GENERAL RELATED DOCUMENTS:

Drawings and general provisions of Contract, including General and Supplementary Conditions and Section 0.45-1 apply to work of this section.

Section 0.45-25 Basic Electrical Materials and Methods apply to work specified in this section.

DESCRIPTION OF WORK:

Extent of service-entrance work is indicated by drawings and schedules.

Types of service-entrance equipment in this section include the following:

- Circuit breakers.
- Fuses.
- Meter sockets.
- Switches.

Switchgear and switchboards used for service-entrance equipment are specified in other Sections 0.45-26 through 0.45-49, and are work of this section.

Transformers used for service-entrance equipment are specified in Sections 0.45-26 through 0.45-49, and are work of this section.

Motor control centers used for service-entrance equipment are specified in Section 0.45-40, and are work of this section.

Refer to other Sections 0.45-26 through 0.45-49 for wire/cables, raceways, and electrical boxes and fittings work required in connection with service-entrance equipment; not work of this section.

QUALITY ASSURANCE:

Manufacturers: Firms regularly engaged in manufacture of service-entrance equipment, of types, sizes, and ratings required, whose products have been in satisfactory use in similar service for not less than 5 years.

Installer's Qualifications: Firm with at least 5 years of successful installation experience with projects utilizing service-entrance work similar to that required for this project.

NEC Compliance: Comply with NEC as applicable to construction and installation of service-entrance equipment and accessories.

NEMA Compliance: Comply with construction and installation requirements of the following NEMA standards for service-entrance equipment and accessories:

|                     |  |
|---------------------|--|
| Std Pub No. AB 1;   | Molded-Case Circuit Breakers.  |
| Std Pub No. FU 1;   | Low-Voltage Cartridge Fuses.   |
| Std Pub No. PF 1.2; | Application Guide for Ground-Fault Protective Devices for Equipment. |
| Std Pub No. PB 2;   | Deadfront Distribution Switchboards.                                 |
| Std Pub No. SG 3;   | Low-Voltage Power Circuit Breakers.                                  |
| Std Pub No. SG 5;   | Power Switchgear Assemblies.   |

UL Compliance: Comply with construction and installation requirements of the following UL standards for service-entrance equipment and accessories:

|         |  |
|---------|--|
| UL 50;  | Electrical Cabinets and Boxes.                               |
| UL 489; | Molded-Case Circuit Breakers and Circuit-Breaker Enclosures. |
| UL 854; | Service-Entrance Cables.                                     |
| UL 869; | Electrical Service Equipment.                                |

Provide service-entrance equipment and accessories which are UL-listed and labeled and marked, "SUITABLE FOR USE AS SERVICE EQUIPMENT."

IEEE Compliance: Comply with applicable requirements of IEEE Std 241 pertaining to service entrances.

ANSI Compliance: Comply with ANSI C2, "National Electrical Safety Code," installation requirements for above ground service-entrance conductors.

SUBMITTALS:

Product Data: Submit manufacturer's data on service-entrance equipment and accessories.

Shop Drawings: Submit dimensioned layouts of service-entrance equipment, including spatial relationships to proximate electrical equipment.

Wiring Diagrams: Submit power, signal and control wiring diagrams for service-entrance work. Clearly differentiate between portions of wiring/cabling that are manufacturer installed and portions that are field installed.

Maintenance Stock, Fuses: For types and ratings required, furnish additional fuses, amounting to one unit for every two installed units, but not less than one unit of each.

PART 2 - PRODUCTS

SERVICE-ENTRANCE EQUIPMENT:

General: Provide service-entrance equipment and accessories; of types, sizes, ratings and electrical characteristics indicated, which comply with manufacturer's standard materials, design and construction in accordance with published product information, and as required for complete installation; and as herein specified.

Overcurrent Protective Devices:

General: Provide overcurrent protective devices complying with Section 0.45-25 5 Basic Electrical Materials and Methods section "Overcurrent Protective Devices," in accordance with the following listing:

Power Circuit Breakers.  
Class L Fuses.

Meter Sockets:

General: Provide meter sockets which comply with requirements of local utility company supplying electrical power to service-entrance equipment of building project.

Available Manufacturers: Subject to compliance with requirements, manufacturers offering meter sockets which may be incorporated in the work include, but are not limited to, the following.

Circle AW Products Co.  
Duncan Electric Co., Inc.  
Federal Pacific Electric Co.  
General Electric Co.  
GTE Sylvania, Inc.  
Square D Company

Switches:

General: Provide safety switches complying with Section 0.45-32 "Circuit and Motor Disconnects," in accordance with the following listing:

Heavy-Duty Safety Switches, provide with NEMA Type 1 enclosures.

Cable/Wire:

General: Provide cable/wire complying with Section 0.45-29 "Wires and Cables," in accordance with the following listing:

Type SE, copper cable for above ground installation.  
Type USE, copper cable for underground installation.

Raceways:

General: Provide raceways complying with Section 0.45-26 "Raceways," in accordance with the following listing:

Rigid Steel Conduit, and fittings.

SERVICE-ENTRANCE ACCESSORIES:

Service-Entrance Caps: Provide service-entrance cable caps, of types, sizes, and number of cable holes indicated; with keyhole mounting brackets, suitable for use with Type SE cable. Construct of weather-resistant hot dip galvanized malleable iron, with clamping shoe in cap to hold cable, and with overlap cover to protect cables from weather.

Available Manufacturers: Subject to compliance with requirements, manufacturers offering service-entrance caps which may be incorporated in the work include, but are not limited to, the following:

Allen-Stevens Conduit Fittings Corp.  
Anchor Electric Co.  
Burndy Corp.  
Crouse-Hinds Co.  
Killark Elect Mfg. Co.  
Midland-Ross Corp.  
OZ/Gedney Co.  
Raco, Inc.  
Thomas and Betts Corp.

Wall and Floor Seals: Provide wall and floor seals complying with Section 0.45-33 "Supporting Devices," in accordance with the following listing:

Wall and Floor Seals.

PART 3 - EXECUTION

INSTALLATION OF SERVICE-ENTRANCE EQUIPMENT:

Install service-entrance equipment as indicated, in accordance with equipment manufacturer's written instructions, and with recognized industry practices, to ensure that service-entrance equipment fulfills requirements. Comply with applicable installation requirements of NEC and NEMA standards.

Coordinate with other electrical work, including utility company wiring, as necessary to interface installation of service-entrance equipment work with other work.

Install fuses, if any, in service-entrance equipment.

Install ground-fault protection devices complying with electrical winding polarities indicated.

Set field-adjustable GFP device and circuit breakers for pickup and time-current sensitivity ranges as indicated, subsequent to installation of devices and CB's.

GROUNDING:

Provide equipment bonding and grounding connectors, sufficiently tight to assure a permanent and effective ground, for service-entrance equipment and wiring/cabling as indicated.

ADJUST AND CLEAN:

Adjust operating mechanisms for free mechanical movement.

Touch up scratched or marred enclosure surfaces to match original finishes.

FIELD QUALITY CONTROL:

Upon completion of installation of service-entrance equipment and electrical circuitry, energize circuitry and demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and retest.

SECTION 0.45-36 - GROUNDING

PART 1 - GENERAL

RELATED DOCUMENTS:

Drawings and general provisions of Contract, including General and Supplementary Conditions and Section 0.45-1 apply to work of this section.

Section 0.45-25 Basic Materials and Methods sections apply to work of this section. Requirements of this section apply to electrical grounding and bonding work specified elsewhere in these specifications.

SUMMARY:

Extent of electrical grounding and bonding work is indicated by drawings and schedules and as specified herein. Grounding and bonding work is defined to encompass systems, circuits, and equipment.

Type of electrical grounding and bonding work specified in this section includes the following:

Solidly grounded.

Applications of electrical grounding and bonding work in this section includes the following:

- Underground metal piping.
- Underground metal water piping.
- Underground metal structures.
- Metal building frames.
- Electrical power systems.
- Grounding plate electrodes.
- Grounding electrodes.
- Counterpoise loops.
- Separately derived systems.
- Raceways.
- Service equipment.
- Enclosures.
- Equipment.
- Lighting standards.
- Landscape lighting.
- Signs.

Refer to other Sections 0.45-25 through 0.45-49 for wires/cables, electrical raceways, boxes and fittings, and wiring devices which are required in conjunction with electrical grounding and bonding work; not work of this section.

SUBMITTALS:

Product Data: Submit manufacturer's data on grounding and bonding products and associated accessories.

Wiring Diagrams: Submit wiring diagrams for electrical grounding and bonding work which indicates layout of ground rings, location of system grounding electrode connections, routing of grounding electrode conductors, also include diagrams for circuits and equipment grounding connections.

QUALITY ASSURANCE:

Manufacturer's Qualifications: Firms regularly engaged in manufacture of grounding and bonding products, of types, and ratings required, and ancillary grounding materials, including stranded cable, copper braid and bus, grounding electrodes and plate electrodes, and bonding jumpers whose products have been in satisfactory use in similar service for not less than 5 years.

Installer's Qualifications: Firm with at least 3 years of successful installation experience on projects with electrical grounding work similar to that required for project.

Codes and Standards:

Electrical Code Compliance: Comply with applicable local electrical code requirements of the authority having jurisdiction, and NEC as applicable to electrical grounding and bonding, pertaining to systems, circuits and equipment.

UL Compliance: Comply with applicable requirements of UL Standards Nos. 467, "Electrical Grounding and Bonding Equipment," and 869 "Electrical Service Equipment," pertaining to grounding and bonding of systems, circuits and equipment. In addition, comply with UL Std 486A, "Wire Connectors and soldering Lugs for Use with Copper Conductors." Provide grounding and bonding products which are UL-listed and labeled for their intended usage.

IEEE Compliance: Comply with applicable requirements and recommended installation practices of IEEE Standards 80, 81, 141 and 142 pertaining to grounding and bonding of systems, circuits and equipment.

PART 2 - PRODUCTS

MANUFACTURERS:

Available Manufacturers: Subject to compliance with requirements, manufacturers offering grounding and bonding products which may be incorporated in the work include, but are not limited to, the following:

Adalet-PLM Div.; Scott Fetzer Co.  
Burndy Corporation.  
Cadweld Div.; Erico Products, Inc.  
Crouse-Hinds Div.; Cooper Industries.  
Eagle Electric Mfg. Co.  
Ideal Industries, Inc.  
Joslyn Corporation.  
Okonite Company.  
OZ/Gedney Div.; General Signal Corp.  
Thomas and Betts Corp.

GROUNDING AND BONDING:

Materials and Components:

General: Except as otherwise indicated, provide electrical grounding and bonding systems indicated; with assembly of materials, including, but not limited to, cables/wires, connectors, solderless lug terminals, grounding electrodes and plate electrodes, bonding jumper braid, surge arresters, and additional accessories needed for a complete installation. Where more than one type component product meets indicated requirements, selection is Installer's options. Where materials or components are not indicated, provide products which comply with NEC, UL, and IEEE requirements and with established industry standards for those applications indicated.

Conductors: Unless otherwise indicated, provide electrical grounding conductors for grounding system connections that match power supply wiring materials and are sized according to NEC.

Conductors: Copper cable; strand diameter 0.045 inch; 0.187 pound per foot; 57,400 circular mils.

Conductors: Copper solid strip 0.051 inch thick; 1 inch wide.

Conductors: Copper solid rod; 0.187 pound per foot.

Conductors: Copper cable; strand diameter 0.045 inch; 14 strands.

Conductors: Copper solid strip; 0.051 inch thick; 1/2 inch wide.

Conductors: Copper solid rod; diameter 0.162 inch.

Bonding Jumper Braid: Copper braided tape, constructed of 30-gage bare copper wires and properly sized for indicated applications.

Flexible Jumper Strap: Flexible flat conductor, 480 strands of 30-gage bare copper wire; 3/4 inch wide, 9 1/2 inches long; 48,250 CM. Select braid with holes sized for 3/8 inch diameter bolts, and protect braid with copper bolt hole ends.

Bonding Plates, Connector, Terminals and Clamps: Provide electrical bonding plates, connectors, terminals, lugs and clamps as recommended by bonding plate, connector, terminal and clamp manufacturers for indicated application.

Ground Electrodes and Plates:

Grounding Electrodes: Solid copper, 5/8 inch diameter by 10 feet.

Grounding Electrodes: Steel with copper welded exterior, 3/4 inch diameter by 10 feet.

Grounding Electrodes: Stainless steel, 3/4 inch diameter x 10 feet.

Plate Electrodes: Sheet copper plate, 20-gage by 36" x 36", with 2 cable attachments sized as indicated for either 1/0 or 2/0 cables.

Electrical Grounding Connection Accessories: Provide electrical insulating tape, heat-shrinkable insulating tubing, welding materials, bonding straps, as recommended by accessories manufacturers for type service indicated.

Field Welding: Comply with AWS Code for procedures, appearance, and quality of welds; and for methods used in correcting welding work. Provide welded connections where grounding conductors connect to underground grounding and plate electrodes.

Ground Bus: Provide 98 percent conductivity copper bus. Rigidly attach to the structure. Use standoff insulated attachment for isolated and low level d.c. systems.

PART 3 - EXECUTION

EXAMINATION:

Examine areas and conditions under which electrical grounding and bonding connections are to be made and notify Contractor in writing of conditions detrimental to proper completion of work. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

INSTALLATION OF ELECTRICAL GROUNDING AND BONDING SYSTEMS:

General: Install electrical grounding and bonding systems as indicated, in accordance with manufacturer's instructions and applicable portions of NEC, NECA's "Standard of Installation," and in accordance with recognized industry practices to ensure that products comply with requirements.

Coordinate with other electrical work as necessary to interface installation of electrical grounding and bonding system work with other work.

Weld grounding conductors to underground grounding electrodes.

Ground electrical service system neutral at service entrance equipment to grounding electrodes.

Ground each separately-derived system neutral to:

Effectively grounded metallic water pipe.

Effectively grounded structural steel member.

Separate grounding electrode.

Connect together system neutral, service equipment enclosures, exposed noncurrent carrying metal parts of electrical equipment, metal raceway systems, grounding conductor in raceways and cables, receptacle ground connectors, and plumbing systems.

Install counterpoises which encircle the building and are connected to each structural column, and to each driven electrode.

Terminate feeder and branch circuit insulated equipment grounding conductors with grounding lug, bus, or bushing.

Connect grounding electrode conductors to 1-inch diameter, or greater, metallic cold water pipe using a suitably sized ground clamp. Provide connections to flanged piping to street side of flange.

Interconnect all ground electrodes. Extend all grounding systems to the electrodes.

Tighten grounding and bonding connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values for connectors and bolts. Where manufacturer's torquing requirements are not indicated, tighten connections to comply with tightening torque values specified in UL 486A to assure permanent and effective grounding.

Install braided type bonding jumpers with code-sized ground clamps on water meter piping to electrically bypass water meters.

Route grounding connections and conductors to ground and protective devices in shortest and straightest paths as possible to minimize transient voltage rises.

Apply corrosion-resistant finish to field-connections, buried metallic grounding and bonding products, and places where factory applied protective coatings have been destroyed, which are subjected to corrosive action.

Install clamp-on connectors on clean metal contact surfaces, to ensure electrical conductivity and circuit integrity.

Isolated Ground System: Where isolated ground receptacles are provided, ground conductors shall be isolated from conventional ac power ground system. Extend isolated ground conductors to the ground electrode system and connect. Ground conductors shall be insulated. Conventional ac power system ground shall be extended to receptacle box for possible use by utilization equipment.

Direct Current Low Level Signal Ground System: Provide a separate ground wire system consisting of insulated ground wires interconnected and increasing in size based upon conductor length. Powered equipment using low level dc signals shall be connected by a minimum No. 10 AWG wire to the low level dc ground system. Ground system conductor size shall increase one standard conductor size (based on NEC ampacity tables for copper conductors in conduit) for each four pieces of equipment served, e.g., five units each connected to a No. 10 AWG copper ground must be connected to a No. 8 AWG ground wire. Nine units with No. 10 AWG must be fed from a No. 6 AWG, etc.

FIELD QUALITY CONTROL:

Upon completion of installation of electrical grounding and bonding systems, test ground resistance with ground resistance tester. Where tests show resistance-to-ground is over 25 ohms, take appropriate action to reduce resistance to 25 ohms, or less, by driving additional ground rods; then retest to demonstrate compliance.

SECTION 0.45-37 - PANELBOARDS

PART 1 - GENERAL RELATED DOCUMENTS:

Drawings and general provisions of Contract, including General and Supplementary Conditions and Section 0.45-1 apply to work of this section.

Section 0.45-25 Basic Electrical Materials and Methods apply to work specified in this section.

DESCRIPTION OF WORK:

Extent of panelboard, load-center and enclosure work, including cabinets and cutout boxes is indicated by drawings and schedules.

Types of panelboards and enclosures in this section include the following:

- Service-entrance panelboards.
- Power-distribution panelboards.
- Lighting and appliance panelboards.

Refer to other Section 0.45-25 through 0.45-49 sections for cable/wire, connectors, and electrical raceway work required in conjunction with panelboards and enclosures; not work of this section.

QUALITY ASSURANCE:

Manufacturers: Firms regularly engaged in manufacturer of panelboards and enclosures, of types, sizes, and ratings required, whose products have been in satisfactory use in similar service for not less than 5 years.

Installers Qualifications: A firm with at least 3 years of successful installation experience on projects with utilizing panelboards similar to those required for this project.

NEC Compliance: Comply with NEC as applicable to installation of panelboards, cabinets, and cutout boxes. Comply with NEC requirements pertaining to installation of wiring and equipment in hazardous locations.

UL Compliance: Comply with applicable requirements of Std No. 67, "Electric Panelboards," and Stds Nos. 50, 869, 486A, 486B, and 1053 pertaining to panelboards, accessories and enclosures. Provide units which are UL-listed and labeled.

Special-Use Markings: Provide panelboards, constructed for special-use, with appropriate UL marks which indicates that special type of use/application.

NEMA Compliance: Comply with NEMA Stds Pub/No. 250, "Enclosures for Electrical Equipment (1000 Volts Maximum)," Pub/No. PB 1, "Panelboards," and Pub/No. PB 1.1, "Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less."

Federal Specification Compliance: Comply with FS W-P-115, "Power Distribution Panel," pertaining to panelboards and accessories.

SUBMITTALS:

Product Data: Submit manufacturer's data on panelboards.

Wiring Diagrams: Submit wiring diagrams for panelboards showing connections to electrical power feeders and distribution branches.

PART 2 - PRODUCTS

ACCEPTABLE MANUFACTURERS:

Available Manufacturers: Subject to compliance with requirements, manufacturers offering electrical panelboard products which may be incorporated in the work include, but are not limited to, the following:

Crouse-Hinds Company.  
Cutler-Hammer Products, Eaton Corp.  
Federal Pacific Electric Co.  
General Electric Company.  
Gould, Inc.  
Nelson Electric; Div. of General Signal Corp.  
Parker Electrical Mfg. Co.  
Siemens-Allis, Inc.  
Square D Company.  
Westinghouse Electric Corp.

PANELBOARDS:

General: Except as otherwise indicated, provide panelboards, enclosures and ancillary components, of types, sizes, and ratings indicated, which comply with manufacturer's standard materials; design and construction in accordance with published product information; equip with proper number of unit panelboard devices as required for complete installation. Where types, sizes, or ratings are not indicated, comply with NEC, UL and established industry standards for those applications indicated.

Service-Entrance Panelboards: Provide dead-front safety constructed factory-assembled service-entrance circuit-breaker type panelboards in sizes and ratings as indicated. Equip with panelboard unit devices, of types, ratings and characteristics indicated. Construct with rectangular bus bars of solid copper,

with conductivity not less than 98 percent, which are securely mounted and braced, and with solderless lugs bolted to main bus bars suitable for service with 277/480Y volts, 3-phase, 4-wire, system. Provide branch circuits with molded-case type single-pole circuit-breakers, with toggle handles that indicate when tripped. Select enclosures which are fabricated by same manufacturer as panelboards, and which mate properly with panelboards. Provide panelboards with UL markings indicating "suitable for use as service-entrance equipment.

Power Distribution Panelboards: Provide dead-front safety type power distribution panelboards as indicated, with panelboard switching and protective devices in quantities, ratings, types and with arrangement shown; with anti-turn solderless pressure type main lug connectors approved for copper conductors. Select unit with feeder connecting at top of panel. Equip with copper bus bars with not less than 98 percent conductivity, and with full-size neutral bus; provide suitable lugs on neutral bus for outgoing feeders requiring neutral connections. Provide molded-case main and branch circuit-breaker types for each circuit, with toggle handles that indicate when tripped. Where multiple-pole breakers are indicated, provide with common trip so overload on one pole will trip all poles simultaneously. Provide panelboards with bare uninsulated grounding bars suitable for bolting to enclosures. Select enclosures fabricated by same manufacturer as panelboards, which mate properly with panelboards.

Lighting and Appliance Panelboards: Provide dead-front safety type lighting and appliance panelboards as indicated, with switching and protective devices in quantities, ratings, types and arrangements shown; with anti-burn solderless pressure type lug connectors approved for copper conductors; construct unit for connecting feeders at top of panel; equip with copper bus bars, full-sized neutral bar, with bolt-in type heavy-duty, quick-make, quick-break, single-pole circuit-breakers, with toggle handles that indicate when tripped. Provide suitable lugs on neutral bus for each outgoing feeder required; provide bare uninsulated grounding bars suitable for bolting to enclosures. Select enclosures fabricated by same manufacturer as panelboards, which mate properly with enclosures.

Panelboard Enclosures: Provide galvanized sheet steel cabinet type enclosures, in sizes and NEMA types as indicated, code-gage, minimum 16-gage thickness. Construct with multiple knockouts and wiring gutters. Provide fronts with adjustable trim clamps, and doors with flush locks and keys, all panelboard enclosures keyed alike, with concealed piano door hinges and door swings as indicated. Equip with interior circuit-directory frame, and card with clear plastic covering. Provide baked gray enamel finish over a rust inhibitor coating. Design enclosures for recessed mounting. Provide enclosures fabricated by same manufacturer as panelboards, which mate properly with panelboards to be enclosed.

Panelboard Accessories: Provide panelboard accessories and devices including, but not necessarily limited to, cartridge and plug time-delay type fuses, circuit-breakers, ground-fault protection units, etc., as recommended by panelboard manufacturer for ratings and applications indicated.

### PART 3 - EXECUTION

#### INSPECTION:

Installer must examine areas and conditions under which panelboards and enclosures are to be installed, and notify Contractor in writing of conditions detrimental to proper completion of work. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

#### INSTALLATION OF PANELBOARDS:

General: Install panelboards and enclosures as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC Standards and NECA's "Standard of Installation", and in compliance with recognized industry practices to ensure that products fulfill requirements.

Coordinate installation of panelboards and enclosures with cable and raceway installation work.

Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Stds 486A and B.

Anchor enclosures firmly to walls and structural surfaces, ensuring that they are permanently and mechanically secure.

Provide properly wired electrical connections within enclosures.

Fill out panelboard's circuit directory card upon completion of installation work.

Insert fuses, of ratings indicated, in installed panelboards, if any.

#### GROUNDING:

Provide equipment grounding connections for panelboards as indicated. Tighten connections to comply with tightening torques specified in UL Stds 486A and B to assure permanent and effective grounds.

#### FIELD QUALITY CONTROL:

Prior to energization of circuitry, check all accessible connections to manufacturer's tightening torque specifications.

Prior to energization of panelboards, check with ground resistance tester phase-to-phase and phase-to-ground insulation resistance levels to ensure requirements are fulfilled.

Prior to energization, check panelboards for electrical continuity of circuits, and for short-circuits.

Subsequent to wire and cable hook-ups, energize panelboards and demonstrate functioning in accordance with requirements. Where necessary, correct malfunctioning units, and then retest to demonstrate compliance.

SECTION 0.45-38 - MOTOR CONTROL CENTERS

PART 1 - GENERAL RELATED DOCUMENTS:

Drawings and general provisions of Contract, including General and Supplementary Conditions and Section 0.45-1 apply to work of this section.

Section 0.45-25 Basic Electrical Materials and Methods apply to work specified in this section.

DESCRIPTION OF WORK:

Extent of alternating-current motor control center (MCC) work is indicated by drawings and schedules.

Types of motor control center components specified in this section include the following:

- MCC supporting structures.
- Bus systems.
- Starter units.
- Controllers.
- Plug-on's.
- Disconnects.
- Overload protection.
- Overcurrent protection.
- Programmable Logic Controller (PLC)

QUALITY ASSURANCE:

Manufacturers: Firms regularly engaged in manufacture of motor control centers of types, sizes, and ratings required, whose products have been in satisfactory use in similar service for not less than 5 years.

Installer's Qualifications: Firms with at least 3 years of successful installation experience on projects with motor control center installation work similar to that required for project.

Codes and Standards:

NEMA Compliance: Comply with NEMA Stds Pub/No. ICS-2, pertaining to construction, testing and installation of motor control centers; and with applicable NEMA standards for circuit-breakers and fuses.

UL Compliances: Comply with applicable requirements of UL Std 486A, "Wire Connectors and Soldering Lugs for Use with Copper Conductors," and UL Std 845, "Electric Motor Control Centers." Provide MCC's and ancillary equipment which are UL-listed and labeled.

NEC Compliance: Comply with requirements of NEC as applicable to motor control center equipment and components.

IEEE Compliance: Comply with applicable requirements of IEEE Std 241 pertaining to construction and installation of motor control centers.

ANSI Compliance: Comply with applicable requirements of ANSI as applicable to motor control centers.

SUBMITTALS:

Product Data: Submit manufacturer's technical product data on motor control center. Application data to include, but not limited to, the following:

- Voltage.
- Phase.
- Frequency.
- Horizontal bus capacity.
- Vertical bus capacity.
- Short-circuit ratings.
- Main and branch circuit-breakers ratings.
- Types of motor starting.
- Type of wiring.
- Enclosures.
- Sections.
- Motor size and overload heaters.
- Panels and transformers.

