GOVERNMENT OF THE KHYBER PAKHTUNKHWA
IRRIGATION DEPARTMENT

REMODELING OF WARSAK CANAL SYSTEM
IN PESHAWAR AND NOWSHERA DISTRICTS

CONTRACT PACKAGE RWCS-01

CONSTRUCTION OF AUXILIARY IRRIGATION TUNNEL AND ALLIED WORKS

TENDER DOCUMENTS

VOLUME - I

- INSTRUCTIONS TO TENDERERS
- TENDER AND APPENDICES
- CONDITIONS OF THE CONTRACT
- SPECIFICATIONS

DECEMBER - 2021

PROJECT DIRECTOR
REMODELING OF WARSAK CANAL SYSTEM
IN PESHAWAR AND NOWSHERA DISTRICTS,
IRRIGATION DEPARTMENT GOVT OF KHYBER PAKHTUNKHWA,
CIVIL COLONY WARSAK ROAD, KABABIYAN, PESHAWAR

NATIONAL ENGINEERING SERVICES PAKISTAN (PVT) LIMITED
1-C, BLOCK-N, MODEL TOWN EXTENSION, LAHORE - PAKISTAN

ELECTRA CONSULTANTS
71, SECTOR N-3, STREET 04, PHASE IV, HAYATABAD, PESHAWAR, PAKISTAN

INTEGRATED CONSULTING SERVICES PVT. LTD.
766, BLOCK: G4, JOHAR TOWN, LAHORE, PAKISTAN

REMODELING OF WARSAK CANAL SYSTEM IN PESHAWAR AND NOWSHERA DISTRICTS

PACKAGE RWCS-01 CONSTRUCTION OF AUXILIARY IRRIGATION TUNNEL AND ALLIED WORKS

TENDER DOCUMENTS

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GOVT OF KHYBER PAKHTUNKHWA IRRIGATION DEPARTMEN
PROJECT DIRECTOR *Remodeling of Warsak Canal System In Peshawar-Nowshera Districts*

NOTICE FOR SINGLE STAGE TWO ENVELOPE ELECTRONIC BIDDING FOR

"Remodeling Of Warsak Canal System in Peshawar and Nowshera Districts Package RWCS-01 Construction of Auxiliary Irrigation Tunnel and Allied Works"

I. Project Director "Remodeling of Warsak Canal System, Civil Colony, Warsak Road Kababian, Peshawar" intends to invite electronics Bids in accordance with KPPRA Procurement Rules 2014 on the basis of "Single Stage Two Envelops Procedure for the following work. The Contractors / Firms having Enlistment / Registration under relevant PK and PEC category are eligible for taking participation.

S #	Name of Work	Earnest Money (Rs. In Million)	Category / Codes	Pre-Bid Meeting at RWCS Project Directorate	Last date & Time of submission of Bids	Date of opening of Technical Bid & Time	Date of Opening of Financial Bid & Time	Period of Completion
1.	**2.**	**3.**	**4.**	**5.**	**6.**	**7.**	**8.**	**9.**
1.	**Balance Work of Remodeling of Warsak Canal System in Peshawar and Nowshera Districts. Package RWCS-01** Construction of Auxiliary Irrigation Tunnel and Allied Structures	2% of Estimated Cost	**C-A** CE-04, CE-06 CE-10, ME-06 **PK-C-A**	10/12/2021 at 11:00 Hrs	20/12/2021 at12:00 Hrs	20/12/2021 at12:30 Hrs	27/12/2021 at 12:00 Hrs	As per Work Order

i. Bid Documents, Terms and Conditions and Instructions to Bidder can be downloaded from the Irrigation Department & KPPRA website address (www.irrigation.gkp.pk & www.kppra.gov.pk).

ii. As per Clause 37(A) of KPPRA Rules, 2014, all bidders must be registered with Khyber Pakhtunkhwa Revenue Authority.

iii. Pre-Bid meeting will be held on 10/12/2021 at 11:00 AM in Office of the undersigned.

iv. Venue of Bids opening is Office of the Project Director Remodeling of Warsak Canal System In Peshawar and Nowshera Districts, Peshawar.

PROJECT DIRECTOR
Remodeling of Warsak Canal System,
Peshawar
Address: Civil Colony, Kababyan, Warsak Road Peshawar
Phone No: 091-9222774
Email: krc_rwcs@yahoo.com

INSTRUCTION FOR CONTRACTORS:

The Contractors/Firms are required to provide Technical Proposal as explained in the Bid Soliciting Documents and reach to the office of the undersigned on or before dated **20/12/2021 at 1200 Hours**. The Technical Bid shall be submitted through courier in sealed envelope clearly marked **Technical Bid** before closing time.

1. Technical Proposal should accompany the following;
    a. Contains an affidavit which ensures that 2% Call Deposit of the estimated cost is attached with the financial proposal.
    b. Enlistment order of Khyber Pakhtunkhwa Works Department (Photocopy).
    c. Renewal of registration for CFY 2021-22 (Photocopy).
    d. Computerized National Identity Card (CNIC Photocopy).
    e. Valid Pakistan Engineering Council Registration copy for calendar year.
    f. Valid registration copy with KPRA & income tax Department.
    g. Form H of the company / Firm.
    h. Documents showing general capabilities, financial soundness, Auditor's Report, relevant performance record, personal capabilities, equipment capabilities & Litigation Status etc.
    i. Any other documents to support the technical proposal.

2. Financial Bids shall also be submitted electronically through E-Bidding, not later than **date 20/12/2021 at 1200 Hours** to be opened later **on 27/12/2021 at 1200 Hours,** after technical evaluation. Bid Security @ 2% (In shape of Call Deposit) in original of the Engineer Estimate. Moreover, each bidder must submit along with their bids an Additional Security to the extent of their bid/rates more than 15% below on Engineer Estimate in the form of percentage in advance along with 2% earnest money. This must be enclosed as a separate envelope which clearly marked as financial proposal. Financial Bid shall be filled online and will be opened by the Project Directorate RWCS on the fix date / time. The CDR and additional security (if required) shall be enclosed.
3. The successful bidder(s) who has quoted a rate more than 15% below on Engineer Estimate and repudiated the Contract, then their entire Security Deposit including earnest money (2%) as well as additional Security (so deposited) must be forfeited in favor of government and bidder will be left with no excuse to claim the same in any court of law.
4. The additional security shall be released to the Contractor in four installments that is 25% to be released upon completion of 25% of the Project, 50% to be released upon the completion of 50% of the Project, 75% to be released upon completion of 75% of the Project and the remaining amount to be released after completion of the Project.
5. All the bidding will be through E-bidding System. The bidders are required to quote their rates above and below on BOQ/MRS System on both MRS and non MRS items.
6. Any bidder who provides incorrect information shall stand disqualified and would be - barred.
7. Time allowed for the completion of the work as specified in the Tender Documents shall start from the issuance of LOA. Electronic Bids validity period is 120 days.
8. Successful bidder should sign the agreement with the RWCS Project Directorate within 28 days after issuance of LOA.
9. Call deposit of the scheduled Banks shall be acceptable.
10. If the evaluated electronic bid costs of two or more than two bidder are equal then the successful bid will be declared through draw.
11. Technical Bids will be opened accordingly as per specified time / date stated in bid soliciting documents.
12. The Employer has the authority to reject any bid or all the bids assigning cogent reasons.
13. Bid security of the 1st, 2nd and 3rd lowest electronic bidder for the specified work will be retained by the RWCS Project Directorate till the approval of bids.

INSTRUCTIONS TO TENDERERS

INSTRUCTIONS TO TENDERERS

(Note: These Instructions to Tenderers alongwith Tendering Data will not form part of the Contract and will cease to have effect once the contract is signed).

A. GENERAL

IT.1 Scope of Tender

1.1 The Employer as defined in the Tendering Data hereinafter called "the Employer" wishes to receive tenders for the construction and completion of works as described in these Tender Documents, and summarized in the Tendering Data hereinafter referred to as the "Works".

1.2 The successful tenderer will be expected to complete the Works within the time specified in Appendix-A to Tender.

1.3 Throughout these bidding documents, the terms 'bid' and 'tender' and their derivatives (bidder / tenderer, bid / tender, bidding / tendering etc.) are synonymous.

IT.2 Source of Funds

2.1 The Employer has applied for/received a loan/credit from the source (s) indicated in the Tendering Data in various currencies towards the cost of the project specified in the Tendering Data and it is intended that part of the proceeds of this loan/credit will be applied to eligible payments under the Contract for which these Tender Documents are issued.

IT.3 Eligible Tenderers

3.1 This Invitation to Eligible Firms / Bidders is open to all pre-qualified intended bidder meeting the following requirements:

a. Duly licensed by the Pakistan Engineering Council (PEC) in Category relevant to the value of the Works.
b. Duly prequalified by the Employer for this specific assignment/tender.
c. Enlisted with Khyber Pakhtunkhwa Works Department.
d. Registered with Khyber Pakhtunkhwa Revenue Authority.
e. Is neither associated, nor has been associated, directly or indirectly, with the Consultants or any other entity that has prepared the design, specifications and other documents for the Project or being proposed for any position in the Project Management.

IT.4 One Tender per Tenderer

1.1 Each tenderer shall submit (through courier services) only one tender (through Courier Services) either by himself, or as a partner in a joint venture. A tenderer who submits or participates in more than one tender (other than alternatives pursuant to Clause IT.16) will be disqualified.

IT.5 Cost of Tendering

5.1 The tenderer shall bear all costs associated with the preparation and submission of their respective tenders and the Employer will in no case be responsible or liable for those costs, regardless of the conduct or outcome of the tendering process.

IT.6 Site Visit

6.1 The tenderers are advised to visit and examine the Site of Works and its surroundings and obtain for themselves on their own responsibility all information that may be necessary for preparing the tender and entering into a contract for construction of the Works. All cost in this respect shall be at the tenderer's own Expense.

6.2 The Tenderers and any of their personnel or agents will be granted permission by the Employer to enter upon his premises and lands for the purpose of such inspection, but only upon the express condition that the tenderers, their personnel and agents, will release and indemnify the Employer, his personnel and agents from and against all liability in respect thereof and will be responsible for death or personal injury, loss of or damage to property and any other loss, damage, costs and expenses incurred as a result of such inspection.

B. TENDER DOCUMENTS

IT.7 Contents of Tender Documents

7.1 The Tender Documents are those stated below, and should be read in conjunction with any Addenda issued in accordance with Clause IT.9.

1. Instructions to Tenderers.
2. Tendering Data.
3. General Conditions of Contract Part-I (GCC).
4. Particular Conditions of Contract, Part-II (PCC)
5. Specifications - Special Provisions
6. Specifications - Technical Provisions.
7. Forms of Tender and Appendices to Tender.
8. Scope of Work (Appendix-D to Tender).
9. Form of Tender Security.
10. Form of Contract Agreement.
11. Forms of Performance Security and Mobilization Advance Guarantee/ Bond.
12. Drawings.

TORs / Guidelines and Terms & Conditions, Instruction and Technical Evaluation Criteria for the **Bid Soliciting Documents** can be downloaded in PDF format, from the official website of Irrigation Department (www.irrigation.gkp.pk)

7.2 The tenderers are expected to examine carefully the contents of all the above documents. Failure to comply with the requirements of tender submission will be at the tenderer's own risk. Pursuant to Clause IT.26, tenders which are not substantially responsive to the requirements of the Tender Documents will be rejected.

IT.8 Clarification of Tender Documents

8.1 Any prospective tenderer requiring any clarification (s) in respect of the Tender Documents may notify the Employer in writing at the Employer's address indicated in

the Invitation to Tenderers. The Employer will respond to any request for clarification which he receives earlier than 21 days prior to the deadline for submission of tenders.

Copies of the Employer's response will be forwarded to all purchasers of the Tender Documents, including a description of the enquiry but without identifying its source.

IT.9 Amendment of Tender Documents

9.1 At any time prior to the deadline for submission of tenders, the Employer may, for any reason, whether at his own initiative or in response to a clarification requested by a prospective tenderer, modify the Tender Documents by issuing addendum.

9.2 Any addendum thus issued shall be part of the Tender Documents pursuant to Sub-Para 7.1 hereof and shall be communicated in writing to all bidders. Prospective tenderers shall acknowledge receipt of each addendum in writing to the Employer.

9.3 To afford prospective tenderers reasonable time in which to take an addendum into account in preparing their tenders, the Employer may extend the deadline for submission of tenders in accordance with Clause IT.20.

C. PREPARATION OF TENDERS

IT.10 Language of Tender

10.1 The tender and all correspondence and documents related to the tender exchanged by a tenderer and the Employer shall be in the bid language stipulated in the Tendering Data and conditions of Particular Application. Supporting documents and printed literature furnished by the tenderers may be in any other language provided the same are accompanied by an accurate translation of the relevant parts in the English language, in which case, for purposes of interpretation of the tender, the English translation shall prevail.

IT.11 Documents Accompanying the Tender

11.1 Bill of Quantities already uploaded on Irrigation Department Officials website (www.irrigation.gkp.pk) and shall be electronically submitted by the respective bidders after quoting his rates within the specified time as reflected in the Notice of Inviting Tender (NIT).

(a) The envelope marked as technical proposal shall contain:
   i. The experience and past performance in the execution of similar & In hand contract;
   ii. The capabilities with respect to personnel and construction equipment's
   iii. The financial status and capacity
   iv. Any other information asked for in the notice inviting tenders / Bid security documents already uploaded on the official website of Irrigation Department.

(b) The second envelope marked as financial proposal shall contain Financial Bid Security in original @ 2% in the shape of Call Deposit and the Additional Bid Security in original if the contractor quoting their bids more than 15% below on Engineer Estimate to the extent of their bid/rates more than 15% below on Engineer Estimate in the form of percentage (in shape of Call Deposit). Bids for which the specified bid security and the additional bid security as the case may be, is not received shall be considered as non-responsive and their financial bid

shall not be considered.

(c) Technical bids shall taken into account the various Appendices to Bid specially the following:

Appendix-E to Tender	Proposed Construction Schedule
Appendix-F to Tender	Method of Performing the Work
Appendix-G to Tender	List of Major Equipment
Appendix-K to Tender	Organization Chart for Supervisory Staff

And other pertinent information such as mobilization programme etc;

11.2 Tenders submitted by a joint venture of two or more firms shall comply with the following requirements;

(a) the tender and in case of a successful tender, the Form of Contract Agreement shall be signed so as to be legally binding on all partners;

(b) one of the joint venture partners shall be nominated as being in charge; and this authorization shall be evidenced by submitting a power of attorney signed by legally authorized signatories of all the joint venture partners;

(c) the partner-in-charge shall always be duly authorized to deal with the Employer regarding all matters related with and/or incidental to the execution of works as per the terms and Conditions of Contract and in this regard to incur any and all liabilities, receive instructions, give binding undertakings and receive payments on behalf of the joint venture.

(d) all partners of the joint venture shall at all times and under all circumstances be liable jointly and severally for the execution of the Contract in accordance with the Contract terms and a statement to this effect shall be included in the authorization mentioned under (b) above as well as in the Form of Tender and in the Form of Contract Agreement (in case of a successful tender); and

(e) a copy of the agreement entered into by the joint venture partners shall be submitted with the tender stating the conditions under which it will function, its period of duration, the persons authorized to represent and obligate it and which persons will be directly responsible for due performance of the Contract and can give valid receipts on behalf of the joint venture, the proportionate participation of the several firms forming the joint venture, and any other information necessary to permit a full appraisal of its functioning. No amendments / modifications whatsoever in the joint venture agreement shall be agreed to between the joint ventures partner without prior written consent of the Employer.

11.3 Tenderers shall also submit proposals of work methods and schedule, in sufficient detail to demonstrate the adequacy of the Tenderers', proposals to meet the technical specifications and the completion time referred to in Sub-Clause 1.2 of IT.1 hereof.

IT.12 Tender Prices

12.1 Unless stated otherwise in the Tender Documents, the Contract shall be for the whole of the Works as described in Sub-Clause 1.1 of IT.1 hereof, based on **percentage above / below** on the tender form as well as BOQ. Any kind of ambiguity, cutting / overwriting in the tender form / BOQ(s) will be liable to rejection.

12.2 The Tenderers are required to quote their premium “percentage above / below” on the Engineer Estimate both in “figures and words” on tender form and BOQ.

12.3 All duties, taxes and other levies payable by the Contractor under the Contract, or for any other cause, as on the date 28 days prior to the deadline for submission of tenders shall be included in the rates, prices and total Tender Price.

Additional / reduced duties, taxes and levies due to subsequent additions or changes in legislation shall be reimbursed / deducted as per Sub-Clause 70.2 of the Conditions of Contract - Part-I, General Conditions.

12.4 Price adjustment during the performance of the Contract is in accordance with the provisions of Clause 70 of the Conditions of Contract. The tenderers shall furnish the prescribed information for the price adjustment formulae in Appendix-C to Tender.

IT.13 Currencies of Tender and Payment

13.1 A tenderer expecting to incur expenditures in other currencies for inputs to the Works supplied from outside the Employer’s country (referred to as the “Foreign Currency Requirements”) shall indicate the same in Appendix-B to Tender. The proportion of the Tender Price (excluding Provisional Sums) needed by him for the payment of such Foreign Currency Requirements either (i) entirely in the currency of the tenderer’s home country or, (ii) at the tenderer’s option, entirely in Pak rupees provided always that a tenderer expecting to incur expenditures in a currency or currencies other than those stated in (i) and (ii) above for a portion of the foreign currency requirements, and wishing to be paid accordingly, shall indicate the respective portions in his tender.

13.2 The rates of exchange to be used by the tenderer for currency conversion shall be the TT&OD Selling Rates published or authorized by the State Bank of Pakistan prevailing on the date 28 days prior to the deadline for submission of tenders.

For the purpose of payments, the exchange rates used in tender preparation shall apply for the duration of the Contract.

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IT.14 Tender Validity

14.1 Tenders shall remain valid for the period stipulated in the Tendering Data after the Date of Tender Opening specified in sub-clause IT.23.

14.2 In exceptional circumstances, prior to expiry of the original tender validity period, the Employer may request that the tenderers extend the period of validity for a specified additional period. The request and the responses thereto shall be made in writing. A tenderer may refuse the request without forfeiting his Tender Security. A tenderer agreeing to the request will not be required or permitted to modify his tender, but will be required to extend the validity of his Tender Security for the period of the extension, and in compliance with Clause IT.15 in all respects. The bidder shall bear all costs to be incurred on such extensions.

IT.15 Tender Security

15.1 The Tender shall submit their financial bids electronically through E-bidding. However, the respective envelope of financial proposal shall contain financial bids security in original @ 2% of Engineer Estimate Cost in the shape of call deposit and additional security to the extent of their bid/rates more than 15% below on Engineer

Estimate in the form of percentage. If the quoted rates are less than 15% on Engineer Estimate.

15.2 The Tender Security shall be in the form of Call Deposit in favour of the Employer valid for a period 28 days beyond the Tender Validity date.

15.3 Any tender not accompanied by an acceptable Bid Security and additional bid security as the case may be, shall be considered as non-responsive.

15.4 The tender securities of unsuccessful tenderers will be returned as promptly as possible, but not later than 28 days after the expiration of the period of Tender Validity.

15.5 The bid security of the successful bidder be retained with the Procuring Entity till completion of the defect liability period and the amount of guarantee will be reduced by an equivalent amount.

The additional security shall be released to the Tenderer in installment, i.e. 25% to be released after 25% completion of the Project, 50% to be released after 50% completion of the Project, 75% to be released after 75% completion of the Project. In case the bidder quotes lower than 10% below the bid cost and the bid is not accompanied by the specified additional Security then the bid shall be considered as non-responsive and the 2nd lowest bidder and so on will be considered accordingly.

15.6 The Tender Security may be forfeited:

(a) if the tenderer withdraws his tender during the period of Tender Validity;

(b) if the tenderer does not accept the correction of his Tender Price pursuant to Sub-Clause 27.2 hereof; or

(c) In the case of successful tenderer, if he fails within the specified time limit to:
   (i) Furnish the required Performance Security
   (ii) Sign the Contract Agreement.

IT.16 Alternate Proposals by Tenderer

16.1 Should any tenderer consider that he can offer any advantages to the Employer by a modification to the designs, specifications or other conditions, he may, in addition to his tender to be submitted in strict compliance with the Tender Documents, submit any Alternate Proposal(s) containing (a) relevant design calculations; (b) technical specifications; (c) proposed construction methodology; and (d) any other relevant details / conditions, provided always that the total sum entered on the Form of Tender shall be that which represents complete compliance with the Tender Documents.

16.2 Alternate Proposal(s), if any, of the lowest evaluated responsive tenderer only may be considered by the Employer.

IT.17 Pre-Tender Meeting

17.1 For clarification of any issue and answering any question on matters related to the Tender, Pre-bid meeting shall be held on the date, time and venue of pre-tender meeting has already been published in the Notice of Inviting Tender (NIT).

17.2 The tenderers are requested to submit questions, if any, in writing so as to reach the Employer not later than one week before the proposed pre-tender meeting.

17.3 Minutes of the pre-tender meeting, including the text of the questions raised and the replies given, will be transmitted without delay to all the intended Tenderers. Any modification of the Tender Documents listed in Sub-Clause 7.1 hereof which may become necessary as a result of the pre-tender meeting shall be made by the Employer exclusively through the issue of an Addendum pursuant to Clause IT.9 and not through the minutes of the pre-tender meeting.

17.4 Absence at the pre-tender meeting will not be a cause for disqualification of a tenderer.

IT.18 Format and Signing of Tender

18.1 Tenderers are particularly directed that the premium quoted on the Form of Tender shall be for performing the Contract strictly in accordance with the Tender Documents.

18.2 All appendices to Tender are to be properly completed and signed.

18.3 No alteration is to be made in the Form of Tender nor in the Appendices thereto except in filling up the blanks as directed. If any such alterations be made or if these instructions be not fully complied with, the tender may be rejected.

18.4 The envelopes shall be marked as technical proposal and financial proposal in bold and eligible letters to avoid confusion. The Tender Document shall be as described in Clause IT.7 and technical proposal shall be as per Bid soliciting Documents. Which can downloaded from Irrigation Department official website. Each tenderer shall prepare the tender by filling out the forms completely and without alterations.

18.5 The Technical and Financial Proposals of the tender shall be typed or written in indelible ink and shall be signed by a person or persons duly authorized to sign on behalf of the tenderer pursuant to Sub- Clause 11.1(a) hereof. All pages of the tender shall be initialed and stamped by the person or persons signing the tender.

18.6 The tender shall contain no alterations, omissions or additions, except to comply with instructions issued by the Employer, or as are necessary to correct errors made by the tenderer, in which case such corrections shall be initialed by the person or persons signing the tender.

18.7 Tenderers shall indicate in the Form of Tender their full and proper addresses at which notices may be legally served on them and to which all correspondence in connection with their tenders and the Contract is to be sent.

18.8 Time allowed for completion of the work as specified in the NIT shall start from the issuance of Letter of Acceptance (LOA). Tenderers should retain a copy of the Tender Documents as their file copy.

D. SUBMISSION OF TENDERS

IT.19 Sealing and Marking of Tenders

19.1 Each tenderer shall submit his tender as under:

(a) Each bid shall comprise a **single package containing two separate envelopes**. Each envelope shall contain separately the technical proposal and the financial proposal.

(b) The envelopes shall be marked as technical proposal and financial proposal separately in one sealed envelope and addressed / identified as given in Sub-Clause 19.2 hereof.

(c) Financial Bids will be submitted electronically through E-bidding, not later than the time and date stipulated in the Tendering Data, and will be opened after technical evaluation at an appropriate date. The bidder must explicitly quote the bids to be valid as specified in the notice of Bid and pursuant to Clause – IT.14

19.2 The inner and outer envelopes shall;

(a) Be addressed to the Employer at the address provided in the Tendering Data;
(b) Bear the name and identification number of the contract as defined in the Tendering Data, and;
(c) Provide a warning not to open before the time and date for bid opening, as specified in the Tendering Data.

19.3 In addition to the identification required in Sub- Clause 19.2 hereof, the inner envelope shall indicate the name and address of the tenderer to enable the tender to be returned unopened in case it is declared “late” pursuant to Clause IT.21

19.4 If the outer envelope is not sealed and marked as above, the Employer will assume no responsibility for the misplacement or premature opening of the Tender.

IT.20 Deadline for Submission of Tenders.

20.1 (a) the bidder shall submit the financial bids electronically within due date and time. Tenders must be received by the Employer through courier service at the address specified no later than the time and date stipulated in the Tendering Data / NIT. Whereas the technical bids may be submitted through courier service within due date and time.

(b) Tenders with charges payable will not be accepted, nor will arrangements be undertaken to collect the tenders from any delivery point other than that specified above. Tenderers shall bear all expenses incurred in the preparation and delivery of tenders. No claims will be entertained for refund of such expenses.

(c) Upon request, acknowledgment of receipt of tenders will be provided to those making delivery.

(d) The bidder must respond to all questions and provide complete information as advised in Bid Soliciting Documents. Any lapses to provide essential information may result in non-responsiveness of the applicants bid.

20.2 The Employer may, at his discretion, extend the deadline for submission of tenders by issuing an amendment in accordance with Clause IT.9, in which case all rights and obligations of the Employer and the tenderers previously subject to the original deadline will thereafter be subject to the deadline as extended.

IT.21 Late Tenders

21.1 (a) Tender Bid received by the Employer after the deadline for submission of tenders prescribed in Clause IT.20 will be returned unopened to such tenderer.

(b) Delays in the mail, delays of person in transit, or delivery of Tender Bid to the wrong office shall not be accepted as an excuse for failure to deliver a tender at the proper place and time. It shall be the tenderer's responsibility to determine the manner in which timely delivery of his Tender Bid will be accomplished.

IT.22 Modification Substitution and Withdrawal of Tenders

22.1 Withdrawal of a tender during the interval between the deadline for submission of tenders and the expiration of the period of tender validity specified in the Form of Tender may result in forfeiture of the Tender Security in pursuance to Clause IT.15.

E. TENDER OPENING AND EVALUATION

IT.23 Tender Opening

23.1 The Employer will open the tenders through Single Stage Two Envelope E-bidding System comprising Technical and Financial Proposals separately or any detail pursuant to Clause IT.22, in the presence of authorized tenderer representatives. Who choose to attend the proceedings. The tenderer representatives who are present shall sign a register evidencing their attendance.

23.2 The Contractor / Firms who fails to provide relevant specialization codes enlisted with PEC and Irrigation in specified category and registered with Khyber Pakhtunkhwa Revenue Authority (KPRA) and valid income tax registration from income tax department, their financial proposals will be considered as non-responsive and returned to the un-opened. Tenders for which an acceptable notice of withdrawal has been submitted pursuant to Clause IT.22 shall not be opened.

23.3 After evaluation and approval of the Technical Proposals the procuring entity, shall at a time with in the bid validity period as specified in the NIT, publicly open the Financial Proposals of the technically qualified / accepted bids only. The Financial Proposals found technically non-responsive shall be returned un–opened to the respective bidders, along with others whose Technically Bids fail to qualify and the bid found to be the lowest evaluated bid shall be processed.

23.4 Name of qualified tenderer his premium, tender price, tender security and additional security if applicable and such other details as the Employer may consider appropriate, will be announced by the Employer at the opening of tenders.

23.5 Employer shall prepare minutes of meeting of the tender opening, including the information disclosed in accordance with the Sub-Clause 23.3.

IT.24 Process to be Confidential

24.1 Information relating to the examination, clarification, evaluation and comparison of tenders and recommendations for the award of a contract shall not be disclosed to tenderers or any other person not officially concerned with such process before the

announcement of tender evaluation report which shall be done at least ten (10) days prior to issue of Letter of Acceptance. The announcement to all Tenderers will include table(s) comprising read out premium **"percentage above / below**", price adjustments made, final evaluated prices and recommendations against all the tenders evaluated. Any effort by a tenderer to influence the Employer's processing of tenders or award decisions may result in the rejection of such tenderer's tender. Whereas any tenderer feeling aggrieved may lodge a written complaint not later than fifteen (15) days after the announcement of the tender evaluation report; however mere fact of lodging a complaint shall not warrant suspension of the procurement process.

IT.25 Clarification of Tenders

25.1 To assist in the examination, evaluation and comparison of tenders, the Employer may, at his discretion, ask any tenderer for clarification of his tender. The request for clarification and the response shall be in writing but no change in the premium offered or permitted except as required to confirm the correction of arithmetic errors discovered by the Employer in the evaluation of the tenders in accordance with Clause IT.28.

IT.26 Examination of Tenders and Determination of Responsiveness

26.1 Prior to the detailed evaluation of tenders, the Employer will determine whether each tender is substantially responsive to the requirements of the Tender Documents. Pursuant to Clause – IT- 21.

26.2 A substantially responsive tender is one which (i) meets the eligibility criteria; (ii) has been properly signed; (iii) is accompanied by the required Tender Security and additional Security; and (iv) confirms to all the terms, conditions and specifications of the Tender Documents and Bid Soliciting Documents, without material deviation or reservation. A material deviation or reservation is one (i) which affects in any substantial way the scope, quality or performance of the Works; (ii) which limits in any substantial way, inconsistent with the Tender Documents, the Employer's rights or the tenderer's obligations under the Contract; or (iii) adoption whereof would affect unfairly the competitive position of other tenderers presenting substantially responsive tenders.

26.3 If a tender is not substantially responsive, it will be rejected by the Employer and returned to the respective bidder as un-open.

IT.27 Correction of Errors

27.1 Tenders determined to be substantially responsive will be checked by the Employer for any arithmetic errors. Errors will be corrected by the Employer as follows:

(a) Where there is a discrepancy between the premium offered in figures and in words, the words will govern.

27.2 The amount stated in the Form of Tender will be adjusted by the Employer in accordance with the above procedure for the correction of errors and with the concurrence of the tenderer, shall be considered as binding upon the tenderer. If the tenderer does not accept the corrected Tender Price, his tender will be rejected, and the Tender Security shall be forfeited in accordance with Sub- Clause 15.6(b) hereof.

IT.28 Evaluation and Comparison of Tenders

28.1 The Employer will evaluate and compare only the tenders determined to be substantially responsive in accordance with Clause IT.26.

28.2 In evaluating the tenders, the Employer will determine for each tender the evaluated Tender Price by adjusting the Tender Price as follows:-

(a) Making any correction for errors pursuant to Clause IT.27

(b) Excluding Provisional Sums and the provision, if any, for contingencies in the Summary Bill of Quantities, but including competitively priced Daywork.

(d) Making an appropriate adjustment for any other acceptable variation or deviation.

28.3 The estimated effect of the price adjustment provisions of the Conditions of Contract, applied over the period of execution of the Contract, shall not be taken into account in tender evaluation.

28.4 If the tender of the successful tenderer is seriously unbalanced in relation to the Employer's estimate of the cost of work to be performed under the Contract, the Employer may require the tenderer to produce detailed price analyses for any or all items of the Bill of Quantities to demonstrate the internal consistency of those prices with the construction methods and schedule proposed. After evaluation of the price analyses, the Employer may require that the amount of the Performance Security set forth in Clause IT.32 be increased at the expense of the successful tenderer to a level sufficient to protect the Employer against financial loss in the event of default of the successful tenderer under the Contract.

F. AWARD OF CONTRACT

IT.29 Award

29.1 Subject to Clause IT.30 and IT.34, the Employer will award the Contract to the tenderer whose tender has been determined to be substantially responsive to the Tender Documents and who has offered the lowest evaluated Tender Price, provided that such tenderer has been determined to be eligible in accordance with the provisions of Clause IT.3 and qualify pursuant to Sub-Clause IT 29.2.

29.2 After the evaluation and approval of the technical bids of the responsive bidder. The financial bids will be opened on the appropriate date to announce the electronically (through E-bidding) submitted bids in the presence of the authorized representative's bidders (who choose to attend the proceedings).

29.3 The Employer shall evaluate the technical proposal on the basis of criteria specified in the bid soliciting document and reject any proposal which does not confirm / meet the specified requirements. During the technical evaluation, no-amendment in the technical proposal will be permitted. A list of technically qualified bidders will be finalized in this manner.

29.4 Pursuant to Clause – IT- 23, Sub-Clause 23.3 process of tender award be carried out.

IT.30 Employer's Right to accept any Tender and to reject any or all Tenders

30.1 Notwithstanding Clause IT.29, the Employer reserves the right to accept or reject any tender, and to annul the tendering process and reject all tenders, at any time prior to award of Contract, without thereby incurring any liability to the affected tenderers or

any obligation except that the grounds for rejection of all tenders shall upon request be communicated to any tenderer who submitted a bid, without justification of grounds. Rejection of all tenders shall be notified to all tenderers promptly.

IT.31 Notification of Award

31.1 Prior to expiration of the period of Tender Validity prescribed by the Employer, the Employer will notify the successful tenderer in writing ("Letter of Acceptance") that his tender has been accepted. This letter shall name the sum which the Employer will pay the Contractor in consideration of the execution and completion of the Works by the Contractor as prescribed by the Contract (hereinafter and in the Conditions of Contract called the "Contract Price").

31.2 No Negotiation with the tenderer having evaluated as lowest responsive or any other tenderer shall be permitted, however, Employer may have clarification meetings to get clarify any item in the tender evaluation report.

31.3 The notification of award and its acceptance by the tenderer will constitute the formation of the Contract, binding the Employer and the tenderer till signing of the formal Contract Agreement.

31.4 Upon furnishing by the successful tenderer of a Performance Security, the Employer will promptly notify the other tenderers that their tenders have been unsuccessful and return their tender securities.

IT.32 Performance Security

32.1 The successful tenderer shall furnish to the Employer a Performance Security in the form and the amount stipulated in the Tendering Data and the Conditions of Contract within a period of 28 days after the receipt of Letter of Acceptance.

32.2 Failure of the successful tenderer to comply with the requirements of Sub-Clause IT.32.1 or Clauses IT.33 or IT.35 shall constitute sufficient grounds for the annulment of the award and forfeiture of the Tender Security.

IT.33 Signing of Contract Agreement

33.1 Within 14 days from the date of furnishing of acceptable Performance Security under the Conditions of Contract, the Employer will send the successful tenderer the Form of Contract Agreement provided in the Tender Documents, incorporating all agreements between the parties.

33.2 The formal Agreement between the Employer and the successful tenderer shall be executed within 14 days of the receipt of Form of Contract Agreement by the successful tenderer from the Employer.

IT.34 General Performance of the Tenderers

The Employer reserves the right to obtain information regarding performance of the Bidders on their previously awarded contracts/works. The Employer may in case of consistent poor performance of the Bidder as reported by the employers of the previously awarded contracts, interalia, reject his bid and/or refer the case to the Pakistan Engineering Council (PEC). Upon such reference, PEC in accordance with its rules, procedures and relevant laws of the land take such action as may be deemed appropriate under the circumstances of the case including black listing of such tenderer and debarring him from participation in future tendering for similar works.

IT.35 Integrity Pact

The Tenderer shall sign and stamp the Integrity Pact provided at Appendix-L to Tender in the Tender Documents for all Federal Government procurement contracts exceeding Rupees ten million. Failure to provide such Integrity Pact shall make the tenderer non-responsive.

IT.36 Instructions not Part of Contract

Tenders shall be prepared and submitted in accordance with these Instructions which are provided to assist tenderers in preparing their tenders, and do not constitute part of the Tender or the Contract Documents.

TENDERING DATA

TENDERING DATA

The following specific data for the Works to be tendered shall complement, amend, or supplement the provisions in the Instructions to Tenderers. Wherever there is a conflict, the provisions herein shall prevail over those given in the Instructions to Tenderers.

Instructions to Tenderers

Clause Reference

A. General

TD.1 Scope of Tender

1.1 Name and address of the Employer

The Employer is:

Irrigation Department, Govt. of Khyber Pakhtunkhwa represented by: Project Director.

Address of the Employer is:

Remodeling of Warsak Canal System in Peshawar and Nowshera Districts,
Irrigation Department Civil Colony, Warsak Road, Kababyan, Peshawar.
Telephone No. 091-9222774
Fax No. 091-9222775

1.1 Name of the Project and Summary of the Works:
Remodeling of Warsak Canal System in Peshawar and Nowshera Districts, package 01 construction of Auxiliary irrigation tunnel and Allied works

Summary of the Works:
The Contract bearing number RWCS-1 shall comprise the construction of about 17,073 feet long, 11.50 feet diameter, drill & blast concrete lined horseshoe shaped irrigation tunnel, construction adit, concrete intake and outlet structures equipped with bulkhead gates. The tunnel will be connected at the inlet with existing reservoir of Warsak Dam. Construction of cofferdam using the sheet pile technology will be required to isolate the intake area during the construction and subsequently dismantling it after the construction.

Following are the major components of the Works:

i. Construction of temporary cofferdam in Warsak Dam Reservoir in front of proposed auxiliary tunnel intake structure.
ii. Construction of RC intake structure with mechanical gates and trash rack etc.
iii. Construction of 11.50 ft dia. 17,073 ft long horseshoe type lined irrigation tunnel
iv. Construction of gated outlet structure at the end of the auxiliary irrigation tunnel
v. Construction of RC lined rectangular channel and flow regulation structure with bridge access
vi. Construction of 1,200 ft long Adit
vii. Slope stabilization works around outlet structure area.
viii. PC Lining of Main Warsak Gravity Canal.

ix. PC Lining of Warsak Minor & Khafoor Dehri Minor.
x. Aqueduct of Warsak Minor.
xi. District Road Bridge of Warsak Minor.
xii. Bifurcator of Khafoor Dehri Minor.
xiii. Glacis Fall of Khafoor Dehri Minor.

TD.2 Source of Funds

2.1 Name of the Source of Financing/Funding Agency:

Government of Pakistan and Khyber Pakhtunkhwa have allocated funds in Pak Rupees to Irrigation Department, Govt. of Khyber Pakhtunkhwa for the Remodeling of Warsak Canal System in Peshawar and Nowshera Districts.

TD.3 Eligible Tenderers

3.1 Delete "/ enlisted" from paragraph b.

Add the following new paragraph at the end of Sub-Clause 3.1:

The foreign constructor shall be eligible to participate in the tendering, subject to the conditions that as per prevailing PEC Bye-Laws for Construction and Operation of Engineering Works.

TD.6 Site Visit

Amend the title of the clause as under:

"Examining Documents and Site Visit"

Add the following new sub-clause at the end of this Clause:

6.3 The tenderers should carefully examine the Instructions to Tenderers, Conditions of Contract, the Specifications comprising Technical Provisions and Special Provisions, the Bill of Quantities (BOQ) and the Drawings and all other documents comprising this Tender and supplied herewith. The Tenderer shall be deemed to have studied all the provisions contained in the Tender Documents during the preparation of his tender and to have carried out any such further study, at his own cost, as he may consider necessary. No claims for additional payment will be considered from the Contractor on the grounds that the information is insufficient, incorrect or misleading.

B. TENDER DOCUMENTS

TD.7 Contents of Tender Documents

7.1 Delete the text of whole Sub-Clause and substitute with the following:

The Tender Documents are those stated below, and shall be read in conjunction with any Addenda issued in accordance with Clause IT.9.

Volume - I

1. Instructions to Tenderers.
2. Tendering Data.

3. Forms of Tender and Appendices to Tender including BOQ's (to be electronically submitted).
4. General Conditions of Contract, Part-I (GCC)
5. Particular Conditions of Contract, Part-II (PCC)
7. Specifications - Special Provisions
8. Specifications - Technical Provisions.
9. Form of Tender Security.
10. Forms of Performance Security
11. Form of Contract Agreement.
12. Form of Mobilization Advance Guarantee/ Bond.

Volume – II

Drawings.

TD.8 Clarification of Tender Documents

8.1 Time limit for clarification

Amend second sentence of first paragraph as under:

No request for clarification will be entertained /received later than 14 days prior to the date fixed for submission of tenders. The Employer's response will be made not later than 7 days prior to date fixed for submission of tenders.

C. PREPARATION OF BIDS

TD.10 Language of Tender

10.1 English.

TD.11 Documents Accompanying the Tender

11.1 Delete the text of whole Sub-Clause and substitute with the following:

The Technical and Financial Bids submitted by the tenderer shall comprise the following

(a) Duly filled-in Form of Tender and following Appendices to Tender in accordance with Clause IT-18 hereof;

i-	Appendix-A to Tender	:Special Stipulations
ii-	Appendix-B to Tender	:Foreign Currency Requirements
iii-	Appendix-C to Tender	Price Adjustment (Under Clause 70)
iv-	Appendix-D to Tender	:Bill of Quantities (to be electronically submitted)
v-	Appendix-E to Tender	:Proposed Construction Schedule
vi-	Appendix-F to Tender	:Method of Performing the Work
vii-	Appendix-G to Tender	:List of Major Equipment – Related Items
viii-	Appendix-H to Tender	:Construction Camp and Housing Facilities
ix-	Appendix-I to Tender	:List of Subcontractors
x-	Appendix-J to Tender	:Estimated Progress Payments
xi-	Appendix-K to Tender	:Organization Chart of the Supervisory Staff and Labour
xii-	Appendix-L to Tender	:Integrity Pact

b) Financial proposals comprises of Tender Security, additional Bid Security in accordance with Clause IT.15 hereof;

c) Written power of attorney authorizing the signatory of the bid to act for and on behalf of the bidder;

d) Copy of Joint Venture, if applicable;

e) The Technical proposal shall comprise of all the valid documents / information as sought in Bid Soliciting Document, whereas the financial bid shall be submitted electronically and the corresponding bid security / additional security as the case may be, be enclosed in the envelop marked as Financial Bid.

f) Any other document required to be submitted in accordance with the Bid Soliciting Documents.

11.2 Add following new paragraph at the end:

"(f) Any tender submitted by a joint venture with a name or partners different than reflected in Technical Proposal for which prior approval of the Employer is not obtained shall be considered as non-responsive".

TD.13 Currencies of Tender and Payment

13.1 Delete text of whole Sub-Clause 13.1 and substitute with the following:

The bidder shall quote his rate on Percentage above / below on Engineer Estimate to be electronically submitted within due date and time as specified in NIT. All payments under the Contract shall be made in Pak Rupees only. Tenderers expecting to incur expenditures in a currency or currencies other than Pak Rupees shall manage foreign currency/currencies at his own arrangement. Any exchange risk in this regard, if any, shall be deemed to be included in premium quoted by the tenderer.

13.2 Delete whole Sub-Clause in its entirety.

TD.14 Tender Validity

14.1 Period of Tender Validity:

120 days after the date of tender opening.

TD.15 Tender Security

15.1 Amount of Tender Security

Not less than two percent (2%) of Engineer Estimate / Bill of Quantities (BOQ's) / Additional Bid Security (if required), if the bidders quotes his rates further lower than 15% below as per KPPRA notification No. S.R.O.(13)/Vol:1-21/2021-22 dated 15.09.2021.

Add the following text at the end of Sub-Clause:

The Tender Security / additional security of a joint venture must be in the name of joint venture submitting the tender.

15.2 **Form of Tender Security**

The Tender Security as an Earnest Money @2% in shape of Call Deposit and

additional security to the extent of their bid / rates more than 15%below on Engineer Estimate in the form of percentage, shall be deposited / submitted in the shape of Call Deposit or Bank Guarantee issued by schedule Bank of Pakistan preferably the Bank of Khyber, Peshawar and shall be in the name of Project Director, Remodelling of Warsak Canal System, Irrigation Department, Peshawar.

TD.16 Alternate Proposals by Tenderer

Delete whole Clause in its entirety.

TD.17 Pre-Tender Meeting

17.1 Date, Time, and Venue of Pre-Tender meeting as per advertised NIT:

Time: 11:00 hours

Venue: Office of the Project Director,

Remodeling of Warsak Canal System in Peshawar and Nowshera Districts, Irrigation Department Civil Colony, Warsak Road, Kababyan, Peshawar.

TD.18 Format and Signing of Tender

18.4 The envelopes shall be marked as technical proposal and financial proposal in bold and eligible letters to avoid confusion. The Tender Document shall be as described in Clause IT.7 and technical proposal shall be as per Bid soliciting Documents downloaded from Irrigation Department official website. Each tenderer shall prepare the tender by filling out the forms completely and without alterations.

18.5 The Technical and Financial Proposals of the tender shall be typed or written in indelible ink and shall be signed by a person or persons duly authorized to sign on behalf of the tenderer pursuant to Sub- Clause 11.1(a) hereof. All pages of the tender shall be initialed and stamped by the person or persons signing the tender.

D. SUBMISSION OF TENDERS

TD.19 Sealing and Marking of Tenders

19.2(a) Employer's address for the purpose of tender submission is:

Project Director,
Remodeling of Warsak Canal System in Peshawar and Nowshera Districts,
Irrigation Department Civil Colony, Warsak Road, Kababyan, Peshawar.
Telephone No. 091-9222774
Fax No. 091-9222775

19.2(b) Name and identification number of the Contract is:

Identification No: RWCS-01

Title: Remodeling of Warsak Gravity Canals System in Peshawar and Nowshera Districts. Contract Package RWCS-01, Construction of Auxiliary Irrigation Tunnel and Allied Works.

19.2(c) Warning:

To be opened on date and time as reflected in the NIT / approved by the Employer.

TD.20 Deadline for Submission of Tenders

20.1(a) Deadline for submission of tenders is:
12:00 hours on 20/12/2021

TD.23 Tender Opening

23.1 Date, Time, and Venue of Tender Opening: (Technical Proposals Only)

Date: 20/12//2021, Time: 12:30 hours

Venue: Office of the Project Director,

Remodeling of Warsak Canal System in Peshawar and Nowshera Districts,
Irrigation Department Civil Colony, Warsak Road, Kababyan, Peshawar.
Telephone No. 091-9222774
Fax No. 091-9222775

Financial bid shall be opened after evaluation of Technical bids and approved by the competent authority, date, time and venue for opening of financial bid shall be notified accordingly and the corresponding will be notified accordingly.

TD.28 Evaluation and Comparison of Tenders

Add following new Sub-Clauses at the end:

28.5 The Employer reserves the right to accept or reject any variation, deviation or alternative offer. Variations, deviations, alternative offers and other factors, which are in excess of the requirements of the Tender Documents or otherwise result in the accrual of unsolicited benefits to the Employer, shall not be taken into account in the Tender evaluation.

TD.32 Performance Security

32.1 Form and amount of Performance Security acceptable to the Employer:

An unconditional Guarantee in the amount equal to 10% (2% Bid Security + 8% Bank Guarantee as per Appendix – A) of the Contract Price shall be acceptable to the Employer. The format of such guarantee is provided in the Tender Documents.

TENDER AND APPENDICES

Remodeling of Warsak Canal System in Peshawar and Nowshera Districts -

Contract Package RWCS-01, Construction of Auxiliary Irrigation Tunnel and Allied works

Tender for Contract No. **RWCS-01**

TENDER

To:

Project Director,
Remodeling of Warsak Canal System in Peshawar and Nowshera Districts,
Irrigation Department Civil Colony, Warsak Road, Kababyan, Peshawar.

Gentleman,

1. Having examined the Conditions of Contract. Specifications, Drawings and Bill of Quantities and Addenda Nos. _____for the execution of the above-named Works, we, the undersigned, offer to execute and complete such Works and remedy any defects therein in conformity with the Conditions of Contract. Specifications, Drawings, Bill of Quantities and Addenda for the sum of Rupees _____ _____ (Rs. _____) or such other sum as may be ascertained in accordance with the said conditions.

2. We understand that the Appendices A to M attached hereto form part of this Tender.

3. As security for due performance of the undertakings and obligations of this Tender, we submit herewith a Tender Security in the amount of Rupees _____ _____ (Rs._____) and additional security of Rs. _____ (if applicable) drawn in your favor or made payable to you and valid for a period of 28 days beyond the Tender validity period.

4. We undertake, if our Tender is accepted, to commence the Works and to complete the whole of the Works comprised in the Contract within the time stated in Appendix-A to Tender.

5. We agree to abide by this Tender for the period of 120 days after the date fixed for receiving the same and it shall remain binding upon us and may be accepted at any time before the expiration of that period.

6. Unless and until a formal Agreement is prepared and executed, this Tender, together with your written acceptance thereof, shall constitute a binding contract between us.

7. We do hereby declare that the Tender is made without any collusion, comparison of figures or arrangement with any other tenderer for the Works.

8. We understand that you are not bound to accept the lowest or any tender you may receive.

Dated this _____day of_____20_____

Signature _____

In the capacity of _____
(In Block Capitals)

Duly authorized to sign tenders for and on behalf of

_____

Address

_____

Witness

_____

_____

Address.

_____

_____

Occupation_____

Appendix-A to Tender

SPECIAL STIPULATIONS

No.	Item	Clause of Conditions of Contract	Specified Limits
1.	Engineer's Authority to issue Variation in emergency	2.1	2% of the Contract Price stated in the Letter of Acceptance.
2.	Amount of Performance Security	10.1	08% of Contract Price stated in the Letter of Acceptance in shape of Bank Guarantee or Call Deposit. In addition to 2% Bid Security.
3.	Time for Furnishing Programme	14.1	Within 42 days from the date of receipt of Letter of Acceptance.
4.	Minimum amount of Third Party Insurance	23.2/25.3	Rs. Two Million per occurrence with number of occurrences unlimited.
5.	Time for issuance of Engineer's Notice to Commence	41.1	Within 42 days after the date of issue of Letter of Acceptance.
6.	Time for Completion	43.1	1480 days from the date of receipt of Engineer's Notice to Commence
7.	Amount of Liquidated Damages	47.1	0.1% of the Contract Price for each day of delay in completion of the Works subject to a maximum of 10% of Contract Price stated in the Letter of Acceptance.
8.	Defects Liability Period	49.1	379 days from the effective date of Taking Over Certificate
9.	Percentage of Retention Money	60.2	10% of the amount of Interim Payment Certificate.
10.	Limit of Retention Money	60.2	5% of Contract Price stated in the Letter of Acceptance
11.	Minimum amount of Interim Payment Certificates (Running bills)	60.2	Rs. 05 Million
12.	Additional Security	15.1	The Contractor quoting their bids more than 15% below on Engineer Estimate shall submit along with their bids an additiona security to the extent of their bid/rates more than 15% below on Engineer Estimate in the form of percentage.
13.	Bid Security	15.5	02% Call Deposit on Engineer Estimated Cost. The Bid Security of successful bidder shall be adjusted by the Employer in form of Performance Security.
14.	Mobilization Advance	60.12	An interest free Mobilization Advance upto 10% of the Contract Price less Provisional Sum stated in the Letter Of Acceptance (LOA) shall be paid by the Employer to the Contractor in two equal parts upon submission by the Contractor of Mobilization Advance guarantee for the full amount of the Advance in a specified form from a scheduled bank of Pakistan.

Initials of signatory of Bid: _____

Appendix-B to Tender

FOREIGN CURRENCY REQUIREMENTS

--- NOT USED ---

Initials of signatory of Bid: _____

Appendix-C to Tender

PRICE ADJUSTMENT UNDER SUB-CLAUSE 70.1 OF CONDITIONS OF CONTRACT

The Tenderer must quote in column 4 of the table, the weightages and coefficients for use in the adjustment formula under Sub-Clause 70.1. *In case of failure of the Tenderer to quote the weightages in the requisite column, the Engineer shall fix such weightages taking into account the middle value of the ranges given for respective items in column 3 of Appendix-C to Tender.*

In filling out the values in column 4, the Tenderer must ensure that the quoted value must fall within the permissible range and the sum of all selected factors ***including fixed portion*** should not exceed 1.

Cost Element	Description	Permissible Range	Factors selected by the Bidder	Applicable Index
1	2	3	4	5
(i)	Fixed Portion	**0.350**	-	-
(ii)	Local Labour (Unskilled labour shall be taken as representative of all types of labor's working at the Site)	***0.17 - 0.23***		Government of Pakistan (GoP) Federal Bureau of Statistics (FBS) - Monthly Statistical Bulletin
(iii)	Cement (Ordinary Portland Cement - OPC ***per bag*** shall be taken as representative of all types of Cement used in the Works)	***0.10 - 0.14***		----------do---------
(iv)	Reinforcing Steel Bars and Structural Steel (1/2" Ø round M.S. Bars ***per tonne*** shall be taken as representative of all types and dimensions of Steel Reinforcement and Structural Steel used in the Works)	***0.15 - 0.21***		----------do---------
(v)	High Speed Diesel (HSD) *(High Speed Diesel per liter shall be taken as representative of all types of fuel used at the Site)*	***0.10 - 0.20***		*Government of Pakistan (GoP) Federal Bureau of Statistics (FBS) - Monthly Statistical Bulletin or in case the rate is not available on the bulletin, the rate issued by Pakistan State Oil (PSO) shall prevail*
	Total		0.650	

Notes:

1) The base cost indices or prices shall be those prevailing on 28 days prior to the latest day for submission of bids for the city of ***Peshawar*** in the province of Khyber Pakhtunkhwa – Pakistan. Current indices or prices shall be those prevailing on 28

days prior to the last date of the submission of Monthly statement for the city of ***Peshawar*** in the province of Khyber Pakhtunkhwa – Pakistan.

2) Any fluctuation in the indices or prices of materials other than those given above shall not be subject to adjustment of the Contract Price.

Initials of signatory of Bid: _____

Appendix-D to Tender

BILL OF QUANTITIES

A. PREAMBLE

1. The Bill of Quantities shall be read in conjunction with the Conditions of Contract, Specifications and Drawings.

2. The quantities given in the Bill of Quantities are estimated and provisional, and are given to provide a common basis for tendering. The basis of payment will be the actual quantities of work executed and measured by the Contractor and verified by the Engineer and valued at the rates and prices tendered in the priced Bill of Quantities, where applicable. *Any unforeseen item cropped up during the execution of work shall be executed and paid on MRS - 2019 with approved premium*. However in case of non schedule item not reflected in the BOQ the respective rates shall be fixed by the Engineer for payment as per Contract.

3. The rates and prices tendered in the priced Bill of Quantities shall, except insofar as it is otherwise provided under the Contract include all costs of Contractor's plant, labour, supervision, materials, execution, insurance, profit, taxes and duties, together with all general risks, liabilities and obligations set out or implied in the Contract. Furthermore all duties, taxes and other levies payable by the Contractor under the Contract, or for any other cause, as on the date 28 days prior to deadline for submission of Tenders, shall be included in the rates and prices and the total Tender Price submitted by the Tenderer.

4. The whole cost of complying with the provisions of the Contract shall be covered in offered premium by the bidders.

5. Provisional sums included and so designated in the Bill of Quantities shall be expended in whole or in part, or not at all, at the direction and discretion of the Engineer. Payment shall be based on the actual cost of goods and materials purchased by the Contractor, the provision of labour, all other charges and profit and determined in accordance with clause 58 of part I, General Conditions.

6. Untill approval of the variation order from the Employer, the varied work shall only be executed if they are the subject of a written instruction from the Engineer and their payment should be made provisionally.

7. Any arithmetic errors in computations or summations will be corrected by the Employer as follows:-

   a) Where there is a discrepancy between the unit rates quoted in figures and in words, the premium in words will govern; and

8. The dismantled materials viz steel, bricks, head regulator gates etc will be the property of the Employer and shall be disposed off according to the provision of Contract / directions of Engineer.

9. The area factor for the District Khyber in MRS 2019 given as 1.08. As per location of the Project the same was accordingly incorporated in the BOQ for the schedule items only, while for non-schedule item factor remains 1.00.

B. WORK ITEMS

1. The Bill of Quantities contains the following Bills and Schedule:

Bill No.	Description
A.1.	Construction of Coffer Dam
A.2.	Intake Structure
A.3.	Construction of Adit
A.4.	Auxiliary Irrigation Tunnel
A.5.	Outlet Structure
A.6.	Regulator Structure
A.7.	Gate Equipment for Tunnel Intake, Outlet, Warsak & Khafoor Minor & Regulators Structure
A.8	Geo technical Investigation at Intake Structure.
B.1	Main Warsak Gravity Canal (Concrete Lining & Earthwork)
B.2	Warsak Minor (Concrete Lining, Earthwork & Structure)
B.3	Khafoor Dehri (Concrete Lining, Earthwork & Structure)
C	Day Work
D	Contingencies

Summary Bill of Quantities

2. Tenderers shall price the Bill of Quantities in Pakistani Rupees.

General

1. Reference is made to sub-clause 52.4 of the General Conditions-Part I. Work shall not be executed on a day work basis except by written order of the Engineer. Tenderers shall enter basic rates for day-work items in the Schedules, which rates shall apply to any quantity of day work ordered by the Engineer. Nominal quantities have been indicated against each item of day work, and the extended total for day work shall be carried forward to the Tender Price.

Day work Labour

2. In calculating payments due to the Contractor for the execution of day-work, the actual time of classes of labour directly doing work ordered by the Engineer and for which they are competent to perform will be measured excluding meal breaks and rest periods. The time of gangers (charge hands) actually doing work with the gang will also be measured but not the time of foreman or other supervisory personnel.

3. The Contractor shall be entitled to payment in respect of the total time that labour is employed on day work, calculated at the basic rates entered by him in the Schedule of Day-works Rates for labour together with an additional percentage, payment on basic rates representing the Contractor's profit, overheads, etc., as described below:

   a) the basic rates for labour shall cover all direct costs to the Contractor, including (but not limited to) the amount of wages paid to such labour, transportation time, overtime, subsistence allowances and any sums paid to or on behalf of such labour for social benefits in accordance with Pakistan law. The basic rates will be payable in local currency only; and

   b) the additional percentage payment to be quoted by the Tenderer and applied to costs incurred under (a) above shall be deemed to cover the Contractor's profit, overheads, superintendence, liabilities and insurances and allowances to labour timekeeping and clerical and office work, the use of consumable stores, water, lighting and power; the use and repair of stagings, scaffolding, workshops and stores, portable power tools, manual plant and tools; supervision by the Contractor's staff, foremen and other supervisory personnel; and charges incidental to the foregoing.

Day-work Material

4. The Contractor shall be entitled to payment in respect of materials used for day-work (except for materials for which the cost is included in the percentage addition to labour costs as detailed heretofore), at the basic rates entered by him in the Schedule of Day-work Rates for materials together with an additional percentage payment on the basic rates to cover overhead charges and profit, as follows:-

   a) The basic rates for materials shall be calculated on the basis of the invoiced price, freight, insurance, handling expenses, damage, losses, etc., and shall provide for delivery to store for stockpiling at the site. The basic rates shall be stated in local currency.

   b) The additional percentage payment shall be quoted by the Tenderer and applied to the payments made under (a) above; and,

   c) the cost of hauling materials used on work ordered to be carried out as day-work from the store or stockpile on the site to the place where it is to be used will be paid in accordance with the terms for Labour and Constructional Plant in this Schedule.

Day-work Constructional Plant

5. The Contractor shall be entitled to payments in respect of constructional plant already on Site and employed on day-work at the basic rental rates entered by him in the Schedule of Day-work Rates for constructional plant. The said rates shall be deemed to include complete allowance for depreciation, interest, indemnity and insurance, repairs, maintenance, supplies, fuel, lubricants, and other consumables, and all overhead, profit and administrative costs related to the use of such equipment. The cost of drivers, operators and assistants will be paid for separately as described under the section on Daywork Labour.

6. In calculating the payment due to the contractor for constructional plant employed on day-work, only the actual number of working hours will be eligible for payment, except that where applicable and agreed with the Engineer, the travelling time from the part of the Site where the constructional plant was located when ordered by the Engineer to be employed on day-work and the time for return journey thereto shall be included for payment.

7. The basic rental rates for constructional plant employed on day-work shall be stated in Pakistani Rupees.

PROPOSED CONSTRUCTION SCHEDULE

Pursuant to Sub-Clause 43.1 of the General Conditions of Contract, the Works shall be completed on or before the date stated in Appendix-A to Tender. The Tenderer shall provide a programme in the bar chart or any other computerized form showing the sequence of work items and the period of time during which he proposes to complete the Works to be performed under the Contract.

Initials of signatory of Bid: _____

Appendix-F to Tender

METHOD OF PERFORMING THE WORK

The Tenderer is required to submit a narrative outlining the method of performing the Work. The narrative should indicate in detail and include but not be limited to:

1. Organization Chart indicating head office and field office personnel involved in management and supervision, engineering, equipment maintenance and purchasing.

2. Mobilization in Pakistan, the type of facilities including personnel accommodation, office accommodation, provision for maintenance and for storage, communications, security and other services to be used.

3. The method of executing the Works, the procedures for installation of equipment and machinery and transportation of equipment and materials to the site.

Initials of signatory of Bid: _____

LIST OF MAJOR EQUIPMENT – RELATED ITEMS

(To be used by the Tenderer)

The Tenderer will provide on Sheet 2 of this Appendix a list of all major equipment and related items, under separate heading for items owned, to be purchased or to be arranged on lease by him to carry out the Works. The information shall include make, type, capacity, and anticipated period of utilization for all equipment which shall be in sufficient detail to demonstrate fully that the equipment will meet all requirements of the Specifications.

Initials of signatory of Bid: _____

LIST OF MAJOR EQUIPMENT

Owned Purchased or Leased	Description of Unit (Make, Model, Year)	Capacity HP Rating	Condition	Present Location or Source	Date of Delivery at Site	Period of Work on Project
1	2	3	4	5	6	7
a. Owned						
b. To be Purchased						
c. To be arranged on Lease						

Initials of signatory of Bid: _____

CONSTRUCTION CAMPS AND HOUSING FACILITIES

The Contractor in accordance with Clause 34 of the Conditions of Contract shall provide description of his construction camp's facilities and staff housing requirements alongwith facilities to be provided for the Engineer as specified in the Special Provisions.

The Contractor shall be responsible for pumps, electrical power, water and electrical distribution systems, and sewerage system including all fittings, pipes and other items necessary for servicing the Contractor's construction camp.

The Tenderer shall list or explain his plans for providing these facilities for the service of the Contract as follows:

1. Site Preparation (clearing, land preparation, etc).

2. Provision of Services.

    a) Power (expected power load, etc).
    b) Water (required amount and system proposed).
    c) Sanitation (sewage disposal system, etc.)

3. Construction of Facilities

    a) Contractor's Office. Workshop and Work Areas (areas required and proposed layout, type of construction of buildings, etc.).
    b) Warehouses and Storage Areas (area required, type of construction and layout).
    c) Housing and Staff Facilities (Plans for housing for proposed staff, layout, type of construction, etc.)

4. Construction Equipment Assembly and Preparation (detailed plans for carrying out this activity)

5. Other Items Proposed (Security services, etc.)

Initials of signatory of Bid: _____

Appendix-I to Tender

LIST OF SUBCONTRACTORS

I/We intend to subcontract the following parts of the Works to sub-contractors. In my/our opinion, the sub-contractors named hereunder are reliable and competent to perform that part of the work for which each is listed.

Enclosed are documentation outlining experience of sub-contractors, the curriculum vitae and experience of their key personnel who will be assigned to the Contract, equipment to be supplied by them, size, location and type of contracts carried out in the past.

Part of Works (Give Details)	**Sub-Contractor (With Complete Address)**
1	**2**

Initials of signatory of Bid: _____

Appendix-J to Tender

ESTIMATED PROGRESS PAYMENTS

Tenderer's estimate of the value of work which would be executed by him during each of the periods stated below, based on his Programme of the Works and the Rates in the Bill of Quantities, expressed in thousands of Pakistani Rupees:

Quarter/ Year/ Period	**Amount (In Thousand Rupees)**
1st Quarter	
2nd Quarter	
3rd Quarter	
4th Quarter	
5th Quarter	
6TH Quarter	
Tender Price	

Initials of signatory of Bid: _____

ORGANIZATION CHART FOR THE SUPERVISORY STAFF AND LABOUR

(To be filled by the Tenderer)

Initials of signatory of Bid: _____

Appendix-L to Tender

(INTEGRITY PACT)

DECLARATION OF FEES, COMMISSION AND BROKERAGE ETC. PAYABLE BY THE TENDERERS OF GOODS, SERVICES & WORKS IN CONTRACTS WORTH RS. 10.00 MILLION OR MORE

Contract No._____ Dated _____
Contract Value: _____
Contract Title: _____

_____ [*name of Tenderer*] hereby declares its intention not to obtain or include the procurement of any contract, interest, privilege or other obligation or benefit from Government of Khyber Pakhtunkhwa/Irrigation Department, Govt. of Khyber Pakhtunkhwa or any administrative subdivision or agency thereof or any other entity controlled by it (Government of Khyber Pakhtunkhwa/Irrigation Department, Govt. of Khyber Pakhtunkhwa) through any corrupt business practice.

Without limiting the generality of the foregoing, [*name of Tenderer*] represents and warrants that it has fully declared the brokerage, commission, fees etc. paid or payable to anyone and not given or agreed to give and shall not give or agree to give to anyone within or outside Pakistan either directly or indirectly through any natural or juridical person, including its affiliate, agent, associate, broker, consultants, director, promoter, shareholder, sponsor or subsidiary, any commission, gratification, bribe, finder's fee or kickback, whether described as consultation fee or otherwise, with the object of obtaining or inducing the procurement of a contract, right, interest, privilege or other obligation or benefit in whatsoever form from Government of Khyber Pakhtunkhwa/Irrigation Department, Govt. of Khyber Pakhtunkhwa, except that which has been expressly declared pursuant hereto.

[*Name of Tenderer*] certifies that it has made and will make full disclosure of all agreements and arrangements with all persons in respect of or related to the transaction with Government of Khyber Pakhtunkhwa/Irrigation Department, Govt. of Khyber Pakhtunkhwa and has not taken any action or will not take any action to circumvent the above declaration, representation or warranty.

[*Name of Tenderer*] accepts full responsibility and strict liability for making any false declaration, not making full disclosure, misrepresenting facts or taking any action likely to defeat the purpose of this declaration, representation and warranty. It agrees that any contract, right, interest, privilege or other obligation or benefit obtained or procured as aforesaid shall, without prejudice to any other rights and remedies available to Government of Khyber Pakhtunkhwa/Irrigation Department, Govt. of Khyber Pakhtunkhwa under any law, contract or other instrument, be avoidable at the option of Government of Khyber Pakhtunkhwa/Irrigation Department, Govt. of Khyber Pakhtunkhwa.

Notwithstanding any rights and remedies exercised by Government of Khyber Pakhtunkhwa/Irrigation Department, Govt. of Khyber Pakhtunkhwa in this regard [the Seller/Supplier] agrees to indemnify Government of Khyber Pakhtunkhwa/Irrigation Department, Govt. of Khyber Pakhtunkhwa for any loss or damage incurred by it on account of its corrupt business practices and further pay compensation to Government of Khyber Pakhtunkhwa/Irrigation Department, Govt. of Khyber Pakhtunkhwa in an amount equivalent to ten times the sum of any commission, gratification, bribe, finder's fee on kickback given by [*name of Tenderer*] as aforesaid for the purpose of obtaining or inducing the procurement of any contract, right, interest, privilege or other obligation or benefit in whatsoever form from Government of Khyber Pakhtunkhwa/Irrigation Department, Govt. of Khyber Pakhtunkhwa.

Name of ***Employer***…….	Name of *Tenderer*……..
Signature: ……	Signature: …….
[Seal]	[Seal]_____

FORMS

- **TENDER SECURITY**
- **PERFORMANCE SECURITY BANK GUARANTEE (Unconditional)**
- **CONTRACT AGREEMENT**
- **MOBILIZATION ADVANCE GUARANTEE FORM**

TENDER SECURITY
(Bank Guarantee)

Security Executed on _____
(Date)

Name of Surety with Address: _____
(Scheduled Bank of Pakistan)

Name of Principal (Tenderer) with Address _____
_____

Penal Sum of Security Rupees. _____ (Rs. _____)

Tender Reference No.RWCS-2: Remodeling of Warsak Canal System in Peshawar and Nowshera Districts – Contract Package RWCS-01 Warsak auxiliary tunnel and allied works

KNOW ALL MEN BY THESE PRESENTS, that in pursuance of the terms of the Tender and at the request of the said Principal (Tenderer) we, the Surety above named, are held and firmly bound unto _____
(hereinafter called the 'Employer') in the sum stated above for the payment of which sum well and truly to be made, we bind ourselves, our heirs, executors, administrators and successors, jointly and severally, firmly by these presents.

THE CONDITION OF THIS OBLIGATION IS SUCH, that whereas the Tenderer has submitted the accompanying Tender dated_____for Contract No. _____
For _____ to the said Employer; and
(Particulars of Contract)

WHEREAS, the Employer has required as a condition for considering said Tender that the Tenderer furnish a Tender Security in the above said sum from a Scheduled Bank of Pakistan or from a foreign bank duly counter-guaranteed by a Scheduled Bank of Pakistan, to the Employer, conditioned as under:

(1) That the Tender Security shall remain valid for not less than 150 days from the date set for opening of Tender regardless of the validity period of the Tender itself;
(2) That the Tender Security of unsuccessful Tenderers will be returned by the Employer _____ after expiry of Tender validity or upon signing of the Contract Agreement; and
(3) That in the event of failure of the successful Tenderer to execute the proposed Contract Agreement for such work and furnish the required Performance Security, the entire said sum be paid immediately to the said Employer as liquidated damages for the successful Tenderer's failure to perform.

NOW THEREFORE, if the successful Tenderer shall, within the period specified therefor, on the prescribed form presented to him for signature enter into a formal Contract with the said Employer in accordance with his Tender as accepted and furnish within twenty eight (28) days of his being requested to do so, a Performance Security with good and sufficient surety, as may be required, upon the form prescribed by the said Employer for the faithful performance and proper fulfilment of the said Contract or in the event of withdrawal of the said Tender within the time specified then this obligation shall be void and of no effect, but otherwise to remain in full force and effect.

PROVIDED THAT the Surety shall forthwith pay the Employer the said sum upon first written

demand of the Employer (without cavil or argument) notice of which shall be sent by the Employer by registered post duly addressed to the Surety at its address given above.

PROVIDED ALSO THAT the Employer shall be the sole and final judge for deciding whether the Principal (Tenderer) has duly performed his obligations to sign the Contract Agreement and to furnish the requisite Performance Security within the time stated above, or has defaulted in fulfilling said requirements and the Surety shall pay without objection the said sum upon demand from the Employer forthwith and without any reference to the Principal (Tenderer) or any other person.

IN WITNESS WHEREOF, the above bounden Surety has executed the instrument under its seal on the date indicated above, the name and seal of the Surety being hereto affixed and these presents duly signed by its undersigned representative pursuant to authority of its governing body.

SURETY

1. Signature _____

2. Name _____

3. Title _____

WITNESS

1. _____

_____
Corporate Secretary (Seal)

2. _____
(Name, Title & Address)
(Seal)

Note:

Bid Security of the Contractor (successful bidder) be retained with the procuring entity till completion of the defect liability period and the amount of the guarantee will be reduced by an equivalent amount.

PERFORMANCE SECURITY
Bank Guarantee (Unconditional)

Guarantee No._____
Executed on _____
Expiry date _____

[Letter by the Guarantor to the Employer]

Name of Guarantor (Bank) with address:_____
(Scheduled Bank of Pakistan)
Name of Principal (Contractor) with address:_____
_____
Penal Sum of Security (express in words and figures)_____
_____
Letter of Acceptance No. _____Dated _____

KNOW ALL MEN BY THESE PRESENTS, that in pursuance of the terms of the Bidding Documents and above said Letter of Acceptance (hereinafter called the Documents) and at the request of the said Principal we, the Guarantor above named, are held and firmly bound unto the _____ (hereinafter called the Employer) in the penal sum of the amount stated above for the payment of which sum well and truly to be made to the said Employer, we bind ourselves, our heirs, executors, administrators and successors, jointly and severally, firmly by these presents.

THE CONDITION OF THIS OBLIGATION IS SUCH, that whereas the Principal has accepted the Employer's above said Letter of Acceptance for _____ _____ (Name of Contract) for the _____ _____ (Name of Project).

NOW THEREFORE, if the Principal (Contractor) shall well and truly perform and fulfill all the undertakings, covenants, terms and conditions of the said Documents during the original terms of the said Documents and any extensions thereof that may be granted by the Employer, with or without notice to the Guarantor, which notice is, hereby, waived and shall also well and truly perform and fulfill all the undertakings, covenants terms and conditions of the Contract and of any and all modifications of said Documents that may hereafter be made, notice of which modifications to the Guarantor being hereby waived, then, this obligation to be void; otherwise to remain in full force and virtue till all requirements of Clause 49, Defects Liability, of Conditions of Contract are fulfilled.

Our total liability under this Guarantee is limited to the sum stated above and it is a condition of any liability attaching to us under this Guarantee that the claim for payment in writing shall be received by us within the validity period of this Guarantee, failing which we shall be discharged of our liability, if any, under this Guarantee.

We,(the Guarantor), waiving all objections and defenses under the Contract, do hereby irrevocably and independently guarantee to pay to the Employer without delay upon the Employer's first written demand without cavil or arguments and without requiring the Employer to prove or to show grounds or reasons for such demand any sum or sums up to the amount stated above, against the Employer's written declaration that the Principal has refused or failed to perform the obligations under the Contract which payment will be

effected by the Guarantor to Employer's designated Bank & Account Number.

PROVIDED ALSO THAT the Employer shall be the sole and final judge for deciding whether the Principal (Contractor) has duly performed his obligations under the Contract or has defaulted in fulfilling said obligations and the Guarantor shall pay without objection any sum or sums up to the amount stated above upon first written demand from the Employer forthwith and without any reference to the Principal or any other person.

IN WITNESS WHEREOF, the above-bounden Guarantor has executed this Instrument under its seal on the date indicated above, the name and corporate seal of the Guarantor being hereto affixed and these presents duly signed by its undersigned representative, pursuant to authority of its governing body.

_____
Guarantor (Bank)

Witness:

1. _____

_____
Corporate Secretary (Seal)

2. _____

_____
Name, Title & Address

Signature _____

Name _____

Title _____

_____
Corporate Guarantor (Seal)

CONTRACT AGREEMENT

THIS CONTRACT AGREEMENT (hereinafter called the "Agreement") made on the _____ day of_____(month) 20_____ between _____ (hereafter called the "Employer") of the one part and _____ (hereafter called the "Contractor") of the other part.

WHEREAS the Employer is desirous that certain Works, viz _____ should be executed by the Contractor and has accepted a Tender by the Contractor for the execution and completion of such Works and the remedying of any defects therein.

NOW this Agreement witnesses as follows:

1. In this Agreement words and expressions shall have the same meanings as are respectively assigned to them in the Conditions of Contract hereinafter referred to.
2. The following documents after incorporating addenda, if any, except those parts relating to Instructions to Tenderers shall be deemed to form and be read and construed as part of this Agreement, viz:

   (a) The Contract Agreement;
   (b) The Letter of Acceptance;
   (c) The completed Form of Tender;
   (d) Special Stipulations (Appendix-A to Tender);
   (e) The Particular Conditions of Contract – Part II;
   (f) The General Conditions – Part I;
   (g) The priced Bill of Quantities (Appendix-D to Tender);
   (h) The completed Appendices to Tender (B, C, E to L);
   (i) The Drawings;
   (j) The Specifications.
   (k) _____ (any other)
3. In consideration of the payments to be made by the Employer to the Contractor as hereinafter mentioned, the Contractor hereby covenants with the Employer to execute and complete the Works and remedy defects therein in conformity and in all respects with the provisions of the Contract.
4. The Employer hereby covenants to pay the Contractor, in consideration of the execution and completion of the Works as per provisions of the Contract, the Contract Price or such other sum as may become payable under the provisions of the Contract at the times and in the manner prescribed by the Contract.

IN WITNESS WHEREOF the parties hereto have caused this Agreement to be executed on the day, month and year first before written in accordance with their respective laws.

Signature of the Contactor	Signature of Employer
_____	_____
(Seal)	(Seal)

Signed, Sealed and Delivered in the presence of:

Witness:	Witness:
_____	_____
(Name, Title and Address)	(Name, Title and Address)

MOBILIZATION ADVANCE GUARANTEE FORM

(Bank Guarantee)

Guarantee No._____ Date _____

WHEREAS (hereinafter called the 'Employer') has entered into a Contract for

_____

(Particulars of Contract)

with _____ (hereinafter called the "Contractor').

AND WHEREAS, the Employer has agreed to advance to the Contractor, at the Contractor's request, an amount of Rupees _____ (Rs _____) which amount shall be advanced to the Contractor as per provisions of the Contract.

AND WHEREAS, the Employer has asked the Contractor to furnish Guarantee to secure the mobilization advance for the performance of his obligations under the said Contract.

AND WHEREAS, _____

(Scheduled Bank of Pakistan)

(Hereinafter called the “Guarantor”) at the request of the Contractor and in consideration of the Employer agreeing to make the above advance to the Contractor, has agreed to furnish the said Guarantee.

NOW, THEREFORE, the Guarantor hereby guarantees that the Contractor shall use the advance for the purpose of above mentioned Contract and if he fails and commits default in fulfilment of any of his obligations for which the advance payment is made, the Guarantor shall be liable to the Employer for payment not exceeding the aforementioned amount.

Notice in writing of any default, of which the Employer shall be the sole and final judge, on the part of the Contractor, shall be given by the Employer to the Guarantor, and on such first written demand, payment shall be made by the Guarantor of all sums then due under this Guarantee without any reference to the Contractor and without any objection.

This Guarantee shall remain in force until the advance is fully adjusted against payments from the Interim Payment Certificates of the Contractor or until _____whichever is earlier.

(Date)

The Guarantor's liability under this Guarantee shall not in any case exceed the sum of Rupees _____ (Rs _____).

This Guarantee shall remain valid up to the aforesaid date and shall be null and void after the aforesaid date or earlier if the advance made to the Contractor is fully adjusted against payments from Interim Payment Certificates of the Contractor provided that the Guarantor agrees that the aforesaid period of validity shall be deemed to be extended if on the above mentioned date the advance payment is not fully adjusted.

GUARANTOR

1. Signature _____
2. Name _____
3. Title _____

WITNESS

1. _____

_____
Corporate Secretary (Seal)

2. _____ _____
(Name Title & Address) Corporate Guarantor (Seal)

PART I - GENERAL CONDITIONS OF CONTRACT

PART I: GENERAL CONDITIONS OF CONTRACT

The Conditions of Contract Part – I; General Conditions shall be those forming Part I of the 'Conditions of Contract for Works of Civil Engineering Construction "fourth edition 1987, reprinted in 1992 with further amendments" prepared by the *Federation International des ingenious – Conseils* (FIDIC).

The standard text of these General Conditions must be retained intact to facilitate its reading and interpretation by tenderers and its review by the Employer.in the English language shall be taken as the definitive version for this Contract. Any amendment and addition to the General Conditions, specific to the contract in hand should be introduced in Part II hereof entitled "Particular Conditions of Contract"

The use of standard conditions of contract for all civil work will ensure comprehensiveness of coverage, better balance of rights or obligations between the Employer and the Contractor, general acceptability of its provisions, and saving in time and cost for bid preparation and review, leading to more economic pricesi,.

The FIDIC Conditions of Contract are copyrighted and may not be copied, faxed, or reproduced. Tenderers are advised to obtain originals of the FIDIC Conditions of Contract directly from:

FIDIC Secretariat

World Trade Center II

P.O. Box 311

CH – 1215 Geneva 15

Switzerland

Phone: +41 22 799 49 01

Facsimile: + 41 22 799 49 01

Direct Phone for publications: + 41 22 799 49 05

Direct E-mail for publications: fidic.pub@fidic.org

(To be purchased, signed and attached with

The Tender Documents by the Tenderers)

PART II - PARTICULAR CONDITIONS OF CONTRACT

PART II - PARTICULAR CONDITIONS OF CONTRACT

1.1 Definitions

(a) (i) The Employer is Irrigation Department, Government. Of Khyber Pakhtunkhwa, its legal successor and assignees. The Employer is represented by, Project Director, Remodeling of Warsak Canal System in Peshawar and Nowshera Districts, Civil Colony, Warsak Road, Kababyan, Peshawar.

(a)(iv) The Engineer is Project Manager, Remodeling of Warsak Canal System in Peshawar and Nowshera Districts, Irrigation Department, Government. of Khyber Pakhtunkhwa, or any other competent person appointed by the Employer, and notified to the Contractor, to act in replacement of the Engineer. Provided always that except in cases of professional misconduct, the outgoing Engineer is to formulate his certifications/recommendations in relation to all outstanding matters, disputes and claims relating to the execution of the Works during his tenure.

The following paragraph is added:

(a)(vi)"Bidder or Tenderer" means any person or persons, company, corporation, firm or joint venture submitting a Bid or Tender.

(b)(v)The following is added at the end of the paragraph:

The word "Tender" is synonymous with "Bid" and the word "Tender Documents" with "Bidding Documents".

The following paragraph is added:

(b)(ix)"Programme" means the programme to be submitted by the Contractor in accordance with Sub-Clause 14.1 and any approved revisions thereto.

(e)(i)The text is deleted and substituted with the following:

"Contract Price" means the sum stated in the Letter of Acceptance as payable to the Contractor for the execution and completion of the Works subject to such additions thereto or deductions therefrom as may be made and remedying of any defects therein in accordance with the provisions of the Contract.

2.1 Engineer's Duties and Authority

With reference to Sub-Clause 2.1(b), the following provisions shall also apply;

The Engineer shall obtain the specific approval of the Employer before carrying out his duties in accordance with the following Clauses:

(i) Consenting to the sub-letting of any part of the Works under Sub-Clause 4.1 "Subcontracting".

(ii) Certifying additional cost determined under Sub-Clause 12.2 "Not Foreseeable Physical Obstructions or Conditions".

(iii) Any action under Clause 10 "Performance Security" and Clauses 21,23, 24 & 25 "Insurance" of sorts.

(iv) Any action under Clause 40 “Suspension”.

(v) Any action under Clause 44 “Extension of Time for Completion”.

(vi) Any action under Clause 47 “Liquidated Damages for Delay”.

(vii) Issuance of “Taking over Certificate” under Clause 48.

(viii) Issuance of Variation Order under Clause 51,except:

a) In an emergency* situation, as stated here below, or

b) If such variation would increase the Contract Price by less than the amount stated in the Appendix-A to Tender.

(ix) Fixing rates or prices under Clause 52.

(x) Extra payment as a result of Contractor’s claims under Clause 53.

(xi) Release of Retention Money to the Contractor under Sub-Clause 60.3 “Payment of Retention Money”.

(xii) Issuance of “Final Payment Certificate” under Sub-Clause 60.8.

(xiii) Issuance of “Defect Liability Certificate” under Sub-Clause 62.1.

(xiv) Release from performance under Sub Clause 66.1.

(xv) Additional payment under Sub-Clause 70.2.

* (If in the opinion of the Engineer an emergency occurs affecting the safety of life or of the Works or of adjoining property, the Engineer may, without relieving the Contractor of any of his duties and responsibilities under the Contract, instruct the Contractor to execute all such work or to do all such things as may, in the opinion of the Engineer, be necessary to abate or reduce the risk. The Contractor shall forthwith comply with any such instruction of the Engineer. The Engineer shall determine an addition to the Contract Price, in respect of such instruction, in accordance with Clause 52 and shall notify the Contractor accordingly, with a copy to the Employer.)

2.2 Engineer’s Representative

The following paragraph is added:

The Engineer’s Representative (ER) shall be Construction Manager, Joint Venture of Consultants comprising NESPAK, Electra and ICS, Remodeling of Warsak Canal System in Peshawar and Nowshera Districts, or any other competent person appointed by the Engineer from time to time.