Shop Drawings: Submit layout drawings of motor control centers showing accurate scaled basic equipment sections including, but not limited to, motor starters, controllers, device panels, and circuit-breakers. Show spatial relationships of MCC components to proximate electrical equipment. Supply ladder logic diagrams showing all PLC programming. Clearly differentiate on wiring diagrams those conductors which are factory-installed and those which are field-installed.

Maintenance Data: Submit maintenance data and parts list for each motor control center; including "trouble-shooting" maintenance guide. Include that data, product data, and shop drawings in a maintenance manual in accordance with requirements of Section 0.45-25.

DELIVERY, STORAGE AND HANDLING:

Handle motor control centers carefully to prevent damage, breaking, and scoring. Do not install damaged sections or components; replace with new.

Store motor control center equipment in clean dry place. Protect

from weather, dirt, fumes, water construction debris, and physical damage.

Comply with manufacturer's rigging and moving instructions for unloading motor control centers, and transporting them to final location for installation.

## PART 2 - PRODUCTS

### ACCEPTABLE MANUFACTURERS:

Available Manufacturers: Subject to compliance with requirements, manufacturers offering motor control centers which may be incorporated in the work include, but are not limited to, the following:

Allen-Bradley Co.  
Cutler-Hammer, Inc.  
Furnas Electric Co.  
General Electric Co.  
Gould, Incorporated  
Siemens-Allis, Inc.  
Square D Company  
Westinghouse Electric Co.

### MOTOR CONTROL CENTERS AND COMPONENTS:

General: Provide motor control centers and ancillary components of sizes, rating Classes, Types, and characteristics and indicated; which comply with manufacturer's standard design, materials, components, and construction in accordance with published product information, and as required for complete installation and as specified herein.

Motor Control Centers: Provide motor control centers for operation on 480Y/227 - 3-phase, 4-wire, 60 Hz grounded service, consisting of one or more vertical sections, each with groupings of control units containing motor starters, thermal overload units and disconnects and including such other electrical equipment as controls, control transformers, metering panels, current transformers, and auxiliary devices as indicated. Design MCC for connection to available faults of not less than 22,000 RMS symmetrical amperes. Provide MCC with NEMA Class 2, Type B wiring.

MCC Supporting Structures: Provide factory-assembled, deadfront, MCC standard supporting structures of Classes and Types indicated; with enclosed vertical sections, as indicated, fastened together to form rigid free-standing assembly. Construct each section 90 inches high with 9 inch horizontal wireways at top and bottom, 20 inches wide, and with 20 inch section depth for front-of-board unit arrangement. Provide NEMA Type 1 enclosures. Construct units with 4 5/8 inches wide, 8 inches deep, 90 inches high vertical wireway in each vertical structure on right side of unit, accessible

through hinged doors, and with supports at proper intervals within for fastening wires/cables. Form supporting members of not less than 13-gage hot-rolled steel. Construct structure doors with removable pin hinges and secure with quarter-turn indicating type fasteners. Provide rear-accessible main lug compartment for connection of incoming cables in top section. Provide removable lifting angle full length of MCC. Design lifting angle to support entire weight of MCC section. Design bottom channels to be removable, provide holes for bolting MCC units to floor.

Provide shipping splits in MCC lineup to allow for shipment of maximum 60 inch long units. Design MCC's so matching vertical sections of same current rating and manufacturer can be added later at either end of lineup without use of transition sections. Provide removable end and top plates to close off openings.

Bus System: Construct bus bars of silver-plated copper, braced to withstand faults of 22,000 RMS symmetrical amperes minimum. Provide main horizontal bus with rating as shown on the drawings, and vertical bus rating of 300 amperes; and construct vertical bus bars with protective barriers to prevent accidental contact of personnel with bus.

Provide silver-plated copper ground bus running full width of MCC at bottom of lineup. Drill ground bus and furnish lugs as indicated.

Starter Units: Provide draw-out type, solid state reduced voltage motor starters with instantaneous magnetic trip only motor circuit protector circuit-breakers and auxiliary control devices as indicated. Construct each starter unit with doors, unit support pans, saddles and disconnect operators; enclose and isolate each unit from adjacent units. Design units so that faults will be contained within compartments; and with 22,000 amperes minimum, RMS symmetrical fault withstand-ability. The starter shall contain six fuse protected silicon controlled rectifiers, two per phase, to regulate motor current.

The starter shall provide smooth and soft starting with an adjustable current limiting to limit starting current to 150% of full load. A solid state 3 phase overload relay to monitor all three phases of load current shall be provided. An overload condition shall automatically de-energize the starter. Under voltage trip shall also be provided. A shorting contractor shall be furnished to by-pass the solid state starter for across-the-line operation. The contractor shall be operated when the motor obtains full load speed. Equip with thermal overload protection device for each motor circuit, unit-mounted pilot devices, START-STOP buttons, selector switches, indicating lights, and control relays. Provide not less than 2 normally-open and normally-closed auxiliary contacts. Provide draw-out units with de-energized position where unit is still supported by structure, but no electrical connection

is made. Provide method of locking unit in de-energized position. Design plug-in units of same NEMA size and branch feeder units of same trip rating, to be interchangeable with each other.

Operator Controls: The following indication lights and switches shall be mounted on the front panel of each starter.

| <u>Light</u> | <u>Function</u>  |
|--------------|--|
| Amber        | Call Lamp - indicates that the automatic control system has commanded the pump to start.   |
| Green        | Pump Running - the starter has closed and the pump flow switch has closed indicating positive flow.  |
| Red          | Pump Field - the starter has closed and the pump flow switch has failed to close after a preset time, or the starter has tripped. In addition a pump high temp. condition or a pump water seal failure will cause a pump failed condition. |

| <u>Control Switches</u> | <u>Function</u>   |
|-------------------------|---|
| PLC Lockout: On-Off     | Two position, maintained selector switch. Locks out the PLC from automatic control.   |
| Reset                   | Momentary Push Button. Any pump trip or failure shall cause the pump to be locked out of PLC control. Only after the reset pushbutton has been depressed shall the PLC be capable of restarting the pump. |
| Stop                    | Momentary Pushbutton. Manually stops pump.  |
| Start                   | Momentary Pushbutton. Manually starts pump.   |

| <u>Meters</u>      | <u>Functions</u>   |
|--------------------|--|
| Ammeter            | Shows current draw of each phase.                                  |
| Running Time Meter | Shows cumulative pump on time, with digital readout.               |
| Level Indicator    | Only one required for entire motor control center. A 4-20 ma panel |

indicator with vertical bar scale and digital readout to show wet-well level.

#### Operator Interface Module

Only one required for entire motor control center. This is a panel mounted keypad with alpha-numeric display that allows the operator to change the wet-well levels that turn the pumps on and off. This module does not allow the operator to alter the PLC program. The operator must enter an access code before he can change any setpoints.

Unit Plug-On: Provide plug-on connections for each electrical power phase. Design contact fingers to be floating and self-aligning; silver plate contacts for obtaining low resistance connections.

Disconnect Operators: Provide external operator handles for switches and circuit breakers. Design handle with up-down motion and with down position indicating OFF. Construct handles which permit locking handle in OFF position with 3 padlocks.

Unit Drops: Provide unit doors securely mounted with rugged concealed-type hinges which allows doors to swing open minimum of 115 degrees for ease of unit maintenance and withdrawal. Fasten doors to structure so that they remain in place when unit is withdrawn.

Closed door must cover unit space when unit has been temporarily removed. Provide interlock for each unit door with associated disconnect mechanism to prevent door from opening when unit is energized.

Circuit - Breakers: Provide factory-assembled, molded-case circuit breakers, motor circuit protector type with permanent instantaneous magnetic trips in each pole, and with fault-current limiting protection, ampere ratings as indicated. Construct with overcenter, trip-free, toggle type operating mechanism with quick-make, quick-break action and positive handle indication. Provide push-to-trip feature for testing and exercising circuit breaker trip mechanism. Construct breakers for mounting and operating in any physical position and in an ambient temperature of 40 degrees Celsius ( $^{\circ}$  C.). Provide with AL/CU rated mechanical screw type removable connector lugs.

#### Programmable Logic Controller:

All control logic for the pump controls, generator controls, and UPS controls shall be resident in the PLC. See respective specification sections for control requirements.

The program shall be started in a read only memory (ROM). It shall not be possible to alter the program in the field. This memory will be non-volatile and capable of withstanding indefinite power loss.

The status of the inputs and outputs shall be checked at the time they are called for in the program rung the CPU is operating on. A battery backed up in memory shall be used for storing field data and operating set points.

The outputs shall be available to be turned "ON" or "OFF" as soon as its rung has been scanned.

The CPU shall check the parity of each word at the time it is scanning that word. The CPU shall contain "trouble" lights to indicate memory parity errors or processor malfunctions.

All CPU operating logic shall be contained on plug-in cards for ease of replacement. Chassis wired logic is not acceptable.

The memory unit shall have spare program capacity equal to 20 percent of the memory used.

#### Systems Input and Output (I/O's):

Additional I/O frames (up to the maximum PC capacity) can be added at any time in the field.

I/O modules shall have key slots which are unique for each card type, so that the wrong card type cannot be inadvertently installed in a slot that was programmed for a different card type.

I/O cards shall be replaceable without removing panel wiring.

I/O cards shall provide at least one common terminal for every two inputs or outputs.

Inputs and outputs shall be provided with reed relay or optical isolation between field circuits and internal circuitry.

Status lights shall be provided for each input and output amplifier indicating a signal is present to turn the input or output "ON".

Outputs shall be fused, and the fuses shall be easily removable without the use of special tools.

Output cards used only for pilot light or annunciator lamp box service shall have a minimum continuous load capacity of 0.25 amperes at 120 VAC.

Output cards used for other loads shall have a minimum continuous load capacity of 10 amperes at 120V AC.

System Operation: The system incorporates three pumps. At any time, only two pumps shall be automatically operated. The third pump can only be activated manually and is reserved for spare. The pumps shall turn on and off with the changing wetwell level as shown in the following schedule:

**Pump Turn On Sequence**

| <u>Rising Wet Well Level</u> | <u>Pumps Activated</u> |
|------------------------------|------------------------|
| 1227.50                      | One Pump On            |
| 1228.75                      | Two Pumps On           |
| 1232.5      High Level Alarm |                        |

**Pump turn Off Sequence**

| <u>Falling Wet Wall Level</u> | <u>Pumps Deactivated</u> |
|-------------------------------|--------------------------|
| 1224.00                       | All Pumps Off            |

Pump Sequencing:

In order to equalize the operating time of all three pumps, the pumps shall be sequenced as to which pump shall be reserved for spare operation. This sequence will advance to the next cycle every time the first pump (lowest wetwell level) turn on command is given.

|  | <u>First Pump On</u> | <u>Second Pump On</u> |
|--|----------------------|-----------------------|
| First Cycle                                  | Pump #1              | Pump #2               |
| Second Cycle                                 | Pump #2              | Pump #3               |
| Third Cycle                                  | Pump #3              | Pump #1               |
| Return to first<br>Cycle and Repeat Sequence |                      |                       |

In any pump fails, the standby pump shall automatically start. No two pumps shall ever start simultaneously.

A contact from the combustible gas detection system shall shut down any pumps in operation whenever a warning level is reached.

Any pump fail signal shall deactivate the pump until manually reset.

PUMP EXERCISE TIMER:

A pump exercise timer shall be provided in the pump control module. During exercise of the engine generator set each pump shall be automatically operated for a period no greater than 30 seconds. Only one pump shall be operated at a time during the exercise

period. An "Off-Auto" switch shall be provided for exercise cycle.

Equipment/System Identification: Provide equipment/system identification nameplates complying with Section 0.45-35 "Electrical Identification," in accordance with Motor Control Schedule on drawings.

Finishes: Thoroughly clean interior and exterior prior to coating of MCC, including bolted joints, with rust inhibiting prime coat. Provide two finish coats of manufacturer's standard color baked-on enamel finish.

### PART 3 - EXECUTION

#### INSPECTION:

Examine areas and conditions under which motor control centers are to be installed, and substrate which will support motor control centers. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

#### INSTALLATION OF MOTOR CONTROL CENTERS:

Install motor control centers as indicated, in accordance with equipment manufacturer's written instructions, and with recognized industry practices; complying with applicable requirements of NEC, NEMA's Std Pub/No. ICS-2, and NEC "Standard of Installation."

Coordinate with other electrical work including wiring/cabbling and raceway work, as necessary to interface installation or motor control centers with other work.

Install fuses, if any, in motor control center units.

Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Std 486A and B.

#### ADJUSTING AND CLEANING:

Adjust operating mechanisms for free mechanical movement.

Touch-up scratched or marred surfaces to match original finishes.

#### GROUNDING:

Provide equipment grounding connections for motor control centers as indicated. Tighten connections to comply with tightening torques specified in UL Std 486A to assure permanent and effective grounds.

FIELD QUALITY CONTROL:

Prior to energization of motor control centers, check with insulation resistance tester for proper values of phase-to-phase and phase-to-ground insulation resistances. Log that data, and submit to Engineer.

Prior to energization of circuitry, check control center electrical circuits for continuity and for short-circuits.

Subsequent to wire/cable and raceway hook-ups, energize motor control center circuitry, check each motor for proper phase rotation, and demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units and proceed with retesting.

SPARE PARTS:

General: Furnish to Owner, with receipt, the following spare parts:

Fuses of each type and rating required, amounting to one unit for each 10 installed units, but not less than three units of each.

SECTION 0.45-41 - INTERIOR BUILDING AND AREA LIGHTING

PART 1 - GENERAL RELATED DOCUMENTS:

Drawings and general provisions of Contract, including General and Supplementary Conditions and Section 0.45-1 apply to work of this section.

Section 0.45-25 Basic Electrical Materials and Methods apply to work specified in this section.

DESCRIPTION OF WORK:

Furnish all labor, materials, and incidentals required to provide and install interior building and area lighting.

Extent of interior and area lighting fixture work is indicated by drawings and schedules.

Types of interior and area lighting fixtures in this section include the following:

Fluorescent  
Incandescent  
High-pressure sodium

QUALITY ASSURANCE:

Manufacturers: Firms regularly engaged in manufacture of interior and area lighting fixtures of types and ratings required, whose products have been in satisfactory use in similar service for not less than 5 years.

Installer: Qualified with at least 3 years of successful installation experience on projects with interior and area lighting fixture work similar to that required for project.

NEC Compliance: Comply with NEC as applicable to installation construction of interior building lighting fixtures.

UL Compliance: Provide interior and area lighting fixtures which have been UL-tested and labeled.

CBM Label: Provide fluorescent-lamp and H.P.S. lamp ballasts which comply with Certified Ballast Manufacturers Association standards and carry the CBM label.

SUBMITTALS:

Shop Drawings: Submit fixture shop drawings in booklet form with separate sheet for each fixture, assembled in luminaire "type" alphabetical order, with proposed fixture and accessories clearly

indicated on each sheet.

DELIVERY, STORAGE AND HANDLING:

Handle lighting fixtures carefully to prevent damage, breaking, and scoring. Do not install damaged fixtures or components; replace with new.

Store lighting fixtures in clean dry place. Protect from weather, dirt, fumes, water, construction debris, and physical damage.

PART 2 - PRODUCTS

ACCEPTABLE MANUFACTURERS:

Available Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include, but are not limited to, the following:

Appleton  
Benjamin  
Columbia  
Day-Brite  
Halophane  
Lithonia  
Prescolite

INTERIOR LIGHTING AND AREA FIXTURES:

General: Provide lighting fixtures, of sizes, types and ratings indicated; complete with, but not necessarily limited to, lamps, lamp holders, reflectors, ballasts, starters and wiring.

Time Switch: The time switch shall be of the synchronous motor-driven type with an astronomic dial and a spring drive reserve feature sufficient to operate 16 hours after a power failure.

Contacts shall be 40 amps per pole at 277 volt, DPST, motor voltage shall be 120 volts, 60 hertz. Time switch enclosure shall be a general purpose, NEMA 1, surface mounted type.

Fluorescent-Lamp Ballasts: Provide fluorescent-lamp ballasts, capable of operating lamp types indicated; with high power factor, rapid-start, and low-noise features; Type 1; Class P; sound-rated A, and with internal thermal protection.

High-Intensity-Discharge Lamp Ballasts: Provide HID lamp ballasts, capable of operating lamp types and ratings indicated; reactor type, high power-factor, core and coil assembly encapsulated in non-melt resin; install capacitor outside ballast encapsulation for easy field replacement.

Lighting Fixture Types:

Refer to fixture schedule on plans for fixture types and lamp data.

PART 3 - EXECUTION

INSTALLATION OF LIGHTING FIXTURES:

Install interior lighting fixtures at locations and heights as indicated, in accordance with fixture manufacturer's written instructions, applicable requirements of NEC, NECA's "Standard of Installation", NEMA standards, and with recognized industry practices to ensure that lighting fixtures fulfill requirements.

Coordinate with other electrical work as appropriate to properly interface installation of interior fixtures with other work.

Fasten fixtures securely to indicated structural support; and check to ensure that solid pendant fixtures are plumb.

ADJUST AND CLEAN:

Clean interior lighting fixtures of dirt and debris upon completion of installation.

Protect installed fixtures from damage during remainder of construction period.

FIELD QUALITY CONTROL:

Upon completion of installation of lighting fixtures, and after building circuitry has been energized, apply electrical energy to demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting.

Replace defective and burned out lamps for a period of one year following the time of Substantial Completion.

At the time of Substantial Completion, replace lamps in lighting fixtures which are observed to be noticeably dimmed after Contractor's use and testing, as judged by the Engineer. Furnish stock or replacement lamps amounting to 15% (but not less than one lamp in each case) of each type and size lamp used in each type fixture. Deliver replacement stock as directed to Owner's storage space.

Refer to Section 0.45-25 for the replacement/restoration of lamps in interior lighting fixtures, where used for temporary lighting prior to date of Substantial Completion.

GROUNDING:

Provide tight equipment grounding connections for each interior lighting fixture installation where indicated.

SECTION 0.45-42 - UNINTERRUPTIBLE POWER SUPPLY SYSTEMS:

PART 1 - GENERAL DESCRIPTION OF WORK:

Furnish all labor, materials, and incidentals required to provide and install an uninterruptible power supply (UPS) system.

Extent of uninterruptible power supply (UPS) system work is indicated by drawings and schedules. UPS is defined to include, but not limited to, rectifiers/chargers, inverters, static transfer and maintenance switches, batteries and accessories.

Application of UPS required for the section include the following:

Communication facilities.

Requirements are indicated elsewhere in these specifications for work including, but not limited to, electrical raceways, and boxes and fittings required for installation of uninterruptible power supply systems. Refer to applicable Section 0.45-26 and 0.45-27, "Raceways", and "Electrical Boxes and Fittings" required in connection with uninterruptible power supply systems; not work of this section.

CODES AND STANDARDS:

NEC Compliance: Comply with NEC as applicable to wiring methods, materials, construction and installation of electrical equipment.

UL Compliance: Comply with applicable requirements of UL 1008, "Automatic Transfer Switches". Provide UPS system components which are UL-listed and labeled.

ANSI/NEMA Compliance: Comply with ANSI/NEMA Std Pub No. ICS 2, pertaining to AC automatic transfer switches and lead-acid batteries.

ANSI Compliance: Comply with applicable portions of ANSI C84.1 pertaining to requirements of steady-state voltage ratings, including tolerances, for electrical power systems and equipment.

IEEE Compliance: Comply with applicable requirements of IEEE standards pertaining to semiconductor rectifier components.

SUBMITTALS:

Product Data: Submit manufacturer's data on uninterruptible power supply systems and components.

Shop Drawings: Submit dimensioned layout drawings of UPS systems and accessories including, but not limited to, rectifiers/chargers, inverters, static transfer switches, maintenance switches, batteries, and instruments, indicating accurately scaled UPS system equipment locations and their spatial relationship to associated equipment, and connections to normal and standby electrical power feeders.

PART 2 - PRODUCTS:

ACCEPTABLE MANUFACTURERS:

Available Manufacturers: Subject to compliance with requirements, manufacturers offering UPS systems which may be incorporated in the work include, but are not limited to, the following:

Best Power Technology, Inc.  
Computer Power, Inc.  
Exide Electronics  
Emerson Electric Co.  
General Electric Co.  
Gould, Inc.  
Sola Div.; General Signal Corp.

UNINTERRUPTIBLE POWER SUPPLY (UPS):

The uninterruptible power supply shall consist of a battery charger, batteries, inverter, static transfer switch instrumentation, battery cable and accessories. Under normal power conditions, the battery charger shall be sized to provide power to the load and at the same time be able to completely recharge discharged batteries within 12 hours. Upon failure of the normal power source, the batteries shall continue to supply power to the system load for a minimum of 30 minutes. The system load is defined as the rated continuous load on the inverter at all times. Load calculations shall be submitted to the Engineer as part of the shop drawing submittal.

The battery charger shall be a completely automatic two-rate solid state, constant voltage type having ac voltage compensation, with dc voltage regulation, automatic surge suppressers, current limiting protection, and complete isolation of ac input from dc output. The charger shall have:

- (1) AC pilot light
- (2) Float-equalize switch and timer
- (3) 2 percent DC ammeter and DC voltmeter
- (4) 2 percent input AC ammeter and AC voltmeter
- (5) AC input circuit breaker to charger

- (6) DC output circuit breaker from charger
- (7) High voltage cutoff to prevent battery damage due to excessive gassing.
- (8) Low charger dc current alarm relay and pilot light
- (9) Low and high voltage alarm relays and pilot lights
- (10) Charger failure alarm relay and pilot light
- (11) Utility power failure pilot light
- (12) Ground detection alarm relay and pilot light
- (13) Input and output terminal boards
- (14) Single phase, three wire, 120/240-volt input

The inverter shall be a solid state dc to ac power inverter able to supply single phase sine wave ac power from a storage battery to the load previously described. The inverter shall be rated at 5 KVA minimum and shall be capable of withstanding a sustained output short circuit without damage. Efficiency shall be 75 percent or better at full load. The output wave form shall be a sine wave employing ferroresonant filter to provide harmonic distortion less than 5 percent for loads with 1.0-0.8 lagging or leading power factor. The inverter shall be capable of operating at full load continuously at ambient temperatures between -7 and +50 degrees C and a relative humidity of 0 to 95 percent. Output voltage shall be maintained within plus or minus 1 percent for plus or minus 15 percent DC change from no load to full load with a unity load power factor. Output shall be grounded, 120/240 volt single phase, three wire.

The inverter and battery charger, shall be mounted in NEMA 1, freestanding sheet steel ventilated enclosure with manufacturer's standard paint finish. All equipment shall be front accessible for servicing, adjustment and connection. All wiring shall be identified. The inverter shall have:

- (1) Inverter available pilot light
- (2) Load powered prime source pilot light
- (3) Load powered by alternate source pilot light
- (4) Inverter failure alarm relay and pilot light
- (5) DC input circuit breaker to inverter
- (6) AC output circuit breaker from inverter

- (7) 2 percent accuracy AC load voltmeter
- (8) 2 percent accuracy AC load ammeter
- (9) Frequency meter, 58 to 62 Hz range
- (10) Inverter on/off switch
- (11) Low voltage cutoff to prevent battery damage due to excessive discharge
- (12) Coincidental line synchronization with phase lock indicator

All alarm contacts for the battery charger and inverter shall be wired to a master alarm relay to provide a common "UPS failure" alarm for remote indication.

The static transfer switch shall be of the solid state static type, 3 pole (neutral switched), 120/240 volts, with automatic transfer and re-transfer capabilities. A test switch shall be provided to allow the bypass switch to be transferred manually when servicing the UPS system.

The bypass switch shall be of the electro mechanical type, 3 pole (neutral switch), 120/240 volts, with manual transfer and re-transfer capabilities. A control switch shall be provided to allow the transfer switch to be transferred manually when servicing the UPS system.

A solid state ampere-hour meter and controller to provide continuous monitoring of battery energy level and low/high alarms shall be furnished. Three field adjustable control relays shall be furnished. One relay shall be set to start an engine generator set upon decreasing battery energy capacity. The second relay shall be set to stop an engine generator set upon increasing battery energy capacity. The third relay shall be set to alarm a low level of battery energy capacity condition. These relays shall be wired to the PLC which will actually do the starting and stopping of equipment.

Starting of an engine generator set shall occur when battery voltage drops to 22.0 volts and utility power is unavailable. A transfer switch within the generator switchgear shall sense bus voltage and transfer, providing power to the UPS system. When the batteries reach 90 percent of full capacity, the engine generator set shall be signaled to enter into a shutdown mode. Should utility power become available while the engine generator set is running, the transfer switch shall transfer to the utility source and the engine generator set shall be signaled to enter into a shutdown mode.

The battery shall be 24 volts nominal and shall be constructed of twenty individual nickel cadmium cells allowing for ease of assembly and replacement of any single cell unit. (1.2 VDC nominal) cell jars are to be of one-piece molded high impact plastic with walls of equal thickness and strength, transparent to allow for visual inspection of plates and separators. Cells shall be equipped with flame arresting flip top vents. Multi-layer battery rack complete with all interconnecting hardware shall be furnished.

Each battery shall be sized to compensate for an operating maximum ambient temperature of 50 degree C and normal power output depreciation over the life of the battery.

The UPS shall conform with current ANS and NEMA standards. The manufacturer shall completely test the UPS before shipment to assure rated performance under ambient conditions specified. Certificate of test shall be provided.

### PART 3 - EXECUTION

#### INSTALLATION OF UPS SYSTEM EQUIPMENT:

Install UPS system equipment and components as indicated, in accordance with equipment manufacturer's written instructions, and with recognized industry practices, to ensure that UPS system equipment complies with requirements. Comply with requirements of NEC, and applicable portions of NECA's "Standard of Installation" pertaining to general electrical installation practices.

Coordinate with other electrical work, including raceways, boxes and fittings, etc., to interface installation of UPS systems work with other work.

#### GROUNDING:

Provide equipment grounding connectins, sufficiently tight to assure a permanent and effective ground, for UPS sytem equipment where indicated.

#### TESTING:

Upon completion of installation of UPS system equipment, and after building circuitry has been energized with normal power source, test UPS system to demonstrate capability and compliance with requirements. When possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units and proceed with retesting.

SECTION 0.45-43 - SECURITY SYSTEM

PART 1 - GENERAL RELATED DOCUMENTS:

Drawings and general provisions of Contract, including General and Supplementary Conditions and Section 0.45-1 apply to work of this section.

Section 0.45-25 Basic Electrical Materials and Methods apply to work specified in this section.

DESCRIPTION OF WORK: Extent of security system work is indicated by drawings, schedules, and as described herein.

QUALITY ASSURANCE:

Manufacturers: Firms regularly engaged in manufacture of security systems of the types, ratings, and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.

Installer's Qualifications: Firms with at least 3 years of successful experience with projects utilizing security systems similar to that required for this project.

Code Compliance: The product shall be UL listed and labeled and comply with appropriate NEC, NFPA, IEEE, and NEMA specifications.

SUBMITTALS:

Product Data: Submit manufacturer's data on security system.

Shop Drawings: Submit layout drawings of the security system showing accurately scaled equipment locations and spatial relationships to associated equipment.

Wiring Diagrams: Submit wiring diagrams for the security system showing connections to all equipment. Clearly differentiate between portions of wiring that are manufacturer-installed and portions to be field-installed.

Maintenance Parts: Furnish required spare parts for 12 months operation.

PART 2 - PRODUCTS

SECURITY SYSTEM:

The Contractor shall furnish and install a complete security system for the pumping station. The security system will be used to remotely alarm at the master station via the radio communication link any unauthorized entrance into the building and ancillary structures. The contractor's shop drawing submittal shall include control drawings and wiring diagrams for the security system and its control cabinet.

The pumping station security system shall consist of a control cabinet, mechanical door switches, proximity switches and shunt key switch.

Each door in the building shall be furnished with a mechanical switch which will close its contacts when the door is opened and will open its contacts when the door is closed. The switch shall be installed in the door frame, with provisions in the frame for access to switch wiring. Double doors shall have two switches, each switch operated by a door.

A shunt key switch as approved by the Engineer, shall be furnished and installed outdoors, in the frame of the door designated by the Engineer as the main entrance door. The key switch shall be used to obtain entrance to the building by authorized personnel, without tripping the security system. The switch shall be single pole, double throw. Access to shunt switch wiring shall be provided on the indoor side of the door frame.

Security switches for the wet well hatches and the pump service switch enclosure shall be of the proximity type having positive make and break contacts through snap-action movement. Contact assembly shall be hermetically sealed in a hydrogen environment. Contacts shall be gold-flashed magnets and internal wiring shall be embedded in an epoxy compound. Switch enclosure shall be brass with threaded conduit entry and shall have two through mounting holes. Proximity switch shall be watertight and UL listed. Each switch shall be installed on a stainless steel bracket for ease of adjustment. Pump hatch proximity switches shall have conductors in sufficient length to be continuous without splice from the switch to the splice box in the pump service switch enclosure.

A suitable target shall be provided for each proximity switch. Mounting of the switch and/or positioning of the target shall be such that the switch is actuated by movement of the target away from the switch a distance of one-half inch or less.

The security control cabinet shall be manufactured of 16-gauge steel, primed and finished painted on phosphatized metal surfaces. The cabinet shall be for wall mounting. The control panel, mounted inside the cabinet, shall be furnished and installed completed with 120/24V AC transformer, auxiliary control relays for interfacing alarm condition with the radio communications link, and other accessories as required to perform the security control specified. The control cabinet shall be capable of providing, but not limited to, the following circuits and functions:

- (a) Open and closed instant circuit
- (b) Open and closed delayed circuit (2-60 seconds)
- (c) Open circuit switched zone
- (d) Arm and disarm switches and lights

The contractor shall install the security system control cabinet on the wall in the generator and control room, as shown on the plans. All power and interconnecting control wiring shall be furnished and installed, as required.

After installation, all power and interconnecting control wiring shall be checked for appropriate connection to terminal board. The contractor shall then perform operational tests to ascertain that the security system is operating as specified.

#### COMBUSTIBLE GAS DETECTION AND ALARM SYSTEM

The combustible gas detection and alarm equipment including appurtenances and accessories, shall be furnished, installed and tested as shown on the plans and as specified herein. All fittings, hangers and supports, anchors and guides where required, and special supports, not otherwise specifically provided for in these Specifications, but necessary to complete the various systems shall be included.

The gas detection and alarm equipment shall be as manufactured by Teledyne Analytical Instruments, Mine Safety Appliances Co., or approved equal and shall conform to the applicable provisions of the codes, standards and specification and as specified herein.

The combustible gas detection system shall detect excessive accumulation of combustible gases in the pump station wet well and in the generator and control room.

The complete system shall be automatic with provisions for local alarm indication, and shall be arranged to initiate alarms and activate ventilation equipment.

When gas is detected in the wet well the following operations shall automatically be initiated:

- (a) Alarm contacts close at warning level providing signal to the radio communication link via the interface terminal cabinet.
- (b) Alarm contacts close at warning level providing signal to remote outdoor flashing red light.
- (c) Ventilating fan designated SF-1 shall be activated at warning level.
- (d) Alarm contacts close at high level providing signal to radio communication link via the interface terminal cabinet.

When gas is detected in the generator and control room the following operations shall automatically be initiated:

- (a) Alarm contacts close at warning level providing signal to radio communication link via the interface terminal cabinet.
- (b) Alarm contacts close at warning level providing signal to remote outdoor flashing red light.
- (c) Ventilating fan designated EF-1 shall be activated at warning level.
- (d) Alarm contacts close at high level providing signal to radio communication link via the interface terminal cabinet.

When combustible gas concentration levels at all gas detector locations have fallen below the present level, and after an adjustable time delay, the ventilation equipment shall shut down and alarm contacts return to normal.

#### Control Settings:

The warning level alarm circuits for combustible gas detectors shall be initially set to close at 15 percent of the lower explosive limit (LEL) of propane in the Generator and Control Room and 15 percent of LEL of methane in the Wet Well. The high level alarm circuits for combustible gas detectors station shall be initially set to close at 30 percent of the lower explosive limit (LEL) of methane in the Generator and Control Room and 30 percent of LEL of propane in the Wet Well.

Equipment:

(a) The system shall consist of three complete self-contained combustible gas monitors requiring only an external AC supply and three remote detectors arranged to detect a concentration of combustible gas in an area associated with the detectors, and upon detection, to alarm and initiate equipment start-up as specified herein.

(b) The control unit shall be an assembly of drawout modules arranged in a NEMA 1 enclosure for wall mounting, and equipped with terminal blocks for connection of all external wiring.

(c) Each module shall include but not necessarily be limited to the following:

Logic, regulation, alarm, and control circuits to operate from internal power supply with a single detector to close two independent contact circuits, one for alarm, and the second for control. Trip points shall be independently and continuously adjustable over the full range of lower explosive limit of the gas concentration. The alarm and control circuit shall be self reset.

Indicating meter, scaled 0 to 100% of lower explosive limit of combustible gas to indicate detector sampled gas concentration.

Adjusting switches to set trip points of alarm and control circuits.

Indicating lights for power-on power-failure and to indicate operation of alarm and control circuits.

Alarm contact circuit for remote annunciation of control module trouble.

Independent alarm contact circuits shall be furnished for remote annunciation of alarm and control circuit operation.

Auxiliary relays, diodes, timers, and other devices to operate with other channel modules as necessary to accomplish the specified annunciation and shut down functions.

Combustible Gas Detection: Combustible gas detectors as shown on the Plans, shall be of the diffusion type, explosion-proof, rated for Class I, Division 1, Group D areas, designed to utilize heat developed by combustion of a portion of the sampled air in contact with a heated element to activate an electric circuit.

Accessories: These shall include auxiliary relays and devices as appropriate to provide for the operation of a flashing red alarm light shown on the Plans as Fixture G.

Spare Parts: The following spare parts shall be furnished:

- (a) Three detector head replacement active elements
- (b) One relay of each type used
- (c) Ten lamps of each type used
- (d) One, calibration gas kit, of 2.07% Methane in air. Kit shall include regulators, adapters, adapter hoses, gas tank and portable carrying case.

Installation: The equipment shall be installed as shown on the Plans and in accordance with the manufacturer's instructions and recommended best practices. All items of equipment shall be operated, adjusted, and, tested for proper performance in accordance with the manufacturer's recommended test procedure and as specified herein. Before any final acceptance tests are made, the Engineer shall be notified 8 days in advance so that such tests may be witnessed.

Testing: The combustible gas detection and alarm system shall be tested, as specified herein, to determine whether or not the requirements of these specifications have been fulfilled. All expendable materials, including the test gas, required for the tests specified herein shall be furnished by the contractor. Should it be necessary to repeat a test because of faulty operation of equipment furnished by the contractor, the contractor shall provide all expendable materials, including the test gas for the retest.

Detection Test: After control wiring tests have been made and the control system is found to function properly, a gas concentration detection test shall be made. All required field testing calibration and measuring equipment including expendable materials such as gas, shall be furnished by the Contractor for all tests conducted. Operation of the combustible gas detection system shall be initiated by introducing a test gas of a known concentration level into the combustible gas detector, so as to verify that the system performs all of its specified functions. The proper operation of all specified functions of the system shall be noted.

Smoke Detectors: The smoke detectors shall be of the photoelectric type and shall have the following features and functions:

- (1) LED monitor indicator.
- (2) Test pushbutton or knob.
- (3) A solid state piezo alarm rated at 85 db at 10 feet.
- (4) A form C SPDT relay contact for initiating, remote annunciation. Contacts shall be rated at 0.5 amperes at 102 VAC.
- (5) Obscuration sensitivity shall be 1.5 to 2.0% per foot.
- (6) UL listed.
- (7) 120 VAC operation.

All smoke detectors shall be completely factory assembled, wired and tested.

RADIO COMMUNICATION LINK:

This work consists of furnishing and installing the radio communication monitoring and reporting system at the pump station.

The monitoring and reporting system shall be compatible and meet all specifications required by Motorola, the manufacturer of the existing computerized control system or approved equal.

The transmitter/receiver unit shall be factory installed in a NEMA 1 metal enclosure. Enclosure shall be manufacturer supplied to the contractor for installation at the location shown on the Plans. Installation method(s) shall be as required by the manufacturer and approved by the Engineer.

A 120 volt, single phase, 60 Hz electric service to the system shall be provided from the Uninterruptible Power Supply. Conduit and conductor shall be installed from the UPS distribution panelboard to the enclosures. Electrical connections to the enclosures shall be performed by the manufacturer of the enclosure.

Communication cable connections at the enclosure shall be performed by the manufacturer of the enclosure.

The contractor shall install wiring from the interface terminal cabinet to the transmitter/receiver units with wiring connections at the enclosure performed by the manufacturer of the enclosure.

Typical alarms to be monitored by the radio communications link via the interface terminal cabinet are:

| Description                        | Quantity |
|------------------------------------|----------|
| 1. Level                           |          |
| a. High level alarm (transducer)   | 1        |
| b. High level alarm (float switch) | 1        |
| 2. Pump Failure                    |          |
| a. Over temperature                | 3        |
| b. Seal failure                    | 3        |
| c. Lack of flow                    | 3        |
| 3. Engine Failure                  |          |
| a. Over crank                      | 3        |
| b. Over speed                      | 3        |
| c. Low oil pressure                | 3        |
| d. High water temperature          | 3        |

|     |   |   |
|-----|---|---|
| e.  | Low battery voltage                         | 3 |
| f.  | Battery charger failure                     | 3 |
| 4.  | Generator Switchgear                        |   |
| a.  | Circuit breaker trip                        | 3 |
| b.  | Manual Transfer Switch - Load Bank Position | 1 |
| 5.  | Combustible Gas                             |   |
| a.  | Wet well                                    |   |
| 1.  | Warning                                     | 1 |
| 2.  | High  | 1 |
| b.  | Generator and control room                  |   |
| 1.  | Warning                                     |   |
| 2.  | High  |   |
| 6.  | Uninterruptible Power Supply                |   |
| a.  | UPS failure                                 | 1 |
| b.  | Low battery capacity                        | 1 |
| 7.  | Security Violated                           | 1 |
| 8.  | Utility Power Failure                       | 1 |
| 9.  | Fuel Level In Tank                          | 2 |
| 10. | Fire  | 1 |
| 11. | Motor Control Center                        |   |
| a.  | PLC Locked Out                              | 3 |

Radio Termination Cabinet: The contractor shall furnish and install an interface terminal cabinet complete with terminal blocks for terminating all signals to be monitored by the Radio Communication Link. The cabinet shall be a NEMA 1 hinged door, surface mounted enclosure sized to handle terminal blocks in sufficient numbers for all items being monitored plus 25 percent spare capacity. The cabinet shall be minimum 6 inches in depth. Terminal blocks shall be 600 VAC, 20 amp UL listed, disconnect type Electrovert Inc. 9700 Series, Phoenix Terminal Block Inc. UK5 Series or equal. Interface terminal cabinet shall be Hoffman or equal.

Outdoor Alarms: Conditions that cause an alarm and actuate a remote outdoor flashing red light are, but are not limited to:

| Description                         | Quantity |
|-------------------------------------|----------|
| 1. Level                            |          |
| a. High level alarm (transducer)    | 1        |
| b. High level alarm (float switch)  | 1        |
| 2. Pump failure                     |          |
| a. Over temperature                 | 3        |
| b. Seal failure                     | 3        |
| c. Lack of flow                     | 3        |
| 3. Engine failure                   |          |
| a. Over Crank                       | 3        |
| b. Over Speed                       | 3        |
| c. Low Oil Pressure                 | 3        |
| d. High Water Temperature           | 3        |
| e. Low Battery Voltage              | 3        |
| f. Fuel Level in Tank               | 2        |
| g. Battery Charger Failure          | 3        |
| 4. Generator Switchgear             |          |
| a. Reverse Power                    | 3        |
| b. Low Voltage                      | 1        |
| c. Failure to Synchronize           | 3        |
| d. Circuit Breaker Trip             | 3        |
| 5. Combustible Gas                  |          |
| a. Wet Well-Warning                 | 1        |
| b. Generator & Control Room Warning | 1        |
| 6. Uninterruptible Power Supply     |          |
| a. UPS Failure                      | 1        |
| b. Low Battery Capacity             | 1        |
| 7. Security System                  |          |
| a. Doors                            | 3        |
| b. Roof Hatch                       | 1        |
| c. Wet Well Hatches                 | 1        |
| d. Pump Service Switch Enclosure    | 1        |
| 8. Utility Power Failure            | 1.       |

Conditions that actuate a remote outdoor flashing amber light are,

but are not limited to:

- |                                |   |
|--------------------------------|---|
| 1. Pumps operating             | 3 |
| 2. Engine/generators operating | 3 |

PART 3 - EXECUTION:

INSTALLATION OF SECURITY SYSTEM:

Install the security system as indicated, in accordance with equipment manufacturer's written instructions and with recognized industry practices; complying with applicable requirements of NEC, UL, and NEMA standards, to insure that products fulfill requirements.

Coordinate with other work, including electrical wiring/cabling work, as necessary to interface with other equipment.

SECTION 0.45-45 - LEVEL PROBE SYSTEM:

PART 1 - GENERAL RELATED DOCUMENTS:

Drawings and general provisions of Contract, including General and Supplementary Conditions and Section 0.45-1 apply to work of this section.

Section 0.45-25 Basic Electrical Materials and Methods apply to work specified in this section.

DESCRIPTION OF WORK: Extent of level probe system work is indicated by drawings, schedules, and as described herein.

QUALITY ASSURANCE:

Manufacturers: Firms regularly engaged in manufacture of level probes and controls of types, ratings, and characteristics required, whose products have been in satisfactory use in similar service for not less than 5 years.

Installer's Qualifications: Firm with at least 3 years of successful installation experience on projects utilizing level probe system similar to that required for this project.

Code Compliance: The product shall be UL listed and labeled and comply with appropriate NEC, NFPA, IEE and NEMA specifications.

SUBMITTALS:

Product Data: Submit manufacturer's data on level probes and control panel.

Shop Drawings: Submit layout drawings of level probes and control panel showing accurately scaled equipment locations and spatial relationships to pumps and control panel.

Wiring Diagrams: Submit wiring diagrams for level probe system showing connections to electrical power panels and equipment. Clearly differentiate between portions of wiring that are manufacturer-installed and portions to be field-installed.

PART 2 - PRODUCTS:

ACCEPTABLE MANUFACTURERS:

Manufacturers: Subject to compliance with requirements, provide level probe system of one of the following:

Consolidated Electric Company

#### LEVEL PROBE SYSTEM:

A submersible level transducer shall be mounted at a fixed elevation as shown on the plans above the wet well floor and shall sense the hydrostatic head pressure at that elevation.

The transducer housing shall be fabricated of Type 316 stainless steel. The diaphragm shall be a 2-5/8 inch diameter heavy duty molded Buna N synthetic rubber. The internal pressure by the lower transducer assembly shall be relieved to atmospheric pressure through a heavy duty urethane jacketed hose/cable assembly and a slack PVC bellows mounted in the NEMA 4X Fiberglass upper assembly. The sealed breather system shall compensate for variations in barometric pressure and expansion and contraction of air due to temperature changes and altitude as well as prevent fouling from moisture and other corrosive elements. The upper assembly shall be mounted as shown on the Plans.

The transducer shall incorporate a variable-capacitance transducer element to convert the sensed pressure to a corresponding electrical value. The sensed media shall exert its pressure against the diaphragm which flexes minutely so as to vary the proximity between an internal ceramic diaphragm and a ceramic substrate to vary the capacitance of an electrical field created between the two surfaces.

A stable, hybrid, operational amplifier assembly shall be incorporated in the transducer to excite and demodulate the sensing mechanism. The transducer shall incorporate laser-trimmed, temperature compensation and high quality components and construction to provide a precise, reliable, stable output signal directly proportional to the sensed pressure over a factory-calibrated range.

The submersible level transducer shall be furnished in two parts for ease of installation; the lower assembly and factory-sealed cable and the upper connection box/sealed breathing system. An intrinsically safe signal barrier shall be provided in the upper connection box. Furnish shielded 2 wire signal cable between the upper connection box and the programmable logic controller and level indicator in the motor control center.

The transducer shall be installed by chain or cable mounting as shown on the plans and furnished with a factory-calibrated range. The transducer/transmitter shall include easily accessible offset and span adjustments in the upper assembly. Span shall be adjustable from 100 percent down to 15 percent of the sensor range. Fine and coarse adjustments for both span and offset shall be provided, using 25 turn potentiometers. Offset and span adjustments shall be noninteractive, for ease of calibration.

Bubbler systems or mechanical float devices for the primary level sensing system will not be acceptable. The level transducer shall be a Model 157GSCI as manufactured by Consolidated Electric Company or equal.

A high level alarm float switch shall be installed as shown on the Plans. The float switch shall be 5-1/2 inch diameter, Type 316 stainless steel, with a mercury switch inside and flexibly supported by a PVC jacketed heavy-duty cable. It shall be installed in accordance with the manufacturer's recommendations.

The float switch shall have a 20 amp rating at 115 VAC. The float cable shall be Type 50 with three No. 14 AWG fine-stranded copper conductors. The float shall be mounted to a 1 inch diameter pipe using Type 316 stainless steel hardware.

The float switch shall be furnished with its own intrinsically safe relay which shall be mounted in a NEMA 4 enclosure located as shown on the Plans. The float switch shall be furnished with such accessories as are required to perform the specific control and alarm functions for the application.

The float switch shall be a Model 9G as manufactured by Consolidated Electric Company, or equal, and shall have a 3 year factory warranty.

### PART 3 - EXECUTION:

#### INSTALLATION OF LEVEL PROBE SYSTEM:

Install level probe system as indicated, in accordance with equipment manufacturer's written instructions and with recognized industry practices; complying with applicable requirements of NEC, UL, and NEMA standards, to insure that products fulfill requirements.

Coordinate with other work, including electrical wiring/cabling work, as necessary to interface installation of level probes with other work.

#### FIELD QUALITY CONTROL:

Subsequent to installation, test and demonstrate functioning of equipment in accordance with requirements. If necessary, correct malfunctioning units, and then retest to demonstrate compliance.

SECTION 0.45-47 - STANDBY POWER GENERATOR SYSTEMS:

PART 1 - GENERAL:

RELATED DOCUMENTS:

Drawings and general provisions of Contract, including General and Supplementary Conditions and Section 0.45-1 apply to work of this section.

Section 0.45-25, Basic Electrical Materials and Methods apply to work specified in this section.

DESCRIPTION OF WORK:

Extent of standby power generator system work is indicated by drawings and these specifications and shall include provision of all labor, materials, and incidentals required to provide and install the standby power generator system(s) complete with transfer switch(es). "Standby power generator system" is defined to include, but not be limited to:

- Engine
- Generator
- Control panel
- Power transfer switch (automatic and nonautomatic)
- Power switchgear and control
- Batteries
- Battery charger
- Accessories
- Exhaust system
- Fuel system

The generator system(s) shall be a standard model of the manufacturer and shall be delivered to the site completely equipped, tested, and ready for installation. All generators shall be prototype tested.

System Responsibility: The engine generator set(s) and accessories described herein shall be furnished by a single supplier in the quantities, sizes, and types specified. All requirements which follow regarding "a" system or system component shall apply for "each" system or system component of a different size or type. The responsibility for the performance to this specification in its entirety shall not be split among the suppliers of individual components.

Types of standby generator system equipment required for project will include the following:

LPG engine driven generators

Permits: All applications, permits, and fees required for the installation shall be submitted, secured, and paid by the Contractor.

Electrical Raceways, cable trays, boxes, and fittings required for installation of standby power generator system are specified in other Sections 0.45-26 through 0.45-48.

Refer to Section 0.45-3 for concrete and grout work required in connection with engine-generator sets.

Power and Control Wiring to the generator, transfer switch, and accessories, except wiring described herein, shall be furnished and installed under other Sections 0.45-25 through 0.45-48.

QUALITY ASSURANCE:

Manufacturers: Firms regularly engaged in manufacture of engine driven standby generator systems of types, ratings, and characteristics required, whose products have been in satisfactory use in similar service for not less than 5 years.

Warranty: The complete engine generator set shall be warranted for a minimum period of 5 years or 1,500 hours, whichever comes first, from the date of final acceptance. Multiple warranties for individual components (engine, generator, controls, etc.) will not be accepted. Satisfactory warranty documents must be provided. The first year, all travel time, mileage, labor, and parts shall be covered; the second and third years, labor and parts only. The fourth and fifth years, parts only shall be covered.

Installer's Qualifications: A firm with at least 3 years of successful installation experience on projects utilizing equipment similar to that required for this project.

NEC Compliance: Comply with applicable requirements of NEC Article 700 pertaining to emergency systems.

NFPA Compliance: Comply with applicable requirements of NFPA 37, "Installation and Use of Stationary Combustion Engines and Gas Turbines".

UL Compliance: Comply with applicable requirements of UL 1008, "Automatic Transfer Switches." Provide standby power generator system components, including automatic transfer switches, which are UL listed and labeled.

ANSI/NEMA Compliance: Comply with applicable requirements of ANSI/NEMA MG 1, "Motors and Generators," and MG 2, "Safety Standard for Construction and Guide for Selection, Installation, and Use of Electric Motors and Generators."

IEEE Compliance: Comply with applicable portions of IEEE Std 446, "IEEE Recommended Practice for Emergency and Standby Power Systems for Industrial and Commercial Applications."

State and Local Code Compliance: Comply with all applicable state and local codes.

Factory Tests: Prior to shipment, each unit shall be factory performance tested under load with the transfer switch and all accessories. All test measurements shall be made by light beam oscillograph. The full block load test shall demonstrate no more than a 15 percent RMS voltage dip and 15 percent frequency deviation measured during the fourth complete cycle following application of the load. Both voltage and frequency shall return to within  $\pm 3$  percent of rating in less than 5 seconds following addition of the block loads. The tests shall be performed in accordance with the manufacturer's standards.

Stepped load test at 1/2, 3/4, and full load for 5 minutes each step.

3/4 block load.

Full block load.

Reactive load test.

Automatic transfer operation.

Automatic retransfer operation.

Engine start and shutdown.

All alarms.

Note: "Full block load" shall be defined as 50 percent of rated kilovolt-amperes (kVA) preload with 50 percent of rated kVA added.

#### SUBMITTALS:

Product Data: Submit manufacturer's data on each engine driven electric generator system and components.

Performance Data: Certified performance data shall be submitted to the Engineer for preliminary approval of each of the generating equipment to be furnished. Such data shall be based on actual prototype tests of similar equipment and include sufficient data to demonstrate suitability of both the alternator and driver for the conditions specified. Submitted test results shall include, but not be limited to:

Maximum power level.

Maximum motor starting capability.

Structural soundness.

Torsiograph analysis per MIL-STD-705B Method 504.2.

Fuel consumption.

Engine and alternator cooling air flow.

Transient response and steady state governing (oscillograph photographs showing required load performance).

Alternator temperature rise per NEMA MG1-22.40.

Single step load pickup per NFPA 76A-822.  
Harmonic analysis and wave form deviation per MIL-STD-705B,  
Method 601.4.  
Three phase short circuit test for mechanical and electrical  
strength.