The following Sub-Clauses 2.7 and 2.8 are added:

2.7 Engineer Not Liable

Approval, reviews and inspection by the Engineer of any part of the Works does not relieve the Contractor from his sole responsibility and liability for the supply of materials, plant and

equipment for construction of the Works and their parts in accordance with the Contract and neither the Engineer's authority to act nor any decision made by him in good faith as provided for under the Contract whether to exercise or not to exercise such authority shall give rise to any duty or responsibility of the Engineer to the Contractor, any Subcontractor, any of their representatives or employees or any other person performing any portion of the Works.

2.8 Replacement of the Engineer

"If the Employer intends to replace the Engineer, the Employer shall, not less than 14 days before the intended date of replacement, give notice to the Contractor, of the name, address and relevant experience of the intended replacement Engineer. The Employer shall not replace the Engineer with a person against whom the Contractor raises reasonable objection by notice to the Employer, with supporting particulars."

5.1 Language(s) and Law

(a)The Contract Documents, shall be drawn up in the English language.
(b)The Contract shall be subject to the Laws of Islamic Republic of Pakistan.

5.2 Priority of Contract Documents

The documents listed at (1) to (6) of the Sub-Clause 5.2 of General Conditions are deleted and substituted with the following:

(1) The Contract Agreement (if completed);
(2) The Letter of Acceptance;
(3) The completed Form of Tender;
(4) Special Stipulations (Appendix-A to Tender);
(5) The Particular Conditions of Contract – Part II;
(6) The General Conditions – Part I;
(7) The priced Bill of Quantities (Appendix-D to Tender);
(8) The completed Appendices to Tender (B, C, E to L);
(9) The Drawings;
(10) The Specifications; and
(11) _____ (any other).

In case of discrepancies between drawings, those of larger scale shall govern unless they are superseded by a drawing of later date regardless of scale. All Drawings and Specifications shall be interpreted in conformity with the Contract and these Conditions. Addendum, if any, shall be deemed to have been incorporated at the appropriate places in the documents forming the Contract.

The following Sub-Clauses 6.6 and 6.7 are added:

6.6 Shop Drawings

The Contractor shall submit to the Engineer for review 3 copies of all shop and erection drawings applicable to this Contract as per provision of relevant Sub-Clause of the Contract.

Review and approval by the Engineer shall not be construed as a complete check but will indicate only that the general method of construction and detailing is satisfactory and that the Engineer's review or approval shall not relieve the Contractor of any of his responsibilities under the Contract.

6.7 As-Built Drawings

During construction, the Contractor shall keep an accurate record of work as executed. Any changes of work shall be marked on copies of the approved drawings including shop drawings. Copies of such marked-up drawings and their electronic copies shall be submitted to the Engineer regularly for his verification and record.

At the substantial completion of the Works under Clause 48, the Contractor shall furnish to the Engineer 6 copies and one reproducible of all drawings amended to conform to the Works as built. The price of such Drawings shall be deemed to be included in the Contract Price.

10.1 Performance Security

The text is deleted and substituted with the following:

The Contractor shall provide Performance Security to the Employer in the prescribed form. The said Security shall be furnished or caused to be furnished by the Contractor within 28 days after the receipt of the Letter of Acceptance. The Performance Security shall be of an amount as stipulated by the Employer in the Appendix-A to Tender. Such Security shall, at the option of the bidder, be in the form of either (a) Deposit at Call or (b) a bank guarantee from any Scheduled Bank of Pakistan or (c) bank guarantee from a bank located outside Pakistan duly counter-guaranteed by a Scheduled Bank in Pakistan.

The cost of complying with requirements of this Sub-Clause shall be borne by the Contractor.

The bid security of successful bidder (i.e 2% of Engineer Estimated Cost in shape of Call Deposit) be retained as a part of Performance Guarantee with the Procuring Entity till completion of defect liability period and the amount of guarantee will be reduced by an equivalent amount.

10.3 Claims under Performance Security

Sub-Clause 10.3 of General Conditions is deleted.

The following Sub-Clause10.4 is added:

10.4 Performance Security Binding on Variations and Changes

The Performance Security shall be binding irrespective of changes in the quantities or variations in the Works or extensions in Time for Completion of the Works which are granted or agreed upon under the provisions of the Contract.

14.1 Programme to be submitted

The programme shall be submitted within the time stated in Appendix-A to Tender, in the computerized form and shall be in the format as provided under Clause SP-17 of Special Provisions. The critical path shall be shown clearly on the programme.

14.3 Cash Flow Estimate to be submitted

The detailed Cash Flow Estimate shall be submitted within 21 days from the date of receipt of Letter of Acceptance

In the third and fifth line, the word ‘quarterly’ is replaced with “monthly”.

The following Sub-Clause 14.5 is added:

14.5 Detailed Programme and Monthly Progress Report

a) For purposes of Sub-Clause 14.1, the Contractor shall submit to the Engineer detailed programme for the following:

(1) Execution of Works;

(2) Labour Employment;

(3) Local Material Procurement;

(4) Material Imports, if any; and

(5) Other details as required by the Engineer.

(b) During the period of the Contract, the Contractor shall submit to the Engineer not later than the 8th day of the following month, 10 copies each of Monthly Progress Reports covering:

(1) A Construction Schedule indicating the monthly progress in percentage;

(2) Description of all work carried out since the last report;

(3) Description of the work planned for the next 56 days sufficiently detailed to enable the Engineer to determine his programme of inspection and testing;

(4) Monthly summary of daily job record;

(5) Photographs to illustrate progress; and

(6) Information about problems and difficulties encountered, if any, and proposals to overcome the same.

(c) During the period of the Contract, the Contractor shall keep a daily record of the work progress, which shall be made available to the Engineer as and when requested. The daily record shall include particulars of weather conditions, number of men working, deliveries of materials, quantity, location and assignment of Contractor’s equipment.

The following Sub-Clauses 15.2 and 15.3 are added:

15.2 Language Ability of Contractor’s Representative

The Contractor’s authorized representative shall be fluent in the English language. Alternately an interpreter with ability of English language shall be provided by the Contractor on full time basis.

15.3 Contractor’s Representative

The Contractor’s authorised representative and his other professional engineers working at Site shall register themselves with the Pakistan Engineering Council.

The Contractor’s authorized representative at Site shall be authorised to exercise adequate administrative and financial powers on behalf of the Contractor so as to achieve completion of the Works as per the Contract.

The following Sub-Clauses 16.3 and 16.4 are added:

16.3 Language Ability of Superintending Staff of Contractor

A reasonable proportion of the Contractor's superintending staff shall have a working knowledge of the English language. If the Contractor's superintending staff are not fluent in English language, the Contractor shall make competent interpreters available during all working hours in a number deemed sufficient by the Engineer.

16.4 Employment of Local Personnel

The Contractor is encouraged, to the extent practicable and reasonable, to employ staff and labour from sources within Pakistan.9

The following Sub-Clauses 19.3 and 19.4 are added:

19.3 Safety Precautions

The Contractor shall be fully responsible for the safety and security of the Site and its surroundings. In order to provide for the safety, health and welfare of' persons including the personnel of the Engineer deployed at the Site in connection with the Works, and for prevention of damage of any kind, all operations for the purposes of or in connection with the Contract shall be carried out in compliance with the Safety Requirements of the Government of Pakistan with such modifications thereto as the Engineer may authorise or direct and the Contractor shall take or cause to be taken such further measures and comply with such further requirements as the Engineer may determine to be reasonably necessary for such purpose.

The Contractor shall make, maintain and submit reports to the Engineer concerning safety, health and welfare of persons and damage to property, as the Engineer may from time to time prescribe.

19.4 Lighting Work at Night

In the event of work being carried out at night, the Contractor shall at his own cost, provide and maintain such good and sufficient light as will enable the work to proceed satisfactorily and without danger. The approaches to the Site and the Works where the night-work is being carried out shall be sufficiently lighted. All arrangement adopted for such lighting shall be to the satisfaction of the Engineer's Representative.

20.4 Employer's Risks

The Employer's risks are:

The whole text is deleted and substituted with the following:

(a) insofar as they directly affect the execution of the Works in Pakistan:

(i) war and hostilities (whether war be declared or not), invasion, act of foreign enemies,
(ii) rebellion, revolution, insurrection, or military or usurped power, or civil war,
ionizing radiations, or contamination by radioactivity from any nuclear fuel, or from any nuclear waste from the combustion of nuclear fuel, radioactive toxic explosive or other hazardous properties of any explosive nuclear assembly or nuclear

component thereof,

(iv) Pressure waves caused by aircraft or other aerial devices travelling at sonic or supersonic speeds,

(v) Riot, commotion or disorder, unless solely restricted to the employees of the Contractor or of his Subcontractors and arising from the conduct of the Works;

(b) loss or damage due to the use or occupation by the Employer of any Section or part of the Permanent Works, except as may be provided for in the Contract;

(c) loss or damage to the extent that it is due to the design of the Works, other than any part of the design provided by the Contractor or for which the Contractor is responsible; and

(d) any operation of the forces of nature (insofar as it occurs on the Site) which an experienced contractor:

(i) Could not have reasonably foreseen, or

(ii) Could reasonably have foreseen, but against which he could not reasonably have taken at least one of the following measures:

(a) Prevent loss or damage to physical property from occurring by taking appropriate measures, or

(b) Insure against.

21.1 Insurance of Works and Contractor's Equipment

The following text is added at the end of paragraph (b):

It is being understood that such insurance shall provide to rectify the loss or damage incurred.

21.4 Exclusions

The text is deleted and substituted with the following:

There shall be no obligation for the insurances in Sub-Clause 21.1 to include loss or damage caused by the risks listed under Sub-Clause 20.4 paras (a) (i) to (iv).

23.2 Minimum Amount of Insurance

The words 'Appendix to Tender' appearing in the text is amended to read as "Appendix-A to Tender".

The following Sub-Clause 25.5 is added:

25.3 Remedy of Contractor failure to Insure

The following text is added at the end of paragraph;

In case the Contractor could not furnish the required insurance policies as mentioned in the Contract clause – 25.1, then in case of any damages the works / machinery and personal, contractor would have sole responsibility for compensation as per standing rules and provision of the contract. In case the Contractor fail in compensation as stated in the preceding para the Employee would be entitled to recover the corresponding amount in accordance with the prevailing law / provision of Contract as debt due from the contractor.

25.5 Insurance Company

The Contractor shall be obliged to place all insurances relating to the Contract (including, but not limited to, the insurances referred to in Clauses 21, 23 and 24) with either National Insurance Company of Pakistan or any other insurance company operating in Pakistan and acceptable to the Employer.

Costs of such insurances shall be borne by the Contractor.

The following Sub-Clause 31.3 is added:

31.3 Co-operation with other Contractors

During the execution of the Works, the Contractor shall co-operate fully with other contractors working for the Employer at and in the vicinity of the Site and also shall provide adequate precautionary facilities not to make himself a nuisance to local residents and other contractors.

The following Sub-Clauses 34.2 to 34.12 are added:

34.2 Rates of Wages and Conditions of Labour

The Contractor shall pay rates of' wages and observe conditions of labour not less favourable than those established for the trade or industry where the work is carried out. In the absence of any rates of wages or conditions of labour so established, the Contractor shall pay rates of wages and observe conditions of labour which are not less favourable than the general level of wages and conditions observed by other employers whose general circumstances in the trade or in industry in which the Contractor is engaged are similar.

34.3 Employment of Persons in the Service of Others

The Contractor shall not recruit his staff and labour from amongst the persons in the services of the Employer or the Engineer; except with the prior written consent of the Employer or the Engineer, as the case may be.

34.4 Housing for Labour

Save insofar as the Contract otherwise provides, the Contractor shall provide and maintain such housing accommodation and amenities as he may consider necessary for all his supervisory staff and labour, employed for the purposes of or in connection with the Contract including all fencing, electricity supply, sanitation, cookhouses, fire prevention, water supply and other requirements in connection with such housing accommodation or amenities.

34.5 Health and Safety

Due precautions shall be taken by the Contractor, and at his own cost, to ensure the safety of his staff and labour at all times throughout the period of the Contract. The Contractor shall further ensure that suitable arrangements are made for the prevention of epidemics and for all necessary welfare and hygiene requirements.

34.6 Epidemics

In the event of any outbreak of illness of an epidemic nature, the Contractor shall comply

with and carry out such regulations, orders and requirements as may be made by the Government, or the local medical or sanitary authorities, for purpose of dealing with and overcoming the same.

34.7 Supply of Water

The Contractor shall, so far as is reasonably practicable, having regard to local conditions**,** provide on the Site, to the satisfaction of the Engineer or his representative, adequate supply of drinking and other water for the use of his staff and labour.

34.8 Alcoholic Liquor or Drugs

The Contractor shall not, otherwise than in accordance with the Statutes, Ordinances and Government Regulations or Orders for the time being in force, import, sell, give, barter or otherwise dispose of any alcoholic liquor or drugs, or permit or suffer any such importation, sale, gift, barter or disposal by his Subcontractors, agents, staff or labour.

34.9 Arms and Ammunition

The Contractor shall not give, or otherwise dispose of to any person or persons, any arms or ammunition of any kind or permit or suffer the same as aforesaid.

34.10 Festivals and Religious Customs

The Contractor shall in all dealings with his staff and labour have due regard to all recognised festivals, days of rest and religious and other customs.

34.11 Disorderly Conduct

The Contractor shall at all times take all reasonable precautions to prevent any unlawful, riotous or disorderly conduct by or amongst staff and labour and for the preservation of peace and protection of persons and property in the neighbourhood of the Works against the same.

34.12 Compliance by Subcontractors

The Contractor shall be responsible for compliance by his Subcontractors of the provisions of this Clause.

The following Sub-Clauses 35.2 and 35.3 are added:

35.2 Records of Safety and Health

The Contractor shall maintain such records and make such reports concerning safety, health and welfare of persons and damage to property as the Engineer may from time to time prescribe.

35.3 Reporting of Accidents

The Contractor shall report to the Engineer details of any accident as soon as possible after its occurrence. In the case of any fatality or serious accident, the Contractor shall, in addition, notify the Engineer immediately by the quickest available means.

The following Sub-Clause 36.6 is added:

36.6 Use of Pakistani Materials and Services

The Contractor shall , so far as may be consistent with the Contract, make the maximum use of materials, supplies, plant and equipment indigenous to or produced or fabricated in Pakistan and services, available in Pakistan provided such materials, supplies, plant, equipment and services shall be of required standard.

43.1 Time for Completion

The words 'Appendix to Tender' appearing in the second line is amended to read as "Appendix-A to Tender".

47.1 Liquidated Damages for Delay

The words 'Appendix to Tender' appearing in the text is amended to read as "Appendix-A to Tender".

49.1 Defects Liability Period

The words 'Appendix to Tender' appearing in the text is amended to read as "Appendix-A to Tender".

51.2 Instructions for Variations

At the end of the first sentence, after the word "Engineer", the words "in writing" are added.

52.1 Valuation of Variations

In the tenth line, after the words "Engineer shall" the following is added:

Within a period not exceeding one-eighth of the completion time subject to a minimum of 56 days from the date of disagreement whichever is later.

53.4 Failure to Comply

This Sub-Clause is deleted in its entirety.

54.3 Customs Clearance

In line 3, after the words "for the Works" add "but shall not be liable to the Contractor for any loss resulting from clearance being delayed or refused"

54.5 Conditions of Hire of Contractor's Equipment

The following paragraph is added:

The Contractor shall, upon request by the Engineer at any time in relation to any item of hired Contractor's Equipment, forthwith notify the Engineer in writing the name and address of the Owner of the equipment and shall certify that the agreement for the hire thereof contains a provision in accordance with the requirements set forth above.

60.1 Monthly Statements

Sub-Clause 60.1 is deleted and substituted as under:

The Contractor shall submit to the Engineer at the end of each month four (4) copies in a tabulated form approved by the Engineer, showing the amounts to which the Contractor considers himself to be entitled together with supporting documents. The statement shall include the following items, as applicable, which shall be taken into account in the sequence listed:

(a) The estimated Contract value of the Works executed upto the end of the month in question based on unit rates and prices of BOQ.

(b) The actual value certified for payment for the Works executed upto the end of the previous month, based on unit rates and prices of BOQ.

(c) The estimated Contract value of the Works for the month in question obtained by deducting (b) form (a);

(d) the value of any variations executed upto the end of the month in question, less the amount certified in the previous Interim Payment Certificate, pursuant to Clause 52;

(e) Amount approved in respect of Day work (if any) executed upto the end of the month in question, less the amount for Day work certified in the previous Interim Payment Certificate, as determined from the Day work Schedule of the Bill of quantities;

(f) An amount reflecting changes in Cost and legislation, pursuant to Clause 70;

(g) Any amount to be deducted for retention, calculated by applying the percentage of retention stated in the Appendix A to Tender to the total of the amount due under paragraphs 60.1 (c), (d), (e) and (f).

(h) Any amount to be deducted as repayment of the Advance under the provisions of Sub-Clause 60.12; and

(i) Any other sum, to which the Contractor may be entitled under the Contract, or otherwise.

60.2 Monthly Payments

In the first line, '28' is substituted by "14".

Paragraph '(a)' is amended to read as under:

"firstly, to the retention of the amount calculated in accordance with paragraph (g) of Sub-Clause 60.1 hereof till the cumulative amount so retained reaches the limit of retention money stated in Appendix-A to Tender."

The following paragraph is added at the end of last paragraph:

Provided further that no amount under Monthly Statement shall be certified by the Engineer until and unless programme of Works submitted in accordance with Sub-Clause 14., has been approved by the Engineer.

60.10 Time for Payment

The following text appearing in 6th to last lines is deleted in its entirety:

"In the event of the failure of the Employer to make payment .....the Contractor's entitlement under Clause 69 or otherwise."

The following Sub-Clause 60.11 and 60.12 are added:

60.11 Secured Advance on Materials

a) The Contractor shall be entitled to receive from the Employer Secured Advance against an indemnity bond acceptable to the Employer of such sum as the Engineer may consider proper in respect of non-perishable materials limited to only Cement and Steel reinforcement brought at the Site but not yet incorporated in the Permanent Works provided that:

(1) The materials are in accordance with the Specifications for the Permanent Works;

(2) Such materials have been delivered to the Site and are properly stored and protected against loss or damage or deterioration to the satisfaction of the Engineer but at the risk and cost of the Contractor;

(3) The Contractor's records of the requirements, orders, receipts and use of materials are kept in a form approved by the Engineer, and such records shall be available for inspection by the Engineer;

(4) The Contractor shall submit with his monthly statement the estimated value of the materials on Site together with such documents as may be required by the Engineer for the purpose of valuation of materials and providing evidence of ownership and payment therefor;

(5) Ownership of such materials shall be deemed to vest in the Employer and these materials shall not be removed from the Site or otherwise disposed of without written permission of the Employer; and

(6) The sum payable for such materials on Site shall not exceed 75 % of the (i) landed cost of imported materials, or (ii) ex-factory / ex-warehouse price of locally manufactured or produced materials, or (iii) market price of other materials.

(b) The recovery of Secured Advance paid to the Contractor under the above provisions shall be affected from the monthly payments on actual consumption basis.

60.12 Financial Assistance to Contractor

Financial assistance shall be made available to the Contractor by the Employer by adopting the following methodology**:**

(a) An interest-free Mobilization Advance up to 10 % of the Contract Price less Provisional Sum stated in the Letter of Acceptance shall be paid by the Employer to the Contractor in two equal parts upon submission by the Contractor of a Mobilization Advance Guarantee for the full amount of the Advance in the specified form from a Scheduled Bank of Pakistan. Such guarantee shall remain valid until the whole advance payment has been repaid, but the amount shall be progressively reduced by the amount repaid by the Contractor as indicated in the Payment Certificate:

(1) First part within 14 days after signing of the Contract Agreement and issuance

of Engineer's Notice to Commence in accordance with Sub-Clause 41.1 of General Conditions; and

(2) Second part within 42 days from the date of payment of the first part, subject to the satisfaction of the Engineer as to the state of mobilization of the Contractor at the Site.

(b) This Advance shall be recovered in equal instalments. Deductions shall commence from third Interim Payment Certificate, and the last instalment shall be deducted three months before the date of completion of the Works as per Sub-Clause 43.1 hereof.

63.1 Default of Contractor

The following para is added at the end of the Sub-Clause:

Provided further that in addition to the action taken by the Employer against the Contractor under this Clause, the Employer may also refer the case of default of the Contractor to Pakistan Engineering Council for punitive action under the Construction and Operation of Engineering Works Bye-Laws 1987, as amended from time to time.

65.2 Special Risks

The text is deleted and substituted with the following:

The Special Risks are the risks defined under Sub-Clause 20.4 sub paragraphs (a) (i) to (a) (v) hereof.

67. 3 Arbitration

In the sixth to eight lines, the words "shall be finally settled ..... appointed under such Rules" are deleted and substituted with the following:

Shall be finally settled under the provisions of the Arbitration Act, 1940 (Act No. X of 1940) as amended or any statutory modification or re-enactment thereof for the time being in force.

The following paragraph is added at the end:

The place of arbitration shall be Peshawar, Pakistan.

68.1 Notice to Contractor

The following paragraph is added:

For the purposes of this Sub-Clause, the Contractor shall, immediately after receipt of Letter of Acceptance, intimate in writing to the Employer and the Engineer by registered post, the address of his principal place of business or any change in such address during the period of the Contract.

68.2 Notice to Employer and Engineer

For the purposes of this Sub-Clause, the respective addresses are:

a) For the Employer:

Project Director, Remodeling of Warsak Canal System in Peshawar and Nowshera Districts, Irrigation Department, Govt. of Khyber Pakhtunkhwa
Civil Colony, Warsak Road, Kababyan, Peshawar.

b) For the Engineer:

Project Manager, Remodeling of Warsak Canal System in Peshawar and Nowshera Districts, Irrigation Department, Govt. of Khyber Pakhtunkhwa
Civil Colony, Warsak Road, Kababyan, Peshawar.

70.1 Increase or Decrease of Cost

Sub-Clause 70.1 of General Conditions of Contract is replaced in its entirety, and substituted with the following:

The amounts payable to the Contractor, pursuant to Sub-Clause 60.1, shall be adjusted in respect of the rise or fall in the cost of labor, materials, and other inputs to the Works as per Appendix C to Tender by applying to such amount the formula prescribed in this Sub-Clause.

(a) Other Changes in Cost

To the extent that full compensation for any rise or fall in costs to the Contractor is not covered by the provisions of this or other Clauses in the Contract, the unit rates and prices included in the Contract shall be deemed to include amounts to cover the contingency of such other rise or fall of costs.

(b) Adjustment Formula

The adjustment to the monthly statements in respect of changes in cost shall be determined from the following formula:-

$$Pn = A + b\frac{Ln}{Lo} + c\frac{Cn}{Co} + d\frac{Sn}{So} + e\frac{Dn}{Do} \text{ .....}$$

Where:

Pn is a price adjustment factor to be applied to the amount for the payment of the work carried out in the subject month, determined in accordance with Paragraphs 60.1 (c), (d) and (e), where any variations (due to inclusion of non schedule item for which unit rate is worked out after rate analysis duly approved by the Employer) when required and day work are not otherwise subject to price adjustment;

A is a constant, specified in Appendix-C to Tender, representing the nonadjustable portion in contractual payments;

b, c, d and e are weightages or coefficients representing the estimated proportion of each cost element (labour, cement, reinforcing steel and high speed diesel) in the Works or Sections thereof, net of Provisional Sums and Prime Cost; the sum of A, b, c, d and e shall be one;

Ln, Cn, Sn and Dn are the current cost indices or reference prices of the cost elements for month “n”, determined pursuant to Sub-Clause 70.1(d), applicable to each cost element; and

Lo, Co, So and Do are the base cost indices or reference prices corresponding to the above cost elements at the date specified in Sub-Clause 70.1(d).

(c) Sources of Indices and Weightages

The sources of indices shall be those listed in Appendix-C to Tender, as approved by the Engineer. Permissible ranges of weightages of each specified material and labour are given in Appendix-C to Tender. Weightages of specified materials and labour, as provided by the Contractor at tendering stage and if not provided as entered by the Employer, have been shown in column 4 of Appendix-C to Tender.

Unless otherwise any adjustment to the weightages is agreed by the Engineer, pursuant to para (f) of this sub-clause, such weightages shall remain applicable during the currency of the Contract.

(d) Base, Current, and Provisional Indices

The base cost indices or prices shall be those prevailing on the day 28 days prior to the latest date for submission of bids. Current indices or prices shall be those prevailing on the day 28 days prior to the last day of the period to which a particular monthly statement is related. If at any time the current indices are not available, provisional indices as determined by the Engineer will be used, subject to subsequent correction of the amounts paid to the Contractor when the current indices become available.

(e) Adjustment after Completion

If the Contractor fails to complete the Works within the Time for Completion prescribed under Clause 43, adjustment of prices thereafter until the date of completion of the Works shall be made using either the indices or prices relating to the prescribed time for completion, or the current indices or prices, whichever is more favorable to the Employer, provided that if an extension of time is granted pursuant to Clause 44, the above provision shall apply only to adjustments made after the expiry of such extension of time.

(f) Weightages

The weightages for each of the factors of cost given in Appendix-C to Tender shall be adjusted if, in the opinion of the Engineer, they have been rendered unreasonable, unbalanced, or inapplicable as a result of varied or additional work executed or instructed under Clause 51. Such adjustment(s) shall have to be agreed in the variation order.

71.1 Currency Restrictions

This Sub-Clause is deleted in its entirety.

72.1 Rates of Exchange

This Sub-Clause is deleted in its entirety.

72.2 Currency Proportions

This Sub-Clause is deleted in its entirety.

72.3 Currencies of Payment for Provisional Sums

This Sub-Clause is deleted in its entirety.

The following Sub-Clauses 73.1, 73.2, 73.3, 73.4, 74.1, 75.1, 76.1, 77.1 and 78.1 are added:

73.1 Payment of Income Tax

The Contractor, Subcontractors and their employees shall be responsible for payment of all their income tax, super tax and other taxes on income arising out of the Contract and the rates and prices stated in the Contract shall be deemed to cover all such taxes.

73.2 Local Taxation

The prices tendered by the Contractor shall include all customs duties, import duties, business taxes, income and other taxes that may be levied in accordance with the laws and regulations in force as of the date 28 days prior to the closing date for submission of bids in Pakistan on the Contractor's Equipment, Plant, materials and supplies (permanent, temporary and consumable) acquired for the purpose of the Contract and on the services performed under the Contract. Nothing in the Contract shall relieve the Contractor from his responsibility to pay any tax that may be levied in Pakistan on his income in respect of the Contract.

73.3 Income Taxes on Staff

The Contractor's staff and labour shall be liable to pay personal income taxes in Pakistan in respect of such of their salaries and wages as are chargeable under the laws and regulations for the time being in force, and the Contractor shall perform such duties in regard to such deductions thereof as may be imposed on him by such laws and regulations.

73.4 Advance Income Tax

Deduction of advance income tax / withholding tax from the net payable bill amounts shall be made in accordance with the prevalent Income Tax Laws of the Government of Pakistan. These deductions shall be deposited, in the Government Treasury by the Employer, to the account of the Contractor.

The Employer shall within 28 days of making any such deduction provide to the Contractor a certificate of tax deducted.

74.1 Integrity Pact

If the Contractor or any of his Subcontractors, agents or servants is found to have violated or involved in violation of the Integrity Pact signed by the Contractor as Appendix-L to his Tender, then the Employer shall be entitled to:

(a) recover from the Contractor an amount equivalent to ten times the sum of any commission, gratification, bribe, finder's fee or kickback given by the Contractor or any of his Subcontractors, agents or servants;

(b) terminate the Contract; and

(c) Recover from the Contractor any loss or damage to the Employer as a result of such termination or of any other corrupt business practices of the Contractor or any of his Subcontractors, agents or servants.

The termination under Sub-Para (b) of this Sub-Clause shall proceed in the manner prescribed under Sub-Clauses 63.1 to 63.4 and the payment under Sub-Clause 63.3 shall

be made after having deducted the amounts due to the Employer under Sub-Para (a) and (c) of this Sub-Clause.

75.1 Termination of Contract for Employer's Convenience

The Employer shall be entitled to terminate the Contract at any time for the Employer's convenience after giving 56 days prior notice to the Contractor, with a copy to the Engineer. In the event of such termination, the Contractor:

(a) shall proceed as provided in Sub-Clause 65.7 hereof; and

(b) Shall be paid by the Employer as provided in Sub-Clause 65.8 hereof.

76.1 Liability of Contractor

The Contractor or his Subcontractors or assigns shall follow strictly, all relevant labour laws including the Workmen's Compensation Act and the Employer shall be fully indemnified for all claims, damages, etc., arising out of any dispute between the Contractor, his Subcontractors or assigns and the labour employed by them.

77.1 Joint and Several Liability

If the Contractor is a joint venture of two or more persons, all such persons shall be jointly and severally bound to the Employer for the fulfilment of the terms of the Contract and shall designate one of such persons to act as leader with authority to bind the joint venture. The composition or the constitution of the joint venture shall not be altered without the prior consent of the Employer.

78.1 Details to be Confidential

The Contractor shall treat the details of the Contract as private and confidential, save in so far as may be necessary for the purposes thereof, and shall not publish or disclose the same or any particulars thereof in any trade or technical paper or elsewhere without the prior consent in writing of the Employer or the Engineer. If any dispute arises as to the necessity of any publication or disclosure for the purpose of the Contract, the same shall be referred to the decision of the Engineer whose award shall be final.

SPECIFICATIONS-
SPECIAL PROVISION

Specifications
Special provisions

SP-01 General

These specifications are general, and the various descriptions and requirements given in these specifications are not necessarily repeated for each separate section of the works; they shall apply to all parts of the Works where they are applicable even when the relevant reference is not made.

SP-02 Location & Extent of Warsak Canal System Project Area

02(1) Location of Project Area

The irrigation supplies for the Warsak Canal System are drawn from Warsak Dam. The multi-purpose Warsak Dam was constructed in early 1960s with assistance from the Government of Canada, after the Indo-Pak Indus Water Treaty during 1960. The dam is located on Kabul River about 19 miles north-west of Peshawar. It supplies water for irrigation, generates electricity and provides drinking water to Peshawar and the surrounding villages. Two tunnels were constructed on both sides of the dam; a 10 ft dia. tunnel on the right side and 5 ft dia. tunnel on the left side. The right side 17,600 ft long 10 ft dia. tunnel supplies the water to the lands of Peshawar and Nowshera Districts having CCA of about 94,913 acres through Warsak Right Bank Canal System. The irrigation system was constructed in period 1963-1967 after the completion of Warsak Dam Project in 1961. The main canal of 550 cusecs capacity bifurcates at rd 20+130 into Warsak Gravity Canal and Warsak Lift Canal having design capacities of 284 cusecs and 200 cusecs respectively. The command areas of Warsak Gravity and Lift Canals are 54,885 acres and 40,028 acres respectively as reported in outlet registers of Irrigation Department, Govt. of Khyber Pakhtunkhwa.

Over the years, the system capacity has reduced due to system deterioration, excessive silt entry into the canal system and equitable irrigation supplies are big challenges for the operators of irrigation canals. Moreover, scarcity of irrigation supplies is proving to be an obstacle in achieving higher cropping intensities unlike in other parts of the province. Therefore, Remodeling Of Warsak Canal System Project has been envisaged to meet with the demands of irrigation supplies; which will result in socio-economic uplift of the area.

The project area lies within administrative boundaries of Peshawar and Nowshera Districts. The Warsak Gravity Canal passes through the thickly populated areas of Peshawar City.

Climatically, the project area is situated in the suburbs of Peshawar City stretching in length west to east and lies in arid to semi-arid region. The winter in Peshawar starts from mid November to the end of March. Summer months are May to September. The mean maximum temperature in summer is over 40 °c (104 °f) and the mean minimum temperature is 25 °c (77 °f). The mean minimum temperature during winter is 4 °c (39 °f) and maximum is 18.35 °c (65.03 °f).

Peshawar is not a monsoon region, unlike other parts of Pakistan but still rainfall is received both in winter and in the summer. The winter rainfall due to western disturbances shows a higher record during the months of February and April. The highest winter rainfall has been recorded in March, while the highest summer rainfall in the month of August. The average winter rainfall is higher than that of the summer. Based on a 30-year record, the average 30-year annual precipitation has been recorded as 400 millimetres (16 in). Wind speeds vary during the year from 5 Knots (5.8 mph) in December to 24 Knots (28 mph) in June. The relative humidity varies from 46% in June to 76% in August.

Peshawar's environment has suffered tremendously due to an ever increasing population, un-planned growth and a poor regulatory framework. Air and noise pollution is a significant issue in several parts of the city, and the water quality, once considered to be exceptionally good, is also fast deteriorating in quality as well as in quantity.

Physiographically, the project area is bounded by hills on all sides except in the north-east side where it is bounded by Kabul river canal system. The difference in canal bed elevations of Warsak Gravity and Warsak Lift Canal is about 165 ft. The land near the hills is undulating and gets fairly leveled towards the Peshawar. The general slope of the project area is 0.75% extending from south to north towards Kabul River. Most of the area exhibits piedmont and alluvial deposits. The loose sediments are composed of boulders, gravels, sand, silt and clays. The soils of the area are generally good for producing all type of crops.

The major river and khwars draining toward the Peshawar city side are Bara River and Narai, Zindai & Aza Khel Khwars.

02(2) Major Works Involved in Remodeling of Warsak Canal System Project

The main works involved in Remodeling Warsak Canal System Project are construction of 700 cfs capacity 5 km long auxiliary tunnel & appurtenant structures, up-gradation and installation of new pumps to lift about 290 cfs of irrigation water for 57 km long Warsak Lift Canal, remodeling of 69 km long Warsak Gravity Canal for 456 cfs and remodeling of nine minors. There are more than 1,000 structures of various types on main canals and minors including cross regulator, silt ejectors, escapes, drainage culverts, superpassages, VR bridges, DR and AR bridges, minor head regulators and watercourse outlets etc.

02(3) Contract Packages

Keeping in view the early and timely completion of the project, total project has been divided into a number of packages. The instant Package viz RWCS-01 Construction of Auxiliary Irrigation Tunnel and Allied Works comprises of Tunnel, Coffer Dam, Construction of Adit, Earthwork, Concrete Lining of Warsak Gravity Canal including minors within the reach.

SP-03 Site of Work for Contract RWCS-01

The site of Works for RWCS-01 (this contract) of Warsak Canal System Project is narrated below:

03(1) **Access to Contract RWCS-01 Area**

The Contract area is adjacent to Warsak Dam Reservoir in the North West side of Peshawar City. The intake structure of 17,073 feet long Auxiliary Irrigation Tunnel is accessible from Warsak Road through metallic road under all weather conditions. The proposed outlet structure area of tunnel is accessible through District Khyber via Shahgai Village.

The row, lines, boundaries and limits are shown on the drawings. All such areas shown on the drawings along with any additional areas adjacent thereto as may be designated by the Engineer from time to time for construction to be performed under the Contract shall comprise the site of Works.

03(2) Within the areas which may from time to time be defined as the site by the engineer, the Contractor shall carry out and perform the construction of the Works, and, subject to the approval of the Engineer, will be permitted to construct temporary roadways, camps, buildings and temporary works which he may require for the construction of the Works. If the Contractor wishes to use any land other than as aforesaid for construction of camps or for any other contractual purposes, the Contractor shall make all necessary arrangements with the owner thereof and shall bear all rentals or other costs connected therewith.

03(3) The Employer will give to the Contractor possession of as much of the area designated and defined as the site and shown on the drawings as may be required to implement the Works, when the Engineer's Notice to Commence Work is given.

SP-04 Climatological Data

The climate of the RWCS-01 area can be classified as arid to semi-arid. The average winter rainfall is higher than that of the summer. Based on a 30-year record, the average 30-year annual precipitation has been recorded as 16 inches.

SP-05 Utilities

The Contractor should enquire on his own for availability of power lines and telephone facilities for the use at his work site. All cellular communication services companies have quite wide coverage in RWCS-01 area.

SP-06 Geology and Ground Water Conditions

06(1) The geology of the strata along the proposed Auxiliary Irrigation Tunnel mainly consists of granite with presence of diorite / meta dolerite and phyllite as shown in the drawings. The sediments deposit in the Warsak Dam Reservoir consists of silly sand to 50 feet (15 meter) depth, sandy silt to a depth of 62 feet (19 meter) and granite gneiss rock top is encountered beyond this depth. Tenderers may refer to the geological and geotechnical investigations recently conducted by the Employer.

06(2) The Employer does not guarantee the correctness of the designation of any materials described in this clause nor any interpretations, deductions or conclusions relative to subsurface and groundwater conditions. Each tenderer and the contractor must form his own opinion of the character of the work and

the materials to be excavated. He must make his own interpretations and satisfy himself by his own investigations regarding all conditions affecting the work to be completed. Tenderers and the contractors must assume all responsibility for the deductions and conclusions as to the nature of condition of the materials to be excavated and of doing the other work as it is affected by the geology at the site of the Works.

06(3) In the area under this Contract, ground water generally lies at relatively medium to deeper depths and cannot be tapped easily by means of tube-wells to supply water for construction and other purposes.

06(4) The limited number of sub-surface soil profiles including sub-soil water levels were observed during geotechnical investigations for the project during the period from August 2012 to December 2012. The information may be collected by the Contractor solely to aid in planning his construction operations. The Employer does not guarantee the reliability or accuracy of any of the sub-soil profiles or sub-soil water elevations for Contract RWCS-01 and assumes no responsibility for any deductions, conclusions or interpretations, which may be made from the information provided.

SP-07 Extent of Work

07(1) under this contract, the Contractor shall construct the following Works:

The Contractor shall construct the Works in accordance with the drawings and specifications and/or as directed by the Engineer/Engineer's Representative. The Contractor shall procure, furnish, provide and arrange all the necessary construction equipment, transportation, fuel, electric power, water and services; be responsible for the construction and maintenance of the necessary construction camps, offices and warehouses, and perform all other works necessary for completion of the Works described herein in complete conformity with these Specifications.

SP-08 Description of the Works

08(1) The work under Contract RWCS -01 involves Construction of the Temporary Coffer Dam with steel sheet piles to cordon off the area of works for Construction of Auxiliary Irrigation Tunnel gated intake structure in Warsak Dam reservoir, Construction of 17,073 feet long 11.5 feet dia. RCC lined Auxiliary Irrigation Tunnel, Construction Adit and Gated Outlet structures with works for slope stability at the end of the Tunnel. The regulation structures for drinking water supplies is to Peshawar City, RCC rectangular channel and bridges to provide are also part of this Contract.
The Contractor is required to proposed the detail for the construction of temporary Coffer Dam and other temporary works for the prior approval of the Engineer, within specified period. The Construction of Coffer Dam will be form one – end only.

SP-09 Annual Closure Of Irrigation Tunnel

Existing Irrigation Tunnel supplying water to Warsak Canal System is annually closed for about one month in early January every year.

SP-10 Drawings

10(1) Tender Drawings

The drawings listed in Volume-II of Tender Documents and hereinafter referred to as Tender Drawings show the scope of the work to be performed by the Contractor. The tender drawings shall not be used as a basis for fabrication or construction, but may be used as the basis for planning, scheduling and placing preliminary orders for materials, subject to corrections based on future issue of construction drawings. Any other drawings if issued through addenda, before opening of tenders, shall become part of the tender drawings.

10(2) Construction Drawings

After award of Contract, tender drawings will be replaced by drawings issued by the Engineer for construction, with such modifications as may be necessary. The drawings issued for construction will include tender drawings re-issued, tender drawings modified and additional drawings as required to develop in greater detail the construction requirements and shall be referred to hereinafter as “Construction Drawings”. The drawings issued for construction will be reviewed by the Engineer for determination of adjustments, if any, of the Contract Price in accordance with the provisions of Sub-Clause-51.1, variations, of the Conditions of Contract-Part 1. The work shall be executed in conformity with the drawings issued for construction.

10(3) Checking Drawings.

The Contractor shall carefully check all drawings issued for construction as soon as practicable after receipt thereof, and shall promptly advise the Engineer of any errors or omissions discovered.

SP-11 Right to Change.

When additional information regarding the geological formations or other conditions becomes available as a result of excavation, testing, model studies, or exploratory work, the Engineer may find it desirable to change alignment, dimensions or design of one or more of the features of the canal to conform to the newly disclosed conditions. Toward this end, the Engineer reserves the right to make such reasonable changes, and the Contractor’s operations shall be conducted so as to accommodate any such reasonable changes in the Works.

SP-12 Drawings and Data to be furnished by the Contractor.

12(1) Shop and Reinforcement Drawings.

All shop drawings required for the work including reinforcing steel detailing, reinforcing bar bending schedules, field erection and layout and construction detail drawings shall be furnished by the Contractor for approval by the Engineer. All drawings shall be complete and shall be submitted in due time and in logical order to facilitate proper coordination.

12(2) **Lift and Placement Drawings.**

At least 28 days prior to starting construction of any concrete lift or other placement, the Contractor shall submit lift or other placement drawings to the Engineer for approval. Lift or other placement drawings shall be to such scale as to show clearly all recesses, openings and embedded structural, mechanical and electrical items etc., if any, in each lift in sufficient detail for proper installation and execution of the work.

12(3) **Plant Layout Drawings.**

Three prints of drawings showing the layout of the plant the Contractor proposes to use on the work shall be submitted by the Contractor to the Engineer for review. The drawings shall be submitted sufficiently in advance of the plant purchase to permit adequate review by the Engineer. The drawings shall show the locations of the principal components of the construction plant; offices; shops and storage buildings; housing facilities and storage areas and yards which the Contractor proposes to construct at the site of the work and elsewhere.

12(4) **Record Drawings.**

The Engineer shall, during the process of work, keep a record of all changes in and corrections to the designs and layouts shown on the drawings. The Contractor shall furnish the Engineer with all requested information, drawings, and other data necessary for such purpose.

12(5) **Other Drawings.**

Drawings showing proposed methods of constructing temporary works, all bar bending schedules and other drawings additional to those referred to hereinabove required by the specifications, shall also be submitted to the Engineer for approval or review as deemed necessary by the Engineer.

12(6) **Procedure for Submittal of Contractor's Drawings and Approvals.**

All shop drawings whenever required by specifications or drawings of the works including layout and construction details shall be submitted by the Contractor for the approval of the Engineer. Three (3) copies of such drawings shall be submitted in the form of prints from the original checked drawings. One print each of such drawings will be returned to the Contractor marked "approved", "approved except as noted", or "returned for correction". The notes "approved" or "approved except as noted" will authorize the Contractor to proceed with the Works. When prints of drawings have been marked "returned for correction", the Contractor shall make the necessary revisions on the drawings and shall re-submit in the same manner as before.

The approval of the drawings by the Engineer shall not be construed as a complete check but will indicate only that the general method of construction and detailing is satisfactory. Approval by the Engineer of the Contractor's drawings shall not be held to relieve the Contractor of his obligation to meet all the requirements of these specifications or his responsibility for the correctness of the contractor's drawings or of his responsibility for the correct fit of the assembled parts in their final positions or of his responsibility for the adequacy of the method of construction.

12(7) **Ownership of Drawings Etc.**

All the drawings, details, bills of materials and any other information or documents furnished by the Contractor shall become the property of the Employer and shall be non-returnable.

SP-13 Cooperation with Other Contractors.

Pursuant to the applicable clause of the Conditions of Contract, the Contractor shall coordinate his work with that of the other contractors at the site, to whatever extent may be necessary to complete the Contract in accordance with the schedule, the drawings and the specifications and the requirements of the Engineer. Should a disagreement or dispute arise between the contractors, the same shall be referred without delays to the Engineer for his decision. Upon such decision, the Contractors shall proceed with the Works in accordance therewith, immediately. In case the access to the Works of other contractors is through the site area of the Contractor, the Contractor shall coordinate with and permit all reasonable access to other contractors.

SP-14 Quality of Materials.

14(1) All materials, fixtures, fittings, and supplies furnished under the Contract Documents shall be new and unused, of standard first grade quality and of the best workmanship and design. No inferior or low grade materials, supplies will be either approved or accepted, and all work of assembly and construction shall be done in a first class and workmanlike manner. In asking for prices on materials intended for delivery to the site and incorporation in the works under any portion of these specifications, the Contractor shall provide the manufacturer or supplier with complete information as may, in any case, be necessary to secure compliance with this clause and, in every case, he shall quote this clause in full to each such manufacturer or supplier.

14(2) Prior to procurement, the Contractor shall furnish to the Engineer, for his approval, the names of the manufacturers of all equipment and materials which he contemplates incorporating in the works. With this information the Contractor shall also furnish such pertinent information as to capacities, efficiencies and sizes, and such other information as may be required by the Engineer. Samples of materials shall be submitted to the Engineer for approval when so directed. Equipment, materials, supplies and articles installed or used without the Engineer's approval shall be at the risk of subsequent rejection.

SP-15 Standards and Specifications.

15(1) except as otherwise provided by these specifications or the drawings, all materials and equipment, and fabrication and testing thereof shall conform to the latest applicable standards and specifications contained in the following list or to equivalent applicable standards and specifications established and approved in the country of manufacture or supply. Copies of these standards and specifications may be inspected at the offices of the Engineer or the Employer or purchased from the indicated agency which published them:

ASTM	American Society for Testing Materials
AISC	American Institute of Steel Construction
ASME	American Society of Mechanical Engineers
ASA	American Standards Association
AWS	American Welding Society

15(2) If the Contractor, at any time and for any reason, wishes to deviate from the above standards or desires to use material or equipment not covered by the above standards, he shall state the exact nature of the changes, the reason for making the change and shall submit complete specifications of the materials and equipment to the Engineer for approval.

SP-16 Inspections and Tests.

All equipment and materials furnished under these specifications and all work performed in connection therewith under the Contract will be subject to inspection by the Engineer or his authorized agent at all times and in all stages of completion. Inspection at the manufacturer's plant may be made to determine that the equipment and materials meet the requirements of these specifications. The Contractor shall notify the Engineer not less than 10 days in advance of the date and place that the equipment or materials will be available for inspection. The Contractor shall furnish promptly without additional charges all facilities, labour, materials reasonably needed for performing such inspection and testing as may be required by the Engineer. No equipment or material shall be transported until inspection at the manufacturer's plant has been made or waived in writing and final drawings have been furnished by the Contractor and accepted by the Engineer. Acceptance of equipment and materials or the waiving of inspection thereof shall in no way relieve the contractor of the responsibility for furnishing equipment and materials meeting the requirements of the Contract Documents.

SP-17 Contract Schedule.

17(1) **General.**

The Contractor shall submit his construction program/plan in accordance with Sub-Clause 14.1 – Program to be submitted, of the Conditions of Contract, to the Engineer for approval. The plan shall contain adjustments if any, to the CPM (Critical Path Method) based bar chart and network construction schedules submitted with the tender. The completion date, milestones, and key targets indicated in Appendix-A to tender shall be shown as such or dates earlier than the said milestone and key target dates, on the construction plan submitted by the Contractor. Other dates including rates of progress for various parts of the Works in the construction plan may be changed by the contractor in the submission for approval. The operations under each section of the plan submitted by the Contractor shall be broken down in greater detail than that shown on the schedule submitted with the tender.

The plan shall also show the timing of provision of all facilities the Contractor is to supply for the Engineer, in such manner that they shall be available as necessary in line with the construction program.

17(2) **Contractor's Construction Schedule Network.**

The Contractor shall prepare a critical path method construction network on primavera software. The network shall show the order and interdependence of calendar dates. Activities shown on the network shall consist not only of the actual construction operations but shall include also the submittal and approval of shop drawings and samples, procurement of materials and equipment, and installation and testing of major and critical items. Activities of the Employer/Engineer or other contractors (or manufacturers) that may affect the progress of such approvals and deliveries of equipment furnished by others, shall also be shown. Related activities shall be grouped on the network for simplification.

The critical path shall be clearly delineated on the network. The sub-selections of activities to be shown on the network shall be subject to approval of the Engineer. The network analysis shall show for each activity its description, preceding and following event (s), numbers duration, earliest expected start, float time, etc. all contract scheduled dates shall be shown.

17(3) **Schedule Coding.**

Appropriate coding structure shall be incorporated in the construction schedule. The basic Work Breakdown Structure (WBS) will be encoded in the activity I.D. other coding will be developed as the project progresses and specific coding needs arise.

17(4) **Resource Loading of the Schedule.**

Each activity in the schedule shall be resource loaded with manpower, equipment, pay items, and other resources that the engineer may deem important in the course of the Project.

17(5) **Submittals.**

(a) The programme of the works shall be submitted by the Contractor within the period and in the manner as stipulated in Sub-Clause 14.1 of Conditions of Contract.

The Engineer shall review such programme and shall approve the initial submittal as the project baseline schedule by which the performance of the Contractor will be measured as per section 17(6) below:

(b) Not used.

(c) Not used.

17(6) **Approved Progress Schedule.**

The approved programme shall be continuously monitored and kept current and updated by the Contractor throughout the work, and at least on every milestone date and submitted for approval. The Contractor's Schedules shall be available for examination during normal business hours. All revisions shall be accompanied by a detailed explanation of the reasons for the changes and

describing any new or modified construction procedure proposed and, if applicable, any steps being taken to improve progress.

SP-18 Lay Out of Works and Surveys.

18(1) **Reference Points, Lines and Levels.**
The Engineer will layout a reference line or lines in the field with accompanying points and bench-marks to enable the Contractor to establish therefrom survey control for construction. The Contractor shall supply plant, equipment, materials and labour for establishing the survey control by the Engineer. Slope stakes will be set by the Contractor before commencement of excavation and will be re-established as required during progress of work using bench-marks and reference points set by the Engineer.

18(2) **Verification.**

The Engineer may make checks as the work progresses to verify lines and grades established by the Contractor and to determine the conformance of the work as it progresses with the requirements of the specifications and drawings. Such checking by the Engineer shall not relieve the Contractor of his responsibility to perform all work in accordance with the drawings and specifications and the lines and grade given therein.

18(3) Based upon the Engineer's basic control, the Contractor shall provide his own primary control points, as needed for the work, and shall preserve and maintain them until otherwise authorized.

The Contractor shall be responsible for maintaining all survey markers/ monuments, and property corners. If any markers/monuments are destroyed by the Contractor, the Contractor shall arrange, at his own cost, to retrace and replace them to the entire satisfaction of the Engineer. If a monument cannot be replaced in its original position, the Contractor shall install a witness corner. The Contractor shall complete and file monument reference cards on all monuments as per instructions of the Engineer.

18(4) The Contractor shall provide experienced construction surveyors with adequate experience in the construction surveys similar in nature as required by this Contract.

18(5) The Contractor shall submit the following to the Engineer for his approval:

(a) at least seven (7) days prior to beginning surveying work, a complete plan for the surveying required to layout the works, including methods and time tables for establishing lines and grades;

(b) accompanying progress payment requests, the Contractor shall submit, for approval, a copy of applicable quantity survey notes and computations and an itemized statement for work performed or placed during the progress period measured on the basis of surveying;

18(6) Based upon Engineer's approved basic control monuments the Contractor shall establish all lines and grades necessary to control the works, and shall be responsible for all measurements that may be required for execution of the work to the tolerance prescribed in item 18(8) below.

18(7) The Contractor shall perform such surveys and computations as are necessary to determine quantities of work performed or placed during each progress payment period, and shall also perform all surveys necessary for the Engineer to determine final quantities of work in place. The Engineer will determine final quantities based on original ground levels determined by the Contractor and agreed by the Engineer.

The Contractor shall notify the Engineer at least 24 hours before performing a quantity survey and, unless specifically waived, quantity surveys shall be performed in the presence of an authorized representative of the Engineer.

18(8) Degree of accuracy for the survey works shall satisfy the following specified tolerances:

(a) Alignment of tangents and curves shall be within 0.1 foot for 1,000 feet i.e., an accuracy of 1:10,000.

(b) Structure points shall be set within 0.01 foot accuracy from point to point, except where installation or operation considerations require tighter tolerances.

(c) Cross-section points shall be located within 0.10 foot, horizontally and 0.01 foot vertically.

(d) Permissible closing error for a leveling line meant for_establishing temporary bench mark (tbms) should not exceed 0.045 x $\sqrt{m}$ foot, where m is in miles. The permissible closing error should be duly adjusted.

18(9) The Contractor shall provide all materials, equipment and labour required for surveying work, including, but not limited to, instruments, stakes, spikes, steel pins, templates, platforms, and tools, and except as required to be incorporated in the work or left in place, all such materials and equipment, shall remain the property of the Contractor. Surveying instruments shall be in perfectly good working condition and shall be subject to rigid inspection for proper operation at least after every two weeks of use. Defective instruments shall be promptly replaced or repaired and adjusted to the satisfaction of the Engineer.

18(10) Survey data shall be recorded in accordance with recognized professional surveying standards. Original field notes, computations, and other surveying data shall be recorded in the Contractor's furnished field books. Notes or data not in accordance with standard formats will be rejected. Illegible notes or data, or use of erasures on any page of a field book will be considered sufficient cause for rejection of part or the entire field book. Copied notes or data will not be permitted; therefore, rejection of part or all of a field book may necessitate re-surveying. Corrections by ruling or lining out errors will be satisfactory.

18(11) The cost of all materials, equipment, and labour required for surveys for the layout of works and quantity surveys required by this clause shall be deemed to be included in the rates and prices of the various items in the bill of quantities and no separate measurement and payment in their respect shall be made.

SP-19 Access to Site

19(1) Right of Way for Access and Haul Routes

The Contractor shall be responsible for providing and maintaining access to site of works. The right of way for access to the works from existing roads will be provided by the Employer. The Contractor shall make his own investigations of the condition of available public or private roads and of clearances, restrictions, bridge load limits and other limitations that affect or may affect transportation and ingress and egress at the job sites. The repair and reinstatement of roadways, drains and canal banks if damaged during operation shall be the responsibility of the Contractor without any additional cost to the employer. The Employer's controlled row along the canal/ distributaries/minors shall be the right of way available to the Contractor for carrying out the Works.

19(2) Haul and Construction Roads

The Contractor shall provide and maintain such haul and construction roads as are necessary for the conduct of the work. No separate payment will be made to the Contractor for the construction and maintenance of such roads and the costs thereof shall be deemed to be included in the premium quoted in the bill of quantities.

19(3) Use of Land outside Row

a) If Employer's controlled land is not available and private land is used by the contractor for field offices, construction plant, storage yards, shops and other construction facilities or other purposes, the contractor shall make all necessary arrangement with the owner of the land and shall pay all rentals or other costs connected therewith.

b) The location, construction, maintenance, operation and removal of the contractor's construction facilities on employer's or government's land shall be subject to the approval of the Employer.

19(4) Restoration of Row.

After completion of the Works, the row outside of the constructed embankments shall be restored by the Contractor to its original conditions.

SP-20 Facilities to be provided by the Contractor.

20(1) Contractor's Camps.

a) Pursuant to provisions of Clause 34 of Conditions of Contract, the Contractor shall provide at his own cost such camps as are required for the proper and efficient progress of the work to house his own employees and to provide site office facilities.

b) The Contractor's camps shall comply with the Pakistan Labour Camp Rules, 1960 issued by the Pakistan health, welfare and local government department and the requirements set forth therein.

c) The Contractor shall submit, for the approval of the Engineer, drawings and specifications of the proposed construction camps, residential and other facilities specified herein, required to be provided by him. The drawings for the construction camp and residential facilities etc., shall show the complete camp layout, including site work, utilities, drainage, landscaping, building locations, details of utilities and pavements, location of security fencing and all other required work.

20(2) **Buildings and Camps.**

All buildings constructed by the Contractor for his camps, workshops and warehouses shall be designed and constructed as temporary structures unless otherwise approved or directed by the Engineer.

Housing for the Contractor's personnel shall be constructed in accordance with his own requirements and certain Pakistani standards as specified herein. Materials, design and construction of the housing shall be subject to the Engineer's approval.

The Contractor shall furnish and equip buildings and other facilities in accordance with the laws and regulations of the Government of Pakistan and its official agencies, and as required for the proper functioning of each facility. All equipment shall be of a type normally used in similar construction and of a grade suitable for the required service. Equipment shall be durable, of non-combustible construction where possible and suitable for easy maintenance. All electric equipment, fixtures, and wiring shall be suitable for operation on 220 v, 50 hz alternating current.

The construction, operation and maintenance of the Contractor's labour camp shall conform to the requirements of the Pakistani labour camps rules, 1960, as published in the gazette of Pakistan, dated June 3, 1960, and to amendments to the rules which may be officially promulgated from time to time and to all applicable provisions of the Pakistan Labour Laws.

20(3) (a) **Camp Office at Site for the Engineer and the Employer**

The Contractor shall provide, equip and maintain at site camp office for the duration of the Contract, at location as approved by the Engineer, for use of the Engineer and the Employer. The site camp office shall be connected to the electrical system, portable water supply system and sewerage disposal system. The office accommodation shall be air-conditioned and fully furnished of covered area not less than 4,000 sq. feet each, as per layout plan, approved by the Engineer. The Contractor shall furnish and maintain the office accommodation with all essential facilities including office tables, chairs, conference room table & chairs, racks, filing cabinets stationeries, kitchen crockery/cutlery and maintenance, etc. along with electricity, water and sanitary facilities as approved by the Engineer.

The Contractor shall provide attendants and security for office throughout the period of Contract. The location plan, layout, type of structure to be built and the furnishings shall be subject to the approval of the Engineer. The Contractor's plans/drawings and specifications shall be submitted for approval of the Engineer within 14 days upon taking over the possession of the site by

the Contractor and the construction shall commence within seven days after approval of the Engineer.

(b) **Single Status Residential Accommodation at Site for Engineer's/ Employer's Personnel**

The Contractor shall provide furnished two (2) executive/senior staff bed rooms and two (2) supervisory staff single status hostel for the Engineer's/Employer's staff and one (1) barracks for ten (10) persons each for the field supporting staff at location approved by the Engineer. The executive/senior staff hostel and supporting staff barracks shall be attached with proper kitchen, toilets and common sitting room facilities. The location, layout and type of building and furnishings will be as approved by the Engineer. The Contractor shall be responsible for provision and continued operation of electricity, natural gas, water, sanitary facilities, up keep, maintenance and security of this facility during the currency of the Contract. He shall provide whole time cook, attendants at the hostel to meet the service requirements. The detail of furnishing for the hostel to be provided by the Contractor is as follows:

- Each bed room of the senior staff in the hostel will be furnished with:
  - 2 wooden (medium size) beds, 2 mattresses, 4 bed sheets, 2 pillows and 2 blankets
  - 1 study desk (wooden 4'x3') with drawers & locks and 2 chairs (wooden and foamed)
  - one easy chair (wooden and foamed)
  - carpet (wall to wall)
  - one wardrobe/Chester
  - one ceiling fan
  - one air conditioner/split unit
  - one tv set.
- Each bed room for the supervisory staff in the hostel will be furnished with:
  - 2 wooden (medium size) beds, 2 mattresses, 4 bed sheets, 2 pillows and 2 blankets
  - 1 study desk (wooden 4'x3') with drawers & locks and 2 chairs (wooden and foamed)
  - one wardrobe/chester
  - one ceiling fan
  - one air conditioner/split unit
- The barrack for field staff shall be furnished with following:
  - ten (10) ordinary M.S. pipe charpoys woven with suitable material
  - one bed side rack with 2 lockable drawers for each charpoy

- ten steel/wooden cabinets sufficient for hanging cloths and keeping belongings of one person for each.
- sufficient ceiling fans and two desert room coolers.

- Kitchen

  The kitchens for senior/supervisory staff hostel and for the barracks shall be provided for each of the following:

  - one cook, two bearers and the utensils including superior quality crockery, cutlery, cooking pans, tea set, etc. to meet the requirements of six in the hostel and twenty support staff in the barracks.
  - each common sitting room for hostel and staff barracks shall be furnished with easy chairs (wooden & foamed), centre tables (4'x2' each), side tables (2'x2' each), colour TV's, ceiling fans and air-conditioners/desert room coolers, dining table with dining chairs, carpet (wall to wall), wooden case for crockery etc. as approved by the engineer.

The workmanship and the quality of all items will be subject to approval of by the Engineer. The Contractor will be responsible for maintenance/repair of the above items and these will be replaced when they become not useable. Above residential accommodation for Engineer's staff shall be located at location approved by the Engineer, in a block separate from Contractor's own office/residential buildings.

(c) Not Used.

20(4) **Temporary Sanitary Facilities.**

(a) Contractor shall provide adequate temporary sanitary conveniences for the use of all employees and persons engaged on the work, including the employer and the Engineer and their employees. He shall ensure that his employees and labour make proper use of the latrines and do not foul the site.

(b) In addition to toilet facilities, suitable and adequate washing facilities shall be provided.

(c) Sanitary facilities shall be located where directed or approved by the engineer and shall be maintained in a clean and sanitary condition during the entire course of the work.

(d) Sanitary facilities for the Engineer and his personnel shall be located within the premises of the Engineer's site offices/cabin.

(e) At completion of the work, sanitary facilities shall be properly disinfected and all evidence of same including temporary buried tanks and foundation removed from the site.

(f) The septic tank and/or temporary holding tank(s) shall be kept pumped out at such intervals that the tank(s) will not overflow and contaminate the ground, flowing streams or surface drainage.

20(5) **Safety Requirements.**

Pursuant to provision of Clause 34.5 of Particular Conditions of Contract, the Contractor shall observe high standards of safety for men and machines at all times and with regard to safety, the Contractor shall comply with existing Pakistani laws.

In prosecuting the Works of this Contract, the Contractor shall provide working conditions on each operation that shall be as safe and not injurious to health as the nature of that operation permits. All the work shall be performed in accordance with applicable local and national laws, codes, requirements and regulations including safety, health, welfare of persons and others. The Contractor shall in general be fully conversant and comply with the relevant sections of all construction regulations enforceable by the law. The work shall also be carried out in compliance with the manual "safety requirements for construction by contract", dated June 1961 published by the Employer, and as amended hereinafter. In all excavation operations, the Contractor shall install, maintain and effectively operate appliances and use methods approved by the Engineer which will effectively reduce the amount of harmful dust and he shall exercise good practice in the control of dust. the crushing of rock, if any, the dumping of stone, the mixing of concrete and the handling of cement, steel and other materials shall be so conducted that these operations will not cause any injury fatal or otherwise, nor be detrimental to health.

20(6) **Fencing of Work Area and Security.**

All work areas, storage areas and such other areas where construction activity by the Contractor is proceeding shall be suitably fenced and guarded. The Contractor shall provide security guards and watchmen, and other personnel and facilities required for security and public safety. The cost of such fencing and security arrangements shall be deemed to have been covered by the premium quoted in the Bill of Quantities.

The Warsak Canal System Project is exposed to tribal concerns. Before starting work, the Contractor shall ensure the security and safety arrangements for his staff and Engineer’s/Employer’s staff.

20(7) **Accident Prevention**

The Contractor shall enforce all necessary rules and regulations for the safe prosecution of the work in order to avoid preventable accidents and to minimize injuries to his employees and those of other concerned entities. Work areas shall be adequately posted with safety signs and posters. Machinery and equipment shall be guarded and all hazards eliminated in accordance with the "safety requirements for construction by contract", dated June 1961, published by the Employer and with the latest "manual of accident prevention in construction" published by the Associated General Contractors of America, Inc. USA. He shall maintain a satisfactory system of inspection and scaling in all open cut excavations.

In addition to the reports which the Contractor may be required to file under the law, he shall file with the Engineer on or before the seventh day of each month a report giving the total force employed on this Contract in man-days during the previous calendar month, the number and, character of all accidents resulting in loss of time, and any other information on classification of employees' injuries received on the work and disabilities arising therefrom that may be required by the Engineer.

20(8) **Medical Facilities.**

The Contractor shall, during the entire period of his operations at the site, provide emergency facilities with adequate medical and surgical equipment for first aid treatment and approved qualified personnel to administer such treatment to all injured persons, including the Employer's and Engineer's personnel. The Contractor shall designate two or more approved competent licensed physicians, one of whom shall at all times be in readiness to answer calls to supply medical and surgical services. The Contractor shall submit for the approval of the Engineer and, upon such approval, install a means of rapidly summoning the physicians to the site of an accident or fire. Ambulance service at the contractor's camp shall be available at all times

20(9) **Fire Protection Facilities.**

The Contractor shall design, provide operate and maintain fire protection facilities for the offices, the construction camps, and as necessary to establish fire protection in accordance with the highest standards. These facilities including staff and equipment shall be provided at no additional cost to the Employer.

20(10) **Safety Devices.**

Safety devices shall be used as required and shall include but not be limited to those described hereinafter. Efficient safety helmets, and safety harnesses where required, shall be provided for all personnel including all authorized visitors to the site. Excavated areas shall be properly guarded from the beginning of excavation until the status of the work removes all possible element of danger. Cages shall be used for hoisting men, and cages or skips for hoisting materials during the construction of underground Works. Full precautions shall be maintained at all times underground works. The Contractor shall carry out underground works in accordance with the recommendations of BS 6164: code of practice for Safety. The efficiency of all safety devices shall be established by satisfactory tests acceptable to the Engineer before the hoists or skips are put into services and at least once every three months thereafter.

20(11) **Storage and Use of Explosives.**

During the course of execution if hard rock formation is encountered where use of explosives is inevitable, blasting will be permitted only when proper precautions are taken for the protection of persons, the Works and property.

Explosives shall be stored, transported, handled and used in accordance with the recommendations of BS 5607: code of practice for safe use of explosive in the construction industry. The Contractor shall comply with all special rules and regulations that may be made by the authorities having jurisdiction and

by the Engineer regarding construction of and storage in magazines, precautions on blasting and the like. The Contractor will be held responsible to the Employer for all claims for damage caused by blasting.

Before starting any drilling and blasting of rock, the Contractor shall submit his proposed plan in writing for such operations to the Engineer for approval and, upon approval, shall not deviate therefrom without the written permission of the Engineer. The Contractor's Plan shall include statements of minimum safe structures. Approval by the Engineer of the Contractor's plan of operation shall in no case relieve the Contractor of full responsibility for the entire drilling and blasting operation, including the safety of persons and the Works.

Accurate daily records shall be kept by the magazine keepers and shall account for each piece of explosive, detonator and equipment from the time of delivery at the magazine until its discharge in use. No explosive shall be stored or used until it has been plainly labeled for identification and accepted by the Engineer as new stock in sound conditions. The Contractor shall also maintain a record for each blasting operation showing the blasting pattern including the location, number and depth of holes, inclination of wedge cut holes, amount and strength of explosives per hole and per round sequence in firing and time delays for relay firing, actual length of pull or blast and other relevant information.

20(12) **Telephone System and Mobile Phones.**

The Contractor shall furnish, install and at all times maintain in good working order, a telephone system in the project construction area for the exclusive use of Employer / Engineer's Representative staff deployed at the Site.

The telephone system shall comprise at least one (1) brand new telephone set having direct dialing national facility. The Contractor shall be responsible for maintenance and billing charges of telephone till the issuance of Defects Liability Certificate.

In addition to above, subject to approval of Engineer's Representative, the Contractor shall provide at least three (3) brand new mobile phone sets of latest model along with sim, for the exclusive use of Engineer's Representative's staff in connection with the Contract. The Contractor shall be responsible for maintenance and billing charges of these mobiles @ Rs. 1000/- per month per set till the issuance of Defects Liability Certificate.

No separate payment for furnishing and maintaining above facility shall be made to the Contractor, and cost thereof, shall be deemed to have been included in the rates and prices of various BOQ items quoted by the Contractor.

The Contractor shall provide this facility within fourteen (14) days of issuance of Engineer's Notice to Commence.

20(13) **Operation and Maintenance of the Camps Facilities.**

For the purpose of operation and maintenance of the camps and facilities provided as above, the Contractor shall comply with all applicable provisions of the Pakistani Labor Laws and specifically to the following requirements:

(a) Camp areas shall be kept dry and free from dense vegetation. Measures shall be taken to control dust within the camp area, by water or oil spraying or other approved means.

(b) Any ponded water within a distance of 2 km of a camp shall be sprayed weekly with oil or other approved anti-malaria liquid.

(d) The Contractor shall provide garbage collection and disposal services for Engineer's offices and construction camps. Disposal shall be by burial (landfill) and/or incineration. Disposal area shall be located at sufficient distance away and downwind from camp facilities and offices so as not to create objectionable odors or health hazards. Equipment, methods of collection and disposal and locations of disposal area shall be submitted to the Engineer for the approval.

(e) The interior walls and ceilings of buildings shall be lime-washed or painted. The whole of the open space around the buildings shall be swept each day and all rubbish removed.

(f) Adequate sanitary convenience, including washing and bathing places shall be maintained at each of the camps. All sanitary fixtures, receptacles, toilet rooms, lavatories and wash rooms shall be cleaned and disinfected at least once every day.

20(14) **Drainage**

The ground around the buildings shall be graded to slope away from building perimeters so as to provide adequate drainage and shall be thoroughly compacted. Excavated material shall be disposed of by filling in low areas or as otherwise directed by the Engineer.

20(15) **Landscape**

The Contractor shall landscape area in the vicinity of the camps, offices and facilities constructed by him with grass, shrubs and trees as required to provide an attractive and pleasant area and to control erosion and local dust. Landscape areas shall be irrigated and fertilized as required to maintain plants in an attractive and healthy condition at all times.

20(16) **Water Supply**

The Contractor shall arrange for the water supply for the staff residences, labour camps, site offices, workyards, workshops, and various camp facilities. Construction of pumps, storage tanks, overhead tank, distribution system, and their proper running and maintenance shall be his responsibility. Chlorinated water shall be supplied 24 hours a day.

Water samples shall be tested every month and certificate submitted to the engineer indicating that the water is fit for human consumption from an agency approved by the Engineer.

20(17) **Electricity Supply**

The Contractor shall provide such electricity as is required for works and temporary works including labour camps, staff residences, offices and various

camp facilities. The Contractor shall also provide standby electricity supply arrangements for labour camps, staff residences, offices and various camp facilities.

20(18) **Fences**

All offices and construction camps shall be completely enclosed with an 8 feet high chain link fence of a type approved by the Engineer. All fences, gates, braces, concrete and other items required for a complete installation shall be furnished and installed by the Contractor.

20(19) **Emergency Facilities**

The Contractor shall provide emergency fire-fighting facilities at all his camps including hose, fire extinguishers, pails, axes, shovels and other emergency fire-fighting tools as may be necessary including equipment for emergency on-the-spot treatment of fire and smoke cases. Approved extinguishers in sufficient quantities shall be installed, maintained and replaced or recharged as necessary in contractor's camps and site offices for the engineer. Carbon dioxide extinguishers or approved equivalents shall be provided where electrical fires may occur.

20(20) **Laboratory Facility.**

The Contractor shall provide and maintain during execution of the Works fully equipped field testing laboratory at the Site along with trained staff up to the satisfaction of the Engineer's Representative. The space and testing equipment shall be finalized in consultation with the Engineer's Representative. No separate payment, in this regard, shall be made to the Contractor, and cost thereof, shall be deemed to have been included in the rates and prices of various BOQ items quoted by the Contractor.

SP-21 Facilities to be provided by the Employer.

21(1) **General**

Without prejudice to the generality of the various clauses of the Contract and except for the facilities referred to hereinafter, particular attention is drawn to the obligations of the Contractor to make his own arrangements for supply, maintenance and furnishing of labour camps, staff residences, offices, workshops, stores and store compounds and watching and guarding thereof.

The Contractor shall give to the Employer written demand of his requirements, well in time for site facilities as herein specified.

21 (2) **Land for Labour Camps and Staff Residences**

The Employer will provide free of charge to the Contractor land within ROW subject to availability, at different locations for constructing residential and office accommodation as specified in appendix-h to tender for his staff and labour. If the Contractor wishes to set up camps at alternative or additional locations, he shall make his own arrangements for acquisition/rental of land.

21 (3) **Area for Storage, Warehouse and Workshop**

The Employer will provide free of charge to the Contractor an open area of adequate size within ROW subject to availability, for use as storage, warehouse and workshop areas indicated in appendix-h to tender. If the Contractor wishes to set up camps at alternative or additional locations, he shall make his own arrangements for acquisition/rental of land. The Contractor shall provide at his own cost, all fencing, any necessary clearing, foundations and above ground structures for sheds, warehouses, covered areas, workshops, electricity, telephone and water distribution etc, as he may need to meet his requirements.

SP-22 Transportation and Handling of Cargo.

22(1) **General.**

The Contractor shall arrange all shipments of imported goods, if any, including materials, plant and equipment required for the works through conference lines vessels including Pakistan National Shipping Corporation (PNSC). The Contractor shall be solely responsible for the shipment of materials, plant, equipment and all other things necessary for completion of works including the selection of routes and carriers to ensure that all shipments are safely and expeditiously transported. It may, however, be noted that carriers of certain nationalities may be prohibited for delivery to Pakistani ports from time to time. The Contractor shall not consign any shipment to any prohibited carriers and shall be responsible for complying with any such regulation of the Government of Pakistan.

22(2) **Transportation Route.**

The Contractor shall make his own enquiries to ensure that adequate unloading and other facilities are available at the port of Karachi/Port Qasim. He is warned that for heavier loads it may be necessary to use ship's tackle and he may, therefore, wish to impose limits on his loads.

The Contractor shall be solely responsible for satisfying himself at the time of shipment as to the clearance gauges, suitability and availability of wagons, availability of railway cranes and costs and charges for railway freight.

Alternative road transportation is available between Karachi/Port Qasim and the site. Improvements and modifications to both railway and road conditions are continually in progress and the best route will depend on the size and weight of any shipment.

22(3) **Port Charges and Port Congestion.**

The Contractor shall be deemed to have obtained all information as to port clearance facilities/charges, loading and unloading facilities/costs, storage facilities/charges, transportation facilities/costs and congestion at Karachi port and port Qasim and shall be deemed to have confirmed the requirements thereof. The Contractor shall be deemed to have included all clearing, forwarding and any other incidental costs in this regard in his tender. The Contractor has the option to use either the Karachi or port Qasim or both at his own risk. All charges, cost and expenses incurred by the Contractor shall not be separately reimbursable. No extension of time will be allowed on account of the Contractor's failure to inform himself of the situation.

SP-23 Environmental Protection.

The Contractor shall exercise care to protect the natural landscape and shall conduct his construction operations so as to prevent any unnecessary destruction, scarring or defacing of the natural surroundings in the vicinity of the works. Except where clearing is required for permanent works, approved construction roads and temporary works, and for excavation operations, all trees and native vegetation shall be preserved and shall be protected from damage which may be caused by the contractor's construction operations and equipment. On completion of the Works, all work areas shall be smoothed and graded in a manner to conform to the natural appearance of the landscape. Where unnecessary destruction, scarring, damage or defacing may occur as a result of the contractor's operations, it shall be required, replanted, or otherwise corrected as directed by the Engineer at the Contractor's expense.

SP-24 Initial Filling of Canal

The Engineer will instruct the Contractor when the initial filling of the canal is to be carried out taking account of the state of completion of the various parts of the Warsak Canal System Project (including Works not forming part of this Contract), together with the expected rate of progress on any remaining parts of the canal works which might be affected by the filling operation. A joint inspection of the substantially completed portion of canal, before filling and after filling the canal with water, will be carried out by the Engineer, Contractor and other stake holders, as per filling procedure and rate of drawdown during emptying, approved by the Engineer. Initial filling of the canal will be carried out by admitting flows through the head regulator into the canal by controlled increments or stages to elevations and for durations to be determined by the Engineer.

The Contractor shall remain in attendance and render such assistance as may be required by the Engineer in monitoring the performance of the canal during and immediately after initial filling operation. Initial filling of the canal is included in the Works to be completed within the Time for Completion specified in appendix A to Tender.

SP-25 Cost of Filling and Emptying the Canal

The canal will be filled up and then emptied after trial running. The cost of filling and emptying the canal (rectification of defects found during inspection, if any) thereof will be borne by the Contractor.

SP-26 -------- Not Used --------

SP-27 Directed and Required.

Unless otherwise stated, wherever in the specifications, or upon the drawings, the words "directed", "required", "permitted", "ordered", "designated", "prescribed" or words of like import are used, it shall be understood that the direction, requirement, permission, order, designation or prescription of the engineer is intended, and similarly the words "approved", "accepted", or "satisfactory" or words of like import shall mean approved by or acceptable or satisfactory to the engineer.

SP-28 Unit Price Break Down.

Within 28 days after receipt of the Engineer's Order to Commence, the Contractor shall submit to the Engineer the breakdown of unit prices for three selected excavation items, three selected fill material items and three selected concrete items in accordance with a prescribed form and instructions furnished by the Engineer.

SP-29 Measurement and Payment – General Provisions.

29(1) **Measurement – General.**

Measurement for payment at the unit and lump sum prices of the Contract will be made by the Engineer of the actual quantities of work performed or items furnished in accordance with the specified methods of measurement. In all cases where a quantity under one item measured for payment is contiguous to the quantity under another item measured for payment, the exact division lines marking the beginning and end of quantity under each item shall be determined by the engineer. Unless otherwise specified under a Contract item, measurement for payment will be made only of material removed or placed, accepted and required as part of the permanent work. Excavation for construction plant and other purposes as for Contractor's own requirements will not be measured for payment.

29(2) **Payments – General.**

Payment will be made as provided in Clauses 55 through 61 of the Conditions of Contract and as specified hereinafter. Payment will be made at the Contract Prices for the Contract items in the accepted tender as defined in the aforementioned clauses, herein below, and in the various clauses on measurement and payment throughout the technical specifications. Unless an item is specifically provided therefore in the bill of quantities, no separate payment will be made for the work required by the special provisions.

29(3) **Compensation Included – General.**

Payment to the Contractor of the amounts based on the actual quantities of work as measured by the Engineer in accordance with specified methods of measurement and the prices stipulated in the accepted tender, will constitute complete compensation for all work shown on the drawings, provided in the specification or other Contract Documents, and all expense incidental thereto; and all cost of accepting the general risks, liabilities and obligations set forth or implied in the Contract Documents. The Contractor will be required to perform such work for such payment whether the work is specifically referred to or otherwise included in a specific item in the bill of quantities or not. Payment under all items shall include, but not necessarily be limited to compensation for furnishing all supervision, labour, plant, equipment, overhead, profit, materials and services, and performing all work required to accomplish and complete the work specified under each item and all other work required by the contract documents. Increase or decrease of costs, of the Conditions of Contract, will not be made for such portions of the work that have been done in violation of the Contract, or for which measurement for payment is not authorized by the Contract.

SPECIFICATIONS-
TECHNICAL PROVISIONS

TECHNICAL PROVISIONS

1 – GENERAL ITEMS

Mobilization and Demobilization

1.1 Scope of Work: The work to be done under this item shall include, but not be limited to the following:

a) Transportation of Contractor's plant and equipment to Site and making such plant and equipment operational.

b) Mobilization of Contractor's personnel and labour at site.

c) Provision of facilities for housing, accommodation, and amenities for staff and labour as described in Clause SP-19 of Special Provisions, and Clause 34 of the Conditions of Contract.

d) Provision of Contractor's field offices, testing laboratories, workshops, warehouses, sheds, storage yards and other operational facilities by the Contractor for proper and efficient execution of the Works.

e) Provision of electrical power supply and standby power supply, to operate and maintain the Contractor's camps, offices, workshops and equipment etc.

f) Provision for potable and raw water systems for use in construction and in camps/housing and offices including installation of the necessary wells, pumps, pipe lines, canal/ ditches, storage tanks and suitable arrangements for delivery of water at various points of requirement.

g) Provision of sanitary, sewerage and storm water drainage systems.

h) Collection of garbage and its disposal.

i) Provision of religious facilities.

j) Provision of lighting and communication systems, security facilities including security fencing and gates; fire fighting arrangement including associated equipment and supplies.

k) Provision of approach roads as may be deemed necessary by the Contractor in his camp areas and haul roads on the Site of works.

l) Operation and maintenance of the above facilities and all other facilities deemed necessary by the Contractor and provided by him for the health and welfare of his labour staff throughout the Contract period to maintain efficient execution of the Works.

m) Handing over to the Employer and/or removal of the facilities on completion and clearance of the Site as per Clauses 32 and 33 of the Conditions of Contract.

n) Demobilization of plant and Contractor's equipment and personnel on completion as per Clause 33 of the Conditions of Contract.

Performance Security

1.2 Within twenty eight (28) days of receipt of the Letter of Acceptance from the Employer, the Contractor shall furnish to the Employer the Performance Security in the amount as specified in Sub-Clause 10.1 of Performance Security of Particular Conditions of Contract Part-II. The forms of Performance Security provided in the Tender Documents or other forms acceptable to the Employer may be used. The cost of arranging such security shall be borne by the Contractor.

Insurance for Works and Contractor's Equipment

1.3 The Contractor shall insure in the joint names of the Employer and the Contractor against all loss or damage from whatever causes arising, in accordance with clause 21 of the Conditions of Contract and in such manner that the Employer and Contractor are covered for the period stipulated in Sub-Clause 20.1 of the Conditions of Contract and are also covered during the Defect Liability Period for loss or damage arising from a cause, occurring prior to the commencement of the Defect Liability Period, and for any loss or damage occasioned by the Contractor in the course of any operation carried out by him for the purpose of complying with his obligations under Clauses 49 and 50 of the Conditions of Contract. The cost of arranging such insurance policy shall be deemed to have been included in the rates and prices quoted by the Contractor in the Bill of Quantities and no separate payment shall be made in this regard.

Insurance against Accident to Workmen

1.4 The Contractor shall insure against accidents or injury to any workman or any other person in the employment of the Contractor or any sub-contractor under Clause 24 of the Conditions of Contract, and shall continue such insurance during the whole of the time that any persons are employed by him. The cost of arranging such insurance policy shall be deemed to have been included in the rates and prices quoted by the Contractor in the various items of Bill of Quantities and no separate payment shall be made in this regard.

Third Party Insurance

1.5 Before commencing the execution of the Works, the Contractor shall insure against his liability for any material or physical damage, loss or injury which may occur to any property, including that of the Employer, or to any person, including any employee of the Employer, by or arising out of the execution of the Works or in carrying out the Contract, in accordance with Clause 23 of the Conditions of Contract. The cost of arranging such insurance policy shall be deemed to have been included in the rates and prices quoted by the Contractor in the Bill of Quantities and no separate payment shall be made in this regard.

Progress Photographs and Video Documentary Film

1.6 (1) Photographs at various stages: The Contractor shall take photographs of all salient features of construction including all structures and at each of the following stages of construction as directed by the Engineer:

a) Before commencement of work
b) Monthly thereafter during construction or at shorter intervals as instructed by the Engineer.
c) Upon completion of any significant work; and
d) Upon completion of the Project before the commencement of Defects Liability Period.

At least two different views of the aforementioned shall be furnished to the Engineer.

(2) Quality and Quantity of Photographs:

a) All photographs shall be coloured and glossy finish.
b) Photographs shall be 5 by 7 inches in size. When larger size prints are required, the Contractor will be paid extra at actual cost.
c) The Contractor shall furnish three (3) copies each of all photographs.
d) The Contractor shall retain all soft copies of all the photographs, which shall be made available to the Engineer on request. The soft copies properly filed and logged shall be handed over to the Employer at the time of his Taking-Over.