Approval Drawings: Shop drawings shall be submitted to the Engineer for approval. Shop drawings shall show dimensional layout, anchor bolts, sectional views of alternator construction, driver specifications, and a bill of materials. Submit a complete list of all materials and equipment to be furnished, giving the manufacturer's name, catalog number, catalog cuts, accessories, dimensions, and ratings. Fabrication and installation shall be in accordance with the approved shop drawings.

Wiring Diagram: Submit wiring diagrams for each engine driven generator unit showing connections to electrical power panels, feeders, automatic transfer switches, and ancillary equipment. Clearly differentiate between portions of wiring that are manufacturer installed and portions to be field wired.

Factory Test Report: Results of the required factory test shall be submitted to and approved by the Engineer prior to shipment.

Field Test Report: Certified copies of the field test procedures and results shall be forwarded to the Engineer.

Product Information: The following information shall be submitted, by the successful bidder, prior to contract award:

Drawings of each generator set and its foundation, housing, or trailer requirements.

Literature describing each unit, including prototype test performance data for the specified model (engine-generator combination).

Drawings and/or literature describing all auxiliary equipment to be furnished.

List of one or more installations using major components of the same or similar type furnished for this application.

Ventilation requirements.

Horsepower of fuel transfer pump drive. Motor to be rated for 120 volt, single phase, 60 hertz power system.

Literature describing each generator:

Generator electrical rating, kVA, kW, amperes, volts, and power factor.  
Number and type of generator bearings.  
Make and type of generator.  
Exciter type and drive.

Literature describing each engine:

Make of engine.  
Specification of fuel requirements.  
Number of cylinders.  
Compression ratio.  
Bore, inches.  
Stroke, inches.  
Piston speed at rated revolutions per minute and feet per minute.  
Cooling capacity.

Permits, Approvals, and Certificates: Submit all permits, approvals, and certificates to the Engineer prior to the submission of approval drawings or attached to the approval drawings.

Operation and Maintenance Manuals: Four operation and maintenance (O&M) manuals for each generator set shall be submitted to the Engineer prior to delivery of the equipment. The O&M manuals shall include instructions on storage, installation, start-up, and operation and maintenance, together with a complete parts list and a recommended spare parts list.

PART 2 - PRODUCTS:

ACCEPTABLE MANUFACTURERS:

Manufacturer: Subject to compliance with requirements, provide standby generator system of one of the following:

Caterpillar Tractor Company.  
Cummins Engine Company.  
Katolight Corporation.  
Kohler Company.  
Onan Corporation Division of Cummins Engine Company.  
Waukesha-Engine Division; Dresser Industries, Inc.

ENGINE-GENERATOR:

General: Furnish and install prototype tested and certified standby power diesel engine driven electric generator assembly units each complete in all respects including silencer, engine control panel, required auxiliaries, and fuel transfer pump. Install and connect all electrical components. The units shall be of the latest commercial type and design with necessary switchgear,

controls, and accessories for operation at 1,200 feet above sea level in an ambient temperature of 120 degrees Fahrenheit (°F.) maximum 25°F. minimum. Cushion mount each engine generator on a heavy steel base with spring type vibration isolators to reduce possibility of torsional vibration. The generator shall be directly connected to the engine housing and driven through a semi-flexible steel disk coupling. Equip each set with associated control equipment to automatically start engine and pick up load or transfer to emergency power as the case may be. Also transfer load back to normal power upon its restoration, and stop engine.

Materials and Workmanship: All materials and parts comprising the units herein specified shall be new and unused, of current manufacture, and of the highest grade, free from all defects or imperfections affecting performance. Workmanship shall be of the highest grade, in accordance with modern practice. The unit shall be constructed in compliance with applicable standards and with additional construction features as indicated.

Rating: Rating shall be based on standby operation at 1,800 revolutions per minute (rpm) when equipped with all necessary operating accessories such as air cleaners, lubricating oil pump, carburetor, jacket water pump, radiator fan, governor alternating current generator and exciter. The unit shall be capable of voltage recovery within regulated range of 7 seconds following sudden load increase from 0 to 100 percent of rated load. The unit shall be capable of operation at 125 percent of rated speed without injury. Ratings shall be as shown on the drawings.

ENGINE:

Engine: Shall be a four stroke cycle, liquid cooled unit. Engine speed shall not exceed 1,800 rpm at normal full load operation. Each engine shall operate on LPG and shall be certified by the manufacturer as capable of developing sufficient brake horsepower at 1,800 rpm to drive the generator at rated kW on a continuous standby basis under the environmental conditions previously stated. The engine of each unit shall be equipped with the following items:

Governor: Shall be a fully enclosed electronic speed sensing load sharing engine governor, capable of providing accurate speed control within 3 percent of rated speed. Frequency regulation shall be within  $\pm .25$  percent of rated frequency during steady state conditions and frequency dip during full load application shall not be greater than six cycles from rated frequency. The load sharing between similar sets shall be within 5% of the full load capacity.

Fuel System: An HD5 propane vaporizer, gas carburetor, regulator and DC gas solenoid valve shall all be provided with FM or UL standards listings. Installation shall be per local, state and NFPA codes and standards.

Cylinder Liners: The engine shall be provided with removable wet type cylinder liners of close grained alloy iron, heat treated for proper hardness to obtain maximum life.

Pistons shall be aluminum alloy with cast iron top ring bands and chrome faced rings.

Valve Train shall employ replaceable valve seat inserts, alloy steel valves, and cast iron guides.

Lubrication: A positive displacement lubricating oil pump shall supply oil under pressure to main bearings, crank pin bearings, pistons, timing gears, camshaft bearings, and valve rocker mechanism. A "dipstick" oil level indicator shall be located in an easily accessible area. A full supply of manufacturer recommended lubricating oil shall be provided.

Oil filters shall be effective full flow lubricating type and shall be provided and located so that lubricating oil is continuously filtered. Replaceable filter elements shall be accessible and easily removable. The filter system shall be equipped with a spring loaded bypass valve to prevent stoppage of lubricating oil circulation in the event the filters become clogged.

Lubricating Oil Cooler shall be a suitable liquid cooled, engine mounted unit.

Air Cleaners: One or more engine mounted, replaceable element, dry type air cleaners of sufficient capacity to protect working parts of the engine from dust and grit shall be provided.

Starting: Each generator engine shall be equipped with a 24 volt, 2 wire, negative ground electric starting system. Both starting systems shall be of sufficient capacity to crank at a speed which will start the engine under operating conditions specified. the starting pinion shall disengage automatically when engine starts and a relay, connected to the alternator, shall disconnect the starting circuit when the alternator develops voltage.

Batteries: Provide two 12 volt, pocket plate nickel cadmium storage batteries with sufficient capacity to crank the engine for at least 30 seconds at firing speed in the ambient temperatures specified and with capacity for starting the engine a minimum of three times. Minimum cranking amperes shall be rated at 0 degrees Fahrenheit (°F.) and shall be equal to or greater than the manufacturer's recommendations. Appropriate starting aids, as recommended by the engine manufacturer, shall be furnished. Provide suitable unit mounted rack for battery mounting and battery cables of adequate size to prevent voltage drop problems during cranking cycle.

Battery Charger shall be a suitable, negative ground, SCR voltage regulated, automatic type. It shall be rated 120 volts ac, single phase input, 24 volts dc output. The charger shall maintain rated dc output voltage with ac input voltage fluctuations of  $\pm 10$  percent and shall output include the following features:

dc cranking circuit disconnect relay.

dc charge rate ammeter.

Dual fusing for ac input and dc output.

Automatic dc voltage regulation including high (equalize) and low (float) rate charge capability.

Automatic load regulation.

Semiautomatic overload protection (current limiting).

Compensation taps for setting the charger for average ac line and battery conditions.

Sealed silicon diode full wave rectifiers.

Automatic surge suppressors.

Internal terminals for input and output connections.

Cooling: The engine shall be furnished with a cooling system having sufficient capacity for cooling the engine when delivering full rated horsepower. A radiator and pusher fan of a type and capacity recommended by the engine manufacturer for the environmental conditions previously described shall be included. Provide 50 percent solution antifreeze for cooling system. The engine shall have an engine driven, centrifugal type pump for circulating water through the cooling system. The radiator shall be provided with a duct adapter flange permitting the attachment of an air discharge duct which will direct the discharge of radiator air through the wall.

Coolant Heater: Furnish a jacket water heating system. The heating element shall be 120 volts, single phase, 60 hertz, and shall be of sufficient wattage to maintain the specified coolant temperature. A thermostat shall control the temperature of the coolant above 65°F. The heater shall be mounted on the engine and disconnected, whenever the engine starts, by an oil pressure switch mounted on the engine.

Alarm Sensing System: Provide sensing elements on the engine to provide the following remote alarms and engine shutdown:

- Low coolant temperature alarm.
- Low oil pressure alarm.
- Low oil pressure shutdown.
- High coolant temperature alarm.
- High coolant temperature shutdown.
- Overspeed shutdown.
- Overcrank lockout.

Gauges and Meters: The engine-generator control panel shall contain the following gauges and meters:

- Engine oil pressure.
- Coolant temperature.
- Engine oil temperature.
- Engine hourmeter.

Mountings: The engine shall be equipped with support legs or base for mounting on a concrete foundation. Suitable spring type vibration isolators with rubber backing shall be provided between the engine and its concrete foundation to provide a minimum of 90 percent isolation.

GENERATOR:

General: The generator of each unit shall be of the engine driven, single bearing, self-aligning, continuous duty, salient pole, synchronous type with full amortisseur windings. It shall be of the drip proof type, entirely self-contained with only line leads brought out for load connections. The generator insulation used shall be NEMA Class F or better. Replacement parts shall be readily available. Each generator shall be equipped with the following items:

Voltage Regulator: The voltage regulator shall be solid state and provide no load to full load regulation within  $\pm 0.5$  percent of rated voltage during steady state conditions. A rheostat shall provide a minimum of  $\pm 5$  percent voltage adjustment from rated value.

Exciter: The generator shall have a brushless static excitation system which shall incorporate silicon controlled rectifiers to provide alternate field excitation. The static exciter shall have the capacity to provide 150 percent of required excitation at rated load and rated voltage. The static excitation system shall incorporate circuitry to permit voltage buildup from residual magnetism.

Controls: Voltage level, voltage drop, and voltage gain controls shall be provided and shall be easily accessible for normal operating adjustments. The voltage level control shall have a minimum range of plus or minus 5 percent from rated voltage. Voltage adjustment instructions and generator schematic wiring diagrams shall be provided, permanently attached on the inside of the exciter assembly.

Drive: The generator drive shall be free from critical torsional vibration within the operating speed range.

ENGINE-GENERATOR:

Engine-Generation Controls: The following engine-generator controls shall be resident in the PLC.

The engine generators shall be activated in response to the pump turn on commands. With one pump on, one engine generator shall run. With two pumps on, two engine generators shall run. The third generator shall only be started manually, except when there has been a generator failure.

Whenever a command to turn on an engine-generator is given, the following sequence of events will occur. The engine will start and come up to operating speed. When the generator is at synchronous speed and voltage a "generator ready" signal will be sent to the PLC. This will initiate a timing cycle of 60 seconds to allow the engine to warm up. After 60 seconds, the generator breaker will close first and then the starter will engage the pump. No two generators shall start simultaneously. Upon receiving a stop signal, the unit shall run unloaded for a period of 5 minutes to cool down.

Generator Sequencing:

In order to equalize the operating time of all three generators, the generators will be sequenced as to which unit is the standby generator. This sequence will advance to the next cycle every time the first pump (lowest wetwell level) turn on command is given.

|  | <u>First Gen. ON</u> | <u>Second Gen. ON</u> |
|--|----------------------|-----------------------|
| First Cycle                                  | Gen. #1              | Gen. #2               |
| Second Cycle                                 | Gen. #2              | Gen. #3               |
| Third Cycle                                  | Gen. #3              | Gen. #1               |
| Return to First<br>Cycle and Repeat Sequence |                      |                       |

Under normal conditions, only two generators will run because no more than two pumps are on. If any generator fails, the standby generator in the sequence shall be automatically activated.

A contact from the gas detection system shall shut down any engine generators in operation whenever a warning level is reached.

ENGINE-GENERATOR:

Install the standby engine-generator unit as indicated, in accordance with the equipment manufacturer's written instructions, and with recognized industry practices to ensure that engine-generator units fulfill requirements. Comply with NFPA and NEMA standards pertaining to installation of standby engine-generator systems and accessories. All electrical connections to the engine-generator shall be of the flexible type.

Coordinate with other work including fuel tanks, piping, and accessories as necessary to interface standby generator system work with other work.

Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Stds 486A and 486B.

Install units on vibration isolators in accordance with manufacturer's indicated installation method.

Connect fuel piping to standby generator equipment as indicated, and comply with manufacturer's instructions unless otherwise indicated. All piping connections shall be of the flexible type.

Align shafts of each engine and generator within tolerances recommended by manufacturer.

Engine Generator Set: Each engine-generator set shall be shipped from the manufacturer completely assembled and ready to operate. The Contractor shall furnish a concrete mounting pad and galvanized steel anchor bolts and shall install the generator using the vibration isolators provided with the set. The engine generator set shall be leveled and secured in place as recommended by the manufacturer.

#### EXHAUST SYSTEM:

Furnish an exhaust system consisting of a minimum 24 inch long flexible stainless steel connecting pipe, side inlet exhaust silencer, necessary additional exhaust pipe, watertight wall thimble with birdscreen, and a flanged condensate drain and petcock. The exhaust silencer shall be of multi-chambered construction and shall provide critical silencing suitable for residential installation. The silencer shall be sized to assure proper operation without excessive back pressure. The exhaust system shall be installed using spring type vibration isolators. Wrap indoor exhaust pipe with Johns-Manville 1,000° F. insulation.

#### GENERATOR SWITCHGEAR:

Structure: The enclosure shall be made from 11 gauge sheet steel. Construction shall be of the formed and welded design provided with barriers and stiffeners to form a solid unitized assembly. Suitable means of lifting shall be provided.

All equipment bases shall be fabricated with an adequate number of anchor bolt holes designed to put the base in direct contact with the concrete pad when bolted.

All doors shall be pan type and be provided with sufficient

concealed hinges and stiffeners to support the door and components for an absolute minimum deflection and wobbling when opening or closing. Doors must operate more than 90 degrees.

Layout: All equipment shall be arranged in a logical manner to facilitate ease of operation and maintenance of the equipment. No meters or switches shall be located above 6'-0" from the finished floor.

Paint: The complete assembly shall be thoroughly cleaned and treated prior to painting. The unit shall be painted ANSI-61, light gray with 2-part epoxy base paint suitable for indoor or outdoor locations.

Bus: The main bus shall be fabricated from tin-plated copper. The maximum temperature rise allowed shall not exceed 65°C over a 40°C ambient (per ANSI C37.20). All joints shall be bolted with a minimum of two bolts. Bus bracing shall withstand the interrupting capacity of the largest breaker furnished.

A 1/4"x2" copper ground bus shall extend the full length of the switchgear and shall effectively ground all non-current carrying metallic parts. A bus joint shall be provided between each shipping split, and when removed, no ground bus will extend beyond the section side. Provisions shall be included to receive site ground connections.

Wiring: Control wiring shall be 600 volt, 90°C switchboard type SIS, minimum size No. 14. Solderless compression type connectors for terminating all wires shall be used. Current transformer circuit terminations shall be ring torque type. Other circuits may be ring or spade type applied with the proper tool. Control wires shall be numbered on both ends with adhesive wire markers applied next to the terminals with the number visible. The low level signal circuits shall be separated and provided with shielded wire to minimize electromagnetic cross talk and interference. Shielded wires shall be grounded at the device only.

Grommetted holes shall be provided between each of the vertical sections to allow control wiring to pass through. Wiring shall not be spliced and shall be free of abrasions and tool marks. The wires shall be neatly laced up and harnessed, and shall be supported to prevent sagging or breakage from weight or vibration. Wiring bundles shall be contained in covered metal or plastic gutters.

All wiring to hinged doors shall be run through door terminal blocks. Terminal blocks shall be provided for all external connections and they shall be readily accessible in an area not exposed to hazardous bus or cables.

Nameplates: Engraved laminated plastic nameplates having black letters on white backgrounds shall identify major components, vertical sections and breakers. Vertical sections shall have

letters 3/8" high; other lettering shall be a minimum of 3/16" high. Nameplates shall be attached with black anodized screws.

Safety: Components shall be enclosed within grounded metal enclosures.

Barriers shall be provided to isolate major components as provided by ANSI C37.20. All connections shall be terminated in accessible areas.

Warning labels shall be provided with "DANGER 480 VOLTS" for all access areas to power circuits.

Locks: Front doors shall be supplied with a lockable handle. All door locks shall be keyed alike to operate from a single key, and one key shall be supplied for each lock. Full height doors will utilize three point latches with roller cams to secure the door firmly when closing.

Keyed interlocks, when required, shall be supplied with one key in each required lock. One extra spare key of each type shall be supplied separately, tagged as: "Spare, store in a safe in a safe place to prevent bypassing interlocks."

Generator Section: Device numbers listed below are "American Standard Device Function Numbers".

A generator section shall be provided for each generator.

Each unit shall contain the following devices:

- 1 Generator main circuit breaker shall be of the molded case type, electrically operated, drawout type construction, with auxiliary contacts (2a & 2b) and solid state overcurrent and short circuit trips. Trip units shall have adjustable long delay, short delay, ground fault and instantaneous trip settings.
- 3 Potential transformers, with primary and secondary fuses, 0.3% accuracy.
- 3 Current transformers, 0.3% accuracy rated at 600V.
- 1 Ammeter with 250 degree scale, 3% accuracy, 300 amp range.
- 1 Voltmeter with 250 degree scale, 3% accuracy, 600VAC range.
- 1 Frequency meter with a 250 degree scale of 55-65 hertz, 3% accuracy.
- 1 Kilowatt meter with 250 degree scale, 3% accuracy.
- 1 Power factor meter with 250 degree scale of .5-1.0-.5 PF, 3% accuracy.
- 1 Reverse power relay (Device 32) with adjustable trip settings from 2% to 15% of the unit's rated power. An adjustable time delay shall be provided with an inverse characteristic.
- 1 Breaker manual-auto switch. Manual position allows breaker to be controlled by open-close pushbuttons. Auto position allows breaker to be controlled by control system.

- 1 Engine Generator on-off-auto switch. On position manually turns the engine generator on. Off position turns the generator off. Auto position allows the engine generator to be controlled by the control system.
- 1 Circuit breaker open-close pushbuttons with open-close trip lights.
- 1 Ammeter phase selector switch.
- 1 Voltmeter phase selector switch.
- 1 Synchronizing switch with removable keyed handle.
- 1 Undervoltage relay, Device 27.
- 1 Frequency relay, Device 81.
- 1 Automatic synchronizer speed matching type (Device 15).
- 1 Automatic engine cranking assembly with pre-alarm and shut down modules.
- 3 Synchronous check relays, Device 25
- 1 Sync scope with lights.

The sync check relays shall allow a generator to power a dead bus on initial start up.

Annunciations and Shut Down:

The following alarms shall be provided and shall perform the listed functions:

| SHUTDOWNS AND LIGHT INDICATIONS | LENS COLOR |
|---------------------------------|------------|
| Reverse Power                   | Red        |
| Low Voltage                     | Red        |
| Failure to Synchronize          | Red        |
| Circuit Breaker Trip            | Red        |
| Low Oil Pressure                | Red        |
| High Water Temperature          | Red        |
| Overspeed                       | Red        |
| Overcrank                       | Red        |
|                                 |            |
| LIGHT INDICATION ONLY           | LENS COLOR |
| Battery Charger Failure         | Amber      |
| Not in Auto                     | Amber      |

Main Breaker Section:

- 1 Molded case "circuit breaker, electrically operated with solid state trip including adjustable long delay, short delay, instantaneous and ground fault setting.
- 1 Breaker open-close push buttons with open-close trip lights.

The following components shall be included:

- 3 Potential transformers, 0.3% accuracy with 4/1 ratio.
- 3 Current transformers, 0.3% accuracy rated at 600V.
- 1 Ammeter with range of 0-600 amps and 5 amp movement.

- 2 Voltmeters with 250 degree scale, 1% accuracy PT rated, 600 VAC range.
- 2 Frequency meters with a 250 degree scale of 55-65 hertz, 3% accuracy.
- 1 Kilowatt meter with 250 degree, 1% accuracy.
- 1 Ammeter phase selector switch.

Auxiliary Section: The auxiliary section of the generator switchgear shall contain the following components:

- 1 Thermal magnetic circuit breaker rated at 480 volts, number of poles and size as shown on the plans.
- 1 Stepdown shielded, isolation transformer with characteristics indicated on the Plans. The transformer shall have an insulation rating of Class 220, and a temperature rise of 115°C with 2-5 percent full capacity below normal taps.
- 1 Secondary thermal magnetic molded case circuit breaker rated at 240 volt, number of poles and size as shown on the plans.
- 1 Automatic transfer switch rated at 240 volt, number of poles and size as shown on the plans. The transfer switch shall have the following features:
  - (a) The automatic transfer switch shall be mechanically held and electrically operated by a single-solenoid mechanism.
  - (b) A minimum withstand current rating of 10,000 amperes at 240 volts.
  - (c) Transfer switch operates based upon UPS battery voltage and availability of generator and utility power. See UPS section for details.
  - (d) Two auxiliary contacts, one normal closed when transfer switch is connected to utility (normal) source and one normal closed when transfer switch is connected to generator bus. Contacts shall operate green and red signal lights on switchboard to indicate transfer switch position.
- 1 Manual transfer switch rated at 480 volts shall be UL listed, conform to NEMA standard ICS2-447; number of poles and size as shown on plans and shall have the following characteristics:
  - (a) Shall be mechanically held, non-automatic, and operated by a single quick make/quick-break mechanism externally operated from outside the switchgear.
  - (b) Shall be rated for continuous duty and be inherently

double throw; mechanically interlocked to ensure only two possible positions - normal or load bank.

- (c) All main contacts shall be silver composition. They shall be of the blow-on configuration and of segmented construction. The operating transfer time in either direction shall not exceed one sixth (1/6) of a second.
- (d) All contacts, springs, and control elements shall be conveniently removable from the front of the transfer switch without major disassembly or disconnection of power conductors.
- (e) Shall conform to the requirements of NEMA Standard ICS 2-447 and UL 1008 and shall be UL listed.
- (f) Shall have auxiliary contacts for remote status and to light a green signal light when the switch is in the "normal" position and a red signal light when the switch is in the "load bank" position. Red and green pilot lights shall be mounted on the switchgear door. DC battery voltage shall provide the source of power for the pilot lights.
- (g) Junction Box on Panel front with terminal lugs wired to switch for connection to future Load Bank.

Testing:

The generator switch gear shall be factory tested to simulate a complete and integrated system. The circuit breakers supplied shall be installed in their actual positions and electrically and mechanically tested. A narrative of the system operation shall be provided and shall be utilized when testing the equipment. Copies of the test reports shall be submitted to the Engineer.

The following separate tests shall be performed on the switchgear.

- Dielectric Test (Per ANSI C37.20, 5.3.1)
- Mechanical Test (Per ANSI C37.20, 5.3.2)
- Grounding of Instrument Transformer Case Test Per (ANSI C37.20, 5.3.3.)
- Electrical Operation and Control Wiring Test (Per ANSI C37.20, 5.3.4.1)
- Control Wiring Insulation (Per ANSI C37.20, 5.3.4.2.)
- Polarity Test (Per ANSI C37.20, 5.3.4.3)
- Sequence Test (Per ANSI C37.20, 5.3.4.4)

All equipment shall be installed under the direct supervision of the manufacturer's representative.

VALVE SWITCHES (PROXIMITY SWITCHES):

Proximity switches shall have positive make and break contacts through snap-action movement. Contact assembly shall be hermetically sealed in a hydrogen environment. Contacts shall be gold-flashed magnets and internal wiring shall be embedded in an epoxy compound. A terminal block for external connections shall be provided. Switch enclosure shall be brass with threaded conduit entry and shall have two through mounting holes. Proximity switch shall be submersible and UL listed. Switches shall be certified not to leak under 20 psig external pressure and shall have an operating temperature range of -65 degrees to +250 degrees F. Proximity switch cable shall be three conductor, submersible type in sufficient length to be continuous without splice from the switch to the motor control center in the pumping station.

A suitable target shall be provided for each proximity switch. Mounting of the switch and/or positioning of the target shall be such that the switch is actuated by movement of the target away from the switch a distance of one-half inch or less.

PART 3 - EXECUTION

EXISTING CONDITIONS:

Inspection: Prior to performing the work required by this section, carefully inspect the installed materials and equipment of all other trades and verify that the project has progressed to a point where this installation may properly begin.

Verify that all equipment furnished under this section of the specification may be installed in accordance with all pertinent codes and regulations, the original design, and the referenced standards.

Discrepancies: If any discrepancies are found, immediately notify the Engineer.

Do not proceed with the installation in areas of discrepancy until all such discrepancies have been fully resolved.

GROUNDING:

Provide equipment grounding connections for engine generator unit as indicated and as required. Tighten connections to comply with tightening torques specified in UL Std 486A to assure permanent and effective grounds.

See the plans for generator grounding requirements.

EQUIPMENT STORAGE:

Spare parts shall be tagged for positive identification and stored, on the site, as directed by the Owner.

INSPECTION:

Provide the services of a qualified representative of the manufacturer to inspect and approve all phases of the installation. Obtain all required installation permits and inspections.

FIELD TEST:

The complete installation shall be tested for compliance with the plans and specifications following completion of all site work. Testing shall be conducted by a representative of the manufacturer. The Contractor shall supply fuel (labor and material for filling up the wet well of the pump station with water and arranging for temporary discharging of the pumps to the wet well for this test), and other equipment required for the test. The Owner shall be notified in advance and shall have the option to witness the tests. The tests to be conducted on site shall be as follows:

Full block load test for 2 hours using two of the three pumps.

Engine shutdown test for all units.

Automatic transfer switch tests.

Transfer to generator after normal source failure.

Retransfer to line after return of normal source.

Transfer from generator to line after return of normal source and failure of generator output.

INSTRUCTION:

When all required tests have been performed and final approval has been given, a qualified representative of the manufacturer shall thoroughly demonstrate, to the Owner's maintenance personnel, the operation and maintenance of all items installed under this section. The manufacturer's representative shall spend at least 1 day performing the required start-up and operation training and 1 day performing maintenance training.

SECTION 0.45-48 - OVERCURRENT PROTECTIVE DEVICES

PART 1 - GENERAL DESCRIPTION OF WORK:

Furnish all labor, materials equipment, and incidentals required to provide and install overcurrent protective devices.

Extent of overcurrent protective device work is indicated by drawings and schedules.

Types of overcurrent protective devices in this section include the following:

Circuit Breakers:

Molded-case.

Refer to other Sections 0.45-25 through 0.49 for cable/wire and connector work required in conjunction with overcurrent protective devices; not work of this section.

CODES AND STANDARDS:

NEC Compliance: Comply with NEC requirements as applicable to construction and installation of overcurrent protective devices.

UL Compliance: Comply with applicable requirements of UL 489, "Molded-Case Circuit Breakers and Circuit-Breaker enclosures", and UL 198D, "High-Interrupting-Capacity Class K Fuses." Provide overcurrent protective devices which are UL-listed and labeled.

NEMA Compliance: Comply with applicable requirements of NEMA Std Pub Nos. AB 1, AB 2 and SG 3 pertaining to molded-case and low voltage power type circuit breakers.

ANSI Compliance: Comply with applicable requirements of ANSI C97.1 pertaining to low voltage cartridge fuses.

FS Compliance: Comply with Federal Specification W-C-375B/GEN pertaining to molded-case circuit breakers.

SUBMITTALS:

Product Data: Submit manufacturer's data on overcurrent protective devices, including: amperes, voltages and current ratings, interrupting ratings, current limitations, internal inductive and non-inductive loads, time-current trip characteristic curves, and mounting requirements.

Shop Drawings: Submit layout drawings of overcurrent protective devices showing spatial relationships of unit to associated electrical equipment, and connections to electrical power supplies.

## PART 2 - PRODUCTS

### ACCEPTABLE MANUFACTURERS:

Available Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include, but are not limited to, the following:

#### Circuit Breakers:

Airpax North American Philips Controls Corp.  
Bryant Electric Co.  
Cutler-Hammer, Inc.  
Federal Pacific Electric Co.  
General Electric Co.  
General Switch Co.  
Gould, Inc.  
GTE Sylvania Inc.  
Heinemann Electric Co.  
Pyle-National Co.  
Square D Company  
Westinghouse Electric Corp.

### CIRCUIT BREAKERS:

General: Except as otherwise indicated, provide circuit breakers and ancillary components, of types, sizes, ratings and electrical characteristics indicated, which comply with manufacturer's standard design, materials, components, and construction in accordance with published product information, and as required for a complete installation.

Molded-Case Circuit Breakers: Provide factory-assembled, molded case circuit breakers of frame size, ampere, and voltage ratings indicated on plans. Provide breakers with permanent thermal and instantaneous magnetic trips in each pole, and with fault-current limiting protection, ampere ratings as indicated. Construct with overcenter, trip-free, toggle type operating mechanisms with quick-make, quick-break action and positive handle indication. Provide push-to-trip button on cover for mechanical tripping circuit breakers. Construct breakers for mounting and operating in any physical position and operating in an ambient temperature of 40 degrees C. Provide breakers with mechanical screw type removable connector lugs, AL/CU rated.

## PART 3 - EXECUTION

### INSTALLATION OF OVERCURRENT PROTECTIVE DEVICES:

Install overcurrent protective devices as indicated, in accordance with the manufacturer's written instructions and with recognized industry practices to ensure that protective devices comply with requirements. Comply with NEC and NEMA standards for installation of overcurrent protective devices.

Coordinate with other work, including electrical wiring work, as necessary to interface installation of overcurrent protective devices with other work.

Fasten circuit breakers without mechanical stresses, twisting or misalignment being exerted by clamps, supports, or cabling.

Set field-adjustable circuit breakers for trip settings as indicated subsequent to installation of units.

ADJUST AND CLEAN:

Inspect circuit-breakers operating mechanisms for malfunctioning and, where necessary, adjust units for the free mechanical movement.

FIELD QUALITY CONTROL:

Prior to energization of overcurrent protective devices, test devices for continuity of circuitry and for short-circuits. Correct malfunctioning units, and then demonstrate compliance with requirements.

SECTION 0.45-49 - EXTERIOR LIGHTING FIXTURES

PART 1 - GENERAL

RELATED DOCUMENTS:

Drawings and general provisions of Contract, including General and Supplementary Conditions and Section 0.45-1, apply to work of this section.

Section 0.45-25 Basic Electrical Materials and Methods sections apply to work specified in this section.

DESCRIPTION OF WORK:

Extent of exterior lighting fixture work is indicated by drawings and schedules.

Types of exterior lighting fixtures in this section include the following:

High-intensity-discharge (HID).

Incandescent.

Applications of exterior lighting fixtures required for project include the following:

Outdoor area lighting.

Outdoor security lighting.

QUALITY ASSURANCE:

Manufacturers: Firms regularly engaged in manufacture of exterior building lighting fixtures of types and ratings required, whose products have been in satisfactory use in similar service for not less than 5 years.

Installer's Qualifications: Firm with at least 3 years of successful installation experience on projects with exterior lighting fixture work similar to that required for project.

Codes and Standards:

NEC Compliance: Comply with NEC as applicable to installation and construction of exterior building lighting fixtures.

NEMA Compliance: Comply with applicable requirements of NEMA Stds Pub/Nos. FA 1, LE 1 and LE 2 pertaining to lighting equipment.

IES Compliance: Comply with IES RP-8 pertaining to exterior

and roadway lighting practices and fixtures.

UL Compliance: Comply with UL standards, including Stds 486A and B, pertaining to exterior lighting fixtures. Provide exterior lighting fixtures which are UL-listed and labeled.

CBM Labels: Provide fluorescent lamp ballasts which comply with Certified Ballast Manufacturers Association standards and carry the CBM label.

ANSI Compliance: Comply with ANSI standards pertaining to exterior lighting fixtures.

SUBMITTALS:

Shop Drawings: Submit fixture shop drawings in booklet form with separate sheet for each fixture, assembled in luminaire "type" alphabetical or numerical order, with proposed fixture and accessories clearly indicated on each sheet.

DELIVERY, STORAGE, AND HANDLING:

Handle lighting fixtures carefully to prevent damage, breaking, and scoring. Do not install damaged fixtures or components; replace with new.

Store lighting fixtures in clean dry place. Protect from weather, dirt, fumes, water, construction debris, and physical damage.

PART 2 - PRODUCTS

ACCEPTABLE MANUFACTURERS:

Available Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include, but are not limited to, the following:

Exterior Lighting Fixtures:

Appleton Electric Co.  
Crouse-Hinds Lighting Product Div.; Cooper Industries, Inc.  
Guth Lighting Div.; General Signal Corp.  
Holophane Div.; Johns-Manville Corp.  
KIM Lighting, Inc.  
McGraw-Edison Co.  
Wide-Light Corp.

High-Intensity Ballasts:

Advance Transformer Co.  
General Electric Co.  
Holophane Div.; Johns-Manville Corp.  
Jefferson Electric Co.  
McGraw-Edison Co.

Sola Electric Div.; General Signal Corp.  
U.S. Lighting Products, Inc.  
Wide-Lite Corp.

EXTERIOR LIGHTING FIXTURES:

General: Provide lighting fixtures, of sizes, types and ratings indicated; complete with, but not limited to, housings, energy efficient ballasts, starters and wiring.

Wiring: Provide electrical wiring within fixture suitable for connection to branch circuit wiring as follows:

NEC Type AF for 120-volts, minimum No. 18 AWG.

High-Intensity-Discharge-Lamp Ballasts: Provide HID lamp ballasts, of ratings, types and makes as recommended by lamp manufacturer, which properly mates and matches lamps to electrical supply by providing appropriate voltages and impedances for which lamps are designed. Design ballasts to operate lamp within the lamp's power trapezoid requirements.

Lamps:

Provide high-pressure sodium lamps in wattages indicated.

Exterior Lighting Fixture Types:

Refer to fixture schedule on plans for fixture types and lamp data.

PART 3 - EXECUTION

INSPECTION:

Examine areas and conditions under which lighting fixtures are to be installed, and substrate which will support lighting fixtures. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

INSTALLATION OF EXTERIOR LIGHTING FIXTURES:

Install exterior lighting fixtures at locations and heights as indicated, in accordance with fixture manufacturer's written instructions, applicable requirements of NEC, NECA's "Standard of Installation," NEMA standards, and with recognized industry practices to ensure that lighting fixtures fulfill requirements.

Coordinate with other electrical work as appropriate to properly interface installation of exterior lighting fixtures with other work.

Tighten connectors and terminals, including screws and bolts, to comply with tightening torques specified in UL Stds 486A and B.

Fasten fixtures securely to poles; and ensure that poles are plumb.

ADJUSTING AND CLEANING:

Clean exterior lighting fixtures of dirt and debris upon completion of installation.

Protect installed fixtures from damage during construction period.

FIELD QUALITY CONTROL:

Upon completion of installation of exterior lighting fixtures, and after building circuitry has been energized, apply electrical energy to demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting.

Replace defective and burned out lamps for a period of one year following the Date of Substantial Completion.

At the Date of Substantial Completion, replace lamps in exterior lighting fixture which are observed to be noticeably dimmed after Contractor's use and testing as judged by Architect/Engineer.

GROUNDING:

Provide equipment grounding connections for exterior lighting fixtures as indicated. Tighten connections to comply with tightening torques specified in UL Std 486A to assure permanent and effective grounds.

EXTRA STOCK:

Furnish stock or replacement lamps amounting to 15 percent (but not less than one lamp in each case) of each type and size lamp used in each type fixture. Deliver replacement stock as directed to Owner's storage space, obtain receipt.

SECTION 0.45-50 - MEASUREMENT AND PAYMENT

Payment will be made on the basis of the lump sum price stipulated in the proposal for General Building and Pump Station complete, except for the 48 inch diameter storm sewer and perimeter fencing listed under a separate item. The limit of work for measurement shall be to the back of concrete curb. The lump sum item shall include the cost of all site improvements shown on the plans and specified herein.

SQUAW PEAK PARKWAY  
SEGMENT 5B  
BRIDGES  
SPECIAL PROVISIONS

# SPECIFICATIONS FOR BRIDGES

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## 1. GENERAL

The Bethany Home Overpass, the Arizona Canal Bridge, and the Glendale Avenue Underpass shall be constructed in accordance with Maricopa Association of Governments Uniform Standard Specifications for Public Works Construction, 1979 edition-revised to date, including current City of Phoenix Supplements thereto, and these special provisions.

These special provisions are intended to add to and compliment the Standard Project Specifications. Where a conflict arises between these Special Provisions and the Standard Project Specifications, these Special Provisions shall take precedence.

## 2. STRUCTURE EXCAVATION AND BACKFILL

### 2.1 General

Structure excavation and backfill shall conform to Section 206 of the Uniform Standard Specifications. The limits of structure excavation and backfill shall be as shown on A.D.O.T. Standard Drawing C-13.40.

The area behind the abutments shall be compacted in accordance with Table 601-2, Type I of the Uniform Standard Specifications.

All backfill against the bridge abutments shall consist of free-draining granular material. Backfill shall be placed in horizontal lifts consistent with the maximum material size and type of compaction equipment in use and to a minimum of 95% of the maximum density at the optimum moisture content plus or minus 3% as determined in accordance with ASTM D-2922 and D-3017. Compaction equipment shall be maintained at least two (2) feet from the structure.

### 2.2 Basis of Payment

No separate payment will be made for structure excavation and backfill and the cost of these items shall be included in the contract price bid for related items.

## 3. ABUTMENT PROTECTION

### 3.1 General

If the earth fill method of providing superstructure support during construction of the Bethany Home Road Overpass and the Glendale Avenue Underpass is utilized, the face of the abutments, piers and wingwalls shall be protected from staining or disfiguring by the fill material or by equipment used in placing and removing the fill. The protection method shall be the sole responsibility of the Contractor. Once a protection method has been selected by the Contractor, it shall be submitted to the Engineer for approval.

Any damage or discoloration to the abutment, piers or wingwalls shall be repaired by the Contractor in an approved fashion at no additional cost to the City of Phoenix.

#### 4. BRIDGE-CONCRETE MIX DESIGN

Concrete shall conform to Sections 505 and 725 of the Uniform Standard Specifications and shall have a compressive strength not less than that shown on the project plans.

#### 5. CAISSONS

##### 5.1 General

The work under this section consists of furnishing all labor, materials and equipment necessary for the construction of the cast-in-place concrete caissons at the various locations in accordance with the details shown on the plans and the Uniform Standard Specifications.

##### 5.2 Construction

Suitable casings shall be furnished and placed when required to prevent caving of the hole before concrete is placed therein.

All loose material existing at the bottom of the hole after drilling operations have been completed shall be removed before placing concrete in the hole. Material resulting from drilling holes shall be used in the adjacent embankment or disposed of as directed.

Before any personnel enter the caisson drill holes for cleaning or inspection purposes, the Contractor shall install a suitable casing or shield for protection against caving.

The use of water for drilling operations or for any other purpose where it may enter the hole will not be permitted. Surface water shall not be permitted to enter the hole, and all water that may have infiltrated the hole shall be removed from the hole before concrete is placed therein. The bottom of the casing shall be maintained not less than 1-foot below top of the concrete during withdrawal and placing operations, unless otherwise permitted by the Engineer.

Placement of Reinforcing Steel: The steel reinforcing cage shall be completely formed at the surface and lowered in one continuous operation with a crane of sufficient capacity. Clearance between the reinforcing steel and the walls of the excavation shall be provided by the use of spacer blocks which are firmly tied to the reinforcing cage in such a manner that they will not become disconnected or disoriented during lowering of the cage into the hole.

Placement of Concrete: Concrete shall be place by pumping through a combination concrete pipe and tremie pipe. The tremie pipe shall be of a rigid, watertight pipe for the full length of the pier and shall not be less than six inches in diameter. The concrete shall be vibrated to insure that the concrete in the hole is dense and homogeneous.

The Contractor shall furnish a pump with a minimum capacity of sixty (60) cubic yards per hour at a pumping head of two hundred (200) feet.

The Contractor will be required to have a second (backup) pump on-site during concreting operations unless the Contractor can assure the Engineer of delivery of a second pump to the site within 45 minutes.

Reinforcing steel shall be in place and tremie pipe shall be inserted to the tip of the hole before concrete placement is started. Concrete shall be placed in a continuous operation. The delivery pipe shall be slowly withdrawn as the elevation of the concrete in the hole rises, but the discharge end of the pipe shall, at all times, be maintained a maximum of 5.0 feet above the surface of the concrete.

### 5.3 Method of Measurement

Measurement for payment of caisson construction shall be by the linear foot for the length from the bottom of the pier cap to the bottom of each caisson.

### 5.4 Basis for Payment

Payment for caisson construction shall be made at the unit price per lineal foot bid for the respective caisson item complete in place.

## 6. VERTICAL RESTRAINERS

### 6.1 Description

The Contractor shall furnish and install restrainer units consisting of cables and assemblies and associated materials or components, in conformance with the details shown on the project plans, and in accordance with the Standard Specifications and these Special Provisions.

### 6.2 Materials

Cables shall be 3.4 inch preformed, 6 x 19, wire strand core or independent wire rope core (IWRC), galvanized ASTM A-603 Class A coating, right regular lay, manufactured of improved plow steel with a minimum breaking strength of 23 tons. Two certified copies of mill test reports of each manufactured length of cable used shall be furnished to the Engineer.

Free ends of cable restrainer units shall be securely wrapped at each end to prevent separation.

The cable assemblies shall be shipped as a complete unit.

One complete cable assembly shall be furnished to the Engineer for testing.

Expanded polystyrene shall be commercially available polystyrene board. Expanded polystyrene shall have a flexural strength of 35 pounds per square inch, minimum, determined in accordance with AASHTO Designation M-203, and a compressive yield strength of between 16 and 40 pounds per square inch, at 5 percent compression. When shown on the plans, surfaces of expanded polystyrene shall be faced with hardboard. Hardboard shall be 1/8-inch minimum thickness, conforming to the Federal Specification LLL-D-180, any type.

Other facing materials may be used provided they furnish equivalent protection. All boards shall be held in place by nails, waterproof adhesive, or other means approved by the Engineer.

Expansion joint filler shall be new non-extruding and resilient filler (bituminous type) conforming to the provisions of ASTM D-1751.

#### 6.3 Construction Requirements

Restrainers shall be installed as indicated on the project plans.

The Contractor shall provide means of holding the cable assemblies in their planned positions.

#### 6.4 Measurement

The Contractor shall be responsible for determining the required length of the cable assemblies.

No separate measurement will be made for Vertical Restrainer.

#### 6.5 Basis of Payment

No separate payment will be made for Vertical Restrainers. The cost of this item shall be included in the price bid for contract items.

### 7. ELASTOMERIC BEARING PADS

#### 7.1 General

Elastomeric bearing pads shall conform to the requirements of these Special Provisions and details shown on plans.

Pads of all elastomer may be cut from large sheets. Curing shall be performed in such a manner as to avoid heating of the material and to produce a smooth edge with no tears or other jagged areas and to cause as little damage to the materials as possible.

## 7.2 Materials

The sole polymer in the elastomeric compound shall be neoprene and shall be not less than 60 percent, by volume, of the total compound.

The elastomer, as determined from test specimens, shall conform to the following:

| TEST   | ASTM DESIGNATION                                      | REQUIREMENT |
|--|---|-------------|
| Tensile strength, psi  | D 412   | 2,250 Min.  |
| Elongation at break, percent                                       | D 412   | 350 Min.    |
| Compression set, 22 hrs. at 158 degrees F., percent                | D 395<br>(Method 8)                                   | 25 Max.     |
| Tear Strength, pounds per inch                                     | D 624<br>(Die C)                                      | 180 Min.    |
| Hardness (Type A)  | D 2240<br>w/ 2 Kg. wt.                                | 55 $\pm$ 5  |
| Ozone resistance 20 percent strain, 100 hrs. at 104° $\pm$ 3.6° F. | D 1149<br>(except 100 $\pm$ 20 parts per 100,000,000) | No cracks   |
| Lower temperature stiffness, Young's Modulus at -30° F., psi       | D 797   | 5,000 Max.  |
| Low temperature brittleness, 5 hrs. at -40° F.                     | D 2137  | Passed      |

After accelerated aging in accordance with ASTM Designation: D 574 for 70 hours at 212 degrees F. the elastomer shall not show deterioration changes in excess of the following:

|                              |  |
|------------------------------|--|
| Tensile strength, percent    | -15  |
| Elongation at Break, percent | -40 (But not less than 300 percent total elongation of the material) |
| Hardness, points             | +10  |

Certificates of Analysis shall be submitted.

### Steel Reinforced Elastomeric Bearing Pads:

Steel reinforced elastomeric bearing pads shall be furnished.

Steel reinforced elastomeric bearing pads shall conform to the requirements for steel-laminated elastomeric bearings as specified in ASTM Designation D 4014.

Metal reinforcement shall be rolled mild steel sheets conforming to the requirements of ASTM A 570, Grade 33 or 40.

The shear modulus of the elastomer shall be 110 pounds per square inch. The elastomer shall be Type CR, Grade 2. The ozone test concentration (partial pressure) shall be 100 millipascals (mPa) formerly referred to as 100 parts per hundred million.

The Contractor shall furnish to the Engineer certification by the manufacturer that the bearings to be furnished conform to all of the above requirements. The certifications shall be supported by Certificates of Analysis.

A sample pad from each lot will be selected at random at the project site for testing. Samples shall consist of complete pads as detailed on the project plans as specified herein. The Contractor shall furnish additional complete pads to replace those taken for testing. All sample pads for testing shall be furnished by the Contractor at his expense. Pads shall be available for sampling at least three weeks in advance of intended use.

#### 7.3 Method of Measurement

No separate measurement will be made for Elastomeric Bearing Pads.

#### 7.4 Basis of Payment

No separate payment will be made for Elastomeric Bearing Pads. The cost of all labor, materials and equipment necessary for the completion of this item in place shall be included in the price bid for contract items.

### 8. CONFINED ELASTOMERIC (POT) BEARINGS

#### 8.1 Description

This work shall consist of designing, testing, furnishing and installing confined elastomeric bearings (pot bearings) of the types and for the load and rotational capacities and at the locations and in accordance with the details shown on the project plans and the requirements of these Special Provisions.

#### 8.2 Definitions

"Pot Bearings" shall consist of a rotational element comprised of an elastomeric disc totally confined within a steel cylinder, including sole plate, piston, TFE discs, cylinders, masonry plate and anchorage as designed and manufactured by the following companies:

Spences Dynamics Corporation  
8-235 Promenade Street  
Providence, Rhode Island 02908

The D.S. Brown Company  
P.O. Box 158  
North Baltimore, Ohio 45872

The various types of pot bearings are defined as follows:

"Fixed Bearings" shall be defined to mean pot bearings that are restrained against all horizontal movement due to horizontal forces equal to or less than ten percent of the vertical load capacity of the bearing.

"Nonguided Expansion Bearings" shall be defined to mean pot bearings that have sliding surfaces of TFE and stainless steel to accommodate structural movement in all horizontal directions.

"Guided Expansion Bearings" shall be defined to mean pot bearings that have sliding surfaces of TFE and stainless steel and guide bars to accommodate structural movement in a specified horizontal direction.

### 8.3 Materials

Structural steel shall conform to the requirement of AASHTO M 183, M 223, or M 222.

Elastomers shall conform to the requirements of Subsection 2.25.2, the applicable requirements of Subsection 2.25.3 and Tables A and B of the AASHTO Standard Specifications for Highway Bridges. The hardness, Type A durometer, shall be  $50 \pm 5$ .

Elastomer seals shall be metal conforming to the following requirements:

Flat brass rings shall conform to the requirements of ASTM B 36, half hard.

Round cross section brass rings shall conform to the requirements of Federal Specification QQB626, Composition 22, half hard.

TFE shall conform to the requirements of Section 27 of the AASHTO Standard Specifications for Highway Bridges.

Stainless steel sliding surfaces shall conform to the requirements of ASTM A 240, Type 304.

## 8.4 Design

### General

Unless otherwise specified on the project plans, pot bearings shall be designed in accordance with the applicable requirements of the AASHTO Standard Specifications for Highway Bridges, and in accordance with the following requirements:

1. The minimum in service rotational capacity in any direction shall be as shown on the project plans.
2. Pot bearings shall be able to accommodate a minimum vertical load equal to the permanent dead load and a maximum vertical load equal to the required bearing capacity as given on the project plans.
3. Guided expansion bearings and fixed bearings shall be able to resist horizontal forces equal to ten percent of the vertical load capacity shown on the project plans.
4. No more than two guided expansion bearings shall be considered to share horizontal loads at any one bent.
5. The horizontal load capacity of guided expansion bearings and fixed bearing shall not include the resistance due to bearing friction.

When required on the project plans, the Contractor shall perform a study to determine the direction and placement of guided expansion bearings supporting skewed or curved structures such that damage due to wedging will not occur.

### Elastomeric Disc

The minimum thickness of the confined elastomeric disc shall be determined by the following formula:

$$t = ID/C$$

where

t = minimum thickness of elastomeric disc

ID = inside diameter of pot cylinder

C = 25 for Less than .011 radians of rotation

20 for .011 through 0.16 radians of rotation

15 for Over .016 radians of rotation

The average pressure on the elastomeric disc shall not exceed 3,675 pounds per square inch under a load equal to the required bearing capacity and the average pressure on the elastomeric disc shall not be less than 700 pounds per square inch due to dead load only.

#### TFE Discs

The average pressure on the TFE discs shall not exceed 3,675 pounds per square inch under a load equal to the required bearing capacity.

#### Guide Bar Connections

The design of high tensile screws shall be in accordance with the requirements of Subsections 1.7.22 and 1.7.41(C) of the AASHTO Standard Specifications for Highway Bridges.

Fasteners not listed in Table 1.7.41(C) shall be designed for an allowable stress in single shear equal to 20 percent of the minimum tensile strength ( $F_u$ ) of the fastener.

### 8.5 Fabrication

#### General

The design and fabrication of pot bearings shall be such that the pot cylinder and piston assembly can be removed for replacement or repair.

The overall height of the pot bearing shall not exceed the nominal height by more than  $3/16$  of an inch or be less than  $1/16$  of an inch under the nominal height of the bearing.

The edges of all parts of the pot bearing shall be broken by grinding so that sharp edges are eliminated.

#### Shop Drawings

Prior to fabrication, the Contractor shall submit eight sets of shop drawings to the Engineer for his approval. The shop drawings shall show complete details of the sole plate and anchorage, masonry plate and anchor bolt hole locations, anchor bolt size and layout, and the method of installation to be followed.

In determining the quality or suitability of a pot bearing submitted for approval for each application, the factors to be considered will include, but will not be limited to, the capability of installing or removing portions of the bearing after installation, and the ability to function without distress to any component.

### Elastomeric Disc

Elastomeric discs shall be fabricated of a maximum of three disc layers.