(3) Identification of Photographs: The following information shall be typed on the back of each print furnished:

a) Title of Project
b) Identification of subject shown
c) Station point of camera and direction of view
d) Date taken
e) Name of Employer/Engineer and Contractor

(4) Permission for Photographs: No photographs of the Site or the Works or any part thereof shall be published or otherwise circulated without the permission of the Employer.

(5) Documentary Film: The Contractor shall arrange for moving pictures to be taken by an approved specialist company of appropriate stages of the construction of the Works and shall have them edited into a video documentary film to suit the requirements as determined by the Engineer, all in colour. The film shall include clips from each stage and location of the Works, and shall be at least one hour in length. The film shall have a spoken commentary in English and background music. Three copies of the video film shall be supplied to the Employer and one copy to the Engineer.

The cost incurred in connection with the activities discussed under Item 1.6 shall be deemed to have been included in the rates quoted by the Contractor in the Bill of Quantities and no separate payment shall be made in this regard.

Transportation facility for the Engineer

1.7 The Contractor shall provide, operate and maintain one number vehicle well maintained and good running condition for the use of Engineer's Representative's staff to meet their exclusive transportation needs in connection with the Contract. The vehicle shall be provided by the Contractor within seven (7) days of receipt of first installment of mobilization advance in accordance with Sub-Clause 60.12 of Particular Conditions of Contract. The Contractor shall furnish supply and provide, as may be necessary without specific direction of the Engineer/Engineer's Representative, all fuels, lubricants, tyres and other supplies, all maintenance, repairs, comprehensive insurance cover and running costs and suitably qualified drivers at all times and will provide a substitute vehicles in case the vehicles are temporarily or permanently rendered unserviceable for any reasons(s)

The Contractor shall maintain the vehicle till the Completion of Contract. The vehicles shall become the property of the Contractor after the Completion of Contract.

No separate payment shall be made to the Contractor for the facilities involved under this sub-clause. The cost thereof shall be deemed to have been included in the price quoted by the Contractor for the work.

Measurement and Payment

1.8 (1) Mobilization and Demobilization: No separate payment will be made for mobilization and payment for this activity shall be deemed to be covered by the tendered rates quoted by the bidder in the shape of percentage above below on Engineer's estimate / BOQ. The Employer will however, make an interest-free mobilization advance to the Contractor as financial assistance for mobilization under Sub-Clause 60.12 of Particular Conditions of Contract, recoverable in equal instalments.

(2) Provisional Sum:

Pursuant to Clause 58 of Conditions of Contract, measurement of Provisional Sum Items will be made as per actual amount incurred and shall inter alia include payment for changes in cost and legislation as per actual amount calculated according to Clause 70 of Conditions of Contract and various unforeseen items.

2 – DIVERSION AND CARE OF WATER

General

2.1 The Specifications under this Section include the technical requirements for planning, designing, testing, construction, maintenance, removal of Temporary Works for diversion and care of water during the period of construction of Permanent Works.

Scope of Work

2.2 The Contractor shall divert the river water from the area of Permanent Works, care for all surface water and groundwater from any source, as may be required, so that all construction works can be performed in the areas free from water, in accordance with the specifications contained in this Section and as shown on the drawings, or as directed by the Engineer.

During construction of Works in the Warsak Dam Reservoir, the reservoir pond level will be maintained by the operators of Dam so as to continue supplying the reservoir water to the off-taking canal and Warsak Hydropower Project. All the Temporary Works under Diversion and Care of Water are, therefore, required to be adequately safe against the maximum pond level at Warsak Dam Reservoir.

The Contractor shall design, furnish, construct, operate, maintain, and remove the necessary facilities and Temporary Works as may be required for diverting the reservoir flows, dewatering the construction areas, for caring all surface water and groundwater from any source, and for general protection of Works conforming to the general accepted engineering practices. **Nothing in the Contract Documents shall relieve the Contractor from full responsibility for the adequacy of the protection and diversion works and care of water.**

The Contractor shall submit all design calculations relating thereto with his proposal, for approval of the Engineer. The Contractor's proposal for diversion and care of water shall not require any change to the location, dimensions, design, or details of any part of the Permanent Works.

Submittals

2.3 The Contractor shall submit his proposed Scheme for diversion and care of water for approval of the Engineer within 28 days of the Engineer's notice to commence work. This submission shall include all information necessary to understand fully the Contractor's Scheme and its interrelationship with the Contractor's Construction Schedule. The submission shall include the following:

- Detailed description of the proposed method of closing and cordoning off the area of Works from the reservoir water, complete with the proposed schedule thereof, materials to be used in cofferdams including steel sheet piles, concrete blocks and stone weights or sizes required for the closure; plan, methodology and schedule for haulage of suitable earth material.
- Description of the methods, including the layout and capacity, of the drainage and dewatering systems proposed for the construction of all cofferdams and other Temporary Works.

- Description of the methods, including the layout and capacity, of the drainage and dewatering systems proposed for the construction of all parts of the Permanent Works.

- Proposed outline specifications for any elements of the Temporary Works not covered by these Technical Specifications, or for which the Contractor wishes to propose alternative specifications.

- Description of any aspects of the Contractor's proposed Scheme which may differ from that submitted with his Tender, giving the reasons for such differences.

After reviewing the initial submission, the Engineer may require the Contractor to submit further information or revised proposals until, in the Engineer's opinion, the proposals are satisfactory and acceptable.

Temporary Works

2.4 The construction of all Temporary Works for the diversion and care of water shall conform to the requirements of the appropriate sections of these Specifications.

(1) Construction of Coffer Dams: The Contractor will construct coffer dams for cordoning the area of works for construction of auxiliary tunnel intake structure. The suitable earth material for construction of Coffer dam and ramps to access the area of works is not available in the immediate vicinity of Warsak Dam. The Contractor will be required to deploy sufficient resources for haulage of earthfill material.

(2) Removal of Coffer Dams: No cofferdam or part thereof shall be removed without written approval of the Engineer and the Engineer is satisfied that removal of coffer dam can be undertaken without detriment to any parts of the Permanent Works protected by the cofferdam, or to the safe conveyance of water through and/or past the site of the Permanent Works, and that the arrangements for the diversion and care of the water, remaining after removal of the cofferdam are to the entire satisfaction of the Engineer.

(3) Dewatering: Except where otherwise specified, shown on the Drawings or approved by the Engineer, the Contractor shall maintain all foundations and other Permanent Works areas well drained and free of water of any origin, including groundwater, seepage, precipitation, run-off or from construction uses.

Except where otherwise approved by the Engineer, the Contractor shall drain, dewater and keep dry all areas of construction that are below the river bed or the groundwater elevation, and shall ensure that all excavated surfaces are maintained in a safe and stable condition.

All embankments whether Permanent Works or Temporary Works, shall be placed in the dry, with the exception of such parts of the Contractor's Scheme as are designed to be placed in water and have received the Engineer's prior approval for that method of placing.

The work to be performed by the Contractor in connection with dewatering shall include, but not necessarily be limited to the following:

- The supply, installation, operation, maintenance and subsequent removal of all pumps, pumping stations, pipe work and other equipment, including sufficient standby equipment, for the dewatering of the works areas and maintaining those areas free of water as required. Should deep well pumps be deployed, they shall be placed at least 100 feet beyond the limits of any completed Permanent Works, except flexible aprons.

- The construction, maintenance and subsequent removal of any temporary sumps, cofferdams, protective bunds or dykes and the like.

- The construction, maintenance and subsequent backfilling of such temporary drains or ditches as are required to efficiently carry all water to sumps or other collection or disposal locations.

- The supply, installation, maintenance, operation and subsequent removal of dewatering wells and/or well points.

a) Groundwater Pressure Relief: The Contractor shall evaluate all groundwater information and take all measures necessary to ensure the stability of all structures and ground surfaces during construction. The measures needed may depend on the precise sequence of such matters as excavation, construction and the installation of drainage wells or well points.

The Contractor's dewatering arrangements may require the drilling of drainage wells from the ground surface, together with the installation of piezometers to monitor groundwater levels and the performance of the dewatering arrangements.

If, in the opinion of the Engineer, the foundation is damaged due to any inadequacy or failure of the Contractor's system for groundwater pressure relief, then the Contractor shall take all corrective measures necessary, as directed by the Engineer, at no additional cost to the Employer.

b) Excavation for Concrete Structures: At all excavations where concrete is to be placed, the water level within and adjacent to the excavation shall be maintained a minimum of two feet below the finished excavation level during the construction and for at least 24 hours after the completion of the structure to an elevation above the natural water table, or for such additional time as the Engineer may require to preclude injury to the foundation or structure.

(4) <u>Maintenance of Temporary Works:</u> The Contractor shall maintain all Temporary Works required for the diversion and care of water, shall carry out any repairs promptly and shall ensure that each part of the Temporary Works functions properly throughout the requisite period.

(5) <u>Removal of Temporary Works:</u> Temporary Works for the

diversion and care of water shall be removed promptly after they have served their intended purpose. The Engineer may, however, permit the removal of certain Temporary Works to be delayed, if he is satisfied that this will cause no detriment to the Permanent Works or to the safe conveyance of water through and/or past the site of the Permanent Works, and that the Contractor has made adequate provision for their subsequent timely removal.

Removal of all Temporary Works for the diversion and care of water shall be carried out in a workmanlike manner acceptable to the Engineer, leaving a clean appearance to the remaining surfaces, and so as not to interfere with the proper completion or future functioning of the Project. Waste material shall be properly disposed of, to the satisfaction of the Engineer.

(6) Reinstatement: Any surfaces which are affected by erosion or deposition due to the flow of water shall be reinstated in such a manner and at such a time as the Engineer may direct, having regard to the construction, safety, stability and proper functioning of the Permanent Works i.e. Re location of road works.

Measurement and Payment

2.5 (1) General: Prior to beginning any work pertaining to Diversion and Care of Water covered under Bill of Quantities (BOQ), the Contractor shall submit a payment schedule in such form as to allocate the total lump sum amount tendered in BOQ to the major divisions of work to be performed under that Item. For each major division of work to be performed, the payment schedule shall show the proportionate part of the total lump sum amount allocated thereto. The above allocation of the lump sum amount shall be approved by the Engineer. Monthly statements for progress payments shall include the amount allocated to each major division of work for each month as approved by the Engineer.

The lump sum price included in the priced Bill of Quantities shall be deemed to cover all costs of diverting the flows, conveying flows through and/or past the site of the Permanent Works, construction and removal of Coffer Dams; procurement, installation and removal of steel sheet piles for Coffer Dams, keeping each part of the Works protected against inundation, well drained and properly dewatered during construction including the furnishing of all power and energy necessary to comply with these Specifications; and of constructing, maintaining, operating and removing all Temporary Works in connection therewith. The steel sheet piles removed from temporary works shall be the property of the Contractor. Any costs resulting from accidental inundation of any working areas, whether due to breakdown, failure or overtopping of the Temporary Works, shall be to the account of the Contractor.

The lump sum price shall be deemed to include all measures for the diversion and care of water required for the proper completion of all Permanent Works, whether or not they are specifically mentioned in the Contract.

The lump sum price shall be deemed to take account of any effects of the measures for the diversion and care of water on any

surfaces, including such effects as erosion and deposition due to the flow of water. The lump sum price shall be deemed to include all costs resulting from the reinstatement of such surfaces.

(2) Measurement: Diversion and care of water will be measured as a complete unit for the Works on Lump sum basis.

(3) Payment: Payment will be made at the lump sum price tendered in the BOQ for the item 'Diversion and Care of Water'.

3 – EARTHWORK

General

3.1 (1) Scope of Work: The earthwork under this Contract involves excavation unclassified for canals, foundations of structures; earthfill for embankments of canals, embankment fills for bed and slopes of the canal in fill and for roads; backfill around or underneath structures; disposal of excess material from excavations; compaction, testing and performing all the related works in accordance with the Specifications and/or as directed by the Engineer.

(2) Plan for Management of Earthwork: The Contractor shall establish, maintain, and operate an equipment fleet sufficient, under modern earthmoving practices, to accomplish the Works in consideration of the site conditions, haul distances, and Technical Specifications. The Contractor shall furnish his plan of the earthmoving portion of the Works to the Engineer using the Mass-Haul Diagram Method and a written narrative of the earthmoving plan. The Mass-Haul Diagram shall begin at the first station of the Project with an ordinate of "0". If the Contractor indicates in the Construction Plan that the earthwork will be performed in independent sections, then the Mass-Haul Diagram shall be submitted separately for each section. The Mass-Haul Diagram shall contain a legend that shows the type of equipment, spread and haul distance for each piece of equipment.

The plan shall also include the Contractor's methodology for excavation, placement of fill, disposal of excess material from excavations, compaction of the embankments and subgrade in the canals (bed and side slopes). For lined section of the canal, subgrade preparation shall be in accordance with the specifications given in Section "Canal Lining".

(3) Levels to be Recorded: Before the surface of any part of the site is excavated or the works thereon begun, the Contractor shall take and record levels and dimensions of any such part. The Contractor shall also take and record such other levels and dimensions as are necessary during the progress of the excavation to allow accurate measurement of the excavation quantities.

All levels and dimensions shall be taken in the presence of the Engineer and recorded in the manner specified or as agreed with the Engineer, and such levels, when agreed with the Engineer, shall form the basis for measurement.

(4) Bench Marks or Datum: Any bench mark, which is used for the Works, shall be correctly related to the datum specified on approved drawings or fixed by the Engineer and the Contractor shall establish and maintain at his own cost, all such permanent bench marks required for the proper execution of Works in the vicinity thereof, in perfect order to the satisfaction of

the Engineer.

(5) Joint Survey Work: Before starting excavation for the Canal, the Contractor shall jointly conduct, record, plot and submit to the Engineer for approval, the measurements to show the existing cross-sections at every 500 feet interval and any other intermediary interval as required by the Engineer. The excavation "pay line" shall also be indicated on these cross-sections and approved by the Engineer.

(6) Setting Out: Before commencing actual execution, the central line of the embankment or excavation shall be distinctly marked with a deep furrow (dag-bel) at least 10 inches wide and 6 inches deep and pegs shall be fixed at every 100 ft along this furrow. Top and bottom edges of the excavation and toes of all embankments shall be clearly lock-spitted. All curves in the alignment shall also be properly laid and half-breadth carefully set out.

(7) Profiles: Having marked the alignment, a complete profile of the embankment or cutting, as the case may be, shall be set out at 500 ft intervals or at every change of section, and also at every curve. This profile shall have a linear dimension of 10 ft. It shall be excavated to the proper level, and banks constructed to the correct height and widths, and all slopes dressed to true form. The correct height of this profile shall be 10 percent more than the designed final level of the embankment so that it may take care of settlement. The ends of all the profile banks shall be stepped so that proper locking takes place at the time of construction of the banks adjoining them.

All labour and implements like bamboos, stakes, strings, pegs, batter boards, etc., required for fixing profiles shall be supplied by the Contractor and the cost shall be deemed to have been included in the unit rates quoted in BOQ.

(8) Trial Earthwork Section: Prior to commence full scale earthwork operations, the Contractor shall construct a Trial Earthwork Section of at least 400 feet of a channel to demonstrate that his proposed methods and equipment, modified as necessary, for excavation, haulage, placing, moisture control, compaction, trimming, and final grading of canal prism etc., will meet the requirements of the Specifications.

Material excavated and used in compacted backfill or embankment will subject to reduction in volume on account of the specified compaction. The trial section shall be used to check the extent of such reduction. The Contractor will allow for this reduction in volume in all calculations for his earthwork plan, and no extra payment will be made over the applicable items in the Bill of Quantities.

No extra payment will be made for the Trial Earthwork Section over and above the payment at the applicable unit rates for items included in the Bill of Quantities for the earthworks involved.

(9) Class, Nature or Conditions of Soil: The Contractor shall acquaint himself with the class, condition, origin or the nature of the ground, sub-soil and also the fluctuating nature of sub-soil water level, which might be encountered during Earthwork (Excavation and Earthfill). The employer does not guarantee or warrant anywhere that the material to be found in the excavation will be similar in nature to that of any samples, which might have been exhibited or indicated on the drawings or anywhere else in the Contract Documents.

The Contractor shall assume all responsibility for deductions and conclusions as to the nature of the materials to be excavated and the difficulties of executing and maintaining the required excavation. The Employer does not guarantee that the excavation can be performed or maintained at the neat lines described in these Specifications or as shown on the drawings. The excavation in wet soil or slushy and daldal conditions or in standing water may be encountered for which Contractor shall be deemed to have made all relevant arrangements of manpower, tools, plants, machinery, equipment or any other means necessary for excavation. Any excavation executed beyond the "pay lines" shown on the drawings will not be considered for the payment by the Engineer, and shall be deemed to be at the expense of the Contractor.

Jungle Clearing, Grubbing and Stripping

3.2 The Contractor shall carry out clearing and grubbing of all the areas within the right of way as shown on the drawings or as determined by the Engineer. Such areas shall be cleared of all trees, bushes, disused buildings and structures, rubbish and other objectionable matter and such materials shall be burned, removed from the site of the work, or otherwise disposed of, as approved by the Engineer.

The area under the embankments of the canals and roads shall then be stripped to a nominal depth of 6 inches as shown on the Drawings or as directed by the Engineer. The material removed shall be placed in spoil banks adjoining the canal or in other approved areas designated by the Engineer. Stripping of the areas under spoil banks will not be required. The Engineer's approval shall be obtained for location and disposal of the stripped materials stockpiled and/or wasted.

Excavation and Foundation Preparation

3.3 (1) Classification of Excavation: Materials excavated will not be classified for payment. Except as otherwise provided in these Specifications / MRS, material excavated will be measured in excavation to the lines and grades shown on the drawings and all materials so excavated will be paid for at the approved rates

reflected in the BOQ / MRS (with approved premium, if any). No additional payment above this unit price will be made on account of any of the material being wet or unsuitable for fill. The Contractor must assume all responsibility for deductions and conclusions as to the nature of the materials to be excavated and the difficulties of making and maintaining a stable excavation required for successful execution of the works.

(2) Excavation for Canal: The canal shall be excavated to the lines, grades and sections shown on the Drawings, or as directed by the Engineer. The slope angle shown on the Drawings are tentative and may be amended by the Engineer depending on the stability of the soils encountered. Care shall be taken to prevent excavation beyond lines and grades shown on the Drawings.

Initial excavation shall be carried out by heavy earthmoving plant selected by the Contractor, followed by rough trimming. This trimming will leave about 12 inches (on bed and side slopes both) for further trimming to arrive at the final level of excavation as shown on the Drawings.

Should a slide occur in an excavated slope and material fall into the open excavation or on to a structure, such material shall be removed and disposed of as approved by the Engineer. If directed by the Engineer, the slide area shall be trimmed, cleared and backfilled with approved compacted material.

If the Engineer concludes that the slide was caused through the fault of the Contractor, the removal and disposal of the slipped material and the clearance and the backfilling of the slide area shall be carried out at no additional cost to the Employer.

Where such slide occurs through no fault of the Contractor, or organic or unstable material is encountered below finished grade, the Engineer will direct additional excavation to remove the material. The replacement material shall be placed and compacted as prescribed for embankments. Payment for the removal of this material shall be measured and paid for as canal excavation and the replacement material measured and paid for as embankment fill.

Should the material forming the bottom or side of any excavation, while acceptable to the Engineer at the time of final trimming, subsequently become unacceptable due to exposure to weather conditions, flooding, or puddling, softening or loosening, during the progress of the Works, the Contractor shall remove such damaged, softened or loosened material and excavate further to sound surface and then backfill with approved compacted material as directed by the Engineer. Such further excavation and rectification shall be at the cost of the Contractor.

a) Excavation in Unstable Sand Dune Area: It is possible that over certain lengths of the channels, particularly in

the sandy reaches, there may occur wind-blown deposits of sand which are liable to settlement under soaked conditions. Such areas are to be investigated by the Contractor during the first three months of the Contract, or as instructed by the Engineer.

Should the above investigations confirm such zones where settlement is liable to occur, the Contractor will be required to carry out a trial on a canal length of 100 feet as follows:

After any necessary clearing and stripping, and recording of the ground levels, excavation shall be carried out not closer than three feet from finished levels. Before further excavation, the whole of the canal prism shall be pre-wetted by soaking to a depth of five feet below the canal bed level. The moisture content of the soil shall be raised 0% to 3% more than the optimum, and shall be maintained at this level for seven days. Following such pre-wetting, the ground profile will be again recorded, and the extent of settlement plotted. Excavation and preparation of canal side slopes shall then proceed as specified.

Following the above trial, the Engineer may order variations to the wetting and excavation procedure to give assurance of minimum subsequent settlement.

Alternatively, or in addition to the pre-wetting above, there may be deposits of sand whose stability is inadequate, and where it will be necessary to remove sandy layers and replace with suitable borrow material, as approved by the Engineer.

b) Excavation in shingle gravel formation and rock not requiring blasting, medium hard rock requiring occasional blasting and hard rock etc. shall be decided by the Engineer in accordance with the specification of CSR.

c) Stockpiling of suitable excavated material where material suitable for earthfill in excess of that required to construct adjacent embankments is encountered and cannot be placed in one continuous operation, then such material shall be stockpiled within the right-of-way as directed by the Engineer for later use.

The Contractor shall be entitled to no additional allowance above the unit rates quoted in the Bill of Quantities on account of the requirement for allowing additional time for drying; and for stockpiling excavated materials which have been deposited temporarily in stockpiles; delays or increased costs due to stockpiling; poor trafficability on the excavated

areas, haul roads, or the embankments; reduced efficiency of the equipment the Contractor elects to use; or on account of any other operations or difficulties caused by dry, very hard, over-wet or slushy materials.

(3) Excavation for Structures: Structural excavation shall include the removal of all material of whatever nature, necessary for the construction of foundations of structures and for pipes and sumps of outlets. Where, in the opinion of the Engineer, the excavation reveals loose and unstable material, such material shall be removed and replaced with compacted "select fill material" conforming to Clause 3.3(4)-b-(ii) or as directed by the Engineer. It shall include furnishing of all equipment and construction of all cribs, cofferdams, caissons, sheeting, shoring, etc, which may be necessary for the execution of the Works. The disposal of unsuitable / surplus material shall be paid on the rates reflected in the BOQ / CSR for the lead approved by the competent authority.

Shallow spread foundations shall be constructed in open excavations, and where necessary, the excavation shall be shored, braced, or protected by cofferdams in order to ensure safety and stability. The Contractor should submit to the Engineer for approval his method of excavation and support for each type of excavation at least three weeks in advance of any work. No excavation shall proceed without the written consent of the Engineer. The Contractor is solely responsible for the safe method of excavation and maintenance of excavations. The Contractor shall ensure the safety of the labour as per local laws.

Excavated material shall be dumped / disposed at a location sufficiently away from the edges of excavation. Finish of the excavated surfaces shall be done to the satisfaction of the Engineer to provide firm foundations upon or against which the concrete is to be placed.

The elevation of the bottoms of footings of structures and pipes for outlets, as shown on the Drawings, shall be considered as approximate only and the Engineer may order, in writing, such changes in dimensions or elevation of foundations as may be necessary to secure a foundation subgrade of adequate bearing capacity.

(4) Foundation Preparation and Compaction

a) Foundations under the embankments of the Canals and elsewhere as directed by the Engineer shall be prepared as follows:

The foundation shall be cleared and stripped of in accordance with Clause 3.2, and be free from standing or running water. The foundation shall be compacted

using as many passes of a roller or any other appropriate equipment to attain specified compaction. The Contractor shall select suitable equipment depending upon his experience and keeping in view the site conditions. The foundation shall be sprayed with water before fill material is placed. The foundation soil with fines passing sieve 200 > 12% shall be brought to a moisture content 1% below to 2% above OMC, and compacted to a depth of 12 inches, below final grade to 95% relative compaction (Rc)of the maximum dry density as determined by ASTM D-698. The foundation of cohesionless soil with fines passing sieve 200 ≤ 12%, however, shall be thoroughly wetted (saturated) and compacted to 70% relative density (Rd) based on ATSM D-4253 and ASTM D-4254. No foundation preparation is required beneath the spoil banks.

b) Structures on Shallow Foundations:

(i) Foundation Bearing on Natural Undisturbed Soil:
The foundation shall be cleared and stripped in accordance with Clause 3.2, and be free from standing or running water. The moisture content of foundation shall be adjusted, and compacted to a depth of 3 feet below final grade to 95% of the maximum dry density determined according to ASTM D-1557 or 85% Rd as per ASTM D-4253 and ASTM D-4254 depending on the type of material as explained under 3.3(4) - a) above. On completion of compaction, the foundation soil shall be covered with a 3-inch thick layer of blinding concrete conforming to specified proportion and strength requirements.

(ii) Foundations Bearing on Compacted Fill:

(a) Material
The fill material underneath the foundations shall meet the requirements of Select Fill Material given hereunder:

- Select Fill Material
  Select fill material shall be composed only of inorganic material, free from deleterious substance, and shall have fines passing U.S. sieve # 200 ≤ 15%. The plasticity index (PI) of the material shall be ≤ 6 and Liquid Limit (LL) ≤ 25%.

The fill material excavated from canal prism and/or foundations can also be used for this purpose if it meets the requirement of Select Fill Material.

(b) Fill Placement

All vegetation, non complying fill, topsoil and other unsuitable materials shall be removed. Prior to placement of the first lift of fill, the ground surface shall be proof-rolled by a minimum of five (5) passes of the same equipment used to compact the fill material.

The fill shall be placed in loose horizontal lifts of 6 inch using suitable spreading equipment, moisture content (mc) adjusted, and compacted in accordance with 3.3(4)-b)-(i) above.

On completion of placement and compaction operations, the foundation shall be covered with a 3-inch layer of blinding concrete conforming to specified proportions and strength requirements.

Placement below groundwater, if encountered, shall require dewatering which shall be carried out as per Section 2 “Care and Handling of Water including Dewatering” of these specifications. Dewatering shall be carried out using shallow well points. Dewatering shall commence prior to start of excavation and W/T shall be lowered and maintained at 2 ft or more below the lowest point of the excavation.

Tolerance for foundations under structures shall be + 0 to - ¼ inch, and elsewhere ± 1 inch. No extra payment shall be made for over-excavation or additional backfill required to meet these tolerances after foundation compaction.

c) Foundation for Canal Concrete Lining shall be prepared as follows:

In the foundation for the concrete lining, after final trimming, the excavated surface shall be moistened with and proofrolled using appropriate extent of compacting effort as deemed necessary to attain required compaction. Moistening shall be carried out in a manner that will not cause flow and damage to the surfaces or make pools and softening of the soils at the base of the slope. The roller shall have a static weight of not less than 12 tons and the static weight per 3-feet width shall not be less than 6 tons. The Contractor shall employ smooth steel drum roller or any other type as directed by the Engineer. No vibratory rollers shall be permitted for the compaction. The foundation shall thus be compacted to 95% of the maximum dry density as determined by ASTM D-698 or 70% relative density whichever is applicable as

explained under a) above.

Before starting the canal lining activities, the Contractor shall ensure and prove by means of testing, as and when required, to the satisfaction of the Engineer that subgrade on which or against which (bed & slopes) canal lining is to be placed, are compacted according to these specifications to a minimum of 1 ft depth below the final grade, measured perpendicular to the surface.

d) Foundations for Roads/Bridge Ramps (Road Formation): The moisture content of the earthfill material shall be adjusted in accordance with the type of material as explained under 3.3-(4)-a) above. The earthfill placed within 3 feet below the final subgrade level shall be compacted as explained under 3.3-(4)-b)-(i).

Compaction requirements at depth more than 3 ft below the final subgrade level shall, however, be 90% Rc of ASTM D1557 or 75% Rd depending upon soil type as explained under 3.3-(4)-a). For further details reference shall be made to section “Miscellaneous Works, Clause 17.5” of Technical Provisions.

(5) Material from Stockpiles and/or Borrow Areas: Material required for embankment fill and/or backfill not available from canal excavations within free haulage limit as expressed in the respective BOQ item/CSR shall be obtained from stockpiles of suitable material subject to the approval of the Engineer. The Contractor must make his proposals for obtaining material from stockpiles and/or borrow areas with his Mass-Haul Diagram as indicated in Sub-Clause 3.1(2) hereof.

Borrow areas shall be stripped carefully of top soil, sod and other matter unsuited for embankments and/or backfills to depth as directed by the Engineer. Stripped off material shall be suitably disposed of. The Engineer’s approval shall be obtained for location and disposal of the stripped materials stockpiled and/or wasted. If materials unsuitable for embankments and/or backfill are found in borrow areas such materials shall be left in place or excavated and set aside in spoil tips as directed by the Engineer.

Surface of borrow areas shall be left after completion of work, in a reasonably smooth and even condition approved by the Engineer. Borrow areas shall be such as to preclude the ponding of water within the borrow area and to be free draining over its entire area. The finished side slopes of borrow areas shall not be steeper than 4 horizontal to 1 vertical and the total depth of the finished borrow pit shall not exceed 6 feet.

(6) Disposal of excess Material: Material excavated in excess of the quantities required for compacted fill or unsuitable material shall be disposed off and disposal point / lead diagram would be subject to the approval of the Engineer and the corresponding lead will be measured and paid as per actual according to the rates reflected in the BOQ / MRS2019. The haulage distance will be the horizontal distance (having no regard to lift or elevation) between the points of excavation to the final point of disposal and placing.

Compacting Earthfill Material

3.4 (1) General: Compaction is required of all earthfill materials for embankments, bed and slopes of canals in fill, roads, backfill around or underneath structures, flood protection bund and spurs along the canal and at other locations. The materials shall be deposited in horizontal layers of uniform thickness and compacted as specified herein. The excavation, placing, moistening, mixing and compacting operations shall be such that the material will be uniformly compacted throughout the required section and will be homogeneous, free from lenses, pockets, streaks, voids, laminations or other imperfections.

Unless otherwise approved by the Engineer the direction of rolling during compaction shall be parallel to the axis of the embankment.

Fill material which does not conform after compaction to the specified requirements shall be removed and replaced or with the approval of the Engineer, may be moistened or dried out to the extent necessary and recompacted.

(2) Compaction Equipment

a) The contractor shall mobilize to the project site sufficient equipment for successfully, orderly, and timely completion of all earthwork operations (excavation, moving, placing, compacting, grading etc) and shall demonstrate during field trials that the equipment mobilized is suitable for on-site soils (GP, GW, SP, SW, SP-SM, SM, SC, ML, and CL groups of USCS). The compaction equipment listed hereunder and specifications contained in this section are only the guidelines to assist the contractor in the selection of the equipment. The final choice shall be the sole responsibility of the Contractor and shall be based on his own assessment of the site conditions and his previous experience of similar jobs performed under similar conditions. The Contractor shall assure, to the satisfaction of the Engineer, during the field trials, that the equipment selected shall attain and deliver the final end results/goals set forth in these Specification.

b) Rollers

i. Vibratory Rollers: The vibratory roller shall be steel-drum roller of either smooth drum or tamping foot type. The roller shall have a total static weight of not less than 12 tonnes, with at least 90% of this weight being transmitted to the ground through the drum when the roller is standing on level ground. The drum shall not be less than 1.5 m in diameter and not more than 2 m wide. The vibrating frequency of the roller during operation shall be between 1,100 and 1,500 vibrations per minute. The roller shall have a dual amplitude facility giving a high amplitude in the range 1.5 to 2.0 mm and a low amplitude. The centrifugal force developed by the roller at 1,250 vibrations per minute shall be not less than 16 tonnes. The power of the motor driving the vibrator shall be sufficient to maintain the specified frequency and centrifugal force under the most adverse conditions which may be encountered during compaction of the earthfill. During compaction the roller shall not travel faster than 5 km per hour. The drum shall be equipped with a suitable cleaning device to prevent the accumulation of material on the drum during rolling.

ii. Sheep-foot (Tamping) Rollers
Tamping rollers shall be used for compacting the earthfill. The rollers shall meet the following requirement:

Roller drums – Tamping rollers shall consist of two or more roller drums mounted side by side in a suitable frame. Each drum of a roller shall have an outside diameter of not less than 5 feet and shall be not less than 5 feet nor more than 6 feet in length.

The space between two adjacent drums, when on a level surface, shall be not less than 12 inches nor more than 15 inches. Each drum shall be free to pivot about an axis-parallel to the direction of travel. Each drum ballasted with fluid shall be equipped with at least one pressure-relief valve and with at least one safety head. The safety head shall be equal to union type safety heads with rupture discs suitable for between 50- and 75-psi rupturing pressures.

The pressure-relief valve is a manually operated valve and shall be opened periodically. Personnel responsible for opening pressure-relief valves shall be instructed to ascertain that valve openings are free from plugging to assure that any pressure developed in roller drums is released at each

inspection.

Tamping feet – At least one tamping foot shall be provided for each 100 square inches of drum surface. The space measured on the surface of the drum, between the centers of any two adjacent tamping feet, shall be not less than 9 inches. The length of each tamping foot from the outside surface of the drum shall be not more than 11 inches and shall be maintained at not less than 9 inches. The cross-sectional area of each tamping foot shall be not more than 10 square inches at a plane normal to the axis of the shank 6 inches from the drum surface, and shall be maintained at not less than 7 square inches nor more than 10 square inches at a plane normal to the axis of the shank 8 inches from the drum surface.

Roller weight – The weight of a roller when fully loaded shall be not less than 4000 pounds per foot of length of drum.

The loading used in the roller drums and operation of the rollers shall be as required to obtain the specified compaction. If more than one rollers is used on any one layer of fill, all rollers so used shall be of the same type and essentially of the same dimensions. Rollers operated in tandem sets shall be towed in a manner such that the prints of the tamping feet produced by the tandem units do not overlap. The design and operation of the tamping roller shall be subject to the approval of the Engineer who shall have the right at any time during the execution of the work to direct such repairs to the tamping feet, minor alterations in the rollers, and variations in the weight as may be found necessary to secure optimum compaction of the earthfill materials. Rollers shall be drawn by crawler-type or rubber-tired tractors. The use of rubber-tired tractors shall be discontinued if the tires leave ruts that prevent uniform compaction by the tamping roller. Tractors used for pulling rollers shall have sufficient power to pull the rollers satisfactory when drums are fully loaded with sand and water.

At the option of the Contractor, self-propelled tamping rollers conforming with the above requirements may be used in lieu of tractor-drawn tamping rollers. For self-propelled rollers, in which steering is accomplished through the use of rubber-tired wheels, the tire pressure shall not exceed 40 psi. During the operation of rolling, the

spaces between the tamping feet shall be maintained clear of materials which would impair the effectiveness of the tamping rollers.

iii. Rubber-tired (Pneumatic-tired) Rollers

Rubber-tired rollers shall have a minimum of four wheels equipped with pneumatic tires. The tires shall be of such size and ply as can be maintained at tire pressure between 80 and 100 pounds per square inch for a 25,000 pound wheel load during rolling operations. The roller wheels shall be located abreast and be so designed that each wheel will carry approximately equal load in traversing uneven ground. The spacing of the wheels will be such that the distance between the nearest edges of adjacent tires will not be greater than 50 percent of the tire width of a single tire at the operating pressure for a 25,000 pound wheel load. The roller shall be provided with a body suitable for ballast loading such that the load per wheel may be varied, as directed by the Engineer, from 18,000 to 25,000 pounds. The roller shall be towed at speeds not to exceed five miles per hour. The character and efficiency of this equipment shall be subject to the approval of the Engineer.

Sheep foot rollers and pneumatic tired rollers may be used for the compaction of soils having fines passing through U.S. sieve # 200, 12% or more. For cohesionless soil with fines passing through sieve # 200 less than 12%, vibratory rollers shall be used.

(3) Moisture Control of Fill: As far as practicable and where necessary, all material to be excavated for compacted embankments from the canal and borrow pits, shall have its moisture content adjusted either by drying or adding water, so that it is within the specified range when the fill is compacted. The water and the fill material shall be thoroughly mixed to uniform moisture content.

The moisture content of the earthfill material with fines passing through sieve 200 ≥ 12% during compaction shall be brought to 1% below to 2% above the OMC. Whenever possible, all water added to condition the material shall be added in one application at the borrow pit or in the channels prior to their excavation. When moisture is added to the areas to be excavated, care shall be taken to moisten the material uniformly to attain the requisite moisture content as required by this Specification. The Contractor shall control the application of water and check on the depth and amount of water penetration during application so as to avoid excess moisture.

If at any location to be excavated before or during excavation operations there is excessive moisture, steps shall be taken to reduce the moisture by excavating and placing in temporary stockpiles materials containing excessive moisture; by excavating drainage ditches; by allowing adequate additional time for drying; or by other means approved by the Engineer.

The earthfill material with fines passing through sieve 200 <12% shall remain thoroughly wetted (saturated) during compaction.

The Contractor shall not be entitled to any additional payment above the applicable unit rates quoted in the Bill of Quantities on account of the requirement for excavating drainage ditches; for allowing additional time for drying; for stockpiling and excavating materials which have been deposited temporarily in stockpiles; delays or increased costs due to stockpiling; poor trafficability on the excavated areas, the haul road, or the embankment; reduced efficiency of the equipment the Contractor elects to use; or on account of any other operations or difficulties caused by overly wet materials. Payment for rehandling and the correspondingly as per approved lead diagram for transporting the materials from the stockpiles to the place of utilization will be made as per BOQ / MRS2019.

(4) Material Requirement: Material for earthfill shall consist of suitable material excavated from canal excavation or structural excavation. Borrow material will be used only when material obtained from canal excavation or structural excavation is unsuitable or is deficient for earthfill formation or its haulage makes it more uneconomical than using borrow material from the vicinity.

The Contractor shall use material belonging to any of the Group Symbols GW, GP, GM, GC, SM, SC, CL, ML, SP-SM, or otherwise specified by the Engineer, of the soil classification chart USBR-5000. Stones and indurated material larger than 3 inches shall be removed from material to be used for compacted embankments. The material shall be free from all rubbish, organic matter, and other deleterious/objectionable substances and shall be approved by the Engineer. Select Fill Material used for the construction of compacted pad underneath the structures shall be in accordance with Clause 3.3(4)-b(ii) “Foundations Bearing on Compacted Fill”.

Sand dune materials having single size particles shall not be used as compacted fill for embankments or backfill about structures and will be classified as unsuitable unless otherwise specified by the Engineer.

(5) Construction Requirements of Embankments for Canals & Roads: Suitable material for earthfill shall be placed in

horizontal layers and compacted with approved equipment appropriate to the type of soils and in a manner determined by the trial section. The thickness of the compacted layer shall not exceed 6 inches unless agreed otherwise by the Engineer.

For canal embankment constructed with soil having fines passing 200 sieve > 12%, the dry density, determined in accordance with ASTM D-1556, of the compacted material in the canal embankment shall not be less than 95 percent of the laboratory maximum dry density determined according to ASTM D-698. Where cohesionless material with fines passing through # 200 sieve are 12% or less (SW, SP or SP-SM groups of USCS) is used, the relative density shall not be less than 70 percent, as determined by ASTM D-4253 and ASTM D-4254.

The top 3-ft of the embankments for roads / bridge ramps shall, however, be compacted to 95% of maximum dry density obtained by Modified Proctor ASTM D1557 or 85% relative density (Rd) based on ASTM D4253, and ASTM D4254 depending on soil type as explained above. Compaction requirements beyond 3 ft shall be in accordance with 3.3 (4)-d) “Foundation for Roads/Bridge Ramps”.

During compaction, the moisture content of the fill material shall be maintained in accordance with Sub-Clause 3.4 (3) hereof. The moisture content shall be uniform throughout each layer. Subsequent layers shall not be placed and compacted unless the previous layer has been properly compacted and approved by the Engineer. The surface of the layer shall be scarified prior to the application of the next layer unless it has been prepared by a sheep-foot roller.

The Contractor shall rework the portions of the embankments which do not meet these requirements in order to achieve the specified compaction to the satisfaction of the Engineer, by following the procedures specified herein.

During dry weather, whether fill is being placed or not, the surface of the fill shall be sprayed with water to prevent cracking of the surface. Should cracking of the fill occur, the Contractor shall remove such cracked material and replace it with fresh compacted material within the specified range of moisture content.

The Contractor shall be responsible for protecting temporary fill surfaces against erosion. At the end of each working day, or if it starts to rain, the surface of the fill shall be made smooth with a drainage slope to induce runoff from the filled areas and leave non areas that can retain water. Where necessary, drainage ditches, and the like shall be formed to assist drainage and to prevent runoff from damaging placed material. Runoff from heavy rain shall be controlled to prevent gulley erosion of the placed fill. Any gulley erosion shall be

repaired with material compacted in accordance with the Specifications, and eroded surfaces shall be restored and graded to ensure a proper bond with new fill placed on them.

Where canal lining is to be placed on embankment fill, such embankment sections shall be overbuilt on the lining side as necessary to ensure that after trimming, the compaction of subgrade over which canal lining is to be placed conforms to the compaction requirement of these Specifications. Prior to commencing lining, the canal prism including bed and slopes shall be trimmed to the required profile and proof rolled. No payment shall be made for over built portion of the canal section and the Contractor shall consider this fact while pricing.

(6) Backfill around or underneath Structures: All backfill around or underneath structures shall be placed to the lines and grades shown on the Drawings and/or established by the Engineer. Select backfill material shall be obtained from approved excavations. When sufficient Select Fill Material is not available from structures excavation and/or from adjacent canal excavation, additional material shall be obtained from approved borrow areas. The Select Fill Material shall be in accordance with Sub-Clause 3.3(4) of the Specifications. The distribution of material shall be uniform and such that compacted backfill is free of lenses, pockets, streaks and other imperfections.

Backfill shall be deposited starting from the lowest elevation of the foundation and spread in uniform horizontal layers. Homogeneous material in backfill shall be compacted by suitable approved equipment to a compacted layer not exceeding 3 inches depth unless otherwise approved by the Engineer. Cohesionless free drainage materials in backfill shall be thoroughly wetted and compacted. Compacted backfill shall have densities, as described in Clause 3.4 (5) “Construction Requirements of Embankments for Canals and Roads”.

The Contractor shall programme his work for such construction of embankments, or backfill in areas required for the construction of bridges and other structures so that no fill shall be placed until the concrete has reached its 28 days strength. Equipment will not work directly next to the concrete structure unless approved by the Engineer. In carrying embankments up to and over culverts or pipe drains and where required in the Contract, up to and over bridges, the Contractor shall concurrently raise the embankments equally on both sides, so that neither side shall have an elevation greater than 12 inches different from the other side.

(7) Limits of Back fill around Structures: When a structure is constructed before the excavation of the adjacent canal section is completed, the amount of material placed around the structure above the original ground surface as backfill shall be the minimum as determined by the Engineer to be necessary for proper protection of the structure, and the remaining fill shall be

placed as embankments.

Final Trimming and Preparation of Sub-grade for Lining

3.5 Final trimming of the whole canal prism (bed and side slopes) shall be carried out by a purpose-built, wire-guided, trimming machine in such a manner that the excavated surface is neat and smooth and, after proof rolling, at the required profile shown on the Drawings.

The Contractor shall programme the final trimming and preparation of sub-grade for lining according to Section-11 “Canal Lining”, such that the concrete lining shall be placed within as short time gap as is feasible. After trimming the material shall be kept moist till the time concrete is placed. Excessive application of moisture resulting in free water running causing erosion of the surface of the soil shall not be permitted. No construction traffic shall be allowed on a surface which has been finally trimmed and proof rolled.

Voids and hollows, as determined by the Engineer, shall be refilled with selected material, moistened as required and compacted in accordance with the requirements for compaction of fill and no additional payment will be made to the Contactor to fill such voids and hollows.

Measurement and Payment

3.6 (1) General

a) The unit rates for earthwork in the BOQ with quoted premium shall be deemed to cover earthwork in all types of soils (dry or submerged under water). Volume of excavation for canals, structures and embankment foundation shall be measured net as the product of cross-sectional area and lengths within the limits shown on the Drawings or as approved by the Engineer. The limits of measurement shall be pay lines as shown on the drawings unless otherwise specifically approved by the Engineer.

b) No separate measurement and payment shall be made for clearing and grubbing, removal and disposal of unsound materials, foundation preparation, scarifying, surveying and making records of ground levels and topography within earthwork and structure reservation limits; supporting excavations; making good slips and falls; excess excavations for working space beyond the permissible limits of workability or any other reason; trimming and dressing surfaces of excavations and embankments; additional material placed on account of, or in anticipation of settlement; compaction trials; control of moisture content; preparation and restoration of borrow pits; scarification; location and shaping of disposal heaps and embankments, and delays due to testing of in-situ materials. All costs on these accounts shall be deemed

to be included in the rates quoted on the respective BOQ / MRS2019.

c) No measurement or payment shall be made of earthwork for the construction and removal of temporary works required for completion of the specified works. Measurement shall not be made for earthwork for any structure or feature that is paid for as a lump sum or Provisional Sum.

All additional excavations made beyond the lines and grades shown on the Drawings owning to unsuitable nature of soils, as a result of inspection by the Engineer, shall be taken as Excavation of Canal or Structure as the case may be. Backfill of such additional excavation carried out with suitable material approved by the Engineer shall be paid at the applicable fill rate. Neither excess excavation nor backfill of excess excavation shall be measured for payment.

(2) Jungle Clearing, Grubbing and Stripping

No separate measurement and payment shall be made for jungle clearing, grubbing and stripping. All costs for such activities shall be deemed to have been included in the unit rates of the other earthwork pay items.

(3) Excavation for Canal

a) Except as specified herein, measurement for payment of unclassified excavation for the canal and rainwater drain, will be made in M^3 (cum) to the lines and grades shown on the Drawings or as prescribed by the Engineer. No payment shall be made for any additional excavation or backfilling required to adjust the sub-grade to correct levels during preparation of the sub-grade as specified.

b) Payment for unclassified excavation for the canal will be made as per unit rates in the Bill of Quantities with approved premium for item “Excavation for Canal”.

c) The BOQ rate for the item “Excavation for Canal and rainwater drain” shall constitute full payment for excavation, dressing and disposal up to 25 m. Additional transportation for disposal of surplus / unsuitable material if required as per site condition shall be paid as per approved lead diagram in accordance with the rate reflected in the BOQ / MRS2019. The haulage distance will be the horizontal distance (having no regard to lift or elevation) between the points of excavation to the final point of disposal and placing.

(4) Excavation for Structures

a) Measurement for payment for excavation unclassified for structures and foundations will be made in M^3 (cum) of the material excavated only outside of or below the excavation "pay line" of the canal or canal prism and will be made only for material excavated at the direction of the Engineer. The division planes for measurement and payment between excavation for structures and excavation for canal will be such that all excavation within the excavation "pay line" of the canal prism, regardless of the existence of structures or other required works, and regardless of whether the excavation for structures or other required works precedes or follows the excavation of the canal prism, shall be paid for at the unit rate tendered in the Bill of Quantities for the Item "Excavation for Canal" and all excavation for structure outside of or below the excavation "pay line" of the canal prism shall be paid for at the unit rate tendered in the Bill of Quantities for the item "Excavation for Structures".

b) Payment for unclassified excavation for structures will be made at the unit price(s) quoted in Bill of Quantities for the items "Excavation for Structures".

c) The unit price(s) quoted for excavation for structures shall constitute full payment for excavation, placing the excavated material in embankment, refilling any excess excavation, and all works necessary to maintain the excavations in good order during construction in accordance with the Specifications set forth and/or as directed by the Engineer.

(5) Carriage of Earthfill Material for the Construction of Embankments for Canal, Protection Bunds and Dowels, etc. and Carriage of Excess Excavated Material for Disposal Including Loading, Unloading and Rehandling

a) The carriage of earthfill material (fill/select fill) for construction of compacted embankments for canal, flood protection bunds, etc. obtained from stockpiles shall be measured in M^3 (cum) of compacted volume according to lines and grades shown on Drawings at the place of use. Carriage of excess excavated material from stockpiles for disposal onto the designated areas shall be measured in M^3 (cum) on the basis of the excavated pay-lines as shown on the drawings.

b) The payment for carriage of earth material obtained

from stockpiles as measured above shall be made at the rates reflected in the BOQ with approved premium / CSR and shall constitute full payment for carriage of earth material from stockpiles from distance as per approved lead diagram including loading, unloading, placing material in embankments and onto places for disposal of excess material, etc.

(6) Furnishing of Earthfill Material (Fill/Select Fill) for the Construction of Embankments for Canal, Protection Bunds and Dowels Obtained from Borrow Areas

a) Measurement for payment for fill material obtained from excavation in Borrow Areas placed in the embankments according to the lines and grades shown on the Drawings or established by the Engineer and duly accepted will be made on the basis of the compacted volume in M^3 (cum).

b) The earthfill material shall be obtained from borrow areas only after the Engineer's approval of the Contractor's plan and methodology submitted as per Clause 3.1(2) hereof. When borrow areas are designated on private lands, the Contractor shall be responsible for the ownership payment of borrowed earth material. If so required to be paid, the rates and prices stated in the priced Bill of Quantities shall be deemed to cover all such ownership payments.

c) Payment for construction of embankments with material obtained from excavation in borrow areas will be made at unit rate quoted in the Bill of Quantities.

d) The amount tendered shall be full payment for completion of the work including excavation from suitable borrow areas; stripping and clearing borrow areas, preparation of material by ripping, excavating, moistening etc., loading and hauling the borrowed material from any distance (with lead to be paid as per approved lead diagram on the rates reflected in the BOQ with approved premium / MRS2019) to the location of its use and unloading, reinstatement of borrow areas after excavation and all other operations related to these items in accordance with the Specifications set forth or as directed by the Engineer.

(7) Compaction of Earthfill Material (Fill/Select Fill) in Embankments for Canal, Protection Bunds and Dowels constructed with suitable material

a) Measurement for payment for compaction of earthfill material placed in embankments with suitable material obtained from excavations, stockpiles and/or borrow

areas, shall be made in M^3 (cum) of the compacted volume of earthfill as shown on the Drawings or as otherwise instructed by the Engineer.

b) Payment for compaction of earthfill in embankments as described in this Section will be made at the unit rates quoted in the Bill of Quantities for compaction of earthfill.

c) The amount tendered shall constitute full payment for Compacting Earthfill Material, including, but not limited to, moistening the soil, machinery for compaction, labour and/or any other activity required to complete the work under this item in all respects in accordance with the Specifications set forth or as directed by the Engineer.

(8) <u>Compaction of Fill/Select Fill Material Underneath the Structures or Backfill around Structures</u>

a) Measurement for payment of compaction for fill/select fill materials placed underneath the foundations or in backfill around the structures shall be made in M^3 (cum) of compacted volume of earthfill/select fill or backfill as shown on the drawings or as otherwise directed by the Engineer in accordance with the specifications.

b) Payment for compaction of fill/select fill or backfill around structures shall be made at the rates reflected in the Bill of Quantities / CSR for Compaction of Fill/Select Fill or Backfill around Structures.

c) The amount tendered shall constitute full payment for all labour, equipment etc. necessary to complete the works conforming to all requirements of the specifications.

(9) --- Not Used ----

(10) <u>SPT-Exploratory Holes for Un-investigated Structures</u>

A provisional sum is included to cover the expenditure of Geotechnical Investigations to be carried out at the location of un-investigated structures to establish the depth of weak soil zone (i.e. soils of inadequate bearing capacity). The amount will be spent as per clause 58 of General Conditions of Contract and/or as directed by the Engineer.

Provisional sum covers but not limited to:

a) Mobilization and demobilization of equipment,

tools, samplers etc. and experienced personnel necessary required for successful completion of field explorations.

b) Movement between structures and setting on locations.

c) Drilling and sampling of deep boreholes upto depth of 110 feet at proposed un-investigated structure locations in accordance with ASTM D1452 or B.S. 5930.

d) Performing Standard Penetration Test (SPTs) at 3 ft intervals in accordance with ASTM D1586 or B.S. 1377.

e) Recovering soil and water samples, labelling, packing and transportation of samples to laboratory approved by the Engineer.

f) Preparation of field logs, and factual report.

(11) Unclassified Excavation for Flood Nullahs

a) Measurement for payment of unclassified excavation for flood channels upstream of syphons/super passage shall be made in M^3 (cum) to the lines and grades shown on the drawings or directed by the Engineer. No measurement/payment shall be made for any additional excavation or back filling required to adjust to correct levels.

b) Payment for unclassified excavation for the flood Nullahs will be made at the unit rate quoted in the Bill of Quantities and shall constitute full payment for excavation materials in Nullah embankments, to distance as reflected in the BOQ / MRS2019. In case of further transportation necessary payment shall be made as per lead diagram approved by the Engineer.

(12) Initial Filling, testing and Emptying of Distributary System

Measurement and Payment for the work specified in Clauses SP-24 and SP-25 hereof will be made in accordance with the requirements of Clause 58 (Provisional Sums) of the Conditions of Contract.

4 - CONCRETE, GENERAL

Scope of Work

4.1 All concrete required to be used for all structures to be constructed under these Specifications, and for all related purposes, and as may be required by the Engineer, shall consist of the materials herein specified and shall be proportioned, mixed, formed, placed, cured and finished in accordance with the herein stated requirements. All concrete work shall conform to all requirements of ACI 301-99. The stipulations and requirements herein set forth shall apply except when such stipulations and requirements are specifically modified by the Engineer for any particular item of work.

Reinforcement

4.2 All reinforcement shall conform to the stipulations and requirements set forth in Section, "Reinforcement".

Aggregates

4.3 All sand and aggregates used in concrete and mortar required under these Specifications, shall be furnished by the Contractor in accordance with the provisions of, and in complete conformity with the stipulations and requirements for sand and aggregates specified in the Section, "Sand and Coarse Aggregates".

Cement/Cementitious materials

4.3 (1) All cements used in concrete and mortar required under these Specifications, shall be furnished by the Contractor in accordance with the provisions of, and in complete conformity with the stipulations and requirements for cements specified in the Section, "Cement".

Water

4.4 Clean fresh potable water shall be used for washing aggregates, mixing, and curing concrete, mortar and grout. Water shall be obtained from a source approved by the Engineer. If required by the Engineer, samples shall be taken from the proposed source of supply and submitted to a laboratory approved by the Engineer for testing at the Contractor's cost. The water shall be free from all injurious substances like oil, acid, salt, alkali, organic matter or other deleterious substances as determined by standard laboratory tests according to B.S.3148 "Tests for Water for Making Concrete" or by AASHTO designation T26-79 (1986) “Quality of Water to be used in Concrete”. The Engineer shall approve the source of water on the basis of the results of such laboratory tests.

Composition

4.5 Concrete shall be composed of Ordinary Portland or slag cement (by replacing 40% OPC or SRC with slag) as specified, sand, coarse aggregate and water, as specified, all well mixed and brought to the proper consistency Composition.

The maximum size of aggregate in concrete for any part of the work shall be the largest of the specified sizes, the use of which is practicable from the standpoint of satisfactory placing of the concrete.

The concrete mix will be designed by the Contractor who will determine the required quality of the concrete for the structures covered under these specifications and will be submitted to the Engineer for approval. The class of concrete for various components of structures has been shown on the Drawings which will be strictly followed.

Trial mixes and tests will be made by the Contractor for the purpose of designing the mixes and for quality control. The Contractor shall co-operate and assist the Engineer in obtaining samples and/or conducting all tests. The proportions of all materials entering into concrete shall be subject to approval by the Engineer. The proportions will be changed whenever such change is necessary to maintain the standard of quality required for the structures covered by these Specifications and to meet the varying conditions encountered during construction. The Contractor will be entitled to no compensation additional to that included in the prices for the applicable items in the Bill of Quantities because of such changes.

Concrete for various structures and parts thereof shall have compressive strengths, for 6” diameter x 12” long cylinder, at least equal to the minimum allowable strength shown in the following Table, except as otherwise shown on the drawings or as directed by the Engineer.

Class	**Compressive Strength at 28 days**	
	Psi	**N/mm^2**
A	5000	34.47
B	4000	27.58
C	3000	20.67
D	1500	10.34

Various classes of concrete to be used shall have slump as shown in the Table below for different types of structure component.

Class	**Structural Component**	**Slump**
A	Pre-stressed	2”-4”
B	Precast	2”-4”
B	Piles	5”-7”
C	Canal Lining (PCC 1:2:4)	1”-3”
B	Cut offs	2”-4”
B	General reinforced concrete for bridges & other structures	1”-3”
C	Plain concrete	1”-3”
D	Lean concrete	2”-4”

The nominal maximum aggregate size to be used in concrete in various structures shall be as follows unless otherwise shown on the drawings or as directed by the Engineer.

General Use		**Nominal Maximum Aggregate Size**
Blinding Concrete		¾″
P.C & R.C	Minimum dimension of structure <12″	¾″
	Minimum dimension of Structure > 12″	1-½″

In general, the mix design, will determine water cement ratio by weight (exclusive of water absorbed by the aggregates), which will be

determined on the basis of producing concrete having suitable workability, density, impermeability, durability and the required strength. The amount of water used in the concrete shall be regulated as required, with the approval of the Engineer to secure concrete of the proper consistency and to adjust for any variation in the moisture content, or grading of the aggregates as they enter the mixer. Addition of water to compensate for stiffening of the concrete resulting from excessive over-mixing or objectionable drying before placing will not be permitted. Uniformity in concrete consistency from batch to batch will be required. The slump of the concrete, after the concrete has been deposited but before it has been consolidated, shall not exceed 3 inches (76.2 mm). The Engineer reserves the right to require a lesser slump whenever such lesser slump is practicable and will produce concrete of better quality or of greater economy. Check slumps shall be taken at the batch plant and at other locations as directed by the Engineer. The slump shall be determined in accordance with ASTM Designation: C143, except that fraction of material larger than 1 ½ inch (38.1 mm) shall be removed by wet screening. For all concrete types the maximum water-cement ratio shall be 0.45.

The compressive strength of the concrete placed during the course of work will be determined by the Engineer on the basis of tests of 6 inch by 12 inch (152.4 mm by 304.8 mm) cylinders, made and tested in accordance with ASTM Designations C31 and C39. All concrete samples from which cylinders are to be cast, the pieces of coarse aggregate larger than 1 ½ inch (38.1 mm) shall be removed by screening or hand picking. The Engineer may allow use of 6 inches x 6 inches cube in place of 6"x12" cylinder. The conversion factor for cylinder strength shall be on the basis that 80% of cube strength is cylinder strength. The Contractor shall provide such facilities as may be necessary for procuring and handling representative test samples. The frequency of tests will be determined by the Engineer on the basis of the placement rate and the structure, but no more often than necessary to assure himself that the concrete being placed conforms to the Specifications and design requirements.

Admixtures

4.6 If the use of retarding or workability agents is approved by the Engineer then this use shall be subject to the following conditions:

a) no reduction of mean strength compared with additive free concrete of the same class;
b) no reduction of cement content prescribed;
c) no corrosive effect on reinforcement steel;
d) dosage of admixture strictly in accordance with the manufacturer's instructions in respect of the specific conditions. Dosage of admixture to be as specified by manufacture of such admixtures.

The Contractor may use a retarder to facilitate the preparation of construction joints, subject to the approval of the Engineer to the composition of the retarder and its method of application.

Batching

4.7 All concrete shall be produced at a batching plant and shall follow the "Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete", ACI 304-00. The Contractor shall provide such means and equipment as are required to accurately determine and control the amount of each separate ingredient entering the concrete. Such means and the equipment and its operation shall at all times be subject to approval by the Engineer. The amounts of cement, sand, and each size of aggregates entering each batch of concrete shall be determined by weight except as otherwise specified and/or authorized by the Engineer.

Mixing

4.8 The concrete ingredients shall be mixed in a batch mixer for not less than 1½ minutes after all ingredients, except for the full amount of water, are in the mixer. The mixing time will be increased where the batch mixer exceeds a capacity of 2 cubic yards (1.53 cubic meters.) The Engineer reserves the right to increase the mixing time when the charging and mixing operations fail to produce a concrete batch throughout which the ingredients are evenly distributed and the consistency is uniform. The concrete shall be uniform in composition and consistency from batch to batch except when changes in composition or consistency are required. Water shall be added prior to, during, and following the mixer-charger operations. Excessive over-mixing requiring the addition of water to preserve the required concrete consistency will not be permitted.

Truck mixers will be permitted only when the mixers and their operations are such that the concrete throughout the mixed batch and from batch to batch is uniform with respect to consistency and grading. Any concrete retained in truck mixers so long as to require additional water to permit satisfactory placing shall be wasted at the expense of the Contractor. Any mixer that at any time produces unsatisfactory results shall be repaired promptly and effectively or shall be replaced.

Temperature

4.9 The temperature of concrete when it is being placed shall be not more than 90 degrees Fahrenheit and not less than 40 degrees Fahrenheit. When the temperature of the concrete as placed may be between 80 degrees Fahrenheit and 90 degrees Fahrenheit, the concrete shall be mixed at the job site and discharged into the work immediately after mixing. If concrete is placed when the weather is such that the temperature of the concrete would exceed 90 degrees Fahrenheit, as determined by the Engineer, the Contractor shall employ effective means, such as pre-cooling of aggregates and mixing water and placing at night, as necessary, to maintain the temperature of the concrete below 90 degrees Fahrenheit while it is being placed. Such arrangements could include:

i. Providing shades and spraying water on gravel stockpiles.
ii. Shading working area including batching and mixing plants, cement silos.
iii. Facilities for insulation.
iv. Painting water tanks and pipelines with reflective paint.
v. Refrigerating the mixing water.
vi. Spraying on formwork and reinforcement with a fog spray of clean water at a temperature not exceeding 77 degree Fahrenheit.
vii. Protection of the concrete during transportation and placing

against solar radiation.

viii. Employing ice or liquid nitrogen for cooling the mixing water.

For the concrete lining of the canal, concrete placement shall not be permitted between 0800 hours and 1700 hours during the months of May, June, July and August.

For other concrete works if, in the opinion of the Engineer, the maximum temperature attained by the concrete during hydration could nevertheless damage the finished work, the Engineer may order the following:

i. Avoiding the placement of concrete during the hottest part of the day.
ii. Placement only at night.

Forms Design

4.10 Forms shall conform to the various shapes, lines, grades and dimensions of the concrete as shown on the Drawings or as established by the Engineer. Forms shall be mortar tight and sufficiently rigid to prevent objectionable deformation during pouring of concrete. The material to be used and the design of the forms shall be subject to approval by the Engineer before erection of forms is started; however, such approval will not relieve the Contractor of responsibility for the adequacy of the forms nor from the necessity for remedying any defects which may develop or become apparent from their use. The Engineer may at any time condemn any sections of forms found deficient in any respect and the Contractor shall promptly remove the condemned forms from the work and replace them at his own expense. Drawings showing the general design and dimensions of forms for structures need not be submitted to the Engineer for approval unless the Engineer requests such submittal.

Forms Construction

4.11 Forms to confine the concrete and shape to the required lines shall be used wherever necessary. Forms shall be of metal, of metal-lined timber, plywood lining, tempered pressed wood lining, or of smooth planed boards, in good condition as required to produce the surface finish specified herein.

A smooth finished surface of the concrete will be required wherever it is a part of a waterway. The forms for such surfaces may be made of either wood or metal and shall be true in every respect to the required shape and size, and shall be of sufficient strength and rigidity to maintain their position and shape under the loads and operations incident to placing and vibrating the concrete. All wood forms on waterway surface shall be planed and sanded to eliminate form marks insofar as it is practicable. Suitable and effective means shall be provided in the construction of all forms for holding adjacent edges and ends of panels and sections tightly together and in accurate alignment so as to prevent the formation of ridges, fins, offsets or similar surface in the finished concrete.

All forms when erected shall be tight. Adequate and suitable means for removing the forms without injury to the surface of the finished concrete shall be provided. Before concrete is placed, the surface of the forms shall be oiled with approved commercial form oil that will effectively prevent sticking of the concrete to the forms and will not stain the

concrete. All bond breaking materials or processes shall be used only after approval by the Engineer.

All forms shall be properly secured in position so as to prevent floating, or other movement, during the placing of concrete. They may be supported during placement of concrete on concrete piers, metal pedestals or by other approved means. Form supports shall be carried to firm foundation so that no settlement of the forms will be possible during construction.

Formwork for successive lifts shall be properly secured and sealed against the face of previous lifts so as to prevent the following:

1. Bulging of concrete at the interface of the two lifts
2. Leakage of fines from the freshly placed layer from between the formwork and the previous lift.

Formwork ties, if placed such that they lie within the body of the concrete, should be treated, subsequent to concreting such that:

1. They do not allow seepage through the path of the ties; and
2. The metal ties do not come in contact with the atmosphere and external water which would corrode the tie.

Preparation for Placing

4.12 Concrete placing shall follow the recommended Practice of ACI 304-00. No concrete shall be placed until all formwork, reinforcement, installation of parts to be embedded, bracing of forms and preparation of surfaces involved in the placing have been approved by the Engineer. Approval of the method of placement proposed will not relieve the Contractor of his responsibility for its adequacy and the Contractor shall remain solely responsible for the satisfactory construction of all work under the Contract. No concrete shall be placed in water, except with the written permission of the Engineer, and the method of depositing the concrete shall be subject to his approval. Concrete shall not be placed in running water and shall not be subjected to the action of running water until after the concrete has sufficiently hardened. All surfaces of forms and embedded materials that have become encrusted with dried mortar or grout from concrete previously placed shall be cleaned of all such mortar or grout before the surrounding or adjacent concrete is placed.

Immediately before placing concrete, all surfaces upon or against which the concrete is to be placed shall be free from standing water, mud, debris or loose material. The surfaces of absorptive materials against or upon which concrete is to be placed shall be moistened thoroughly so that moisture will not be drawn from the freshly placed concrete. For concrete placed on ground the water table should be maintained at least 3 ft. below the lowest concrete level until the concrete has hardened.

Where fresh concrete is to be placed on excavated earth as shown on drawings, the Contractor shall place a 3 inches (76.2 mm) thick layer of blinding concrete before placing fresh concrete. The blinding concrete shall be spread uniformly over the foundation to be protected and allowed to set for 24 hours prior to the placement of the fresh concrete as per provisions of these specifications.

Concrete surfaces upon or against which concrete is to be placed, and to which new concrete is to adhere, that have become so rigid that the new concrete cannot be incorporated integrally with it, are defined herein as "construction joints". The surfaces of construction joints shall be clean and damp when covered with fresh concrete or mortar. Cleaning shall consist of removal of all laitance, loose or defective concrete, coatings or foreign material. The surface of construction joint shall be cleaned by wet sandblasting or other approved methods and then washed thoroughly with high pressure air-water jets immediately prior to placement of fresh concrete. The sandblasting and washing shall be performed at the last opportunity prior to placement of concrete. All pools of water shall be removed from the surfaces of construction joints before the new concrete is placed.

The surfaces of all contraction joints or expansion joints as shown on the Drawings shall be thoroughly cleaned of accretions of concrete or other foreign material by scraping, chipping or by other means satisfactory to the Engineer.

Placing

4.13 The method and equipment used for transporting concrete shall be such that concrete having the required composition and consistency will be delivered to the work, without objectionable segregation or loss of slump. Concrete shall be placed and compacted well within the initial setting time.

Concrete shall be placed only in the presence of the Engineer or his authorized representative. After the surfaces have been prepared satisfactorily, surfaces of construction joints upon which new concrete is to be placed shall be covered with a layer of mortar approximately 3/8-inch (9.53 mm) thick. The mortar shall have the same proportions of cement and sand as the regular concrete mixture, unless otherwise directed. The water-cement ratio of the mortar shall not exceed that of the concrete to be placed upon it, and the consistency of the mortar shall be suitable for placing and working in the manner hereinafter specified. The mortar shall be spread uniformly and shall be worked thoroughly into all irregularities of the surface. Concrete shall be placed immediately upon the fresh mortar. In placing concrete against formed construction joints, special precautions shall be taken to ensure that the new concrete is to be brought into intimate contact with the surface of the joint, by careful puddling and spading with the aid of suitable tools.

Re-tempering of concrete will not be permitted. Any concrete which has become so stiff that proper placing cannot be assured shall be wasted and no payment will be made to the Contractor for such wasted concrete. The placement of concrete shall be carried on at such a rate and in such a manner that formation of cold joints is prevented. Concrete shall be deposited in all cases as nearly as practicable directly in its final position and shall not flow in a manner to permit or cause segregation. Excessive separation of coarse aggregate in concrete, caused by allowing the concrete to fall freely from too great a height, or at too great an angle from the vertical, or to strike the forms or reinforcement will not be permitted, and where such separation would otherwise occur, the Contractor shall provide suitable drop chutes and baffles to confine and control the quality of falling concrete.

Except as intercepted by joints, all formed concrete shall be placed in continuous approximately horizontal layers, the depths of which generally shall not exceed 20 inches (508 mm). The Engineer reserves the right to require lesser depths of layers where concrete in 20 inches (508 mm) layers cannot be placed in accordance with the requirements of these Specifications. All intersections of construction joints with concrete surfaces shall be made straight and level or plumb.

In placing concrete in large thick lifts, the exposed area of fresh concrete shall be kept at the practical minimum, by first building up the concrete to the full width of the structure and to full height of the lift over a restricted area at one end of the structure and then continuing in similar progressive stages to the full area of the structure. The slope formed by the unconfined upstream edges of the successive layers of concrete shall be kept as steep as practicable in order to keep its area to a minimum. Concrete shall be placed directly at its final location. Use of vibrators to move concrete to its final position shall not be permitted. Concrete along these edges shall not be vibrated until adjacent concrete in the layer is placed, except that it shall be vibrated immediately when conditions are such that the concrete will harden to the extent that later vibration will not fully consolidate and integrate it with more recently placed adjacent concrete. Clusters of large aggregates shall be scattered before new concrete is placed over them. Each deposit of concrete shall be vibrated completely before another deposit of concrete is placed over it.

Concrete shall not be placed during rains sufficiently heavy or prolonged to wash mortar from coarse aggregate on the slopes of the placement. During such rains mortar should not be spread on construction joints and diluted mortar already spread shall be removed and replaced before continuing with the work. Once placement of concrete has commenced in a structure, placement shall not be interrupted. Sufficient arrangements should be made to cover the green concrete in case heavy rain commences during concreting. This may be achieved by using polyethylene sheets or tarpaulin in sheets over the area being concreted such that rain water does not reach the green concrete. Placing of covering sheets directly on the concrete shall not be permitted.

Concrete buckets where used shall be capable of promptly discharging the low-slump, concrete mixes specified and the dumping mechanism shall be designed to permit the discharge of as little as 0.5 cubic yard (0.38 cubic meter) portion of the load in one place. Buckets shall be suitable for attachment of and use of drop chutes where required in confined locations.

Construction joints shall be approximately horizontal unless otherwise shown on the Drawings or directed by the Engineer. Arrangements should be made to avoid feather edges less than 60° whether they are in the current lift or in a subsequent lift, by chamfering that part of the lift to an angle of at least 90° and width at least 6”.

If concrete is placed monolithically around openings having vertical dimensions greater than 2 feet, or if concrete in decks, floor slabs, beams, girders, or other similar parts of structures is placed monolithically with supporting concrete, the following instructions shall be strictly observed:

a) Placing of concrete shall be delayed from one to three hours at the top of openings and at the bottoms of levels under decks, floor slabs, beams, girders, or other similar parts of structure members when bevels are specified; and in bottom of such structure members when bevels are not specified but in no case shall the placing be delayed so long that the vibrating unit will not readily penetrate by its own weight the concrete placed before the delay. When consolidating the concrete placed after the delay, the vibrating unit shall penetrate and re-vibrate the concrete placed before the delay.

b) The last 2 feet (0.61 meters) or more of concrete placed immediately before the delay shall be placed with as low a slump as practicable and special care shall be exercised to effect thorough consolidation of the concrete.

c) The surfaces of concrete where delays are made shall be clean and free from loose and foreign material when concrete placing is started after the delay.

d) Concrete placed over openings and in decks, floors, beams, girders and other similar parts of structures shall be placed with as low a slump as practicable and special care shall be exercised to effect thorough consolidation of the concrete.

Each layer of concrete shall be consolidated to the maximum practicable density, so that it is free from pockets of aggregates, and closes snugly against all surfaces of forms and embedded materials. In consolidating each layer of concrete the vibrating head of the vibrator shall be allowed to penetrate and re-vibrate the concrete in the upper portion of the under-lying layer. All concrete shall be consolidated with electric or pneumatic, power-driven immersion-type vibrators, operating at speeds of at least 7,000 revolutions per minute when immersed in the concrete. Additional layers of concrete shall not be placed until the layers previously placed have been worked thoroughly as specified.

Removal of Forms

4.14 The Contractor shall be responsible for ensuring that sufficient time has elapsed for the concrete to attain sufficient strength before removal of forms. The time and method of removal and moving of forms shall be as directed by the Engineer, and this work shall be done with care so as to avoid injury to the concrete. No loading on green concrete will be permitted. Use of crow bars for removing formwork by wedging against the newly hardened concrete shall not be permitted. As soon as the forms are removed, the surface of the concrete shall be carefully examined, and any defective concrete or irregularities in the surface shall be immediately repaired to the satisfaction of the Engineer.

In general, the minimum elapsed time before removal of forms shall be one days for unloaded walls and other side forms, seven days for supporting walls and conduits and 14 days for slab and bridge decks.

Curing

4.15 All concrete shall be cured in accordance with ACI 308-01. The

Contractor shall have all equipment and materials needed for adequate curing and protection of the concrete on hand and ready to use before actual concrete placement begins. All concrete shall be cured either by water curing or by use of wax-base or water emulsified, resin-base curing compound expect as specified otherwise. The curing compound shall be white-pigmented. The contractor shall furnish copies of manufacture's specifications and copies of all purchase order for curing compound far enough in advance of planned use so as to allow a testing period of at least 45 days; for approval by the Engineer. Concrete cured with water shall be kept wet for at least 7 consecutive days (14 days in case of reinforced concrete) immediately (after the initial set) following placement or until covered with fresh concrete, by covering with water-saturated material, or by a system of perforated pipes, mechanical sprinklers, or porous hose, or by any other approved method which will keep all surfaces to be cured continuously (not periodically) wet. Water used for curing shall meet the requirements of these Specifications for water used for mixing concrete.

Protection

4.16 The Contractor shall protect all concrete against injury until final acceptance by the Engineer. Exposed surfaces of all concrete shall be protected from the direct rays of the sun for at least the first three days after placing. Such protection shall be made effective as soon as practicable after the placing of unformed concrete or after the removal of forms from formed concrete.

Finishes and Finishing including Tolerances

4.17 Finishing of concrete surfaces shall be performed only by skilled workmen and in the presence of the Engineer or his authorized representative. Concrete surfaces will be tested by the Engineer where necessary to determine whether surface irregularities are within limits hereinafter specified. Surface irregularities are classified as "abrupt" or "gradual". Offsets caused by displaced or misplaced form sheating, or lining, or form sections, or by loose knots in forms, or otherwise defective form lumber, will be considered as abrupt irregularities, and will be tested by direct measurement. All other irregularities will be considered as gradual irregularities, and will be tested by use of a template, consisting of a straight-edge or the equivalent thereof for curved surfaces. The length of the template will be 5 feet (1.52 meters) for testing of formed surfaces and 10 feet for testing of unformed surfaces. Before acceptance of the work, the Contractor shall clean all exposed surfaces, unless otherwise specified, of unsightly encrustation and stains.

Unless otherwise specified, the classes of finish for formed surfaces shall be as follows:

a) Formed surfaces upon or against which backfill or concrete is to be placed will require no treatment after form removal except for the removal and repair of defective concrete and for the specified curing. Correction of surface irregularities will be required for depressions only, and only for those which, when measured as described in sub-clause (1) shall not exceed ¼ inch (6.35 mm) for abrupt irregularities and ½ inch (12.70 mm) for gradual irregularities.

b) Submerged and below ground formed surfaces which are

not exposed to the action of flowing water and are not prominently exposed to public view will need no sack rubbing and no grinding other than that needed for repair of surface imperfections. Surface irregularities, measured as described in sub-clause (1) shall not exceed ¼ inch (6.35 mm) for abrupt irregularities and ½ inch (12.70 mm) for gradual irregularities.

c) Formed surfaces of structures above ground which are prominently exposed to public view shall have skillfully and accurately constructed forms of fir plywood lining, tempered pressed wood lining or smooth planed boards with tongue and groove or shiplap joints. Steel lining will not be permitted. There shall be no visible offsets, bulges or misalignment of concrete. Surface irregularities, measured as described in sub-clause (1) shall not exceed 1/8 inch (3.18 mm) for abrupt irregularities and ¼ inch (6.35 mm) for gradual irregularities.

d) The surfaces of all waterway passages and all other formed surfaces subject to the action of flowing water, shall have forms constructed of metal, metal-lined timber, fir plywood lining, tempered pressed wood lining or smooth planed boards. The forms must be strong and held rigidly and accurately to the correct alignment. Surface irregularities, measured as described in sub-clause (1) shall not exceed zero for abrupt irregularities and 1/4 inch (6.35 mm) for gradual irregularities.

Interior unformed surfaces shall be sloped for drainage where shown on the Drawings or as directed by the Engineer. Surfaces which will be exposed to the weather and which would normally be level, shall be sloped for drainage. Unless the use of other slopes on level surfaces is indicated on the Drawings or directed by the Engineer, narrow surfaces, such as tops of walls and curbs, shall be sloped approximately ¼ inch (6.35 mm) per foot of width; broader surfaces, such as platforms and decks, shall be sloped approximately 1/8-inch (3.18 mm) per foot. Unless otherwise specified, classes of finish for unformed surfaces shall be as follows:

a) Unformed surfaces that will be covered by backfill or by concrete shall be finished by sufficient levelling and screening to produce an even uniform surface. Surface irregularities, measured as described in sub-clause (1) shall not exceed 3/8-inch (9.53 mm) for gradual irregularities.

b) A hard steel trowel finish shall be applied to unformed surfaces that will be exposed to view or that will be subjected to the action of flowing water. Floating and Trowelling may be performed by use of hand or power-driven equipment. Floating and trowelling shall be started as soon as the screened surface has stiffened sufficiently, and shall be the minimum necessary to produce a surface that is free from screed marks and is

uniform in texture. Surface irregularities, measured as described in sub- clause (1) shall not exceed ¼ inch (6.35 mm) for gradual irregularities and no trowel marks or abrupt irregularities will be permitted. Joints and edges shall be tooled.

Tolerances for Concrete Construction

4.18 In general, the permissible construction tolerances for reinforced concrete and lining and conduits shall conform to the requirements of the following table as applicable. The specific tolerances for each structure and part thereof shall be as determined by the Engineer. Notations on the Drawings of specific maximum or minimum tolerance in connection with any dimension shall be considered as supplemental to the tolerances specified herein and shall control. The Contractor shall be responsible for setting and maintaining concrete forms sufficiently within the tolerance limits so as to ensure that the completed work will be within the tolerances specified herein. Concrete work that exceeds the tolerance limits specified herein shall be remedied or removed as directed by the Engineer and repaired or replaced at the expense of the Contractor.

1.	Variation from the plumb: a. In the lines and surfaces of piers, abutment walls and in arises b. For control-joint grooves, and other conspicuous lines	 In 10 feet 1/4 inch In 20 feet maximum 3/8 inch In 40 feet or more 3/4 inch In 20 feet maximum 1/4 inch In 40 feet or more 1/2 inch
2.	Variation from the level or from the grades indicated on the Drawings: In floor, ceiling, beam soffits, and in arises	 In 10 feet 1/4 inch In 20 feet maximum 3/8 inch In 40 feet or more 3/4 inch
3.	Variation of the linear building lines from established position in plan and related position of piers, abutment walls and partitions.	In 20 feet maximum ±1/2 inch In 40 feet or more ± ¾ inch
4.	Variation in the sizes and locations of sleeves, floor openings, and wall openings	± 1/4 inch
5.	Variation in cross-sectional dimensions of piers and beams and in the thickness of slabs and walls.	Minus 1/4 inch Plus 1/2 inch
6.	Footings: a. Variation of dimensions in plan b. Misplacement or eccentricity c. Reduction in thickness	 Minus 1/2 inch Plus 2 inch 2 percent of the footing width in the direction of misplacement but not more than ±2 inches Minus ……. 5 percent of specified thickness
7.	Variation in steps: a. In a flight of stairs b. In consecutive steps	 Rise ± 1/8 inch Tread ± 1/4 inch Rise ± 1/16 inch Tread ± 1/8 inch

Repairing Concrete

4.19 If, after stripping of forms, any concrete is found to be not formed

Surfaces

as shown on the Drawings, or is out of alignment or level, or shows a defective surface, it shall be considered as not conforming with the intent of these Specifications and shall be removed and replaced by the Contractor at his expense unless the Engineer grants permission to patch the defective area, in which case patching shall be performed as described in the following sub-clauses.

Defects that require replacement or repair are those that consist of honeycomb, damage due to stripping of forms, loose pieces of concrete, bolt-holes, tie-rod holes, ridges at form joints and bulges due to movement of the forms. Ridges and bulges shall be removed by chipping or tooling followed by rubbing with a grinding stone. Honeycomb and other defective concrete shall be chipped out, the chipped openings being sharp- edged and shaped so that the filling will be keyed in place. All holes shall be thoroughly moistened for 24 hours before the filling is placed. The surface of the filling shall be finished flush with the surrounding wall, and shall have the same texture and color. All patches shall be cured.

When, in the opinion of the Engineer, the extent of the imperfections in structures exposed to view are such that patching alone would not produce a wall of satisfactory appearance, the Contractor will be required to give such walls, as well as adjacent walls, a sack rubbed mortar finish in accordance with the Engineer's instructions.

Imperfections, and holes equal to, or greater than the least surface dimensions, narrow slots, cuts for repair of cracks, and bolt and tie-rod fastener recesses, shall be filled with dry pack mortar composed of one part of Ordinary Portland to two parts of regular concrete sand (volume measurement) together with a non-shrink patching compound, approved by the Engineer, in the amount specified by the manufacturer, and just enough water so that, after the ingredients are thoroughly mixed, the mortar will stick together on being moulded into a ball by slight pressure of the hands and will not extrude free water. Chipped-out honeycomb areas and other imperfections permitted by the Engineer to be repaired shall be filled with dry pack mortar as described above, bonded with epoxy. Immediately prior to placing the mortar, the surface of the area to be filled shall be coated with an epoxy bonding compound as approved by the Engineer. Mixing and application of the epoxy bonding compound shall be in strict accordance with the manufacturer's recommendations. Mortar repairs shall be placed in thin layers and thoroughly compacted by suitable tools. Care shall be taken in filling rod, bolt and pipe holes so that the entire depth of the holes is completely filled with compacted mortar.

Concrete filling shall be used for holes extending entirely through concrete sections; for holes in which no reinforcement is encountered and which are greater than 1.0 square foot (929.03 square cm) in area and deeper than 4 inches (101.6 mm); and for holes in reinforced concrete which are greater in area than 0.5 square foot (464.52 sq. cm.) and which extend beyond reinforcement.

Bitumen Coating to Concrete Surface in Contact with Soil

4.20 Where ordered by the Engineer or shown on the Drawings, bituminous coatings shall be applied to concrete structures in order to protect the concrete against attack from naturally occurring soluble sulphates.

Before applying any coating, the surface of the concrete shall be

cleaned of all dirt, dust and loose material and, where necessary, any surface shall be made good so that it is smooth and free from air or water holes. No bituminous coating shall be applied until the Engineer has approved the preparatory work.