The upper edge of elastomeric discs that are retained by flat brass sealing rings shall be recessed to accommodate the rings.

The thickness of each elastomeric disc shall be within a tolerance of  $-0.0$  to  $+1/8$  of an inch of the design thickness.

The diameter of each elastomeric disc shall be within a tolerance of  $+ 1/16$  of an inch of the design diameter for diameters less than or equal to 20 inches and within a tolerance of  $+ 3/32$  of an inch of the design diameter for diameters over 20 inches.

### TFE Discs

TFE discs having the same diameter as the inside diameter of the pot cylinder and a thickness of 0.015 of an inch each, shall be located above and below the elastomeric disc for the purpose of lubrication.

### Pot Cylinder

Pot cylinders shall be machined from a solid plate or fabricated by welding a flame cut shape to a plate. Fabricated pot cylinders shall be 100 percent ultrasonically tested at the interior weld and magnetic particle tested at the exterior weld.

The minimum depth of the cavity in the pot cylinder shall be such that a minimum of 0.10 of an inch vertical clearance remains between the top of the cavity and the closest point of contact of the elastomer seal with the cylinder wall upon rotating the piston an amount equal to the required rotational capacity plus 0.02 radians.

The inside diameter of the pot cylinder shall be the same as the diameter of the elastomeric disc and shall be machined to a tolerance of  $+ 0.005$  of an inch for diameters up to and including 20 inches and to a tolerance of  $+ 0.007$  of an inch for diameters over 20 inches. The internal finish of the pot cylinder shall be equal to or less than 125 micro inches root mean square.

The underside of the pot cylinder shall be machined parallel to the inside to a Class A tolerance for flatness as hereinafter specified.

The pot cylinder shall be connected to the masonry plate by means of a full fillet weld around the entire perimeter of the pot cylinder or shall be seated in a formed recess in the masonry plate, without welding, to a depth of 0.019 of an inch minimum.

## Piston

The outside diameter of the piston shall be 0.03 of an inch to 0.05 of an inch less than the inside diameter of the pot cylinder where flat brass sealing rings are used and shall be 0.02 of an inch to 0.10 of an inch less than the inside diameter of the pot cylinder where round brass sealing rings are used to contain the elastomeric disc.

The piston thickness shall be at least eight percent of the inside diameter of the pot cylinder for square shaped pots and at least six percent of the inside diameter of the pot cylinder for round shaped pots.

The lower outside edge of pistons using round brass section sealing rings shall be beveled to accept and retain the brass rings and permit full design rotation.

For laterally restrained pot bearing designs that incorporate a slotted keyway in the top surface of the piston, a cold finished steel bar shall be press fit into the keyway slot and welded at both ends or, alternately, the piston and steel bar shall be machined from one piece of steel.

The diameter of the piston shall be within a tolerance of  $\pm 0.005$  of an inch for diameter less than or equal to 20 inches and within a tolerance of  $\pm 0.007$  of an inch for diameters over 20 inches.

The surface on the upper side of the piston shall be machined to a Class A tolerance for flatness and the surface of the lower side of the piston shall be machined to a Class B tolerance for flatness as hereinafter specified. Machined finishes shall be equal to or less than 125 micro inches root mean square.

## Elastomer Seals

- (1) Flat brass rings shall meet the following requirements:

The width shall be a minimum of  $3/8$  of an inch for bearing capacities less than or equal to 1,000 kips and a minimum of  $1/2$  of an inch for bearing capacities over 1,000 kips.

The thickness shall be a minimum of 0.050 of an inch.

Two rings shall be used for bearing capacities less than 1,000 kips; three rings shall be used for bearing capacities that are greater than or equal to 1,000 kips and less than or equal to 3,000 kips; four rings shall be used for bearing capacities over 3,000 kips.

The rings shall fit snugly against the surface of the inside perimeter of the pot cylinder and the ring ends shall be cut at an angle of 45 degrees with a minimum gap of 0.050 of an inch between ring ends. Piston ring gaps shall be staggered 180 degrees apart.

- (2) Round cross section rings shall meet the following requirements:

The rings shall be one piece with the ends brazed to form a solid ring.

The rings shall fit snugly against the surface of the inside perimeter of the pot cylinder

#### TFE Sliding Surface

Unfilled TFE shall be a minimum of 1/8 of an inch thick and a maximum of 5/16 of an inch thick when recessed into the top of the piston for half its thickness and a minimum of 3/32 of an inch thick and a maximum of 1/8 of an inch thick when bonded to the top surface of the piston.

Filled TFE shall be minimum of 1/16 of an inch thick and a maximum of 3/32 of an inch thick when bonded to the top surface of the piston. The bond shall meet the peel test requirements for 25 pounds per inch in 180 degrees. When recessed into the surface of the piston for half its thickness it shall be a minimum of 3/32 of an inch thick and a maximum of 3/16 of an inch thick.

TFE surfaces shall meet the requirements for a Class A tolerance for flatness as hereinafter specified.

#### Stainless Steel Sliding Surface

Stainless steel sliding surfaces for expansion bearings shall not be less than 0.040 of an inch thick nor more than 0.090 of an inch thick and shall be connected to the bottom of the sole plate by means of a seal weld around the entire perimeter of the sliding surface such that the stainless steel is in constant contact with the sole plate and the sliding surface is smooth and flat.

The stainless steel sliding surface area shall be such that it completely covers the TFE sliding surface in all operating positions and such that a minimum of one inch clearance between the edges of the two sliding surfaces will be maintained for every direction of movement.

The stainless steel sliding surface shall meet the requirements for a Class A tolerance for flatness as hereinafter specified and the surface finish shall be equal to or less than ten micro inches root mean square.

## Guide Bars

Guide bars shall be connected to the sole plate by welding or by high tensile screw connections.

The clearance between the guide bars and the parallel surface upon which the bars bear horizontal load shall be  $1/16$  of an inch unless otherwise specified on the project plans.

The dimensions and locations of guide bars shall be such that the guided member is contained within the guide bars throughout the entire structural movement and rotation of the bearing.

Guide bar lengths shall be fabricated to a tolerance of  $+ 1/8$  of an inch and the sectional dimensions of the bar shall be fabricated to a tolerance of  $\pm 1/16$  of an inch.

The distance between guide bars, as measured perpendicularly to the bars and along the surface of the sole plate shall be to a tolerance of  $1/32$  of an inch of the nominal dimension.

Guide bars shall be parallel to surfaces upon which they bear and to other guide bars to within a tolerance of  $\pm 1/32$  of an inch for the full length of the bar.

Surfaces on the guide bar that bear against another surface shall meet the requirements for a Class A tolerance for flatness as hereinafter specified.

## Sole Plate

The sole plate thickness shall be within a tolerance of  $-1/32$  of an inch to  $+ 1/8$  of an inch and no beveled edge shall be less than  $5/8$  of an inch thick.

The plan dimension tolerances for sole plates shall be as follows:

Plan dimensions less than or equal to 30 inches shall be within a tolerance of  $-0$  inches to  $+ 1/8$  of an inch.

Plan dimensions over 30 inches shall be within a tolerance of  $-0$  inches to  $+ 3/32$  of an inch.

The upper surface of the sole plate shall conform to the requirements of a Class B tolerance for flatness as hereinafter specified.

Pot bearings requiring a center guided key shall have a recess machined into the sole plate a maximum of  $1/8$  of an inch wider than the shear key.

## Masonry and Distribution Plates

The plan dimension tolerances for masonry and distribution plates shall be as follows:

Plan dimension less than or equal to 30 inches shall be within a tolerance of -0 inches to + 1/8 of an inch.

Plan dimensions over 30 inches shall be within a tolerance of -0 inches to + 3/16 of an inch.

The surfaces of masonry and distribution plates shall conform to the requirements of a Class B tolerance for flatness as hereinafter specified.

## Welding

All welding and inspection of welding for structural steel shall be performed in accordance with the requirements of the American Welding Society, (AWS) Structural Welding Code AWS D1.1-80, and of the AASHTO Standard Specifications for Highway Bridges. In the event of any conflict, the latter Specifications shall govern.

The use of electro-slag welding process on structural steel will not be permitted.

## Tolerances for Flatness

The flatness of bearing surfaces shall be determined by placing a precision straightedge on the surface to be measured and attempting to insert a feeler gauge, of the required flatness tolerance, under the straightedge.

The precision straightedge shall be longer than the "nominal dimension" being measured, where the term "nominal dimension" shall be interpreted to mean the actual dimension of the plate under the straightedge where the straightedge is not parallel to any plan dimension of the plate being measured.

The feeler gauge shall have an accuracy of plus or minus 0.001 of an inch and a plate shall be considered as acceptable if the feeler gauge does not pass under the straightedge for any random position of the straightedge on the plate surface.

Tolerances for flatness shall be as follows:

|         |        |   |                     |
|---------|--------|---|---------------------|
| Class A | 0.0005 | x | "nominal dimension" |
| Class B | 0.001  | x | "nominal dimension" |
| Class C | 0.002  | x | "nominal dimension" |

## Finishes

The exterior and interior surfaces of pot bearings shall be zinc metalized in accordance with the requirements of AWS C2.2. Zinc metalizing shall be a minimum of six mils on exterior surfaces and a minimum of two mils on interior surfaces.

Anchor bolts, nuts and washers shall be galvanized after fabrication in accordance with the requirements of ASTM A 153.

## 8.6 Testing

### Friction Test

The coefficient of friction shall be determined for at least one sample, chosen at random from the production lot, in accordance with the requirements of Subsection 2.27.4 of the AASHTO Standard Specifications for Highway Bridges.

### Load Test

A proof load test shall be performed on at least one sample, chosen at random from the production lot, by applying a load equal to 150 percent of the design capacity for a period of one hour.

The test bearings shall show no indications of failure or other defects while under load or subsequently upon disassembly and inspection.

## 8.7 Certification

Certificates of Analysis conforming to the requirements of Section 106.2 of the Standard Specifications shall be submitted.

The certificates shall include three certified copies of all tests hereinbefore specified, including friction tests, load tests, peel tests, ultrasonic tests and magnetic particle tests.

## 8.8 Erection

The pot bearings shall be installed in strict accordance with the manufacturer's recommendations, subject to these special Provisions and the approval of the Engineer.

## 8.9 Methods of Measurement

No separate measurement will be made for this item.

## 8.10 Basis of Payment

No separate payment will be made for this item. The cost of this item including all material, equipment and installation costs shall be included in the price bid for other items.

9. DECK JOINT ASSEMBLIES

9.1 Description

This work shall consist of furnishing and installing expansion devices including the seals, anchorage system, hardware, and sliding cover plates, where required, in conformity with the project plans, the requirements of these Special Provisions, and the Arizona Department of Transportation Standard Specifications for Road and Bridge Construction, 1982 Edition, revised to date. Deck joint assemblies shall have the movement rating shown on the project plans.

Materials

Any of the designated types of models of deck joint assemblies manufactured by the following manufacturers or an approved equal will be acceptable:

| <u>Manufacturer</u>  | <u>Movement Rating</u> |
|--|------------------------|
| Delastiflex CP200<br>Wabo Alu-Strip Type III, RV 200E or RV-300E<br>Wabo Bendoflex 250<br>Steel Flex SS200 | Up to 2"               |
| Delastiflex CP300<br>Wabu Alu-Strip Type III RV-300E<br>Steel Flex SS300                                   | 2" - 3"                |
| Delastiflex CP400<br>Wabu Alu-Strip S-400<br>Steel Flex SS400<br>On-Flex 40 SS, Type SC Steel Extrusion    | 3" - 4"                |
| Wabo Bendoflex 450<br>Delastiflex DL-450<br>On-Flex 40 SD, Type SC Steel Extrusion                         | 4" - 4-1/2"            |

The name, address and telephone number for the manufacturers of the listed deck joint assemblies and the name and telephone number for the factory trained representative to contact are as follows:

| <u>Manufacturer</u>  | <u>Representative</u>                                       |
|--|---|
| The D.S. Brown Co.<br>P.O. Box 158<br>North Baltimore, OH 45872<br>Phone: (419) 257-3561     | John Appleton<br>Phone: (503) 234-3573 or<br>(503) 234-3489 |
| Structural Accessories, Inc.<br>P.O. Box 10<br>Terryville, CT 06786<br>Phone: (203) 589-8826 | Pete Meyer<br>Phone: (602) 437-1900                         |

Watson-Bowman & Acme Corp.  
P.O. Box 9  
Getzville, NY 14068  
Phone: (716) 691-7566

J. Patrick McGuckin  
Phone: (602) 279-4636

If the Contractor elects to furnish an expansion joint not listed above, one of the conditions for approval will be that the Contractor shall furnish for the proposed expansion joint a one year satisfactory service report or data for an installation similar to the proposed conditions and application.

## 9.2 Construction Requirements

### General

Deck joint assemblies shall consist of metal and elastomeric assemblies which are anchored to the concrete over the joint. Strip seal assemblies shall be bolted into a formed recess in the concrete using cast-in-place anchors. The completed assembly shall be in planned position, shall satisfactorily resist the intrusion of foreign material and water and shall provide bump free passage of traffic. Deck joint assemblies shall impart negligible forces to the cast-in-place anchors or bridge members due to expansion or contraction.

For each type and size of seal on a project, one piece of the material supplied shall be at least 18 inches longer than required by the project plans. The additional length will be removed by the Engineer and used for testing by the Materials Section. Certificates of Compliance conforming to the requirements of Subsection 106.05 shall be submitted.

### Shop Drawings

Prior to fabrication, the Contractor shall submit eight (8) sets of shop drawings to the Engineer for his approval in accordance with the requirements of Subsection 105.02. The shop drawings shall show complete details of the cast-in-place anchor layout and the method of installation to be followed, including formed recess details, a temperature correction chart for adjusting the dimensions of the joint according to the ambient temperature and any additions or rearrangements of the reinforcing steel from that shown on the project plans.

In determining the quality or subquality of a deck joint assembly submitted for approval for each application, the factors to be considered will include, but will not be limited to, the ability of the assembly to resist the intrusion of the foreign material and water throughout the full range of movement, the capability of installing or removing elastomeric portions of the assembly at any amount of closure, and the ability to function without distress to any component.

### Strip Seals

Strip seals shall be of a configuration as determined by each manufacturer and as shown on the project plans. Each seal element shall be marked on the top surface with the manufacturer's name or trademark, the lot number and the size designation.

The strip seal shall be furnished and installed in one continuous length and field splices will not be allowed unless otherwise specified.

### Welding

All welding shall be in accordance with the requirements of Subsection 604-3.06.

### Armor

Metal for strip seal assemblies shall be aluminum alloy extrusions or steel. Where structural aluminum parts come into contact with concrete, they shall be coated with a coal tar type bituminous paint on the applicable surfaces to the satisfaction of the Engineer. All steel, except A588, shall be hot dip galvanized in conformance with provisions in Subsection 604-3.05.

### Painting

No paint is required for metal components made from steel conforming to the requirements of ASTM A 588 and for aluminum conforming to the requirements of ASTM B 221. All other exposed metal surfaces, not in contact with the joint seal or concrete shall be painted in accordance with the requirements of SECTION 610 - PAINTING. The paint shall be one coat each of the Paint Numbers 1, 2, and 3.

### Joint Preparation and Installation

Joints to be sealed shall be covered or otherwise protected at all times prior to installing the elastomeric portion of the assembly. The elastomer shall be installed at such time and in such a manner that it will not be damaged by construction operation.

For the strip seal assemblies the Contractor shall employ a factory trained representative of the joint manufacturer to provide on-site technical assistance at the time of the form-out of the recess and the installation of the anchorage, assembly and seal.

Stiffened metal pan forms shall be used to form the recess. The formed recess shall be sandblasted to remove all residue that could effect the adhesion of sealants. Irregularities shall be ground down to a level surface and pits and hollows shall be leveled with an epoxy grout meeting the approval of the Engineer.

If the Contractor elects to form the joint with a secondary concrete pour, the surface of the existing concrete shall be coated prior to the pour with an epoxy specifically formulated for bonding new concrete to the old concrete. The epoxy shall be approved by the Engineer.

Strip seal assemblies that utilize metal side sections shall not be installed into the formed recess until the Contractor has applied a thin bead of sealant, or other approved material, to the horizontal surface of the formed recess. The sealant shall be applied along a line parallel to the centerline of the joint for the joint's entire length. The sealant shall be located such that it will produce a water-tight barrier along both the near edge and far edge of the metal-to-concrete contact area.

The Contractor shall seal the space between the edge of the strip seal assembly side sections and the vertical faces of the formed recess with an approved nonshrink grout or an approved sealant, as recommended by the manufacturer and approved by the Engineer. If the space is sealed with grout, it shall fill the space for its full depth and, if sealant is used, the sealant shall be to a depth of one-half of an inch, minimum.

All anchors shall be re-tightened to the manufacturer's recommended torque at least four hours after initial tightening.

Immediately prior to the installation of the seal element, the metal contact surfaces of the joint armor shall be clean, dry and free of oil, rust, paint or foreign material. The contact surfaces of the seal element shall be cleaned with normal butylacetate, using clean rags or mops, immediately prior to application of the lubricant-adhesive or sealant. The lubricant-adhesive or sealant shall be applied to the seal element and joint armor contact surfaces at the rate recommended by the manufacturer.

The seal element shall be installed in strict accordance with the manufacturer's recommendations, subject to these Special Provisions and the approval of the Engineer, using equipment manufactured specifically for the installation of said element. The equipment shall not cause structural damage to either the seal element or the joint armor and shall not twist, distort, or cause other malformations in the installed seal element. Any perforation or tearing of the seal element due to installation procedures or construction activities will be causes for rejection of the installed seal element.

### 9.3 Method of Measurement

No separate measurement will be made for Item 9 - Deck Joint Assemblies.

#### 9.4 Basis of Payment

No separate payment will be made for Item 9 - Deck Joint Assemblies. The cost of all labor, materials and equipment necessary for the completion of this item in place will be included in the price bid for other items.

#### 10. POST-TENSIONING

##### 10.1 General

The work under this item shall consist of post-tensioning the cast-in-place concrete bridges in accordance with the details shown on the plans and Section 602 of the Arizona Department of Transportation Standard Specifications for Road and Bridge Construction, 1987 Edition revised to date.

##### 10.2 Basis for Payment

Payment for this item will be made at the contract Lump Sum price bid for Item \_\_\_\_\_ - POST-TENSIONING Bethany Home Road Bridge ITEM - POST-TENSIONING Grand Canal and ITEM \_\_\_\_\_ - POST-TENSIONING Glendale Avenue Bridge, complete in place.

#### 11. PRESTRESSING CAST-IN-PLACE CONCRETE (SOIL ANCHORS AND TIE-BACKS):

##### Description:

This work shall consist of furnishing all materials, labor, tools, equipment and other necessary items required for designing, detailing, constructing, testing and monitoring the permanent soil anchors and post tensioned tie-backs for the 3rd Avenue underpass abutment as shown on the project plans and as specified in these special provisions.

Project plans show only conceptual details indicating the type, size and location of the anchors. The information shown on these plans has not been designed and is not sufficient for construction purposes. The contractor shall design the anchor system with similar structural characteristics.

##### Qualifications:

The contractor or the subcontractor chosen for the design and construction of the soil anchors shall specialize in the design and construction of permanently anchored walls and have at least five years of experience in this field.

Submittals:

The contractor shall submit the following information with his bid:

- A. Evidence of the successful completion of at least five projects similar in concept and scope to the proposed construction.
- B. Resumes of project managers, superintendents, foremen, drilling operators and any other personnel actively involved that are to be employed on this project showing the type, length and number of permanent ground anchors each has installed within the past five years. The supervising engineer shall have at least three years of experience in the design and construction of permanent ground anchors. All drilling operators shall have at least one year of experience installing permanent anchors.

Final Design:

Within thirty calendar days of the award of the contract, the contractor shall submit the following design information:

Calculations and working drawings prepared, stamped and signed by a civil or structural engineer registered as a Professional Engineer in the State of Arizona. These drawings shall show explicit details to allow an expeditious review of the proposed design and construction procedure by the Engineer. The drawings and calculations shall include:

- A. A description of the anchor installation (including drilling, grouting and stressing information).
- B. Estimated anchor capacity, tendon type and capacity, anchorage type, minimum unbonded lengths, total anchor lengths, angle of installation, and anchor locations and spacing.
- C. Corrosion protection details for the anchors and hardware.
- D. Detailed plans for proof, creep, performance and lift-off testing of anchors showing loading and measuring devices to be used, test locations, and testing procedures to be followed.

The review of the design by the Engineer will be completed within thirty calendar days of the submittal. This review and acceptance of the plans and methods of construction by the Engineer shall not, in any way, relieve the contractor of his responsibility for the successful completion of the work.

Design Criteria:

The design shall include analysis of the states of stress in anchors at critical stages of construction using design criteria specified on the project plans.

The tendon size shall be determined so that the design load for the anchor does not exceed 60 percent of the minimum yield tensile strength of the tendon. The maximum load applied to the tendon shall not exceed 80 percent of the guaranteed ultimate tensile strength of the tendon.

The contractor shall be responsible for determining the anchor bond length necessary to develop the design load and stressing length force based on the design criteria.

Existing Conditions:

Geotechnical Data:

Boring logs are available in the project plans to assist the contractor in evaluating existing conditions for the design and construction of the soil anchors.

General soil and rock strata descriptions and indicated strata boundaries are based on engineering interpretations of all available subsurface information and may not reflect the actual variations in subsurface conditions between borings and samples. The contractor shall draw his own conclusions on the subsurface conditions depicted by the subsurface investigation report.

Materials:

Soil anchor and tie-back tendons shall be fabricated from single or multiple elements of the following:

- A. Steel bars conforming to ASTM A 722, "Uncoated High-Strength Steel Bars for Prestressed Concrete."
- B. Seven-wire strand conforming to ASTM A 416, "Uncoated Seven-Wire Stress-Relieved Strand for Prestressed Concrete."
- C. Wires conforming to ASTM A 421, "Uncoated Stress-Relieved Strand for Prestressed Concrete."
- D. Compact seven-wire strands conforming to ASTM A 779-80, "Uncoated Seven-Wire Compacted, Stress-Relieved Steel Strand for Prestressed Concrete."

Mill test reports for each heat or sampling lot of prestressing material used to fabricate tendons shall be submitted to the Engineer.

The stressing anchorage shall be capable of developing 95 percent of the guaranteed ultimate tensile strength of the prestressing steel in an unbounded state.

Prestressing steel couplers will not be allowed.

Centralizers shall be fabricated from material which is nondetrimental to the prestressing steel. Wood centralizers will not be permitted. The centralizer shall be positioned at 5 to 10 feet intervals in the bond length to provide a minimum of 0.5 inch of grout cover.

Spacers shall be used to separate elements of multi-element tendons. They shall be fabricated from material which is nondetrimental to the prestressing steel. A combination centralizer-spacer may be used.

Type I, II or III portland cement conforming to ASTM C 150 shall be used for grout. Cement shall be fresh and shall not contain any lumps or other indications of hydration. The grout shall be capable of reaching a cube strength (AASHTO T106) of 3,500 psi in seven days. Grout mix design shall be submitted to a testing laboratory for testing and approval 30 days prior to construction.

Water for mixing grout shall be potable.

Grout additives will not be allowed.

A smooth plastic sheath shall encapsulate the entire free length. The sheath shall have a minimum thickness of 0.05 inches. A grease film, compounded to provide corrosion inhibiting and lubricating properties, shall be placed between the sheath and the prestressing steel. The grease film shall completely fill the void area between the sheath and prestressing steel. The allowable content of deleterious substances in the grease shall not exceed the following:

| <u>Compound</u> | <u>Test Method</u>       | <u>Maximum<br/>Quantity (PPM)</u> |
|-----------------|--------------------------|-----------------------------------|
| Chlorides       | ASTM D 512               | 10                                |
| Nitrates        | ASTM D 992               | 10                                |
| Sulfides        | APHA "Sulfides in Water" | 10                                |

The sheath shall be sealed at the extremities to the tendon by means of tape or a heat-shrink sleeve.

Electrodes for welding shall be E70XX low-hydrogen (excluding E7014 and E7024).

Materials not specified herein shall meet the applicable requirements of the Standard Specifications.

**Construction Requirements:**

Tendons shall be fabricated in accordance with approved details and shall be free of dirt, detrimental rust, or other deleterious substances. Prior to installation, they shall be handled and stored in such a manner as to avoid corrosion and physical damages. Damage such as abrasions, cuts, nicks, welds, weld splatters, or heavy corrosion and pitting, will be cause for rejection of the tendon. Rejected tendons shall be replaced at no cost to the City. The bond length shall be decreased prior to installation.

The holes for the anchors shall be drilled at the locations shown on the approved design plans. The hole diameter shall not be less than 3 inches, if pressure grouting is used in the bond length (pressure greater than 60 psi) and 4 inches if non-pressure grouted (less than 60 psi). The diameter of the drill bit shall not be less than 1/8 inch smaller than the specified hole diameter. The hole shall remain open until grouting begins. Casing may be necessary to maintain an open hole. The hole shall extend a minimum of 2 feet beyond the specified tendon length. The holes shall be drilled to the inclination specified on the approved design plans with a 3 degree tolerance.

After the hole is drilled to final depth, the tendon shall be inserted and grouting performed. Grout shall always be injected at the lowest point of the anchor. The grout shall be placed around the anchor and shall extend at least two feet above the bond length. After grouting, the tendon shall remain undisturbed until the grout has reached a cube strength of 3,500 psi. The following data shall be recorded during the grouting operation:

- a) Type of mixer
- b) Water/cement ratio
- c) Grout pressure
- d) Type cement
- e) Test sample strengths
- f) Volume of grout placed in bond and free lengths

After stressing and testing, all void spaces left by drilled and anchor installation, including the annular space surrounding the free length, shall be filled with grout.

**Prestressing Concrete:**

Post tensioning shall be in accordance with the requirements of Section 602 of the Arizona Department of Transportation's Department for Road and Bridge Construction, 1987 Edition.

Anchor Testing and Stressing:

Each anchor shall be tested. The maximum test load shall not exceed 80 percent of the guaranteed ultimate tensile strength of the tendon. At each abutment, the first three tie-backs and 5 percent of the remaining anchors shall be performance tested. The first two tie-backs and one-fourth of the anchors selected for performance tests shall be creep tested.

Performance Test:

The performance test shall be made by incrementally loading and unloading the anchor in accordance with the following schedule. At each increment, the movement of the tendon shall be recorded to the nearest 0.001 inches, with respect to a fixed reference point. The jack load shall be monitored with a calibrated load cell certified by an independent testing laboratory under the supervision of an Arizona Registered Professional Engineer. The increments of load shall be as called for in the following columns:

| (Column 1)               | (Column 2)  |
|--------------------------|---|
| 0                        | 0.75 P  |
| 0.25 P (P = design load) | 0.50 P  |
| AL (AL = alignment load) | AL  |
| 0.50 P                   | 0.50 P  |
| AL                       | 0.75 P  |
| 0.50 P                   | 1.00 P  |
| AL                       | 1.50 P (Hold for<br>creep test)<br>Adjust to transfer<br>load to<br>1.00P |
| 0.50 P                   |   |
| AL                       |   |
| 0.50 P                   |   |
| 0.75 P                   |   |
| 1.00 P                   |   |
| 1.25 P                   |   |
| (Cont'd. under Column 2) |   |

The alignment load shall be maintained at approximately 5 percent of the design load to prevent misalignment of testing equipment. Each load increment shall be held until movement ceases, or a minimum of 2 minutes.

Creep Test Portion of Performance Test:

The creep test shall consist of holding the 1.50 P load for 50 minutes while tendon deflections are measured from a fixed reference point at 0, 1/2, 1, 5 and 50 minutes.

Acceptance Criteria for Performance Test:

The total movement measured shall be between 80 percent of the theoretical elastic elongation of the stressing length and the theoretical elastic elongation of the stressing length plus 50 percent of the bond length.

The creep movement shall not exceed 0.080 inches during the final time increment of the creep test.

Proof Test:

The proof test shall be performed by incrementally loading the anchor according to the following schedule. At each increment, the movement of the tendon shall be recorded to the nearest 0.001 inches with respect to a fixed reference point. The jack load shall be monitored with a calibrated pressure gauge or load cell. If a hydraulic pressure gauge is to be used, it shall be calibrated with the load cell during the performance testing outline above. The increments of load are as follows:

0  
0.25 P  
0.50 P  
0.75 P  
1.00 P  
1.25 P  
1.50 P (Hold for creep test)  
Adjust to transfer load of 1.00 P

Creep Test Portion of Proof Test:

The creep test to be done as part of the proof test shall hold the 1.50 P test load for 5 minutes. Anchor movement shall be recorded at 0, 1/2, and 5 minutes. If the movement between the 1/2 and 5 minute readings is greater than 0.080 inches, the load shall be maintained for an additional 45 minutes.

Acceptance Criteria for Proof Test:

Same as performance test.

Corrections:

If anchors fail during performance, proof, or creep testing, the contractor shall modify the design or construction procedure, subject to review by the Engineer. Any anchors that have failed testing shall either be removed or repaired as directed by the Engineer at the contractor's expense. All anchors left in place shall have passed the testing requirements.

Method of Measurement:

Measurement of permanent soil anchors and post tensioned tie-backs will be as a single lump sum unit.

Basis of Payment:

Payment for this work will be made at the lump sum contact price for ITEM \_\_\_\_\_. The contract price shall include the cost of designing the system, furnishing all materials and constructing the soil anchors and tie-backs, post-tensioning and testing, all as specified herein and on the project plans.

12. ELECTRICAL AND TRAFFIC SIGNAL HARDWARE

12.1 General

Electrical and traffic signal hardware, such as junction boxes, mounting plates, brackets, slip joints, etc., shall be placed in the structures as indicated on the plans.

12.2 Measurement

No separate measurement will be made for these items.

12.3 Basis for Payment

No separate payment will be made for these items. The cost for these items including all material, equipment and installation costs shall be included in the price bid for other items.

### 13. SALT RIVER PROJECT CONSTRUCTION SPECIFICATIONS

#### 13.1 General

Construction of the Arizona Canal Bridge shall comply with the following Salt River Project Specifications for Bridge Crossings of Salt River Project Canals.

13.2 Prior to any work being done a construction clearance must be obtained from the SRP Supervisor of Transmission (236-5461).

13.3 Elevations of the proposed bridge floor and underside of the bridge deck are to be verified by the Engineer prior to placing concrete.

13.4 No concrete shall be placed without prior approval of the Engineer.

13.5 Realignment of the canal bank from the existing bank to the tie-in to the wing wall of the bridge is not to exceed 24 to 1 taper.

13.6 The exact length and alignment of retaining walls or wing walls, if required, will be determined in the field at the time of construction by the Engineer prior to setting forms. If the canal bank is disturbed during installation of retaining wall footings, the bank is to be reshaped, compacted, and lined, as directed by the Engineer in accordance with SRP Canal Lining Specifications, CE 3.06.

13.7 The canal bank lining is to be 3 inch thick handplaced concrete or 1-1/2 inch thick pneumatically applied lining (minimum 3,000 psi 28 day strength) placed over 6 inch by 6 inch w1.4 by w1.4 (10 gauge) welded wire fabric. The bank lining under the bridge is to be tied to the underside of the bridge or to the abutment. The lining taper below the bridge is to be no flatter than 1:1 and no shelf will be permitted at the top of the lining. The bank lining is to extend 3 feet beyond the disturbed portion of the bank or to a point opposite 1-foot beyond the furthest end of the Maintenance Equipment Underpass ramp structures, whichever is greater. The lining is to be keyed in with a 12 inch deep cutoff lip for the full perimeter of the lining or is to be tied to the existing lining.

13.8 The canal bottom lining is to 4 inch thick nonreinforced shotcrete or poured concrete (minimum 2000 psi 28 day strength) unless otherwise specified. The bottom lining is to extend 3 feet beyond the disturbed portion of the bottom or to a point opposite 1' beyond the furthest end of the Maintenance Equipment Underpass ramp structures, whichever is greater. The bottom lining is to be keyed in with a 12 inch deep cutoff lip for the full perimeter or tied to the existing lining.

13.9 If the existing bottom and bank lining does not meet the above requirements, it shall be removed and replaced as specified herein. All bottom and bank preparation is to conform to the minimum standards as stipulated in SRP Specifications CD 3.06.

13.10 All concrete, plaster, or headwalls are to be sprayed with a white pigmented curing compound, immediately after finishing or form removal.

13.11 Any abandoned structures found within the zone of construction are to be completely removed to the Engineer's satisfaction.

13.12 Any material placed in the canal or other SRP facility is to be completely removed to the Engineer's satisfaction.

13.13 The approach ramp material shall consist of a well graded aggregate base in accordance with MAG Specifications Section 7.02, or a similar material approved by the Engineer, thoroughly mixed with a minimum of 20 percent to a maximum of 40 percent fines (material that will pass the #200 sieve).

13.14 All backfill is to be carefully placed in 8 inch compacted lifts and compacted to a minimum of 90 percent standard Proctor density, ASTM D-698.

13.15 All damage to SRP facilities is to be repaired by the Licensee or his contractor to the Engineer's satisfaction. If emergency repair work is necessary or the Licensee fails to complete all work covered by this License in a reasonable time as determined by the Engineer, this work will be performed by SRP forces and the Licensee agrees to pay the full cost of said work.

#### 14. SPECIAL CONSTRUCTION REQUIREMENTS

##### 14.1 General

The Contractor shall schedule his construction operations so to install the concrete canal lining during the period of the canal dry-up.

The Contractor is hereby informed that only vehicles with weights conforming to Arizona highway legal loading will be permitted on the newly constructed bridges.

Caisson Alignment and Dimensions: The caissons shall be installed as shown on the design drawings and in accordance with these specifications. No caisson shall be off center from its design location more than three (3) inches at the top of the caisson. No vertical caisson shall be out of plumb more than 1-1/2 percent of its length. Batter caissons shall not deviate more than 5 percent of their lengths from design inclination. All caissons and shafts shall be at least as large in diameter as shown on the design drawings.

#### 14.2 Bethany Home Road Overpass

The Contractor will be allowed to close Bethany Home Road to all but local traffic during construction as set forth by the City of Phoenix Traffic Barricade Manual (latest edition) or by the Engineer. The Contractor shall furnish false work drawings to the Engineer for approval.

Backfilling behind both abutments shall be done simultaneously with a differential height limit of two feet.

#### 14.3 Glendale Avenue Overpass

The sequence of construction of the Glendale Avenue Underpass shall be as follows as directed by the Engineer:

- A. Construct detour.
- B. Construct Abutments No. 1 and No. 2 and Piers
- C. The temporary embankment between Abutment No. 1 and Abutment No. 2 shall be carefully built so as to support the casting of the concrete superstructure if the Contractor elects this method of support.
- D. After work on the superstructure has been completed, the temporary embankment shall be removed.

BOND ISSUE OR BUDGET PROJECT  
CITY OF PHOENIX, ARIZONA  
ENGINEERING DEPARTMENT

PROPOSAL to the City Engineer of the City of Phoenix.

In compliance with the Advertisement for Bids, by the City Engineer, the undersigned Bidder:

Having examined the contract documents, site of work, and being familiar with the conditions to be met, hereby submits the following Proposal for furnishing the material, equipment, labor and everything necessary for the completion of the work listed and agrees to execute the contract documents and furnish the required bonds and certificates of insurance for the completion of said work, at the locations and for the prices set forth on the inside pages of this form.

Understands that construction of this project shall be in accordance with all applicable Maricopa Association of Governments' (MAG) Uniform Standard Specifications and Uniform Standard Details, latest revision, and the City of Phoenix Supplements, latest revision to the MAG Uniform Standard Specifications and Details; except as otherwise required by the project plans and specifications.

Understands that his proposal shall be submitted with a proposal guarantee of cash, certified check, cashier's check or surety bond for an amount not less than 5 percent of the amount bid.

Agrees that upon receipt of Notice of Award, from the City of Phoenix, he will execute the contract documents.

Work shall be completed within \_\_\_\_\_ calendar days, beginning with the day following the starting date specified in the Notice to Proceed. The time allowed for completion of the work includes lead time for obtaining the necessary materials and/or equipment.

The Bidder hereby acknowledges receipt of and agrees his proposal is based on the following Addenda.

\_\_\_\_\_  
\_\_\_\_\_

ENGINEERING DEPARTMENT - City of Phoenix, Arizona

BID SCHEDULE

| PAY<br>ITEM<br>NO. | DESCRIPTION   | APPROX.<br>QUANTITY<br>& UNIT |               |        |
|--------------------|---|-------------------------------|---------------|--------|
|                    |   |                               | UNIT<br>PRICE | AMOUNT |
|                    | I. ROADWAY  |                               |               |        |
| 1                  | CLEARING AND GRUBBING                               | 1<br>L.S.                     |               |        |
| 2                  | SUBGRADE PREPARATION                                | S.Y.                          |               |        |
| 3                  | TOPSOIL (CLEAN FILL)                                | C.Y.                          |               |        |
| 4                  | ROADWAY EXCAVATION                                  | C.Y.                          |               |        |
| 5                  | FULL CONSTRUCTION (LOCAL BORROW)                    | C.Y.                          |               |        |
| 6                  | PORTLAND CEMENT CONCRETE PAVEMENT<br>(PCCP 11 1/2") | S.Y.                          |               |        |
| 7                  | PORTLAND CEMENT CONCRETE PAVEMENT (8")              | S.Y.                          |               |        |
| 8                  | ASPHALT CONCRETE SURFACE COURSE (D 1/2)             | TON                           |               |        |
| 9                  | ASPHALT CONCRETE BASE COURSE (A 1-1/2)              | TON                           |               |        |
| 10                 | ASPHALT CONCRETE (C -3/4)                           | TON                           |               |        |
| 11                 | AGGREGATE BASE COURSE                               | TON                           |               |        |
| 12                 | EMULSIFIED ASPHALT FOR TACK COAT (SS-1h)            | TON                           |               |        |
| 13                 | ALLEY SURFACING (A.B.C.) T=6"                       | S.Y.                          |               |        |
|                    |   |                               |               |        |
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| PAY<br>ITEM<br>NO. | DESCRIPTION  | APPROX.<br>QUANTITY<br>& UNIT |               |        |
|--------------------|--|-------------------------------|---------------|--------|
|                    |  |                               | UNIT<br>PRICE | AMOUNT |
| 14                 | CONCRETE CURB & GUTTER, M.A.G. STD.<br>DET. 220, TYPE "A"                  | L.F.                          |               |        |
| 15                 | CONCRETE CURB & GUTTER, M.A.G. STD.<br>DET. 220, (MOD. 11 1/2"), DETAIL 1. | L.F.                          |               |        |
| 16                 | CONCRETE ROLL CURB & GUTTER, M.A.G. STD.<br>DET. 222, TYPE "A"             | L.F.                          |               |        |
| 17                 | CONCRETE SINGLE CURB, M.A.G. STD.<br>DET. 222, TYPE "A"                    | L.F.                          |               |        |
| 18                 | CONCRETE VALLEY GUTTER, M.A.G. STD.<br>DET. 240, (MOD. 11 1/2"), DETAIL 21 | S.F.                          |               |        |
| 19                 | CONCRETE CURB & GUTTER, 25" MOUNTABLE,<br>DETAIL 4                         | L.F.                          |               |        |
| 20                 | CONCRETE CURB & GUTTER, 31" MOUNTABLE,<br>DETAIL 4                         | L.F.                          |               |        |
| 21                 | CONCRETE BARRIER, SINGLE FACE 2'-8",<br>DETAIL 13                          | L.F.                          |               |        |
| 22                 | CONCRETE BARRIER, SINGLE FACE 2'-8",<br>DETAIL 30                          | L.F.                          |               |        |
| 23                 | CONCRETE BARRIER, SINGLE FACE 3'-6",<br>DETAIL 31                          | L.F.                          |               |        |
| 24                 | CONCRETE BARRIER, SINGLE FACE 5'-0",<br>DETAIL 31                          | L.F.                          |               |        |
| 25                 | CONCRETE BARRIER, DOUBLE FACE 3'-6",<br>DETAIL 15                          | L.F.                          |               |        |
| 26                 | TEMPORARY CONCRETE BARRIER (DETOUR)  | L.F.                          |               |        |
| 27                 | CONCRETE SIDEWALK, C.O.P. STD. DET. P-1230                                 | S.F.                          |               |        |

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| PAY<br>ITEM<br>NO. | DESCRIPTION  | APPROX.<br>QUANTITY<br>& UNIT |               |        |
|--------------------|--|-------------------------------|---------------|--------|
|                    |  |                               | UNIT<br>PRICE | AMOUNT |
| 28                 | CONCRETE BIKE PATH, T=4"                                   | S.F.                          |               |        |
| 29                 | CONCRETE BIKE PATH, T=9"                                   | S.F.                          |               |        |
| 30                 | CONCRETE DRIVEWAY ENTRANCE, C.O.P. STD.<br>DET. P-1255     | S.F.                          |               |        |
| 31                 | CONCRETE DRIVEWAY ENTRANCE, M.A.G. STD.<br>DET. 250        | S.F.                          |               |        |
| 32                 | CONCRETE ALLEY ENTRANCE, M.A.G. STD.<br>DET. 260 (MOD. 9") | S.F.                          |               |        |
| 33                 | SCOPE PAVING   | S.Y.                          |               |        |
| 34                 | CONCRETE SPILLWAY  | S.Y.                          |               |        |
| 35                 | CONCRETE MEDIAN NOSE, DETAIL 18                            | S.F.                          |               |        |
| 36                 | WROUGHT IRON FENCE, DETAIL 23                              | L.F.                          |               |        |
| 37                 | G.R.E.A.T. ATTENUATOR ASSEMBLY                             | EA.                           |               |        |
| 38                 | SURVEY MARKER, M.A.G. STD. DET. 120-1,<br>TYPE A           | EA.                           |               |        |
| 39                 | SURVEY MARKER, M.A.G. STD. DET. 120-1,<br>TYPE B           | EA.                           |               |        |
| 40                 | SURVEY MARKER, M.A.G. STD. DET. 120-1,<br>TYPE C           | EA.                           |               |        |
| 41                 | SAFETY BOLLARD, DETAIL 16                                  | EA.                           |               |        |
|                    |  |                               |               |        |
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BID SCHEDULE

| PAY<br>ITEM<br>NO. | DESCRIPTION  | APPROX.<br>QUANTITY<br>& UNIT |               |        |
|--------------------|--|-------------------------------|---------------|--------|
|                    |  |                               | UNIT<br>PRICE | AMOUNT |
| 42                 | SAFETY BOLLARD (REMOVABLE), DETAIL 17                          | EA.                           |               |        |
| 43                 | ADJUST TYPE A WATER VALVE, M.A.G. STD.<br>DET. 391-1           | EA.                           |               |        |
| 44                 | ADJUST MANHOLE FRAME & COVER, M.A.G. STD.<br>DET. 422          | EA.                           |               |        |
| 45                 | RETAINING WALL CONCRETE  | C.Y.                          |               |        |
| 46                 | RETAINING WALL STEEL   | LBS.                          |               |        |
| 47                 | NOISE WALL CONCRETE  | C.Y.                          |               |        |
| 48                 | NOISE WALL STEEL   | LBS.                          |               |        |
| 49                 | REMOVE CONCRETE SINGLE CURB, CURB & GUTTER                     | L.F.                          |               |        |
| 50                 | REMOVE CONCRETE SIDEWALK, DRIVEWAY, VALLEY<br>GUTTER AND SLABS | S.F.                          |               |        |
| 51                 | REMOVE STRUCTURES BACKFILL & COMPACT                           | 1<br>JOB                      |               |        |
| 52                 | REMOVE PIPE, BACKFILL & COMPACT                                | L.F.                          |               |        |
| 53                 | DEMOLITION OF BUILDING   | 1<br>L.S.                     |               |        |
| 54                 | REMOVE SWIMMING POOLS  | EA.                           |               |        |
| 55                 | MISCELLANEOUS REMOVAL AND OTHER WORK                           | 1<br>L.S.                     |               |        |
|                    |  |                               |               |        |
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| PAY<br>ITEM<br>NO. | DESCRIPTION                                     | APPROX.<br>QUANTITY<br>& UNIT | AMOUNT        |          |
|--------------------|---|-------------------------------|---------------|----------|
|                    |   |                               | UNIT<br>PRICE |          |
| 56                 | TRENCHING AND BACKFILL FOR A.P.S. STREET LIGHTS | L.F.                          |               |          |
| 57                 | TRAFFIC CONTROL DEVICES (CONSTRUCTION)          | JOB                           |               |          |
| 58                 | UNIFORMED, OFF-DUTY, LAW ENFORCEMENT OFFICER    | 300<br>HRS.                   | 19.00         | 5,700.00 |
| 59                 | 15" STORM SEWER PIPE                            | L.F.                          |               |          |
| 60                 | 21" STORM SEWER PIPE                            | L.F.                          |               |          |
| 61                 | 24" STORM SEWER PIPE                            | L.F.                          |               |          |
| 62                 | 30" STORM SEWER PIPE                            | L.F.                          |               |          |
| 63                 | 48" STORM SEWER PIPE                            | L.F.                          |               |          |
| 64                 | 15" CATCH BASIN CONNECTOR PIPE                  | L.F.                          |               |          |
| 65                 | 18" CATCH BASIN CONNECTOR PIPE                  | L.F.                          |               |          |
| 66                 | 21" CATCH BASIN CONNECTOR PIPE                  | L.F.                          |               |          |
| 67                 | STORM SEWER MANHOLE, STD. DET. 520 & 522        | EA.                           |               |          |
| 68                 | STORM SEWER MANHOLE, STD. DET. 520 & 420        | EA.                           |               |          |
| 69                 | CATCH BASIN, TYPE M, C.O.P. DET. P-1569         | EA.                           |               |          |
|                    |   |                               |               |          |
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BID SCHEDULE

| PAY<br>ITEM<br>NO. | DESCRIPTION   | APPROX.<br>QUANTITY<br>& UNIT |               |        |
|--------------------|---|-------------------------------|---------------|--------|
|                    |   |                               | UNIT<br>PRICE | AMOUNT |
| 70                 | CATCH BASIN, TYPE M-1, L=3', C.O.P.<br>DET P-1569                     | EA.                           |               |        |
| 71                 | CATCH BASIN, TYPE M-1, L=6', C.O.P.<br>DET P-1569                     | EA.                           |               |        |
| 72                 | CATCH BASIN, TYPE M-1, L=10', C.O.P.<br>DET P-1569                    | EA.                           |               |        |
| 73                 | CATCH BASIN, TYPE M-1, L=17', C.O.P.<br>DET P-1569                    | EA.                           |               |        |
| 74                 | CATCH BASIN, TYPE M-2, L=17', C.O.P.<br>DET P-1569                    | EA.                           |               |        |
| 75                 | CATCH BASIN, TYPE N, SINGLE, C.O.P.<br>DET P-1570                     | EA.                           |               |        |
| 76                 | CATCH BASIN, TYPE N DOUBLE, C.O.P.<br>DET P-1570                      | EA.                           |               |        |
| 77                 | CATCH BASIN, TYPE N, TRIPLE, C.O.P.<br>DET P-1570                     | EA.                           |               |        |
| 78                 | CATCH BASIN, TYPE N, TRIPLE (MOD.) C.O.P.<br>DET P-1570, DETAIL ____. | EA.                           |               |        |
| 79                 | CATCH BASIN, TYPE N, DOUBLE (MOD.) C.O.P.<br>DET P-1570, DETAIL ____. | EA.                           |               |        |
| 80                 | 6' X 6' STORM SEWER JUNCTION BOX, SPECIAL<br>DETAIL ____.             | EA.                           |               |        |
| 81                 | PAVEMENT REPLACEMENT, TYPE "A"  | S.Y.                          |               |        |
| 82                 | PAVEMENT REPLACEMENT, TYPE "B"  | S.Y.                          |               |        |
| 83                 | PIPE SUPPORT ACROSS TRENCH, M.A.G.<br>DET. 403                        | EA.                           |               |        |
|                    |   |                               |               |        |
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| PAY<br>ITEM<br>NO. | DESCRIPTION  | APPROX.<br>QUANTITY<br>& UNIT |               |        |
|--------------------|--|-------------------------------|---------------|--------|
|                    |  |                               | UNIT<br>PRICE | AMOUNT |
| 84                 | PIPE PLUG M.A.G. DET. 427  | EA.                           |               |        |
| 85                 | CONCRETE PIPE COLLAR   | EA.                           |               |        |
| 86                 | PREFABRICATED TEE 15" X 15"  | EA.                           |               |        |
| 87                 | PREFABRICATED TEE 15" X 48"  | EA.                           |               |        |
| 88                 | PREFABRICATED TEE 24" X 48"  | EA.                           |               |        |
| 89                 | PREFABRICATED TEE 21" X 21"  | EA.                           |               |        |
| 90                 | GENERATOR BUILDING AND PUMP STATION                                  | L.S.                          |               |        |
| 91                 | 12" R.G.R.C.P. CLASS IV, PRIVATE IRRIGATION                          | L.F.                          |               |        |
| 92                 | 15" R.G.R.C.P. CLASS IV, PRIVATE IRRIGATION                          | L.F.                          |               |        |
| 93                 | IRRIGATION MANHOLE, (4'X4')  | EA.                           |               |        |
| 94                 | 36" IRRIGATION STANDPIPE, STD. DET. 503,<br>TYPE "A" (MODIFIED)      | EA.                           |               |        |
| 95                 | 48" IRRIGATION STANDPIPE, STD. DET. 503,<br>TYPE "B" (MODIFIED)      | EA.                           |               |        |
| 96                 | 18" R.G.R.C.P., CLASS V, (S.R.V.W.U.A.)<br>SRP DRAWING NO. A-101-152 | L.F.                          |               |        |
| 97                 | MANHOLE (S.R.V.W.U.A.)SRP DRAWING NO.<br>A-101-152                   | EA.                           |               |        |
|                    |  |                               |               |        |
|                    |  |                               |               |        |