The protection shall be applied using Bituproof bituminous coatings as manufactured by Shell Composites Ltd. Galvin Road, Slough, Bucks., UK, or another equivalent similar approved coatings. The grades of coating and the method of application shall be as follows:

a) First Coat (Primer)

An application of bituproof Type 3, diluted with an equal volume of water, shall be well scrubbed into the concrete and allowed to dry.

b) Second Coat

A heavy brush coat of Bituproof Type 5 containing a cement slurry, consisting of 1 volume of ordinary portland cement, 1 volume of water and 10 volumes of Type 5, shall be laid on in one direction and allowed to dry. To introduce the cement slurry to the Bituproof, the cement shall be mixed thoroughly with the water, the whole being added to the Bituproof, stirring thoroughly to ensure uniform dispersion. The Bituproof/cement slurry mix shall be used within one hour of preparation.

c) Third Coat

A heavy brush coat of Bituproof Type 5/Cement slurry mix prepared as for the previous coat shall be laid on at right angles to the previous coat and allowed to dry.

The application rate for the above primer and subsequent coats shall in total provide not less than 0.20 lb of Bituproof per square foot. Additional coats where required by the Engineer to make good damage to the protective coating or as otherwise ordered shall be applied in the same manner as the third coat described herein.

Each coat shall be thoroughly dry before applying a subsequent coat and shall be considered as dry when no staining occurs on a wet finger which is rubbed vigorously over the coating. Each subsequent coat shall be applied within 72 hours of the previous coat being applied. The coating shall not be immersed in water for at least ten days after it is dry.

The coating shall only be applied to the surfaces when shaded from direct sunlight and the coated surfaces shall continue to be so shielded until the final coat is thoroughly dry.

In order to provide protection to the underside of structures, the bituminous coatings shall be applied to the blinding layer before the placing of the structural concrete. The blinding layer shall first be given a wood float finish. The blinding and protection shall extend beyond the outer edge of the structural concrete by at least 4 inches so that subsequent coatings applied to the structural concrete can overlap the blinding layer and provide unbroken protection. The structural concrete

shall not be placed on the blinding layer until the protection is thoroughly dry, and not in any case until 60 hours have elapsed following the completion of the protection.

Construction Joints

4.21 Joints shall be provided at locations indicated on the drawings and according to details shown or otherwise approved by the Engineer. The method and materials used in the construction of such joints shall be subject to approval of the Engineer. The joints shall be constructed in accordance with the provisions of these Specifications.

Construction joints are joints which are purposely placed in concrete to facilitate construction; to reduce initial shrinkage stresses and cracks; to allow time for the installation of embedded metalwork; or to allow for the subsequent placing of other concrete. Bond is required at construction joints regardless of whether or not reinforcement is continuous across the joint.

The location of all construction joints in concrete work shall be subject to approval of the Engineer, and the joints shall be constructed in accordance with the Specifications and Drawings. No separate payments shall be made for construction joints.

Contraction & Expansion Joints

4.22 Contraction and expansion joints of the types shown on the Drawings shall be constructed where shown on the Drawings. Expansion joints shall also be provided at all road bridges at the junction of abutment walls and piers with canal concrete lining and shall conform to the specifications given in section – “Miscellaneous”.

Contraction joints shall be constructed at location shown on the Drawings. The joints shall be made by forming the concrete on one side of the joint and allowing it to set before concrete is placed on the other side of the joint. The surface of the concrete first placed at the contraction joint shall be coated with curing compound and two coats of bitumen before the concrete is placed on the other side of the joint. Special care shall be taken to ensure proper compaction of concrete near the joint faces.

Where shown on the drawings, a groove will be formed on one side of the joint and filled with elastomeric sealant in accordance with section 11.6(7).

Testing of Concrete

4.23 Strength tests of the concrete placed during the course of the work will be made by the Engineer in an approved laboratory at the Contractor's expense. The Contractor shall assist the Engineer in obtaining, for control purposes, such number of cylinders as the Engineer may direct, but in general, three sets of three cylinders taken from each 6750 cubic feet of concrete or fraction thereof, or from each day’s pour, whichever is less, of each class of concrete placed, shall govern. Test specimens will be made and cured by the Contractor in accordance with the applicable requirements of ASTM Designation C31-87, "Standard Method of Making and Curing Concrete Compressive and Flexural Test Specimen in the Field".

Cylinders will be tested by the Contractor in accordance with the applicable requirements of ASTM Designation C39-86, "Standard Method of Test for Compressive Strength of Cylindrical Concrete Specimens". The

test result will be based on the average of the strength of the test specimens except that if one specimen in a set of three shows manifest evidence of improper sampling, moulding, or testing, the test result will be based on the average of the remaining two specimens. If two specimens out of a set of three show such defects, the results of the set will be discarded and average strength shall be determined from test results of other sets. The standard age of test will be 28-days, but 7-days tests may be used at the discretion of the Engineer, based on the relation between the 7-days and 28-days strengths of the concrete as established by tests for the materials and proportions used. If the average on the strength tests of the specimens cured under laboratory controls, for any portion of the work, falls below the minimum allowable compressive or flexural strength at 28-days required for the class of concrete used in that portion, the Engineer may change the proportions of the constituents of the concrete, as necessary to secure the required strength for the remaining portions of the work. If the average strength of the specimens cured under actual field conditions as specified hereinbefore, falls below the minimum allowable strength, the Contractor will make such changes in the conditions for temperature and moisture under which the concrete work is being placed and cured as may be necessary to secure the required strength. The Contractor will also be required to bear any additional expense due to sub-strength concrete.

Where the results of the strength tests of the control specimens indicate that the concrete as placed does not meet Specification requirements or where there is other evidence that the quality of the concrete is below Specification requirements, core-boring tests will be made by the Contractor in accordance with the applicable requirements of ASTM Designation C42-77, "Standard Method of obtaining and Testing Drilled Cores and Sawed Beams of concrete". If the concrete in the structure will be more than superficially wet under service conditions, the cores shall be immersed in water for at least 48 hours and tested wet. In the event that the core-boring test indicates that the concrete placed does not conform to the Drawings and Specifications, measures as prescribed by the Engineer shall be taken to correct the deficiency. However, the Engineer shall have the authority to prescribe such corrective measures (and the Contractor shall take such measures) if in the Engineer's opinion the results of the test specimens, without coring, warrant such action. If a strength deficiency is found and is due to the Contractor's fault or negligence, the entire cost of replacing faulty concrete shall be borne by the Contractor.

Measurement and Payment

4.24 (1) <u>Concrete using Ordinary Portland Cement</u>

a) Measurement will be made for the volume of concrete acceptably placed in the Permanent Works within the lines and grades as shown on the Drawings, and not as batched, or as otherwise directed or approved by the Engineer. Where concrete is placed upon earth or blinding concrete layer, measurement will be made to the foundation lines and grades shown on the Drawings or as otherwise directed and approved by the Engineer. No deductions will be made for rounded or bevelled edges or for space occupied by reinforcing steel. No deduction will be made for voids, piping, electrical conduits or any other embedded items which are each less than 100

square inches (645.16 square cm) in cross-section. No measurement will be made for concrete that is wasted for any reason or that is rejected.

b) All concrete required for work under these specifications shall be included in the unit rates tendered in the Bill of Quantities for the appropriate items in which such concrete is incorporated. The unit rates tendered for such work shall be deemed to cover all costs of concrete, other than reinforcing steel which is measured separately, including, but not limited to furnishing water, sand and aggregates, admixtures, curing/sealing compound, formwork joint sealants, forms and form oil or compound and also including all operations, but not limited to, batching, mixing, temperature control, transportation, preparation for placing, placing, curing, protection, finishing and repairing concrete surfaces, installing and removing forms, shuttering, scaffolding and preparation of construction joints, and carrying out all tests and other operations, procedures, stipulations and requirements set forth herein or otherwise related to the item. In case of mass concrete formwork will be paid separately in accordance with the relevant item of MRS2019 as approved by the Engineer.

c) The item of mass / plum concrete shall be executed in accordance with the specifications spilled over against the relevant item of MRS2019.

d) No payment will be made for the concrete used for casting concrete specimens for testing, their curing, transportation to the laboratory and their testing. No additional payment except that mentioned in the respective BOQ Items will be made to the contractor for any change in mix design of concrete to achieve the required strength. Additional Financial implication if any involved in change of mix design for achieving the specified strength is deemed to be included in the premium quoted by the bidder on the BOQ / MRS2019.

Measurement and Payment

4.24 (2) Bituminous protection:

a) Bituminous protection as specified in Clause 4.20 shall be measured by net area covered in per M^2 of final three coats applied surface in accordance with the specifications to the limits shown on the Drawings or as directed by the Engineer, irrespective of whether it is horizontal, vertical, sloping or curved surfaces. Payment made at unit rate quoted in the BOQ / MRS2019 for this item shall constitute full compensation for finishing and application of bituminous materials.

b) Measurement and payment shall be made for final three coats applied surface and no measurement for individual coat shall be made.

Measurement and Payment

4.24 (3) Contraction Joints:

a) Measurement of contraction joints in concrete structures shall be made of the length of the joints prepared according to design lines of the structures in running meter.

b) Payment shall be made at the unit rate tendered per running-meter in the BOQ for joints in concrete structures and shall constitute full compensation for the work of providing joints in concrete structures complete in all respects including two coats of bitumen on vertical face of contraction joint and providing sealant in groove where shown on the drawings.

5 – CEMENT

Scope of Work

5.1 The Contractor shall procure transport, store and handle all Ordinary Portland Cement (OPC) and Sulphate Resisting Cement (SRC) required in the construction of the Works.

Requirement

5.2 All cement shall be of Pakistani origin unless otherwise approved by the Engineer. All cement, shall be Ordinary Portland Cement conforming to ASTM C150-98 type-1 or BS-12 except where the use of Sulphate Resisting cement conforming to ASTM C150- 81 Type V or B.S.4027 is specified and shown on the drawings.

The Contractor will use Pozzolanic materials (blast–furnace slag, flyash or calcined clay) blended Ordinary Portland Cement/Sulphate Resisting Cement by replacing 40% cement with Pozzolanic material. The Portland blast-furnace slag cement shall conform to BS 146 to ASTM C 595. Raw or Calcined natural pozzolan shall conform to ASTM C618 Class N or Class F. Slag shall consist of finely ground granulated iron blast-furnace slag and shall conform to ASTM C989 Grade 80, 100 or 120.

The proportions of SRC and Pozzolanic materials will be determined by the Contractor and approved by the Engineer for each mix. The mix will normally be designed by the Contractor to have:

- a mortar bar reduction not less than 75% at 14 days when tested in accordance with ASTM C441, and
- a heat of hydration of less than 70 calories per gram of pozzolanic materials (blast-furnace slag, flyash or calcined clay) at 7 days when tested in accordance with ASTM C186.

Unless otherwise permitted, cement from not more than three plants shall be used and, in general, only the product of one plant shall be used in any particular section of the work.

Transportation

5.3 Transportation of the cement from the cement plant to the point of use shall be accomplished in such a manner that the cement is completely protected from exposure to moisture. Cement which has been adversely affected by moisture, as determined by the Engineer, shall be rejected. Cement in sacks shall be delivered in strong, well-made, paper or cloth bags, each plainly marked with the manufacturer's name, brand, type of cement and the weight of cement contained therein.

The Contractor shall ensure that the cement sacks are not damaged during handling and transportation by the Contractor. Packages received in broken or damaged condition shall be rejected.

The Contractor shall have, at the site of the work, sufficient supply of accepted quantity of cement and shall guard against

possible shortage from every cause.

Inspection and Tests

5.4 Sampling, inspection and testing of all cement will be performed by the Engineer at the expense of the Contractor, and such sampling, inspection and testing will be in accordance with ASTM Designation: C150 or the equivalent tests of the British Standards Institution as designated by the Engineer. The Contractor shall notify the Engineer, the source and name of manufacturer from where he intends to procure cement and the Engineer shall have the right, at all times, to inspect the process of manufacture, the laboratory records of analysis and tests made at the cement plant and to take samples of the cement for testing. The Contractor shall provide all necessary assistance to the Engineer for taking of samples. If required, the contractor shall provide test certificate of the factory from which cement is procured for the specific lot supplied for works.

The Engineer may test the cement kept in storage at any time before use. Cement failing to pass such tests shall be rejected. If any cement proves unsatisfactory and portions of it have been used in concrete, mortar or grout, then such concrete, mortar or grout will be removed and replaced, using acceptable cement, at the Contractor's expense. Test cylinders or cubes from concrete or mortar being used in the work may be made by the Engineer at any time for purposes of testing. The Contractor shall furnish all cement concrete or mortar required for testing without charge to the Employer.

Cement may be rejected, at the discretion of the Engineer, if it fails to meet any of the requirements of these specifications. In the event of the cement failing to meet the requirements of these specifications, the cement shall be re-sampled and retested. If retest prove the cement delivered is unsatisfactory, it shall be promptly removed from the site. Cement may be accepted on the basis of the 7 day test results, provided results justify such acceptance. Otherwise, the results of the 28-days test at the normal testing rate must be approved prior to shipment of the cement from the plant. Cement, which has been in storage at the site longer than four months, shall not be used until retesting proves it to be satisfactory.

Storage

5.5 The Contractor shall provide suitable storage for cement at proposed places convenient to the work, and the cement shall, at all times, be carefully protected against moisture and exposure to air. Cement storehouses shall be weather-tight; shall have tight floors set at a proper distance above the ground; shall be large enough to maintain a sufficient supply of cement on hand to prevent delays or interruptions to the work and shall have sufficient floor space for storing each truck load of cement separately and affording convenient access thereto for sampling, counting of packages and removal. Cement in packages shall not be piled to a height exceeding 7 feet.

To prevent undue aging of sacked cement after delivery, the Contractor shall use sacked cement in the chronological order in

which sacked cement was stored so that it may readily be distinguished from other shipments. All empty sacks shall be promptly disposed of.

The Contractor shall employ competent storekeepers who shall have charge of the cement storehouses and keep suitable record of the delivery and use of all cement. Copies of these records shall be furnished to the Engineer at the close of each day's work, showing in such details as he may require, the quantity of cement used during the day in each part of the work.

Measurement and Payment

5.6 No separate measurement and payment will be made for cement used in any required construction under these. Specifications and all costs of providing cement including handling, transportation and storage shall be included in the unit rates tendered in the Bill of Quantities for the respective items in which cement is to be used.

6 – SAND AND COARSE AGGREGATES

Scope of Work

6.1 All aggregates to be used for the Works to be constructed under the Contract and for all related purposes, and, as may be required by the Engineer, shall consist of the materials herein specified and shall be in accordance with the requirements stated herein. The stipulations and requirements herein set forth shall apply except where such stipulations and requirements are specifically modified by the Engineer for any particular item of work.

The contractor shall propose sources of sand and aggregates for approval of the Engineer and shall be responsible for their procurement, transportation, testing and storage at site.

Source of Natural Sand

6.2 All natural sand required for the work to be done under these Specifications shall be furnished by the Contractor. Such natural sand shall be obtained from river deposits or other approved sources. The Contractor will be permitted to obtain natural sand at no charge from sources that are the property of the Employer. If natural sand is obtained from sources not owned or controlled by the Employer, the Contractor shall make all necessary arrangements with the owner and shall pay all rentals and other costs connected therewith.

Approval of a source of natural sand shall not be construed as constituting approval of all materials taken from the source, and the Contractor shall be responsible for the specified quality of all such materials used in the work. The Contractor shall submit to the Engineer, for preliminary tests and approval, a representative 100-pound sample of natural sand proposed for use at least thirty (30) days before use of such material is required.

Processing Natural Sand

6.3 The deposit of natural sand shall be cleared by the Contractor of all vegetation and other objectionable matter and all unsuitable soil, sand and gravel shall be removed. The deposit shall be developed and operated so as not to detract from the usefulness of the deposit. The material shall be screened and washed as necessary to produce natural sand meeting the requirements herein set forth.

Concrete Aggregate Plant

6.4 Aggregate plant capable of producing approved sizes of concrete aggregates meeting the Specifications at the rate necessary to meet the requirement of the construction schedule shall be furnished, installed, operated and maintained by the Contractor at locations approved by the Engineer.

Facilities shall be provided for proper crushing, screening, washing, classification, storing, reclaiming, and delivery of aggregates to the batching and mixing plant.

All crushing shall be performed in a minimum of two stages to obtain aggregates of cuboid or spheroid shape. Jaw crushers shall

not be used except as the primary crusher. To achieve an acceptable particle shape, the fine aggregate may be manufactured using crushers specially adapted (Rollobar or similar) to suit the type of material available.

The plant shall include facilities for washing coarse and fine aggregates after separation into the various size groups in order to remove any fine material and organic matter before delivery to the concrete batching and mixing plant.

The coarse aggregate as produced and stockpiled will be graded into nominal sizes as per Contractor's plan approved by the Engineer.

Handling and Stockpiling Aggregates

6.5 The Contractor shall handle, load, transport, unload and stockpile all aggregates as required to perform the construction of the Works specified herein. All methods employed by the Contractor for unloading, loading, handling and stockpiling aggregates shall be subject at all times to the approval of the Engineer.

The location and arrangement of all stockpile areas shall subject to the approval of the Engineer. The Contractor shall clear and evenly grade for drainage, all sites designated for stockpiling and shall handle stockpiling operations of aggregates so that segregation and breakage will be kept to a minimum and that stockpiled material will not be contaminated with soil or other foreign material due to rain, surface and sub-surface waters. The Contractor will be required, at his own expense, to reprocess aggregates which may become segregated or contaminated due to improper stockpiling and lack of adequate protection. The Contractor shall conduct all stockpiling operations in such a manner as to deposit all materials directly in final position in the stockpiles and in layers not more than 4 feet deep. Aggregates shall not be moved from place to place in the stockpiles except as superficial levelling may be necessary to provide suitable roadways for trucks in placing successive layers, and the Contractor shall provide effective means to prevent breakage of aggregates caused by trucks operating over the stockpiles. Dumping over the ends or sides of the stockpiles will not be permitted. Necessary measures to avoid rock breakage and to prevent materials from segregating by running down the outside slopes of stockpiles shall be adopted.

The total capacity of the storage for each category of aggregates shall be sufficient to ensure progress of work on the site for a duration of at least 5 days.

Aggregates Testing

6.6 The following tests are to be performed on the aggregates.

Characteristic	Test Method ASTM	Application
Grain size analysis	C 136	All aggregates
Water content	C 566	Fine aggregates
Water content	C 566	Coarse aggregates
Sieve analysis	C 136	All aggregates

Sp. Gravity and Absorption	C 127	Coarse aggregates
Sp. Gravity and Absorption	C 128	Fine aggregates
Los Angeles	C 131-C 535	Aggregates above 1/8 inch.
Organic matter	C 40	Fine aggregates
Characteristic	**Test Method ASTM**	**Application**
Sand equivalent	D 2419	Fine aggregates
Soundness	C 88	All aggregates
Flakiness and Elongation	BS 812	Coarse aggregates
Unit Weight and voids	C 29	All aggregates
Light Weight Pieces	C 123	All aggregates
Clay lumps & Friable Particles	C 142	All aggregates
Alkali Reactivity	C 227-C 289	All aggregates
Petrographic analysis	C 295	All aggregates
Water-Soluble Chloride (Cl)	C 1218 or BS 812	All aggregates
Water-Soluble Sulfates (SO3)	BS 1377	All aggregates

All aggregates shall be continuously tested to ensure compliance with Specifications. The normal testing frequency is given in Section 18 – Quality Control and Quality Assurance.

Sand

6.7 The term "sand" is used to designate aggregates in which the maximum size of particles is 3/16 of an inch (4.76 mm). Sand to be used under these Specifications shall be processed from natural deposits. The sand particles shall be hard, dense, durable, un-coated inorganic rock fragments and all sand shall be free from injurious amounts of clay lumps, soft or flaky particles, shale, alkali, organic matter, loam, mica and other deleterious substances. The sand shall conform to ASTM Designation C33-99. The sand shall be washed, classified and otherwise processed as required. The maximum percentage of individual deleterious substances in the sand shall not exceed the following values:

Percent, By weight

Materials Passing No. 200 Screen
(ASTM Designation: C117-95) 3
Lightweight Material
(ASTM Designation: C123-98) 2
Clay Lumps
(ASTM Designation: C142-97) 1
Total of Other Deleterious Substances
(such as Alkali, Mica, Coated Grains,
Soft Flaky Particles and Loam) 2

Water-Soluble Chloride (Cl) 0.06
Water-Soluble Sulfate (SO_3) 0.40*

The sum of the percentages of all deleterious substances shall not exceed five percent, by weight. Sand producing a color darker than the standard in the calorimetric test for organic impurities (ASTM Designation: C40-98) may be rejected. When required by the Engineer, the sand shall be subjected to a soundness test and may be rejected if the portion retained on a No. 50 screen, when subjected to five cycles of the sodium- sulphate test for soundness (ASTM Designation: C88-99a), shows a weighted average loss of

more than eight percent, by weight.

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* Subject to the total sulfate (SO_4) in the mix < 4% by weight of Cement.

When tested by means of standard screens (ASTM Designation: E11-95), sand shall conform to the following limits:

Screen No.	Individual Percent, By Weight Retained on Screen
4	0-05
8	6-15
16	10-25
30	10-30
50	15-35
100	12-20
PAN	3-7

If the individual percentage retained on the No. 16 screen is 20 percent or less, the maximum limit for the individual percent retained on the No. 8 screen may be increased to 20 percent. Fineness modulus of sand should range from 2.3 to 3.1.

All sand for mortar used in the construction of Masonry shall be natural sand furnished by the Contractor and when tested by means of standard screens (ASTM Designation: E11-95), shall conform to the following limits:

Screen No.	Percent, By Weight, Passing Screen
8	100
100	15 (Maximum)

Within the above range, the sand shall be well-graded and shall be as coarse as practicable for the production of workable mortar.

The natural and finished sand will be subject to testing by the Contractor to determine whether the sand produced conforms to the requirements of these Specifications. The Contractor shall furnish, without charge, such assistance as the Engineer may require in obtaining representative samples for testing purposes and in inspecting plant facilities and operations of the Contractor.

Aggregates

6.8 The term "aggregates" is used to designate aggregates which are reasonably well-graded within the range of 3/16 of an inch to 3 inches (4.76 to 76.2 mm) or any size or range of sizes within such limits. Aggregates to be used under these Specifications shall consist of natural deposit or quarried and crushed rock. The aggregates shall consist of well shaped, hard, dense, durable and un-coated rock fragments, and all aggregates shall be free from injurious amounts of deleterious substances. The percentage of individual deleterious substances in any size aggregates shall not exceed the following

values:

Percent
by Weight

Material Passing No. 200 Screen (ASTM Designation: C117-95) 1
Lightweight Material (ASTM Designation: C123-98).....2
Clay Lumps (ASTM Designation: C142-97).....1/2
Other Deleterious Substances 1
Water-Soluble Chloride (Cl) 0.06
Water-Soluble Sulfate (SO_3) 0.40*

The sum of the percentages of all deleterious substances in any size shall not exceed three percent, by weight. Aggregates may be rejected if they fail to meet the following test requirements:

a) Los Angeles rattler test (ASTM Designation: C131-81). If the loss exceeds ten percent, by weight, at 100 revolutions, or 40 percent, by weight, at 500 revolutions.

b) Sodium-Sulphate soundness test (ASTM Designation: C88-99a). If the weighted average loss after five cycles is more than ten percent, by weight.

c) Specific gravity (ASTM Designation: C127-88). If the specific gravity (saturated surface-dry basis) is less than 2.60.

The aggregates as produced and stockpiled will be graded in three nominal sizes as follows:

Designation of Size of aggregate	**Nominal Size Range**	**Minimum Percent Retained on Screen indicated**
3/4 inches (19.05 mm)	3/16 to 3/4 inches (4.76 to 19.05 mm)	45 to 80 percent on 3/8 inches (9.53 mm)
1.5 inches (38.1 mm)	3/4 to 1.5 inches (19.05 to 38.1 mm)	45 to 80 percent on 1 inch (25.4 mm)
3 inches (76.2 mm)	1.5 to 3 inches (38.1 to 76.2 mm)	25 to 40 percent on 2.5 inches (63.5 mm)

Aggregates will be separated into specified sizes such that, when tested by screening on the screens designated in the following tabulation, the material passing the undersize test screen (significant undersize) will not exceed two percent, by weight, and all materials will pass the oversize test screen:

Size of Square Opening in Screen

Aggregate Size	**For Undersize Test**	**For Oversize Test**
3/4 inches (19.05 mm)	No. 5	7/8 inch (22.22 mm)
1.5 inches	5/8 inches (5/8 inches)	1.75 inches (44.45

(38.1 mm)		mm)
3 inches (76.2 mm)	1.25 inches (31.75 mm)	3.5 inches (88.9 mm)

* Subject to the total sulfate (SO_3) in the mix < 4% by weight of Cement.

All screens used for gradation tests, for oversize and undersize tests, will be woven wire cloth sieves conforming to the requirements of ASTM Designation: E-11-81 with respect to permissible variations in average openings. The Contractor shall get the sources of sand and aggregates approved in advance.

Measurement and Payment

6.9 No separate measurement and payment will be made for sand and aggregates used in construction of any required works under these Specifications and all costs of providing such sand and aggregates shall be included in the unit rates of the relevant items tendered in the Bill of Quantities for the respective Items in which such materials are to be used.

7 – BLINDING CONCRETE UNDER FLOOR SLABS AND FOUNDATIONS OF ALL STRUCTURES

Scope of Work

7.1 The work to be done under Blinding concrete consists of constructing the concrete under floors and foundations of all structures wherever shown on the Drawings.

Where concrete is to be placed on a flat excavated surface, a layer of blinding concrete as shown on drawings shall be placed immediately after completion of the excavation and cleaning, unless the concrete can be placed within 72 hours of completion of excavation and cleaning. Blinding concrete shall be allowed to set for 24 hours prior to placement of fresh concrete. The upper surface of the blinding concrete shall not be higher than the required cover below the lowest layer of reinforcing steel. The final excavated level shall be calculated to allow for the thickness of blinding layer.

General

7.2 All concrete materials and the production, forming, placing, curing and repairing of concrete under these Specifications shall be in accordance with the provisions of, and in complete conformity with the stipulations and requirements for concrete specified in the Section "Concrete, General".

All sand and aggregates used for concrete under these Specifications shall be furnished by the Contractor in accordance with the provisions of, and in complete conformity with the stipulations and requirements for sand and aggregates specified in the Section, "Sand and Aggregates".

Sulphate Resisting Cement or slag cement, as proposed by the Contractor and approved by the Engineer, shall be used for blinding concrete under floor slabs and foundation.

All concrete shall be constructed in accordance with the details shown on the Drawings or as directed by the Engineer.

Measurement and Payment

7.3 (a) Measurement for payment for blinding concrete using Sulphate Resisting Cement and slag cement, as approved by the Engineer, required to be placed directly upon or against surfaces of excavation shall be based on nominal volume of blinding concrete measured in hundred cubic feet placed in the permanent works. Measurement will be made by multiplying the thickness by the area covered, measured in the plane of the required surface (not on a horizontal projection) as shown on the Drawings or as otherwise approved or as directed by the Engineer.

(b) Payment for Blinding Concrete under all structures will be made at the unit rate per hundred cubic feet tendered in the Bill of Quantities for blinding concrete.

(c) The amount tendered shall be full payment for completion of the work specified herein and elsewhere in these Specifications for blinding concrete, and all other work related to the item.

8 – REINFORCED CONCRETE EXCLUDING STEEL REINFORCEMENT

Reinforced Concrete Using Sulphate Resisting Cement

8.1 The work to be done under the item Reinforced Concrete using sulphate resisting cement excluding cost of steel reinforcement, consists of constructing concrete in the structures as shown on the Drawings and as directed by the Engineer.

All materials for concrete and the production, components, forming, placing, curing and repairing of concrete under these Specifications shall be in accordance with the provisions of and in complete conformity with the stipulations and requirements for concrete specified in the Section 4 - "Concrete General":

All sand and aggregates used for concrete under these Specifications shall be furnished by the Contractor in accordance with the provisions of, and in complete conformity with the stipulations and requirements of the relevant Section - "Sand and Coarse Aggregates".

Concrete in all structures as shown on the Drawings, shall be cast in accordance with the details shown on the Drawings or as directed by the Engineer.

Where concrete is to be poured in lifts, the time interval between vertically adjacent pours shall be 3 days and between horizontally adjacent pours it shall be 7 days. Maximum lift height shall be ten (10) feet.

The cement used shall be Sulphate Resisting Cement.

Measurement and Payment

8.2(1) (a) Measurement and payment for Reinforced concrete using sulphate resisting cement and excluding cost of steel reinforcement required to be placed upon or against surfaces of excavation or upon layer of blinding concrete will be made as shown on the Drawings or as modified by the Engineer. In measuring concrete for payment, the volume of openings, recesses, ducts, embedded piping and metalwork, each of which are larger than 100 square inches (645.16 square cm) in cross section shall be deducted.

(b) Payment will be made at the unit rate per hundred cubic feet tendered in the Bill of Quantities for reinforced concrete using sulphate resisting cement and excluding cost of steel reinforcement.

(c) The amount tendered shall be full payment for completion of the work specified herein clause 4.24(1) and elsewhere in these Specifications and on the Drawings for the BOQ item for reinforced concrete using sulphate resisting cement but excluding cost of steel reinforcement and all other work related to the item. The cost of Steel Reinforcement will be paid under the

respective BOQ item for steel reinforcement.

8.2(2) Measurement and Payment for Reinforced Cement Concrete Class B for Sump well walls and floor shall be made in hundred (%) cubic feet of concrete placed as per Clause 8.2(1) above.

Reinforced Concrete Using Ordinary Portland Cement

8.3 The work to be done under the item Reinforced concrete using ordinary Portland cement excluding cost of steel reinforcement consists of concrete in deck slabs and girders of bridges, R.C.C. railing over bridges, pile caps and structures above NSL, as shown on drawings and as directed by the Engineer.

All materials for concrete and the production, forming, placing, curing and repairing of concrete under these Specifications shall be in accordance with the provisions of and in complete conformity with the stipulations and requirements for concrete specified in the Section 4 - "Concrete General":

All sand and aggregates used for concrete under these Specifications shall be furnished by the Contractor in accordance with the provisions of, and in complete conformity with the stipulations and requirements of the relevant Section - "Sand and Coarse Aggregates".

Concrete in all structures as shown on the Drawings, shall be cast in accordance with the details shown on the Drawings or as directed by the Engineer.

Where concrete is to be poured in lifts, the time interval between vertically adjacent pours shall be 3 days and between horizontally adjacent pours it shall be 7 days. Maximum height of lift shall be ten (10) feet.

The cement used shall be Ordinary Portland Cement.

Measurement and Payment

8.4(1)

(a) The Measurement and payment for Reinforced concrete using Ordinary Portland Cement and excluding cost of steel reinforcement required to be placed upon or against surfaces of excavation or upon layer of blinding concrete will be made as shown on the Drawings or as modified by the Engineer. In measuring concrete for payment, the volume of openings, recesses, ducts, embedded piping and metalwork, each of which are larger than 100 square inches (645.16 square cm) in cross section shall be deducted.

(b) Payment will be made at the unit rate per hundred cubic feet tendered in the Bill of Quantities for reinforced concrete using ordinary portland cement and excluding cost of steel

reinforcement.

(c) The amount tendered shall be full payment for completion of the work specified herein clause 4.24(1) and elsewhere in these Specifications and on the Drawings for the BOQ item for reinforced concrete using ordinary Portland cement but excluding cost of steel reinforcement and all other work related to the item. The cost of Steel Reinforcement will be paid under the respective BOQ item for steel reinforcement.

8.4(2) Measurement and Payment for reinforced Cement Concrete Class B for Pump House/Wireless room, roof slabs, beams, etc shall be made in hundred (%) cubic feet of Concrete placed as per Clause 8.4(1) above.

9 – STEEL REINFORCEMENT

Scope of Work

9.1 The work to be done under the item, Reinforcement, consists of furnishing, cutting, fabricating, and placing all steel reinforcement as indicated on the Drawings or otherwise, required for construction of the Works.

Material and Size of Bars

9.2 All steel reinforcement shall be approved by the Engineer and shall conform to the following standards:

Steel reinforcement bars shall be deformed bars conforming to the provision of ASTM Designation A615-81(a), "Standard Specifications for Deformed and Plain Billet Steel Bars for Concrete Reinforcement" and shall have a minimum yield strength of 60,000 psi (413.7 N/mm^2).

Reinforcement wherever shown on Drawings will be typical for work of similar nature. Construction drawings showing reinforcement details, will be furnished to the Contractor after the award of contract.

The Contractor shall furnish mill test certificates of all reinforcement furnished, which will show the results of different tests made in accordance with the stipulations and requirements in the aforestated ASTM Standard Specifications. The Engineer may from time to time obtain samples from reinforcement bars for testing at the Contractor’s expense. Such testing of Reinforcement shall be done from the Laboratory approved by the Engineer.

Fabrication and Cleaning

9.3 Steel reinforcement, before being positioned, shall be free from loose mill and rust scale, oil, grease and from coatings that destroy or reduce the bond. Where there is delay in depositing concrete, reinforcement shall be re-inspected and cleaned when necessary.

Reinforcement shall be accurately formed to the dimensions indicated on the Drawings included herein or upon the construction drawing to be furnished to the Contractor. Bends for bars shall be made around a pin having a diameter not less than six time the bar diameter, except for stirrups less than 5/8 inch diameter for which the pin diameter shall be four (4) times the diameter of bar. The bend for bars larger than one inch (25.4 mm) shall be made around a pin of eight (8) bar diameters as per requirement of ACI 318-95. All bars shall be bent cold.

Bars with kinks or bends not shown on the Drawings, shall not be used. Reinforcement shall not be straightened or re-bent in a manner that will injure the material.

The Contractor shall prepare Bar Bending Schedule for the construction Drawings and submit four (4) copies to the Engineer for his approval 28 days prior to commencement of fabrication of steel. Fabrication shall be carried out in accordance with approved Bar

Bending Schedule.

Fixing of Reinforcing Steel

9.4 Reinforcement shall be accurately positioned and secured against displacement by using annealed iron wire ties or suitable clips at intersections, and shall be supported as required by concrete or metal supports, spacers or metal hangers. In all cases sufficient supports for horizontal reinforcement shall be used so that there will be no sagging of the bars, or mesh. Where portions of the supports will be exposed on concrete surfaces designated to receive a smooth finish, the supports shall be made of non-corrodible metal.

Reinforcement in slabs on the ground shall be supported by means of precast concrete blocks. The concrete blocks shall have a horizontal surface approximately 3 inches by 4 inches (76.2 mm by 101.6 mm). The reinforcement in all other slabs and in beams shall be supported by means of metal chairs.

The spacing of bars shall be as shown on the drawings or as directed by the Engineer. The minimum center-to-center distance between parallel bars shall be two and one-half times the diameter of the bars, but in no case shall the clear spacing between the bars be less than one and one-half times the maximum size of the coarse aggregate.

Unless otherwise shown all reinforcement shall be placed so that the clear distance between the face of the concrete and nearest reinforcement is 3 inches (76.2 mm) except against earth where minimum cover of 4 inches (101.6 mm) shall be provided.

When it is necessary to splice reinforcement at points other than shown on the Drawings, the location/placement of such splice shall be determined by the Engineer. The overlap in splices in deformed bars shall be as shown on the drawings and in accordance with the requirement of ACI 318-95.

Embedment length for Deformed bars shall be as shown on the drawings and in accordance with the requirements of ACI 318-95.

Measurement and Payment

9.5 (a) Measurement for payment for reinforcement shall be on the basis of the theoretical unit weight, taken from ASTM A615, of the reinforcement actually placed in the concrete and RCC piles in accordance with the Drawings or as directed by the Engineer.

(b) Steel in laps indicated on the Drawings or as required by the Engineer shall be paid for at the Contract Unit Price. No measurement will be made for supports, chairs wastage or additional steel in laps which are authorized for convenience of the Contractor.

(c) Payment for reinforcement will be made at the unit rate per metric tonne tendered in the Bill of Quantities for respective items of Reinforcement in concrete or concrete piles.

(d) The amount tendered shall be full payment for furnishing of reinforcing steel at site and completion of the work specified herein and elsewhere in these Specifications and on the

Drawings or the BOQ item for Reinforcement, and all other work related to the item.

10 – STONE PITCHING AND STONE APRON

Stone Pitching

10.1 The work to be done under stone pitching consists of furnishing and transporting materials and placing them at locations shown on the Drawings or as directed by the Engineer in accordance with these Specifications.

Materials – Base Filter Layer, Stone Pitching & Rock Spalls

10.2 (1) Base Filter layer: Base filter layer under stone pitching shall consist of a mixture of 20% medium to coarse sand with 80% graded material. The graded material shall consist of gravel well graded to a maximum size of less than 1½ inches.

(2) a) Stone Pitching for Structures on Main Canal: Stone for pitching shall consist of rock fragments or boulders/pebbles which are dense, sound, angular and resistant to abrasion. The stones shall be generally cuboid in shape with the largest dimensions not exceeding twice the smallest dimensions. The stones individually shall weigh between 40-120 lbs with 80 percent shall be 80 lbs or larger and not more than 5 percent shall weigh less than 40 lbs.

b) Stone Pitching for Areas Other than Main Canal: Stone for pitching shall consist of rock fragments which are dense, sound, angular and resistant to abrasion. Individual fragments shall be free from cracks, seams and other defects that could tend to increase unduly their destruction by water. The required size of stone shall be determined by the specified nominal weight P50. At least 50% by weight of the material shall consist of stones having a mass heavier than the nominal mass P50.

P50 = 40 pounds and range 15 to 50 pounds.

The heaviest stone shall not have mass higher than 1.2 times the maximum specified mass. No more than 15% by mass of the material shall consist of stone having a mass more than the maximum specified. The upper limit of P50 shall be less than 1.4 P50. No more than 5% by mass of the material shall consist of stone having a mass less than the minimum specified.

(3) Rock Spalls: All interstices in stone pitching shall be well filled with rock spalls. The rock spalls shall be rock fragments size between 2 inches and 4 inches.

(4) Testing of Materials: Stone & rock spalls may be rejected if they fail to meet the following test requirements:

a) Los Angeles abrasion test (large size Coarse Aggregate ASTM Designation: C535-96). If the loss exceeds ten percent, by weight, at 200 revolutions, or 40 per cent, by weight, at 1000 revolutions;

b) Los Angeles abrasion test (small size Coarse Aggregate ASTM C131-96). If the loss exceeds ten percent by weight at 100 revolution or 40 percent by weight at 500 revolution;

c) Specific gravity (ASTM Designation: C127-88). If the specific gravity (saturated surface-dry basis) is less than 2.60.

d) Test for Rock Slabs to Evaluate Soundness of Rip Rap by use of Sodium Sulfate or Magnesium Sulfate, ASTM D 5240.

e) Test for Evaluation of Durability of Rock for Erosion Control under Wetting and Drying Conditions, ASTM D5313.

Material Sources

10.3 The contractor shall propose the sources of base filter layer, stone pitching and rock spalls for approval of the Engineer. The use of the materials shall always be subject to approval of the Engineer. All the requisite tests will be carried out by the Contractor under supervision of the Engineer either at Contractor's Laboratory or at an approved laboratory at the cost of the Contractor.

Placement

10.4 Structures and locations where stone-pitching is required shall include, but not be limited to the guide banks, spurs, link channels and other locations as shown on the drawings.

The base filter layer shall be placed to a uniform thickness and finished to a reasonably smooth and even surface as shown on the Drawings or as directed by the Engineer. Before placement of the base filter, the surface over which the base filter is to be placed shall be trimmed to the proper lines and grades and shall be moistened with water and tamped or rolled with suitable tools or equipment for the purpose of forming a firm foundation.

Stone used in the stone pitching shall be hand picked and placed and bedded in such a manner that the completed stone pitching is stable and without tendency to slide. Large open spaces between the stone shall be avoided. Care shall be taken to ensure that all stone is well-bedded on its flattest surface. The stone shall be placed so as not to project above the neat lines shown on the Drawings or as directed by the Engineer. All interstices in the stone pitching shall be well-filled with rock spalls. The amount of rock spalls used shall not be in excess of that required to fill the voids in the revetment stone.

Measurement and Payment

10.5.1 (a) Measurement for stone pitching shall be made in hundred cubic feet as volume of the material placed over the excavated sloping surfaces of channel cross-section or elsewhere as shown on Drawings.

(b) Unit rates tendered in BOQ shall constitute full compensation for completion of work specified herein and elsewhere in these specifications and as shown on Drawings for stone pitching and all other work related to the item. No separate payment shall be made for any dewatering required for placing stone pitching and its cost shall be deemed to have been included in the unit rates tendered in the BOQ.

10.5.2 (a) Measurement for base filter layer shall be made in hundred cubic feet as volume of the material placed over the excavated sloping surfaces of channel cross-section as shown on Drawings.

(b) Unit rates tendered in BOQ shall constitute full compensation for completion of work specified herein and elsewhere in these specifications and as shown on Drawings for base filter layer and all other work related to the item. No separate payment shall be made for any dewatering required for placing base filter layer and its cost shall be deemed to have been included in the unit rates tendered in the BOQ.

10.5.3 Measurement and payment for stone pitching grouted in 1:4 cement sand mortar shall be made in hundred (%) cubic feet of the specified stone actually placed as per drawings and shall constitute full payment for procurement of materials and all operations involved for completion of works specified herein.

Stone Apron

10.6 The work to be done under stone apron consists of furnishing, transporting materials and placing them in stone apron at locations shown on the Drawings or designated by the Engineer in accordance with the specifications and Engineer's instructions.

Materials

10.7 (1) Base Filter Layer: Base layer for the stone apron shall consist of a mixture of 20% medium to coarse sand with 80% graded material. The graded material shall consist of gravel well graded to a maximum size of 3 inches.

(2) a) <u>Stone Apron for Structures on Main Canal</u>: Stone for apron shall consist of rock fragments or boulders/pebbles which are dense, sound, angular and resistant to abrasion. The stones shall be generally cubical in shape with the largest dimensions not exceeding twice the smallest dimensions. The stones individually shall weigh between 40-120 lbs with 80 percent shall be 80 lbs or larger and not more than 5 percent shall weigh less than 40 lbs.

b) <u>Stone Apron for Areas Other than Main Canal:</u> Stone for apron shall consist of rock fragments which are dense, sound, angular and resistant to abrasion. Individual fragments shall be free from cracks, seams and other defects that could tend to

increase unduly their destruction by water. The required size of stone shall be determined by the specified nominal weight P50. At least 50% by weight of the material shall consist of stones having a mass heavier than the nominal mass P50.

P50 = 40 pounds and range 15 to 50 pounds.
The heaviest stone shall not have mass higher than 1.2 times the maximum specified mass. No more than 15% by mass of the material shall consist of stone having a mass more than the maximum specified. The upper limit of P50 shall be less than 1.4 P50. No more than 5% by mass of the material shall consist of stone having a mass less than the minimum specified.

(3) Rock Spalls: All interstices in stone apron shall be well filled with rock spalls. The rock spalls shall be rock fragments size between 2 inches to 4 inches.

(4) Testing of Materials: Stone & rock spalls may be rejected if they fail to meet the following test requirements:

a) Los Angeles abrasion test (large size ASTM Designation: C535-96). If the loss exceeds ten percent, by weight, at 200 revolutions, or 40 per cent, by weight, at 1000 revolutions;

b) Los Angeles abrasion test (small size Coarse Aggregate ASTM C131-96). If the Loss exceeds ten percent by weight at 100 revolution or 40 percent by weight at 500 revolution;

c) Specific gravity (ASTM Designation: C127-88). If the specific gravity (saturated surface-dry basis) is less than 2.60.

Material Source

10.8 The Contractor shall propose the source of base filter layer, stone apron and rock spalls for approval of the Engineer. The use of the materials shall always be subject to approval of the Engineer. All the requisite test, will be carried out by the Contractor either at Contractor's Laboratory under the supervision of the Engineer or at an approved laboratory at the cost of the Contractor.

Placement

10.9 The area designated for placement of stone apron shall be excavated to the lines and grades shown on the Drawings or as directed by the Engineer.

The base filter layer shall be placed to a uniform thickness and finished to a reasonably smooth and even surface as shown on the Drawings or as directed by the Engineer. Before placement of the base filter, the surface over which the base filter is to be placed shall be trimmed to the proper lines and grades and shall be moistened with water and tamped or rolled with suitable tools or equipment for

the purpose of forming a firm foundation.

The stone shall be hand-placed over the filter layer in such a manner that open spaces between stones are avoided. The stone for apron shall be placed in such a manner that open spaces between stone are avoided (open joints throughout the entire depth being filled with smaller stones and rock spalls).

At locations where stone apron in the trough is to be placed below ground water table level, the water in the trough shall be pumped out and water table to be brought sufficiently below the formation level to form a stabilized bed for stone apron. The method used to draw down the water table level shall be subject to the approval of the Engineer.

After dewatering, the trough section shall be formed to the proper lines and grades and shall be tamped with suitable equipment to form a firm foundation for stone apron.

Measurement and Payment

10.10.1 (a) Measurement for payment for stone apron shall be made in hundred cubic feet, within outlines of the stone in place and on the basis of their thickness shown on the Drawings. No separate measurement for payment shall be made for excavating and preparing trough, dewatering if required and all costs on their account shall be deemed to be included in the unit rate for the BOQ item stone apron.

(b) Unit rate tendered in BOQ shall constitute full compensation for completion of work specified herein and elsewhere in these specifications and on Drawings for stone apron.

(c) The amount tendered shall be full payment for completion of the work specified herein and elsewhere in these Specifications and on the Drawings for stone apron including excavation of trough for the stone apron and all work related thereto.

10.10.2 (a) Measurement for payment for base filter layer shall be made in hundred cubic feet, within outlines of the base filter layer in place and on the basis of their thickness shown on the Drawings. No separate measurement for payment shall be made for excavating and preparing trough, dewatering if required and all costs on their account shall be deemed to be included in the unit rate for the BOQ item stone apron.

(b) Unit rate tendered in BOQ shall constitute full compensation for completion of work specified herein and elsewhere in these specifications and on Drawings for stone apron.

(c) The amount tendered shall be full payment for completion of the work specified herein and elsewhere in these Specifications and on the Drawings for stone apron including excavation of trough for the base filter layer and all work related thereto.

10.10.3 ---- Not used ----

11 – SURFACE EXCAVATIONS

Scope of Chapter

11.1 This chapter covers all rock excavation above ground which form part of the Permanent Works.

Definitions

11.2 "Topsoil" is material from the surface layers of the ground which is capable of supporting plant life.

"Common material" is naturally occurring granular or cohesive material such as clay, silt, sand, gravel and boulders of up to 0.65Y^3 in volume, which can be removed by mechanical excavation, without ripping, drilling and blasting or barring and wedging.

"Rock" is naturally occurring material which cannot be loosened except by ripping, drilling and blasting or by barring and wedging or similar means. Boulders exceeding 0.65 Y^3 shall also be designated as "rock.

“Mechanical excavation” means excavation using the breaking, ripping or by barring and wedging methods intended for the gentle excavation of the rock mass in the sensitive areas.

"Controlled perimeter blasting techniques" include, but are not limited to, pre-splitting, smooth wall blasting and line drilling and shall be used to produce smooth rock faces conforming to the prescribed lines and to minimise blast induced fractures outside the required excavation lines.

"Pre-splitting" consists of drilling a single row of closely spaced holes, loading all or selected holes lightly and continuously, and firing them simultaneously before any adjoining main excavation area is blasted to produce a crack along the line of pre-split holes to which a subsequent main excavation blast can break.

"Smooth wall blasting" consists of drilling a single row of closely spaced holes with a suitable burden/space ratio, loading all the holes lightly and continuously with a uniform charge of small diameter explosive, and firing them simultaneously as the last delay period in the round.

"Line drilling" comprises drilling a line of holes of appropriate diameter spaced not more than twice the hole diameter to form a surface of weakness along which the rock will break. Blasting is not permitted in the line drilled holes, and the first line of production holes next to the line drilled holes shall be lightly charged to avoid damage to the line drilled break surface.

"Underwater rock blasting" means blasting rock material and boulders of over 0.65 Y^3 in volume in the river below the water surface.

"Clearing and grubbing" means the removal, transport and disposal of all trees, brush, stumps, fences, existing structures, debris, roots, buried logs, foundations of structures (except concrete or masonry in mortar), rubbish and other materials foreign to the natural topsoil in the areas to be occupied by Permanent works, spoil and stockpile areas,

and where interfering with the prosecution or functioning of the work.

"Stripping" consists of removing all, humus, vegetable material and all or part of the organic topsoil unsuitable for Agricultural Soil in the areas indicated on the Construction drawings or as directed by the Engineer, to a minimum depth of 1ft below original ground level.

"Over-excavation" means any excavation area which extends beyond the payment line (ie the lines and levels shown on the Drawings or directed by the Engineer), irrespective of the reasons for such excavation.

"Spoil" is excavated material which is unsuitable for use in the Permanent Works or is material which is surplus to the requirements of the Permanent Works.

"Stockpile" is a deposit of excavated material, which is established by controlled placing and grading procedure with safe slopes for temporary storage of material to be reused for the Works or for permanent deposit of surplus material which is not reused under the Contract.

General Requirements

11.3 (1) Setting out Surveys:

Setting out of the Works shall be carried out by the Contractor with a frequency not less than that required to give accurate control of excavated slopes and levels. The Contractor shall carry out all surveys necessary to establish the location of instrumentation installed in the rockworks, the lines of the outside slopes and surfaces of the rockworks, and the location of every sample taken for testing purposes.

The equipment and methods employed by the Contractor for setting out and survey of the rockworks shall be subject to the approval of the Engineer.

Immediately after final completion of any rockworks, the Contractor shall carry out an accurate survey as directed by the Engineer to confirm that the specified levels and side slopes have been fully achieved.

(2) Lighting of Working Areas:

The Contractor shall provide lighting to supplement the minimum specified elsewhere in the Contract, with which the following intensity of illumination shall be provided.

Illumination in all working areas shall be sufficient for the safe and satisfactory performance of the operations being undertaken in each area.

Illumination in the excavations, borrow areas, quarries and stockpile areas shall be of such intensity that it is possible to distinguish the difference in colour and texture of material when selective borrowing is necessary, but shall in all cases be not less than 50 Lux.

Illumination in areas where material is placed shall be of such intensity that it is possible to distinguish the difference in colour and texture of materials being placed and allow safe and easy traffic for construction, but shall in all cases be not less than 100 Lux.

Static lighting equipment shall be the main source of illumination in all areas and the use of earthmoving plant headlights alone shall not be considered satisfactory illumination of working areas.

The quality of lighting in the working areas shall be subject to the approval of the Engineer.

(3) Submittals:

In addition to the contractual requirement for the construction programme, the Contractor shall prepare and submit the following programmes and records at the times stated and in a form which shall be agreed and approved by the Engineer.

a) Within 1 month the Commencement Date, the Contractor shall submit an updated (with respect to the tender) mass-haul diagram giving the following details:

- Transport routes between excavation areas and stockpiles, between excavation areas and place of direct use or between stockpile and use as fill or aggregate

- Origin of material for the temporary works

b) At least 28 days before the start of excavation and stockpiling and backfilling, the Contractor shall submit a method statement including a schedule of his operations to the Engineer for review and approval. The method statement shall include:

- Analyses of excavation location and quantities to be excavated.
- Determination of the characteristics of the materials to be excavated, transported and stockpiled.
- Identification of the stockpile area that shall receive material.
- Details of the proposed excavation methods and sequences and equipment used.
- Handling details and quality assurance of excavated material, if any.
- Analyses of fill or stockpile location and quantities to be placed.
- Required characteristics of fill and origin of suitable material.
- Details of the proposed placement methods, sequences and equipment used for fill.
- Details of the layout of the proposed stockpiles, placing sequences and equipment used in stockpiles.
- Provisions for Health, Safety and Environmental Protection.
- Inspection and testing plan for fill material.

c) Prior to starting any excavation, the Contractor shall carry out a topographic survey which will be used for measurement purposes and submit his survey to the Engineer for approval.

d) During the progress of the work: a weekly report showing the volumes excavated and the volumes placed in the different stockpiles for the previous week together with equivalent cumulative values for the four week period.

e) Not later than 3 days after the end of each 4 week period: drawings with cross sections and a plan of the upper surface of each excavation and different stockpiles showing the levels reached at the end of the previous month.

(4) Certification:

The Contractor shall certify that he is familiar with the site conditions, the condition of adjacent existing structures, equipment, and that he has considered these conditions and that the plan meets the intent that adjacent ground, existing structures and associated equipment are not damaged.

(5) Clean Up:

During excavation, the Contractor shall at all times keep the surfaces and slopes of the rock free from accumulations of rubbish, waste materials or rejected or unsuitable fill material to the satisfaction of the Engineer.

On completion of the Works the Contractor shall remove from within the limits of the excavation area all construction equipment, surplus materials and rubbish and shall leave the area in a neat, clean and presentable condition, all to the satisfaction of the Engineer.

Excavation

11.4 (1) Setting out the Work:

The lines, levels or grades of the Permanent Works and the co-ordinates of reference points on the Permanent Works will be given on the Drawings, and it will be the responsibility of the Contractor to set out the Works in accordance with this Chapter and the requirements of the Chapter on Surveying and Setting Out of the General Specification.

(2) Control of Water in Rock Excavations:

Excavation for the foundation of Permanent Works shall be performed in the dry. The Contractor shall at all times maintain control of water entering excavations from any source.

Final surfaces shall be protected against damage by erosion and movement of construction equipment. Any damage caused shall be repaired by the Contractor. Water shall not be allowed to flow across or down any excavated surface which is liable to erode. Water emerging on to excavated surfaces shall be tapped and led away by

suitable means before any Permanent Works are placed on or against such surfaces.

The Contractor shall provide enough sumps to deal with all flows encountered and shall by pumping or otherwise keep the water level in such sumps at least 1.5 ft below the lowest excavated surface for as long as may be required for the purpose of constructing the Permanent Works.

The Employer will not be held responsible for damage due to flooding by stormwater or seepage, and the Contractor shall reinstate, make good or remove and repeat any Work so affected as directed by the Engineer.

Excavations which are liable to deteriorate under rainfall shall either be covered to prevent damage by rainfall or left high and trimmed immediately before being covered by Permanent Works. It is the Contractor's responsibility to programme his work in such a way that the cleared ground is not unduly exposed to inclement weather before commencing earthworks. Any deterioration, after clearing, for any reason whatsoever, shall be remedied by the Contractor at his own expense.

(3) General Requirements:

a) Stockpiles

All excavated material will remain the property of the Employer and, if not incorporated immediately in the Works or not suitable for the Works, shall be placed in designated stockpile areas within the boundaries of the site as shown on the Drawings or as otherwise approved by the Engineer.

The Contractor, at his own discretion, may use stockpiled materials or materials direct from excavation for producing fill or concrete aggregates for temporary or permanent works as long as the material complies with the specified material quality requirements. In this case, the Contractor shall carefully separate the material excavated in accordance with its suitability for subsequent use as fill or concrete aggregate.

Proposed stockpile locations are shown on the Drawings. The Contractor may request and seek the approval of the Engineer for different or additional stockpile areas within the boundaries of the site as long as they do not interfere with other infrastructure and do not obstruct water courses.

The Contractor may also request further stockpile areas outside the boundaries of the site and in excess to the areas shown on the Drawings. Obtaining all approvals and rights of way from any third parties as may be required for such areas is the sole responsibility of the Contractor.

The Contractor shall design and construct the stockpiles to avoid obstructing or polluting watercourses. The design of the

slopes of each stockpile shall consider whether the stockpile is a permanent or a temporary structure. The side slopes shall be formed to remain permanently stable under all design conditions. The top of the stockpile shall be graded to prevent the ponding of water. Adequate drainage shall be provided at all stages of raising the stockpile.

b) Contractor's Equipment

Prior to commencement of excavation, the Contractor shall submit to the Engineer full details of the Equipment he proposes to use and the arrangements he proposes to make including a detailed working schedule.

c) Ground Levels

Before any rock excavation is commenced, the site of the excavation shall be surveyed by the Contractor for measurement purposes. This survey shall be carried out when the rock surface has been exposed by clearing all overlying material and the surveyed levels shall be used as the initial levels for the measurement of rock excavation. Drawings recording the survey shall be prepared by the Contractor and signed by the Contractor and the Engineer as a true record and the Contractor shall then supply a digital record and two prints of the drawings to the Engineer.

Such records shall not be altered in any way unless such alterations are agreed and signed by both the Contractor and the Engineer.

d) Excavated Surfaces

All excavated surfaces shall be finished to the lines and levels shown on the Drawings unless the Engineer directs that such lines and levels are to be determined by recognisable changes in foundation material.

When such lines and levels are stated to be nominal, the final lines and levels will be instructed by the Engineer to take into account the conditions of the ground exposed as the excavation nears the nominal lines and levels shown on the Drawings and the Contractor may be required to carry out the excavation in more than one stage in order to arrive at the final lines and levels.

Excavated surfaces which will remain permanently exposed on completion of the Permanent Works shall be cleared of all loose material, pieces of rock, debris, rubbish and the like and left neat and tidy and adequately drained.

e) Supports to Excavations

The responsibility of the Contractor for the safety and care of the Works under the Contract shall include taking the following measures:

i) The Contractor shall excavate the sides of excavations which are not positively supported to slopes which will remain stable.

ii) The sides of excavations which are not cut to a stable slope shall be properly and adequately supported to the extent necessary to ensure stability during the period of construction of the Permanent Works and the excavation shall then be backfilled unless otherwise indicated on the Drawings.

iii) No materials, plant or other load shall be placed so close to any excavation that the stability of the sides of the excavation is endangered.

iv) The Contractor shall remove or otherwise secure by barriers, netting or other means any material which might fall and thereby cause damage to the Permanent Works or injury to any person.

The Contractor shall be responsible for the installation and subsequent removal of all necessary sheeting, timbering, strutting, shoring and the like to secure the excavations, to prevent any movement of adjacent ground and to ensure the safety of workmen and freedom from damage to structures, buildings, streets, sewers, drains, walls, services or any other thing. Where an excavation is to be backfilled no perishable materials shall be left in place within the excavation.

Where temporary underpinning is required, the Contractor shall submit to the Engineer full details of the design, materials to be used and method of working proposed.

f) Support to Permanent Rock Slopes

Permanent rock slopes shall be supported as shown on the Drawings or as directed by the Engineer on site. The standards of material, workmanship and testing of the support measures shall be as specified in Chapter .

g) Slips and Over-excavation

The Contractor shall avoid excavating beyond the lines and levels shown on the Drawings. If the Contractor disturbs ground adjacent to excavations or damages material beyond the limits of the required excavation all costs of reinstating, repairing or replacement with concrete or other materials as directed by the Engineer shall be at the Contractor's expense.

Slippages, excavation for working space, over-excavation and damaged areas shall be made good in accordance with

relevant Specifications. In the case of surfaces on which or against which Permanent Works are to be constructed, this remedial work shall comprise replacing the slipped, over-excavated or damaged material with suitable filling material or with concrete as instructed by the Engineer.

Falls, subsidence and other damage which has the effect of removing or reducing support to existing or proposed structures, services and the like shall be made good in concrete or otherwise.

In the case of permanently exposed surfaces, remedial work shall comprise replacing and compacting material similar to that which has been removed in order to provide a surface not less satisfactory than adjacent correctly excavated surfaces.

The removal of materials in slides or subsidence and subsequent remedial measures will not be paid for unless such occurrences were due to geological reasons and beyond the control of the Contractor and could not have been prevented by the exercise of due care and diligence. Measurement for payment as excavation, backfill or concrete will only be made if the Contractor has informed the Engineer in writing within 24 hours of the occurrence of the over-excavation. Where payment is made for the removal of such material, it will be at the rates for earthworks excavation contained in the Bill of Quantities and shall apply to the condition and situation of the material at the time of removal, regardless of its conditions and situation prior to the slip.

h) Records of Excavation and Geological Mapping

After completion of each section of Permanent Works excavation, the Contractor shall provide the Engineer with a record of the excavation. The record shall comprise all relevant information including the following:

- the location of the excavation
- the elevation of the original ground, original rock surface and of any groundwater which was encountered during the excavation
- the rates of discharge of and measures taken to deal with groundwater
- the elevation, thickness and classification of all strata encountered
- the instructed and actual profiles of the excavation.

In addition to the above record, the Contractor shall map the exposed geology over all finally excavated surfaces (foundation surfaces, cut slopes). The field mapping shall be carried out to a scale of 1:50. The Contractor shall then supply a digital record and two prints of the maps at a scale of 1:100 to the Engineer.

i) Tolerances for Excavation for Foundations of Structures

The final excavation of foundations for permanent works structures shall be in accordance with the lines and levels shown on the drawings to the following tolerances:

plan location ± (0.4in) 10 mm
plan dimensions + 4in (100 mm); - 0in (0mm)
vertical levels + 0in (0 mm); - 4in (100 mm)

The Contractor shall not be eligible for any additional or separate payment for concrete or other materials required for refilling the additional volume resulting from applying the excavation tolerances.

(4) Use of Explosives

a) General Requirements

The Contractor shall not be allowed to use explosive for excavating the rock slopes and foundations in the tunnel intake area, however the rock slopes in the outlet area may be excavated using the explosives.

The Contractor shall submit full details of his proposals and programme for the use of explosives to the Engineer for his approval before blasting commences.

The storage, transport, handling and use of explosives on Site shall be in accordance with agreed safety standards provided that this requirement shall not override any statutory or contractual requirements which apply to the Site.

The Contractor shall display in his Site office a copy of any applicable Statutory Regulations and the applicable section of the approved Health and Safety Policy and shall supply second copies to the Engineer.

All excavation shall be performed in accordance with modern best practice, using methods and techniques that will reduce overbreak to a minimum, including stopping short the ends of final holes above the final line or level by an amount which will ensure that after all loose material has been removed the surface will be at the required position. The Contractor shall select the depth and spacing of holes, the amount of explosive used per hole and the number and sequence of delays in order to avoid as far as practicable fracturing or otherwise damaging the ground below or beyond the required excavation line or level or causing any damage to adjacent and nearby property or Permanent Works. Where in the opinion of the Engineer it would be impracticable to avoid such fracturing or damage, the use of explosives shall cease and excavation shall be continued by other means.

In cases where flying debris is likely to damage the Permanent Works or property whether inside or outside the Site, steel

netting, blast blankets or other means shall be used to prevent the ejection of such debris.

If third parties are likely to be disturbed by the use of explosives on Site, the Contractor shall as far as practicable forewarn such third parties of the imminence of blasting in order to minimise such disturbance.

The Contractor shall keep records of all blasting carried out showing the time and location of each blast, the type and amount of explosives used, together with any other relevant data. Two copies of these records shall be sent to the Engineer weekly relating to the previous week's work.

If in the opinion of the Engineer the use of explosives is likely to be dangerous to persons, property or the Permanent Works, or the Contractor has not taken all possible safety precautions to avoid such damage, the Engineer may forbid blasting operations and the Contractor shall comply with such instruction immediately.

b) Controlled Perimeter Blasting

Controlled perimeter blasting techniques shall be used on all faces that form part of the Permanent Works, on faces steeper than 1 vertical to 1 horizontal against which concrete is to be placed and where shown on the Drawings.

Drill holes for controlled perimeter blasting shall be drilled on the required excavation line at a spacing of not more than 2ft (600 mm). The spacing of perimeter holes may be varied in the light of results as work proceeds, subject to the approval of the Engineer.

The diameter, charge and detonation sequence of all blast holes within a distance of 19.7 ft (6.0 m) normal to the final excavated line shall be regulated to ensure that a minimum of damage will result to the face when the main charge is fired.

c) Controlled Excavation

With the exception of holes for controlled perimeter blasting on the periphery of the excavation, boreholes for blasting outside controlled areas for horizontal faces shall not extend into such areas. Ground within controlled areas for horizontal faces shall be blasted in layers not more than 5ft (1.5 m) thick and the ends of holes for blasting the final layer shall not be drilled closer than 1ft (0.3 m) to the required final line or level.

Where such line or level is shown as nominal all loose and fractured material shall be removed after blasting the final layer together with any other material which is unsuitable as a foundation or which projects undesirably. The resulting surface shall be taken as the final line or level.

Where lines and levels are not shown as nominal, excavation shall continue without the use of explosives after the final layer has been blasted in accordance with this Clause until the final lines and levels have been achieved.

d) Controlled Blasting

Where directed by the Engineer or where flying debris is likely to damage the Permanent Works or property inside or outside the Site, controlled blasting shall be carried out to prevent the ejection or slippage of any debris.

e) Monitoring of Blasting Operations

The Contractor shall supply and operate seismographic equipment to monitor his blasting operations. The equipment shall be of the three component type for measuring vertical, transverse and longitudinal wave forms.

Unless otherwise agreed in writing by the Engineer, trial blasts, initial blasting in general, initial blasts in new areas and blasts adjacent to completed concrete, sprayed concrete, grout or structures shall be monitored. The Engineer may also require additional monitoring as work proceeds. The location of seismographs for any given blasting operation shall be subject to the approval of the Engineer.

A record of each seismographic measurement shall be delivered promptly to the Engineer following each monitoring operation together with a detailed diagram of the blast showing the quantity of explosive detonated with each delay and the distance to the sensors from the blast location.

If the results of the monitoring indicate that the Contractor's blasting method endangers either completed excavation or Permanent Works or nearby structures, the Contractor shall alter his blasting method to prevent such damage.

f) Restrictions on Blasting

When excavations are carried out using explosives the Contractor shall arrange his excavation and concrete placing programmes so that as far as practicable it will not be necessary to use explosives close to Permanent Works construction.

Unless otherwise agreed in writing by the Engineer, blasting shall not be carried out within 32.8ft (10 m) of the Permanent Works, and at distances greater than 32.8ft (10 m) the Engineer may instruct restrictions on blasting to prevent damage to the Permanent Works.

The general criterion of safety of concrete structures (including structures of sprayed concrete or grout) shall be the critical velocity of displacement of particles or elements of concrete

structures, which should not exceed the values given below:

Time since placement of concrete	**Maximum velocity of displacement of particles in/sec (cm/sec)**
0-12 hours	0.1 (0.25)
12-24 hours	0.2 (0.5)
24-48 hours	0.4 (1.0)
2-4 days	0.6 (1.5)
4-7 days	1.0 (2.5)
more than 7 days	1.57 (4.0)

The Peak Particle Velocity shall not exceed 0.4in/sec (10 mm/sec) measured at the walls of the neighbouring irrigation tunnel.

The above limits on particle velocity are given as a guide and may be modified by the Engineer on the basis of seismographic records and observations during the progress of the work.

Maximum peak particle velocities shall be the maximum instantaneous vector sum of three components measured in three mutually perpendicular directions (transverse, vertical and longitudinal).

g) Disposal of Explosives

Outdated explosives shall not be retained in the site storage place. If such explosives are to be destroyed at the site, the Engineer shall be informed at least 24 hours before the destruction is due to take place. No explosives may be destroyed in any part of the underground or blasting works.

(5) Mechanical Excavation

Mechanical excavations shall be accomplished by breaking, cutting, wedging, barring, hammering, or mechanical ripping, or by percussion such as rock breaker, hoe-ramming with an excavator, or a combination thereof. The Contactor shall select and be responsible for methods and procedures used.

The Contractor shall do all excavation work in accordance with good modern practice, using methods and techniques that will minimize overbreak beyond the limits shown on the Drawings and that will preserve the rock beyond these limits in the soundest possible condition.

The intent of mechanical excavation through this Specification is that the adjacent structures and ground to tunnel intake and existing mechanical and hydro mechanical equipment will not be damaged by the rock excavation. Damage shall mean any structural defect, crack, deformation or other change to the structure or equipment caused by the excavation methods.

Excavation shall therefore be performed using a suitable state of the practice equipment in such a manner that it produce the particle velocities (from percussive excavation) not exceeding the industry reported figures such as the levels of PPV shall fall in the range of 1.8 in/sec (45 mm/s) @ 16ft (5m), 0.02 in/sec (0.4 mm/s)@ 65ft (20m), and 0.004in/sec (0.1 mm/s) @ 165ft (50m) from the site of works.

The limiting particle velocities for various sensitive neighbourhoods shall be reviewed by the Seismicity Specialist and may be amended, if necessary, in order to achieve the intent of this Specification.

Preparation of Foundations

11.5 (1) General

The suitability of each part of a foundation for placing concrete, or other material, will be determined by the Engineer. No concrete, or other material, shall be placed by the Contractor on any part of a foundation until the foundation surfaces in that part have been inspected, surveyed and approved in writing by the Engineer as ready for concrete, or other material, placement.

Removal of the bottom layer of excavation of not less than 1ft (0.30 m) to foundation level in soil or soft rock foundations liable to deteriorate shall be carried out immediately prior to foundation preparation and covering with concrete, or other material, according to the Engineer's instructions.

(2) Dewatering

No concrete, or other material, shall be placed on any part of the foundation until that part of the foundation has been dewatered.

Dewatered foundations shall be kept free from water until the permanent structure has reached the levels established by the Engineer. Groundwater encountered during excavation shall be properly tapped and diverted from the excavation - the discharge of the diverted water shall be measured daily.

Immediately prior to placing concrete or other material, the surface of each portion of the foundation shall be properly cleaned or where necessary moistened to obtain a good bond with the material. Any tapped source of groundwater shall be sealed by grouting or any other approved method.

(3) Filling of Existing Excavations

All portions of excavations made for test pits or other subsurface investigations and all other cavities existing within the area to be covered by the permanent works which extend below the surface designated for the permanent works foundation shall be filled with material fulfilling the requirements specified for that section (or zone) of the permanent works in contact with the foundation at the location, or with other fill materials if so directed by the Engineer. The preparation of such areas and the placing and compaction of this fill material shall be in accordance with the applicable provisions of this Specification.

(4) Preparation of Foundations for Concrete Works

a) Trimming of Surface

The concrete works shall generally be found on slightly weathered rock or on rock of better condition. Knobs, irregularities, steps and overhangs in the foundation either existing or resulting from the removal of rock fragments shall be removed using blasting, breakers, barring, wedging or other effective means.

Where blasting is required it shall be performed using very light charges to minimise damage to the foundation rock, and all such blasting shall be complete before any grouting works begin within 65ft of the point of blasting.

Alternative treatments may be instructed by the Engineer.

b) Pre-cleaning of Surface

The rock surfaces shall be cleaned by breakers, picks, shovels and brushes to remove all semi-detached blocks, and any adhering and loose or weathered material. The surface shall then be cleaned with air and water jets so that it may be inspected for joints and fissures.

c) Treatment of Joints, Cracks and Fissures

Surface joints, cracks and fissures shall be cleaned out by means of hand tools to a depth of at least three times the width of the joint, crack or fissure at the surface, or else to the depth at which they become tight, then flushed out with water jets until the water runs clear. Surface joints, cracks and fissures shall be filled with cement mortar or cement grout.

d) Treatment of Faults, Shear Zones and Zones of Weak Rock

Gouge or weak material shall be excavated for a depth of at least three times the width of the fault or band of weak material at the surface at its widest point, but for not less than a depth of 1.6ft. The excavation shall be backfilled with dental concrete as specified below.

e) Local Treatment of Surface

i- Dental Concrete:

Concrete Class ---- shall be used where instructed by the Engineer to fill voids and depressions in the surface of the foundation.

The concrete shall be placed against clean and wetted surfaces. Particular care shall be taken to ensure that

the entire foundation surface including the inside surfaces of all joints, cracks, fissures and faults against which the concrete is to be placed is completely free of any material which could prevent an intimate and continuous bond between the concrete and the rock.

The concrete shall be compacted by vibration or ramming and cured for a minimum period of three days unless the Engineer approves the covering of the concrete with fill material before this time has elapsed.

Concrete shall be prepared, transported, placed and cured in accordance with the requirements of the Chapter on Conventional Concrete of this Specification.

ii- Shotcrete:

Shotcrete shall be used where instructed by the Engineer as a treatment of the rock surface. Shotcrete shall be placed against a wetted surface and protected with a curing paint or cured otherwise for a minimum period of three days.

The requirements for the preparation of the foundation surface to receive shotcrete shall be as specified above for dental concrete.

Shotcrete shall be prepared, handled and placed in accordance with the requirements of Chapter ---- of this Specification.

f) Final Cleaning

After trimming, smoothing and local treatment, and prior to placement of the concrete, the foundation surface shall be cleaned by compressed water and air jets and all loose materials shall be eliminated so as to allow final inspection and approval by the Engineer.

Immediately prior to placement of concrete the surface shall be wet, but no free water shall be allowed to remain on the surface within thirty minutes prior to material placing.

Measurement and Payment

11.6 (1) Excavation General

Payment for any class of excavation specified herein will be made at the appropriate unit price entered in the Schedule, which shall include, but not be limited to, the entire cost of the following:

- Provision of all labour, equipment and materials required for excavation, including any hand work necessary for trimming excavated surfaces; cleaning, preparation, protection and maintaining excavated surfaces in satisfactory condition until concrete or fill is placed; any temporary supports necessary to support the sides of the excavations.

- Loading, hauling and unloading the excavated material on stockpiles, deposit areas or points of incorporation in Permanent Works; clearing of the deposit areas and placing and trimming the excavated materials on permanent deposit areas.

- Surveying, setting-out and checking of excavated profile and alignment, and any subsequent rectification works resulting from undue or incorrect surveys; provision of suitable equipment for, and delays due to carrying out this work.

(2) Rock Excavation

Measurement for payment for rock excavation will be of the in situ gross volume removed between the original rock surface and the lines and grades shown on the Drawings or as directed by the Engineer.

Payment will be made at the unit price "per cubic ft" separately for blasting and mechanical means entered in the Schedule for rock excavation which shall include the entire cost of, but not be limited to, the following:

- Provision for all labour, equipment and materials.

- Complying with all requirements of statutory laws and regulations relating to blasting work at the quarry site and any restriction resulting therefrom; obtaining all necessary permits and licenses for the purchase, use, storage and transport of explosives or any other material and equipment and monitoring the particle displacement Velocity due to blasting.

- Surveying, setting out and checking of rock profile and alignment, and

- Provision of suitable equipment for any subsequent rectification works and delays due to carrying out this work.

(3) Controlled Perimeter Blasting

Measurement for payment of controlled perimeter blasting (pre-splitting, smooth wall blasting or line drilling) will be the area shown on the Drawings or established on site by the Engineer.

Payment will be made at the unit prices “per square ft” entered in the Schedule for the various methods of controlled perimeter blasting which shall include the entire cost of setting out, drilling, charging and detonating and all associated materials, manpower and equipment.

(4) Controlled Excavation of Foundation Area

Measurement for payment of controlled excavation of outlet foundation surface shall be the area shown on the Drawings or established on site by the Engineer.

Payment will be made at the unit price “per square ft” entered in the

Schedule which shall include the entire cost of setting out, controlled excavation by whatever means and all associated labour, equipment and materials.

(5) Exclusions

Although required (either explicitly or implicitly) by the Specification, no extra measurement for payment or payment will be made for the following:

- Excavation of any type of material at quarry and borrow areas.
- Hauling to and placement in stockpiles.
- Excavation and hauling from stockpiles or quarries.
- Extra work caused by the Contractor's negligence in setting out the structures and slopes.
- Surveys for recording the original ground surface and any other surface thereafter for the purpose of measuring quantities and all related works and reporting.
- Mapping the geology of the excavated surfaces.
- Removal of the materials resulting from the slides or overbreak caused by the Contractor's poor or inappropriate working methods or negligence and or lack of care and for the additional materials required to fill the voids so created.
- Additional work of removing material and backfilling voids with approved material where Over Excavation due to adverse geological conditions coincides with that due to Contractor's poor or inappropriate working methods or negligence.
- Excess excavation required for Contractor's convenience and the resulting additional backfilling with approved materials.
- Additional work resulting from the Contractor changing slopes without prior approval by the Engineer. In such event, payment will be made only to the lines and grades shown on the Drawings.
- Excavation which is required for the installation of Temporary works.
- Draining, drainage ditches shaping, and trimming the stockpiled material in the deposit areas to the lines and grades designed by the Contractor and approved by the Engineer.
- Access to any stockpile area, preparation and grading of the area, diversion of water courses and drainage.
- Dewatering and keeping the surface excavation sites dry.
- Protection of foundation and slopes.
- Work or materials required when foundation surfaces have been

allowed to become unsuitable due to the action of ground or surface water or disturbed or loosened due to negligence of the Contractor.

- Extra work or material required to repair damage to the final excavation surfaces caused by construction equipment.

- Quality Control and testing of materials whether in-situ, in place or temporarily stockpiled, including reporting as specified.

(6) Bolts and Anchors for Support of Permanent Slopes

Measurement of rock bolts and anchors shall be based on the number of each type and size correctly installed by the Contractor and approved by the Engineer.

Payment shall cover all labour, equipment and materials associated with furnishing bolts/anchors, drilling holes, installing and any testing of rock bolts and anchors which are shown on the Drawings or which are instructed and approved by the Engineer.

No payment will be made for such work not shown on the Drawings or for work not instructed by the Engineer or for work required for the Contractor's convenience or for work instructed by the Engineer due to bad workmanship of the Contractor for whatever reason.

(7) Reinforcement Steel Welded Mesh

Measurement of reinforcement mesh shall be based on the weight, in kg or tonnes, of the wire net and reinforcement mesh correctly installed by the Contractor and approved by the Engineer.

Payment shall cover furnishing and erecting wire net and reinforcement mesh which is shown on the Drawings or which is instructed and approved by the Engineer.

No payment will be made for such work not shown on the Drawings or for work not instructed by the Engineer or for work required for the Contractor's convenience or for work instructed by the Engineer due to bad workmanship of the Contractor for whatever reason.

(8) Shotcrete for Support of Permanent Slopes

The measurement of shotcrete shall be based on the theoretical plane area (excluding the additional area resulting from depressions and humps) correctly covered to the prescribed thickness by the Contractor and approved by the Engineer.

No additional payment will be made in cases where the average shotcrete thickness is found to be greater than specified.

Payment shall cover all labour and materials associated with furnishing the ingredients, mixing, conveying, applying and any testing of shotcrete which is shown on the Drawings or which is instructed and approved by the Engineer.

No payment will be made for such work not shown on the Drawings or for work not instructed by the Engineer or for work required for the Contractor's convenience or for work instructed by the Engineer due to bad workmanship of the Contractor for whatever reason.

No payment will be made for shotcrete or its constituents lost due to improper working methods or rejected on account of improper mixing, or lost by leakage due to the failure of the Contractor to caulk surface leaks or for placing shotcrete outside the concrete pay line as a result of careless excavation or excavation intentionally performed by the Contractor to facilitate his operations but not required for the Works.

12 – TUNNEL EXCAVATION AND SUPPORT

Excavation

12.1 **(1) General**

a) General Requirements

Tunnel excavation as specified hereunder shall include excavation of the tunnel, construction adit, construction niches and intake and outlet portals regardless of shape and by whatever means. Excavation shall be made to the lines, grades and dimensions shown on the Drawings or, in certain cases, as directed by the Engineer. The general dimensions, arrangements and details of typical sections of the tunnel are shown on the Drawings. Temporary and permanent supports shall be furnished and installed according to the Drawings or as directed by the Engineer. During construction, the tunnel shall be drained, illuminated and ventilated as specified hereunder.

If any particular operation or activity necessary for the proper performance of the work has not specifically been mentioned, it shall be deemed to have been included in the prices for the tunnel excavation and support. The specifications of concrete for lining the tunnel are given in relevant chapters. Cast In-Place Concrete shall be applied. The Contractor shall be responsible for all methods of working underground including the design, provision and implementation of all the required safety measures for the Works and workmen within these in accordance with the recommendations of BS 6164 and ITA. The intersection of construction adit and main tunnel shall be constructed as gated access to main tunnel after the completion of work. This access shall be used for inspection and maintenance of tunnel in future.

b) New Austrian Tunnelling Method (NATM)

The tunnel excavation and support shall follow the so-called "New Austrian Tunnelling Method (NATM)" whereby the rock formations surrounding an opening are integrated into an overall ring-like support structure. In this way, the surrounding formations become themselves part of this supporting structure. Rock bolts shall be installed and/or shotcrete shall be applied where required to maintain the integrity of the rock formations around the tunnel and prevent loss of loosened rock. In more jointed rock masses, the shotcrete shall be reinforced by steel mesh/fibre reinforced and lattice girders, and the length and number of rock bolts shall be increased. In fault and shear zones it may become necessary to use arched steel sets, lagging, spiling and face support (if required) in order to prevent failure of the rock mass.

Installation of arched steel supports will only be necessary if the rock mass is not capable of supporting itself immediately and there will be insufficient time to place rock bolts, and shotcrete to prevent loosening of the rock and subsequent collapse. This will probably be the case along possible fault and weak rock zones.

The application of the NATM requires rigorous deformation monitoring by means of survey and special devices to measure rock

deformation and anchor stresses. Continuous monitoring and reporting shall be carried out by the Contractor in close co-operation with the Engineer.

c) Mechanical Excavation

The mechanical excavation using the hydraulic rock breakers shall be used for the gentle excavation of the rock mass at the intake portal, initial length of the tunnel and construction adit approachable by the equipment, and the cut slope above the intake portal.

The mechanical excavation shall be adopted to keep the net vibration as low as possible in order to avoid the detrimental impact on the sensitive neighbourhood around the intake i.e., the existing dam, operational hydro-turbines and particularly the liquefaction prone reservoir silt deposits.

Normally, for the hydraulic rock breakers the reported typical measured levels of PPV are 1.8 in/sec (45 mm/s) @ 16ft (5m), .02 in/sec 0.5 mm/s@ 65ft (20m), and 0.004in/sec (0.1 mm/s) @ 165ft (50m) from the site of works.

The mechanical excavation shall require vibration monitoring by the specialized staff of the Contractor with the assistance of the Engineer.

d) Lighting and Communication

The Contractor shall install and maintain illumination as required for safe and efficient working conditions and inspection of the work executed.

The Contractor shall install and maintain a system of tele-communication at all work fronts. Communication equipment shall in addition be available at each 275 yards (250m) in the tunnel.

The Contractor shall maintain all temporary and permanent roadways in good and dry conditions to facilitate efficient and quick transportation above-ground as well as under-ground.

e) Ventilation of Tunnel

The air inhaled by workmen and other persons during tunnelling work shall contain not less than 17 percent of oxygen, and shall not contain a concentration of contaminants such as gases, vapours and dust greater than is safe for their health, having regard to the effects of time, temperature, humidity and the combined effects of several contaminants.

The Contractor shall provide evidence that his tunnel ventilation installations meet the requirements of nationally and internationally recognised standards regarding construction method, type of equipment employed and other factors.

f) Supply of Detailed Documents by the Contractor

The Contractor shall submit shop and fabrication drawings with related details, construction and method drawings, plant details, diagrams and details of all layouts, material handling operations, and calculations as stipulated in the following.

- Details of the proposed methods of setting out before commencing work, and at such stages during the progress of the work as the Engineer may require, together with a copy of all instructions given to the Contractor's supervisory staff and others concerning the setting out of the work and the maintenance of correct line and level.
- Drawings of, and calculations (where required) for all structures and methods to be used to support the tunnel during excavation prior to commencement of the permanent structure specified.
- Drawings, diagrams and details of all proposed site layouts, materials handling operations and spoil disposal arrangements.
- Drawings of, and calculations (where required) for any grout injection proposals, including drilling pattern and extent of treatment, details of plant and equipment, including method of treatment and method of injection, and details of testing.
- Details of chemical characteristics of grout proposed to be used in ground treatment, of the means of controlling spillage and pollution, and of the arrangements for protection of workers and storage of materials.
- Drawings of, and calculations for, groundwater lowering and other groundwater control, including details of associated plant.
- Details of all proposed measures for compliance with environmental quality requirements.
- The contractor shall carry out the following tests and submit reports two weeks before the start of blasting operation:
    - Contractor Blasting Test Report
    - Blast Vibration Test Report

(2) Reference Standards

Standards referred to in this Chapter are listed below with their serial designation and are declared to be a part of this specification unless stated otherwise. Work shall be performed in accordance with the reference standards. The Contractor shall maintain one copy of the latest revision of each document at Site.

This specification prevails the standards in case of discrepancies.

When no standards are listed, the work shall be performed according to modern methods and recognised good practice.

American Association of State Highway and Transportation Officials (AASHT

AASHTO T 106	Standard Method of Test for Compressive Strength of Hydraulic Cement Mortar (Using 2 in. or 50 mm Cube Specimens)

American Concrete Institute (ACI)

ACI 318	Building Code Requirements for Reinforced Concrete

ACI 506	Guide to Shotcrete
ACI 506.1	State-of-the -Art Report on Fibre Reinforced Shotcrete
ACI 506.2	Specification for Materials, Proportioning and Application of Shotcrete
ACI 506.3	Guide to Certification of Shotcrete Nozzlemen

American Society for Testing and Materials (ASTM)

ASTM A 82	Steel Wire, Plain, for Concrete Reinforcement
ASTM C 94	Standard Specification for Ready-Mixed Concrete
ASTM A 185	Steel Welded Wire Fabric, Plain, for Concrete Reinforcement
ASTM A 615M	Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
ASTM A 767M	Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement
ASTM A 775M	Standard Specification for Epoxy-Coated Reinforcing Steel Bars
ASTM A 820	Standard Specification for Steel Fibers for Fiber Reinforced Concrete
ASTM C39	Standard Test Method for Compressive Strength of Cylindr Concrete Specimens
ASTM C 42	Standard Test Method for Obtaining and Testing Drilled Co and Sawed Beams of Concrete
ASTM C 150	Standard Specification for Portland Cement
ASTM C 511	Standard Specification for Moist Cabinets, Moist Rooms, ar Water Storage Tanks
ASTM C 1018	Standard Test Methods for Flexural Toughness and First-Crack Strength of Fiber-Reinforced Concrete (Using Beam with Third-Point Loading)
ASTM C 1116	Standard Specification for Fiber-Reinforced Concrete and Shotcrete
ASTM C 1140	Standard Practice for Preparing and Testing Specimens fro Shotcrete Test Panels
ASTM C 1141	Standard Specification for Admixtures for Shotcrete
ASTM D 4435	Standard Test Method for Rock Bolt Anchor Pull Test

British Standards Institution (BS)

BS 6223	Friction Welding of Joints in Metal

International Society for Rock Mechanics (ISRM)

Suggested Methods for Rock Characterization, Testing and Monitoring

New Hampshire Department of Transportation

FHWA-NH-RD-12323W – Ground Vibration Emanating from Construction Equipment

US Army Corps of Engineer

Tunnels and Shafts in Rocks - EM 1110-2-2901

(3) Material and Equipment

a) General

All equipment, materials and structural components which the Contractor is to provide for the sole purpose of tunnel excavation in accordance with the requirements of the Contract and which are not permanently incorporated in the Works may be new or used materials to the full satisfaction of the Engineer.

All materials and structural components which the Contractor is to supply and install and which are permanently incorporated in the Works, shall be new, unless otherwise specified. All installation materials must comply with the relevant standards and requirements regarding quality and dimensions. All quality assurance certificates and test results/certificates shall be submitted to the Engineer for review prior to the start of the Work.

b) Equipment

Electrical, pneumatic, or diesel driven equipment may be utilized for the different operations involved in the tunnel excavation. In case the latter type is used, the Contractor shall provide the necessary facilities to safely remove all noxious gases resulting from the operation of the equipment. If the exhaust gas removal system is not adequate, the Engineer can request, without extra cost for the Employer, the suspension of its operation or the instigation of measures necessary to correct the defects of the removal system.

c) Ventilating Systems

The ventilating system shall be of sufficient capacity to maintain an adequate supply of fresh air in tunnel throughout the construction period and shall meet the requirements of internationally recognized standards.

The design of the ventilation system shall provide for all categories of construction equipment to be used underground. For each person working in the tunnel, a minimum amount of 3 m^3/min of fresh air shall be provided.

If diesel-powered equipment is used, then the minimum quantity of fresh air to be supplied shall be 3m^3/min for each kW of power employed underground, in addition to the requirements for personnel.

Particulars of the proposed ventilation system shall be submitted to the Engineer for review and information prior to acquisition and installation of the ventilation and exhaust system. The Engineer shall have the authority to instruct the Contractor to halt the Work during the tunnel excavation if the ventilation system does not perform satisfactory till the system is restored to the satisfaction of the Engineer. Under such circumstances the Contractor shall not claim the cost and compensation of time lost.

d) Use of Combustion Engines

Underground use of internal combustion engines burning gasoline or liquefied petroleum gases (propane, butane, propylene, butylene) is forbidden.

The Contractor shall demand proof from prospective suppliers of diesel-powered equipment for use underground that the proposed equipment conforms to the requirements of the U.S. Bureau of Mines, or equivalent requirements as approved by the Engineer.

e) Instruments Monitoring Gas Concentrations

The Contractor shall install at least two instruments within the tunnel which indicate continuously on a dial the concentration of hydrogen sulphide at locations within 6 in (150 mm) of the excavation invert. These instruments shall trigger a horn alarm, within hearing distance of personnel in the tunnel, to warn when the concentration of hydrogen sulphide exceeds 5 mg/litre.

The Contractor shall provide separate instrumentation for the monitoring of the Lower Explosive Limit (LEL) of gases within 12in (300 mm) of the crown of the excavation. The Contractor shall also provide at least two instruments which indicate continuously on a dial the percentage of LEL present at at least two locations within the tunnel on as determined by the Engineer. An alarm horn and danger light system shall be provided to warn personnel at working areas underground when the 5 percent LEL is reached or exceeded.

All instruments for the monitoring of gas concentration within the tunnel shall be approved and calibrated by a testing laboratory approved by the Engineer.

Whenever it is found that permissible gas concentrations, as specified herein, are exceeded, all personnel shall be immediately evacuated from underground. Personnel shall not return underground until after ventilation has been improved so that gas concentrations are reduced to less than the allowable limits.

The Contractor shall submit his detailed proposals for ventilating and monitoring the tunnel atmosphere to the Engineer for review according to the Drawings.

f) Lightning Indication System

The Contractor shall install a proven lightning warning system in the vicinity of the tunnel portals.

In the event of a lightning alarm, charging and blasting activities shall be interrupted for the duration of a thunderstorm or for the duration of the alarm, whichever is longer.

g) Traffic Management System

The Contractor shall install, maintain and operate a traffic management system for underground traffic that prevents accidents at crossings and congestion/gridlock along the hauling routes.

(4) Certificates

The Contractor shall submit manufacturers' and suppliers' certificates of compliance with the relevant standards.

(5) Execution of Work

1- General

The Contractor shall select the working methods for excavation of the different rockmass classes in the various openings. In case of delays, the Engineer reserves the right to stipulate other working methods, if these can be expected to speed up the progress of the work. The Contractor may submit alternate methods for excavation for the Engineer review and approval at no additional cost to the Employer.

Survey points, benchmarks, boundary stones and the like shall not be removed or obstructed without the Engineer's written consent. Where required, additional survey points shall be placed.

Extra benchmarks to be provided by the Contractor shall be indicated by plates, approx. 10 in x10 in size, with benchmark inscriptions written in black letters on a light background with clearly legible weatherproof oil paint.

A binding work schedule/programme with explanatory report shall be submitted by the Contractor prior to the start of excavation work. The schedule shall show the quantity, type and capacity of the equipment provided, blasting pattern and charges, the working method envisaged for transportation and distribution of excavated material, the location of stockpiles and main storage areas, as well as the approximate number of site operators, etc. This work schedule and any amendments made thereto during the duration of the Contract shall be subject to the review of the Engineer and this schedule shall be binding for tunnel excavation if not directed otherwise by the Engineer.

Excavation shall comply with the lines and dimensions indicated on the Drawings, except in those areas where special protection is necessary or where, due to local conditions, the Contractor requests modifications. In this case the Engineer shall define the new excavation lines. No protuberances or loose material shall be left within the outlines defined by the excavation lines.

Prior to start of the excavation at the intake portal, the Contractor shall execute boreholes at the proposed intake location in consultation with the Engineer to verify the overburden and rock depth profile. The data of such investigations shall be provided to the Engineer for review and to verify the design or any design revision of the intake structure placement.

2- Setting-out

The Contractor's methods for setting out the work and for the

maintenance of correct line and level of the tunnel excavation shall be subject to the review of the Engineer.

3- Method of Excavation

The suitability of method, technique and type of equipment for tunnel excavation under the designed geometry, size and existing rock conditions shall be at the discretion of the Contractor.

Existing bore logs and geological sections derived from information inferred from the parallel running existing tunnel shall only be taken as an indication of the rock or soil conditions which can be expected during excavation. Neither the Employer nor the Engineer shall be held responsible for the accuracy and reliability of previous investigations. The Contractor shall verify the suitability of his selected working methods and equipment with regard to the expected rock conditions.

4 - Mucking

All material resulting from tunnel excavations shall be removed from the Site as soon as practicable and be placed in disposal areas at suitable locations identified by the Contractor and approved by the Engineer. The muck resulting from the intake working face shall be disposed at suitable location on the right bank of the reservoir in such a way that this shall not erode or slide in the reservoir.

Excavated material from the Works which is accepted by the Engineer for re-use shall, if possible, be placed directly in its final position; otherwise it may be stockpiled or deposited on Site as approved by the Engineer.

Rock resulting from excavations may be crushed and stock-piled in appropriate places to be used in any part of the Works for which it meets the Technical Specifications of this Contract. The Employer shall be the owner of the material resulting from tunnel excavation and the Contractor cannot sell or use such material in works not covered by his Contract without the Engineer's prior approval.

The Employer may permit the Contractor for equipment movement with allowable load in consultation with WAPDA. The Contractor shall be responsible for maintaining the loading capacity and submit undertaking in this respect any damage to the bridge for negligence of the Contractors equipment movement shall be rectified / repaired by the Contractor.

5- Field Trials for Blasting Technique

At the start of tunnelling works, the Contractor shall carry out field trials with his proposed drilling and blasting patterns to check that his drilling and blasting techniques meet the requirements of the Technical Specifications. The techniques used in these field trials shall generally be in accordance with the Contractor's proposals accepted by the Engineer at the time of Acceptance of the Tender or with such modifications as accepted by the Engineer from time to time. During the progress of the excavation, these techniques shall be varied as necessary to suit rock conditions and to obtain the best practicable excavation surface after blasting. The techniques used shall at all times be subject to the review of the Engineer.

Limits for blasting induced vibrations are defined as peak particle velocities (inch/sec) measured at the structure. The limit is valid for both horizontal and vertical peak particle velocities.

The blasting in the tunnel after the intake portal excavation shall be carried out in such a way that it does not cause detrimental impact on the surroundings. The Contractor shall adopt a blasting procedure from the site of intake portal to a reasonable distance that shall produce vibration not more than the normal level of vibration produced by hydraulic rock breakers i.e., (PPV are 45 mm/s @ 5m, 0.4 @ 20m, and 0.1 @ 50m from the site of works).

The blast vibration for the rest of the tunnel excavation shall not exceed the Peak Particle Velocity (PPV) more than 0.5 inch/sec (12.5mm/sec) measured at the concrete rock interface of the parallel running existing irrigation tunnel. This limit shall be applied for the full length of the tunnel.

The PPV limit may be adjusted by the Engineer according to the results of blast test report, characteristic frequencies obtained and experience gained during execution.

The Contractor shall monitor its blasting operations as well as magnitude and intensity of ground vibrations when required. The Contractor is responsible for keeping the peak particle velocity below given limit and to document this by vibration recording instruments available at the site. The vibration recorder shall have minimum 3 channels and be able to record peak particle velocities in the range 0.1– 4 in/sec with an accuracy of 0.05in/sec. The instruments shall give linear recordings in the frequency area 5 to 300 Hz. Both horizontal and vertical geophones shall be available. The records shall be submitted weekly. The Contractor shall provide a yearly certificate from the manufacturer or approved authority verifying the accuracy of the vibration monitoring apparatus.

Before commencing the rock excavation work, the Contractor shall work out and present a quality assurance plan which ensures that the rock excavation work is performed according to the Contract requirements.

6- Excavation Classification

The tunnel excavation is divided into different classes in order to differentiate the level of effort and advance rate due to the varying properties and structure of the rock mass encountered. The different degrees of hindrance resulting from the installation of support around the freshly excavated opening are also implicitly included in the classification. However, the installation of support is measured and paid for separately from excavation.

The class of excavation is derived directly from the Rock Mass Rating of the parent rock mass as defined by Norwegian Geotechnical Institute (NGI) Barton (1977).

The assignment of an individual excavation class shall always apply

to the whole of the excavation cross section as defined by the nominal excavation line, even if the partial excavation method (e.g. top heading and benching) is being used.

Inflow of groundwater shall not be taken as a criterion for the assignment of excavation classes. Difficulties caused by the inflow of water during the excavation are covered elsewhere in these specifications.

The link between Excavation Class and Rock Mass Rating is as follows:

Excavation Class	**Jointing Freq. per Cub. m or per 1.3 Cub. Yards**	**Rock Mass Description on the Barton Chart**
Q1	5 < Jv <10	Good to Fair
Q2	10 < Jv < 20	Poor
Q3	20 < Jv <27	Very Poor
Q4a	Jv > 27	Extremely Poor (crushed)
Q4b	---	Extremely Poor (Decomposed)

The estimated proportions of different rock masses are shown on the Drawings in the form of percentages of different Rock Mass Descriptions. Rock Mass Descriptions are directly related to Excavation Classes via ranges of Rock Quality Ratings as shown in the above table. The proportion of Excavation Classes given on the Drawings is indicative only and the Contractor must be prepared to deal with all possible classes. Prior to starting excavation, it will not be feasible to define the exact location and extent of each excavation class along the tunnel. Unforeseen item will be treated on actual ground condition.

7- Supporting Faces of Excavation

The excavations shall at all times be properly secured to prevent movements or loss of ground outside their boundaries, settlement of, or damage to property or injury to persons. The Contractor shall, at his own expense, make good any damage to structures, services or other properties caused by such movements, loss of ground or water and settlement/deformation.

Any exposed face where excavation is to be discontinued shall be permanently protected.

All supports which are left permanently in the Works shall be of steel treated as specified. The Engineer may order that steel poling boards and other steel supports shall be used either temporarily or permanently, if he considers this to be necessary. However, the fact of his having ordered or having not ordered that steel supports shall be used and/or left permanently in any excavations, shall not relieve the Contractor from his sole responsibility for any damage or injury resulting from this operation.

8- Excavation through Earth, Weak or Weathered Rock and Rock

Earth, Weak or Weathered Rock

The Contractor shall excavate through earth or weak and weathered rock by means of acceptable methods, which will allow an appropriate excavation and avoid cave-ins and slides. He shall use the excavation and transportation equipment that best suits the underground conditions. The excavation shall be coordinated with the installation of lagging and supports and with the backfilling operation behind supports to provide a permanent support for all the materials surrounding the tunnel. Where rock blocks are encountered, the excavation shall be started using manual methods or pneumatic tools so as not to disturb surrounding materials. In case it is impossible to excavate using these methods and it becomes necessary to resort to explosives, blasting shall be as specified below. If rock blocks of considerable size are found, it may be necessary to resort to line drilling to diminish any harmful effect from blasting on the remaining material.

As a part of his obligations, the Contractor shall take all necessary precautions to protect tunnel against cave-ins produced by seepages or other causes. He shall permanently keep a crew dedicated to backfilling holes resulting from over-excavation or cave-ins; due to the Contractor operation the cost of this operation shall be included in the prices stipulated for tunnel excavation. When the material found at the work front is saturated or has a consistency that may give rise to cave-ins with normal excavation operations, the Contractor shall proceed to place a temporary support at the front, drive lagging and/or forepoling steel bars ahead of the excavation and take all necessary precautions to avoid cave-ins. Backfilling of holes or voids shall be made with structural concrete and compacted in an appropriate way. Seepage water shall be collected and discharged in temporary drains of concrete or plastic pipes laid with open joints surrounded by a gravel and sand filter, where required. The cost of seepage drains, seepage protection work and pumping required during the excavation shall be included in the prices for excavation.

Rock

The Contractor shall excavate through rock by means of any appropriate method. He shall use excavation and transportation equipment which meet the requirements stated in these Technical Specifications except where restricted by the Engineer under these specifications. Supports and/or rock bolts will be placed in sections where the quality of the rock so requires. The excavation and support installation shall be made in a co-ordinated way to avoid the action of unbalanced forces on the tunnel support. Use of explosives shall be made as indicated below in these Technical Specifications.

As the excavation advances, the rock encountered shall be observed according to its fracture conditions for determining the length and number of boreholes, the charge of dynamite per hole and the sequence of detonation, with the aim of reducing the over-excavation to a minimum and maintaining the periphery as close as possible to

that shown on the Drawings. If required, core drilling ahead shall be carried out to enable the selection of an appropriate excavation and support method. A systematic and permanent inspection of the surfaces of excavated sections shall be made to determine the quality and conditions of the supports.

The surfaces shall be cleaned with water and air jets in order to facilitate their inspection. All shattered pieces of rock shall be removed and backfill and wedges shall be placed to maintain the excavation in a stable position. Where the removal of shattered or loose rock is not sufficient to guarantee that cave-ins will not occur, the vaults and walls shall be supported by means of shotcrete or shall be reinforced by means of rock bolts or steel supports, with or without lagging. When it becomes necessary to reinforce a section of tunnel excavation, this operation shall be finished before continuing with further excavation. Where it is necessary to place laggings, they shall be packed at the contact with vaults and walls in such a way as to obtain safe protection. If the excavated surfaces which are to be covered by concrete or shotcrete show excessive protuberances or depressions that make concrete or shotcrete placing difficult, the Engineer can demand that the surface be trimmed until a surface that allows good lining quality and bonding is obtained. There shall be no separate payment for any of this trimming operation and its cost shall be included in the prices for expected excavation through rock.

9- Feeler or Pilot Holes

It may be necessary for the Contractor to drill feeler or pilot holes ahead of the tunnel excavation to determine in advance the nature of the materials to be excavated or the existence of natural cavities or faults. The cost of drilling feeler or pilot holes shall be included in the prices for excavation.

Failure of the Contractor to ascertain the rock conditions ahead of tunnel face shall not relieve the Contractor of the sole responsibility for the safety of the underground works or of the liability for injuries to, or deaths of, persons or damage to property or of any of his obligations under the Contract whatsoever.

10- Safety Measures and Support during Construction

The Contractor shall provide all safety measures necessary to avoid any danger to personnel, equipment, installations and the structure itself and not only in the case of obvious danger, but also in the case of merely suspected danger, the Contractor shall immediately take adequate safety measures.

The safety of the underground excavation shall, at all times, be the sole responsibility of the Contractor, as well as the adoption and implementation of all necessary measures to protect the personnel engaged in underground work from cave-ins, harmful gases or vapours, explosions, intoxications, electric shocks, floods and all other possible accidents in the construction of tunnel. The Contractor shall take all precautions normally adopted for this type of work and

those that the Engineer may deem necessary within the scope of the work. Lack of compliance with any safety measures shall be cause for the Engineer to suspend the execution of the Works until the causes that determined the suspension are remedied, and in such cases the Contractor shall have no right to claim for time extensions or extra costs.

The locally required safety requirements shall be observed by the Contractor. In the event of rock falls owing to unfavourable bedding, jointing, local faults, etc., work shall be carried out with particular care and adequate protective safety measures.

When the excavations are being executed through zones of earth, earth/rock sequence, weak or weathered rock or any other zones where the rock is unstable, it shall be stabilised during excavation work or supported permanently by means of steel supports with permanent or temporary liners or lagging placed as required by local conditions with the prior approval or order of the Engineer. When the excavation is being made through sound and relatively unaltered rock, only local support by means of shotcrete, steel support or rock bolts might be required when the structural characteristics of the rock could otherwise cause dangerous conditions. These supports shall be installed in such a way that they can easily be inspected at any time. All safety measures and requirements related to the construction activities and those described hereunder shall be obligatory for the Contractor in all respects.

Where relatively light arched steel rib supports are used, care shall be taken to ensure that the arched rib is subjected to a uniform load/support along its circumference (by means of wedging or placing of short props against the rock). An adequate longitudinal bracing system shall be provided as a safeguard against buckling and overturning.

Anchor grip plates shall bear flat against the rock or shotcrete and shall not be placed on projections or fill, but, wherever possible, in depressions or similar areas of the rock surface.

Steel rib supports and anchoring shall be installed in accordance with the respective provisions of the following sub-chapters.

Timber blocking and lagging may be used to secure tunnel supports. Such blocking and lagging shall be removed before concreting, except in those cases where, in the opinion of the Engineer, the removal of such blocking and lagging will create unsafe working conditions that would endanger the health or life of the workmen or the orderly progress of the tunnel construction.

Where rock bolts are provided for the purpose of producing an arching effect in unstable rock or for securing loose rock parts in otherwise stable rock, the rock bolts shall be placed by mechanical means only. Their installation shall, at the Engineer's request, be proven by means of a torque wrench which shall be periodically calibrated and checked for safe and accurate functioning.

11- Care of Excavation

The tunnel excavation shall be done with utmost care. The excavation shall conform to the widths, lengths and depths shown on the Drawings and/or shall be carried out in sections and to such dimensions as required for the particular conditions.

Drilling and blasting operations for excavation shall be carried out to meet the following requirements:

- Minimum loosening of material at the excavation surface and walls.
- The least possible vibration to be imparted to all excavation supports or lining (especially the concrete lining), neighbouring 60 years old concrete lined tunnel, and the surrounding rock mass.
- A pressure wave of such magnitude that it will not have any adverse effects on any formwork, fresh concrete and buildings above ground, neighbouring excavations and existing tunnels, etc.
- The least possible amount of overbreak.
- Minimise rock falls in fault zones and elsewhere.

Blasting control of rock excavation without creating excessive overbreak shall be carried out by drilling perimeter blasting holes filled with light charges of explosive. The procedure is known as smooth profile blasting (refer to the relevant Clause later in this Section). Smooth blasting shall generally be required on all excavated surfaces permanently exposed or against which concrete or shotcrete will be placed.

Whenever, in the opinion of the Engineer, further blasting may damage the rock upon or against which concrete or shotcrete is to be placed, the use of explosives shall be discontinued, and the excavation shall be completed by wedging, barring, channeling, line drilling and other suitable methods.

Damage to, or incorrect alteration of, any of the work areas caused by improper blasting or due to any other operation executed by the Contractor shall be repaired or indemnified by him at his own expense in a manner acceptable to the Engineer. Unstable or loose material appearing during excavation and which in the Engineer's opinion may endanger the personnel or the Works, shall be immediately and safely removed, and the Contractor shall have no right to special or additional payment for this operation.

To ensure workmanlike excavation and supporting operations and the progress of the Works to schedule, only experienced supervisory staff and skilled miners shall be engaged and the most suitable machinery and equipment shall be used. Furthermore, adequate extra facilities and stand-by plant shall be provided.

Should any excavation be made of greater dimensions than shown on the Drawings, then the excess space shall be filled in with such material and in such a manner as the Engineer may direct.

All excavations shall be taken down to a firm surface. Before any foundation or lining material is placed all loose material and foreign matter shall be removed from the periphery of the excavated opening. In particular, the firmness and integrity of the invert of the excavated opening shall be approved by the Engineer. The final 6 in (150 mm) of the material to be removed shall be left undisturbed until shortly before construction of the foundation or lining is to commence if, in the opinion of the Engineer, such a precaution is necessary.

12- Prerequisites for Blasting

The Contractor shall not obtain or use any explosives without the express permission in writing of the local security forces or other authorities concerned. The Contractor shall comply strictly with all regulations stipulated by the authorities regarding purchase, storage, issuance, supervision use of explosives and their transport to and from the Site, by himself and by the security forces, all of which shall be deemed to have been included in the relevant prices.

13- Blasting Requirements

Blasting shall be carried out carefully by licensed/qualified experts only and the Employer and/or the Engineer will not be liable for any claims arising from damage or alleged damage, injury to the public, etc., due to blasting.

Blasting shall be carried out at specified times and sufficient notices and barriers shall be erected for safety purposes. Immediately before blasting is due, adequate warning shall be given. Upon completion of blasting, an "all clear" signal shall be given.

This signal shall be withheld by the responsible blasting foreman or blasting engineer until he is satisfied that all charges loaded have detonated and that no delayed explosions or misfiring can be expected. Adequate warning, as mentioned above, shall be given and the required portion of the Site shall be cleared, before electrical resistance measuring or testing of the firing line is carried out.

The Contractor shall ensure that ventilation tubes and supply lines are at all times safely grounded, so as to prevent injury to persons and/or unintended ignition of explosive charges by lightning.

14- Smooth Blasting

Smooth blasting shall be considered as a controlled blasting technique with closely spaced contour (perimeter) blast holes filled with light charges or low power explosive and fired last in the blasting sequence of a round. The Contractor shall arrange the spacing, charges and timing of blasting so that the result of the blasting is a smooth profile as expected

15- Blasting Records

The Contractor shall record on agreed forms all blasting events including location, time, charge, type of explosives, detonator type and arrangement, purpose, etc. These records shall be available to the Employer and Engineer at any time.

16- Precautions for Blasting

Blasting that occurs near existing structures shall not be permitted without taking the necessary precautions and without the Engineer's approval. All possible precautions shall be taken to preserve the rock found outside the excavation lines in the best possible condition. The amount and quality of explosive and sequence of detonation shall be such, that it will keep overbreak to a minimum outside prescribed lines. The Contractor shall take care that the excavations do not exceed the limits shown on the Drawings taking all necessary precautions regarding the spacing and arrangement of boreholes, explosive amounts and sequence of detonation. The acceptance of the drilling and blasting method used shall not relieve the Contractor from any of his obligations nor diminish his responsibility under the Contract. If the system used by the Contractor causes over-break outside the allowed limits, the Engineer can demand a change of system, the execution of line drilling without charges or any other modification that he deems suitable. This changed system of excavation will not be grounds for claiming any additional payments beyond those tendered for the material excavated to the lines shown on the Drawings.

17- Dealing with Explosives

All pertinent specifications regarding the general requirements for storage and care of explosives shall be applicable taking into account the following:

- Charges shall not be prepared underground.
- Blasting caps shall be separately packed according to type in clearly marked boxes and shall be sent to the work front in a vehicle; this vehicle shall be followed by another one carrying the explosives in open boxes; only the necessary amount of explosives and caps shall be sent to the front; all remaining caps and explosives shall be taken away before the blast.
- The net hole depth shall be checked before placing the charge.
- In case the detonators are electric, when preparing them outside of the excavation, the base wire ends shall be protected with insulating caps or neoprene fittings. Such insulators shall be removed after charging the holes to make the proper connections.
- Each of the prepared blasting charges shall be checked by means of a galvanometer, or a special ohmmeter, at a prudent distance, to guarantee the continuity of the complete grid network.
- The ends of the main wires shall be connected to the detonator immediately before the blast; the detonation system shall be kept at a safe distance as agreed by the Engineer from the front, but non-essential personnel shall be moved back further.
- Should an ignition system without electric detonators be used,

the manufacturer's recommendations shall be followed.

If the Contractor is planning to use electric detonators, he shall install lightning detectors that give continuous information about the atmospheric electric activity. The Contractor shall install alarms directly connected to the detectors at each work front. When explosives are being charged at a front where electric detonators are used and a storm is detected, the personnel shall be quickly moved to a prudently distant location until atmospheric conditions become normal.

18- Ventilation

The Contractor shall install, maintain and operate a temporary ventilation system for underground work. The installation and operation of the ventilation system shall follow the excavation work to continuously provide respiratory conditions not detrimental to the health of the labour force.

The design of the ventilation system shall comply with the requirements of internationally recognised standards. The ventilation system may be of the forced supply or forced extraction type, including local air movers or any combination thereof.

The ventilation system shall be operated continuously throughout the excavation and concreting phase in accordance with the requirements of the work.

19- Lighting and Power

For each section of the Works, the Contractor shall provide an adequate lighting system which shall be maintained in operation during the execution of the respective work. All underground electrical supply shall comply with the recommendations of BS 6164 or as approved by the Engineer.

Besides the general lighting system, he shall provide special lighting for the excavation front, where any work is being executed, or where it is necessary to inspect a part of excavation. This lighting system shall consist of flood lights, or any other type approved by the Engineer. Energised wires or lamp bulbs shall not be permitted in the immediate vicinity of the work front.

All power and lighting wires shall be installed and maintained in optimal conditions of insulation and safety.

Power and lighting cables shall be installed on one side of the tunnel and the detonator wires shall be installed on the opposite side and sufficiently distant from telephone or communication wires.

All wires shall be firmly fixed on walls, by means of insulators of adequate design and capacity and their installation shall be made in such a way that wires are not damaged during construction. The illumination on a horizontal plane at floor level shall not be less than 10 lux. At working faces and at other places where work is in

progress or inspections are necessary, illumination on a plane at the face or other place shall not be less than 100 lux. The lighting network voltage should be of the order of 50 V. However, if the Contractor so prefers, he can install a system with a higher transmission voltage by means of insulated cables of special design, acceptable to the Engineer, from which the lighting network shall be supplied at the specified voltage. In this case, the Contractor shall furnish at his own cost waterproof, explosion-proof and water-tight transformers for installation underground. For the general lighting system the Contractor may use incandescent or fluorescent lamps, sodium lamps or any other type acceptable to the Engineer which provide the minimum specified intensity of light.

The Contractor shall supply and maintain helmet lamps for the use of all personnel including the Engineer's staff and authorized visitors. An additional inspection lamp shall be available at each working face at all times.

The temporary lighting shall remain in service until tunnel construction is complete.

Without prejudicing the liability of the Contractor under the Conditions of Contract or his responsibility to adopt all measures for ensuring the safety of his workmen and others, the Contractor shall, in connection with any installation for lighting, power and signalling, observe the following:

a) Lighting supply underground shall be independent of the power supply for any plant or small tools.

b) All lamp holders shall be of approved non-conductive material.

c) All wiring shall be properly insulated with vulcanised rubber or other approved material, particular care being taken to insulate connections.

e) All wiring shall be securely fixed clear of any moving plant, man access, seepage flow, source of heat or other possible damage.

f) All circuits shall be sub-divided and protected by fuses of low current rating.

g) Power supplies to fixed plant and equipment, tunneling machines and the like shall be adequately protected against unauthorised or accidental damage and shall be marked with the applicable maximum voltage. All cables shall be able to withstand continuous immersion in water, contact with hydraulic fluid, vibration from moving machinery, heat, abrasion and mechanical damage.

i) High voltage step-down transformers, including the related switchgear, shall be installed in recesses outside of the excavation lines.

20- Communication

The Contractor shall provide and maintain the following minimum communication system throughout all underground work: A robust two-way telephone system shall be installed between each working

face, each fire point, a continuously manned control point, and the Engineer's and Contractor's site offices, the first aid station, batching plants and other important facilities, as deemed necessary by the Contractor and/or instructed by the Engineer.

21- Pressure, Water and Air Pipes

The Contractor shall furnish and install all pressure, water and air pipes including all accessories that are necessary for the execution of the work.

22- Form of Invert during Construction

Immediately after mucking out, the invert shall be levelled suitably. All ground water and service water shall be drained off immediately so as to make and maintain the invert suitable for use by persons and vehicles.

Any covers and barriers required shall be installed immediately.

23- Access

Without prejudice to the liability of the Contractor under the Conditions of Contract and his responsibility to adopt all measures for ensuring the safety of his workmen and others, the Contractor shall, in connection with the provisions of safe access to the Works, observe the following requirements:

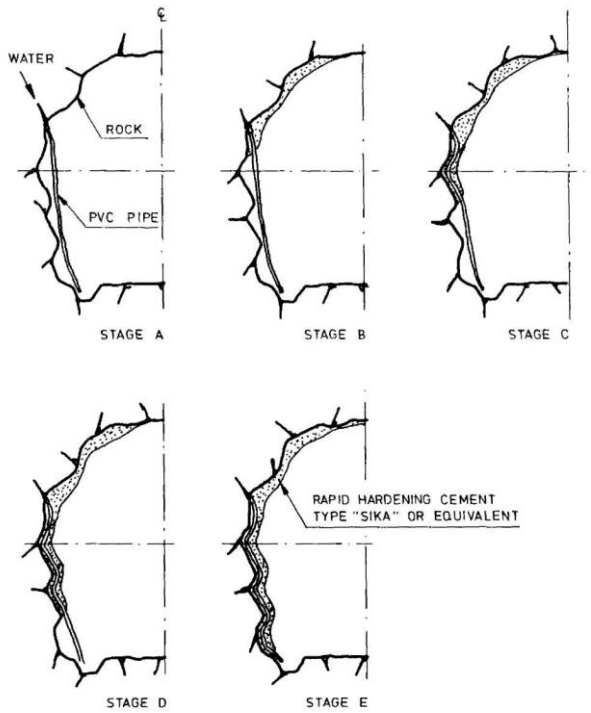
a) Walkways shall be provided through tunnel works providing a minimum clear space 6ft (1800 mm) in height and 2.5 ft (750 mm) in width with a walking surface not less than 1.3ft (400 mm) wide. The walking surface shall be free from irregularities and sufficiently rough to provide an adequate foothold. Water should not be allowed to stand or accumulate at or above walkway level at any point. Any accidental spillage of spoil or other material shall be removed immediately. Walkways elevated by 6.56 ft (2 m) or more shall be provided with guard rails and toeboards.

b) Ladder access and/or staircases shall be provided where required as soon as possible.

24- Drainage

Dewatering shall be continued until the respective works or sections of the works are temporarily accepted by the Engineer. The water has to be collected, channelled and pumped out to open air.
Water from fissures or faults running over a rock surface to be shotcreted, shall be collected in drain-pipes and a channel formed by rapid hardening mortar (Oberhasli-Method or similar) prior to shotcreting.

The “Oberhasli” Method of Draining Water from Fissures and Cracks



After placing primary lining, a systematic drainage along the excavation shall be executed prior to placing structural concrete.
If an unexpectedly severe influx of water is encountered from faults or fracture zones, it will be necessary to reduce as quickly as possible the inflow of water by grouting or other means.

25- Control of Water

Methods for controlling groundwater for all sections and stages of tunnel excavation may include groundwater lowering, ground treatment, or a combination thereof.

The technique adopted shall ensure stability of opening and excavated face during and after construction and shall ensure that no washing out of fine materials, which may lead to progressive settlement or loss of stability.

Water in the excavation shall be conveyed towards sumps and piped from the Works to the surface drainage system. Pumps shall be adequately sized to provide sufficient capacity to meet abnormal conditions (including failure of a pump).

26- Fire-Fighting

Notwithstanding the Contractor's liability under the Conditions of Contract and the requirements and recommendations of the local fire fighting authorities, the Contractor shall observe the following requirements, where applicable:

a) Fire fighting equipment shall be in compliance with internationally recognized standards.

b) Vulnerable areas, such as material stores, shall be provided with individual fire points.

c) An alarm procedure shall be developed for any type of emergency that fire fighters may be called upon to tackle.

d) Burning and welding in the tunnel shall be kept to a minimum and propane shall be used in preference to acetylene. Gas cylinders shall not be stored below ground and shall be removed immediately after use. Sand buckets and extinguishers shall be immediately available when cut-welding is carried out.

e) Storage of combustible materials below ground shall be kept to that required for immediate or emergency use only. Waste shall be removed at the end of each shift.

f) A site fire squad shall be designated and trained to use apparatus, monitor its readiness, check and report on unsafe practices.

g) Access to the Site for emergency vehicles shall be maintained at all times.

27- Treatment of Faults and Minor Cracks

In the case that during tunnel excavation some cracks, shearing zones or open faults will be found which do not require support, the Contractor shall remove all the material filling the crack or fault down to a depth equal to the width of the crack, or as otherwise directed by the Engineer and its surface shall be cleaned with water and air jets. If lining is planned for the section in question, then rock bolts will be installed to secure the opening. If the section in question is to remain unlined, then besides the installation of rock bolts, dry mortar, shotcrete or gunite reinforced with wire mesh shall be used to fill and cover the cracks according to dimensions and details shown on the Drawings or as directed by the Engineer.

28- Tunnel Collapse (Cave-in)

The Contractor shall, at all times, take all measures deemed necessary to avoid collapses (cave-ins) in tunnel and related openings.

In the event that indications of a collapse (cave-in) are observed, then the Contractor shall take all necessary preventative support measures and then immediately notify the Engineer. In such cases the Contractor shall take all measures ordered by the Engineer. He shall execute such measures and all work required to control the cave-in. The cost for this operation shall be included in the prices for tunnel excavation.

In the event that a collapse occurs, then the Contractor shall remove all collapsed material, repair any damage caused by the collapse and backfill the opening with concrete at his own expense. The Contractor shall permanently keep a crew at the excavation front devoted to backfilling voids and/or dealing with collapses. The cost for this operation shall be included in the prices for tunnel excavation.

29- Overbreak due to Special Shapes and Intersections

The cost of any overbreak and the subsequent backfilling with concrete due to special shapes or intersections which are shown on the Drawings or which are to be expected in view of the condition of the rock and the method of excavation shall be included in the prices and will not be paid for separately.

30- Overbreak Required for Operational Reasons

Excavation not shown on the Drawings, but considered necessary by the Contractor for construction operations, such as excavations for recesses, lay-bys, side drifts, mucking pits, pump sumps, drain ditches, rail grooves, as well as spaces for supply facilities and the like may be made only if accepted by the Engineer.

31- Overbreak due to Contractor's Fault

Where overbreak is caused by inappropriate working methods or negligent work (e.g. wrong location of drilling holes, careless blasting operations, excessive pulls, incorrect extension of the tunnel axis, etc.), no payment will be made either for the overbreak beyond the excavation lines or for the additional concrete required for backfilling.

The Contractor shall be responsible for all cave-ins, erosion and over-excavation of tunnels in earth. He shall take all necessary measures, at his cost, to control the excavation and make all the repairs ordered by the Engineer.

32- Overbreak due to Geological Conditions

The cost incurred in connection with overbreak due to geological conditions will be refunded to the Contractor only in case of unexpected and unavoidable occurrences which could not be avoided by proper excavation and support methods. Assessment, of geological overbreak and its payment requires the approval of the Engineer.

Such approval will only be given if the Contractor requests measurement directly after excavation or as long as the overbreak materials are still visible. The Engineer's approval will be recorded on the measurement sheet only. Any cost claimed under this heading shall not be accepted if claimed after the placing of shotcrete or concrete. Overbreak at tunnel inverts will not be accepted as being due to geological conditions.

Where overbreak due to geological conditions coincides with those due to the Contractor's fault, any cost for overbreak and additional concrete involved shall not be claimed.

Paylines for excavation are the radii and/or dimensions as defined below under the sub-section “Measurement and Payment”.

The unit rates for approved geological overbreak shall include

mucking, transport and safety measures.

33- Excavated Profiles

Excavation shall be carried out according to the dimensions shown on the Drawings including all excavation for ditches, drains, recesses, , etc., as far as these are shown on the Drawings.

Single projections of solid rock (no more than one per four square meters of excavated surface) may project into the design cross-section up to 4in (10 cm), provided the concrete lining is thicker than 12in (30 cm). Where the lining of concrete is thinner than that, the rock may project into the concrete no more than one third of its thickness. No projections will be allowed where steel reinforcement is required.

34- Backfill with Concrete

For backfilling of excavated niches, recesses, overbreak and other temporary underground openings, unreinforced concrete of the same class as the lining shall be provided by the Contractor.

Over-excavation which, in the opinion of the Engineer, might endanger the stability of the entire structure shall immediately be backfilled with the same class of concrete as the lining without either extra payment or time extension.

35- Convergence Measurement

Convergence anchors shall be 1ft (300mm) long, high yield 0.6 inch (16mm) diameter reinforcing bars welded to a stainless steel head to suit the convergence tape used for the measurement purpose.

The convergence anchors shall be fully resin bonded into 1.5 inch (38mm) diameter percussion drilled hole enlarged at the surface to allow the head to be recessed.

Convergence stations shall generally be installed within 3 ft (1m) of the face and the zero reading established before the face is advanced.

The readings shall be taken between all stations at the following frequencies:

- After each blast, until the graph show the initial rapid linear convergence phase has passed
- Thereafter at two blast intervals until the face has advanced to at least 65ft (20m)
- Thereafter at weekly intervals until the readings have stabilized

(6) Tests and Properties

To fulfill the Contractor’s design obligation, the Contractor shall, at any time, supply rock, soil, and water samples for testing purposes. The number and types of tests to be carried out by the Contractor

shall be determined by the Engineer.

Any change in rock and soil conditions shall immediately be reported to the Engineer. In the event of large inflows of water, the quantity of water shall be determined at the Engineer's request.

(7) Auxiliary Works

a) General

All auxiliary works shall be included in the prices for underground excavation and shall include, but not be limited to, the following:

Any and all labour equipment, temporary installations or materials required for performing the underground excavation, including drilling and blasting.

Provision of adequate lighting in tunnel throughout the construction period until permanent lighting is installed where applicable.

Provision of sufficient ventilation underground, including all ducts, hoses, supply and exhaust pipes, etc., required for construction work.

Provision of adequate methods for the removal and disposal of excavated materials to disposal areas either shown on the drawings or as directed by the Engineer.

All materials required for placing temporary supports.

Transportation of muck to disposal areas and its compaction.

Seepage drains, seepage protection and pumping during excavation.

All costs regarding general requirements for storage and care of explosives.

All facilities for dewatering/drainage of tunnel excavation, including controlled conveyance of water to nearby streams.

b) Excavation for Contractor's Convenience

Underground openings not shown on the Drawings but which the Contractor excavates for his own convenience, such as, recesses, niches or similar, shall be subject to review by the Engineer prior to the start of such excavation.

The Contractor shall design his own underground openings with all rock support measures necessary for the permanent stability of the excavated profiles to the satisfaction of the Engineer.

The Contractor shall be solely responsible for his works and the adequacy, successful functioning and stability of the excavations.

Where required for the safe and proper functioning of a structure or

of the project as a whole, the Contractor shall backfill or plug with concrete all openings which have been made for his own convenience. The Contractor shall design such backfill and plugs to withstand all foreseeable load cases. The load cases and the design calculations will be subject to the approval of the Engineer.

No extra payment will be made for such excavation, design and subsequent backfilling/plugging.

(8) Measurement and Payment

Measurement of tunnel excavation shall be based on the following:

- The volume of material in-situ, in m³ (cubic m), before excavation.

- The theoretical lines, grades and dimensions shown on the drawings with due consideration of the thicknesses of subsequently installed support and lining.

Payment items are provided for different excavation classes. Payment shall cover all the costs of labour, equipment and material associated with setting out, blasting, loading, hauling, unloading to stockpile or dump.

Although required (either explicitly or implicitly) by the Specifications, no extra measurement for payment or payment will be made for the following:

- hauling to and placement in stockpiles.
- surveys.
- mapping the geology of the excavated surfaces.
- removal of materials resulting from over-break caused by the Contractor's poor or inappropriate working methods or negligence and for the additional materials required to fill the voids so created.
- additional work of removing material and backfilling voids with approved material where Over Excavation due to adverse geological conditions coincides with that due to Contractor's poor or inappropriate working methods or negligence.
- excess excavation required for Contractor's convenience and the resulting additional backfilling with approved materials.
- draining, drainage ditches shaping, and trimming the stockpiled material in the deposit areas to the lines and grades designed by the Contractor and approved by the Engineer.
- access to any stockpile area, preparation and grading of the area, diversion of water courses and drainage.
- dewatering and keeping the tunnel excavation site dry.

The convergence stations will be measured and paid as number of installed:

- stations comprising 3 measuring bolts, one in the roof and one in each wall or as directed by the Engineer.

Steel Support 12.2 **(1) General**

a) Scope of Work

The work covered by this sub-chapter includes the manufacture and installation of steel supports in an approved manner to the lines, grades and dimensions as shown on the Drawings as well as the furnishing of lagging, wedges, tie-rods and other accessories required to safely support the tunnel as shown on the Drawings or as instructed by the Engineer. Actual spacing of the structural steel supports shall be determined by local conditions exposed during excavation. For the uniform distribution of pressure, collar braces between the structural steel support sets shall be held in place by tie rods to complete the support system.

Steel supports shall be placed as soon as possible after excavation of each face is finished and in such a way that the natural strength of the rock is optimally used.

The type and extent of structural support measures shown on the Drawings are assessment based on limited knowledge prior to excavation. The type and extent of structural support measures actually installed after excavation shall not be reason to modify the unit prices stipulated in the Bill of Quantities, to change the terms of the Contract or to diminish the Contractor's responsibility.

No statement hereafter shall be construed to relieve the Contractor from his responsibility for the safety of tunnel or from liability for injuries to, or death of, persons or damage to property.

b) Responsibility of the Contractor

The absence of the order for the installation of supports shall not relieve the Contractor of his sole responsibility for safe excavation. In an emergency, the Contractor shall promptly begin the installation of adequate supports and submit his scheme as soon as possible thereafter for subsequent approval. Sufficient support material shall always be on hand in order to carry out the work without delay.

Nothing specified in this Sub-chapter shall prevent the Contractor from installing such amounts of supports or timbering or steel liner plates, at his own expense, as he may consider necessary for the safety of the excavation.

c) Steel Rib Support - Design and Fabrication

Steel ribs shall comply with ASTM A36 or approved equivalent. The design and fabrication of steel rib supports, including size, mass, accessories and methods of installation in all parts of the tunneling shall be subject to review and approval by the Engineer.

d) Steel Rib Support Installation

Where steel rib supports are required, the rock shall be excavated to enable the steel ribs to be installed true to lines and grades shown on Drawings, and shall be maintained by the Contractor in proper

condition and alignment.

e) Temporary Timbering

Suitable temporary timbering may be used only if accepted by the Engineer where such temporary timbering is necessary to support the roof and sides of the excavation during construction and to facilitate installation of permanent supports. Such temporary timbering shall be removed by the Contractor shortly before placing the concrete and/or shotcrete lining and it shall be the Contractor's responsibility during excavation to conduct his operations so that no temporary timber is installed which cannot be removed when required and as directed by the Engineer.

(2) Material and Equipment

a) General

The Contractor shall furnish all steel supports consisting of structural steel ribs as shown on the Drawings, foot beams, lagging and other approved structural steel members, complete with bolts, nuts, wedges, tie rods and other accessories required for assembling the permanent structural steel supports and supporting them in place.

Suitable steel liner plates, if required, shall be provided with continuous inner flanges for bolting adjacent plates together and providing the necessary shoring strength. For filling voids behind this lining with grout, injection holes in the plates shall be provided. In sections where ingress of water is expected, plates with sealing flanges shall be used.

Occasionally, it may be appropriate to use lagging made out of corrugated steel sheets. These sheets shall be provided with openings to place gravel fill. Welding or clamps may be used to connect supports and plates.

b) Tests and Properties

The Contractor shall furnish certified copies of reports to the Engineer of all tests and inspections required to show compliance with the applicable Standards and assembly instructions

c) Measurement and Payment

Measurement of structural steel support shall be based on the weight, in tonnes or kg, of the steel support correctly installed by the Contractor and approved by the Engineer.

Payment shall cover furnishing, erecting and removing structural supports which are shown on the Drawings or which are instructed and approved by the Engineer.

No payment will be made for such work not shown on the Drawings or for work not instructed by the Engineer or for work required for the Contractor’s convenience or for work instructed by the Engineer due

to bad workmanship of the Contractor for whatever reason.

d) Scaling

The scaling is to be performed in accordance with the best prevailing practice. It is required that the Contractor keeps available equipment in efficient working order for the scaling works, such as:

- scaling rods
- scaling platform to be mounted on shovel
- hydraulic scaling hammer
- equipment for cleaning/scaling by high-pressure water flushing.

All loose rock is to be removed to the degree possible by high-pressure flushing with combined water and air, 0.75in (20 mm) nozzle and minimum pressure 145psi (10bar).

No extra payment shall be made for the scaling. The Contractor shall cover the scaling effort in the rate of excavation of respective rock class.

Rock Bolting and Accessories

12.4 **(1) Materials**

Rock bolts of the following types may be used:

- Fully grouted deformed steel bars
- Resin end-anchored bolts (deformed steel bars)
- Fully grouted expansion-shell bolts (deformed steel bars)

Bolts designated to serve as permanent support shall normally be fully grouted with cement mortar, but resin end anchored and fully resin-grouted bolts may be approved as permanent support, if corrosion protected in accordance with para 2 below. Permanent rock bolts shall conform to the following requirements:

a. Deformed steel bars and plain steel bars shall conform to ASTM A 615M, Grade 400 having a minimum yield-point strength of 400 N/mm^2.

b. Corrosion-protection with hot-dip zinc coating (minimum 80 micro m) shall conform to ASTM A 767 alone or in combination with epoxy coating conform to ASTM A 775 or similar. Bolt accessories shall be provided with the same corrosion protection as the rock bolt.

c. Threaded rock bolts shall be provided with rolled threads of min. 6in (150 mm) length of the same corrosion protection or better than the bolt itself. The threaded part shall withstands a force equal to the actual ultimate load of the rebar. If the threaded part is separate and to be connected to the rock bolt, the rock bolt and the threaded part shall be connected by friction welding according to BS 6223. The friction weld shall have the same corrosion protection or better than the bolt and threaded part. The friction weld shall withstand a force equal to the actual ultimate load of the rebar.

d. All type of bolts shall be provided with a 8in (200 mm) diameter dished anchor plates of 0.25in (6 mm) thickness, semi-spherical washers and nuts. The assembly shall adjust to angular displacement from normal up to 45o. The steel quality of the anchor plates shall conform to ASTM A 36/A 36M. Other accessories shall be of steel quality compatible with the quality of the rock bolt.

e. Bottom part of bolts for end-anchoring with polyester resin anchoring shall be provided with a spring or other device for efficient mixing of the polyester resin.

f. Polyester resin capsules shall be of quality giving sufficient bond strength to comply with requirements for pull tests.

g. The cement mortar used for grouting of rock bolts shall comply with the following requirements:

- Shall not react chemically with zinc coating
- Expansion 1 - 3 %, to be completed before completed hardening of the grout
- Max. grain size 0.02in (0.5 mm)
- Compressive strength min. 6500 psi (45 MPa) at 28 days

h. Resin end anchored bolts shall be hot-dip zinc and epoxy coated. Fully grouted rock bolts shall as a minimum be hot dip zinc coated. Additional epoxy coating will be required unless the grouting material for bolting has been verified not to cause undesired chemical reactions with the zinc coating.

i. The tensioning of all the rock bolts in the corresponding reach shall be checked as part of the inspection. In case of loose bolts, the bolts shall be retensioned. In case of overbreak around other bolts ends, redrilling and/or resetting of bolts shall be done.

(2) Accessories

The Contractor shall provide all necessary accessories, additional boreholes where required or other items necessary for installation and anchoring or grouting of the bolts.

(3) Execution

Drilling and Installation of Fully Cement-grouted Bolts

Fully grouted deformed steel bars with or without expansion shell end anchoring shall be installed in accordance with the following instructions:

a. Rock bolts may be installed in a systematic and predetermined pattern, or in an irregular manner as directed by the Engineer.

Rock bolts shall be installed perpendicular to the rock perimeter, or otherwise as directed by the Engineer.

b. The diameter of the drill holes shall be minimum 0.4 in (10 mm) and maximum 1.2in (30 mm) larger than diameter of the rock bolt.

c. Drill holes shall be flushed with water for their entire length before grouting.

d. Rock bolts shall be cleaned to remove dirt, grease or any other impurities before installation.

e. The entire hole shall be filled with a mortar (grout) before installation of rock bolt.

f. When the bolt is grouted after installation, ensure that the hole is filled with grout.

g. In upward slanting boreholes measures shall be taken to prevent loss of mortar. The bolt shall then be secured by wedges or other means to prevent movements during hardening of the mortar

h. Bolt ends shall not protrude more than 2in (50 mm) outside nuts if not otherwise decided by the Engineer.

i. Anchor plate, washers and nuts shall be located outside the reinforced shotcrete. In conjunction with welded wire fabric or rock straps, the rock bolts shall be installed in depressions of rock surface if possible.

j. The nut of grouted rock bolts shall be tighten to achieve a force at anchor plate of approximately 450lbs (2.0 kN). Carry out tightening when minimum 290psi (2 MPa) grout strength has been obtained.

k. For grouted expansion-shell bolts, the maximum working load shall be limited to 50% of the ultimate load, when pre-stressed before grouting.

Drilling and Installation of Resin End-anchored Bolts

Resin-end anchored bolts shall be installed in accordance with the manufacturer's issued written instruction.

The bolts shall have an anchored length of minimum 10in (250 mm) in high strength rock types (unconfined compressive strength, UCS, >22ksi (150 MN/m2) and 20in (500 mm) in medium strength rock types UCS 7.2- 22 ksi (50-150 MN/m2). For low strength rock types the minimum anchored length will be 1 m. The diameter of the boreholes' inner end shall be 0.4-0.5in (10-12 mm) larger than the bolt diameter.

The bolts may be installed in a systematic, predetermined pattern, or in an irregular manner as deemed necessary.

(4) Forepoling Bolts

Forepoling bolts shall be installed in the roof, if required, and/or instructed by the Engineer. The bolts shall be embedded completely in mortar. The spacing of the bolts shall not be more than 1 ft (30 cm) and the longitudinal overlapping of the fans shall not be less than

4.5ft (1.5 m). The fan holes have to be drilled slightly inclined.
The mortar shall be of a quick hardening type as approved by the Engineer. Blasting shall not be undertaken unless the mortar has sufficiently hardened

(5) Testing

Documentation of properties of grouts to be used for grouting of rock bolts shall be submitted to the Engineer. The grout properties to be documented will comprise, but are not limited to consistency, setting time, strength at different ages, porosity, expansion and permeability of hardened grout.

The Contractor shall fill in Quality Control forms which state type of rock bolts and asseccories, condition of corrosion protection, installation method and tensioning.

The Contractor shall perform quality control of rock bolt installation according to the Quality Control Procedure described by the Engineer. The Engineer's control engineer shall have free access to participate in the quality control.

End anchored rock bolts are to be tested by pull test. Grouted rock bolts are to be tested by test grouting of rock bolts in plastic tubes.

The following control categories will be included in the Quality Control Procedure:

<u>Category I - Visual control of bolts and accessories</u>

Visual control of corrosion protective coatings on rock bolts and accessories prior to installation. In case of any damage of polyester coating, mending is to be performed with a result complying with the requirements for epoxy/polyester coating. In case the damage penetrates the zinc layer, rock bolts or accessories will not be accepted.

<u>Category II - Control of tensioning by use of hydraulic jack</u>

<u>Category III - Pull tests</u>

By use of hydraulic jack with a pull force of 80 % of the yield strength. Required number of tests for a given bolted area and required number of acceptable results for approval of the bolted area is defined in relevant clause.

<u>Category IV Test grouting of bolts in plastic tubes</u>

This test shall be performed concurrent with the bolting of a defined area or tunnel interval. Assessment of number of test bolts is described in relevant clause.

The same number of tubes with internal diameter equal to the hole diameter are mounted in a rack, and test bolts are inserted and

grouted with use of the same grout and same method as for the rock bolting. Grouting of the test bolts are to be spread out through the whole period of grouting of the given area or tunnel interval.

After 10 hours of hardening the plastic tube is removed for control of how well the bolt is covered by concrete. If less than 95 % of the bolt surface within the tube is covered by grout that bolt is rejected.

Number of accepted test bolts required for approval of the given area or tunnel interval is defined in relevant clause.

Criteria for Assessment of Test Numbers and Acceptance of Test Results

The method for selection of test bolts shall comply with International Standard ISO 2859-1 “Sampling procedures and tables for inspection by attributes”. The areas or tunnel reaches to be tested will be defined by the Engineer. The Engineer will define bolt groups in the order of 200 to 500 bolts as lot sizes for the inspection (testing). Assessment of sample size will be done in accordance with ISO 2859-1. Table I, general inspection level II. A lot size of 151 - 280 bolts requires a sample size G of 32 bolts for normal or tightened control or of 13 bolts for reduced control.

Evaluation of results will be in accordance with Table IIA (single normal control) or Table IIB (single tightened control), with Acceptable Quality Level AQL 2.5. With normal inspection (testing) this requires that a size G sample has not more than 2 test failures. Switching from normal to tightened control will be done (according to ISO 2859-1) “when two out of five or less executive lots have been non-acceptable on original inspection (that is, ignoring resubmitted lots or batches for this procedure)”. With tightened control only 1 test failure is accepted for sample size G. “When tightened inspection is carried out, normal inspection shall be reverted to when five consecutive lots have been considered acceptable on original inspection”. Procedures for switching from normal to reduced and from reduced to normal are described in ISO 2859-1.

Measure to be taken in case of rejection are rebolting as defined by the Engineer.

If the test results for a defined group of end anchored rock bolts do not satisfy the requirements, control of all bolts in the group will be required. All bolts which do not pass the pull test, with a pull force of 80 % of the yield strength is the Contractor’s responsibility and will have to be replaced by the Contractor.

If the test results for a given group of grouted rock bolts do not satisfy the demands defined by AQL 4.0 in ISO 2859-1, the prices for the bolts in that group will be reduced with 25 %, and the Engineer may require additional bolting to correct the deficiency in quality.

(6) Tests and Properties

a) General

The Contractor shall furnish the Engineer with test certificates from the manufacturers of the materials he intends to use in the Works. Upon the Engineer's written consent, the Contractor shall use the approved material. Periodical control of the material shall be performed as specified in relevant clauses of the Technical Specifications. The frequency of those tests shall be established by the Engineer.

All testing of materials shall be considered as auxiliary works and no additional payment to the Contractor is foreseen.

b) Load Definitions

Load definitions are as follows:

- Setting load is the force that draws or pushes the expanding wedge into the anchor grip as the bolt or anchor is placed.
- Bond load is the resistance of the placed bolt or anchor to forces tending to pull it from the borehole.
- Nominal load is the design bond load.
- Tension load is the force stressing the bolt or anchor fixed in the borehole.
- Yield load is the force at which the yield point of the bolt or anchor material is exceeded.
- Ultimate load is the load at which the bolt or anchor breaks.

c) Testing of Rock Bolts

Two types of testing are foreseen: standard pull-out tests and tensile tests. Details on the equipment to be used for these tests shall be submitted to the Engineer two months prior to commencement of the tests.

Standard pull-out tests are specified in order to define the suitability of the rock bolts for the intended purpose. The load bearing capacity (breaking load) of 6.5ft (2 m) long rock bolts shall be tested in 6-hour rounds during the first 24 hrs after the installation. For each 6-hour round, 3 tests in each rock category shall be performed.

The load bearing capacity (breaking load) is specified as 1.8 times the nominal load.

The load shall be gradually applied on the rock bolt/anchor with simultaneous measurement of the displacements of the head until failure. Data shall be recorded on load-displacement diagrams indicating the cause of failure. Data records shall be accompanied by well documented information on the rock (type of rock, strike and dip of strata, presence of water etc.), geometry of the borehole and its position to the rock strata (if applicable), quality of the rockbolt/anchor, type of mortar or resin used and records of installation and grouting procedure (if applicable).

For the testing of grouted rock bolts (dowels), the Engineer may choose to grout the bolts only partially, as otherwise the connection

between testing machine and the bolts may be the weak link. The varying length of the grouted section and corresponding failure load will be used to evaluate the required bond length for a certain diameter of bolt, hole diameter and rock type.

The movement of the bolt end shall be measured by theodolite and by 3 point distance measurement between the testing machine and the nut resting on the rock surface/shotcrete or concrete pad as well. For fully grouted rock bolts, the plate shall have a sufficiently large hole to allow the mortar surrounding the bolt to be pulled out of the rock.

In underground Works, at least ten standard pull-out tests shall be performed in each type of rock encountered.

Tensile tests are the routine quality control tests as specified below.

Testing procedure shall be the same as that for standard pull-out test, as described above, but the ultimate test load shall not be greater than the nominal load of the rock bolt. The tested bolts/ anchors shall be deemed to have failed at the specified nominal load if, during the test, a sudden change in the load/strain ratio occurs. The test duration is defined as the period from the beginning of the loading until the ultimate load is maintained for 10 minutes.

Not less than 4% of installed bolts/anchors (1 out of 25) shall be tested for quality control. If more than 10% of the tested bolts/anchors cannot withstand the specified load, all installed bolts/anchors in the particular section (group) shall be tested. All defective bolts/anchors shall be replaced without extra payment to the Contractor.

For a fully grouted bolt, the bolt is assumed to have failed if a sudden change in the slope of the load/deformation curve is observed, or if otherwise the bond between the bolt and the mortar, or between rock and the mortar is observed to have broken. The load plot shall start at 2 tons, which is generally required to take up the slack in the system.

(7) Auxiliary Works

Unless otherwise specified, all and any kind of works, materials, services, safety measures etc. required for the completion of work, as well as, and if so requested by the Engineer, all testing and sampling shall be included in the unit prices in the Bill of Quantities.

(8) Measurement and Payment

a) Bolts for Permanent/Temporary Support

Measurement of rock bolts shall be based on the number of each type and size correctly installed by the Contractor and approved by the Engineer.

Payment shall cover all labour and materials associated with furnishing, drilling holes, installing and any testing of rock bolts which are shown on the Drawings or which are instructed and approved by the Engineer.

No payment will be made for such work not shown on the Drawings or for work not instructed by the Engineer or for work required for the Contractor's convenience or for work instructed by the Engineer due to bad workmanship of the Contractor for whatever reason.

Measurement of reinforcement mesh shall be based on the weight, in kg or tonnes, of the reinforcement mesh correctly installed by the Contractor and approved by the Engineer.

Payment shall cover furnishing and erecting reinforcement mesh which is shown on the Drawings or which is instructed and approved by the Engineer.

No payment will be made for such work not shown on the Drawings or for work not instructed by the Engineer or for work required for the Contractor's convenience or for work instructed by the Engineer due to bad workmanship of the Contractor for whatever reason.

Shotcrete

12.5 (1) General

For general concrete specifications reference is made to relevant chapter on "concrete works". Supplementary specifications relating to rock support are given below.

Shotcrete shall be applied plain or reinforced by steel fibres as directed by the Engineer. Only robots and wet mix method shall be used. All plant and methods for shotcreting shall be approved by the Engineer. Shotcreting shall be carried out by experienced operators only.

The shotcreting equipment shall include a robot being furnished with a boom mounted nozzle operated by remote control operators to always work from a supported and safe place.

The Contractor shall keep equipment of site able to catch the rebound material, in order to measure the quantity of it (by weight).

The Contractor is responsible for informing the Engineer about the location of areas to be shotcreted at the latest 12 hrs. In advance for programmed work. When shotcrete is applied as initial support in tunnel, the Engineer shall be informed at the latest 1 hour in advance.

In cases where a major part of the surface is to be covered by shotcrete, sufficient time shall be allowed for the Engineer to record the geological features before the shotcreting takes place.

(2) Materials

a) Composition

- Portland Cement Type I complying with ASTM C 150. Portland Cement Type III may be used when high early strength is required (stabilisation at tunnel face). The total Alkali content in the mix shall be less than 0.2lbs/ft3 (3.2 kg/m3).
- Micro silica may be included in the mix for improvement of pumpability and more cohesive consistency. (Maximum 12 % of cement weight)
- When sulphate content in ground water exceeds 150 ppm, achieve sulphate resistance by the use of micro silica (minimum 5 percent of the cement weight) and a low ratio (< 0.45) of: (water)/(cement + silica). The amount of water in the concrete includes added water, sand moisture and water from additives, silica slurry etc.
- The aggregate shall be a well grained sand with a maximum content of 20% (by weight) of grains with .sizes larger than 0.3in (8 mm). Measures should be taken to prevent the presence of particles in excess of 0.8in (20 mm).
- Use admixtures in accordance with ASTM C 1141.
- Accelerating admixture should not contain water-soluble chlorides or materials corrosive to steel. The accelerator shall not contain Alkali, unless otherwise accepted in writing by the Engineer. Setting accelerators shall be a certified product supplied by an approved Supplier.

A trial shotcrete design shall be batched, applied and tested at an earliest possible time for the Engineer's agreement of the mixes and methods to be used.

b) Reinforcement

The following types of reinforcement of shotcrete may be used:

Steel Fibers

Fibre-reinforced shotcrete conforming to ASTM C 1116, Type I. Steel fibres conforming to ASTM A 820 with minimum fibre length of 0.7in (18 mm)and aspect ratio >40.

Wire Fabric

Welded wire fabric conforming as described above.

Lattice Girders

Lattice girders shall be prefabricated. The girders including invert struts, shall be of triangular form, 6 x 6 x 6 in, with main bar diameter of 0.9in (22 mm). The steel bar quality shall be as defined above.

The design of the girders shall be approved by the Engineer prior to production.

c) Shotcrete

Compressive Strength

Required compressive strength (f'c in accordance with ACI 318, Chapter 5) for laboratory-cured shotcrete is:
1450psi (10 MPa) at 24 hours (1 day)
2900psi (20 MPa) at 7 days
4350psi (30 MPa) at 28 days

For shotcrete cured in-situ (cores taken from rock surface) until testing time, required compressive strength (f'c in accordance with ACI 318, Chapter 5) is 3625psi (25 MPa) after 28 days.

Bond Strength

No specific bond strength is specified, but shall be as good as possibly achievable. No drummy shotcrete will be accepted.

Flexural Toughness

Requirements for average/minimum flexural toughness for fibre-reinforced shotcrete are 3.0/2.5 for index (I5) and 6.0/5.0 for index (I10).

(3) Execution

a) Shotcreting

Crew shall be instructed, supervised and trained before commencement of Work to obtain shotcrete quality in accordance with specifications and standards.

Only wet mixture shotcrete process may be used.

Maximum thickness of first layer shall be 2.4in (60 mm). Maximum thicknesses of second and subsequent layers shall be 4in (100 mm) each. Subsequent layers shall not be applied until previous layer has cured for minimum 2 hours.

Distance between nozzle and surface of application shall be in range of 3.28ft to 6.6ft (1.0 to 2.0 m). The nozzle position shall be at right angles to surface of application. Crevices shall be filled first.

All surfaces to be shotcreted shall be thoroughly scaled and then cleaned by water flushing and if required by sand blasting until they are free of dust, all traces of dirt, oil, grease, rebound material or other harmful matter. The surfaces shall be kept moist, but not wet, until the shotcrete is applied. If water occurs on surfaces to be shotcreted, the Engineer will decide whether shotcreting shall take place or the leakage is to be grouted or drained.

When a specified thickness is ordered by the Engineer, the sprayed mean thickness shall be at least the specified thickness and the sprayed minimum thickness on protruding rock shall be at least 50 % of the specified thickness. In addition the roughness of the contour shall be smoothened to a maximum angle of 1:12 looking

downstream and 1:4 looking upstream with smooth transitions.

The shotcrete shall be kept moist for at least 7 days by continuous sprinkling or by any covering kept continuous wet. On final surfaces curing membranes shall be used if the curing conditions are deemed unsatisfactory by the Engineer. Any curing compound shall comply with ASTM C309. Twice the normal application rate recommended by the manufacturer shall be used.

Rapid drying at the end of the curing period is to be avoided. Natural curing may be authorised by the Engineer if the atmospheric conditions surrounding the shotcrete are satisfactory, i.e. sufficient high relative humidity. All rebound shotcrete and all overspray shall be removed.

b) Reinforcement

Steel Fibers

- Steel fibre shall be added to shotcrete according to pre-construction test results and, if necessary, changed accordingly to test results achieved during construction.
- Steel fibre-reinforced shotcrete shall not be used in combination with wire reinforcement.
- Steel fibres shall be stored in dry environment. Corroded steel fibres shall not be used.

Welded Wire Mesh

- Before mounting welded wire fabric, first layer of shotcrete shall be applied to even surface.
- Welded wire fabric shall be installed so that it follows irregularities of surface as near as possible and with one pitch overlap.
- Additional bolts shall be used for fixation of welded wire fabric. At least one fixing point per 3yards2 (2.5 m2) shall be used. For two layers of welded wire fabric reinforcement, each layer shall be fixed to each bolt.
- If more than one layer of welded wire fabric is used, minimum one layer of shotcrete is required in-between.
- Chain link mesh is not acceptable as shotcrete reinforcement.
- Welded wire fabric shall be covered by a 6in (50 mm) shotcrete layer as a minimum.

Lattice Girders

The girders shall be installed in proper ascendance with given profile lines, but as close to the actual rock surface as possible. Prior to installation, the rock surface shall as a minimum be supported by 2.4in (60 mm) thick fiber reinforced shotcrete. The girders shall be fixed to the rock by rock bolts. The sections of girders shall be jointed by proper bolted joints. Shotcrete shall be used to ensure a good and evenly distributed load transfer. Blocking and wedging will not be permitted. Where specially yielding rock support are required, deformable steel tubes or similar may be requested to connect girder joints.

(4) Testing

Testing shall be performed at intervals as defined by the referred standards or as determined by the Engineer.

(5) Pre-Construction Testing

a) General

Different mixtures shall be tested by alternating proportions of cement, water, aggregates and admixtures. All pre-construction test results shall be evaluated in completeness before commencing shotcrete application for permanent rock support. Pre-construction test report is to be prepared with accurate description of final mixture design with admixtures, slump and fibre content.

Compressive Strength

Compressive strength tests shall be performed in accordance with ASTM C 39 and as follows:

- Prepare 6 test panels for each mixture design. Shoot by production equipment, onto vertical panels of minimum size 2.5ft x 2.5ft x 0.3ft (0.75 m x 0.75 m x 0.10 m) boxes made of material stiff enough to ensure adequate results from shotcreting equipment and attached to appropriately aligned surfaces.
- Wait 6 hours before removing panels for transportation to laboratory. During these 6 hours, protect panels from sun and keep them wet.
- Apply curing conditions in laboratory in accordance with ASTM C 511, storing in moist cabinet or moist room.
- Drill and prepare 9 cores of 2 to 4 in (50 to 100 mm) diameter and about 4in (100 mm) long from each panel, in accordance with ASTM C 42.
- Test one group of 3 cores from each panel at 24 hours, one group at 7 days and one group at 28 days.
- Test and evaluate an equal number of molded cylinders for similar shotcrete mixtures without accelerator.
- Follow procedure for mixture selection and evaluation as described in ACI 318, Chapter 5.3.
- Test of each mixture design shall consist of total of at least 54 individual tests, divided into 3 groups. Limitations on results are as follows:
    - Do not permit more than 10 percent of all individual test results to fall below required strength. Failures shall be evenly distributed between different groups and panels.
    - Do not permit more than 1 percent of average of test results from groups of 3 consecutive tests to fall below required strength.
    - Do not permit more than 1 percent of all random individual tests to have results lower than 85 percent of required strength.

Flexural Toughness

Flexural toughness of fibre-reinforced shotcrete shall be tested in accordance with ASTM C 1018 and as follows:.

- Test different quantities of fibres such as 3.1, 3.7,4.3, 4.9 lbs/ft3 (50, 60, 70, 80 kg/m3).
- Each test shall consist of 6 beam specimens. Prepare beams in accordance with ASTM C 1018 under curing conditions in accordance with ASTM C 511.
- Continue test procedure and record load and deflection until failure occurs in specimen.

Slump

Two slump tests for each shotcrete mixture design shall be performed in accordance with ASTM C 143.

(6) Testing During Construction

Compressive Strength

Perform compressive strength tests in accordance with ASTM C 39 and as follows:

- Test compressive strength for each 100 Y3.
- After application of 1000 Y3 of shotcrete with satisfactory test results, test frequency may be reduced to each 300 Y3.
- Drill 16 cores of diameter 2 to 4in (50 to 100 mm), 4 from each of two different locations in tunnel roof and 4 from each of two different locations in tunnel wall, shortly before testing takes place. Test all cores 28 days after shotcreting.
- As alternative to cores drilled in wall or roof (or when required layer is less than 50 mm thick), two vertical test panels may be shotcreted by production equipment and sampled during ordinary production. Use as panels boxes made of material stiff enough to ensure adequate results from shotcreting equipment and measuring minimum 1.6 x 1.6 x 0.3ft (500 mm x 500 mm x 100 mm). Keep panels wet and wait for 6 hours before transporting to laboratory.
    - Drill and prepare 4 cores with diameter of 2 to 4in (50 to 100 mm) and length of about 4 in (100 mm) from each panel in accordance with ASTM C 42.
    - Test two cores from each panel at 24 hours. When not feasible at 24 hours, test at 7 days. Test remaining two cores at 28 days.
- Evaluate test results in accordance with ACI 318, Chapter 5.6 (28 day results only).

Bond Strength

Bond shall be checked at random by knocking on the shotcrete with a crowbar or a hammer. A dull response indicates areas of no bond. The control shall be documented by a written report and carried out at a frequency of at least one test per 5 Y2. Areas of dull response

shall be clearly marked and the Engineer shall make an assessment of additional support required. The checking shall be carried out covering the total area of shotcrete.

Slump

Each shotcreting crew shall check slump for compliance with approved mixture when starting shift. Target slump has been established at preconstruction stage and tolerances are plus or minus 40 mm. In accordance with ACI 301-89, item 3.5, tolerance of up to 1in (25 mm) above maximum indicated shall be allowed for one batch in any five consecutive batches tested. Shotcrete of lower than usual slump may be used provided it is properly applied.

Flexural Toughness

Flexural toughness of fibre-reinforced shotcrete shall be measured for each 1000 Y3 of applied fibre-reinforced shotcrete. Each test shall consist of 3 beam specimens in accordance with ASTM C 1018.

Fibre Content

Fibre content shall be tested as follows:

Test actual fibre content “prior to spraying” of fibre-reinforced shotcrete by washing out and weighing steel fibres from the container of fresh shotcrete.

Test actual fibre content “as sprayed” by scraping of 22 lbs (10 kg) freshly sprayed concrete before the shotcrete has gained to much strength.

Perform 3 tests for each 250 Y3 of fibre-reinforced shotcrete applied. The steel fibres should be extracted by a magnet and the weight recorded. The fibre percentage should be recorded and compared with the percentage given in the mix specification.

Thickness

Measure shotcrete thickness systematically, every 6.5 x 6.5ft (2 m x 2 m), during shotcrete work. Measure thickness by suitable methods such as using different kinds of bolts (either dummy or active), T-bars, drilling or manual penetration in fresh shotcrete.

Perform spot checks with frequency of one location every 1000 Y2. Each location shall consist of four measurements; one in each corner of 3.28ft x 3.28ft (1 m x 1 m) square of areas with specified shotcrete thickness greater than or equal to 2in (50 mm).

Thickness shall be ensured during application. The requirements for results are as follows:
Minimum 85 percent of systematic measurements are required to have thickness equal to or greater than specified.

Shotcrete thickness at protruding rock edges, may be reduced locally

to half specified thickness. Exceptionally, at very limited edges, shotcrete thickness of minimum 30 mm can be accepted. For specified thickness of 2in (50 mm), local minimum thickness at protruding edges shall be 30 mm.

If average shotcrete thickness of four measurements in one location for spot checking is less than specified, result shall be reported to the Engineer for evaluation and further actions as necessary.

Surfaces covered with 1.2in (30 mm) shotcrete for sealing purpose shall only be inspected for complete coverage visually.

a) Rebound

Rebound shall be kept to a minimum, continuously monitored and, at the request of the Engineer, its type and quantity shall be ascertained. It shall be entirely removed and under no circumstances may it be sprayed over or used again as spray material.

b) Drain Holes

Where drain holes have been drilled and instruments have been installed into rock on which shotcrete is to be placed, the Contractor shall take all necessary precautions to prevent such holes from being plugged or instruments from being damaged.

c) Construction Joints

Construction joints or stop joints shall be provided as approved or required by the Engineer and shall be sloped at 45 degrees to the adjacent shotcrete surface in a clean, regular edge. Before placing the adjoining work, the sloped portion and adjacent shotcrete shall be prepared as specified herein.

d) Layers of Shotcrete

Before a subsequent layer of shotcrete is placed, the preceeding layer shall be checked for hollowness, to the satisfaction of the Engineer. The Contractor shall repair all hollow, sandy, cracked or spalled areas and any other areas where, in the opinion of the Engineer, the shotcrete is faulty, by removing the shotcrete to a sound area of rock or shotcrete, carrying out surface preparation as specified herein and reshooting that area to the satisfaction of the Engineer. Such repair shall be carried out at the expense of the Contractor.

e) Surface Finish of Shotcrete

Finished shotcrete surfaces shall be such as to require no further treatment. If surface finish and roughness do not satisfy the Engineer, then a thin levelling course shall be placed on the fresh shotcrete on the instructions of the Engineer. This thin levelling

course shall be included in the unit prices for the respective shotcrete items and shall not be paid extra.

Whether or not a smooth finished surface is additionally required shall be decided by the Engineer.

f) Curing

During a period depending on local conditions and to be agreed upon with the Engineer, the freshly placed shotcrete shall be protected against low temperature, running water, chemical attack and vibrations until it hardens. The fresh shotcrete shall be kept moist for at least seven (7) days. Timing of the shotcreting operation shall be such that the air temperature after shotcreting shall be above freezing-point for at least seven (7) days. If shotcreting is carried out at low temperatures, an adequate protection of placed shotcrete shall be provided.

(7) Auxiliary Works

Auxiliary works, to be included in the unit rates for shotcreting, shall include, but are not necessarily limited to, the following:

- Cost of furnishing at Site and for handling, transporting and storing of all shotcrete materials.
- Mobilisation.
- Demobilisation.
- Furnishing and relocation on Site of all equipment necessary to perform shotcreting work in accordance with these Technical Specifications.
- Preparation of surfaces for shotcreting.
- Mixing and placing of shotcrete.
- Removal of rebound material.
- Care and disposal of waste water and waste materials.
- Repairs and clean-up of the concrete linings and for furnishing all labour and supplies such as cement, water, additives and aggregates for the work, rehabilitation of drain holes/ instrument holes if plugged or damaged by shotcreting operations.
- All auxiliary works necessary to satisfactorily complete the work.
- Drilling and proper maintenance of drainholes.
- All tests for quality control and preliminary tests.
- Verification of shotcrete thickness.
- All protective measures.

(8) Measurement and Payment

a) Shotcrete Measured by Area

For shotcrete measured by area, the measurement of shotcrete shall be based on the theoretical plane area (excluding the additional area resulting from depressions and humps) correctly covered to the prescribed thickness by the Contractor and approved by the Engineer.

No additional payment will be made in cases where the average

shotcrete thickness is found to be greater than specified.

Payment shall cover all labour and materials associated with furnishing the ingredients, mixing, conveying, applying and any testing of shotcrete which is shown on the Drawings or which is instructed and approved by the Engineer.

No payment will be made for such work not shown on the Drawings or for work not instructed by the Engineer or for work required for the Contractor's convenience or for work instructed by the Engineer due to bad workmanship of the Contractor for whatever reason.

No payment will be made for shotcrete or its constituents lost due to improper working methods or rejected on account of improper mixing, or lost by leakage due to the failure of the Contractor to caulk surface leaks or for placing shotcrete outside the concrete payline as a result of careless excavation or excavation intentionally performed by the Contractor to facilitate his operations but not required for the Works.

b) Shotcrete Measured by Volume

In sections with geological overbreak the measurement shall be based on the in-situ surveyed volume of the overbreak section as approved by the Engineer.

For shotcrete measured by volume, the measurement of shotcrete shall be based on the theoretical plane volume (excluding the additional area resulting from depressions and humps) correctly filled to the prescribed paylines by the Contractor and approved by the Engineer.

Payment shall cover all labour and materials associated with furnishing the ingredients, mixing, conveying, applying and any testing of shotcrete which is shown on the Drawings or which is instructed and approved by the Engineer.

No payment will be made for such work not shown on the Drawings or for work not instructed by the Engineer or for work required for the Contractor's convenience or for work instructed by the Engineer due to bad workmanship of the Contractor for whatever reason.

No additional payment will be made in cases where the shotcrete is found to be outside the prescribed paylines shown on the Drawings.

Rebound shall not be paid.

c) Steel Fibre

Measurement of steel fibre will be based on the fibre contented specified by the Engineer (in kg/m3) and the volume calculated from the theoretical plane area correctly covered to the prescribed thickness. Additional areas resulting from depressions or humps will not be measured.

No payment shall be made for steel fibre and shall deemed to be

included in steel reinforced fibre shotcrete item.

Payment shall cover the costs of all labour, equipment and materials associated with incorporating the steel fibre in the shotcrete and of testing the product.

d) Welded Mesh

Welded wire fabric for reinforcement of plain shotcrete is measured by installed area and paid as welded mesh specified as accessories under rock bolts.

e) Lattice Girders

Lattice girders are bent to suit different tunnel arches and divided into sections to suit subdivision of cross sections. Lattice girders are measured as weight of ribs as pre-fabricated and supplied by order of the Engineer. A separate item is measured for the installation of feet of ribs used. Rock bolts and shotcrete is paid additional.

Concrete Lining

12.6 **(1) General**

The face of the formwork shall nowhere be more than 8in (200 mm) inside the theoretical rock contour unless otherwise specified by the Engineer. The Engineer may require that the rock surface shall be trimmed so that an acceptable thickness of the concrete is ensured.

Loose material shall be removed from the tunnel invert along the walls so that the concrete support footing rests on rock.
Plain concrete Class C shall normally be used for concrete rock support, but reinforcement may be called for depending on the circumstances.

Where concrete rock support at the face is required, concreting shall be carried out immediately after mucking out. For such concreting, a steel form covering the walls and the roof shall be used. Requirements for forms is as for tunnel lining, but the length of the form shall be 5 m and the form shall be adequately designed to operate at the face

(2) Execution

The tunnel is designed with continuous concrete lining to be performed behind the face. The work shall be carried out according to the provisions of Chapter on “Concrete Works”.

All surfaces of rock upon or against which concrete is to be placed shall be clean and free from oil, objectionable coatings and loose, semidetached, or unsound fragments, including loose or defective shotcrete. All loose material shall be removed from the tunnel inverts along the walls so that the footing of the lining rests on clean rock.

Forms for tunnel lining shall be constructed in such lengths that each concrete placement of walls and roof can be completed without cold

joints. At each end the concrete lined section shall be cambered (1:12) toward the tunnel contour with smooth transitions.