ENGINEERING DEPARTMENT - City of Phoenix, Arizona

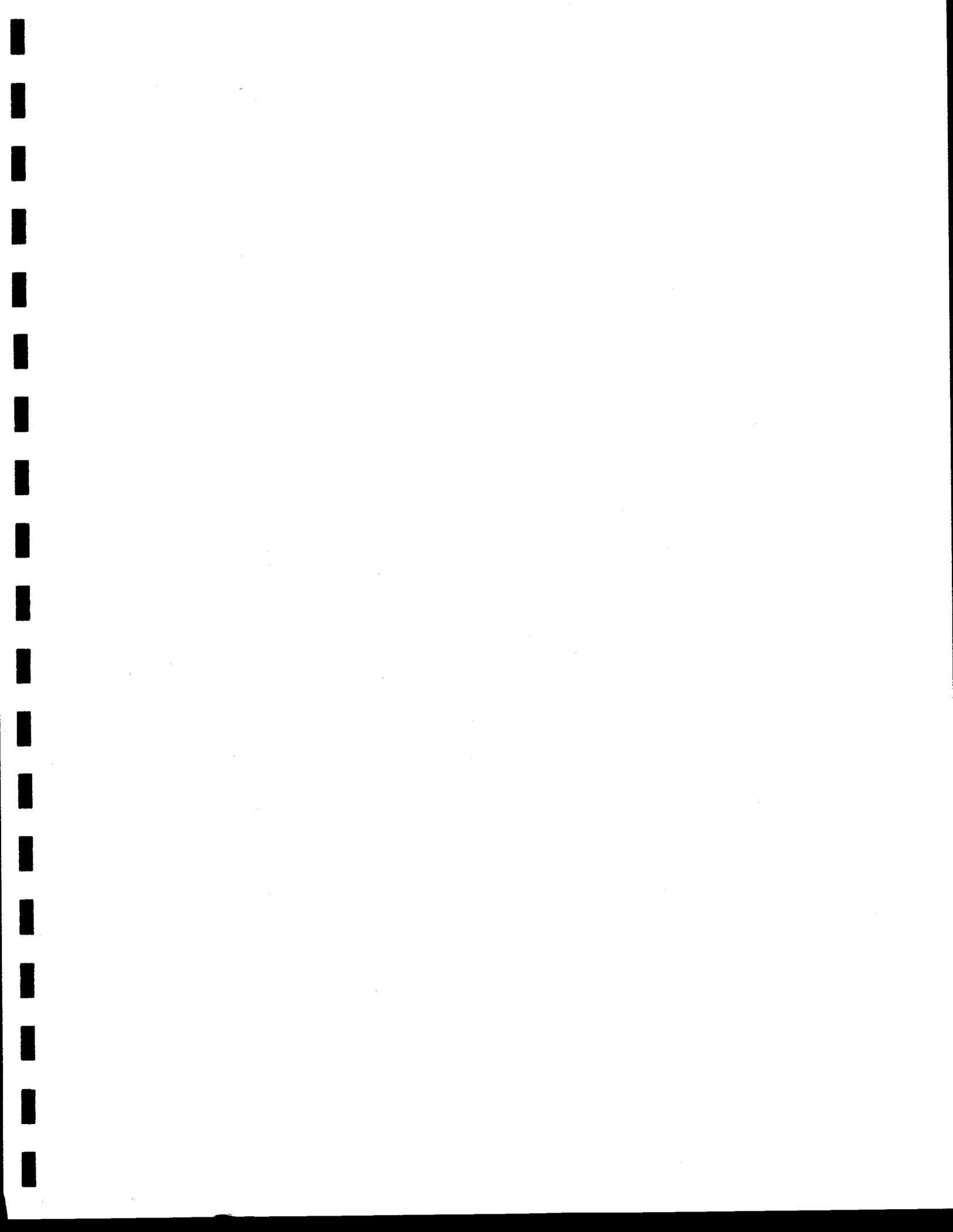
BID SCHEDULE

| PAY<br>ITEM<br>NO. | DESCRIPTION  | APPROX.<br>QUANTITY<br>& UNIT |               |        |
|--------------------|--|-------------------------------|---------------|--------|
|                    |  |                               | UNIT<br>PRICE | AMOUNT |
| 151                | OMIT   | L.F.                          |               |        |
| 152                | TUNNEL LIGHTING (S. MAINT. RD. PED. U.P.)                    | L.F.                          |               |        |
| 153                | TUNNEL LIGHTING (N. MAINT. RD. PED. U.P.)                    | L.F.                          |               |        |
|                    | SUBTOTAL: II LIGHTING (ITEMS 112-153)                        |                               |               | \$     |
|                    | <u>III. UTILITIES</u>  |                               |               |        |
|                    | <u>SANITARY SEWER</u>  |                               |               |        |
| 154                | 8" SANITARY SEWER PIPE - VCP                                 | L.F.                          |               |        |
| 155                | 12" SANITARY SEWER PIPE - VCP                                | L.F.                          |               |        |
| 156                | 15" SANITARY SEWER PIPE - VCP                                | L.F.                          |               |        |
| 156A               | 8" SANITARY SEWER PIPE - DIP                                 | L.F.                          |               |        |
| 157                | 12" SANITARY SEWER PIPE - DIP                                | L.F.                          |               |        |
| 158                | 4" VCP SERVICE CONNECTION                                    | L.F.                          |               |        |
| 159                | SANITARY SEWER MANHOLE, 4' DIAMETER - STD.<br>DET. 420 & 424 | EA.                           |               |        |
| 160                | SANITARY SEWER MANHOLE, 5' DIAMETER - STD.<br>DET. 420 & 424 | EA.                           |               |        |
|                    |  |                               |               |        |
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ENGINEERING DEPARTMENT - City of Phoenix, Arizona

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| PART<br>ITEM<br>NO. | DESCRIPTION  | APPROX.<br>QUANTITY<br>& UNIT |               |        |
|---------------------|--|-------------------------------|---------------|--------|
|                     |  |                               | UNIT<br>PRICE | AMOUNT |
| 161                 | SEWERY SEWER CLEANOUT, STD DET. 441                | EA.                           |               |        |
| 162                 | SEWERY SEWER SERVICE TAP                           | EA.                           |               |        |
| 163                 | ENCASEMENT - M.A.G. DET. 404                       | L.F.                          |               |        |
| 164                 | SEWERY SEWER ENCASEMENT - M.A.G. DET 404<br>(S.D.) | L.F.                          |               |        |
|                     | <u>WATER</u>                                       |                               |               |        |
| 165                 | 1" WATER LINE WITH FITTINGS                        | L.F.                          |               |        |
| 166                 | 1" WATER LINE WITH FITTINGS                        | L.F.                          |               |        |
| 167                 | 1" WATER LINE WITH FITTINGS                        | L.F.                          |               |        |
| 168                 | 1" WATER LINE WITH FITTINGS                        | L.F.                          |               |        |
| 169                 | 1" WATER LINE WITH FITTINGS                        | L.F.                          |               |        |
| 170                 | 1" WATER LINE WITH FITTINGS - D.I.P.               | L.F.                          |               |        |
| 171                 | 1" WATER LINE WITH FITTINGS - D.I.P.               | L.F.                          |               |        |
| 172                 | 1" WATER LINE WITH FITTINGS - C.C.P.               | L.F.                          |               |        |
| 173                 | 1" WATER LINE VALVE                                | EA.                           |               |        |



ENGINEERING DEPARTMENT - City of Phoenix, Arizona

BID SCHEDULE

| PAY<br>ITEM<br>NO. | DESCRIPTION  | APPROX.<br>QUANTITY<br>& UNIT |               |        |
|--------------------|--|-------------------------------|---------------|--------|
|                    |  |                               | UNIT<br>PRICE | AMOUNT |
| 174                | 2" WATER LINE VALVE                                  | EA.                           |               |        |
| 175                | 4" WATER LINE VALVE                                  | EA.                           |               |        |
| 176                | 6" WATER LINE VALVE                                  | EA.                           |               |        |
| 177                | 8" WATER LINE VALVE                                  | EA.                           |               |        |
| 178                | 12" WATER LINE VALVE                                 | EA.                           |               |        |
| 179                | 20" WATER LINE VALVE                                 | EA.                           |               |        |
| 180                | 6" X 6" TAPPING SLEEVE AND VALVE M.A.G.<br>DET. 340  | EA.                           |               |        |
| 181                | 8" X 12" TAPPING SLEEVE AND VALVE M.A.G.<br>DET. 340 | EA.                           |               |        |
| 182                | 6" X 12" TAPPING SLEEVE AND VALVE M.A.G.<br>DET. 340 | EA.                           |               |        |
| 183                | WATER LINE VALVE BOX & COVER - M.A.G. 391,<br>TYPE A | EA.                           |               |        |
| 184                | WATER LINE VALVE BOX & COVER - M.A.G. 391,<br>TYPE B | EA.                           |               |        |
| 185                | WATER LINE CUT & PLUG - C.O.P. DET. P-1343           | EA.                           |               |        |
| 186                | FIRE HYDRANT, COMPLETE                               | EA.                           |               |        |
| 187                | WATER METER, COMPLETE                                | EA.                           |               |        |
|                    |  |                               |               |        |
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BID SCHEDULE

| PAY<br>ITEM<br>NO. | DESCRIPTION                                    | APPROX.<br>QUANTITY<br>& UNIT |               |        |
|--------------------|--|-------------------------------|---------------|--------|
|                    |  |                               | UNIT<br>PRICE | AMOUNT |
| 188                | WATER LINE CUT & PLUG - C.O.P. DET. P-1343     | EA.                           |               |        |
| 189                | REMOVE & SALVAGE FIRE HYDRANT                  | EA.                           |               |        |
|                    | SUBTOTAL: III UTILITIES (ITEMS 154-189)        |                               |               | \$     |
|                    | IV. LANDSCAPING & IRRIGATION                   |                               |               |        |
| 190                | 15 GAL. TREE ACACIA ABYSSINICA                 | EA.                           |               |        |
| 191                | 24" BOX TREE ACACIA SMALLII                    | EA.                           |               |        |
| 192                | 24" BOX TREE CERATONIA SILIQUA                 | EA.                           |               |        |
| 193                | 24" BOX TREE CERIDIUM MICROPHYLLUM             | EA.                           |               |        |
| 194                | 15 GAL. TREE EUCALYPTUS TORQUATA               | EA.                           |               |        |
| 195                | 24" BOX TREE FRAXINUS VELUTINA<br>"RIO GRANDE" | EA.                           |               |        |
| 196                | 24" BOX TREE JACARANDA MINOSIFOLIA             | EA.                           |               |        |
| 197                | 24" BOX TREE OLEA EUROPAEA                     | EA.                           |               |        |
| 198                | 20' TRUNK PALM PHOENIX CANARIENSIS             | EA.                           |               |        |
| 199                | 20' TRUNK PALM PHOENIX DACTYLIFERA             | EA.                           |               |        |
|                    |  |                               |               |        |
|                    |  |                               |               |        |
|                    |  |                               |               |        |



ENGINEERING DEPARTMENT - City of Phoenix, Arizona

BID SCHEDULE

| PAY<br>ITEM<br>NO. | DESCRIPTION   | APPROX.<br>QUANTITY<br>& UNIT |               |        |
|--------------------|---|-------------------------------|---------------|--------|
|                    |   |                               | UNIT<br>PRICE | AMOUNT |
| 214                | 5 GALLON SHRUB CASSIA ARTEMISIODES                              | EA.                           |               |        |
| 215                | 5 GALLON SHRUB ENCELIA FARINOSA                                 | EA.                           |               |        |
| 216                | 5 GALLON SHRUB LANTANA CAMARA                                   | EA.                           |               |        |
| 217                | 1 GALLON GROUNDCOVER LANTANA MONTEVIDENSIS<br>"TRAILING YELLOW: | EA.                           |               |        |
| 218                | 1 GALLON GROUNDCOVER LANTANA MONTEVIDENSIS                      | EA.                           |               |        |
| 219                | 5 GALLON SHRUB LARREA TRIDENTATA                                | EA.                           |               |        |
| 220                | 5 GALLON SHRUB LEUCOPHYLLUM FRUTESCENS<br>"SILVER CLOUD"        | EA.                           |               |        |
| 221                | 1 GALLON GROUNDCOVER MYOPORUM PARVIFOLIUM                       | EA.                           |               |        |
| 222                | 5 GALLON SHRUB NERIUM OLEANDER<br>"ALGIERS"                     | EA.                           |               |        |
| 223                | 5 GALLON SHRUB NERIUM OLEANDER<br>"PETITE PINK"                 | EA.                           |               |        |
| 224                | 5 GALLON SHRUB NERIUM OLEANDER<br>"SISTER AGNES"                | EA.                           |               |        |
| 225                | 1 GALLON SHRUB ROSMARINUS OFFICINALIS                           | EA.                           |               |        |
| 226                | 1 GALLON SHRUB ROSA BANKSIAE                                    | EA.                           |               |        |
| 227                | 1 GALLON GROUNDCOVER SANTOLINA VIRENS                           | EA.                           |               |        |
|                    |   |                               |               |        |
|                    |   |                               |               |        |

ENGINEERING DEPARTMENT - City of Phoenix, Arizona

BID SCHEDULE

| PAY<br>ITEM<br>NO. | DESCRIPTION                                 | APPROX.<br>QUANTITY<br>& UNIT |               |        |
|--------------------|---|-------------------------------|---------------|--------|
|                    |   |                               | UNIT<br>PRICE | AMOUNT |
| 228                | 5 GALLON SHRUB TECOMARIA CAPENSIS           | EA.                           |               |        |
| 229                | 5 GALLON SHRUB XYLOSMA CONGESTUM            | EA.                           |               |        |
| 230                | CACTUS CARNEGIEA GIGANTEA                   | EA.                           |               |        |
| 231                | 1 GALLON YUCCA HESPERALOE PARVIFLORA        | EA.                           |               |        |
| 232                | 5 GALLON CACTUS OPUNTIA FICUS-INDICA        | EA.                           |               |        |
| 233                | PLANT GUARANTEE AND MAINTENANCE (1 YEAR)    | 1<br>L.S.                     |               |        |
| 234                | RAINBIRD #5055 IMPACT ROTOR POP-UP          | EA.                           |               |        |
| 235                | RAINBIRD #4045 IMPACT ROTOR POP-UP          | EA.                           |               |        |
| 236                | RAINBIRD #1804 POP-UP LAWN SPRAY            | EA.                           |               |        |
| 237                | RAINBIRD 1400 SERIES PRESET BUBBLER         | EA.                           |               |        |
| 238                | RAINBIRD EMT-M SERIES SINGLE OUTLET EMITTER | EA.                           |               |        |
| 239                | RAINBIRD RCM-8 AUTO CONTROLLER              | EA.                           |               |        |
| 240                | RAINBIRD RCM-12 AUTO CONTROLLER             | EA.                           |               |        |
| 241                | RAINBIRD RPA-2" BACKFLOW PREVENTION UNIT    | EA.                           |               |        |
|                    |   |                               |               |        |
|                    |   |                               |               |        |
|                    |   |                               |               |        |
|                    |   |                               |               |        |

ENGINEERING DEPARTMENT - City of Phoenix, Arizona

BID SCHEDULE

| PAY<br>ITEM<br>NO. | DESCRIPTION  | APPROX.<br>QUANTITY<br>& UNIT |               |        |
|--------------------|--|-------------------------------|---------------|--------|
|                    |  |                               | UNIT<br>PRICE | AMOUNT |
| 242                | RAINBIRD RPA 1-1/2" BACKFLOW PREVENTION UNIT       | EA.                           |               |        |
| 243                | RAINBIRD HLB-20 PRESSURE REGULATOR ASSEMBLY        | EA.                           |               |        |
| 244                | RAINBIRD HMB-20 PRESSURE REGULATOR ASSEMBLY        | EA.                           |               |        |
| 245                | RAINBIRD G100-1" ELEC. REMOTE CONTROL VALVE        | EA.                           |               |        |
| 246                | RAINBIRD G150 1-1/2" ELECTRIC REMOTE CONTROL VALVE | EA.                           |               |        |
| 247                | RAINBIRD G200-2" ELEC. REMOTE CONTROL VALVE        | EA.                           |               |        |
| 248                | END FLUSH CAPS                                     | EA.                           |               |        |
| 249                | 6" SCHEDULE 40 BLACK STEEL SLEEVE                  | L.F.                          |               |        |
| 250                | 4" SCHEDULE 40 BLACK STEEL SLEEVE                  | L.F.                          |               |        |
| 251                | 3" SCHEDULE 40 BLACK STEEL SLEEVE                  | L.F.                          |               |        |
| 252                | 2" SCHEDULE 40 BLACK STEEL SLEEVE                  | L.F.                          |               |        |
| 253                | 4" PVC SCHEDULE 80 PIPE (MAIN LINE)                | L.F.                          |               |        |
| 254                | 2-1/2" PVC SCHEDULE 80 PIPE (MAIN LINE)            | L.F.                          |               |        |
| 255                | 4" PVC CLASS 200 PIPE (MAIN LINE)                  | L.F.                          |               |        |
|                    |  |                               |               |        |
|                    |  |                               |               |        |
|                    |  |                               |               |        |

ENGINEERING DEPARTMENT - City of Phoenix, Arizona

BID SCHEDULE

| PAY<br>ITEM<br>NO.                                   | DESCRIPTION                                   | APPROX.<br>QUANTITY<br>& UNIT |               |        |
|--|---|-------------------------------|---------------|--------|
|  |   |                               | UNIT<br>PRICE | AMOUNT |
| 256  | 3" PVC CLASS 200 PIPE (MAIN LINE AND LATERAL) | L.F.                          |               |        |
| 257  | 2" PVC CLASS 200 PIPE (MAIN LINE AND LATERAL) | L.F.                          |               |        |
| 258  | 1-1/2" PVC CLASS 200 PIPE (LATERALS)          | L.F.                          |               |        |
| 259  | 1-1/4" PVC CLASS 200 PIPE (LATERALS)          | L.F.                          |               |        |
| 260  | 1" PVC CLASS 200 PIPE (LATERALS)              | L.F.                          |               |        |
| 261  | 3/4" PVC CLASS 200 PIPE (LATERALS)            | L.F.                          |               |        |
| 262  | 1-1/4" PVC CLASS 315 PIPE (MAIN LINE)         | L.F.                          |               |        |
| 263  | 1/2" PVC CLASS 315 PIPE (LATERALS)            | L.F.                          |               |        |
| SUBTOTAL: IV. LANDSCAPING IRRIGATION (ITEMS 190-263) |   |                               |               |        |
| V. <u>BETHANY HOME ROAD BRIDGE</u>                   |   |                               |               |        |
| 264  | CLASS "AA" CONCRETE, f'c = 5500 psi           | 2,613<br>C.Y.                 |               |        |
| 265  | CLASS "A" CONCRETE, f'c = 3500 psi            | 1,634<br>C.Y.                 |               |        |
| 266  | CLASS "A" CONCRETE, f'c = 3000 psi            | 861<br>C.Y.                   |               |        |
| 267  | REINFORCING STEEL                             | 781,440<br>LBS.               |               |        |
|  |   |                               |               |        |
|  |   |                               |               |        |
|  |   |                               |               |        |
|  |   |                               |               |        |

ENGINEERING DEPARTMENT - City of Phoenix, Arizona

BID SCHEDULE

| PAY<br>ITEM<br>NO. | DESCRIPTION   | APPROX.<br>QUANTITY<br>& UNIT |               |        |
|--------------------|---|-------------------------------|---------------|--------|
|                    |   |                               | UNIT<br>PRICE | AMOUNT |
| 268                | POST-TENSIONING   | 1<br>L.S.                     |               |        |
|                    | SUBTOTAL: V. BETHANY HOME ROAD BRIDGE<br>(ITEMS 264-268)      |                               |               | \$     |
|                    | <u>VI. MAINTENANCE EQUIPMENT UNDERPASS</u>                    |                               |               |        |
| 269                | CLASS "A" CONCRETE, f'c = 3000 psi                            | 576<br>C.Y.                   |               |        |
| 270                | REINFORCING STEEL   | 103,730<br>LBS.               |               |        |
|                    | SUBTOTAL: VI. MAINTENANCE EQUIP. UNDERPASS<br>(ITEMS 269-270) |                               |               | \$     |
|                    | <u>VII. ARIZONA CANAL BRIDGE</u>                              |                               |               |        |
| 271                | CLASS "AA" CONCRETE, f'c = 4500 psi                           | 5,310<br>C.Y.                 |               |        |
| 272                | CLASS "A" CONCRETE, f'c = 3500 psi                            | 1,271<br>C.Y.                 |               |        |
| 273                | CLASS "A" CONCRETE, f'c = 3000 psi                            | 2,713<br>C.Y.                 |               |        |
| 274                | REINFORCING STEEL   | 1,949,545<br>LBS.             |               |        |
| 275                | 36" DIAMETER CAISSON  | 5,324<br>L.F.                 |               |        |
| 276                | 60" DIAMETER CAISSON  | 1,784<br>L.F.                 |               |        |
| 277                | POST-TENSIONING   | 1<br>L.S.                     |               |        |
|                    | SUBTOTAL: VII. ARIZONA CANAL BRIDGE (ITEMS 271-277)           |                               |               | \$     |
|                    |   |                               |               |        |
|                    |   |                               |               |        |



ENGINEERING DEPARTMENT - City of Phoenix, Arizona

BID SCHEDULE

| PAY<br>ITEM<br>NO. | DESCRIPTION   | APPROX.<br>QUANTITY<br>& UNIT |               |        |
|--------------------|---|-------------------------------|---------------|--------|
|                    |   |                               | UNIT<br>PRICE | AMOUNT |
|                    | <u>X. STORM SEWER</u>                                     |                               |               |        |
| 286                | 15" STORM SEWER PIPE                                      | L.F.                          |               |        |
| 287                | 18" STORM SEWER PIPE                                      | L.F.                          |               |        |
| 288                | 21" STORM SEWER PIPE                                      | L.F.                          |               |        |
| 289                | 15" CONNECTOR PIPE  | L.F.                          |               |        |
| 290                | PREFABRICATED TEE 18" X 18" X 15"                         | EA.                           |               |        |
| 291                | PREFABRICATED TEE 21" X 21" X 15"                         | EA.                           |               |        |
| 292                | STORM SEWER MANHOLE, STD. DETAIL<br>520 AND 522           | EA.                           |               |        |
| 293                | CONCRETE CATCH BASIN, TYPE M-1,<br>L=6', STD. DET. P-1569 | EA.                           |               |        |
| 294                | CONCRETE CATCH BASIN, TYPE M-2<br>L=17', STD. DET. P-1569 | EA.                           |               |        |
| 295                | CONCRETE CATCH BASIN, TYPE "N",<br>SINGLE, DETAIL P-1570  | EA.                           |               |        |
| 296                | CONCRETE CATCH BASIN, TYPE "N",<br>DOUBLE, DETAIL P-1570  | EA.                           |               |        |
| 297                | CONCRETE CATCH BASIN, TYPE "N"<br>TRIPLE, DETAIL P-1570   | EA.                           |               |        |
| 298                | PERMANENT PIPE SUPPORT, STD. DETAILS<br>403-1&2           | EA.                           |               |        |
| 299                | STORM SEWER PIPE COLLAR, 15" STD.<br>DETAIL 505           | EA.                           |               |        |
|                    | SUBTOTAL: X. STORM SEWER (ITEMS 286 - 299)                |                               |               | \$     |
|                    |   |                               |               |        |
|                    |   |                               |               |        |

SUMMARY

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|       |                                 |    |
|-------|---------------------------------|----|
| I.    | ROADWAY                         | \$ |
| II.   | LIGHTING                        | \$ |
| III.  | UTILITIES                       | \$ |
| IV.   | LANDSCAPING AND IRRIGATION      | \$ |
| V.    | BETHANY HOME ROAD BRIDGE        | \$ |
| VI.   | MAINTENANCE EQUIPMENT UNDERPASS | \$ |
| VII.  | ARIZONA CANAL BRIDGE            | \$ |
| VIII. | GLENDALE AVENUE BRIDGE          | \$ |
| IX.   | PEDESTRIAN UNDERPASS            | \$ |
| X.    | STORM SEWER ST - 850891         | \$ |

TOTAL AMOUNT OF BID ITEMS 1 THRU 299 INCLUSIVE \$

ADDITION (+) OR DEDUCTION (-) \$

Provision is made for the bidder to include an addition or deduction in his bid, if he wishes, to reflect any last minute adjustment in prices. The addition or deduction if made, will be proportionately applied to the prices bid for Items ?????????????????????? and payment made therefore.

TOTAL AMOUNT OF BID, ITEMS 1 THRU ???, INCLUSIVE FOR ?????? AND ?????? \$

---

WRITTEN WORDS & \_\_\_\_\_/100 DOLLARS

THIS PROPOSAL IS SUBMITTED BY \_\_\_\_\_

a corporation organized under the laws of the State of \_\_\_\_\_, a partnership consisting of \_\_\_\_\_

or Individual trading as \_\_\_\_\_

of the City of \_\_\_\_\_

Respectfully submitted,

FIRM \_\_\_\_\_

ADDRESS \_\_\_\_\_

BY \_\_\_\_\_

Officer and Title

\_\_\_\_\_  
Date

\_\_\_\_\_  
Phone Number

ATTEST:

\_\_\_\_\_  
Officer and Title

\_\_\_\_\_  
Witness: If Bidder is an  
Individual

Index No. \_\_\_\_\_

SURETY BOND

That we, \_\_\_\_\_, as Principal, (hereinafter called the Principal), and the \_\_\_\_\_ a corporation duly organized under the laws of the State of \_\_\_\_\_, as Surety, (hereinafter called the Surety), are held and firmly bound unto the City of Phoenix as Oblige, in the sum of five percent (5%) of the total amount of the bid of Principal, submitted by him to the City of Phoenix for the work described below, for the payment of which sum, well and truly to be made, the said Principal and the said Surety, bind ourselves, our heirs, executors, administrators, successors and assigns, jointly and severally, firmly by these presents, and in conformance with A.R.S. #34-201. WHEREAS, the said Principal is herewith submitting its proposal for \_\_\_\_\_

NOW, THEREFORE, if the City of Phoenix shall accept the proposal of the Principal and the Principal shall enter into a contract with the City of Phoenix in accordance with the terms of such proposal and give such Bonds and Certificates of Insurance as specified in the Standard Specifications with good and sufficient Surety for the faithful performance of such contract and for the prompt payment of labor and material furnished in the prosecution thereof, or in the event of the failure of the Principal to enter into such contract and give such Bonds and Certificates of Insurance, if the Principal shall pay to the City of Phoenix the sum of money set forth above as liquidated damages for failure of the Principal to enter into the contract, then this obligation shall be null and void, otherwise to remain in full force and effect.

Signed and sealed this \_\_\_\_\_ day of \_\_\_\_\_ A.D., 19 \_\_\_\_\_

\_\_\_\_\_  
Principal

\_\_\_\_\_  
Title

WITNESS:

\_\_\_\_\_

\_\_\_\_\_  
Surety

\_\_\_\_\_  
Title

WITNESS:

\_\_\_\_\_