Concrete pads, curbs, pedestals, and similar means devised by the Contractor to support the tunnel forms will be subject to approval by the Engineer on the basis of the effects of such devices on the structural properties of the tunnel section and the finish of the lining. If the supports come to the surface of the lining, the supports will be subject to the provisions of the specifications governing construction joints.

Forms for tunnel lining shall be provided with rows of openings along each side. The bottom row shall be located with the centreline of the openings approximately 4ft above the tunnel invert. Succeeding rows shall be located on 4ft centres above the next lower row. Two rows of openings shall be placed near the crown, the openings in the rows shall be staggered. Openings shall permit access for inspection and vibration of concrete being placed behind the forms. Each row of openings shall be provided with a safe and convenient platform for access to the openings. The layout of the openings shall be approved by the Engineer.

After the concrete has been built up over the arch at the start of the placement, the end of the discharge line shall be kept well-buried in the concrete during placement of the arch and side walls to assure complete filling. The end of the discharge line shall be marked so as to indicate the depth of burial at any time, and withdrawal of the discharge line shall be in increments that will keep the discharge line buried. Cutting of the discharge line will be permitted only in situations where the line cannot be withdrawn or the line is plugged within the concrete in the arch. Special care shall be taken to force concrete into all irregularities in the rock surfaces and to completely fill the tunnel arch. Ventilation pipes or hoses, extending from outside of the form and ending in the high points of potential air pockets, shall be used to facilitate evacuation of entrapped air, as required. Placing equipment shall be operated by experienced operators. Cold joints in tunnel lining shall be avoided where practicable. If placing is interrupted by equipment breakdown or similar causes, the concrete at the joint shall be thoroughly consolidated to a reasonably uniform and stable slope while the concrete is plastic. The concrete at the surface of such cold joints shall be cleaned and dampened as required for construction joints before being covered with fresh concrete.

Curing of the tunnel lining concrete shall be by means of water spraying in such a manner that surfaces will be kept continuously wet for a 10 day curing period.

(3) Measurement and Payment

Formwork for concrete rock support at the face shall be measured by the net area of the formwork. The volume of concrete measured at the face shall be the net volume defined as formwork area multiplied by distance to theoretical contour. Filling of cavities beyond the theoretical contour shall not be included unless the excavation is

ordered by the Engineer or caused by abnormal over break.

Concrete lining behind the face shall be measured in cubic feet of lining for the specified tunnel cross section. The rate shall include concrete of specified Class and all works required except formwork. Formwork for the Tunnel Lining will be paid as per Bill of Quantities (BOQ) for the Tunnel Lining.

Cleaning of rock surfaces with high pressure water as well as drainage of water leakages are to be included in the unit prices above.

When abnormal overbreak is accepted for payment, additional concrete volume in support works and lining required to fill such volume will be measured by the m3 and paid for as concrete cast at the face or behind the face as the case may be.

Concreting of the invert will be measured as volume of concrete class applied.

Reinforcement will be measured and paid as in Concrete Works.

13 – DRILLING AND GROUTING WORK

Scope of Work

13.1 (1) The scope of work under this section comprises all operations required for the efficient and safe performance of the drilling and grouting work including survey at location of works, installation of grouting plant and pipes, drilling of holes, water testing in boreholes, mixing, pumping and injecting grout and all temporary works required for the safe access to the location of the works and their performance including scaffolding as required.

(2) The required drilling other than related to blasting and rock support include but not limited to following:

- Exploration for Geological Conditions at Intake Structure and within the Tunnel
- Grouting
- Test Samples Collections and Thickness verification
- Drainage Holes

(3) Generally the grouting shall be done at the following locations:

- Contact Grouting of Tunnel Lining
- Consolidation Grouting in Tunnel where required
- Probe Drilling and Pre-grouting in Tunnel

The volume of drilling and grouting work to be executed under the Contract in terms of spacing of holes, depths and inclination of holes, consumption of grout, duration of grout injection and definition of refusal criteria, general location within the tunnel and alignment of grouting works and the volume of respective drilling and testing has been assessed on the basis of exploratory work and geological assessment made before tendering. The actual volume of drilling and grouting works to be executed, the grout mixes, the grouting pressures and the refusal criteria will be determined and adapted by the Engineer in accordance with the conditions revealed as the execution of the Works proceeds.

Definitions

13.2 The following terms whenever used in this section of the Specification have the following meanings:

- "Contact Grouting" means low pressure grouting in shallow holes of the joints/cavities between a concrete structure and the bedrock as well as grouting of the near surface fissures and joints of the rock.

- "Consolidation Grouting" means low pressure grouting in shallow holes arranged in a pattern under the concrete lining.

- “Probe Drilling and Pre-grouting” means drilling in advancing tunnel face and grouting the rock mass before excavation.

- "Refusal" is the verified non-acceptance of grout in excess of the defined limit for a defined period at the maximum allowable pressure of that stage as measured on an accurate flow meter.

- "Drainage hole" means a hole in the bedrock drilled to a specified depth and inclination for the purpose of draining water from the bedrock to prevent build-up water pressure in the rock.

General Requirements

13.3 (1) The Contractor shall satisfy the Engineer that he is experienced in this type of work and possesses the necessary staff and equipment for the proper execution of the work.

(2) The Contractor shall arrange at all times that all drilling and grouting operations on the Site are performed under the direct supervision of foremen thoroughly experienced in this type of work and who will be guided by Engineering Geologists or Geotechnical Engineers as Works Manager of the drilling and grouting operations.

(3) The Engineer's approval in writing shall be obtained before any pressure grouting operations are performed. All constructional plant and materials required or which may be required during drilling, water pressure testing, grouting, cleaning and other attendant operations in grouting shall be on Site and fully prepared for the work. The Engineer's approval to commence drilling and grouting will only be given after all these preparations and other relevant requirements of the Specification have been complied with.

(4) The Contractor shall provide the Engineer with safe access to the grout plant and grout agitator at all times during grouting operations, and provide cooperation and assistance in the taking of grout samples for testing.

(5) Indicative markers shall also be installed at the grout locations as per the instruction of the Engineer to monitor upheaval during the grouting operation.

Submittals

13.4 (1) At least 30 days in advance of grouting operations, the Contractor shall submit to the Engineer:

- A list of the drilling and grouting equipment including water meters and flow meters together with manufacturer’s brochures of the plant and devices.
- The credentials of the suppliers of the materials to be used, product brochures and safety information on special materials that are to be used, and a list of materials that are to be provided in bulk.
- A method statement for measuring, proportioning, mixing, transporting and injecting grout.
- A drawing showing the proposed locations of the plant and the anticipated reaches the temporary materials storage, waste material storage, equipment repair facilities, site offices and full details of the access to the reaches.
- Sequences and program of grouting operations including production rates and their inter-dependencies with the progress of other construction activities.
- A quality control plan for execution including the inspection and testing schedule of material properties and construction quality.
- The safety equipment and procedures that will be used for the

drilling and grouting operations.

- The telecommunication system to be provided and used at the grouting sites.
- Trial grout mix design and laboratory test results for the final approval of the grout mix selection.

(2) During execution of the work, the Contractor shall submit on a daily basis the progress records of dates and times of each hole that is drilled to completion and the automated recording charts of the grouting plant showing the grouting parameters of each stage to completion and shall use this record to create a continually updated record of the grouting works executed.

(3) After finalisation of sections of work as defined by the Engineer which may comprise approximately one reach, the Contractor shall submit a construction report comprising:

- Reference number, location and elevation of holes having been grouted
- For each stage grouted:
  - Pressure / flow charts over the period of injection and total volume of grout injected
  - Grout mix
  - Grout routine test results
  - Results of water pressure testing
- General remarks and extraordinary events such as surface leaks, grout interconnections, and the like.
- A summary of grout intakes and water pressure test results.

(4) During execution of the work, the Contractor shall submit periodically an updated work plan and grouting sequence schedule which is adapted in accordance with the actual grouting requirements as updated and instructed by the Engineer according to the findings of the proceeding grouting operations.

Equipment

13.5 (1) Drilling Equipment

The drilling equipment shall be used for drilling of exploratory drillholes, grout holes, check holes, drainage holes etc. in rock and/or soil and concrete both above and underground.

Percussion or rotary drilling equipment shall be capable of drilling holes up to 60 ft length in any direction underground and 100ft above ground. Percussion drilling equipment shall be available from start of excavation work.

The type and capacity of all drilling equipment shall be subject to approval by the Engineer for the particular class of drilling. Bits with a minimum diameter of 1.5 in (38 mm) shall be used for drilling, however a larger diameter not less than 50mm diamond coring bit equipped with double tube core barrel shall be used for above ground exploratory holes at the intake site investigation.

The Contractor shall provide equipment for measuring accurately the

slope and azimuth of all holes and shall carry out such measurements where directed by the Engineer. Internal combustion engines shall not be used in tunnel.

(2) Equipment for Water Pressure Tests

The Contractor shall keep adequate stock of all types and dimensions of packers considered as necessary from start of tunnelling works. The packers shall be of duly tested types, designed for expansion either mechanically or by other approved means (e.g. pneumatically).

After expansion, packers shall provide an impermeable seal for pressurised water and later grouting in any position with pressure as defined for grouting equipment. Packers shall be equipped with a valve to allow sealing of the hole at the end of the grouting process.

Single packers shall be used for testing in stages during drilling. Double packers shall be used for testing after completion of drilling. Double packer separation shall be adjusted to local rock mass conditions.

Pressure gauges and pumps for water pressure tests shall conform to standard requirements or as directed by the Engineer.

For flushing holes the Contractor shall have available a high capacity water pump, air compressor and other equipment (radial flushing lead) needed for efficient flushing operation.

Equipment for Packer tests in exploratory drill holes at the intake shall include even flow pumps capable of delivering at least 300 litres/min, flow meter (calibrated in meters/min.) Bourdon pressure gauges of different ranges, single and double pneumatic packers of approved design

(3) Grouting Equipment

Grouting equipment shall be capable of effectively batching and producing a colloidal mix as specified and of delivering and pumping this grout mix into the grout circulation system. The grout circulation system shall be capable of carrying the return flow of grout which is surplus to the grout required for injection.

Automatic pressure/time and flow/time chart recorders shall be employed such that the grouting parameters at the collar of the borehole can be identified for each grouting stage and can be evaluated for each hole or group of holes of one reach.

The arrangement of the grouting equipment shall be such as to provide a continuous circulation of grout of uniform consistency throughout the grouting system and to permit accurate pressure control at all rates of grout acceptance. Pressure gauges and valves shall be supplied at the pump, at each hole being grouted, and

elsewhere as required to ensure the necessary control of grouting operations

Equipment for cement grouting shall be available and in working order at any time at the site.

Equipment for cement grouting shall include, but are not limited to:

- Grout mixer
- Grout agitator
- Grout pump

Flow meter, pressure gauges for air, water and grout supply lines, grout supply, valves, packers and fittings to supply a continuous flow of grout and an accurate pressure control

The Grout Mixer shall be a high-speed colloidal grout mixer. The mixer shall be capable of mixing grouts having water, cement ratios between 0.4 and 1.0. An accurate measurement of materials shall take place at the mixer so that mix proportions can be exactly controlled. Cement shall be given to the mixer by weight or by volume. Each component given to the mixer shall be measured to an accuracy of + 5 %.

The Grout Agitator shall be capable of keeping grout of specified water-cement ratios (between 0.4 and 1.0) in suspension. It shall be equipped with screen to remove particles not passing a 0.2in (4.75 mm) sieve. The sump shall be graduated to metric standards so that the volume of grout injected into a hole can be measured accurately. The capacity of the agitator should not be less than twice that of the mixer.

The grout pumps shall be a progressive cavity, pulse free type, capable of handling thin and viscous grouts with no pulse. The pump shall be equipped with a pressure regulating device securing a maximum grouting pressure within + 10 % of the required pressure.

Pressure gauges shall be Bourdon type or similar of heavy duty quality and shall measure pressures up to 14.5 psi (0.1 MPa) and 725psi (5 MPa) or as appropriate to the range of grouting pressure employed. Two pressure gauges shall be supplied for the grouting plant, one at the header and one at the pump. In addition a pressure recording unit shall be connected to the pressure line from the grout pump. The dial size of the pressure gauge shall not be less than 6 in (150 mm) and the minimum graduation shall not be more than 7.2psi (0.05 MPa) for gauges registering 145psi (1 MPa) maximum and 29psi (0.2 MPa) for gauges registering 5 MPa maximum. The pressure recording unit shall record the pressure within + 14.5psi (0.1 MPa). The records may be in analogue or digital form and with the possibility of pressure readings every minute. The Contractor shall supply a calibrated master gauge for each pressure range for checking the accuracy of all gauges used.

The pump and the connected agitator shall be located at a distance

of maximum 80ft (25 metres) from any hole being grouted.

Packers to be used in the drillholes during measurement of water loss or during grouting shall be able to effectively seal off the part of the drill hole below the packer. The dimension and construction of the packer shall correspond to the diameter of the drillhole, to the drilling method used to produce the hole, and to the applied pressure. Double packers as well as single are to be available.

All equipment shall at all times be clean and in proper working condition. The Contractor shall supply sufficient operating personnel, supervision, labour, spare parts and tools to operate the equipment at full capacity and top efficiency. The quantity of each type of equipment shall be sufficient to satisfy the time schedules of the combined operations so that there may be no delay in one area which might obstruct other operational areas.

The grouting plant shall be provided with satisfactory storage for adequate supplies of grouting material so that the operations may proceed without interruptions. The plant shall be provided with suitable housing for protection against rain and direct sunshine.

Drilling

13.6 All holes shall be drilled to an accuracy of ± 2° of the angle specified except as noted below. Holes shall be drilled from the positions shown on the Drawings or as directed by the Engineer with a tolerance of 250 mm.

(1) Drilling Requirement

Both percussion and rotary core drilling will be required for the ground and inside the tunnel. Holes will be required to be drilled at various angles, including vertically upwards.

No grease, oil or other material insoluble in water shall be used to lubricate drilling rods and any alternative method of lubrication proposed shall be subject to the approval of the Engineer. If the Engineer permits the use of an additive in the drilling water the Contractor shall submit a sample of the additive for the Engineer's approval not less than 30 days prior to its intended use, and the concentration of any such approved additive in the drilling water shall not exceed the manufacturer's recommendation.

All holes for grouting and drainage purposes shall be drilled with a flow of clean water, sufficient to ensure that drill grindings are completely washed out. Air flushing shall not be used except with the express permission of the Engineer which will be given only in exceptional circumstances, Mud flushing will not be permitted in these holes.

All drilled holes shall be protected from being clogged or obstructed by fitting a cap or plug or other suitable device to the top of the hole. Any hole which becomes clogged or obstructed before completion of operations shall be cleared and cleaned out properly or another hole shall be drilled adjacent to that hole at the Contractor's expense.

If any borehole cannot be completed in accordance with the Specification because it has been drilled off line or because tools are jammed in the hole or for any other reason the Engineer may instruct the work to be discontinued and the hole to be redrilled or a replacement hole shall be drilled at the Contractor's expense at a location to be designated by the Engineer.

(2) Exploratory Holes

It is envisaged that cored holes shall be required for investigating engineering geological conditions at the intake approach channel, intake foundation and tunnel or the efficacy of grouting.

Holes up to 100 feet deep and producing cores of not less than 2 in (50 mm) diameter will be required in various foundations and as confirmatory holes to test the efficacy of the grouting carried out to form consolidation grouting. The locations, directions, depth and timing of holes will be as directed by the Engineer during the execution stage.

(3) Grout Holes

The position, direction, spacing, depth, order and timing of drilling of all grout holes shall be as specified on the Drawings or as directed by the Engineer.

No core recovery will be required from grout holes except for holes which are drilled for exploratory purposes either before or after grouting. Either roto-percussion (DTH) type or rotary type drilling machines with non-coring type bits may be used for non-cored grout holes.

(4) Drain Holes

To relieve local water pressure behind concrete and sprayed concrete holes not less than 2 in (50 mm) diameter shall be drilled through the concrete and 1.6 ft (0.50 m) into the rock as ordered by the Engineer. No drainage holes shall be drilled until any grouting required in the vicinity has been carried out to the satisfaction of the Engineer.

The layout and diameter of holes for drainage shall be as shown on the Drawings, or as instructed by the Engineer.

Drainage holes through concrete and rock shall be lined with approved slotted PVC sleeves only where directed by the Engineer.

The Engineer may order that certain holes shall be drilled deeper into rock. In the case of sprayed concrete such holes may be required at any time after application of the sprayed concrete.

(5) Concrete Sampling Cores

Where instructed by the Engineer, rotary core holes for the extraction of cores 3 in (75 mm) in diameter shall be drilled at any angle into

concrete for the purposes of extracting cores for testing. The Contractor shall re fill the holes with concrete as directed by the Engineer.

Immediately after recovery, cores shall be clearly marked to show their location and wrapped in an approved type of waterproof material, placed in suitable boxes packed with sawdust and delivered immediately to the laboratory. The cost of such testing of concrete is deemed to be included in the Contractor's rates for sprayed and CIP concrete.

(6) Drilling to Check Thickness of Shotcrete and Concrete

Holes not less than 1.25in (32 mm) diameter shall be drilled through the sprayed concrete and CIP in random locations as ordered by the Engineer. The holes shall be flushed out prior to inspection by the Engineer. The Contractor shall provide access to each hole so that the Engineer can safely inspect the thickness of concrete. The holes may be left open to act as drainage holes or shall be plugged with mortar as ordered by the Engineer.

The costs of drilling such check holes in sprayed and CIP concrete is deemed to be included in the Contractor's rates for sprayed concrete and CIP Concrete.

Logging

13.7 All drill holes shall be logged. The log shall include the following as a minimum.

- Precise location, direction and depth of each hole
- Location of weakness zones, including notes on variation in penetration rate and colour of returned flushing water. Location shall be recorded if loss of flushing water occurs.
- Location, nature and quantity of any occurrence seepage.
- If water loss tests are performed, present the results graphically.

Water Pressure Testing

13.8 Water pressure testing shall be performed to determine hydraulic conductivity of surrounding rock mass and the need for consolidation grouting. Water pressure testing shall be carried out in exploratory boreholes (drillholes), grout holes and check holes as directed by the Engineer, and with pressures as specified.

Prior to testing, the boreholes shall be flushed with water if necessary in combination with air, for cleaning of the hole, and the equipment shall be calibrated to the satisfaction of the Engineer.

Water pressure tests shall be recorded in Lugeon units, and 1 Lugeon is defined as a loss of water of 1 litre per minute per metre of borehole under test at an overpressure of 10 bar. If the length of the borehole under test exceeds 5 m, the length of the borehole shall be taken as 5 m for the purpose of calculating the Lugeon value. For applied overpressures other than 10 bar the Lugeon value shall be assumed to be linearly proportional to the test pressure.

The water pressure tests shall be performed with double packers and/or simple packers as directed by the Engineer. The water pressure test shall normally start with the upper packer located at the top of the hole, and then with setting of packers at 5 m depth intervals. For each test, the water pressure shall be maintained in periods of 5 minutes with recording of water loss until 2 consecutive measurements of the loss are equal.

The water pressure applied shall be adjusted to the rock conditions in such a manner that heaving of the rock surface is prevented. As a guideline, water pressures equal to those given for grout pressures can be applied. As a general rule the pressure close to the top of the hole should at a maximum be 29psi (0.2 MPa). In tunnels the water pressure at 0.3 -3.2 ft (0.1-1 m) depth should at a maximum be 72psi (0.5 MPa). At deeper packer placing the maximum pressure will be determined by the Engineer.

In cases where the tests indicate open or partly open connecting channels between two or more boreholes, flushing with water or a combination of water and air may be required to clean out infill material prior to grouting. For such flushing the Contractor shall have available a high capacity water pump.

CORES

The cores obtained from drill-holes shall be carefully removed from the core barrel by means of a hydraulic or pneumatic core extruder and placed on plastic sheeting in core boxes. The plastic sheeting shall then be wrapped over the top of the core and sealed with adhesive tape so as to preserve its moisture.

Cores shall be placed in the boxes in the correct sequence.

Fractured material which can be reassembled to form clearly defined core shall be reassembled and packed securely. Material which does not conform to the definition of core shall be spread throughout its length and packed securely. Core losses shall be shown by wooden blocks of a square cross section of approximately the same area and of a length equal to that of the core lost; these should be inserted immediately after the core is placed in the core box.

Each core run shall be segregated by labelled wooden blocks 2.5 cm thick and the depth of the bottom of each run shall be marked on the partitions in the core box with paint.

No box shall contain more than 5 meters of core.

Before the completion of a drill-hole the cores from that hole shall be stored neatly at the drill-hole locations in such a manner that inspection of the cores can be made easily. The boxes containing the cores shall be stored under cover and protected from the weather, to the satisfaction of the Engineer’s Representative. The Contractor shall transport all boxes containing cores from the site to any

approved agency as directed by the Engineer's Representative.

Grouting

13.9 (1) Grouting Materials

Grout will generally be composed of Ordinary Portland Cement, super-plasticiser and water and may also contain admixtures such as sand, bentonite or retarders. Such materials shall be used only when ordered or approved by the Engineer. The proportions of all ingredients shall be as instructed or approved by the Engineer. Water and cement used for grouting shall comply with the requirements of the relevant specification and in addition the cement shall have a minimum specific surface of 3500 cm2/g and shall also be tested, transported and stored in accordance with the relevant specification.

On request of the Engineer, the Contractor shall provide fine cement with a minimum specific surface of 4,500 cm2/g instead of the ordinary Portland Cement.

A certificate shall be obtained by the Contractor from the manufacturer of the bentonite powder, stating from which manufacturer's consignment the material delivered to Site has been taken, and showing properties of the consignment as determined by the manufacturer. This certificate shall be made available to the Engineer on request.

The types of grout that shall be used for the Works are as follows:

a) Cement Grout

In view of the planned intended use of one single cement grout mix for all types of contact, and consolidation grouting operations, the Contractor shall produce a stable cement grout mix, with super-plasticiser admixture to increase penetrability and with the following characteristics:

W/C (Water / Cement Ratio):	0.60 to 0.80
Relative Cohesion (Cohesion / Unit Weight)	0.08 to 0.15 mm (with super-plasticiser admixture)
Marsh funnel flow time	29 to 32 s
28 days compressive strength	2100 to 3000psi (15 to 21 MPa)

The given Marsh Funnel flow time is for ASTM apparatus.

b) Mortar Grout

The mortar grout shall be composed of cement, sand and water, with

the possible additions of bentonite and/or super-plasticiser admixture. In principle, unless otherwise directed by the Engineer, mortar grout shall only be used for the contact grouting behind steel lagging in tunnel, and for cavity grouting around concrete structures.

Set accelerating admixture shall be added to the grout where necessary to reduce the setting time.

The Contractor shall design and test the required cement and mortar grout mixes, which shall be approved by the Engineer before use in the Works. The Contractor shall perform in the site laboratory tests on all type of grouts to be used in the Works as directed by the Engineer.

Prior to any grouting operation with a new mix instructed by the Engineer, a laboratory testing program on each grout mix shall be carried out for determination of the following parameters for the approval of the mix by the Engineer:

- Specific gravity,
- Bleed,
- Marsh viscosity (Marsh funnel flow time)
- Strength,
- Initial, thixotropic and final set time

At each grout plant, the following routine tests on approved grout mixes shall be carried out:

- for each mix:
    - Marsh viscosity
- for one out of twenty mixes:
    - Specific gravity
    - Bleed
    - Initial set time
    - Temperature of grout

The test frequencies given above for one out of twenty mixes might be relaxed by the Engineer, if in his opinion the laboratory test results demonstrate that the grout is accurately mixed and provided in sufficiently constant quality.

Grout that cannot be injected within one hour after mixing and that does not contain a retarder shall not be used and shall be disposed of in a manner to be approved by the Engineer.

(2) Cement Grouting Execution

Grouting will be done according to procedures and criteria approved by the Engineer.

Check holes will be drilled between grouted holes when the grout agents have set, and the grouting will continue in a split spacing system until control holes demonstrate that the required permeability is reached.

The procedure for cement grouting starts with drilling of grout holes. During drilling, measurements of water loss shall take place at specified intervals by placing a packer at a certain distance above the bottom of the hole. Before placing the packer the hole shall be completely washed free of all loose particles or accumulations of fines by directing a water jet, or a jet comprising water and compressed air, against the bottom of the hole. allowing free flow to the surface. The flushing shall last for at least 3 minutes or until the returning water is clean. If the water pressure testing reveals washing of gouge material into neighbouring holes, a more comprehensive flushing has to be done.

Grouting is to be performed in all holes where the water losses exceed the requirements defined by the Engineer.

Normally cement grouting is to be performed with a cement suspension consisting of cement, water and admixtures as specified. For mortar grouting, the required bentonite proportion is 2 % of the cement by weight. The detailed procedure will be defined during the construction phase according to the local rock mass conditions. Depending on the rock mass conditions, other grouting principles might be used, i.e. the GIN method.

If grout is pressed from one hole into neighbouring holes, all holes shall be grouted simultaneously according to the above described procedure.

The Contractor shall be able to hook-up to such holes for simultaneous grouting of up to 5 holes. After grouting, all holes shall be filled up with quick setting grout with w/c < 0.45.

The grouting sequence shall start with the leanest grout mix at each packer setting. If the grout take exceeds 100 kg cement without increasing grout pressure, a richer grout mix or other grout types shall follow. The grouting of one stage shall not be approved as completed till it has been set under given pressure for at least 10 minutes.

If grout is found to by-pass to rock surface during grouting, such leaks shall be plugged or caulked. Plugging materials and spill of grout shall be removed as required by the Engineer.

Grout holes shall be flushed to the bottom of the hole with clean water before commencing water pressure testing, or before commencing injection if no water pressure test has been performed. Flushing shall continue until clean water emerges at the top of the hole.

If any grout hole becomes blocked and cannot be flushed out, it shall be reamed out or redrilled and subjected to a permeability test before grouting continues. If such action cannot be carried out or is not successful, a new hole shall be drilled alongside the blocked hole.

If during the grouting of any hole grout is found to flow from points in the rock surfaces, such leaks shall be immediately and effectively

plugged or caulked by the Contractor. As a safeguard against rock or concrete displacement, or while grout leaks are being caulked, the Engineer may require the reduction of the pumping pressure or the discontinuation of pumping

(3) Contact Grouting of Concrete Lining

Contact grouting shall be carried out in tunnel to fill any voids between the concrete lining and the surrounding ground.

Contact grouting shall be done not less than 28 days after the concrete linings or surrounds have been completed.

For grouting of the contact of tunnel liner and surrounding ground the holes shall be drilled through the concrete lining or surround and 1ft into the rock at approximately 10ft centres along the crown and at half height of tunnel and elsewhere as directed by the Engineer.

The pressure to be used for grouting shall be directed by the Engineer considering the local site conditions.

Upon completion of the grouting at any hole all concrete, steel or foundation surfaces over which grout has flowed shall be cleaned and restored to their original condition.

The cost of contact grouting is deemed to be included in the Contractor's rates for tunnel concrete lining.

(4) Consolidation Grouting for Tunnel

Grouting to strengthen fissured rock and to decrease the permeability of the ground shall be carried out in tunnel and other places where shown on the Drawings or as directed by the Engineer.

The work shall be carried out by grouting through holes drilled through the finished concrete lining after completion of contact grouting into the surrounding rock. The lengths of holes and grouting pressures to be used shall be as shown on the Drawings or as directed by the Engineer.

Packers shall be located 1.5 ft into the rock in all holes for consolidation grouting to prevent high pressure grout penetrating into the previously grouted concrete-ground contact.

Pre-excavation consolidation grouting may be required in zones of high seepages and shear/fault zones. The zones requiring pre-grouting shall be identified during the excavation and be treated as directed by the Engineer.

Measurement and Payment

13.10 (1) Measurement for payment of short drain holes of 3 feet at the isolated locations shall be based on the “number of holes” of correctly, drilled, installed and approved. Payment shall include the costs of all labour, equipment and materials associated with supply, and installation as per the specifications.

(2) Measurement for payment for set up ready to start drilling at grout and exploratory holes shall be made once for each hole and payment shall be made as the "Number", as provided in the Schedule. Measurement for payment for set up ready to start drilling shall be made again if the Engineer instructs additional drilling after the drilling had been agreed to be completed and the rig had been moved away.

(3) Measurement for payment for set up ready to start drilling at grout holes and exploratory holes shall include the cost of transfer between boreholes irrespective of the transfer distance.

(4) Measurement for payment for drilling shall be made by the “linear foot” of depth along the axis of the hole for drilling in in-situ rock. Payment will be made at the unit rate “per foot” as entered in the schedule for drilling within defined depth zones. For measurement and payment purposes, drilling through concrete shall be considered as drilling through in-situ rock.

(5) Measurement for payment for set up ready to start water pressure testing shall be made once for each test and payment shall be made as the "Number", as provided in the Schedule.

(6) Measurement for payment for water pressure tests shall be made by the number of tests performed and approved by the Engineer as the “Number” as entered in the schedule for the defined depth zone, the test is executed.

(7) Measurement for payment for setting of packers is made once for each stage to be grouted irrespective of the number of stages in a hole, the length of a stage or the number of times the operation is carried out in each stage. Payment will be made as the “number” as entered in the schedule for the defined depth zone, the packer is set.

(8) Measurement for payment for grouting materials (cement etc.) shall be made by the dry weight of the materials (excluding water) injected into the boreholes and by the weight of the liquid of other admixtures.

(9) No payment shall be made for grout materials lost as a result of improper anchorage of grout pipes or connections, rejected by the Engineer due to improper mixing, grout lost by leakages or surplus grout mixed but not injected due to refusal or expired storage time.

14 – STEEL SHEET PILING

Scope of Work

14.1 The work to be done under "Steel Sheet Piling", consists of furnishing, handling, transporting, cutting and driving steel sheet piles for the Works as shown on the Drawings or directed by the Engineer in accordance with these specifications. The piles shall be removed and stocked at the place as specified by the Engineer.

Materials

14.2

14.2.1 Sheet Pile Section

i. Steel sheet pile sections and connecting accessories shall be of the type as shown on drawings or their equivalent section as approved by the Engineer. Where pile sections other than those shown on the Drawings are approved for use, the Contractor shall be responsible for producing revised layout Drawings for approval of the Engineer. Piles shall be straight and neither twisted about the longitudinal axis nor having the transverse section distorted to an extent that prevents piles interlocking or cause hindrance in pile driving.
ii. Steel sheet piles shall be capable of being interlocked, one with another, to form a continuous wall or diaphragm. Where more than one shape of section is provided, transition and connecting sheet piles shall be provided to ensure continuity.

14.2.2 Caulking Material

Bituminous material for sealing steel sheet piling interlocks shall be furnished by the Contractor and shall be equivalent of the "Noah's Pitch" as manufactured by the Philip Carey Manufacturing Company, 25th Warren Avenue, Chicago, Illionois, U.S.A. or an approved equivalent non-setting cold applied bituminous material of such consistency that it does not run or flow and yet can be easily applied into the interlocks.

Workmanship

14.3 Bituminous material for sealing steel sheet piling interlocks shall be furnished by the Contractor and shall be equivalent of the "Noah's Pitch" as manufactured by the Philip Carey Manufacturing Company, 25th Warren Avenue, Chicago, Illinois, U.S.A. or an approved equivalent non-setting cold applied bituminous material of such consistency that it does not run or flow and yet can be easily applied into the interlocks.

14.3.1 Storage and Handling

i. Before taking delivery of steel sheet piles, the Contractor shall submit to the Engineer for approval detailed proposals for storing, handling and transporting the piles. If required by the Engineer, the Contractor shall either modify the details or submit new proposals.
ii. Steel sheet piles which are of different types, cross-section, weight or length shall be stored in separate

stacks. Piles shall be supported clear of the ground on suitable bearers and bearers shall be placed where necessary between piles in the stack. Piles may be stacked either on top of each other, with the longitudinal axes parallel so that the piles rest together, or with a number of piles side by side in layers, with the longitudinal axes of the piles in alternate layers placed orthogonal. The number of layers of piles resting on a pile shall be suitably limited. It shall be possible to lift piles freely from the stack without gripping the piles remaining in the stack.

iii. Piles shall be lifted using only lifting holes and standard shackles or slinging attachments provided or recommended by the manufacturer of the piles.

iv. Piles shall be transported on suitable vehicles or trailers and shall be adequately supported and properly secured so that the piles are not distorted or damaged in transit.

14.3.2 Coating of Interlocks Prior; to drive the interlocks of piles shall receive two coats of NOAH's Pitch or equivalent material approved by the Engineer.

14.3.3 Driving of Sheet Piles

i. The Contractor shall drive sheet piles to the lines, levels and dimensions shown on the Drawings. Finished piles shall not depart from their correct positions by more than the following limits, where:

- 'The line of the piles' at any level means the line through the points of intersection of the axes of the piles and the horizontal plane at that level;
- 'The plane of the piles' means the plane containing the axes of the piles; and
- 'True' means in accordance with the Drawings.

ii. The line of the piles shall not vary from the true line by more than 2 inches in plan.

iii. The inclination of the plane of the piles shall not vary from the true inclination by more than 1 in 100. The inclination of any pile axis in that plane shall not vary from the line of greatest slope in that plane by more than 1 in 200.

iv. The finished level of the top of any pile shall not vary from the true level by more than 1 inch.

v. The finished level of the bottom of any pile shall not vary from the true level by more than 1 % of the specified length of the pile. Piles shall be prevented from being driven below the true level during the driving of

neighbouring piles.

vi. Adjacent piles may be rotated relative to each other about their clutches by not more than 4½ degrees in the case of Framingham sections, and not more than the amount recommended by their manufacturers in the case of other types of piles. The rotation shall be only for the purposes of accommodating horizontal curves and minor changes in alignment or, when piling with Framingham section piles, for increasing or decreasing the number of piles in a length of sheet pile wall as necessary to suit the required arrangements.

14.3.4 Extended Piles

Unless otherwise directed by the Engineer, where a pile is driven below the required level, or where cutting has shortened the length of a pile, so that subsequently the pile cannot comply with the specified requirements as regards levels, the Contractor shall extend the pile by splicing to it a supplementary length as specified herein and shall drive the extended pile so that the top and bottom are at the required levels. Subject to the approval of the Engineer, the Contractor may cut off the top of a pile to conform to the required level.

14.3.5 Construction Plant and Methods

i. The Contractor shall choose suitable appropriate equipment and Temporary Works for sheet piling. Pile-driving and extracting equipment may be of either percussive or vibratory type, provided that the Contractor demonstrates to the satisfaction of the Engineer, that the methods and equipment proposed, do not result in ground resonance which might adversely affect neighboring existing structures or work under construction. The equipment shall be sufficiently robust, heavy and powerful to drive and extract the piles as specified without damaging them, and the size and type of equipment shall be changed as necessary when driving a pile. Suitable driving caps, helmets, dollies and anvil blocks shall be provided which shall be of the correct size to suit the section of the pile to be driven and to avoid distorting or damaging the pile. Should distortion or damage occur, the defective portion of pile should be cut off. Pile grips shall hold the pile tightly. The direction of the driving forces produced by pile driving and extracting equipment shall be parallel to the longitudinal axis of the pile. Except where a suitable cradle is provided for mounting the pile driving equipment on the side of a pile, pile driving and extracting equipment shall normally be placed centrally upon a pile or piles. Suitable leg-guides, piling frames or guide frames of adequate rigidity and stability to hold piles firmly in place during driving shall be provided. The

vertical spacing between guides to accommodate the pile shall be as small as possible and shall, in any case, not exceed by more than 1/2 inch the overall thickness of the pile.

ii. At all times during driving, piles shall be firmly held within the guides by suitable packing pieces, which shall not be wedges. Framingham-section piles shall be provided with packing pieces for each pile. Suitable arrangements shall be made to accommodate bends, curves, relative rotation in adjacent piles, and special piles, as required.

iii. Unless otherwise approved by the Engineer, standard piles shall be driven in pairs and guided in panels comprising a limited number (not exceeding 20) of pairs of piles. The pair of piles at each end of a panel shall be partially driven to an adequate depth so that additional guidance during the driving is provided for the intermediate pairs of piles in the panel, which shall be pitched and held in place ready for driving. The intermediate pairs of piles shall be driven subsequently in turn in such a manner that the penetration of the bottom of an intermediate pair beyond that of an adjacent intermediate pair is suitably limited to ensure that adequate support and guidance is at all times provided by the adjacent pair. The panel shall be driven in stages, the number and dimensions of the stages being related to the lengths and sections of the piles driven, and in such a way that the guides remain in position as long as possible, being removed in turn at the end of each stage as necessary to allow the pile-driving equipment to drive the subsequent stage. At the end of a panel, the partially driven pairs may remain in the partially driven position to provide guidance during subsequent driving of the adjacent panel and may be used for the support of the guides for the adjacent panel. Deviation from verticality shall not be corrected by means of props or tensioned ties other than the approved supports and guides.

iv. Pile driving shall not be assisted by jets of water or air directed into the ground except with the approval of the Engineer.

v. Until the driving of a pile is completed, the Contractor shall not excavate below the existing ground surface adjacent to the pile unless such excavation is either approved or ordered by the Engineer.

vi. If there is any defect in the horizontal or vertical alignment of the piling, or if a break through any cause whatsoever occurs or is suspected to have occurred in the continuity of the piling, the Contractor shall withdraw such pile or piles as may be necessary to remedy the defect or suspected defect. If any distortion, creep or

fanning occurs in the line of the piles, the Contractor shall take steps to rectify the defect and shall where necessary supply and drive suitable tapered piles to the satisfaction of the Engineer.

14.3.6 Piles in Trench

The Contractor may, with the approval of the Engineer, excavate a trench in which the steel sheet piling is subsequently pitched and driven. If such a trench is allowed to be excavated, the void between the piles and undisturbed ground shall be backfilled with reinforced cement concrete (1:2:4) immediately after driving of the piles is completed. Steel reinforcement to be provided shall meet the minimum steel reinforcement requirements set forth in the ACI Code 318-02 and modifications or as directed by the Engineer.

14.3.7 Cutting Piles

Steel sheet piles shall be cut either by using suitable flame cutting equipment or by sawing, mechanically or by hand, without flames or sparks, as directed or approved by the Engineer. Off-cuts shall be either disposed of from the Site or, if required and suitable for use in the Permanent Works, stored at Site at locations designated by the Engineer.

14.3.8 Holes in Piles

i. Steel sheet piles in the Permanent Works shall be free from holes other than the holes specified on the Drawings or small holes less than ¾ inch diameter and not more than 8 inches from the top of the piles to assist in pitching the piles prior to driving. No other holes will be permitted without the prior approval of the Engineer. Where such approval is given, the holes shall subsequently be patched with steel plate of equal thickness to the material removed. As directed by the Engineer, either a single patch welded continuously on both sides or two patches applied one on each side of the pile and continuously welded shall be used.

ii. Holes may be drilled or flame cut, but the size of the hole as formed measured in any direction shall not exceed by more than 20% the diameter of the required circular hole. All holes for bolts, tie rods and drains shall be drilled or flame cut after the sheet pile has been driven.

14.3.9 Welding of Piles

i. All welding of piles shall conform to the requirements of BS 5135 or approved equivalent and splicing of piles shall be by full strength butt welds. Welded joints in adjacent spliced piles shall be staggered by not less than 2 feet. Details of the proposed weld procedures shall be submitted to the Engineer for approval. All slag shall be

removed and any sharp projections shall be ground smooth.

ii. All welders shall pass qualification tests relevant to the weld procedures in use in accordance with BS 4871 or approved equivalent. Welders shall produce satisfactory evidence of having been engaged in welding for at least 9 months in the preceding 12-month period. If the work of any welders employed on the Contract is unsatisfactory, the Contractor shall carry out such further welder qualification tests as are necessary to demonstrate that the welders are proficient.

iii. Welds shall subject to non-destructive testing by processes which may include but shall not necessarily be limited to radiographic, ultrasonic, magnetic particle, or dye penetration methods, depending on the type of weld and its position in the structure.

iv. If any work shows defects or fails to comply with the requirements of these Specifications for any reason, it shall be repaired or rejected, even though it may have been carried out by qualified welders using approved procedures.

14.3.10 Water Tightness of Piling

Steel sheet piling against which concrete is to be cast shall be clean and watertight. All such steel sheet piling shall be free from loose rust, loose mill-scale, oil, grease and earth or any other substance which, in the opinion of the Engineer, is likely to prevent bonding between the concrete and the piles.

14.3.11 Protection of Piling

The surface of steel piles and permanent wallings which will not, on completion of the Works, be buried in the ground or in concrete, shall, after being exposed, be blast cleaned and painted with black bituminous paint applied in two coats: the first applied within 2 hours of blast cleaning and the second within 24 hours of application of the first coat.

14.3.12 Piling Records

The Contractor shall maintain a full record of all steel sheet piling works. This record shall include the following:

i. Identification number for each pile;
ii. Pile section;
iii. Pile size;
iv. Description of special piles;
v. Original length;
vi. Supplementary length;
vii. Final length;
viii. Levels of any obstructions met in piling;

ix. Levels at which any substantial change in rate of penetration occurred;
x. Number of blows, or time, to penetrate 4 inches at 5 feet intervals in the final 15 feet of driving;
xi. Type, size and rated energy of pile-driving plant;
xii. Stage driven by each type of plant.

A copy of the records of each day's piling shall be submitted to the Engineer before the next day's piling begins or within 24 hours of the end of the day's piling whichever shall be sooner.

Measurement And Payment

14.4 a) Measurement

Measurement for payment of specified steel sheet piling shall be measured by weight in tonne actually placed irrespective of driven depth as per drawings or as directed by the Engineer.

b) Payment

Payment will be made for the quantity measured as above at the unit price per tonne quoted in the Bill of Quantities for the respective Item "Steel Sheet Piling", which shall constitute full compensation for furnishing steel sheet piling at site including all materials, labour, equipment, tools, bolts, guides, bracings for the completion of the work specified herein and elsewhere in these Specifications and on the drawings and all other work related to this Item, including disposal of all scrap and damaged piles or stock piling of off-cut pile at locations designated by the Engineer for use in the works.

No additional payment shall be made for temporary support works, surplus piles not driven, pulling out of sheet piles and stacking etc or the use of any specialized equipment.

15 – BORED AND CAST-IN-SITU RC PILES

General

15.1 The scope of work, general requirements and submittals to be made by the Contractor shall be as follows:

Scope of Work

15.2 All works to be performed under these Specifications shall be carried out at the proposed locations shown on the Drawings and shall include but not be limited to the following:

a) Construction of bored & cast in-situ RC test piles for pile load tests (Test Pile).

b) Performance of load tests on piles.

c) Construction of bored & cast in-situ RC piles for various structures under this contract (working piles).

d) Performance of proof load tests on the working piles selected by the Engineer.

e) Keeping complete record of all the operations performed during boring, construction and load testing of the piles stated above.

General Requirements

15.3 The general requirements for RC piles shall be as follows:

a) Type, Diameter and Length of Piles:

i- Bored cast & in-situ reinforced concrete (RC) piles shall be constructed as shown on the Drawings.

ii- Piles diameter and length shall be as shown on the Drawings.

iii- The Engineer may direct the positions, the number, diameter and length of piles to be changed at his discretion and according to design requirements during the progress of the work(s).

b) Tolerances in Location and Plumbness:

i- Each pile shall be placed with its top being within 2 inches (50.8 mm) of the correct position as shown on the Drawings.

ii- Piles shall be cast as accurately as possible vertical. The maximum allowable deviation from the vertical shall not exceed 0.5 degree (1:114) on any Section of the length of the pile.

iii- If tolerances (i and/or ii) are exceeded, piles shall

be replaced at the Contractor's expense.

c) Cutting of Pile Heads: The pile heads shall be cut to the levels shown on the Drawings and the cut shall be level, smooth, and horizontal. Due care shall be taken to protect the edges and reinforcement. No extra payment shall be made for this work. Pile cut off levels shall be shown on the shop drawings to be submitted by the Contractor for approval of the Engineer.

d) Order of work: The order in which construction and load testing of piles shall be carried out will be decided by the Engineer, who will have the discretion to alter the same during the course of the work.

e) Plant: The Contractor shall keep on the site sufficient plant to meet all requirements of the work. The plant shall be in satisfactory operating condition and capable of efficiently performing the work as per these Specifications.

f) Supervisory Staff: The Contractor shall have at site at all times, only qualified, experienced and thoroughly competent persons, who shall conduct and supervise drilling, pile construction and load testing operations. Since the construction of piles requires special knowledge and utmost care, the Contractor shall have at least one qualified and experienced Engineer specialized in this field of work who shall be present full time during execution. The Contractor shall remove from the site any employee who does not in the opinion of the Engineer, meet these requirements.

g) Site Conditions: The Contractor is responsible for any damage to the existing superstructures, sub-structures utility lines caused due to piling work. The contractor shall ensure that pile construction works shall not interfere with the work of the other Contractors working in the area.

   Where approval has been given to the Contractor for carrying out concreting operations at night or in places sunshine hours are limited, the Contractor shall provide adequate lighting at all points where mixing, transporting, placing of concrete is in progress.

   When concrete is to be manufactured, transported and placed in hot weather, specific precautions as required by the Engineer shall be observed and all the relevant standards applicable in this connection shall be adhered to.

h) Quality Assurance: Quality of concrete for piles shall

comply with Section, "Concrete General" and the relevant standards.

The materials, used in pile construction (cement, aggregates, steel reinforcement etc.) shall conform to the requirements of relevant Sections of technical provisions.

i) Standards and Codes of Practice: The latest edition of Internal Standards and codes such as American, British or German etc., shall be used. All materials and workmanship shall, unless otherwise specified, comply with these standards and codes.

The Contractor shall make available at the site for the use of the Engineer, one copy of each of all relevant Standards & Codes used and quoted in the documents and Drawings at his own expense. No additional cost will be made to the contractor for this.

Submittals

15.4 The Contractor shall be required to make following submittals:

(1) Method Statement: The Contractor shall submit to the Engineer before start of piling work a detailed description of the equipment, materials and procedures that will be used. The description shall include equipment specifications, loading capacities, protective devices, test apparatus, detailed installation procedures, test procedures and other documents ordered by the Engineer. Contractor's construction procedures shall be type-written and shall include charts and diagrams as applicable and necessary, to fully explain the subject procedures, methods and equipment operation in order to allow effective review by the Engineer. The method statement shall be submitted to the Engineer at least 2 weeks prior to commence the work.

(2) Survey and Location: The Contractor shall carry out a levelling survey and provide excavated ground elevations for each pile location. The elevations shall be given with respect to a permanent Bench Mark. The locations of piles shall be established by the Contractor as per shop drawings as approved by the Engineer. Establishing the pile locations accurately in the field shall be the sole responsibility of the Contractor.

(3) Protective Measures: The Contractor shall submit to the Engineer procedures for the following:

a) Both hot and cold weather concreting procedures shall be submitted to the Engineer by the Contractor regardless of the need for the immediate implementation of such procedures. Procedures shall include insulation, enclosures and the like. Finishing procedures and timing

and duration of curing shall be described.

b) Protection of concrete against damage due to mechanical contact and construction operations.

c) Proposal regarding necessary facilities for drainage of the excavated areas. It shall be the Contractor's sole responsibility to keep the site free of ponding water during rain and during boring and construction of piles.

(4) Placement Schedule: The Contractor shall submit a placement schedule for review prior to start of concrete placement operations. Daily concrete pour schedules shall be submitted 24 hours in advance of planned pours.

(5) Testing Programme: The Contractor shall submit test programme for all specified requirements along with the testing schedule.

(6) Test Reports: The contractor shall submit test reports showing the results of required tests and compliance with specified standards and codes. Test reports shall be certified by the Contractor at the testing agency approved by the Engineer.

(7) Samples: The Contractor shall submit to the Engineer for acceptance prior to purchase, fabrication or delivery samples of materials or products where required by the Engineer.

Substitute products, materials or fixtures proposed by the Contractor shall be submitted as samples to the Engineer for his approval. The samples shall be accompanied by detailed information about materials.

(8) Shop Drawings: The Contractor shall submit for Engineer's review and acceptance detailed shop drawings showing layout, arrangement, dimensions locations of piles, pile diameters and lengths, pile marks and details of construction showing reinforcement of the piles. The drawing shall also indicate the cut off level, tip elevation of each pile and all other necessary details required for completion of the construction work or required by the Engineer.

Shop drawings shall be submitted to the Engineer for his acceptance and approval in accordance with the requirements setforth in the "Special Provisions".

Products

15.5 The products and materials shall meet the following requirements.

(1) <u>General:</u> All materials used in the Works shall be subjected to inspection and testing as and when directed by the Engineer.

Should the Engineer decide not to carry out tests on a material or materials himself or under his direction, the Contractor shall, whenever required, obtain from the Manufacturer and submit to the Engineer the certificates, showing that tests of materials having been carried out in accordance with the requirements of this Specification.

Before ordering any materials proposed to be used in the execution of the Works, the Contractor shall submit to the Engineer for his written approval the name(s) and address(es) of the firm(s) from which he proposes to order the material(s).

If the Engineer is in doubt about the quality of the delivered materials, the Contractor shall demonstrate through the relevant tests that the quality of the materials fully satisfies the requirements of this Specification.

(2) Concrete: Concrete for bored & cast-in-situ piles shall be in accordance with the requirements specified in the Section-4 "Concrete, General".

In addition to meeting the strength requirements, the concrete for bored & cast in-place piles shall have adequate workability for the method of placing employed in the casting of piles and the consistency will meet the requirement as stipulated in the Section - “Concrete, General”.

The concrete shall be supplied in sufficient quantity to ensure that the concreting of each cast in-place pile proceeds without interruption.

The concrete shall be of class B described in Section-4 “Concrete, General”, (having a minimum compressive cylinder strength of 4,000 psi in accordance with the Specifications and Drawings.

(3) Concrete Aggregates: Coarse and fine aggregates used for concrete under these Specifications shall be furnished by the contractor in accordance with the provisions of and in complete conformity with the requirements of the Specification in Section-4 “Concrete Aggregates”.

(4) Reinforcing Steel: Reinforcing steel shall conform to the requirements set forth in the Section-9 "Reinforcement". All placing shall be in accordance with the Drawings furnished or as approved by the Engineer.

(5) Drilling Fluid: The drilling fluid used for all types of drilling shall be clean water, free from suspended sediments. The Contractor may be allowed to use bentonite slurry as drilling fluid with the prior approval of the Engineer.

(6) Casing of Holes: Casing of holes shall be according to the provisions given below:

a) The hole shall be cased upto the bottom.

b) The casing shall be made of cylindrical steel pipes of inside diameter equal to the pile diameter and shall have sufficient strength so as to maintain position and shape during drilling operations. Casing used during concreting should be free from internal projections and encrusted concrete which might prevent the proper formation of piles. It shall also be free from distortion and shall be of uniform cross-section throughout.

c) The casing may be omitted only where it can be shown to the satisfaction of the Engineer that lowering of reinforcement cage and concreting operations will not cause caving of the bore hole.

d) It shall be the Contractor's responsibility to pull out the casing from the holes at the time of concreting of piles. No extra payment shall be made for pulling out the casing or for leaving the same inside the hole.

Execution

15.6 The procedures for execution shall be as follows:

(1) Drilling: Drilling shall be performed as described below:

a) General:

i- Before starting the piling work, the contractor shall complete clearing, levelling and setting out of the site. Any obstacles shall be removed, as directed by the Engineer. If the presence of existing underground utilities is known or suspected, the Contractor shall carry out such diversion or protection of these as directed by the Engineer.

ii- All excavations shall be carried out as nearly as possible to the exact dimensions of the pile foundations to minimize backfilling.

iii- All surplus excavated material from excavations not required for back filling shall, if considered unsuitable by the Engineer, be disposed of as directed.

iv- All installation procedures shall be subject to the Engineer's approval. No pile boring shall take place within 48 hours of the concreting of any pile which

is within a radius of 10 feet.

v- The sequence of work shall be decided by the Engineer. The test piles shall be constructed and load-tested prior to the start of main piling. Additionally, proof load tests shall also be carried out on working piles during construction of piles. The piles for proof load tests shall be selected by the Engineer.

b) Method of Drilling: The drilling of holes for piling shall be done by straight or reverse rotary rig or any other suitable method proposed by the Contractor, subject to approval of the Engineer. Regardless of the method used for drilling holes, the following specifications shall be adhered to by the Contractor.

i- After completion of drilling operations the bore hole length shall be checked and recorded.

ii- The deviation from the vertical shall not exceed 0.5 degree (1 in 114) on any section of the length for the holes.

iii- Drilling operations shall be carried out in such a way as to avoid any disturbance of the soil especially at the bottom of the hole. (i.e., sand boiling).

c) Stabilizing the Holes: The Contractor shall ensure at all times that the hole does not collapse during and after boring. The Contractor may use bentonite slurry or any other drilling method with written approval of the Engineer. When bentonite slurry is used strict compliance with sub-section “f” herein below shall be ensured. The nominal diameter of pile is defined as the minimum cross-section of unlined portion of borehole. The possible enlargement of the pile shaft during boring, placement and compaction of the concrete, shall not be taken for measurement and for increase in the admissible load.

It may also be noted that no extra payment shall be made for using bentonite slurry or adopting alternative drilling method(s) for advancing the boreholes in satisfactory manner.

d) Removal of Mud: The excavated material from boreholes shall be disposed of by the Contractor under instructions of the Engineer at no extra cost.

e) Clean out and Control at the Bottom of the Piles: After the bore has reached its final penetration as stipulated

on the Drawings and as may be additionally ordered by the Engineer, on the basis of data obtained in the field, and after it has been completely cleaned of all earth and otherwise made ready to receive the reinforcement and thereafter the concrete, the Contractor shall so inform the Engineer. All disturbed soil and loose materials shall be pumped out in such a manner that after cleanout operation, the bottom of borehole remains horizontal and in undisturbed condition. The clean out pumping arrangement shall be such that the lower end of the pump can be moved all over the cross-section by a routine operation. The suction of the pump shall be adjustable. At the end of clean-out operations, a break shall be made for a period of at least five minutes, then pumping shall be resumed and shall continue until the bottom of hole is cleaned. The Engineer shall check the actual bore penetration achieved, the cleanliness of the boreholes and the amounts and directions, if any, by which the borehole is out of position and/or out of plumb and having satisfied himself on these and on any other points which he may consider relevant, shall sign pour slip for the borehole authorizing the Contractor to proceed with the placing of reinforcement. The Contractor shall under no circumstances proceed with the placing of reinforcement in the boreholes or with the subsequent concreting without having first obtained the written authority signed separately for each and every borehole.

f) Bentonite Slurry: Where the use of bentonite slurry is approved for the purpose of maintaining the stability of the walls and base of bore, the Contractor's proposals in accordance with clause (v) herein below shall include details of the slurry. These shall include inter-alia.

- The source of the bentonite
- The constitution of the slurry
- Specific gravity, viscosity, shear strength and pH value of slurry.
- The methods of mixing, storing, placing, removal and recirculating the slurry, and
- The provision of stand-by equipment.

i- Tests shall be carried out to ensure that the proposed constitution of the slurry is compatible with the ground water: Proposals for the constitution and physical properties of the slurry shall include average, minimum and maximum values. The specific gravity of the slurry shall not be less than one and one tenth (1.1) in any case at any time. The Contractor shall use additives where necessary to ensure the satisfactory

functioning of the slurry.

ii- A manufacturer's certificate showing the properties of the bentonite powder shall be delivered to the Engineer for each consignment delivered to site. Independent tests shall be carried out at laboratory approved by the Engineer on samples of bentonite frequently.

iii- The Contractor shall carry out tests at site during the course of the piling to check the physical properties of the bentonite slurry in the works. These tests shall include, inter-alia, density, viscosity, shear strength and pH tests. The test apparatus and test methods shall be those given in "Recommended Practice" Standard by American Petroleum Institute (API) New York City, 1957, reference API RP 29, Section-I, II and VI.

iv- The frequency of tests shall be that which the Contractor considers necessary to ensure that the bentonite slurry is in accordance with his proposals and as such other times as the Engineer may direct.

v- Should the physical properties of any bentonite slurry deviate outside the agreed limits, such slurry shall be replaced, irrespective of the number of times it has been used by new bentonite slurry of correct physical properties. Adequate time shall be allowed for proper hydration to take place consistent with the method of mixing, before using slurry in the works.

vi- The Contractor shall control the betonite slurry so that it does not cause a nuisance either on the site or adjacent waterway or other area. After use it shall be disposed of in a manner approved by the Engineer.

vii- The level of the slurry in the bentonite shall be maintained so that internal fluid pressure always exceeds the external water pressure.

viii- If chiseling is used when boring through hard strata or to overcome obstructions, the stability of the excavation shall be maintained by methods acceptable to the Engineer.

(2) <u>Concreting</u>: Concreting of piles shall be done as given herein below:

a) Placing of Steel Reinforcement: The cage of reinforcement shall be assembled on the ground and

securely tied by means of binding wire in such a manner as to form a rigid cage.. It shall be lowered in the bore hole carefully keeping the cage concentric with the bore hole. Adequate concrete spacers shall be provided around the cage to ensure the required concrete cover to be available on all sides of the cage. Concrete spacer blocks specially pre-cast for this purpose shall be securely attached to the reinforcement at a suitable spacing and each quarter point so as to ensure that the concrete cover stipulated on the drawings is maintained throughout and that the reinforcement cage is not displaced in the casing during the course of subsequent concreting operations. In addition concrete spacer blocks shall be located immediately below and immediately above the lap at 4 points spaced around the cage. Particular care shall be taken to ensure that none of the spacer blocks move out of position to the inside of the reinforcement cage due to spacer blocks or lapped reinforcement or any other reasons which might interfere with concrete placement. Depth of the hole shall be measured just before and after the lowering of cage. In case it is found that the soil has caved into the hole during the lowering of the cage, the contractor shall be required to adequately clean the hole to the satisfaction of the Engineer, before the start of concreting at his own cost.

b) Composition of Concrete: Composition of concrete shall be according to clause 4.05 of the Section-4 "Concrete, General".

c) Batching of Concrete: Batching of concrete shall be as per requirements of clause 4.06 of the Section "Concrete, General".

d) Mixing of Concrete: Mixing of concrete shall be done in accordance with clause 4.07 of the Section “Concrete General”.

e) Conveying: Concrete shall be conveyed from mixer to piles as rapidly as practicable by methods which will prevent segregation or loss of ingredients. Any wet batch hopper through which the concrete passes shall be conical in shape. There shall be no vertical drop greater than 5 feet. Belt conveyers, chutes, or other similar equipment will not be permitted for conveying concrete except where the use of such equipment is approved in writing by the Engineer, in advance of any use.

f) Placing:

i- General

Once the bore hole has reached the required depth and the reinforcement cage properly installed, and such depth has been checked and recorded concreting operations shall be carried out. Approval of the Engineer shall be obtained before starting any concrete pour. Concrete pouring will not be permitted when in the opinion of the Engineer weather conditions prevent proper placement. Unless otherwise approved concrete pouring shall be performed only in the presence of a duly authorized representative of the Engineer.

ii- Mixing-Placing Interval:

Concrete shall be placed within thirty minutes, after it has been mixed.

iii- Placing Temperature

Concrete shall be delivered to the piles at the coolest temperature which is practicable to produce under current conditions but in no case at a temperature in excess of 90°F (32°C) or lower than 41 °F (5°C).

iv- Placing Method

Pouring of concrete shall be done by an efficient tremie technique. The method and equipment used shall be subject to the prior approval of the Engineer. The tremie pipes shall have to be large enough with due regard to the size of the aggregate. For ¾ inches (19.5 mm) aggregate, the tremie pipe shall be of diameter not less than 6 inches and for larger aggregate, larger diameter tremie pipes shall be used. The hopper and tremie pipe shall have to be a closed system embedded in the placed concrete, through which water can not pass. When concrete is deposited by tremie, the tremie seal shall be effected in a manner which will not produce undue turbulence in the water around the pipe. The discharge end shall be kept submerged continuously in the concrete and the shaft kept full of concrete to a point well above the water surface. The tremie shall not be moved horizontally during a placing operation. The rate of placing concrete in the borehole shall be neither less than 30 feet (9.15 meters) per hour and nor more than 50 feet (15.24 meters) per hour.

When a casing is used, it shall be lifted upto height

less than the height of casing already filled in with concrete. The bottom of casing shall stop to an elevation of 5 feet (1.52 meters) lower than the top of the concrete. Particular care shall be taken in order to avoid earth slide inside the hole.

During the progress of pouring, the Contractor will ensure that a standby equipment is available in order to cope with plant break down if encountered.

The Contractor shall not be permitted to place concrete while it is raining. Should it rain while the concrete placement is already in progress, the Contractor shall carry on with proper and sufficient precautions, the concrete placement operation until the pile is completed and shall cover the concrete already placed and under setting condition with polythene or similar impervious sheets. No additional payment shall be made for any such emergency and protection works.

All tremie tubes shall be scrupulously cleaned after use for subsequent concreting.

Concrete in piles shall be continued upto two feet above cut off levels as shown on the Drawings and shall be broken down to cut-off levels prior to placement of pile caps. The contractor shall break back the concrete in the top portion of the piles to the final elevation which will be 3 inches above the bottom of the pile cap and at the same time exposing the length of pile reinforcement required for lapping and binding with the pile cap. The contractor shall also establish and record the actual co-ordinates of the centers of the broken-off pile tops with respect to theoretical centre line of each pile cap as shown on the Drawings and the tolerance in this respect shall not exceed 2” in any direction. No separate payment will be made for manufacturing, placing and breaking of this part of concrete.

v- Protection and Curing

As each pile cap is completed, the projected length shall be immediately and carefully protected from any condition that will damage or adversely affect the hardening of concrete. Concrete shall be cured for 28 continuous days by an approved method.

vi- Stripping and Finishing

Any cracked or defective concrete in the head of

the completed pile shall be cut away and made good with new concrete well bonded into the old. The reinforcement in the pile shall be exposed for a sufficient distance to permit it to be adequately bonded to the pile cap. This shall be done carefully to avoid shattering or otherwise damaging the rest of the piles. The reinforcement shall then be cleaned and bent to form an anchorage into the concrete of the super-structure as directed by the Engineer.

Where a temporary casing is used, the top of the pile shall be brought up sufficiently above the required finished level to allow for slumping on withdrawal of the casing and to permit all laitance and weak concrete to be removed.

Particular attention shall be paid to the compaction of the concrete in the top 3 feet (0.91 meters) or so of the pile.

vii- Damaged Piles

Should any pile be damaged or not conforming to the requirements of this Specification the Contractor shall be responsible for repairing or replacing the pile to the requirements and satisfaction of the Engineer without cost to the Employer.

Should the Engineer doubt the efficiency of any pile so repaired, he may order the Contractor to construct additional piles, at points selected by him without cost to the Employer. The Engineer may direct the Contractor to proof load test the doubtful pile.

Any piles that are damaged or imperfect and thus rejected by the Engineer shall be removed and discarded.

When the rejected pile is withdrawn, the space shall be filled solid with gravel or broken stone without extra payment therefor.

Debris from pile cut-offs and damaged piles shall not be buried in required fill under slabs at grade or in required embankments but shall be disposed of by the Contractor off the site of the work.

Piles which, in the opinion of the Engineer, are defective in any way shall be rejected and replaced by the Contractor without any extra cost.

viii- Safety Precautions

Before commencing piling operations, reference shall be made to Pakistan statutory safety requirements. In addition, the safety precautions in British Standard CP 2004 shall be strictly followed.

The presence of the gas mains, electric cables, water mains and other services that may be damaged and cause injuries shall be investigated before work is commenced. The site shall be kept clear of dangerous obstructions.

High tension overhead power lines shall not be approached nearer than 15 feet (4.57 meters) because of the danger of sparking.

A safety supervisor shall be appointed on site, the supervisor being qualified in accordance with the statutory regulations. First-aid boxes in the charge of a responsible person shall be kept at all the locations.

Fencing shall be provided to prevent free access to the site and all open pits and boreholes shall be covered.
If lighting by electricity is provided, it is preferable that the voltage for trailing cables shall not exceed 60 V. Electrical installations shall be properly earthed. Cables shall be protected from accidental damage and kept clear of movable equipment plugs and socket connections shall be of water-proof type.

Safety helmets and safety footwear shall always be worn by all workers. Piling sites are often wet and use of rubber boots shall be essential.

All boring and concreting equipments shall be cleaned regularly.

Helmets, driving caps, etc., shall be inspected regularly for damage or fracture.

If cast in-place piles are finished below ground level, proper covers shall be provided to prevent workmen from falling into the holes.

Loading Tests on Piles

15.7 The procedure for loading test on piles shall be as given below:

a) Pile load tests shall be conducted to failure on test

piles prior to commence actual piling work. The number and location of test piles shall be given by the Engineer in the field. Test piles shall be constructed first, cured for 28 days and then load tested for load carrying capacity by the procedure specified in ASTM D 1143.

Proofload tests shall be conducted on selected working piles during and after execution of piling work of the constructed piles. The number of proofload tests, selection of proofload test pile, and magnitude of load shall be decided by the Engineer. The proofload should be a sum of DVL* + 50% SWL*.

In case of failure of a working pile it shall be considered as a damaged pile to be replaced by another pile at no extra cost to the Employer.

b) The Contractor shall be responsible for bringing all equipment and supplies to the site for satisfactory performance of the test according to ASTM D 1143, or any other method approved by the Engineer.

c) The Contractor shall submit to the Engineer an up-to-date calibration certificate from a laboratory approved by the Engineer, showing correctness of the gauge and/or load cell to be used with the hydraulic jacks.

d) The apparatus shall be calibrated as per requirements of ASTM D1143. The Contractor shall submit to the Engineer details of calibration within 7 days prior to commencing testing for his review and approval.

e) The pile head shall be cut-off or built up to the necessary elevation and shall be capped appropriately to produce a horizontal bearing surface.

f) Care shall be taken to ensure that the center of gravity of the kentledge is on the axis of the pile and that the load applied by the jack is coaxial with the pile.

g) Settlement of pile head shall be recorded using dial gauges and precise leveling in accordance with ASTM D 1143.

h) The record of pile load test shall be kept on an approved format as given in Forms-1 to 3 of Technical Provisions. The Contractor shall prepare load-time settlement curves for each such load test. Two copies of the relevant field data and the graphs shall be supplied to the Engineer within 48 hours of the completion of the test.

* DVL (Design Verification Load) and Specified Working Load (SWL) should be as per definition of Institute of Civil Engineer U.K.

Record and Reports

15.8 The following tests, records and reports shall be prepared by the Contractor at his own expense.

(1) Records: The Contractor shall keep accurate records of all the works accomplished under this contract. All such records shall be preserved in good condition and order by the Contractor until they are delivered and accepted by the Engineer. The Engineer shall have the right to examine such records at any time prior to their delivery to him.

The following information shall be included in the records for each pile.

a) Pile number and elevation of top of bore hole and top of pile.

b) Type of rig used and a brief description of drilling operations

c) Type of soil encountered in the hole with values of cohesion and angle of internal friction.

d) SPT resistance values (N-values)

e) Date and depth of bore when drilling operations were performed and piles constructed

f) Total depth of each bore hole

g) Size and length of casing, if used

h) Quantity of concrete and steel used for the construction of each pile

i) Quantity of constituents for each batch of mix, water cement ratio and the result of all quality control tests

j) Date and time of load testing of piles, load and settlements readings during the loading and unloading of the test piles (For test piles only)

k) Graph of time-load-settlement relationship for test (For test piles only)

l) Remarks concerning any unusual occurrence during drilling, concreting and load testing of piles.

The presence of Engineer's representative or the keeping of separate records by his representative shall not relieve the Contractor of the responsibility for the work specified in this clause. Payment will not be made for any work for which records have not been furnished by the Contractor.

(2) Reports: Reports of each pile construction and pile load test shall be communicated to the Engineer as follows:

a) Oral reports as the work proceeds.

b) A report in duplicate not later than 48 hour after the completion of each hole, concreting of piles and load testing of piles. Proforma record of piling work for pile load test record is enclosed as Form-2 and Form-3.

c) Daily record for bored piles on the format shown in Form-1.

d) Five copies of the final report of the works within one month of completion of the last pile.

(2) The final report shall include:

a) Layout showing the "As built" arrangement of piles, their exact locations, dimensions, length, reinforcements, cut off elevation and the location of test piles

b) A tabulation of the loads and settlement readings during the loading and unloading of the test piles

c) A graphic representation of the test results in the form of time-load-settlement curves.

Measurement and Payment for RC Piles

15.9 (a) Measurement for construction of R.C. piles including test piles of various diameters will be made per running meter of the pile cast below cut off level.

(b) Payment for construction of R.C. piles of various diameters will be made at the unit rate per foot length tendered in the Bill of Quantities for construction of R.C. piles of each specified diameter as measured above.

(c) The amount tendered shall be full payment for completion of the work specified herein and elsewhere in these Specifications and on the Drawings, and BOQ for construction of R.C. piles and shall include the cost of supplying all materials, drilling for piles of the specified diameter, placing reinforcement cage, concreting and finishing, complete as stipulated under these specifications except the cost of Reinforcement which will be paid separately under BOQ item for Reinforcement Steel for

R.C. piles.

Measurement and Payment for Load Test on Test Piles

15.10 (a) Measurement for pile load tests will be made for the number of tests actually performed and accepted in accordance with these Specifications.

(b) Payment will be made for acceptable number of tests performed and on the basis of unit rate per number quoted in the Bill of Quantities for arranging and performing load tests on working piles.

(c) The unit rate quoted in BOQ shall be full compensation for carrying out and completing load test and shall include all costs and expenses for the equipment, accessories, loading and unloading arrangement, providing measuring devices, preparing reports, clearing site and all other operations required for the completion of the test to the satisfaction of the Engineer.

Measurement and Payment for Proof Load Test on Working Piles

15.11 (a) Measurement for pile proof load tests will be made for the number of tests actually performed and accepted in accordance with these Specifications.

(b) Payment will be made for acceptable number of proof load tests performed and on the basis of unit rate per number quoted in the Bill of Quantities for arranging and performing proof load tests on working piles.

(c) The unit rate quoted in BOQ shall be full compensation for carrying out and completing proof load test and shall include all costs and expenses for the equipment, accessories, loading and unloading arrangement, providing measuring devices, preparing reports, clearing site and all other operations required for the completion of the test to the satisfaction of the Engineer.

FORM - 1

DAILY RECORD FOR BORED PILES

Employer: _____ Engineer: _____

Piling Contractor: _____ Rig Type/No. _____

Project: _____ Structure _____

Pile shape/size: _____ Pile No. _____

GENERAL

Rig Moved From Pile No. _____

Existing Ground Level _____

Required Levels: Cut-off: _____ Toe: _____

Under-ream Shoe/Size: _____

Cross Section of Pile: _____

Length of Pile: _____

_____

STRATA

Depth	Soil/Rock Description/ Classification	Sampler/Test reports @ 5' interval or change of strata			
		C	Ø	N	

Ground Water Observation: _____

Date Boring Commenced: _____

Reason for Any Delay During Boring: _____

Reinforcement: _____

Concrete mix type: _____ Quantity Used: _____

Slump: _____ Test Cylinder/Cubes No. _____

_____

Casing Pull: _____

_____

Concrete Drop: _____

Volume of soil removed _____

Volume of concrete placed _____

_____

Level of Theoretical Pile Top:

Level of Cast Pile Top:

Pile Center Deviations:
x: _____y:

Weather Conditions:
_____
_

Remarks

(Included further details required by the Engineer)

Supervisor's Signature

Date: _____

FORM - 2

PROFORMA FOR RECORD OF PILING WORK

SITE:

CLIENT: _____

CONSULTANT: _____

CONTRACTOR: _____

DATE: _____

PILE NO._____ PILE DIA_____ PILE LENGTH _____

GROUND LEVEL_____ PILE TOP LEVEL_____ PILE TIP LEVEL _____

DRILLING RECORD

Date started _____

Date completed _____

Drilled depth _____

Diameter _____

Bore Log: _____

Depth	Soil Classification	Brief description of soil

CONCRETING RECORD

Reinforcement _____

Concreting started _____

Concreting completed _____

No. of cement bags used _____

Concrete Mix _____

Slump _____

Water/Cement ratio _____

No. of cubes prepared _____

Qty. of concrete used _____

Qty. of concrete required (calculated) _____

Actual Quantity of concrete used _____

Remarks: _____

FORM - 3

PILE LOAD TEST

Project_____ Test Location _____

Dia. of Pile_____ Length of Pile _____

Cut off Level_____ Ground Level_____

G.W.T_____ Date of Casting_____ Date of Testing_____

Test Jack_____ Max. Test Load_____Max. Travel or Ram_____

Gross Settlement_____ Net Settlement_____Date of Calibration_____

Test Termination Date _____

Time Interval	Pressure Gauge Readings	Settlement Gauges				Mean	Remarks
		1	2	3	4		

Employer _____ Engineer _____ Contractor _____

16 – BRICKWORK

Scope of Work

16.1 All brick masonry required to be constructed under these Specifications and for all related purposes, including Brick masonry profiles under canal lining and other structures as directed by the Engineer, shall consist of the materials herein specified and cement sand mortar shall be proportioned, mixed, and bricks placed in accordance with the requirements stated herein. The requirements set forth herein shall apply to all brickwork, except when such requirements are specifically modified by the Engineer for any particular item of work.

Portland Cement

16.2 Portland cement shall conform to the requirements set forth in Section 5 - Cement.

Mortar Sand

16.3 Sand for mortar used in the construction of brick paving and brick masonry required under these Specifications shall be furnished by the Contractor in accordance with provisions of and in complete conformity with the requirements for sand specified in the Section - “Sand and Coarse Aggregates”.

Water

16.4 The water used in the manufacture of bricks and in the preparation of mortar shall be potable and in complete conformity with the requirements of section - 4 “Concrete, General”.

Bricks

16.5 For all brickwork only first class bricks shall be used. They shall be thoroughly burnt without being vitrified, shall be regular, uniform in shape and size with sharp and square edges, parallel faces and of deep red or copper colour. The bricks shall be free from flaws, cracks, chips, stones, nodules of lime or kankar or any other blemishes. Bricks over-burnt, under-burnt, vitrified and irregular shall not be used.

A first class brick in an oven-dried condition shall not absorb more than one sixth of its weight when soaked for one hour in water at 70 to 80 degrees Fahrenheit and shall show no efflorescence on subsequent drying. The average compressive strength of five (5) representative bricks shall be not less than 2,000 lb/in^2 when tested in accordance with ASTM Designation: C67. Such testing shall be carried out regularly for each lot of bricks or as directed/approved by the Engineer.

All bricks shall be manufactured by the Trench Kiln Method or other standard methods approved by the Engineer. Each finished brick shall be of standard size (9”x4.5”x3”) first class, and weigh between seven (7) and nine (9) pounds. All bricks shall have a “frog” 1/4 of an inch deep on upper face.

Each finished brick for tile lining shall have standard size (12”x6”x2”) first class.

The bricks shall be sorted and arranged in stacks of 2,000 bricks each. Each stack shall be ten (10) courses high and two (2) bricks thick so that at least one end of every brick is visible for

inspection. Sufficient room shall be allowed between each stack so that all bricks may be inspected by the Engineer.

Mortar Composition

16.6 Mortar for all brickwork requiring mortar, shall consist of one part Portland cement to three parts of sand by volume (1:3) and sufficient water to produce the proper consistency for the intended use as specified in these Specifications or on Drawings

Where directed by the Engineer for increased workability, hydrated lime putty, approved by the Engineer shall be added to the mortar, but shall not exceed 25 percent, by volume, of the dry cement.

Mortar Batching

16.7 Methods and equipment used for mixing mortar shall be such as will accurately determine and control the amount of each separate ingredient entering into the mortar and shall be subject to the approval of the Engineer. If a mixer is used, it shall be of approved design and the mixing time, after all the ingredients are in the mixer, except for the full amount of water, shall be not less than two minutes.

Mortar shall be mixed only in sufficient quantities for immediate use and all mortar not used within thirty (30) minutes after addition of the water to the mix shall be wasted. Retempering of mortar will not be allowed. Mixing troughs and pans shall be thoroughly cleaned and washed at the end of each day's work.

Construction

16.8 The methods and equipment used for transporting the bricks and mortar shall be such as will not damage the bricks nor delay the use of mixed mortar.

All brickwork shall be placed only after the foundation surfaces have been prepared satisfactorily in accordance with these Specifications and the Engineer's instruction.

Bricks shall not be placed during heavy or prolonged rain which may wash the mortar from the bricks. Mortar already spread which becomes diluted by rain shall be removed and replaced before continuing with the work. Workmen shall not be allowed to walk on the brickwork before it is fully set.

All bricks to be used in brickwork with mortar joints shall be moistened with water for three to four hours before they are used, by a method which will ensure that each brick is thoroughly and uniformly wetted. All bricks shall be free from water adhering to their surface when they are placed in the brickwork.

All bricks shall be skillfully laid with level courses, uniform joints, square corners, plumb vertical and true surfaces, except otherwise shown on Drawings or directed by the Engineer. Brickwork constructed for a waterway will be of the best standard of workmanship obtainable, and objectionable offsets in the brick work shall be removed by and at the expense of the Contractor. The smoothest practicable finished surface of the brickwork will be

required whenever it is a part of waterway.

Curing

16.9 All brickwork requiring mortar shall be cured by water curing or other acceptable methods. All methods and operations of the Contractor in curing the different portions of the work shall be subject to the Engineer's approval.

When curing by water, the brickwork shall be kept wet for at least 10 days, unless specified elsewhere in these Specifications, by covering with water saturated material, or by a system of perforated pipes, mechanical sprinklers, porous hose, ponding, or by any other approved method which will keep all surfaces to be cured continuously wet. Water used for curing shall meet the Specifications for water used in the manufacture of bricks.

Repairing Brickwork

16.10 If after the completion of any brickwork, any bricks are found to be out of alignment or level, or do not conform to the lines and grades shown on the Drawings, or show a defective surface, they shall be removed and replaced by the Contractor at his expense unless the Engineer grants permission, in writing, to patch or replace the defective area.

Dry Brick Pitching

16.11 (1) General: Dry brick pitching shall consist of a double layer of bricks laid without mortar joints on a plain cement concrete class "C" foundation, all placed in accordance with the stipulations and requirements herein set forth and the details shown in the Drawings or directed by the Engineer.

All materials and operations of the Contractor for placing dry brick pitching under these Specifications shall be in accordance with the provisions of, and in complete conformity with the stipulations and requirements for "Brickwork" and "Concrete General" setforth in these Specifications.

(2) Dry Brick Pitching: Bricks shall be placed upon the plain cement concrete class "C" foundation to the lines and grades shown in the Drawings or established by the Engineer. The first layer of bricks shall be laid flat (9-inch by 4-1/2 inch side) in such a manner that a smooth and even surface is obtained upon which the second layer of bricks may be laid. The second or top layer of bricks shall be laid on edge (9-inch by 3-inch side) and in zig-zag pattern. All bricks shall be closely fitted together so that all edges of the bricks are in contact with each other.

(3) Brick Masonry Profile: The dry brick pitching shall be divided into bays by brick masonry profiles (pacca brickwork) by means of bricks laid with cement-sand mortar (ratio 1:3) and as shown on the Drawing. Proper curing shall be provided as directed by the Engineer.

Brick Masonry

16.12 (1) General: Brick masonry (pacca brickwork) shall consist of bricks laid with mortar joints, cement pointing and cement plaster, all placed in accordance with the stipulations and

requirements herein set forth and the details shown in the Drawings or directed by the Engineer.

All materials and operations of the Contractor for constructing brick masonry, cement pointing and cement plaster under these Specifications shall be in accordance with the provisions of, and in complete conformity with the stipulations and requirements for “Brickwork setforth in these specifications”.

(2) Construction: All brick masonry (pacca brickwork) shall be constructed in accordance with the Engineer’s instructions and the stipulations and requirements set forth herein, as follows:

i. The exterior and interior facing of all brick masonry shall be of first class bricks laid with mortar joints and the English bond unless otherwise shown in the Drawings or directed by the Engineer. Brick masonry shall be laid where possible from one face only and each brick shall be set with both bed and vertical joints filled with mortar and the bricks shall be bedded-in by firmly tapping with the handle of the trowel. Brick courses shall be carried up as neatly as possible in a uniform manner during construction.

ii. The exposed face of all brick masonry shall have the smoothest practicable finish and be kept clean and free from streaks of mortar. Whenever such streaks are formed they shall be washed off immediately and not allowed to harden.

iii. Horizontal joints shall be parallel and vertical joints in alternate courses shall be directly over one another. The thickness of the joints shall be 1/4 of an inch and the height of four (4) courses as laid shall not exceed by more than one inch the height of four dry bricks stacked one upon the other. Excess mortar at the other edges shall be removed and joints drawn straight with the edge of a trowel and a straight edge. At the completion of the work all holes or defective mortar joints shall be cut out and repointed.

iv. When fresh brick masonry is to join the existing brick masonry or new brick masonry that has partially or fully set, the exposed joining surface of the existing or set brick masonry shall be cleaned, roughened and wetted so as to effect the best possible bond with the new work. All loose bricks and mortar shall be removed.

v. The joints of brick masonry, which are to be pointed or plastered, shall be raked out with a hook to a depth of half an inch. The raking shall be done before the mortar sets each day.

vi. Bricks shall be cut, dressed or grooved, as required for shaping, fittings and for other purposes. Corners shall be made with cut bricks, five bricks shall be used for each corner.

(3) Pointing of Brick Masonry

i. Striking Joint

All unplastered faces of brick masonry at locations shown in the Drawings or as directed by the Engineer shall be finished by striking joints in accordance with the stipulations and requirements set forth herein, as follows:

ii. Cement Mortar

The cement-sand mortar for pointing of brick masonry will have a mix ratio 1:3.

iii. Preparation of Surface

Before pointing brick masonry, the joints shall be raked out with a hook (not hammer or tessi) to a depth of half an inch. If, for any reason, the joints are not struck as the work proceeds, they shall be raked out before the mortar sets.

All mortar dust coming out of the joints as a result of raking shall be washed off and the brick masonry watered for 24 hours. The face shall once again be washed just before starting pointing.

The surface prepared in the manner described above shall be inspected by the Engineer and shall be approved before actual pointing begins.

iv. Method of Pointing

The mortar shall be filled in the joints flush with brick masonry with a pointing trowel and then pressed in with proper pointing tools. Lining with a spike on a mass of mortar shall not be allowed.

The pointing tools for horizontal joint shall be such as to form weathered and struck joints; and for vertical joint, triangles, so as to make a (v) notch in the joint. Care shall be taken not to develop a cutting edge in the tools since the idea is to compress the green mortar into the joints and not to cut it away.

The mortar shall not be spread irregularly over the

edges and corners of the bricks, which shall be left clearly visible. The practice of smearing mortar over defects in bricks, to hide them, shall not be allowed and shall render the whole brick masonry liable to be rejected.

v. Washing after Pointing

After pointing, the face of the brick masonry shall be cleared off all surplus mortar sticking to the face. No washing shall be done till the pointing has set.

vi. Curing

Cement pointed brick masonry shall be kept wet for ten (10) days after completion. The work shall be protected during that period from extreme fluctuations of weather.

(4) Cement Plaster for Brick Masonry

i. Composition

The cement sand plaster for brick masonry will have 1:3 mix ratios for various work items as shown in the Drawings or as directed by the Engineer.

ii. Plaster Thickness

The cement plaster will have the thickness of ¾” as shown in the Drawings or as directed by the Engineer.

iii. Preparation of Surface

Before plastering, the joints of brick masonry shall be raked out with a hook (not hammer or tessi) to a depth of half an inch. The joints shall be raked out before the mortar sets each day.

All mortar dust coming out of the joints as a result of raking shall be washed off, and the brick masonry watered for 24 hours before plaster is applied. The face shall once again be washed just before starting plastering.

All putlog holes shall be filled up before starting plastering.

The surface prepared in the manner described above shall be inspected by the Engineer and shall be approved before the actual plastering begins.

iv. Method of Plastering

Unless otherwise specified or directed by the Engineer, wooden screeds three inches wide and having a thickness equal to the plaster thickness shall be fixed vertically 8 feet to 10 feet apart to act as gauges and guides in applying the plaster.
The arises shall be plastered for a space of four inches on each side and up to the ceiling, except in case of openings where it shall run around them. This plaster shall also serve as a guide for thickness etc. Unless otherwise specified or directed by the Engineer all corners and arises shall be rounded off to a radius of 3/4 inch.

The mortar shall be laid on the wall between the screeds, using a plastering float and pressing mortar so that the raked joints are properly filled. The plaster shall then be finished off with a wooden straight-edge reaching across the screeds. The straight-edge shall be worked on the screeds with an upward and sideways motion, two (2) inches or three (3) inches at a time. Finally the surface shall be finished off with a plastering wooden float. Metal floats shall not be used.

The plaster shall be laid to a true and plumb surface and tested frequently with a straight-edge and plumb-bob. The straight-edge shall not be less than ten (10) feet in length. As the work proceeds, all horizontal lines and surfaces shall be tested with a level, and all jambs and corners with a plumb-bob.

v. Curing

Plastering shall be kept wet for ten (10) days after completion.

(5) Brick flooring

i. The work covered by this item consists of furnishing and laying 4 inch sand over prepared earth to required slope and grade and 4.5 inch thick brick on edge in 1:5 cement sand mortar. These joints of these bricks are struck at the top of flush pointing.

ii. The method consists of placing bricks on edge for flooring in 1:5 cement sand mortar over 4 inch sand and striking the joints of bricks with flush pointing laid over thoroughly consolidated bottom by ramming and watering before laying this floor.

iii. The concrete flooring properly laid shall be cured for 7 days.

(6) White or Colour Washing

The whitewash shall be made from pure fat lime brought to site of work in the form of un-slaked lime. Water shall be added to this lime in a container until the mixture is of consistency cream and allowed to rest until cracks shall appear on its surface (48-72 hours). After screening through coarse cloth, gum at the rate of 4 oz. boiled with 10 oz. of rice shall be added to each cubic feet of whitewash. The colour pigment if required shall be added and mixed with white wash and stirred to give the required shade. Enough quantity shall be prepared in one go so as to meet the requirement of one complete room.

Measurement and Payment

16.13 (1) Measurement and payment for all brickwork required under these Specifications will be made at the unit rate per cubic meter tendered in the Bill of Quantities for the appropriate item in which such brickwork is incorporated. The unit rates tendered for such work shall include, but not be limited to, the cost of procuring bricks, water, sand, cement; the cost of all operations of batching, mixing, classification, transportation, preparation for placing, curing, protection, finishing and repairing brick surfaces; and of all other operations, procedures and requirements necessary to complete the brickwork in accordance with the Specifications.

(2) Dry Brick Pitching:

i. Measurement for dry brick pitching shall be in 100 cubic feet to the outlines, thickness and grades shown in the Drawings or determined by the Engineer.

ii. Payment for dry brick pitching shall be made at the contract unit tender rate for cubic meter. Payment shall include the full compensation for providing material, equipment, tools, laying and labour including all incidentals necessary to complete the work as per Specifications.

(3) Brick Masonry (Pacca Brickwork)

i. Measurement: Measurement for brick masonry (pacca brickwork) in the wing walls for canal structures and outlets flared walls shall be in cubic meter to the outlines, thickness and grades as shown in the Drawings or determined by the Engineer.

ii. Payment: Payment for brick masonry (pacca brickwork) measured as above shall be made at the unit rates tendered for respective BOQ items in cubic meter. Payment shall include full compensation for providing materials, equipment, tools, laying of brick masonry in cement-sand mortar, soaking of bricks,

dressing, flaring, curing and labour including all incidentals necessary to complete the work as per Specifications.

(4) Cement Plaster for Brick Masonry

i. Measurement: Measurement for cement-sand plaster for brick masonry, up to 20 feet height, shall be in 100 square feet to the outlines, thickness and grades shown in the Drawings or determined by the Engineer.

ii. Payment: Payment for cement-sand plaster for brick masonry, up to 20 feet height, shall be made at the unit tender rates per square meter. Payment shall include full compensation for providing materials, equipment, tools, plastering, curing and labour including all incidentals necessary to complete the work as per Specifications.

(5) Pointing of Brick Masonry

i. Measurement: Measurement for pointing of brick masonry up to 20 feet height shall be in square meter to the surface outlines shown in the Drawings or determined by the Engineer.

ii. Payment: Payment for pointing of brick masonry up to 20 feet height, shall be made at the unit tender rate per square meter. Payment shall include full compensation for providing materials, equipment, tools, pointing, curing and labour including incidentals necessary to complete the work as per Specifications.

17 – GATE EQUIPMENT

17.1 GENERAL

Introduction

17.1.1 This section specifies general requirements for the design, manufacture, delivery to Site, installation, testing and commissioning of gate equipment to be furnished and installed in accordance with the provisions in these documents. The Contractor shall provide all labour, material, equipment, and transportation for the satisfactory completion of work and maintain the equipment during defect liability period.

Works to be Done

17.1.2 The Contractor shall:

A. Design, detail, manufacture, furnish, deliver to the Site, install, test and commission the following equipment in accordance with specifications and as shown on the Tender Drawings.

B. Furnish a complete set of maintenance tools needed for the lubrication, adjustment and normal maintenance of each item of the Equipment. These tools shall be properly mounted in heavy-duty steel cabinets provided with locks, suitable for wall mounting. The price for each set of maintenance tools shall be included in the quoted price of the respective B.O.Q item.

C. Furnish a complete set of erection supplies. The price for erection supplies shall be included in the quoted price of the equipment to which it belongs. Erection supplies shall consist of the following quantities in excess of the total quantity required for site assembly for each type of the Equipment.

Erection Supplies	**Excess Quantity (Percentage)**
1. Bolts, screws, studs, nuts, washers and similar parts that are to be placed and/or removed during field installations	5
2. Electrodes for field welding	25
3. Expansion anchors or other anchors	10
4. Lubricating grease or oil	20

D. Furnish the basic spare parts for each equipment. The cost of the following basic spare parts shall be included in the corresponding Equipment cost:

Description Item/Unit		**Fixed Wheel Gates**	**Slide Gates**	**Stoplogs**
a.	J-type seal (ft.)	90	-	25
b.	Wedge type seal (ft.)	40	15	60

Description Item/Unit		Fixed Wheel Gates	Slide Gates	Stoplogs
c.	Bronze seals (ft.)	-	20	-
d.	Lubrite bushes and washers (one set contains one bush & two washers) (set)	18	-	-
e.	Rubber block (Nos)			
	- for lower corners	7	-	6
	- for upper corners	-	-	-
f.	Roller Bearing	25% of each size	-	-
g.	Wire ropes alongwith sockets and turn buckles	7 - sets	-	-

All spare parts shall be interchangeable with and of the same material and quality as the original parts. All spare parts shall be treated and boxed as required to preserve them against deterioration during storage. Boxes shall be clearly marked for identification of the parts they contain.

E. The Contractor shall submit drawings, data and perform all other work specified hereinafter.

Drawings Furnished by the Engineer

17.1.3 The general arrangement of the Equipment shall conform to the Tender Drawings. The Tender Drawings are not intended to define the detailed design of the Equipment to be furnished and installed but are merely illustrative to show the general layout of the Equipment except where limiting or mandatory dimensions, elevations, tolerances and similar features are indicated. Alternative details and arrangements will be considered if, in the judgment of the Engineer, those are not inferior to the details and arrangement shown on the Tender Drawings

Contractor's Drawings and Data

17.1.4 A. General

1. The Contractor shall submit drawings and instructions as outlined hereunder. The sequence of submission to the Engineer for review shall be such that information is available for review of each drawing when it is received. Contractor's drawings and design data, submitted formally shall have certification by an authorized representative of the Contractor to the effect that information shown thereon has been checked by the Contractor and is correct for use in the Project, except for drawings of a preliminary nature furnished for information which shall be clearly identified as such. Before submitting any drawing for review, the

Contractor shall submit a list of drawings he proposes to submit, showing sequence of submittal and submittal dates to meet the requirements of the Contract Documents.

2. The applicable parts of the requirements of all paragraphs with reference to the drawings shall apply equally to design data, calculations, catalog pages, illustrations, descriptions, printed specifications, draft reports or any other similar data submitted for review.

B. Outline Drawings

The Contractor shall submit outline drawings of the Equipment together with data, to permit final design of the structures into which the Equipment is to be incorporated. Outline drawings and/or data shall be submitted in accordance with a schedule mutually agreed upon between the Contractor and the Engineer.

C. Detailed Drawings and Data

1. General

Before proceeding with the manufacture of Equipment, the Contractor shall submit general assembly drawings, subassembly drawings, detail drawings, calculations, design criteria, design data, catalog pages, specifications and similar engineering documents required to demonstrate fully that all parts will conform to the provisions and intent of these Specifications and to the requirements of their installation, operation, and maintenance. The drawings shall show all necessary dimensions and fabrication details, including the design of welded and bolted joint connections, tolerances on fits and clearances, and all field joints and subassemblies in which the Contractor proposes to transport the Equipment.

2. Detailed Drawings

Detailed Drawings shall include the following wherever applicable:

a. General arrangement drawings for embedded parts: These drawings shall show all final dimensions, tolerances, and details of field connections.

b. General arrangement drawings for gates and stoplogs: These drawings shall show all final dimensions and tolerances, surface finishes, details of field connections and final weights.

c. General arrangement drawings of the hoists for the Gate Equipment: These drawings shall show all final dimensions and tolerances, details of field connections,

final weights, and loads on foundation bolts.

d. Slot and sill beam details showing seal contact with the embedded sealing faces.
e. Typical seal details.

f. Seal splice and seal corner details.

g. Structural detail drawings of each gate and Stoplog.

h. Hoist platform and access ladder details.

i. Details of the hoist gear box, hoist drum and couplings.

j. Assembly match mark sheets.

k. Other drawings not specifically listed but required to develop the detail drawings.

3. Structural Design Data

The calculations and design data, shall include the following:

a. Structural analysis for fixed wheel gates, slide gates, stoplogs, hoisting arrangement, dogging devices, embedded parts and major structural parts.

b. Weight and center of gravity calculations.

4. Mechanical Design Data

The calculations, design data, etc shall include the following:

a. Required hoisting/operating force calculations

b. Speed reduction and gear box calculations.

D. Review of Drawings

1. a) Three (3) copies on durable paper with dark lines on a white background and one durable paper-type reproducible shall be furnished of each drawing submitted. All drawings submitted shall in so far as practicable, be of standard size, measuring approximately 33 in. x 23.5 in. Printed catalogs and data shall be submitted in five (5) copies.

b) One copy will be returned to the Contractor marked "Approved", "Approved Except as Noted", or "Not Approved". Review will not relieve the Contractor of responsibility for conformity with Specified

requirements and correct detail and fit of parts when installed. No revision affecting the design shall be made after a drawing has been "Approved" without resubmitting the drawing.

2. When copies of drawings have been marked "Approved Except as Noted", or "Not Approved", the Contractor shall make the necessary corrections and resubmit three (3) copies and one reproducible. Number and date shall show every revision.

E. Record Drawings

Prior to completion of the work under the Contract, the Contractor shall furnish one complete full size set of all Contractor's drawings of equipment as finally built, including any field changes, stamped "As Built Drawings". The drawings shall be accompanied by 2 sets of electronic uneditable copies on compact disks of approved quality.

F. Installation Instruction

1. General

The Installation Instructions shall be prepared in one volume, divided into two sections as referred below, and shall cover instructions for Installation, (hereinafter referred to as the Installation Section), testing and setting to work (hereinafter referred to as the Site Testing Section). The volume shall be strongly bound in a durable cover of approved legend, and shall bear on the spline in bold letters an approved shortened version of the title.

2. Installation Section

This section shall include full and detailed instructions as to all procedures and precautions to be observed in installing, assembling and adjusting the Equipment and as to the use of the Erection and Maintenance Tools. It shall include or be accompanied by drawings clearly showing installation marking and particularly any match-marking and shall embody in particular a full statement as to installation tolerances to be observed.

3. Site Testing Section

This section shall include full detailed directions as to the methods and procedures to be followed and the quantities to be observed and recorded in checking the accuracy of installation, and the carrying out of Site tests as required by the Specifications. It shall also include a schedule of tests and a description of all instruments to be provided for these tests and of their use.

4. Number of Copies

The Contractor prior to producing the final volumes shall submit two (2) draft copies to the Engineer for approval. After its approval the Contractor shall provide six (6) fair copies alongwith 2 sets of electronic uneditable copies on compact disks of approved quality for the use of the Employer and the Engineer.

G. Operating and Maintenance Manuals

The Contractor shall submit two (2) draft copies of detailed operating and maintenance manuals for the Equipment for Engineer's review. After Engineer's review, six (6) complete, durable bound copies of the manuals shall be furnished. The operation and maintenance manuals shall include reduced-size copies of applicable drawings, applicable parts' lists, and catalogs covering all equipment furnished or which may be needed in operation, maintenance, repairs, dismantling or assembling, and for repair and identification of parts for ordering replacements.

Technical Designations

17.1.5 Wherever the following technical terms occur in these Documents, these shall be understood to have the following meanings:

"DRAWINGS" means the drawings furnished by the Engineer or any modifications of such drawings approved in writing by the Engineer.

"GATE EQUIPMENT": All equipment to be furnished under the Contract which includes gates, stoplogs, lifting beam and all accessories, including embedded parts, hoisting/operating system arrangement, platforms, access ladders, spare parts, erection & maintenance tools and all appurtenances including supplementary equipment. The word "Equipment" wherever used instead of "Gate Equipment" shall mean as Gate Equipment.

"GATE UNIT": Completely operational group of equipment parts that are required and are sufficient to close one opening. A gate unit will normally include one gate, one hoist with hoisting deck, one set of embedded parts, access ladders and all required appurtenances.

"GATE": The movable or moving parts of a gate serving to close one opening.

"HOIST": A device serving to move (open and close) a gate, including all related equipment necessary to assure safety.

"EMBEDDED PARTS": The group of parts of a gate equipment, which is to be embedded in concrete or otherwise permanently attached to the civil work, such as frames, seal-plates, sill beams, bearing plates and rails. All welding pads, erection studs and

anchorages to be furnished by the Contractor are also considered embedded parts except as otherwise noted.

"HOISTING/OPERATING DECK": Comprise steel structure consisting of beams, chequered plates, required to install the hoists/operating system and related equipment.

Standards

17.1.6 The standards under which work is to be performed or tested are cited throughout the Tender Documents. Where such standards are cited, it shall be understood that the latest issue or revision in effect at time of submission of Tender shall apply. If it is desired to deviate from the cited or approved standards, a statement of the exact nature of the proposed deviation shall be submitted for approval. Other equivalent standards may be substituted provided approval is obtained from the Engineer. Name of the standards and abbreviations are given below:

Name	**Abbreviation**
American Gear Manufacturer's Association	AGMA
American Institute of Steel Construction, Inc.	AISC
American National Standards Institute	ANSI
American Iron and Steel Institute	AISI
American Society of Mechanical Engineers	ASME
American Society for Testing and Materials	ASTM
American Welding Society	AWS
Federal Specifications Board	U.S. Fed. Spec.
United States Bureau of Reclamation	USBR
Institute of Electrical and Electronics Engineers	IEEE
International Organization for Standardization	ISO
National Bureau of Standards	NBS
National Electrical Code	NEC
Crane Manufacturers Association of America	CMAA
National Electrical Manufacturer's Association	NEMA
Society of Automotive Engineers	SAE
Steel Structures Painting Council	SSPC

Underwriter's Laboratories, Inc.	UL
Antifriction Bearing Manufacturers Association	AFBMA

B. Or Equal

For convenience certain equipment, articles, materials, or processes are designated by trade name or catalog name and number. Such designation shall be deemed to be followed by the words "or equal".

Shop Assembly and Tests

17.1.7

A. General

Materials shall be new and of first-class quality, suitable for the purpose, free from defects and imperfections, and of the grades, classes and types listed herein, or their equivalents. However, while selecting the materials the Contractor shall keep in view water analysis results and may propose materials having better qualities to resist the chemicals present in the water.

B. Material specifications

1. Structural Steel

a. for skinplate, main components of gate leaf, stoplogs.	ASTM-A36, "Specification for Structural Steel".
b. for embedded parts (except seal bearing plates and guide plates and rails which will be of CRES) and supports etc.)	ASTM-A36, "Specification for Structural Steel".
2. Corrosion-Resisting (or Corrosion Resistant) Steel (bars, bolts, nuts, and washers, etc.) (Symbol: "GP - CRES").	ASTM-A276, "Specification for Stainless and Heat Resisting Steel Bars and Shapes, "Type: Series 316L.
3. Corrosion-Resisting (or Corrosion Resistant) Steel (pins and rods) (Symbol: "CRES")	ASTM-A276, "Specification for Stainless and Heat Resisting Steel Bars and Shapes," Type: Series 403 or 410.
4. Stainless Steel (plate, sheet and strip).	ASTM-A240, “Specification for Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet and Strip for Pressure Vessels.

5.	Corrosion-Resisting Steel Castings	ASTM-A743, "Specification for Corrosion Resisting Iron-Chromium - Nickel Alloy Casting for General Applications" Grade CA-15 and CF-8.
6.	Cast Steel Wheels	ASTM-A583, "Specification for Cast Steel Wheels for Railway Service."
7.	Carbon Steel Axles	ASTM-A21, "Specification for Carbon Steel Axles, Non-Heat- Treated for Railway use."
8.	Steel Shafting	ASTM-A29, "Specification for Steel Bars Carbon and Alloy, Hot Rolled, Cold Finished"
9.	Steel Bolts and Nuts	ASTM-A307, "Specification for Low-carbon Steel Externally and Internally Threaded Standard Fasteners," and ASTM-A325. "Specifications for High-Strength Bolts for Structural Steel Joints Including Suitable Nuts and Plain Hardened Washers,"
10.	Lock Washers	Spring steel, SAE proportions, regular series.
11.	Forged Steel	ASTM-A668, "Specification for Steel Forgings, Carbon and Alloy, General Industrial Use,".
12.	Cast Steel	ASTM-A27, "Specification for Mild-to-Medium-Strength Carbon- Steel Castings for General Application," Grade 65-35.
13.	Round Wire Rope	ASTM-A492 "Specification for Stainless and Heat Resisting Steel Wire Rope and U.S. Fed. Spec. RR-W-410b. "Wire Rope and Strand,"
14.	Wire Rope Fittings	Contractor's standard fittings for the type of rope used.
15.	Permanent self	"Lubrite" A cast bronze alloy

	lubricating bearings and washers with rated coefficient of friction less than 0.15.	(ASTM-B22, "Specification for Bronze Castings for Bridges and Turntables," Alloy E) with self-lubricating inserts.
16.	Lubricating Fittings	According to manufacturer's published data.
17.	Bronze Bushings, Sleeve type Bearings and other Lubricated Wearing Parts	SAE Standard Specification No. 64 for Phosphor Bronze.
18.	Anti-Friction Bearings	According to manufacturer's published data.
19.	Steel Pipe	ASTM-A53, "Specification for Welded and Seamless Steel Pipe," Welded Grade.
20.	Expansion Anchors	According to manufacturer's published data.
21.	Concrete Anchor Studs	According to manufacturer's published data.
22.	Gears and Speed Reducers.	AGMA Standard.
23.	Rubber Seals.	The rubber seals shall be molded and the material shall be compounded of natural rubber or copolymer of butadiene and styrene or a blend of both. The compound shall contain not less than 70% by volume of the basic polymer and the remainder shall consist of reinforcing carbon black, zinc oxide, accelerators, anti-oxidants, vulcanizing agents, and plasticizers.
24	Fluoro-carbon Clad Rubber Seals.	Rubber seals shall be as specified above. A fluoro-carbon sheath shall be bonded to the rubber on the sealing surface. The sheath shall be abrasion resistant. The outside surface of the fluoro-carbon shall be free of adhering or bonded rubber.

Test of Materials

17.1.8 A. General

Unless otherwise directed all materials or parts used in the Gate Equipment shall be tested, in conformity with applicable methods prescribed by the ASTM, or such other organization as may be specifically required, and in general accordance with the best commercial methods. When requested, tests shall be made in the presence of the Engineer. Stocked material may be used, provided evidence is furnished to the Engineer to show that such material meets the requirements specified herein, in which case tests on stocked materials may be waived.

B. Test Certificates

Certified material test reports shall be furnished in triplicate to the Engineer as soon as possible after the tests are made. The test certificate shall identify the component for which the material is to be used and shall contain all information necessary to verify compliance with the Specifications.

C. Rubber Seals

1. All rubber seals shall be tested for and shall have the following physical properties:

a.	Tensile Strength min. 3000 lbf/sq. in.	ASTM-D412, "Tests for Rubber Properties in Tension."
b.	Elongation at Break min. 450%	ASTM-D412
c.	300% Modulus, min. 850 lbf/sq.in.	ASTM-D412
d.	Shore Durometer (Type A) 60 to 70	ASTM-D2240, "Test for Rubber Property-Durometer Hardness".
e.	Specific Gravity	1.15 $\pm$ 0.03
f.	Absorption of Water by Weight, max. 5%	ASTM-D471, "Test for Rubber Property-Effect of Liquids,"
g.	Compression set (constant deflection) or Original Deflection max. 30%.	ASTM-D395, "Test for Rubber Property-Compression.
h.	Tensile Strength after Oxygen Bomb Aging 48 hr. 70°C, 48 hr, 158° F, 300 lbf/sq.in., percentage of Tensile Strength before Aging min. 80	ASTM-D572, "Test for Rubber Deterioration by Heat and Oxygen Pressure".

2. On rubber seals with fluoro-carbon cladding, the rubber shall be tested as specified above. The fluoro-carbon shall be tested for and shall possess the following physical properties:

Tensile strength	2000 lbf/sq.in (min.)
Elongation	250% (min.)

3. The fluoro-carbon cladding on rubber seals shall be tested for adhesion in accordance with ASTM-D413, "Tests for Rubber Property Adhesion to Flexible Substrate," using either the machine method or the dead-weight method.

4. Except where tolerances for rubber seals are specified on the Tender Drawings, seal dimensions are nominal and slight variations will be acceptable.

Design Criteria and Working Stresses

17.1.9 A. General

The general design criteria covering the design loads, load combinations and maximum unit stresses considered for the design of Equipment are described below.

The design of Equipment will be based on the guidelines of the U.S. Army Corps of Engineers and U.S. Bureau of Reclamation, except as modified and supplemented by the design criteria described in this Section.

B. Design Loads

The Gate Equipment is designed for the applicable loads described hereunder.

1. Dead Loads

The dead load includes the weight of the components, machinery elements, equipment, protective devices and contained fluids. Eccentricity of loading shall be taken into account.

2. Hydrostatic Loads

Components of Equipment subject to water pressure will be designed for hydrostatic loads corresponding to the maximum differential pressure expected during the life of the Project.

3. Friction

The friction forces considered in the design will be based on the applicable coefficients of friction taken from the following table:

	Maximum	Minimum
Rubber on steel	1.0	0.3
Rubber on corrosion-resisting steel	0.8	0.2
Fluoro-carbon on corrosion-resisting steel	0.15	0.05
Corrosion-resisting steel on carbon steel, non-lubricated	0.5	0.1
Corrosion-resisting steel on carbon steel, lubricated	0.18	0.08
Corrosion-resisting steel On corrosion-resisting steel	Not acceptable	
Bronze on corrosion-resisting steel, non-lubricated	0.5	0.15
Bronze on corrosion-resisting steel, lubricated	0.2	0.07
"Lubrite" on corrosion-Resisting steel	0.2	0.06
Anti-friction bearings	As recommended by bearing manufacturer.	

4. Wind Load

Horizontal wind load of 25.6 lbs/sq.ft., acting in any direction on the projected area of affected components, will be considered in the design.

5. Seismic Loads

All components of gates will be designed to withstand safely the seismic forces computed by using the following seismic coefficients and design factors:

- DBE: An Design basis earthquake (DBE) equivalent to a horizontal ground acceleration equal to 0.22 g acting simultaneously with a vertical acceleration equal to 1/3 of horizontal acceleration.

- Seismic forces: Seismic forces considered for

the design of each gate leaf are taken as the sum of inertia and hydrodynamic forces. The inertia forces are equal to the product of the mass and the effective acceleration of the gate leaf assembly. The hydrodynamic forces are assumed equal to the product of added mass of water acting on the skinplate and the effective acceleration of the skinplate. The seismic forces on all other components of the gates and hoists are taken equal to the product of their mass and effective acceleration.

6. Live Loads

The live loads on walkways and catwalks which are transmitted to the gates and hoists will be taken as uniformly distributed loads (UDL) equal to 105 lbf/sq.ft.. In addition to this UDL, any superimposed concentrated loads likely to be placed on the walkway and catwalks will also be considered.

7. Thermal Loads

The thermal forces will be considered in the design of the components when temperature fluctuations relative to an assumed erection temperature would exceed 10°C. The following temperature variations are assumed:

- For components located above water or periodically exposed and submerged: + 70°C - 0°C.

- For components partly submerged or protected from direct sun: + 50°C - 0°C

- For components permanently submerged in water : + 20°C - 0°C

8. Miscellaneous Loads

Loads due to changes in conditions of support, lifting and raising forces as well as impact will also be considered in the design of components thus affected.

C. Load Combinations and Conditions

The detailed design of Equipment will be based on the most critical loading condition applicable to major components. The Contractor shall be required to investigate the following loading conditions and load combinations for the final design

of the Gate Equipment.

1. Erection Conditions

   - Normal loading: Equipment in any stage of erection subjected to applicable dead and live loads plus forces resulting from the erection procedures.

   - Exceptional loading: Normal loading plus wind loads.

2. Operating Conditions

   Normal Loading:

   - For vertical fixed wheel and slide gate leaf assembly : Dead weight, friction, thermal, hoisting and maximum hydrostatic loads when the gate is resting on the sill, being lifted, partially opened or being closed, with maximum water pressure.

   - For stoplogs: Dead weight, friction, thermal and normal maximum hydrostatic loads when stoplogs are resting on the sill.

   - For mechanical hoist/operating system: Dead weight, live, thermal, friction and rated hoist/operating loads.

   Exceptional loading :

   - For Gate: Loading when the gate is jammed.

   - For stoplogs: Loading when the stoplog is jammed.

   - For fixed wheel gates, slide gate and hoists operating system: Normal loading plus seismic forces for OBE.

3. Maintenance Conditions

   Normal loading :

   The Gate Equipment in the normal maintenance position with applicable dead, live, thermal, imposed and support loads.

   Exceptional loading :

   Normal loading plus wind load plus OBE.

D. Working Stress

1. Factor of Safety - Mechanical Components

A factor of safety not less than 5, based on the ultimate strength of material, will be used under normal loading.

2. Allowable Stresses:

Summary of allowable stresses is given here as under:

Fy = Yield Stress
Fu = Ultimate Stress
Fa = Allowable Stress

Type of Stress	**Normal**	**Load Cases Exceptional**
a. For structural members		
Bending	0.6 Fy	0.8 Fy
Shear	0.4 Fy	0.5 Fy
Tension	0.45 Fy	0.5 Fy
Bearing pressure (machined surfaces)	0.8 Fy	0.85 Fy
Combined stresses	0.75 Fy	0.95 Fy
Buckling - AISC value	1.0 Fa	1.3 Fa
Hertzian stresses Lbs/in^2 BHN	755 BHN	850
(BHN=Brinell Hardness not exceeding 300 BHN)	No.	
b. For all mechanical and electrical components	0.33 Fy OR 0.2 Fu	0.67 Fy OR 0.4 Fu
	whichever	is less

3. Design Criteria for Gate Hoist

a) Loads

The loads used in hoist /operating system design shall include the following:

- Suspended weight of gate including weight of hoist rope, fittings, side seal friction and wheel friction.

- Load due to operating motor maximum torque. Maximum motor torque used for design purposes shall be the maximum torque which the motor can develop over its entire speed range with an impressed voltage equal to 112 percent of its rated voltage.

b. Efficiencies

Efficiencies of operating machinery components shall be assumed as no greater than the following:

- Speed reducer with worm gear	68 percent
- Speed reducer (triple reduction)	70 percent
- Gear and pinion	95 percent
- Bearings	96 percent

c. Operating Speed and Force

The hoisting speed for all fixed wheel and slide gates shall not be less than 1/16 in. per revolution for hand operated hoists. For motorized hoists the speed will be 1 ft. and 6 inches per minute for fixed wheel & slide gates respectively. The operating force on handle shall not be more than 17 lbs for all manually operated hoists.

d. Shafting

Shafting shall be designed in accordance with Clause 17.1.9(D) "Working Stresses". A shock or fatigue factor of 1.25 shall be used for shafting, except for speed reducers, which shall conform to applicable AGMA standards.

e. Gears

Gear design shall be in accordance with applicable AGMA standards.

f. Drums

The minimum diameter of the drum for winding the rope shall be not less than 20 times the nominal rope diameter. The outside diameter of the drum flanges or spacers shall not be less than the outside diameter of the rope wrapped on the drum. With gate resting on the sill, there shall be at least two complete wraps on each drum.

g. Walkways and Catwalks

Walkway flooring shall be designed for a uniformly distributed live load of 105 lb/sq. ft. plus a superimposed concentrated load of the heaviest piece of hoisting equipment or sub-assembly. Stair treads and their fastenings shall be designed for a concentrated live load of 1000 lbs. The catwalk shall be of clear width as shown on the Drawings and shall be designed for a uniform live load of 50 lb. per sq. ft. plus a single movable concentrated load of 1000 lb. The catwalk structure shall be sufficiently rigid to deflect no more than 0.250 in. under the above maximum live load conditions.

h. Hoist/Operating Platforms

The platforms shall be designed to suit the proposed equipment layout. All mechanical components will be supported directly on the structural members of the platform. The platform gratings shall be all welded construction and shall be fastened to the steel supports by clips or fasteners subject to the approval of the Engineer. Platforms will be tied down to concrete pier by means of anchor bolts designed to resist all possible loading cases. Platforms shall be designed to carry the specified live loads, dead loads, machinery loads, catwalk loads, and normal hoisting/operating loads at the specified basic stress. The platform shall also be designed to resist the loads resulting from stall torque of the operating motors together with dead and machinery loads. Deformation of the hoist platforms shall be limited to the amount, which will limit the maximum gear misalignment to that permitted by AGMA Standards.

Minimum Dimensions 17.1.10 A. Material Thickness

1.	Plate thickness on any structural member except webs of rolled shapes	3/8 in.
2.	Webs of rolled shapes	5/16 in.
3.	Embedded metal with exposed surfaces	1/2 in.
4.	Completely embedded metal	7/16 in.

5. Diameter of bolts or screws on gate structures — 3/8 in.

6. Diameter of adjusting bolts between frame or embedded part and welding pad — 5/8 in.

B. Weld Size

Fillet weld, leg length — 1/4 in.

Electrical Features 17.1.11 A. General:

Electrical equipment shall conform to all applicable IEEE, ANSI, and NEMA Standards. Conduit and wiring installation shall conform to ANSI-C1 (NFPA-70), "National Electrical Code", considering the tropical conditions of the location. All requirements of these Documents and all Contractor's guarantees shall be based on operation under tropical conditions.

B. Electrical Voltage Ratings: Electrical voltage ratings of power supply shall be as follows:

1. Motors

   a. 400 V, 50 Hz, 3-phase ac for motors rated 1/2 hp and above.
   b. 230 V, 50Hz, single-phase ac for motors rated less than 1/2 hp.

2. Controls, Lights, and Heaters

   a. 230 V, 50Hz, single-phase ac.
   b. 110 V, dc.

C. Motors

1. General: Motors shall be of the squirrel cage induction type designed for full voltage starting and operation with rise upto 85°C above 50°C ambient temperature. They shall be classified as totally enclosed externally air cooled. All motors shall be capable of furnishing the required output for the required hoisting cycle without reaching injurious temperatures, with the combined variations of voltage and frequency not exceeding 10% of rated voltage and frequency, provided the frequency variation does not exceed 5%. The motors shall conform to the requirements of NEMA Publication No. MG-1, "Motors and Generators". Following are general requirements.

2. Insulation: All motors shall have Class F insulation of the sealed type suitable for application in humid or

damp tropical locations.

3. Terminal Boxes: Terminal boxes shall be of cast metal or rugged sheet metal covers with gasket. They shall be designed and mounted so that they can receive conduit from the top, bottom, or either side.

4. Finish: Motors shall have tropical protection finish, which shall include corrosion-resisting hardware, and a corrosion- resisting finish on the rotor and shaft.

5. Bearings: Bearings shall be ball or roller type in accordance with NEMA Publication MG-1, Par. MG1-14.37 and as required for each application. Ball and roller bearings may be of the sealed, permanently lubricated type.

6. Lifting Eyes: Lifting eyes (eye bolts) shall be furnished on all motors weighing more than 110 lb.

D. Main Disconnecting Switches

The main disconnecting switches shall be 3-pole, non-fusible, 600 V, heavy-duty safety switches or non-automatic circuit breakers. The switches shall be provided with pressure-type line terminals for incoming power cables of the size to be given by the Employer. Each disconnecting switch shall be suitably housed in a weatherproof NEMA Type IV enclosure.

E. Motor Starters

1. The motor starters selected shall be capable of meeting the starting and continuous running requirements of the connected load. The motor starters and associated control devices shall conform to the requirements of NEMA Publication No. ICS " Industrial Controls and System", except that no starter smaller than NEMA size 1 shall be used.

2. Each starter shall be a combination (circuit breaker and magnetic contactor) ac reversing across-the-line type starter with 3-pole thermal overload relays with manual reset. The circuit breaker shall be 3-pole, 600 V ac, 50 Hz, enclosed with molded case and minimum 100 A fuses. The breaker trip units shall be interchangeable and the instantaneous magnetic trip units shall be adjustable where applicable. Instantaneous magnetic trip units when not adjustable, shall be set at approximately 10 times the continuous current rating of the circuit breaker. The circuit breaker shall have a minimum NEMA interrupting capacity of at least 22,000-A rms symmetrical at 480 V ac. The

poles of the breakers shall operate in unison and completely isolate the contactor from the supply voltage. The operating magnet coils shall be encapsulated, cast or similarly constructed such that oil, fungus or moisture will not damage them.

3. Motor starter auxiliary contacts and associated circuit shall be provided as required.
4. The motor starters shall be in a weatherproof NEMA Type IV enclosure, or open type mounted in a weatherproof control panel. The starters shall be mounted in the electrical equipment area. If open type starters are furnished, a barrier shall be provided to separate the high voltage circuits from any other electrical equipment mounted in the common control panel.

F. Electrical Wiring and Terminals

1. Internal wiring of enclosures, panels, switches housings, etc. shall be complete and ready for operation. Wiring shall be neatly arranged, grouped, properly supported, enclosed in conduits or otherwise protected as required, and terminated. Provisions for external incoming wiring connections (by the Employer) to terminals or cable plug receptacles at the side of the control panels shall be in accordance with requirements to be given by the Employer.

2. Wire shall be 600 V, 90° C. stranded copper conductor with moisture, heat and oil resistant insulation suitable for conductor capable of maximum operating temperature of 75° C. Minimum conductor size shall be 2.5 mm2 (No. 14 AWG). Construction of the wire shall conform to ICEA Publication No. S-6-402, NEMA Publication No. WC5 "Thermoplastic Insulated Wire and Cable for Transmission and Distribution of Electrical Energy".

3. Terminal blocks shall be rated not less than 600 V and 30-A. Terminal marking strips shall have the wire designations printed thereon corresponding to those on the wiring diagrams. At least 20% extra terminals and connections shall be provided in each group of terminal blocks and in each set of plug-in receptacles.

G. Conduits

1. General

Conduits shall be installed for routing of and for mechanical protection of all wiring external to control cabinets (such as the motor feeders). Rigid metal

conduit or liquid-tight flexible conduit with associated conduit fittings, boxes and hardware shall be used. Installation of all conduit, boxes, fittings, and accessories shall conform to the requirements of ANSI-C1, "National Electrical Code," insofar as applicable.

2. Rigid Metal Conduit

Rigid metal conduit shall be black enameled steel of 16 SWG wall thickness. The coating shall be of enamel which should not flake or crack from bending or rough usage.

3. Flexible Conduit

Flexible conduit shall be hot-dip galvanized conforming to UL-1, "Flexible Steel Conduits", or liquid-tight flexible conduit.

4. Conduit Fittings and Covers

Conduit fittings and covers shall be galvanized, or cadmium plated gray iron or malleable iron castings with gaskets as required. They shall comply with NEMA Publication No. FB-1, "Conduit Fittings, Cable Fittings, and Accessories".

5. Outlet, Terminal, Junction, and Pull Boxes

Cast Ferrous or Aluminum outlet terminal, junction, and pull boxes shall conform to U.S. Fed. Spec. W-C-58a, "Conduit Outlets and Entrance Caps, Electrical, Cast Metal for Shore Use". Covers shall be secured with screws. Gaskets shall be provided for boxes.

H. Relays

The relays selected and their contact configuration shall be as required by the circuitry. Relays shall be provided with covers. Relay coils and contacts shall be suitable for continuous operation in the control circuitry for which they are used. The relay coils shall be of a type that requires a minimum continuous current. The relays shall be vibration proof and shock-proof.

I. Running Time Meters

A running time meter suitable for operation on the rated control voltage shall be furnished to totalize the running time of motor. The meter register shall be non-reset, shall provide for recording up to at least 9999 hr of elapsed operating time.

J. Solenoids

Coils for solenoid shall be rated for tropical environmental conditions. They shall be encapsulated or impregnated with a resin, which resists oil, fungus, dampness or moisture. Solenoid coils shall have continuous duty ratings, adequate to perform the intended duty.

K. Electrical Control Cabinet

1. General

a. The operating electrical control cabinet shall contain all relays, time relays, motor starters, disconnecting switches, control and lighting transformers, and any additional electrical equipment required to provide proper and safe operation of the system. All electrical control components shall be mounted inside the control cabinet. No equipment shall be installed on the doors of the enclosure. All the control and indication equipment shall be labeled in English language.

b. A local control panel shall be mounted on the electrical control cabinet.

2. Enclosure

a. The enclosure of the electrical control cabinet shall be a NEMA Type IV weatherproof cabinet constructed of heavy gauge steel not less than 0.125 inch thick. This cabinet shall be provided with hinged and gasketed doors on the front and on any other side required for full access to the equipment. All indicating equipment shall be visible with the door in the closed position; all controls shall be behind the doors.

b. The doors shall be furnished with cylinder type locks and shall be keyed alike (master key). The door which should be opened for operation of the control panel, but which shall not offer access to any other electrical equipment, shall also have a different key not suitable to unlock other doors of the cabinet, (operator's key). Six keys of each type shall be furnished.

c. The cabinet shall be provided with openings and glands for conduits entering from the rear, from below or from either side, as practicable. Terminal boxes and connector receptacles shall be provided on either side or at the rear of the

cabinet.

d. For control cabinets installed exposed to the weather, a rain protective canopy shall be provided above the door, which is to be opened to operate the controls.

3. Local Control Panel

a. The local control panel shall contain all pushbuttons, indicating lights, position indicators, selector and transfer switches, meters, and other indicating devices, required for proper and complete operational control of the equipment. These control items shall be functionally displayed in appropriate locations. A main disconnecting switch shall be mounted on the local control panel.

b. If the local control panel is arranged on a hinged inside door, this door shall be provided with a lock keyed alike with the enclosure door(s) (master key).

c. The local control panel shall be provided with a switch to turn off all indicating lights when the control module is unattended.

4. Indicating Lights

Indicating lights shall be complete with lamps, and colored lenses or caps. Lamps shall be replaceable from the front of the panel. They shall be suitable for continuous operation.

5. Pushbuttons

Pushbuttons shall be of the flush panel mounted, heavy duty type, rated 600 V, with momentary contact circuits rated 10-A continuous. Number of contact circuits shall be as required by the switching function. Pushbuttons shall be furnished with engraved legend plates in English.

6. Selector Switches

The selector switches shall be of the flush panel mounted, heavy-duty type, rated 600 V, with contact circuits rated 10-A continuous. Number of contact circuits shall be as required by the switching functions. Each selector switch shall be provided with a legend plate in English clearly marked to show each operating

position.

7. Common Control Transformer

A control transformer shall be provided in each of the control modules. The control transformer shall have sufficient volt-ampere capacity to continuously carry the control circuit load required for the control module. A fuse shall be provided in the ungrounded leg of the control transformer secondary.

8. Control Panel Lighting and Outlets

a. Lighting: The control panel shall have lighting provided to facilitate operation and maintenance. A lighting transformer shall be provided and mounted within the control panel. Its primary supply feeder and each secondary branch feeder shall be protected by thermal magnetic circuit breaker.

b. Outlets: Two 230 V ac convenience outlets shall be provided in each control panel for maintenance tools. They shall be rated 15-A, 2-pole, 3-wire, and shall conform to NEMA Standard WD-1.

9. Grounding

All electrical equipment within the control module shall be effectively bonded and grounded. Each control module shall be provided with a ground pad or bus for accepting this external ground cable. The Contractor shall design complete grounding system and submit for Engineer's approval.

10. Heaters

All cabinets containing electrical control and switching equipment and instruments shall be equipped with electric heaters for moisture control. The construction of the enclosures and the placement of the heaters shall ensure effective circulation of air and prevent damage to equipment by overheating. The heaters shall be rated for 115% of the nominal operating voltage. The heaters shall be designed to provide adequate heat to keep the cabinet dry when energized at their nominal operating voltage. Controls shall be of the automatic differential thermostat type to limit temperature rise when the heater circuits are energized.

Workmanship 17.1.12

A. General

Components and spare parts shall be interchangeable wherever possible. Surface finish of machined parts shall be adequate for their functional requirements. Machining of fits on renewable parts shall be accurate and to specified dimensions so that replacements made to drawings size may be readily installed.

B. Electric Welding

1. General

All welds shall be made continuous and watertight. All butt welds shall be full penetration welds welded from both sides.

2. Preparation of Base Material

Members to be joined by welding shall be cut to shape and size by mechanical means such as shearing, machining, grinding, or by gas or arc cutting, to suit the conditions. Design of welded joints and selection of weld filler metal shall allow thorough penetration and good fusion of the weld with the base metal. The edges of surfaces to be welded shall be sound metal free of visible defects, such as laminations or defects caused by cutting operations and free from rust, oil, grease, and other foreign matter.

3. Welding Qualifications

The qualification of welders for all welding, including weld repairs shall conform to the relevant AWS Standard Specifications. The Contractor shall furnish the facilities, all equipment, materials and other articles required to perform qualification tests of his welders and welding operators.

4. Weld Finish

Welds shall in general display good appearance and a surface suitable for painting. Structural welds shall be ground and blended to avoid stress raisers. All welds, which require nondestructive examinations, shall be dressed by chipping and grinding as required for good interpretation by the selected weld examination methods.

C. Steel Castings

Castings shall be free from injurious defects and shall be satisfactorily cleaned for their intended use. Surfaces of castings, which do not undergo machining, shall be dressed for good

appearance and painting. The location of existing defects shall be determined, and all defects, which impair the strength or utility of the casting, shall be removed. The structure of the castings shall be homogeneous and free from excessive nonmetallic inclusions. An excessive concentration of impurities or separation of alloying elements at critical points in a casting shall make it liable for rejection.

D. Nondestructive Testing

1. General

Unless otherwise indicated, all nondestructive tests shall be in accordance with ASTM Standards.

2. Examination of Welds

a. Main Welds

All butt welds on skinplates and beam flanges, and all welds on other main components shall be given complete nondestructive examination by ultrasonic, dye penetrant, or magnetic particle methods, supplemented by radiographic examination. Supplemental radiographic examinations shall include examination of areas where interpretations by other methods is unclear or where the integrity of the weld is doubtful.

b. Secondary Welds

The Engineer shall have the right to request random spot-check examination of welds, including radiographic examination, as part of the Equipment inspection.

c. Technique and Acceptance Standard

Examination of welds shall be in accordance with the technique and acceptance standards of "AWS Code D-1.1 welding in Building Construction".

3. Examination of Castings

All major castings shall be given a complete ultrasonic examination and a radiographic examination insofar as practicable. Where radiographic examination is not practicable due to configuration or accessibility, the castings shall be examined by dye penetrant or magnetic particle methods in addition to the ultrasonic

method.

4. Examination of Forgings

Major forgings shall be given ultrasonic examination with liberal overlap and other applicable nondestructive tests, to determine that they are sound. The structure of forgings shall be homogeneous and free from excessive nonmetallic inclusions. An excessive concentration of impurities or separation of alloying elements at critical points in a forging will be cause for its rejection.

E. Structural Work

Design and fabrication of structural parts shall conform to the applicable provisions of the AISC "Specification for the Design, Fabrication, and Erection of Structural Steel for Buildings," of the AISC "Code of Standard Practice for Steel Buildings and Bridges."

F. Machine Work

1. General

All tolerances, allowances, and gauges for metal fits between plain (nonthreaded) cylindrical parts shall conform to ANSI-B4.1. "Preferred Limits and Fits for Cylindrical Parts," for the class of fit as shown or otherwise required. All drilled holes for bolts, which are intended to match other drilled holes, shall be accurately located and drilled from templates. No machining shall be done on working surfaces of "Lubrite" bushings or washers.

2. Finished Surfaces

All surfaces that are indicated on the drawings or those that require machining for their intended function, or those that are usually machined according to good shop practice shall be machined. Surface finish qualities shall be adequate for the intended use and shall be indicated on the Contractor's drawings and shall be in accordance with ANSI-B46.1. "Surface Texture". Compliance with specified surface will be determined by sense of feel and by visual inspection of the work compared to standard roughness specimens, in accordance with the provisions of ANSI B-46.1.

3. Unfinished Surfaces

So far as practicable, all work shall be laid out to secure proper matching of adjoining unfinished

surfaces. Where there is a large discrepancy between adjoining unfinished surfaces they shall be chipped and ground smooth, or machined, to secure proper alignment. Unfinished surfaces shall be true to the lines and dimensions shown on the Drawings and shall be chipped or ground free of all projections and rough spots. Depressions or holes not affecting the strength or usefulness of the parts may be filled in an approved manner. Corrosion resistant steel seal plates shall have all surfaces thoroughly cleaned and those in contact with seals shall have a surface finish of 63 RMS or finer.

4. Pins and Pin Holes

Pin holes shall be bored true to gauges, straight, and at right angles to the axis of the member. Pinholes shall have a surface finish of 125 RMS or finer. The boring shall be done after the member is securely fastened in position.

5. Protection of Machined Surfaces

a. Machine-finished surfaces shall be thoroughly cleaned of foreign matter. Finished surfaces of large parts and other delicate surfaces shall be protected with wooden pads or other suitable means. Unassembled pins and bolts shall be oiled and wrapped with moisture- resistant paper or protected by other approved means.

b. Finished surfaces of ferrous metals to be in bolted contact shall be washed with a rust inhibitor and given one thin coat of white or blue lead and tung oil.

G. Lubrication

Before assembly all bearing surfaces, journals, and grease and oil grooves shall be carefully cleaned and lubricated with an approved oil or grease. After assembly, each lubricating system shall be filled with an approved lubricant. "Lubrite" bearings shall not be greased and shall be assembled dry according to the manufacturer's instructions. Solvents shall not be used on "Lubrite" bearings.

H. Tolerances

1. General

All tolerances shall be selected by the Contractor to correspond to the accuracy required for the proper operation of the equipment considering the nature and

function of the part. All tolerances shall be indicated on the Contractor's drawings and submitted for review. The tolerances specified in the Tender Documents are maximum tolerances applicable to the equipment when it is installed. It shall be the Contractor's responsibility to establish finer shop tolerances, if necessary to meet the specified design or operational requirements or for interchangeability of spare parts. All tolerances shall be selected with due consideration to the nature and function of the parts and to the corresponding accuracy required to secure proper operation, but shall not exceed the tolerances specified in these Documents.

2. Fixed Wheel Gates, Slide Gates, Stoplogs and Embedded Parts

a. Skin plate:
The bottom and top edge of each skin plate shall be parallel within ± 0.002 in. per 10 in. height. The length of the two diagonals connecting the skin plate corners shall be within ± 0.030 in. for any 10 ft. of skin plate perimeter or within ± 0.125 in. maximum, whichever is smaller.

b. Sealing Surfaces
The plane formed by side and sill seals shall be true within ± 0.060 in.

c. Sill Seal Backing Bars
Sill seal backing bars shall be within ± 0.060 in. of a plane surface formed by the top of sill beam.

d. Embedded Parts

Seal Bearing Plates for Gates and Stoplogs:
Each bearing plate shall be within + 0.060 in. of the design plane along its length and ± 0.008 in. along its width. Bearing plates shall be checked by means of 10 ft. and 5 ft. straight edges and feeler gauges. The maximum deviation from 10 ft. straight edge shall not exceed 0.080 in. and 0.02 in. from the 5 ft. straight edge.

Track Plates
Track plates for gates shall be within ± 0.040 in. of design plane along their entire length and ± 0.004 in. across their width. Tracks shall be checked by means of 10 ft. and 5 ft. straight edges and feeler gauges and shall be straight

within ± 0.008 in. over any 10 ft. length or ± 0.002 in over any 5 ft. length.

Sealing Surfaces

- Side and top seal bearing plates shall be in the same plane within ± 0.030 in.
- Sill beams shall be square with the centerline of side seal bearing plates and shall have a maximum camber of not more than 0.060 in. for the entire length.

Guides

All guiding surfaces of each guide shall be straight within ± 0.04 in. over any 10 ft. length. All guides shall be parallel with their opposite guide across the opening within ± 0.125 in.

Structures and Embedded Parts 17.1.13

A. Structures

1. The structure of each item of the Equipment and embedded parts shall basically be of welded steel construction. All welding shall be done in the shop, except welded field splices.

2. Field Splices

a. Field splices (or field connections) shall be provided wherever required for compliance with the size of weight limits for transportation.

b. Permanent field splices shall be made either with fitted bolts or with high-strength bolts, or by field welding. Semi-permanent (disconnectable) field connections shall be made with pins or bolts. Fitted pins or bolts shall be used if exact positioning is required.

c. The location and arrangement of field splices shall be such that they do not affect the integrity, rigidity, function or alignment of the structure. Field splices shall be located, as far as possible, away from highly stressed areas, and shall not be made in main girders.

d. Field welded splices shall not be used where distortions due to welding might affect finished tolerance requirements. Chamfering and other preparation for field welding shall be completed in the shop. Backing cover plates shall be provided for

temporary connection during shop assembly and field welding.

e. Exact relative position and alignment of members to be connected by field splicing shall be established by shop-reamed dowels, fitted bolts or closely fitted shear lugs, so that no field alignment work is required at the connection. The strength, quality and arrangement of such dowels, bolts or lugs shall be proportional to the member size and adequate for their purpose.

f. No field or shop welded splicing shall be used on members heat treated in the shop.

3. Stress Relieving

The Contractor shall stress relieve all parts which are to be heat-treated. In addition, the Contractor shall stress relieve any part where stress relieving is required to obtain the specified tolerances or other required features.

4. Drain Holes

Drain holes or other openings of suitable size, quantity and location shall be provided to ensure effective drainage of all water accumulated from submergence or weather conditions.

B. Sealing System

1. General

a. Each Gate Unit shall be provided with a sealing system consisting of seals mounted on the gate and seal plates embedded in the concrete structures. Seals shall not be mounted on embedded parts.

b. The sealing system for slide gates shall consist of side, bottom and top seals. The sealing system shall be continuous providing a tight closed sealing line without gaps when the gate is closed.

c. The sealing system for fixed wheel gates and stoplogs shall consist of side and bottom seals. The sealing system shall ensure a tight closed sealing without gaps when the gate is closed.

2. Seal Plates

   a. The sealing surface of the seal plates shall be arranged as shown on the Tender Drawings.

   b. Seal plates shall be of an adequate width to ensure that seals remain on seal plates under all possible working conditions. These working conditions shall cater for the most unfavorable combinations of all factors causing relative position change, including the following:

      - the contact width of the expanded rubber seal when compressed by maximum load.

      - the extreme lateral positions of the gate as limited by actual clearances.

      - the most unfavorable manufacturing and erection tolerances.

      - deformation or deflection of structures.

      - thermal expansion effects.

3. Seal Profiles

   Seals shall be of one of the following profiles, as specified.

   a. Wedge Type Seal
      Wedge type seals shall be without cladding and shall have a rectangular profile with chamfers as required.

   b. L & J-Type Seals
      L & J-type (music note type) seals shall be with fluoro-carbon cladding as shown on the Drawings.

   c. Bronze Bars
      Bronze Bars shall have rectangular profile as shown on the Drawings.

   d. Gaskets
      Gaskets shall be flat or of some other profile suitable for their function.

4. Seal Arrangement and Mounting

   a. L & J-Type Seals
      - L & J-type seals shall be arranged to have a positive initial pre-compression when the

gate is closed and to have water admitted to the reverse side of the seal so that water pressure increases seal compression. Mountings shall provide adequate freedom of movement for seal deflection.

- Seals shall be seated on seal seating bars and held in place by clamp bars bolted to the gate.

- Seal seating bars shall be continuous within each section.
- Clamp bars shall be arranged in sections ending at corners.

- Clamp bars shall be fastened with CRES bolts, nuts and washers.

- The splices of clamp bars shall overlap all seal splices by at least 4 in.

b. Wedge Type Seals

- Wedge type seals shall seal by expansion of the edge of their profile when the seal is compressed due to the gate weight or water load.

- Wedge type seals shall be seated on the gate skinplates or seal seating bars, and clamped as specified for J-type seals.

c. Seal Corners

- Corners where seals of the same type of profile are connected shall be molded in one piece.

- Corners where wedge type seals are connected to L & J-type seals shall be overlapped and cemented.

- At corners where the sealing plane is shifted, corner blocks shall be provided. Corner blocks shall be compressible.

5. Seal Splices

a. Seal lengths
Seals shall be furnished in sections as long as feasible. Each section shall have minimum 6 in. of excess length for field splices and for trimming the seal end in the

field.

b. Shop Splices
All splices other than those specified herein as field splices shall be connected in Contractor's shop.

c. Field Splices
Connections between a lower corner block and either a side seal or a bottom seal, shall be field spliced.

C. Guiding System

1. General

Guiding system shall perform one or more of the following functions:

- When the gate is handled above the working area, the guiding system shall ensure that the gate is in the required position and shall correctly engage the frame when lowered.

- When the gate is handled in its working area the guiding system shall ensure that the gate remains engaged with the frame.

2. Guide Plates and Guide Rails

a. Guide plates shall be used for restricting the gate in one or two directions per plate. Guide rails shall be used for restricting the gate in two or three directions per rail. Guide rails and guide plates shall be part of the embedded parts.

b. Geometry, clearances and contact areas in the guiding system shall be established according to the requirements shown on the drawings.

c. When defining the extreme positions of the gate for geometric layouts, the most unfavorable combination of all possible effects, such as shifts in clearances, tolerances, deformations and expansions shall be considered.

D. Gate Accessories

1. Lifting Lugs
Two lifting lugs shall be provided on each gate for making connection to hoisting means, as shown on the Drawings.

2. Handling Eyes
   Permanent handling eyes shall be provided on gates for attachment to lift the gates for handling during manufacture, erection and maintenance.

3. Dogging Devices
   Gates shall be provided with dogging devices to hold them in maintenance position at the top of the slots.

4. Ballast
   Ballast, if necessary, shall be confined within the structure, without protrusions.
5. Counter Weight
   Fixed wheel gates, if necessary, shall be provided with appropriate counter weight to minimize the hoisting effort. It shall have to be checked by Contractor for each fixed wheel gate.

6. Access Ladders, Hoisting Deck and Railing
   Access ladders, hoisting deck and railing shall be provided as shown on drawings.

E. System for Alignment and Anchorage of Embedded Parts

1. All embedded parts shall be set in blockouts and aligned with studs field welded to welding pads embedded in first stage concrete where required.

2. The embedded parts shall be reasonably smooth, true to form and free from twists, warps and kinks, so that they may readily be brought within erection tolerance and straightness requirements.

3. The system for alignment and anchorage shall include the following:

   a. Alignment studs with two nuts and two oversized washers.

   b. Erection brackets shall be shop welded to the embedded parts or frames wherever required. The brackets shall be arranged to provide the following:

      - Ease of placing the embedded part on studs already welded to welding pads.

      - Convenient access for adjusting and tightening of all nuts.

      - Strong and rigid holding in position during placement of second stage concrete.

4. Welding pads embedded in first stage concrete shall be located so as to provide a minimum 4 in. distance between a construction joint and the nearest edge of the welding pad.

F. Hoisting / Operating Machinery

1. Fixed Wheel Gates

Manually/electrically operated wire rope and drum type hoist shall be installed at all the fixed wheel gates.

2. Slide Gates

Manually operated stem type hoist shall be installed at all the slide gates.

3. Stoplogs

Mobile crane shall be used to handle stoplogs.

G. Embedded Parts for Gate Equipment

1. General
Embedded parts of the Equipment shall include all the metal parts, which are to be embedded in first stage or second stage concrete or otherwise permanently attached to the civil structure.

Each set of embedded parts supplied and installed by the Contractor in first and second stage concrete shall include the following:

a. Frame
A complete frame shall include one sill beam, two side seal plates (including side seal bearing plates and guide rails). The frame shall also include slot corner protection angles and welding pads.

b. Appurtenances
Appurtenances shall include embedded bearing plates, seating plates for installing hoisting machinery, platforms, dogging devices etc.

2. Seal Bearing Plates, Guide Plates and Rails

a. The side and sill seal bearing plates, guide plates and rails shall be of CRES.

b. Splices shall be avoided on side seal bearing plates, if possible. If splices cannot be avoided

because of transportation limitations, the seal bearing plates shall be spliced by field welding and grinding. Field splices on corners between different seal bearing plates shall also be spliced by field welding and grinding.

c. The side seal bearing plates shall extend from the sill beam to the top of the gate.

d. The top of the side seal bearing plates, guide plates and rails shall be tapered to ensure safe and correct engagement of the seals and guide blocks when the gate is lowered

Name Plates

17.1.14 The Equipment items shall be provided with nameplates, written in English, suitably engraved, weather resistant, containing operating instructions, warnings, or other information essential to the proper use of the Equipment. Information on these nameplates shall include rated capacity of lifting hooks and lifting lugs or pins, required for lowering and raising the gate.

All nameplates shall be permanently attached to the respective parts, components or equipment items in clearly visible locations.

Miscellaneous Equipment Details

17.1.15 The following stipulations referring to miscellaneous design details shall be applied to all Equipment covered by these Specifications.

A. Locking of Bolted connections

All screws, bolts and nuts shall be provided with a locking device.

B. Handling Provision

All parts components and assemblies which are heavier than 33 lbs shall be provided with suitable provisions for handling, such as eyebolts, lugs, hooks, tapped holes for eyebolts or holes with rounded corners for passing slings.

Painting

17.1.16 A. Scope

The Contractor shall furnish and apply all paints as specified herein, before packing and transportation, with the exception of those parts or surfaces that are expressly designated as unpainted. Surfaces to be painted shall receive the preparatory treatment and number of coats prescribed in the painting schedule. The applicable provisions of the SSPC shall apply unless specifically covered otherwise in this clause.

B. Standard Products

All materials, supplies, and articles furnished shall be the standard products of recognized and reputed manufacturers.

C. Surface Preparation:

1. Cleaning and preparation of surfaces shall be as specified in Clause 17.1.16.E, "Painting Schedule".

2. Surfaces to be painted shall be cleaned before applying paint or surface treatment. All oil, grease, dirt, rust, loose mill scale, weld spatter, slag or flux deposit, old weathered paint, and other foreign substances shall be removed as hereinafter specified. The removal of oil and grease shall, in general, be accomplished before mechanical cleaning is started. Where specified, blast cleaning shall be done in accordance with SSPC-SP-10. "Near White Blast Cleaning". Clean cloths and clean fluids shall be used to avoid leaving a thin film of greasy residue on the surfaces being cleaned. Cleaning and painting shall be so programmed that dust or spray from the cleaning process will not fall on wet, newly painted surfaces. Where required, imperfections and holes in surfaces and open joints between matching surfaces shall be filled or obliterated in an approved manner. Any required wash treatment shall be done in accordance with the paint manufacturer's instructions. Extreme care shall be exercised when blast cleaning machinery components to prevent blasting materials from entering or damaging bearings, machined surfaces and similar precision parts.

3. Surface preparation and paint application shall be done after the parts are completely finished and checked in shop assembly. The parts shall be disassembled to the extent necessary to enable cleaning and painting those surfaces, which are inaccessible when assembled. After finish painting and drying, parts shall be reassembled as required for transportation and paint. Bolts and other connections that will not be removed in erection shall be painted by touch-up.

D. Colors

Colors shall be as directed. Alternate coats of paints having the same color shall be tinted in order to insure that all surfaces are properly coated with the specified number of paint coats. Unless otherwise specified, the color of all undercoats shall match the color of the finish paint.

E. Painting Schedule:

	Surface	Method of Surfaces Preparation	Coats
1.	Ferrous Metal Subject to Continuous Immersion in Water.	SSPC-SP10, Near White Blast Cleaning	Two coats in workshop of Zinc Rich Primer Epoxy paint with minimum dry film thickness 50 microns. Two coats at site of Epoxy Paint, each coat minimum 200 micron dry film thickness.
2.	Ferrous Metal subject to intermittent immersion and splash, exposed to favorable atmosphere or humid environment.	SSPC-SP10, Near White Blast.	Two coats in workshop of Pigmented Epoxy Paint with total dry film thickness of 50 micron. Two coats at Site of Epoxy Paint, each coat minimum 200 micron dry film thickness
3.	Ferrous Metal Expected not to Come in Contact with Water.	SSPC-SP10, Near White Blast Cleaning except galvanized surfaces.	Two coats of Silicone Aluminum Paint, total dry film thickness not less than 30 micron.
4.	Ferrous Metal Embedded in Concrete, Welding (erection) pads, erection studs: embedded parts surfaces in contact with concrete.	Clean	None
5.	Corrosion Resistant Steel Surfaces.		
	a. Seal Plates	Clean thoroughly, and grind smooth if required	None
	b. Other	Clean	None
6	Galvanized Surfaces	ASTM A 123 & A 153	Galvanize per ASTM A 123 & A 153

7. Mating Machined Surfaces

Mating machine-finished surfaces including bored and reamed holes, shall be thoroughly cleaned of foreign matter, and coated with a suitable rust- resisting compound which can be easily removed by a commercially available petroleum solvent. Finished surfaces of large parts shall be further protected with wooden pads or by other suitable means. Unassembled fittings, pins, bolts and nuts shall be oiled and wrapped with moisture-resistant paper or

protected by other approved means.

F. Paint Materials

The make of the paints to be used shall be selected by the supplier. The suppliers shall submit his proposed paint schedules together with applicable paint specifications for approval. However, the paint materials specifications shall meet the following requirements.

1. Zinc Rich Epoxy Primer
   Zinc rich epoxy primer shall conform to Permobel Protective Primer, manufactured by ICI, Pakistan, or equivalent.

2. Etch/Wash Primer
   Etch/Wash Primer manufactured by ICI, Pakistan, or equivalent.

3. Pigmented Epoxy Paint
   Pigmented Epoxy Paint shall conform to M10 Aluminum Epoxy finish manufactured by ICI, Pakistan or equivalent.

4. Coaltar Epoxy Paint
   Coaltar epoxy paint shall conform to Coaltar Epoxy Paint C-200 manufactured by ICI, Pakistan, or equivalent.

5. Silicone Aluminum Paint
   Silicone Aluminum paint shall conform to Dual Pack H/R Silicon Aluminum Paint manufactured by ICI, Pakistan, or equivalent.

G. Paint Materials for Field Touch-Up

The Contractor shall furnish paint for the field touch-up painting, of the same quality and color as used in shop painting.

Shop Assembly and Tests

17.1.17 (a) General

1. All shop assemblies and tests specified below for the various items of equipment will be witnessed by the Engineer and completed shop inspection reports shall be signed by him or his authorized representative. Copies of all shop inspection records shall be furnished to the Engineer. No equipment shall be transported to Site until it has been inspected. Prior to major shop assemblies and tests the Contractor shall submit an outline of the procedures and tests he plans to perform to

demonstrate fulfillment of the requirements of the drawings and Specifications.

2. While assembled, each item of Equipment shall be checked for dimensions, tolerances and accuracy of alignment. Any errors and misalignments discovered shall be corrected.

3. Before disassembling and after installation of dowels and fitting bolts between bolted subassemblies, all parts shall be clearly match marked.

(b) Gates and Stoplogs

1. Each finished and painted gate & stoplog including seals, wheels, hoists and all other applicable accessories shall be completely shop assembled. All field splices shall be assembled. Welded field splices shall be temporarily bolted for shop assembly.

2. All seals shall be fitted to their supports during the shop assembly and proper allowances shall be made for shrinkage after aging. Seal sections, which are furnished in excessive lengths for field splicing, shall be mounted successively.

Installation 17.1.18 A. Installation of Embedded Parts

(a) General

Each set of embedded parts shall be assembled in its blockout, brought to line and grade within the applicable tolerances and firmly secured in place on the alignment studs. The alignment studs shall be located with care so that no subsequent bending or forcing is required to match them with the corresponding holes in the frame and guide members. The alignment studs shall then be welded to the embedded welding pads. Alignment studs shall be adjusted and firmly tightened to hold the frames and guides securely in position while concrete is being placed in the blockouts. Additional bracing shall be provided where necessary to ensure the required alignment. Extreme care shall be taken to ensure that the guiding, bearing and sealing surfaces are within the tolerances specified throughout their entire length. Placement of concrete in blockouts shall not proceed until the frames and guides have been completely assembled,

cleaned of dirt, aligned, and secured at least throughout the height of the openings. The use of the gates as a support or brace for the guides during placement of concrete shall not be permitted. Caution shall be exercised in placing the concrete to avoid distortion and displacement of the frames and guides. Before placing the concrete in any one lift, and between placement of successive lifts, alignment tolerances shall be checked and remedial action shall be taken. Suitable windows shall be provided in the concrete forms to facilitate concrete placement and inspection. After all blockout concrete has been placed and forms removed the blockout concrete will be inspected and the embedded parts will be sounded to detect any voids. All voids shall be filled by pressure grouting. No grout holes shall be drilled in the sealing or bearing surfaces.

The tolerances specified in Clause 17.1.12 (H2) shall be met during installation of embedded parts for gates and stoplogs.

(b) Installation of Gates

The gates shall be installed as shown on the approved drawings. The bottom of the gate when erected shall be in true alignment to ensure a tight even bearing of the rubber seal on the embedded sill beams. The sides of the gate shall be in true alignment so that the seal when installed will have a tight and even bearing on the embedded sealing surfaces. The rubber seals shall be installed after the gate has been painted. The wheels on fixed wheel gates shall be properly and truly aligned keeping in view the proper deflection of the side seals.

(c) Installation of Gate Hoists

Each gate hoisting equipment complete with all accessories shall be assembled and installed as per approved drawings.

(d) Installation of Hoist Platform, Deck and Access Step Ladder

All hoist platform parts shall be accurately assembled and erected as shown on the approved drawings, and all match-marks of the fabricator shall be accurately followed. All of the material shall be handled carefully so that no part will be bent, broken or otherwise

damaged. Hammering which will injure or distort the members will not be permitted. Bearing surfaces and surfaces to be in permanent contact shall be cleaned carefully before the members are assembled or erected. At bolted connections, the bolts shall be drawn tight, and where required, the threads shall be burred or spot-welded so that nuts cannot become loosened. Where required, bolt holes shall be reamed in the field to provide a light-driving fit.

Inspection and Testing 17.1.19 (A) General

1. All equipment, apparatus, material and supplies forming part of the Equipment shall be subjected to inspection and tests at the plant of the Contractor at the discretion of the Engineer in the presence of a representative of the Engineer for conformity to the requirements of the Specifications. For field-testing of the Equipment, the method and procedure of the tests and inspection shall be as specified for the particular items or in conformity with one of the applicable recognized standards for making such tests and inspections or as approved by the Engineer. After being assembled by the Contractor in place at site, each complete machine or structural unit shall be operated through a sufficient number of complete cycles to demonstrate to the satisfaction of the Engineer that it meets specification requirements in all respects and is suitable for performing the work intended. Field tests shall be conducted under the supervision of the Engineer. The Contractor shall submit a schedule of the specified testing programme to the Engineer for his approval. Testing of related equipment shall be coordinated so that testing may proceed with a minimum of delay. Field tests shall start, proceed, stop and be resumed in accordance with the approved schedule and as directed by the Engineer.

2. Remedy of Defects
Defects disclosed during trial operations and tests shall be remedied. The Contractor shall stop work and shall notify the Engineer immediately when any defect is disclosed so that an assessment may be made as to where the responsibility for the defect lies, and so as to permit the recording of necessary data as to the extent of delay and the additional costs of work, labour and material required for remedying of the

defect. After defects in Equipment have been remedied, the Equipment shall be subjected to such retesting as may be necessary to demonstrate satisfactory operation.

3. Commissioning Tests
After the installation of each system or item of the Equipment and the system in which it operates, including testing and adjusting as outlined above, has been completed, the Equipment and system shall be given commissioning tests as specified for the respective item of the Equipment. During the final test, the Equipment shall be placed in service under normal operating conditions, and fully loaded where possible.

Commissioning tests will be witnessed by the Engineer and the Employer.

4. Records and Reports
Records of all tests shall be kept by the Contractor. All test reports shall be signed by the Contractor and shall be in the format approved by the Engineer. When approved by the Engineer, five (5) copies of the test reports shall be submitted by the Contractor to the Engineer. All site test reports will be combined into one comprehensive report to be prepared by the Contractor.

5. Test Equipment, Materials and Labour

Except as otherwise specified, all plant, testing equipment, materials and labour required for the performance of tests shall be furnished by the Contractor.

(B) Field Stage Tests
From time to time at various stages of installation, tests of sub-assemblies of the Equipment as instructed by the Engineer, will be carried out by the Contractor. The Contractor will conduct such tests, make records of all measurements, and instruct and advise as to any corrections or adjustments he considers desirable. A record of all stage tests shall be embodied in a report.

(C) Performance Tests

1. Commissioning Tests
After each, Equipment has been installed, commissioning tests shall be conducted to prove that all parts have been accurately assembled and are

operating correctly.

a. Testing of Fixed Wheel and Slide Gates
Each gate shall be operated in its respective guide slot through a sufficient number of complete cycles to ensure that it is suitable for performing its intended function. Minor adjustments necessary to achieve the above shall be made where required. All joints and connections in the gate and sealing surfaces, which are field welded and where leakage may occur, shall be tested for water tightness prior to field painting. The gates and their embedded parts shall be thoroughly cleaned for all foreign material, with particular attention being paid to bearing and sealing surfaces, and the paint repaired where necessary.

b. Testing of Gate Hoists
After installation, the hoisting equipment shall be tested for proper operation and adjusted, if required. Each gate shall be operated through a number of complete cycles and, gate position indicators shall be tested for proper operation. Any defects and improper operation discovered during the tests shall be corrected by the Contractor and the appropriate tests repeated. All instrumentation and test equipment required for tests shall be furnished by the Contractor.

c. Testing of Stoplogs and Lifting Beam
Each section of the stoplog shall be operated with the help of lifting beam and mobile crane through sufficient number of cycles to ensure that it is suitable for performing its intended function. Minor adjustment necessary for smooth operation of stoplogs, and lifting beam shall be made by the Contractor.

2. Final Acceptance Tests

a. After the entire Equipment of a project feature has been completely assembled at the Site and placed in satisfactory operation, it shall be tested at or near full head by the Contractor to determine whether or not the requirements of the Specifications have been fulfilled.

b. The installed Equipment shall be tested to the satisfaction of the Engineer to prove that they meet the design and functional requirements of the Specifications.

17.2 FIXED WHEEL GATE EQUIPMENT

General **17.2.1** Fixed wheel gate equipment shall be provided for the structures as shown on drawngs.

(A) Scope

This section specifies the detailed requirements for the design and manufacture of the fixed wheel gate equipment to be furnished and installed in accordance with these Specifications. These requirements supplement and/or modify the applicable requirements of Section 17.1 "General".

(B) Fixed Wheel Gate Equipment

1. The fixed wheel gate equipment shall be complete with all parts and components required for installation and operation in accordance with the Specifications, except for those parts explicitly specified to be furnished by others.

For each structure of the following equipment shall be provided.

- Fixed wheel gates
- Hoists
- Hoisting Platforms, Access ladder and Railings
- Embedded metal parts which shall consist of all embedded parts including seal bearing plates, sill beam, guide rails, welding pads embedded in first stage concrete, alignment studs with nuts and washers.

2. Spare parts as listed in Clause 17.1.2(D) heretofore.

(C) Design Loading Conditions

The fixed wheel gates shall be designed for the loading conditions specified in Clause 17.1.9, heretofore.

Fixed Wheel Gate 17.2.2 A. Skin-plate Structure

The gate shall be of welded construction and consist of upstream skin plate strengthened by horizontal and vertical stiffener plates all conforming to ASTM-A36. Wheel axles shall be attached to end vertical stiffener plates by means of locking plates. Wheels shall move on downstream stainless steel/CRES rails. Special care shall be exercised in the fabrication of all parts

affecting the strength, rigidity and water tightness of the gate. Unless otherwise specified herein or shown on the Drawings, all connections shall be welded.

Each gate leaf shall be completely assembled in the shop and be free of twists, bends and open joints. Pockets or depressions that may hold water shall be provided with effective drains. Connections between structural members for the gate leaf shall have continuous welds designed to develop full strength of the members. Sections of skinplate shall be connected by continuous welding all around.

B. Wheels

Each gate shall be provided with fixed wheels of material conforming to ASTM-A583. The wheel rims shall be heat-treated to a minimum BHN of 225. Wheel shafts shall conform to the material of ASTM-A276. The rails will have hardness not less than 275 BHN.

Holes for the wheel shafts shall be bored and counterbored in pairs to a common axis after the gate's leaf is fully fabricated. The accuracy of locating and boring holes shall be such that the axis of the completed holes will be perpendicular to the vertical centerline of the gate and lie in a common plane which shall be parallel to the skinplate surface of the gate within a tolerance of plus or minus 0.060 in. Wheels on the same side of the gate shall be in a common plane through the mid-point of the wheel treads within a tolerance of + or - 0.006 in. and such plane shall be parallel to the corresponding plane through the wheels on the other side of the gate.

The bushings of the gate wheels shall be self-lubricating, lubrite bushings, suitable for use in water.

C. Seals

L & J-type rubber seals with fluoro-carbon cladding shall be attached to gate on upstream side with holding plates and bolts. Sill seal shall be compression type attached to bottom of gate with holding plates and bolts. Side and sill seals shall bear against stainless steel/CRES bearing surfaces. Sill beam steel strip and side seal bearing plates shall have hardness not less than 150 BHN. Joints in rubber seal shall be minimum in number. Holes in seals and gate skin plates will be drilled in workshop. After match marking, the seals will be attached to gates in field. Complete leak proof seal corner blocks shall be provided.

D. Embedded Parts

1. General

The fixed wheel gate shall be provided with one set of embedded parts which shall include sill beam, stainless steel/CRES seal bearing plates, guide rails, welding pads embedded in first stage concrete and alignment studs with nuts and washers. The guide rails shall extend from sill beam to top of the piers and side seal bearing plates shall extend from sill beam to 1 ft. above the top of fixed wheel gate. The top edge of guide rails and side seal bearing plates shall be tapered.

2. Guides

Gate side slots will act as guides for the gate. The width of the slots shall be such that it will provide ample clearance for gate movement and at the same time it will not allow the wheel collars to come out of rails. The rails shall also act as guides for gate wheels and will restrict the lateral movement of the gate.

E. Gate Hoist and Control

1. General

Manually/electrically operated wire rope and drum type hoist shall be provided for the gate operation. Each gate shall have an independent local control panel. The hoisting arrangement shown on the drawings is indicative only. The Contractor shall design the system and shall start fabrication after approval by the Engineer. The hoist shall consist of the following equipment:

a. Worm-gear Reducers
The worm-gear reducers shall be standard, high-grade reduction units suitable for the service intended, and the proportioning of all parts therein shall be in accordance with the best engineering practice. Either cylindrical or double envelope-type worm-gear reducers will be acceptable. The reducers shall be standard, regularly produced commercial units, manufactured in accordance with standard practice for heavy-duty worm-gear speed reducers. The worm-gear shaft shall extend through the housing on one end for the attachment of flexible coupling and on other

end for fixing of motor assembly and also handle for manual operation of the gate. Keyways shall be cut to suit all flexible couplings. Worm shaft and gear shaft openings shall be provided with seals or packing glands. The gear reduction ratio shall be selected such that one man effort will be required to lift the gate manually. The minimum output torque rating shall be not less than the torque required to lift the gate at a speed of 0.060 in. per revolution of handle.

b. Drums and Ropes

Drums shall be of fabricated construction or cast steel. Drum diameter shall not be less than 20 times the rope diameter. When assembled, the shafts and drums shall have a common horizontal axis. Each drum shall be supported by grease-lubricated, self-aligning, roller bearings and pillow blocks mounted on a common base plate. Drums shall be accurately machined and keyed properly to the shafts. Drums shall have sufficient grooves to provide two dead-wraps of the rope on them when the gate is fully closed. Drums shall be equipped with integral cable clamps. Rope shall be standard hoisting wire rope made of plow steel, galvanized, non preformed and regular lay. Rope size shall be selected according to the loading given in design criteria. Provision for adjusting the length of one of the two ropes in each hoist shall be made. The ends of the wire rope shall be fitted with wire rope fittings for connection to the gate. Dust covers shall be constructed of 16 gauge sheets steel. One intermediate shaft support containing a split babbitted bearing shall be provided between each drum and gear reduction unit.

c. Drive Shafts

The lengths of the drive shafts will depend upon the length of the worm-gear output shaft and shall be such that when the hoist is completely assembled with proper clearances between the faces of the halves of the flexible couplings, the distance between the drums will be approximately as shown on the Drawings.

d. Flexible Couplings

The flexible couplings shall be fully enclosed, dustproof, geared type, and shall be bored for tight fits on the shafts and shall be fitted accurately on the shafts, shall be of the size

rated for the shafts they connect and shall have torque ratings suitable for the load transmitted. The flexible couplings shall be designed for oil or grease lubrication, and shall be all metallic except that oil or grease seals may be of suitable non-metallic material.

e. Lubricating Fittings
Lubricating fittings shall be provided for parts needing lubrication.

f. Bearings and Bearing Blocks
Bearings and bearing blocks shall be of standard well known manufacturer like SKF or other equivalent known make.

g. Shafting
Shafting shall have provision for longitudinal movement. Lateral shaft deflections shall not be more than 0.01 in. per foot length of shaft and angular shaft deflection shall not exceed 0.08 deg. per foot.

F. Hoisting Platform
Hoisting platform shall be furnished for the gate to support the gate and all hoist loads. The hoisting platform shall consist of structural steel framework and grating/chequered plate flooring and access step ladder. Before being laid out, all structural steel components shall be straight and free from kinks and bends. All working surfaces shall be finished neatly. Connections between adjoining members shall be welded or bolted. Holes for bolts shall be accurately located and drilled 0.060 in. larger than the nominal size of the bolts. When placed in structure, the length of bolt shall extend at least 0.25 in. beyond the nuts. Washers shall be used with all bolts. Beveled washers shall be used on sloping member.

G. Handrailing

Handrailing of 2 in. dia schedule 40 painted steel pipe shall be provided along the opening side of all the hoist platforms, catwalks, walkways, piers and steps. Bends and turns shall be smooth and accurately formed. Railing and parts shall be shop assembled in convenient sections. Welded sections may be used provided that all welds are ground smooth. Railing shall be painted as specified in Clause 17.1-16 E2 "Ferrous Metal Expected not to come in contact with Water".

H. Gate Position Indicator and Gate Locking Arrangement

A gate position indicator shall be provided and installed with the gate so that the operator, while working on the hoist, can easily see and read the position of the gate. Position indication shall be shown by a pointer on a 12 in. diameter circular graduated scale. The Contractor shall design and provide required mechanism of speed reduction so that total travel of the gate can be calibrated on the scale. The Contractor shall also be required to provide a device to lock the gate at any position.

Shop Painting

17.2.3 The fixed wheel gate shall be painted as specified in Clause 17.1.16E(1) "Ferrous Metal Subject to Continuous and Intermittent Immersion in Water".

16.3 SLIDE GATE EQUIPMENT

General

17.3.1

Vertical slide type gates shall be installed at structures as shown on drawingd to regulate the flow of water.

A. Scope

This section specifies the detailed requirements for the design and manufacture of the slide gate equipment to be furnished and installed in accordance with these Documents. These requirements supplement and/or modify the applicable requirements of Section 17.1 "General".

B. Vertical Slide Gate Equipment

1. The slide gate equipment shall be complete with all parts and components required for installation and operation in accordance with these Documents, except for those parts explicitly specified to be furnished by the others.

2. Spare parts as listed in Clause 17.1-2(D) heretofore.

C. Design Loading Conditions

The vertical slide gates shall be designed for the loading conditions specified in Clause 17.1.9, heretofore.

Slide Gate

17.3.2 A. Skin-plate Structure

The slide gate shall be of welded construction

and consist of upstream skin plate strengthened by horizontal and vertical stiffener plates all of conforming of ASTM-A36. Special care shall be exercised in the fabrication of all parts affecting the strength, rigidity and water tightness of the gate. Unless otherwise specified herein or shown on the Drawings, all connections shall be welded.

Each gate leaf shall be completely assembled in the shop and be free of twists, bends and open joints. Connections between structural members for the gate leaf shall have continuous welds designed to develop full strength of the members. Sections of skinplate shall be connected by continuous welding.

B. Seals

Bronze bars shall be attached to gate on downstream side serving both as seals as well as load bearing. Wedge type rubber seal installed to the bottom of the gate shall act as sill seal. Side and top seals shall bear against CRES bearing surfaces having hardness not less than 150 BHN.

C. Embedded Parts

Each slide gate shall be provided with one (1) set of embedded parts which shall include sill beam, side channels with CRES seal bearing plates and anchor bolts, nuts & washers embedded in the concrete.

The side channels will act as guides for the gate. The width of the channels shall be such that it will provide ample clearance for gate movement.

D. Gate Hoist

Manually operated hoisting system shall be provided for each gate. Hoisting system shall consist of vertical screw type stems having square/Acme threads and associated worm gears and bevel gears etc. Hoisting arrangement shown on the Tender Drawings is indicative only. The Contractor shall design the system and shall start fabrication after approval by the Engineer.

E. Hoisting/Operating Deck and Platform

Hoisting/operating deck shall be furnished for the gate to support the gate and all hoist loads. The hoisting deck and platform shall consist of structural steel framework and gratings / chequered plate flooring. Before being laid out, all structural steel components shall be straight and free from kinks and bends. All working surfaces shall be finished neatly. Connections between adjoining members shall be welded or bolted. Holes for bolts shall be accurately located and drilled 0.060 in. larger than the nominal size of the bolts. When placed in structure, the length of bolt shall extend at least 0.25 in. beyond the nuts. Washers shall be used with all bolts. Bevelled washers shall be used on sloping member. Steel ladders shall be provided on both sides of each gate.

F. Handrailing

Handrailing of 2 inch dia. Schedule 40 painted pipe railing and posts shall be provided along the opening side of all the hoisting platforms. Bends and turns shall be smooth and accurately formed. Railing and posts shall be shop assembled in convenient sections. Welded sections may be used provided that all welds are ground smooth.

G. Gate Position Indicator and Gate Locking Arrangement

A gate position indicator shall be provided and installed with the gate so that operator while working on the hoist can easily see and read the position of the gate. Position indication shall be shown by a pointer on a 12 in. diameter circular graduated scale. The Contractor shall design and provide required mechanism of speed reduction so that total travel of the gate can be calibrated on the scale. The Contractor shall also be required to provide a device to lock the gate at any position.

Painting

17.3.3 Painting shall be carried out in accordance with Clause 17.1.16 (1) of these specifications.

17.4 STOPLOGS

General

17.4.1 Structural Steel Stoplogs shall be provided at the Cross Regulators Structures of main canal for inspection, maintenance and repair of the waterway and fixed wheel gates of the Canal.

Stoplogs shall be designed to withstand the applicable

differential head at each structure.

Wooden stoplogs of Deodar wood shall be provided at the head regulator for inspection and repair of slide gates of all the canal distributaries.

A. Scope

This section specifies the detailed requirements for the design and manufacture of the stoplogs to be furnished and installed in accordance with these Documents. These requirements supplement and/or modify the applicable requirements of Section 17.1 "General".

B. Steel Stoplogs

1. The stoplogs shall be complete with all parts and components required for installation and operation in accordance with these Documents.

2. Following steel stoplog equipment will be required for each cross regulator:

- Stoplogs Section

- Embedded parts which shall consist of all embedded parts including seal bearing plates, sill beam, guide plates, welding pads embedded in first stage concrete, alignment studs with nuts and washers etc.

- One (1) lifting beam for each structure

- No of wooden stoplogs as mentioned in sub section 17.4.5. here under:

C. Design Loading Conditions

All the stoplogs shall be designed for the loading conditions as specified in Clause 17.1.9.

Steel Stoplogs 17.4.2 A. General

The stoplogs shall be installed on structures as shown in the drawings.

B. Stoplogs Structure

The stoplogs shall be of vertical-lift type with downstream skinplate and seals. The structure shall be of welded construction conforming to ASTM-A36. No seismic load shall be considered for the design of stoplogs. The skinplate shall be reinforced by vertical and horizontal members welded to the skinplate. All

the stoplog sections shall be numbered.

C. Seals and Clamps

Each stoplog section shall be provided with J-type side and wedge-type bottom rubber seals. The seals shall be fastened to the stoplogs by CRES steel clamp bars.

D. Guide Shoes

Two guide shoes of CRES on each side of each stoplog section shall be arranged to engage with embedded guide plates.

E. Embedded Parts

Each set of embedded parts for stoplogs shall consist of two side-seal bearing and guide plates and one sill beam, all of corrosion-resisting steel. The guide plates shall extend from the sill beam to the top of the waterway. The side seal bearing plates shall extend from sill beam to 1 ft. above the top of stoplog and their top edges shall be tapered to avoid damage to side seals when stoplogs are lowered. The embedded parts shall be installed in the blockouts and adjusted by means of alignment studs attached to welding pads embedded in first stage concrete. After the alignment of the embedded parts, the blockouts shall be filled with concrete.

Lifting Beam 17.4.3 One lifting beam for each size of steel stoplog set shall be provided. The lifting beam shall be of welded construction. The beam shall be equipped with two semi-automatic engaging and disengaging hooks. Two guide rollers on each side of the lifting beam shall engage with the guide plate embedded in concrete for the stoplogs. The semi-automatic hooks and guide rollers shall be mounted on corrosion-resisting steel pins with self-lubricating bushings.

Wooden Stoplogs 17.4.4 The work under this section covers furnishing wooden stoplog of First Class Deodar wood alongwith embedded metal parts as shown in Drawing No. KC-6C/MC/TD/F10, for isolating steel slide gates of the distributaries for maintenance of the gates. The furnishing of stoplogs shall include sawing, planning, wroughting wood and providing and fixing steel parts of stoplogs i.e. end strips and rods etc., as per irrigation practice and/or as directed by the Engineer.

Shop Painting 17.4.5 The stoplogs and lifting beams shall be painted as specified in Clause 17.1.16 E (1) “Ferrous Metal Subject to Continuous and Intermittent Immersion in Water”.

17.5 MEASUREMENT AND PAYMENT

Fixed Wheel Gate Equipment

17.5.1

A. Gate Leaf Assembly and Hoisting Machinery

- Measurement for payment will be made for each complete set of gate leaf assembly and hoisting machinery acceptably installed and maintained in accordance with the provisions of the Contract.

- Payment will be made for the number of sets measured as provided above at the contract unit rate for each unit given in B.O.Q and shall constitute full compensation for all works and services related to this item.

B. Hoisting Deck, Platform, Access Step Ladder, Railing and Embedded Metal Parts

- Measurement for payment will be made for each set of hoisting deck, platform, access step ladder and embedded metal parts acceptable installed and maintained as a complete set in accordance with provisions of the Contract.

- Payment will be made for the number of sets measured as provided above at the Contract unit rate for each unit given in B.O.Q and shall constitute full compensation for all works related to this item.

Slide Gate Equipment

17.5.2 A. Gate Leaf Assembly and Hoisting Machinery

- Measurement for payment will be made for each complete set of gate leaf assembly and hoisting machinery acceptably installed and maintained in accordance with the provisions of the Contract.

- Payment will be made for the number of sets measured as provided above at the contract unit rate for each unit given in B.O.Q and shall constitute full compensation for all works and services related to this item.

B. Hoisting Deck, Platform, Railing and Embedded Metal Parts

- Measurement for payment will be made for each set of hoisting deck, platform, access step ladder and embedded metal parts acceptably installed and maintained as a complete set in accordance with provisions of the Contract.

- Payment will be made for the number of sets measured as provided above at the Contract unit rate for each unit given in B.O.Q and shall constitute full compensation for all works related to this item.

Steel Stoplog Equipment

17.5.3 A. Stoplog Sections and Embedded Metal Parts

Measurement for payment will be made for each complete set of stoplog sections and embedded metal parts acceptably installed and maintained in accordance with the provisions of the Contract.

Payment will be made for the number of sets measured as provided above at the contract unit rate for each unit given in B.O.Q and shall constitute full compensation for all works and services related to this item.

B. Lifting Beam

- Measurement for payment will be made for each unit of lifting beam acceptably installed and maintained in accordance with provisions of the Contract.

- Payment will be made for the number of units measured as provided above at the Contract unit rate for each unit given in B.O.Q and shall constitute full compensation for all works related to this item.

Wooden Stoplog Equipment

17.5.4 Measurement for payment will be made for each complete set of stoplog sections and embedded metal parts acceptably installed and maintained in accordance with the provisions of the Contract.

Payment will be made for the number of sets measured as provided above at the contract unit rate for each unit given in B.O.Q and shall constitute full compensation for all works and services related to this item.

18 – CANAL LINING

Scope of Work

18.1 The work to be done by the contractor under this item shall include preparation of the subgrade and dressing, constructing concrete lining and all incidental operations necessary to construct concrete lining in branch canals, distributaries and minors, in accordance with the Drawings and these Specifications and subject to approval of the Engineer.

Trial Section

18.2 Before starting full scale canal lining operations, the Contractor shall carry out a trial section of the complete prism of the canal for a length of not less than 50 feet. This trial section should be carried out in the same area on which trial section for earthwork has already been accepted and approved by the Engineer. The Contractor shall submit his proposals for this trial section to the Engineer for approval at least 14 days before he proposes to start the trial.

The trial section shall demonstrate the sequencing of lining operations, the effectiveness and the quality control of the Contractor's methods including, but not limited to the following matters:

- Preparation of sub-grade and dressing
- Concrete batching arrangements,
- Arrangement for construction of concrete lining, forms, transporting, placing, vibrating, screeding and finishing concrete, placement of joints and associated fillers, sealants, curing etc.

The trial section will be incorporated into the Works provided it complies in all respects with these Specifications. Should it not so comply, the Engineer may either instruct remedial measures, or complete removal of the trial section, reinstatement of the foundations, and a repeat trial, all at the Contractor's expense.

Preparing of Subgrade for Canal Lining

18.3 (1) <u>Ensuring proper compaction of subgrade</u>: Prior to canal lining, the contractor shall prepare the subgrade including dressing of bed and side slopes filled or excavated sections of canal and any other backfill or 1:7:20 over which canal lining is to be placed as per direction of Engineer representative. Before proceeding with canal lining, the contractor shall ensure and prove to the satisfaction of the Engineer by means of compaction tests that the subgrade of the whole canal prism (slopes and bed) is in a state of compaction equal to 95% Standard Proctor or 70% relative density depending upon the type of material, to a minimum depth of one feet below the final grade, measured perpendicular to the surfaces of the canal prism. No separate payment shall be made for compaction tests and their cost shall be deemed to have been included in the unit rates quoted for the other relevant items given in the BOQ. The Contractor shall re-work the areas which fail to meet the compaction requirements as described above and shall perform compaction by employing appropriate equipment and methods in order to ensure that the reworked portions meet the compaction requirements described above and as specified in Section - "Earthwork".

A channel sections having bed widths up to 5ft. at bed (lined design section) shall be completely filled, compacted and re excavated to design

shape for concrete lining. For sections having bed width more than 5ft., appropriate side pads with extra 2ft. wide strip above design earth face of compacted earthfill shall be provided and re-excavated to design shape instead of complete filling of the prism or as approved by the Engineer.

(2) Refilling of Over-excavated Areas: If at any point material has been excavated beyond the neat lines required to receive the canal lining, the excess excavation shall be refilled with compacted fill material and according to Section – "Earthwork". If at any point the foundation material is disturbed or loosened during the excavation process or otherwise, it shall be moistened if required and thoroughly compacted by tamping, rolling or other approved methods in accordance with Section – "Earthwork" to form firm foundations to place the concrete lining.

(3) Finishing to Lines and Grades: In addition to the above, the work under subgrade preparation shall include but not be limited to cutting, filling, compacting, reworking, dressing and finishing the canal prism to true and even surfaces to the lines and grades shown on the Drawings in accordance with these Specifications and as directed by the Engineer.

(4) Stabilizing Layer: A 1.5 inches thick 1:6 cement sand, stabilized layer shall be placed over the properly moistened sub-grade before placing the concrete for canal lining as shown on the drawing or as directed by the Engineer. Stabilizing layer shall not be used where 1:7:20 is used.

(5) 1:7:20 Cement Concrete, Stone Ballast/Nullah Shingle:

1:7:20 Cement Concrete, Stone Ballast, 1.5" to 2" nullah shingle well graded and well cleaned shall be placed underneath the lining before placing the concrete in thickness as required and directed by the Engineer's representative.

Concrete Lining

18.4 (1) General: Concrete for canal lining shall be of Class-C (3,000 psi) plain cement concrete, and shall be constructed in the canal prism as shown on the Drawings, and its strength shall be as specified herein.

Plain cement concrete for canal lining shall be plastic enough to consolidate well and stiff enough to stay in place on specified slopes over stabilized layer on the compacted subgrade as shown on the drawings. Slump shall be in the range of 1 inch to 3 inches. The water-cement ratio shall be adjusted to achieve the specified slump and strength but shall not exceed 0.45 in any case. The compressive cylinder strength of the concrete (28 days) shall be 3,000 psi and the concrete will be cured by application of a curing compound or water subject to approval of the Engineer following the submission of a request including supporting procedural methods and documentation by the Contractor. Nominal maximum size of aggregate for concrete in Canal Lining shall be ¾ inches. The subgrade shall be well moistened but not muddy at the time of placing concrete.

(2) Materials and Procedures: All the materials used in concrete canal lining including cement, sand, fiber, aggregate, water, curing compound and admixtures etc., mixing and batching, sampling and testing shall be in accordance with the standards and specifications given in other sections of these specifications relevant to these items.

(3) Formwork: Forms for the concrete canal lining shall be in accordance with Section – "Concrete, General" and as approved by the Engineer.

(4) Concrete Temperature: For concrete temperatures, refer to sub-section `Temperature' of the Section-"Concrete, General" of the Specifications.

(5) Method of Concrete Lining: The contractor shall carry out concrete lining by manual operations using a steel trowel and profile boards for finishing and compacting. PC profiles shall be provided under the lining as shown on the Drawings. As such profiles are shown provisionally on the Drawings. After the preparation of sub-grade, a trench of size 9 inches wide and 3 inches deep shall be excavated at the location of profiles. The PC profiles shall be allowed to harden and shall be cured as specified herein and elsewhere in these specifications. Top surface of the PC profiles shall be painted with two coats of hot bitumen before concrete lining is placed.

Lining shall be done in alternate panels of the specified size as shown in the drawings. The alternate panel shall be allowed to harden enough and shall be compound / water cured before placing the concrete for lining the adjoining panel.

(6) Replacement of Damaged/Rejected Concrete Panels: Where a damaged/rejected panel of concrete canal lining is to be replaced, the old concrete shall be removed to the edges of the adjacent panels. The surfaces of the existing concrete shall be prepared as a contraction joint. Fresh concrete shall then be placed against the existing concrete with the full groove contraction joint formed adjacent to the existing concrete. The groove shall be sealed with elastomeric sealant in accordance with para 18.6(7) of this section.

(7) Curing: The Contractor shall cure lined surfaces of the Canal as follows:

a) The exposed surfaces of the concrete shall be cured with an approved, white pigmented curing compound which forms a water-retaining membrane on the surfaces of the concrete. Curing compound shall conform to ASTM Designation: C-309. The compound shall be of uniform consistency and quality within each container and from shipment to shipment. In case of water curing the concrete surface is to be covered with jute bags and the contractor shall ensure round the clock moistening of the surface as specified and directions of Engineer.

b) Curing compound shall be applied to the concrete surfaces by spraying in one coat to provide a continuous, uniform membrane over all areas. Coverage shall not exceed 150 square feet per gallon and on rough surfaces coverage shall be decreased as necessary to obtain the required continuous membrane. Mortar encrustation and fines on surfaces shall be removed prior to application of the curing compound. The repair of all other surface imperfections shall not be made until after application of curing compound.

c) The costs for furnishing and applying all materials for curing concrete shall be included in the unit rate tendered in the Bill of Quantities for the applicable concrete item on which the curing materials are sued.

(8) Tolerances for Concrete Construction: The canal lining shall be built to the lines, grades and dimensions shown on the Drawings. The dimensions shown on the Drawings will be subject to such modifications as may be found necessary by the Engineer to adapt to the conditions exposed by the excavation or to meet other site conditions. Where the thickness of any portion of concrete is variable, it shall vary uniformly between the dimensions shown.

Tolerances for Canal Lining

	Description	Limit
(i)	Departure from established alignment	± 2 in. on tangents ± 4 in. on curves
(ii)	Departure from established profile grade. Departures set forth above shall be uniform and no correction shall be made in less than 100 feet.	±1 in.
(iii)	Reduction in thickness of lining	(-¼) inch of specified thickness provided that average thickness over any 20 feet length is not less than the specified thickness.
(iv)	Variation from specified width at any height.	± 1 inch of specified width.
(v)	Variation from specified height of lining.	± 1 inch of established height.

Joints in Canal Lining

18.6 (1) General: Generally contraction joints shall be constructed or placed in concrete canal lining as shown in the drawings.

The joints shall be made along straight lines and the required shape and dimensions shall be maintained during any subsequent finishing operations until the concrete has hardened.

(2) Construction joints: The concrete lining operations are finished at the end of day by pouring complete panel and in no case concrete lining operations are stopped by partial pouring of the panel.

(3) Contraction Joints: Contraction joints shall be the joints placed in concrete to accommodate shrinkage of a monolithic unit or movement between monolithic units. The joints shall be so constructed that there will be no bond between the concrete surfaces forming the joint. The concrete lining placing operations should be scheduled such that stoppage of day's work is at specified location of the contraction joint as for as possible.

Contraction joints shall be constructed at location shown on the Drawings. The joints shall be made by forming the concrete on one side of the joint and allowing it to set before concrete is placed on the other side of the joint. The surface of the concrete first placed at the contraction joint shall be coated with curing compound and two coats of bitumen before the concrete is placed on the other side of the joint. Special care shall be taken to ensure proper compaction of concrete near the joint faces.

A groove will be formed at the top of lining on one side of the joint as shown on the Drawings and filled with elastomeric sealant in accordance with paragraph (6) below.

(4) Expansion Joints: At an intervals of 100 ft. along the canal or as shown on drawing, a transverse control joint shall be constructed as an expansion joint. It shall be formed in the same way as an ordinary control joint except that:

- The joint will be open to the bottom.
- A compressible filler ½ inch (12.7 mm) thick of bituminous, sand and sawdust in ratio 1:2:2 or as approved by Engineer shall be provided between the two adjacent concrete panels at the time of placing the second one. It shall extend through the full depth of the concrete lining except the upper 1.0 inches (25.4 mm) which shall be filled, during concrete placing, by a timber former to form a sealing groove.
- Not less than seven days nor more than 21 days after the last of the adjacent concrete was placed, the joint shall be sealed. This shall be done by carefully removing the timber former and then cleaning and sealing the resulting groove as specified.

(5) Approval of Joints: One copy and one reproducible of the drawings and data showing the joints, joint intersections, and the method of construction shall be submitted by the Contractor to the Engineer for approval.

(6) Edges: The Contractor shall tool or chamfer edges of concrete where shown on the Drawings and elsewhere as directed by the Engineer.

(7) Sealant: The elastomeric sealant to be used in joints shall be of the type suitable for immersion in water and conforming to ASTM C920 type S or M or equivalent subject to approval by the Engineer.

The sealant shall be filled in the groove as soon as the concrete has gained its 14 days strength in order to avoid deposition and consolidation of any undesirable material in the groove which may impair the function of the joint.

The concrete groove shall be sand blasted to produce a rough surface and to remove all debris, scale, dirt, oil, laitance, curing compound, and other foreign materials just before the application of the elastomeric sealant. The concrete shall be at least 14 days old before it is sand blasted. The joint groove that has been sandblasted shall be blown out under high pressure compressed air to remove all residue. Elastomeric sealant shall not be placed in dusty weather or while rain is falling. At the time of placing the joint sealant, the joint groove shall be clean and dry.

The storage and application of the sealant and any necessary primer shall be strictly in accordance with the manufacturer's recommendations. The method of mixing the sealant shall result in homogeneous material.

The sealant shall be extruded at the bottom of the joint groove and shall be tooled as necessary to work the sealant into intimate contact with the concrete without entrapping air. The top surface of the sealant shall be tooled to the shape shown on the Drawings.

Elastomeric sealant which does not cure to a homogenous, rubber like compound, or which does not bond to the joint-groove faces or to this Specification shall be removed and replaced by the Contractor at no additional cost to the Employer.

Measurement and Payment

18.7 (1) Sub-grade Preparation including dressing: Measurement for payment of sub-grade preparation including dressing shall be made for the surface area of sub-grade prepared under the canal lining in bed and side slopes and shall be measured in M^2 (sqm).

Payment shall be made at the unit rate tendered per M^2 (sqm) in the BOQ for preparation of sub-grade and dressing and shall constitute full compensation for the work performed for sub-grade preparation and dressing including all labour, equipment, operations and compaction testing etc., complete in all respects.

(2) Stabilized Layer 1:6 Cement Sand Under the Canal Lining: Measurement of 1:6 cement sand stabilized layer under the canal lining shall be made of the area in M^2 (sqm).

Payment shall be made at the unit price quoted per M^2 (sqm) in the Bill of Quantities for completion of work.

The amount tendered shall be full payment for completion of the work including but not limited to procurement, transportation, placing and compaction according to the specifications and as directed by the Engineer.

(3) Concrete Lining: Measurement for payment of concrete placed in lining shall be made of the volume of the concrete placed for

canal lining according to the design lines in M^3 (cum).

Payment shall be made at the unit rate tendered per hundred cubic feet in the BOQ for concrete for canal lining and shall constitute full compensation for the work performed for moistening of subgrade prior to concrete placement and concrete placement including material, labour, equipment and its operation, curing compound, admixtures and testing etc., complete in all respects.

(4) Contraction Joints: Measurement of contraction joints in canal lining shall be made of the length of the joints prepared according to design lines for canal linings in running meter. The joints not filled with the joint sealant shall not be measured for payment.

Payment shall be made at the unit rate tendered per running foot in the BOQ for joints in canal lining and shall constitute full compensation for the work of providing joints in canal lining complete in all respects including two coats of bitumen on vertical face of contraction joint and providing sealant in the groove.

(5) Expansion Joints: Measurement of expansion joints in canal lining shall be made of the length of the joints prepared according to design lines for canal linings in running meter.

Payment shall be made at the unit rate tendered per running meter in the BOQ for joints in canal lining and shall constitute full compensation for the work of providing joints in canal lining complete in all respects including providing filler and sealant in the groove.

(6) Bathing Steps: Measurement for installing reinforced concrete bathing steps, shall be made in M^3 (cum) of reinforced concrete placed in bathing steps as per drawings.

Payment for installing reinforced concrete bathing steps shall be made at the unit rate tendered per M^3 (cum) and shall constitute full payment for materials including curing compound, admixtures, etc. complete in all respects excluding reinforcement.

(7) Cement Concrete (1:7:20): Measurement for payment of 1:7:20 placed under lining shall be made of volume of the concrete placed according to design line or as directed by the Engineer in M^3 (cum) and shall constitute full compensation for work performing for moistening of subgrade prior to placement of 1:7:20 including labour equipment and its operation, curing compound, admixtures and testing etc., complete in all respects.

19. MISCELLANEOUS WORKS

Items of Miscellaneous Works

19.1 These specifications cover the following items:

- Waterstops
- Expansion Joints
- Reinforced Concrete G.I, Angle Iron, Railing
- Construction of Metalled Approach Roads and Ramps
- Surfacing of Roadways Over Bridges
- Galvanized Iron Pipe
- PVC Pipes
- Rungs
- Canal Distance Markers and Boundary Pillars
- Shingle Road Surfacing
- Miscellaneous Metal Work
- Elastomeric Bearing Pad
- 3-Ply Bitumenastic Felt Paper
- Enameled Iron Gauge
- Expansion Joints in Bridge Deck Slabs
- RCC Pipes for Outlets
- Precast Concrete Block Apron
- Damp Proofing
- Roof Insulation
- Metal Works, Doors and Windows
- Cast Iron pipes and Fittings
- Mild Steel Pipes
- Two Layers of 8 gauge G.I sheets used as bearing pad with bitumen in between
- Two G.I Sheets of 1/16 inch thickness each for Roof Felt packing
- Providing Rainwater Outlets for Bridges
- Operator’s hut and septic tank

19.2 WATERSTOPS

Scope of Work

19.2.1 Rubber or polyvinylchloride (PVC) waterstops shall be installed where shown on the Drawings or as directed by the Engineer. The Contractor shall furnish all waterstops, including rubber plugs, gum rubber, rubber cement, bolts, nuts, washers and polyvinyl joint material. The Contractor shall fabricate all special intersections, slices and joints, and make bends at corners as shown on the Drawings or as directed by the Engineer. All joints, splices, bends and intersections shall be made in strict accordance with the manufacturer's printed instructions, using materials approved by the manufacturer, and shall be formed to produce a strong, sound and watertight joint.

Material of Waterstops

19.2.2 Rubber waterstops shall be of natural rubber, synthetic rubber or a blend of both. The rubber when tested in accordance with US Federal Test Method Standard No. 601, shall have the following properties:

Physical Characteristic	Requirement	Test Method
Minimum Tensile strength	2500 psi (17.24 N/mm^2)	4111
Minimum Elongation at break	450 %	4121
Minimum Tensile strength at 300% elongation	900 psi (6.21N/mm^2)	4131
Durometer Hardness-Shore Type A	60 to 70	3021
Water immersion maximum change in weight	5 %	6631
Minimum Tensile strength after aging, as a percentage of tensile strength before aging (Oxygen bomb method)	80 %	7111
Compression max.	30 %	3311
Minimum Adhesion on 18 ounce cotton fabric	18 psi (0.12 N/mm^2)	8011 & 8021

PVC waterstops shall be extruded from an elastomeric plastic compound, the basic resin of which shall be PVC. The compound shall contain such additional resins, plasticizers, stabilizers or other materials needed to ensure that when the material compound is extruded to the shapes and dimensions shown, it will have the following physical characteristics, when tested by the US Corps of Engineers test method specified below:

Physical Characteristic	Requirement	Test Method
Tensile strength using die III, not less than	1759 psi (12.12 N/mm^2)	C 568
Ultimate elongation using die III, not less than	350 %	C 573
Low temperature brittleness, no sign of failure such as cracking or chipping at	-35°F	C 570
Stiffness in flexure, 1/2 inch span, not less than	400 psi (2.76 N/mm^2)	C 571

The contractor shall submit the manufacturer's literature and samples of waterstops to the Engineer for his approval prior to installation.

The gum rubber for making field splices of rubber waterstops shall be uncured rubber. In case it has been exposed at temperatures above 100 degrees Fahrenheit, it will be considered unfit for use. All rubber shall be stored in as cool a place as practicable, preferably at 70 degrees Fahrenheit or less, and in no case shall the rubber be stored in the open or exposed to the direct rays of the sun. All rubber shall be stored so as to permit free

circulation of air about the rubber.

The Contractor shall take suitable precautions to support and protect the waterstops during the progress of the work. Any damaged waterstop shall be replaced with the approval of the Engineer at no additional cost to the Employer.

Measurement and Payment

19.2.3 (a) Measurement of waterstops shall be made in linear meter of the length shown on the Drawings.

(b) Payment for waterstops shall be made at the unit rate per foot length of water stop tendered in the Bill of Quantities for providing and fixing waterstops. The tendered rate shall be deemed to cover all costs of waterstops including supplying, fixing, jointing and all other works related to the item.

19.3 EXPANSION JOINTS

Scope of Work

18.3.1 The work to be done under the item “Expansion Joints” consists of providing expansion joints in concrete where designated on the Drawings or directed by the Engineer in accordance with the provisions and requirements stipulated herein. The work to be done by the Contractor shall include all operations and materials necessary for providing an expansion joint in concrete, filling these expansions joints with expansion joint material or expansion joint filler and sealing the outer exposed surface with expansion joint sealer where shown on the drawings or as directed by the Engineer.

Material

19.3.2 Expansion joint filler shall be preformed, cross-linked, non-absorbent, semi-rigid cellular polyethylene type, to be applied over the full joint width except as otherwise indicated on the drawings and shall conform to requirements of ASTM D1752-84 (Reproduced 1996), "Standard Specifications for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction".

Elastomeric joint sealer suitable for use in water conforming to the requirements of ASTM D1190 “Standard Specification for concrete joints sealer not poured elastic type”.

Construction

19.3.3 Expansion joint filler shall be placed in all expansion joints of concrete structures except as shown otherwise on the Drawings. The concrete surface of the expansion joint shall be free of all coatings, dirt, laitance and other foreign materials. The expansion joint filler shall be positioned against the concrete previously placed in a manner recommended by the manufacturer, and with no gaps between adjacent panels of filler material, before the subsequent concrete is placed. Care shall be exercised in storing and handling the joint filler.

After concrete placement is completed, all exposed edges of expansion joint filler shall be sealed. At the top of all horizontal

expansion joints and at the surface of all vertical expansion joints that will be in contact with flowing water, the expansion joint filler shall have been set back by one inch or as shown on the drawings, from the base of the chamfer, and this set back depth shall be filled with the joint sealer. The completed expansion joint shall be well-sealed and be neat in appearance to the satisfaction of the Engineer.

Measurement and Payment

19.3.4 (a) Measurement of Expansion joints shown on the Drawings and as described herein above, shall be made in linear meter of the joints acceptably formed according to the length shown on the Drawings.

(b) Payment for expansion joint shall be made according to the rate tendered in the Bill of Quantities per linear foot of the joint which shall be deemed to cover all costs including supplying and installing the joint filler, joint sealer and all other works related to the BOQ item for providing and filling expansion joints.

19.4 REINFORCED CONCRETE AND G.I PIPE/ANGLE IRON RAILING

Scope of Work

19.4.1 The work to be done under the item “Reinforced Concrete and G. I. Pipe/Angle Iron Railing” consists of, but not limited to construction of reinforced concrete G. I. Pipe/Angle Iron railing or along the bridges and other structures including the reinforcement, fixing in position and finishing it complete in all respects as given in the specifications and shown on the Drawings and as directed by the Engineer and performing all other works necessary for the proper completion of the Works.

General

19.4.2 All concrete materials and the production, forming, placing, curing and repairing of concrete under this section shall be in accordance with the provisions of, and in complete conformity with the stipulations and requirements for concrete specified in the Section 4 - "Concrete General" and shall conform to the concrete class requirement shown on the Drawings.

All sand and aggregates used for concrete under these specifications shall be furnished by the Contractor in accordance with the provisions of, and in complete conformity with, the stipulations and requirements for sand and aggregates specified in the Section 6 - "Sand and Coarse Aggregates".

Cement used shall be Ordinary Portland Cement and shall be in conformity with the stipulations and requirements for Portland Cement specified in the Section 5 - Cement.

Reinforcement used shall be grade 40 steel and shall be in conformity with the stipulations and requirements for reinforcement specified in the section 9 - Reinforcement.

Zinc coated steel pipe (G. I. pipes) shall be galvanized and threaded and shall conform to BS Specification 1387-1957 “Steel tubes and Tubulars” medium tube.

Fitting and specials for zinc coated steel pipe (G. I. pipes) shall be galvanized and threaded and shall conform to the applicable requirements of BS specification 1387-1957.

Measurement and Payment

19.4.3 (a) Measurement and payment for reinforced concrete railing or G. I. pipe or angle iron railing will be made on the basis of linear meter of the railing acceptably constructed and installed. The quantity shall be determined by measurement of the completed handrail from end to end of rails. Vertical posts and intermediate horizontal lengths shall not be measured for payment.

(b) The rate tendered for respective items in BOQ shall be full payment for constructing RC railing or G. I. pipe or angle iron, railing and shall include cost of all materials including concrete or G.I pipe or angle iron reinforcing steel, construction, fixing in position and for completion of the work specified herein and elsewhere in these specifications for and on the drawings for reinforced cement concrete railing or G. I. pipe railing, and all other work related to the item.

19.5 CONSTRUCTION OF METALLED APPROACH ROADS AND RAMPS

Scope of Work

19.5.1 The work under this contract involves the scarification of existing road, breaking of road pavement structure, construction of embankments or excavation for the road formation of metalled approach roads and ramps, brick edging, granular sub-base, water bound macadam and asphaltic wearing course, and other allied works.

Embankments for Road or Road Formation

19.5.2 (1) Scope of Work: The work under this contract involves excavation, earthfill for road embankments, compaction, testing and all other related works in accordance with the Specifications and/or as directed by the Engineer.

(2) Materials and Construction: Materials and construction requirements shall be in accordance with Section - 3 “Earthwork” of Technical Provisions except the following:

a) The material within the three feet below the bottom elevation of roadway sub-base, shall meet the requirements of ‘select material’ as stipulated in section of Earthwork of the Specifications.

In-place density determinations of the compacted layers shall be made in accordance with AASHTO T 191 or other approved methods. For all soils, with the exception of rock fill materials, containing more than 10% oversize particles (retained on ¾ inch/19 mm sieve), the in-place density thus obtained shall be adjusted to account for such oversize particles as directed by the Engineer. Subsequent layers shall not be placed and compacted unless the previous layer has been properly compacted and accepted by the

Engineer.

Material for embankment at points inaccessible to normal compaction equipment shall be placed in horizontal layers of loose material not more than 6 inch thick and compacted to the densities specified.

b) Embankment on Existing Roads:
Before fill is placed and compacted on an existing roadway, the existing embankment and/or pavement may be levelled by cutting, rooting or scarifying by approved mechanical means to a depth to be determined by the Engineer. The earth, old asphalt or other material arising as a result of this operation will be declared by the Engineer to be either suitable or unsuitable for use in the embankment subbase.

Scarified material removed from the existing road surface may be placed in the embankment in thin layers in strict compliance with the instructions of the Engineer. No extra compensation shall be allowed for the storing and rehandling of such material for the disposal of material discarded at the Contractor's own choice or for the use of borrow in its place.

c) Embankment in Areas of High Water Level and Salinity:
Irrigation of areas, such as rice fields and fish or natural ponds upon which embankments are to be placed, shall have been halted at least two months in advance of, and drained or kept drained of all surface water prior to commencing with the placing of fill, and all clearing and grubbing shall have been performed, manually if necessary, in accordance with the relevant articles.

Where embankments are to be placed in areas of high water levels and salinity conditions and which is inaccessible to heavy construction equipment, a special working platform shall be first established, consisting of a blanket of fill material placed on top of the soft layer. The material of the working table shall consist of normal or processed granular fill material obtained from borrow excavation. This material shall conform to the following specifications:

Sieve Size	Percentage of Weight Passing Mesh Sieve, AASHTO T 27
3 inch (75 mm)	100

The remaining grading shall be such as to avoid intrusion into the working platform material of subgrade or natural ground surface material. For this condition to be met it will be required that the ratio

$$\frac{D_{15} \text{ – (Working Platform Material)}}{D_{85} \text{ (Natural Ground Material)}} \leq 5$$

D_{85} and D_{15} mean the particle diameters corresponding to 85% and 15%, respectively, passing (by weight) in a grain size analysis.

Construction of this working table shall proceed from one edge of the soft area by using the fill as a ramp for further material transport.

The thickness of the working table as prescribed above shall be approximately 1.5 feet unless directed otherwise by the Engineer, and the width shall be that of the embankment. The placement and compaction of the working table shall be carried out by use of light equipment.

No density requirements are specified for the working platform, however, subsequent layers above it shall be compacted to the densities as specified.

In those area of high water levels and salinity with soft subsoils and where embankment are high such as approach fills to structures, Special Provisions shall be made to measure and determine likely fill settlements will be accomplished. These preconditions are necessary in order to specify particular construction procedures which may be necessary and to establish the time at which the pavement structure can be placed to avoid cracks and subsidence of these layers.

d) Trial Section:

Before starting the formation of the embankment the Contractor shall construct a maximum of three trial sections of 100 feet each for each soil type proposed to be sued for compaction as directed by the Engineer. The soils used in the trials shall be the same as those intended to be used for the formation of embankment and the compacting equipment shall be same equipment that the Contractor will use for the main work and that has been accepted by the Engineer.

The object of these trials will be to determine the optimum moisture content and the relationship between the number of passes of compacting equipment and density obtained for the soil types under trial and for the verification of the soil type itself. No separate payment will be made for this work, which will be required as a subsidiary obligation of the Contractor.

e) Excavation in Embankments:

Unless otherwise specified in the Special Provisions,

the Contractor may choose with the approval of the Engineer to excavate for structures, culverts, and pipe culverts after the embankment has been placed. Any space remaining after the placing of such structures or culverts and deducting for specified bed or backfill, shall be filled with material approved by the Engineer and compacted as follows:

Layers not more than 6 inches in loose thickness shall be placed and compacted in succession, with mechanical tampers or tires or tracks of motor driven equipment operated transversely to the roadway, to the densities as specified. Moisture content shall be adjusted as directed by the Engineer.

The excavation in embankment and the placing of backfill for the purposes described above shall not constitute any claims for payment but shall be covered under the contract unit price paid for other works in which the operation is involved.

f) General Requirement:

To avoid interference with the construction of bridge abutments and wing walls the Contractor shall, at points to be determined by the Engineer, suspend work on embankments and/or in cuts forming the approaches to any such structure until such time as the construction of the latter is sufficiently advanced to permit the completion of the approaches without the risk of interference or damage to the bridge works. The cost of such suspension of work shall be included in the contract unit prices for embankment. In carrying embankments us to or over bridges, culverts or pipe drainage, care shall be taken by the Contractor to have the embankments brought to equally on both sides and over the top of any such structure.

When as a result of settlement, an embankment requires the addition of material up to 12 inches in thickness to bring it up to the required grade level, the top of the embankment shall be thoroughly scarified before the additional material is placed, and no extra payment shall be made for the scarification.

The Contractor shall be responsible for the stability of all embankments and shall replace any portions that in the opinion of the Engineer have been damaged or displaced due to carelessness or neglect on the part of the Contractor. Embankment material which may be lost or displaced as a result of natural causes such as storms, cloud-burst or as a result of unavoidable movement or settlement of the ground or foundation

upon which the embankment is constructed shall be replaced by the Contractor with acceptable material from excavation or borrow. No additional compensation will be allowed for the replacement except that the quantity of material required will be paid for at the contract price for the type of material used.

During construction the roadway shall be kept in shape and drained at all times. When unsuitable material has been placed in the embankment by the Contractor he shall remove it without extra payment.

(3) Measurement and Payment: The measurement shall be made in cubic meter of the volume of embankment compacted in place, after clearing, grubbing and stripping, scarification of existing road and/or of breaking of road pavement structure, as directed by the Engineer.

The quantities, determined as provided above shall be paid for at the contract unit price tendered in the Bill of Quantities. The payment for compacted embankments for ramps of approach roads, service roads and banks as measured above shall be deemed to include the cost of stripping under the embankment, scarifying of existing road, breaking of road pavement, excavation, payment of royalties to landowners and/or local communities, if any, the cost of hauling material from any distance compaction and all the costs necessary for the proper completion of the work prescribed in this item.

Brick Edging

19.5.3 (1) Description: This item shall consist of brick installed on vertical edge between the pavement structure and shoulders in such a manner that the brick is laid on compacted shoulders and top of brick is flushed with the slope of road pavement.

(2) Material Requirements:
Bricks: Quality of bricks shall meet the material requirement as specified under Section - 'Brickwork'.

(3) Construction Requirements: A trench of appropriate dimensions shall be excavated to accommodate brick on vertical edge, so that top of the brick becomes flushed with the top of road pavement and to ensure that one face of the brick remains in contact with the pavement structure. The cavities on the other face of the brick shall be refilled with the excavated shoulder material and properly compacted. The brick shall be laid in accordance with the line and grade of the road pavement. It shall be ensured that bricks are installed in vertical positions.

(4) Measurement and Payment:

(a) Measurement
Brick edging when laid and finished to the required grade and line shall be measured per linear meter

installed and approved by the Engineer.

(b) Payment
The quantity as providing and measured above shall be paid per linear meter for excavation of trench, installation of bricks, compacted backfill of cavities and dressing of berms including material, watering, tamping, labour, equipment, tools and incidentals necessary to complete the item.

Granular Sub-Base

19.5.4 (1) Description: This item shall consist of furnishing, spreading in one or more layers and compacting granular subbase according to the specifications and drawings and/or as directed by the Engineer. Granular subbase shall consist of natural or processed aggregates such as gravel, sand or stone fragments which shall conform to the following requirements.

(2) Material Requirements: The subbase material shall be clean and free from organic matter and other deleterious substances, and shall be of such nature that it can be compacted readily under watering and rolling to form a firm, stable base.

The material shall comply to the following grading and quality requirements:

a) The subbase material shall have a gradation curve within the limits for Grading C, D or E given below:

Grading Requirements for Subbase Material

Sieve Designation Standard Alternate		Mess Percent Passing		
Mm		Grading C	Grading D	Grading E
50.0	2 in.	-	-	-
25.0	1 in.	100	100	100
9.5	3/8 in.	50-85	60-100	-
4.75	No.4	35-65	50-85	55-100
2.00	No.10	25-50	40-70	40-100
0.425	No.40	15-30	25-45	20-50
0.075	No.200	5-15	5-20	6-20

The Coefficient of Uniformity D60/D10 shall be not less than 3, where D60 and D10 are the particle diameters corresponding to 60% and 10%, respectively, passing (by weight) in a grain size analysis.

b) The material shall have a CBR value of at least 50%, determined according to AASHTO T193. The CBR value shall be obtained at a density corresponding to 98% of the maximum dry density determined according to AASHTO T180 Method D.

c) The coarse aggregate material retained on sieve No.4 shall have a percentage of wear by the Los Angeles

Abrasion to (AASHTO T96) of not more than 40 percent.

d) In order to avoid intrusion in the subbase of silty and clayey material from the subgrade, it will require that the ratio D15 (Subbase)/D85 (Subgrade) is less than 5.

D85 and D15 mean the particle diameters corresponding to 85% and 15%, respectively, passing (by weight) in a grain size analysis.

e) The fraction passing the 0.075mm (No.200) sieve shall not be greater than two-third of the fraction passing the 0.425 mm (No.40) sieve. The fraction passing the 0.425mm sieve shall have liquid limit not greater than 25 and a plasticity index of 6 or less.

(3) <u>Construction Requirements:</u>

a) Spreading:
Granular subbase shall be delivered to the roadbed as a uniform mixture. Segregation shall be avoided during spreading and the final compacted layer shall be free from concentration of coarse of fine materials.

Granular subbase shall be deposited on the roadbed in a quantity which will provide the required compacted thickness without resorting to spotting, picking up or otherwise shifting the subbase materials.

Where the required thickness is 6 inches or less, the aggregates may be spread and compacted in one layer. Where the required thickness is more than 6 inches, the aggregates shall be spread and compacted in 2 or more layers of approximately equal thickness, and the maximum compacted thickness of any one layer shall not exceed 6 inches. All subsequent layers shall be spread and compacted in a similar manner.

Granular subbase shall be spread with equipment that will provide a uniform layer conforming to the specified item both transversely and longitudinally within the tolerances as specified.

b) Compacting:
The moisture content of subbase material shall be adjusted prior to compaction by watering with approved sprinklers mounted on trucks or by drying out, as required, in order to obtain the required compaction.

The subbase material shall be compacted by means of

approved vibrating rollers or steel wheel rollers (rubber tyre rollers may be used as a supplement), progressing gradually from the outside towards the center, except on super elevated curves, where the rolling shall begin at the low side and progress to the high side. Each succeeding pass shall overlap the previous pass by at least one third of the roller width. While the rolling progresses, the entire surface of each layer shall be properly shaped and dressed with a motor grader, to attain a smooth surface conforming to the required lines and grades.

Any area inaccessible to rolling equipment shall be compacted by means of mechanical tampers.

The compaction of the subbase layer shall be continued until the result in satisfactory to the Engineer.

If the layer of subbase material, or part thereof does not conform to the required finish, the Contractor shall, at his own expense, rework, water, and recompact the material before next layer of the pavement structure is constructed.

Immediately prior to the placing of first layer of base course the subbase layer (both under the traveled way and the shoulders) shall be to the required level and shape. Any watering and reshaping of the surface of the subbase will be at the Contractor's expense.

No material for construction of the base shall be placed until the subbase has been approved by the Engineer.

c) Compaction Requirements:
The relative compaction of each layer of the compacted subbase shall not be less than 100 percent of the maximum dry density determined according to AASHTO T180 Method D. The field density shall be determined according to AASHTO T191 or other approved method. For all materials, the field density thus obtained shall be adjusted to account for oversize particles (retained on 19 mm sieve) as directed by the Engineer.

d) Trial Sections:
At least 10 days before the main work of subbase construction is started the Contractor shall spread and compact a trial section as directed by the Engineer. The object of the trial section is to check the suitability of the materials and the efficiency of the equipment and construction methods which is proposed to be

used by the Contractor. Therefore, the Contractor shall use the same material, equipment and procedures that he proposes to use for the main work. One trial section of material and/or construction equipment/procedures proposed for use.

After final compaction, the Engineer may carry out compaction tests, field CBR tests and such other tests which he finds necessary.

If a trial section shows that the proposed material, equipment or procedures in the Engineer's opinion are not suitable for subbase, the material shall be removed at the Contractor's expense, and a new trial section shall be constructed.

If the basic conditions regarding type of material, equipment or procedures change during the execution of the main work, new trial sections shall be constructed when directed by the Engineer.

The Engineer may allow that the compaction requirements be changed based on results from the trial sections.

e) Tolerance:
The subbase shall be compacted to the desired level and cross slope as shown on the drawings.

(4) Measurement and Payment:

a) Measurement:
The quantity of subbase to be paid for shall be measured in cubic meter by the theoretical volume in place as shown on the drawings or as directed and approved for construction by the Engineer, placed and accepted in the completed granular subbase course. No allowance will be given for materials placed outside the theoretical limits shown on the cross-sections. Trial sections shall not be measured separately but shall be included in the quantities above.

b) Payment:
The accepted quantities measured as provided above shall be paid for at the contract unit price per cubic meter of GRANULAR SUBBASE, for the Pay Item listed below and shown in the Bill of Quantities, which price and payment shall constitute full compensation for furnishing all materials, hauling, placing, watering, rolling, labour, equipment, tools and incidentals necessary to complete the item.

Waterbound Macadam Base

19.5.5 (1) Description: This work shall consist of furnishing and placing one or more course of mechanically crushed stone base with filler on a prepared surface in conformity with the lines, grades,

thicknesses and typical cross-sections shown on the Drawings.

(2) Material Requirements: Coarse aggregate shall conform to the quality requirements as specified, except that no CBR testing will be required. The gradation curve of the coarse aggregate shall be within the envelope limits given below:

US Standard Sieve Sizes	Percent Passing by Weight
63.5 mm (2½ in.)	100
50 mm (2 in.)	90-100
37.5 mm (1½ in.)	35-70
25 mm (1 in.)	0-15
19 mm (3/4 in.)	0-5

Fine aggregate (filler material or screenings) shall consist of natural sand or crushed stone screenings free from clay lumps, dirt and other objectionable material. The fine aggregate shall be of the following gradation:

US Standard Sieve Sizes	Percent Passing by Weight
9.5 mm (3/8 in.)	100
4.35 mm (No.4)	85-100
0.15 mm (No.100)	10-30

The material passing the No.40 sieve shall have a Liquid Limit of 25 (maximum) and a Plasticity Index between 4 & 6.

(3) Construction Requirements:

a) Equipment:
Any combination of machines or equipment that will produce the results meeting these specifications may be used. These include mechanical spreaders, water sprinklers and rollers/compactors.

b) Surface Preparation:
The surface on which the base material is to be constructed shall be approved and accepted by the Engineer prior to placing the crushed stone base aggregate.

c) Spreading and Compaction:
Crushed stone shall be deposited and spread on the prepared surface to the proper depth so that the compacted layer will not exceed 4 inches maximum thickness. Each layer shall be inspected thoroughly before rolling to detect high or low spots. Crushed stones shall be added or shifted to provide a true surface. The coarse aggregate layer, after being laid to proper thickness, shall be lightly rolled sufficient only to establish the required grade and level of the

stones.

Spreading of the coarse aggregates shall be followed by rolling with a smooth wheel roller weighing at least 10 tons. Rolling shall begin at the lower edge of the shoulders to lock the stones firmly at the edge, then progress gradually towards the other edge. Rolling shall continue until the aggregate is well keyed and does not creep ahead of the roller.

Following the initial rolling, dry screenings shall be applied uniformly over the surface. Dry rolling shall be continued while screenings are being applied. The surface shall be swept with mechanical or hand brooms to aid spreading of the screenings.

When the intersitices in the coarse aggregate are filled with screenings, the surface shall be sprinkled with water until it is saturated. The rolling, sprinkling and application of additional screenings shall continue until a grout is formed that fills all the voids and forms a wave of grout in front of the roller.

When more than one layer is required to complete the base course to the thickness shown on the drawings, each layer shall be constructed as before prescribed.

d) Construction Control Testing:
Tests for compliance with the requirements will be made as often as deemed necessary and to the satisfaction of the Engineer.

e) Maintenance:
The completed base course shall be maintained in an acceptable condition until the necessary subsequent treatment is applied.

(4) <u>Measurement and Payment:</u>

a) Measurement:
The quantity of base shall be measured in cubic meter by the theoretical volume in place as shown on the Drawings or as directed and approved for construction by the Engineer, placed and accepted in the completed Waterbound Macadam Base Course. No allowance will be given for materials placed outside the theoretical limits shown on the cross-sections.

b) Payment:
The accepted quantities measured as provided above shall be paid for at the contract unit price per cubic meter of Water-bound Macadam Base, for the pay item listed below and shown in the Bill of Quantities, which price and payment shall constitute full

compensation for furnishing all material, hauling, placing, watering, rolling, labour, equipment, tools and incidents necessary to complete the item.

Bituminous Prime Coat

19.5.6 (1) Description: The work shall consist of furnishing and applying asphaltic material on a prepared and untreated surface in accordance with these specification and to the width on the typical cross section or as directed by the Engineer.

(2) Material Requirements: Asphaltic Material shall conform to the requirement of Asphaltic material, either cut back MC 70 or emulisified.

(3) Construction Requirements: Prime coat shall be applied only when the surface is dry except that when emulsified asphalt is used, the surface may be reasonably moist. No application shall be made when the weather is foggy or rainy or when the atmospheric temperature is below 15 deg C unless otherwise directed by the Engineer.

a) Equipment:
The liquid asphalt material shall be spread by means of pressure distributor of not less than 1200 liters capacity, mounted on pneumatic tyres of such width and number that the load produced on the road surface will not exceed 560 lb per inch (100 Kg per cm) width of tyre and it shall be of recognized manufacturer.

The tank shall have a heating device able to heat a complete charge of asphaltic liquid up to 180 deg. C.

The heating device shall be so that over heating will not occur. The tank shall be insulated in such a way that the drop temperatures when the tank is filled, will be less than 2 deg. C per hour. A thermometer shall be fixed to the tank in order to control continuously the temperature of the liquid.

The distributor shall be able to vary the spray width of the asphalt liquid in steps of maximum 4 inch (100 cm) to a total of width of 13 feet (4 m). The spraying base shall have nozzles from which liquid is sprayed fan shaped on the road surface equally distributed over the total spraying width.

The distributor shall be furnished with a tachometer indicating the speed in foot or in meter per minute. The tachometer shall be visible from the driver’s seat. The function of the distributor shall be so exact that the deviation from the prescribed quantity to be sprayed on any square meter does not exceed 10%. The distributor shall be equipped with a device for hand spraying of the bituminous liquid.

b) Application of Asphlatic Material:

Before applying prime coat, the full width of the surface to be treated shall be swept with a power broom to remove all dirt and other objectionable material. Where required by the Engineer, the surface shall be lightly sprayed with water but no saturated. Asphaltic material shall be applied by mean of pressure distribution and at a temperature ranging between 27 deg. C to 100 deg. C depending on the type of asphalt being used. Spraying of asphalt will be between 1.33 and 3.58 gallons per 100 square feet (0.65 to 1.75 litres per square meters). The temperature and the exact rate shall be specified by the Engineer. The prime coat shall be left undisturbed for a period of at least 24 hours and the contractor shall maintain the prime coat until next course is applied. Care shall be taken that the application is not in excess of the specified amounts; any excess shall be blotted with sand or similarly treated. Arrangement should be made that the surface of structures, trees etc. are not marred with the spray.

4) Measurement and Payments

The quantities of liquid asphalt either Cut Back or Emulsified shall be measured in square meter as actually covered by the prime coat within the limits shown on the drawings or as directed by the Engineer and paid for separately as per BOQ Item.

The rate shall include all material, labour, equipment and any work necessary therefore to complete the work satisfactorily.

Asphaltic Wearing Course (Bituminous mat)

19.5.7

(1) Description: The Contractor shall furnish all materials for the complete construction of the asphaltic wearing course including liquid asphalt and mineral aggregates, mixing at specified temperature, transporting, spreading and compacting in approved manner on bituminous prime coat. The materials to be used in surfacing of roadways shall conform to the following requirements:

(2) Material Requirements

a) Liquid asphalt shall be cut-back asphalt, medium curing type (MC), and shall be provided in the proper grades for its intended use.

b) Mineral aggregates used for metalling of roadways shall consist of sand and aggregates furnished by the Contractor in accordance with the provisions of, and in complete conformity with

the stipulations and requirements for sand and aggregates specified in Section "Concrete Aggregates". The Contractor will be required to blend the required quantity of sand and aggregates to produce mineral aggregates with the following gradation properties:

Screen Size designation	Percent by weight passing sieve
1 inch	100
3/4 inch	95 to 100
3/8 inch	60 to 80
No. 4	50 to 60
No. 8	25 to 45
No. 50	5 to 25
No. 200	2 to 10

All screens used for gradation test shall be woven wire cloth sieves conforming to the requirements of ASTM Designation: E-11.

(3) Construction Requirements: After the completion of the prime coat and when the quantity of asphaltic material to be mixed with the mineral aggregates has been determined by the Engineer, the bituminous mat shall be prepared by mixing the mineral aggregate with the required quantity of asphaltic material on the primed base course or by other means and methods approved by the Engineer. The Contractor shall mix the mineral aggregates and asphaltic material until a product of uniform color and consistency is produced. The asphaltic material shall be applied uniformly and under pressure and at the specified temperature. The bituminous mat materials, with or without additive, shall have a moisture content of two percent or less by weight at time of laying.

After the asphaltic material and mineral aggregates have been prepared as described above, the bituminous mat shall be spread to a uniform thickness at the required locations and be compacted until the surface is smooth, firm and of the density specified by the Engineer. Rolling shall proceed longitudinally starting at the edges of the material and progressing toward the center and shall be performed immediately after the material has been spread. On completion of the rolling operation the bituminous mat shall be true to the section shown on the Drawings, smooth, and free from humps, depressions or irregularities. When a straight edge 10 feet long is laid on the finished surface of the bituminous mat, the surface shall not vary more than one quarter inch from the lower edge of the straight edge in any place. Should the bituminous mat show an excess or deficiency of asphaltic material or uneven distribution thereof due to insufficient mixing or other causes, after the mat is laid, the condition shall be corrected by thorough scarifying of the mixed material; adding surfacing or asphalt as required; and spreading and compacting until a bituminous mat satisfactory to the Engineer has been produced.

(4) Measurement and Payment:

(a) Measurements for payment for surfacing of roadways

will be made of square meter of the asphaltic wearing course constructed in accordance with these Specifications and the Engineer's instructions, placed to the lines and thicknesses specified herein. The areas of all roadways and other areas designated by the Engineer, will be measured for payment only once and no additional payment will be made because of the thickness of pavement required, because of the number of layers involved in constructing the pavement or because of prime coats being required.

(b) Payment for surfacing of roadways will be made at the unit rate per square meter tendered in the Bill of Quantities for Surfacing of metalled approach roads and ramps.

The amount tendered shall be full payment for completion of the work specified herein and elsewhere in these Specifications and on the Drawings for Surfacing of metalled approach roads and ramps. No separate or additional payment will be made under this or any other item for use at the Contractor's option of alternative method for surfacing of roadways.

19.6 SURFACING OF ROADWAYS OVER BRIDGES

Scope of Work

19.6.1 The work to be done under Surfacing of Roadways over Bridges, consists of constructing asphalt wearing course (bituminous mat) including application of bituminous coating for roadways as shown on the Drawings or as directed by the Engineer. The asphaltic wearing course shall consist of bituminous mat of mineral aggregates and asphalt. The operations in constructing the asphalt wearing course shall include but not be limited to cleaning of deck, application of prime coat, mixing, placing, spreading and compacting the bituminous mat of mineral aggregates and asphalt on the designated areas and all incidental work required for surfacing of roadways in accordance with the Contract Documents and the Engineer's instructions.

Material

19.6.2 The Contractor shall furnish all materials for the complete construction of the asphaltic wearing course including liquid asphalt for prime coat, for mineral aggregates and mineral aggregates and construct the surfacing in conformity with the stipulations and requirements specified in the Sub-Section 19.5 “Construction of Metalled Approach Roads and Ramp”.

Construction Requirements

19.6.3 After cleaning and removing any foreign material from the final prepared surface, as approved by the Engineer, bituminous prime coat shall be applied prior to start the construction of asphaltic wearing course in accordance with the requirements of section 18.5.6 “bituminous prime coat” except that rate of application shall be 0.31 to 0.82 gallons per 100 square feet (0.15 to 0.4 liters per square metres). The prime coat shall be applied over the areas designated on the Drawings or as directed by the Engineer. The temperature during application shall remain within the range specified for the grade of asphalt being used. After the liquid asphalt has penetrated the surface, the treated area shall be covered where necessary with sand or other granular material in sufficient quantity to absorb any excess of asphalt remaining on the surface. The asphalt wearing course shall not be placed on top of the primed base until authorized by the Engineer. Prior to the placement of the asphalt course, the primed base shall be broomed and thoroughly cleaned of all extraneous material.

After the completion of the prime coat and when the quantity of asphaltic material to be mixed with the mineral aggregates has been determined by the Engineer, the bituminous mat shall be prepared by mixing the mineral aggregate with the required quantity of asphaltic material on the primed base course or by other means and methods approved by the Engineer. The Contractor shall mix the mineral aggregates and asphaltic material until a product of uniform color and consistency is produced. The asphaltic material shall be applied uniformly and under pressure and at the specified temperature. The bituminous mat materials, with or without additive, shall have a moisture content of two percent or less by weight at time of laying.

After the asphaltic material and mineral aggregates have been prepared as described above, the bituminous mat shall be spread to a uniform thickness at the required locations and be compacted until the surface is smooth, firm and of the density specified by the Engineer. Rolling shall proceed longitudinally starting at the edges of the material and progressing toward the center and shall be performed immediately after the material has been spread. On completion of the rolling operation the bituminous mat shall be true to the section shown on the Drawings, smooth, and free from humps, depressions or irregularities. When a straight edge 10 feet long is laid on the finished surface of the bituminous mat, the surface shall not vary more than one quarter inch from the lower edge of the straight edge in any place. Should the bituminous mat show an excess or deficiency of asphaltic material or uneven distribution thereof due to insufficient mixing or other causes, after the mat is laid, the condition shall be corrected by thorough scarifying of the mixed material; adding surfacing or asphalt as required; and spreading and compacting until a bituminous mat satisfactory to the Engineer has been produced.

Measurement and Payment

19.6.4 (1) Bituminous prime coat

The quantities of liquid asphalt either Cut Back or Emulsified shall be measured in square meter as actually covered by the prime court within the limits shown on the drawings or as directed by the Engineer and paid for separately as per BOQ Item.

The rate shall include all material, labour, equipment and any work necessary therefore to complete the work satisfactorily

(2) Asphaltic wearing course (bituminous mat)

Measurements for payment for surfacing of roadways will be made of the volume in square meter of the asphaltic wearing course constructed in accordance with these Specifications and the Engineer's instructions, placed to the lines and thicknesses specified herein. The areas of all roadways and other areas designated by the Engineer, will be measured for payment only once and no additional payment will be made because of the thickness of pavement required, because of the number of layers involved in constructing the pavement or because of prime coats being required.

Payment for asphaltic wearing course will be made at the unit rate per square meter tendered in the Bill of Quantities.

The amount tendered shall be full payment for completion of the work specified herein and elsewhere in these Specifications and on the Drawings for Surfacing of Roadways over Bridges. No separate or additional payment will be made under this or any other item for use at the Contractor's option of alternative method for surfacing of roadways.

19.7 GALVANISED IRON PIPES

Scope of Work

18.7.1 The work to be done under this item consists of fabrication and placing of standard galvanized iron drain pipes of

specified diameter at the decks of bridges, gauge wells or elsewhere as shown on the Drawings or as directed by the Engineer.

Material

19.7.2 The standard schedule 40 pipe shall conform to requirements of ASTM Designation A 120.

Galvanizing

19.7.3 All steel and iron work of whatever kind, described to be galvanized, is to be pickled in dilute hydrochloric acid and then washed, fluxed and stoved and coated with zinc by means of dipping in a bath of molten zinc. All articles are to be immersed in the bath only for the time sufficient for them to attain the temperature of the bath and they are to be withdrawn at such speed that a coating of 90 micron thickness on each face is achieved. Every article is to be covered evenly on all sides. The galvanizing shall conform to the BS 729 "Hot dip galvanized coatings on iron and steel articles".

Measurement and Payment

19.7.4 (a) The pipes of the approved type provided and installed in place shall be measured by length in linear meter of pipe actually installed in place in accordance with the Drawings and accepted by the Engineer.

(b) The payment shall be made at the unit rate tendered in the BOQ for drain pipes and shall constitute full compensation for all costs of labour, material and placing of drain pipes, in concrete to the satisfaction of the Engineer.

19.8 PVC PIPES

Scope of Work

18.8.1 The work to be done under this item consists of providing and placing PVC pipes of specified diameter in place or as shown on the Drawings or directed by the Engineer.

Material

19.8.2 The PVC pipes shall conform to following standards and specifications

Standard	Item
ASTM D1785	Polyvinyl chloride (PVC) pipe, schedules 40, 80 and 120.
ASTM D2466	Polyvinyl chloride (PVC) pipe fittings, schedule 40.
ASTM D2467	Socket type polyvinyl chloride (PVC) pipe fittings schedule 80.

In addition:

(a) The pipe should be homogenous throughout and free of visible cracks, holes or other defects. The pipe shall be as uniform as commercially practicable in colour, opacity, density and other physical properties.

(b) The pipes should meet all the necessary requirements of dimensions and tolerances, sustained pressure, burst pressure, workmanship and appearance as outlined in the above referred standards to ensure quality.

(c) The Contractor will be responsible for carrying out all the tests required to confirm that the material/product meets the prescribed requirements as outlined in the above referred specifications to the satisfaction of the Engineer.

Measurement and Payment

19.8.3 (a) The pipes of the approved type provided and installed in place shall be measured by length in linear meter or pipe actually installed in place and accepted.

(b) The unit rate of PVC pipe shall be for providing in place the specified diameter pipe per m. run and shall be deemed to be the full payment of material, labour and all other activities required to complete the work.

(c) The measurement for payment of flap covers shall be made as numbers of flap covers provided and installed in accordance with the Specifications, Drawings and as approved by the Engineer.

(d) The payment for flap covers shall be made at the rate per number quoted in BOQ for this item. The quoted rate shall be deemed to cover all costs of providing, fixing and all other related works complete in all respects.

19.9 RUNGS

Scope of Work

19.9.1 The work to be done under Rungs will consist of 1 inch diameter deformed mild steel bars embedded in new concrete or drilling and grouting in the existing concrete or in brick work at the specified locations and in the manner shown on the Drawings. The shape, dimensions, depth of embedment of the rungs in concrete, the spacing between rungs and other details shall be as shown on the Drawings or as directed by the Engineer and in accordance with the Specifications.

Materials and Construction

19.9.2 The rungs shall be of deformed mild steel of minimum yield strength as mentioned on drawings and shall be fabricated to the shape and dimensions as shown on the Drawings and conforming to ASTM 615. The materials, mixing, placing, and curing of concrete lining shall conform to the provisions of Section – “Concrete, General” and “Canal Lining” of these Specifications.

Measurement and Payment

19.9.3 Measurement will be made by number of rungs acceptably furnished and embedded in concrete, concrete canal lining and brick work.

Payment will be made at the unit rate per number tendered in the Bill of Quantities for Rungs, and shall constitute full compensation for all cost of labour, materials, tools and equipment required for furnishing and installing Rungs to the satisfaction of the Engineer.

19.10 CANAL DISTANCE MARKERS AND BOUNDARY PILLARS

Scope of Work

19.10.1 The work to be done consists of furnishing and placing permanent canal distance markers on dowel at intervals of 1,000 feet along the service road of canal and boundary pillars at intervals of 5,000 feet on both sides of the Canals at edge of ROW in accordance with the Drawings and these Specifications, and of furnishing, placing and maintaining temporary canal distance markers and boundary pillars at the same intervals until placement of the permanent one.

Materials and Workmanship

19.10.2 All concrete materials, casting, curing and repairing of concrete for canal distance markers and boundary pillars shall be in accordance with the provisions of, and in complete conformity with, the stipulations and requirement for concrete specified in the Section-4“ Concrete, General”.

Permanent Markers and Boundary Pillars

19.10.3 Permanent canal distance markers and boundary pillars shall be the `concrete burjies’ and shall be in accordance with the dimensions and details shown on the Drawings. The finished surfaces of distance markers shall be free of adhering concrete and shall be reasonably smooth. Castings have all figures and features shall be casted integrally by embossing in the markers on all three sides. All markers shall be identical except the numbers indicating the canal RD shall be one, two and three-digit numbers as required for the appropriate canal distance. The size/font of letters shall be as approved by the Engineer.

Boundary pillars and distance markers shall be pre-cast units of concrete class C (3000 psi) using Ordinary Portland Cement, placed accurately in accordance with the Drawings and the Engineer’s instructions. Distance markers shall be painted as shown on the Drawings and to the satisfaction of the Engineer.

Temporary Markers

19.10.4 On commencement of work on the Canals, the Contractor shall furnish and place temporary canal distance markers and boundary pillars at or near the locations designated for the permanent one and maintain each temporary marker/pillar in good condition until such time as it is replaced by a permanent one. The temporary markers may be of any type and material suitable for the intended purpose provided the size and design are such as to be clearly visible and are acceptable to the Engineer. The temporary marker/pillars for a designated location shall be removed from the site after the permanent marker/pillars for the position has been fixed and accepted by the Engineer.

Measurement and Payment

19.10.5 (a) Measurement for payment of canal distance markers and boundary pillars will be made in number only for the permanent markers/pillars furnished and installed in accordance with these Specifications, Drawings and instructions of the Engineer.

(b) Payment for both canal distance markers and

boundary pillars will be made at the respective unit rate tendered in the Bill of Quantities for these Items.

The amount tendered shall be full payment for furnishing all material, casting, curing, and fixing including labour for completion of the work specified herein and elsewhere in these Specifications and as shown on the Drawings for the respective BOQ items for canal distance markers and boundary pillars, including all costs of furnishing and installing permanent and temporary canal distance markers and boundary pillars.

19.11 SHINGLE ROAD SURFACING

General

19.11.1 Shingle Road surfacing shall be done for the Inspection road on the left bank of the canals as shown on Drawings or as instructed by the Engineer. Interchanges/ramps providing access to other roads shall also be provided with shingle surfacing.

This section shall consist of furnishing, spreading, compacting granular base material, in one or more layers and on a prepared subgrade according to the Specifications and Drawings and/or as directed by the Engineer.

Subgrade Preparation

19.11.2 The embankments compacted for which required compaction has been ensured by the contractor in accordance with the requirements and specifications described in Section - “Earthwork”, shall be used as prepared subgrade under Shingle Road Surfacing.

Granular Base

19.11.3 (1) Material: Granular base material shall consist of natural or processed aggregate such as gravel, sand, or stone fragments, and shall be clean and free from dirt, organic matter and deleterious substances, and shall be of such nature that it can be compacted by rolling to form a firm, stable base.

(2) Gradation: The material shall comply with the following grading and quality requirements:

(a) The base material shall have a gradation within the limits given below:

Sieve Designation	Percentage Passing, by Weight .
2 inch	100
1 inch	55-85
3/4 inch	50-80
3/8 inch	40-70
No. 4	30-60
No. 10	20-50
No. 40	10-30
No. 200	5-15

The Coefficient of Uniformity D60/D10 shall be not

less than 3, where D60 and D10 are the particle diameters corresponding to 60% and 10% respectively, passing (by mass) in a grain size analysis curve.

(b) The material shall have a CBR value of at least 50%, determined according to ASTM D1883. The CBR value shall be obtained at a density corresponding to 98% of the maximum dry density determined according to ASTM D1557.

(c) The coarse aggregate material retained on sieve No. 4 shall have a percent wear by Los Angeles ASTM C131 of not more than 40% at 500 revolutions.

(d) The ratio D15 Base/D85 Subgrade should be less than 5, where D85 and D15 are the particle diameters corresponding to 85% and 15% respectively passing by mass in a grain size analysis curve.

(e) The fraction passing the No. 200 sieve shall not be greater than two thirds of the fraction passing the No. 40 sieve.

(f) The fraction passing No. 40 sieve shall have a liquid limit of not greater than 25, and a plasticity index of between 4% and 8% as tested according to ASTM D4318.

(3) Construction: Granular base shall be spread on approved subgrade layer as a uniform mixture. Segregation shall be avoided during spreading and the final compacted layer shall be free from concentrations of coarse or fine material.

Granular base shall be deposited on the subgrade in a quantity which will provide the required compacted thickness without resorting to spotting, picking, or otherwise shifting the base material.

When the required thickness is 6 inches or less, the aggregate may be spread and compacted in one layer. When the required thickness is more than 6 inches, the aggregates shall be spread and compacted in 2 or more layers of approximately equal thickness.

No hauling or placement of material will be permitted when, in the judgment of the Engineer, the weather or road conditions are such that the hauling operation would cause cutting or rutting of the subgrade.

(4) Compaction Trials: Prior to commencement of granular base operations, the Contractor shall construct a trial length of 1500 feet with the same approved base material as will be used in the construction to determine the adequacy of the Contractors method and equipment, the loose depth measurement necessary to result in the specified thickness of compacted material, the field moisture content, and the relationship between the number of compaction

passes and the resulting density of the material.

(5) Compaction: The moisture content of base material shall be adjusted prior to compaction by watering with approved sprinklers mounted on trucks, or by drying out, as required in order to obtain the specified compaction.

The base shall be compacted by means of approved vibrating rollers or steel wheel rollers, and rubber tyred rollers, progressing from the outside towards the center. Each succeeding pass shall overlap the previous pass by at least one third of the roller width. While the rolling progresses, the entire surface of each layer shall be properly shaped and dressed with a motor grader, to attain a smooth surface free from ruts and ridges and having a proper section. Rolling shall continue until the entire thickness of each layer is thoroughly and uniformly compacted to specified density.

Any area inaccessible to rolling equipment shall be compacted by means of mechanical tampers, where the thickness in loose layer shall not be more than 4 inches.

If the layer of base material or part thereof does not conform to the required finish, the Contractor shall, at his own expense, rework, water and recompact the material.

The relative compaction of each layer of the compacted base shall not be less than 98% of the maximum dry density determined according to ASTM D1557. The field density shall be determined according to ASTM D1556 or other approved method. For all material, the field density thus obtained shall be adjusted to account for oversize particles retained on 3/4 inch sieve as directed by the Engineer.

Measurement and Payment

19.11.4 (1) Subgrade Preparation: No measurement and payment shall be made separately for preparation of subgrade under Shingle Road Surfacing.

(2) Granular Base:

(a) The quantity of granular base for payment shall be the theoretical volume in place as shown on the Drawings or as directed and approved by the Engineer. No allowance will be given for material placed outside of the theoretical limits shown on the cross sections.

(b) The accepted quantities calculated as provided above shall be paid for, at the unit price per thousand cubic feet tendered in the Bill of Quantities.

(c) The rate quoted in BOQ for this item shall be full compensation for furnishing all materials, hauling, placing, watering, mixing, rolling, labour, equipment, tools, and all incidentals necessary to complete the item.

19.12 MISCELLANEOUS METAL WORK

Scope of Work

18.12.1 The work to be done under Miscellaneous Metalwork, consists of furnishing, transporting, storing, erecting, installing, galvanizing and painting miscellaneous metalwork as shown on the Drawings and in accordance with these Specifications.

The Contractor shall furnish and install all anchor bolts and nuts, assembly bolts and nuts, brackets, clips and miscellaneous plates and shapes required including those to be embedded in concrete, if any.

Materials

19.12.2 All materials shall be new, of the best commercial quality, as approved by the Engineer, and shall meet the following requirements:

(a) Structural steel shall be in accordance with ASTM Designation: 36.

(b) All bolts and nuts shall be in accordance with ASTM Designation A 307, Grade A.

(c) All arc-welding electrodes shall be of the E60 classification in accordance with the latest edition of the American Welding Society “Specifications for Iron and Steel Arc-Welding Electrodes”, and shall be suitable for the positions and other conditions of intended use.

(d) Expansion anchors shall be the lead and metal-alloy compound unit type.

(e) All galvanized steel pipe shall be Schedule 40 Steel Pipe conforming to the requirements of ASTM Designation: A120.

(f) Floor grating shall be of galvanized steel of the required size, type and strength for the intended use and shall be of best commercial quality as determined by the Engineer.

Drawings

19.12.3 The Contractor shall prepare necessary shop and erection drawings covering materials to be furnished for the miscellaneous metalwork. All drawings shall be furnished for approval of the Engineer in accordance with the applicable provisions of SP-11 – “Drawings and Data to be Furnished by Contractor”, of the Special Provisions.

Fabrication

19.12.4 All work shall be equal to the best modern practices in the manufacture and fabrication of metalwork notwithstanding any omissions from these Specifications or Drawings. Details of design and fabrication not covered by the Drawings or by these Specifications shall conform to the latest “Specification for the Design, Fabrication, and Erection of Structural Steel for Building” of the American Institute of Steel Construction, herein-after designated the AISC Code.

Before being laid out or worked in any away, materials shall

be straight and free from sharp kinks and bends. If straightening is necessary, it shall be done by methods that will not injure the metal.

Shearing and cutting by torch or electric arc shall be performed carefully, and all portions of the work which will be exposed to view after completion shall be finished neatly. Re-entrant cuts and copes on beams or channels shall be filleted before cutting.

All holes shall be cylindrical, unless otherwise shown on the Drawings; perpendicular to the member, clean-cut and without burred or ragged edges. Holes shall be punched or drilled to full size. Holes shall be accurately and carefully placed. Edge distances and bolt spacing shall conform to the requirements of the AISC Code.

Welding

19.12.5 All welding and work related thereto shall comply with the latest edition of the American Welding Society "Standard Specifications for Welded Highway and Railway Bridges". All welding terms shall be interpreted in accordance with the American Welding Society definitions of welding terms, unless otherwise noted.

Members to be joined by welding shall be cut accurately to size. The edges of the member shall be sheared, flame cut or machined to suit the type of welding. The cut surfaces shall expose sound metal free from injurious defects. The surfaces of plates to be welded shall be free from rust, grease and other foreign matter for a distance of at least ¾ of an inch back from the edge of the weld.

All welding shall be performed by the electric-arc method, by a process which will exclude the atmosphere from the molten metal, and where practicable, using automatic machines. After being deposited, welds shall be cleaned of slag and shall show uniform sections, smoothness of weld metal, feather edges without overlap, and freedom from porosity and clinkers. All pinholes, cracks and other defects shall be repaired by chipping or grinding the defects to sound metal and rewelding.

Arc-welding equipment shall be of a type approved by the Engineer that will produce proper voltages, amperages and polarity for all uses and positions for which the electrodes are suitable.

All welding operators assigned to the work shall have passed the qualification test for welding operators as specified in the ASME Code. If required, the Contractor shall furnish to the Engineer a certified copy of the results of physical tests of specimens welded in the qualification tests. If in the opinion of the Engineer, the work of any welder at any time appears questionable, such welder shall be required to pass another qualification test witnessed by the Engineer. All cost connected with making the qualification tests of welding operators shall be borne by the Contractor.

Erection and Installation

19.12.6 All structural steel parts shall be accurately assembled and erected as shown on the Drawings, and all match marks of the fabricator shall be accurately followed. Hammering that will injure or

distort the members will not be permitted. Bearing surfaces and surfaces to be in permanent contact shall be cleaned carefully before the members are assembled or erected. At bolted connections, the bolts shall be drawn tight, and where required, the threads shall be burred or spot welded so that nuts cannot become loosened. Where required, bolt holes shall be reamed in the field to provide a light-driving fit.

For the installation of the miscellaneous metalwork, only mechanics skilled in their various trades shall be employed. The material shall be carefully handled so that no part will be bent, broken, or otherwise damaged, and any damage caused by the Contractor shall be repaired by and at the expense of the Contractor and in a manner satisfactory to the Engineer.

Metalwork to be embedded in concrete shall be installed when the concrete is being placed or, if shown on the Drawings or directed by the Engineer, recesses or blockout shall be provided in the concrete and the metalwork shall be grouted in place after the concrete has been placed. Anchor bolts and anchor bolt inserts shall be placed when the concrete is placed, unless otherwise directed by the Engineer. Where it is impracticable to place anchors or anchor bolts required for the installation of comparatively light metal accessories before the concrete is placed, holes shall be drilled in the concrete after the concrete has set thoroughly and expansion bolt or lead expansion anchors shall be installed therein.

Metalwork to be embedded in concrete shall be placed accurately and shall be held in its correct position while the concrete is being placed. The surfaces of all metalwork to be in contact with or embedded in concrete shall be thoroughly cleaned of all paint, rust, dirt, grease, loose scale, grout, mortar and other foreign substances immediately before the concrete is placed. No surface in contact with concrete shall be painted. Exceptional care shall be taken to ensure that all frames, guides and other fixed metalwork are installed in exact position and alignment.

Anchor Bolts

19.12.7 Anchor bolts shall be cleaned of all foreign material before they are embedded in concrete. Anchor bolts shall be supported rigidly in such a manner as to prevent displacement or undue vibration during the placing of the concrete.

Galvanizing

19.12.8 All steel and iron work of whatever kind described shall be galvanized as per standards and specifications given herein under Clause 18.7.3.

Painting

19.12.9 (a) General: All miscellaneous metalwork other than mentioned as galvanized, shall be painted with approved colour as directed by the Engineer. The contactor shall clean the surface and apply paint and protective coatings as hereinafter provided and furnish all required material. Surfaces not required to be painted coated, but adjacent to surfaces that are to be cleaned and painted shall be appropriately protected during the cleaning and painting operations. Tinting for color contrast, except for the last coat, shall be done by using not more than three ounces of tinting color per U.S.

gallon (22 gms/1) of paint. Surfaces which have been painted shall be handled with care and protected as necessary to preserve the coating in good condition. Temporary or permanent welding will not be permitted on area where the welding will damage the paint unless the painted surfaces that would be damages thereby are accessible for repairing and inspection.

Each undercoat and of paint shall be of a different color enabling easy differentiation between the coats of paint.

Except where specified, the contractor will to be required to disassemble machinery, equipment or other metal work for the purpose of painting the interiors.
Metalwork which is required to be painted shall be procured with a single undercoat applied in the workshop. On site this coat shall be touched up and repaired as required before further coats are applied in the field. Any shop coat on manufactured item shall be cleaned and painted as specified.

The contractor shall procure the painting materials according to a schedule which will ensure that the paint will not be stored longer than the limits recommend by the manufacturers.

b) Cleaning and Painting Tabulation

Sr. No.	Item	Method of surface preparation A, B or C as in para (c)	Painting or coating material as in para (e)	Number of Coats.
1.	Ferrous metal exposed to view, water bearing, wet, intermittently submerged or submerged.	(‘C)	VR-6 vinyl resin paint and mastic	6 or more to produce a minimum dry film thickness of 3 mm
2.	Ferrous metal exposed to view, water bearing, wet, intermittently submerged or submerged but for item not included in 2 above:	‘B’ for areas of type IV, red lead shop coat ‘C’ for unpainted surfaces	Prime coat – red lead primary paint type IV Finish coat – phenolic resin aluminum paint	1 2
3.	Ferrous surfaces to be in contact with water.	‘C’	Coal tar epoxy paint, Black	2 or more to produce a minimum dry film thickness of 4 mm
4.	Non-water bearing metal work subjected to ordinary atmospheric exposures and public view but for items not included in this tabulation. i) Canal distance	‘A’ for damaged painted surface to receive additional paint ‘B’ for unpainted ferrous surfaces damaged areas of painted surfaces.	Prime coat – red lead priming paint type II for ferrous metal surfaces Finish coat – machinery paint or regular aluminum paint as directed	1 for unpainted surface 1 or more as required for repair or damaged painted surfaces

	markers ii) Miscellaneous metalwork			
5.	Ferrous surface which will be inaccessible after installation or assembly	'B' or 'C'	Priming paint specified for other surfaces or the same metal work	3 if unpainted 2 if primed
6.	All machine – finished surfaces of ferrous metal work including screw threads that will be exposed during shipment and while awaiting installation	'A'	Corrosion preventive compound grade 1	1 heavy coat
7.	Damaged area of galvanized surfaces that do not require finish painting	'B'	Zinc dust – Zinc Oxide or Zinc dust chlorinated rubber priming paint (surfaces subject to normal exposure) zinc dust chlorinated rubber priming paint (for buried and damp surfaces)	2 or more coats to produce a minimum dry film thickness of 1 mm. 2 or more coats to produce a minimum dry film thickness of 2 mm.

c) Preparation of Surfaces

Surface preparation shall be in accordance with one of the following methods. The method to be used for each item, is indicated in the painting tabulation. Weld spatter, burrs, or other objectionable surface irregularities shall be removed or repaired before cleaning. Any grit or dust remaining from the cleaning operation shall be removed before the surfaces are painted. Cleaning solvent shall be mineral spirits or xylol except that xylol shall be used for surfaces which require coal-tar coatings. In the event that rust forms or the surfaces become otherwise contaminated in the interval between cleaning and painting, or between coats of paint, recleaning will be required.

Method A: All oil, grease and dirt shall be removed by the use of clean solvent and clean wiping material.

Method B: All oil, grease and dirt shall be removed by the use of clean solvent and clean wiping material. Following the solvent cleaning, the surfaces to be painted shall be cleaned of all defective or damaged areas of existing paint, and of all loose rust, loose mill scale, and other foreign substance by scraping, chipping, blasting, power wire brushing or other effective means.

Method C: All oil, grease and dirt shall be removed by the use of clean solvent and clean wiping material. Following the solvent cleaning, the surfaces to be painted shall be blast cleaned to base metal, using dry, hard, sharp sand or steel grit, to produce a grey-etched surface. The blasting material shall pass a No.16 United States standard screen and at least 85 per cent shall be retained on a No.50 United States standard screen.

d) Application

Materials shall be thoroughly mixed at the time of application. Surfaces shall be clean and free from moisture at the time of application. Effective means shall be provided for removing free oil and moisture from the air-supply lines of all spraying equipment. Nozzle pressure consistent with acceptable finish results shall be employed when spray painting. Each coat shall be free from runs, pinholes, and sags. Each coat shall be allowed to dry or to harden before the succeeding coat is applied. Thickness specified in millimeters shall be measured by an approved dry-film thickness gauge. Red-lead priming paint, regular or phenolic-resin aluminium paint, and machinery paint may be thinned if necessary to permit satisfactory application, in which event mineral spirits shall be used and the amount of thinner shall be kept to a minimum and in no event shall it exceed 15 percent of the paint. Thinning of other materials will be permitted only if approved. If necessary to improve application properties, cold-applied paints may be heated by means of a hot-water bath to temperatures not exceeding 42.5°C.

Application of specific materials shall be as follows:

i) Red-lead priming paint shall be applied at a maximum coverage of 500 square feet per U.S. gallon per coat (10.76 m^2/l). The first coat shall be applied by brush and subsequent coats shall be applied by either brush or spray. Following the first coat, an additional tinted brush coat shall be applied over all rivets, welds, bolts, seams, sharp corners and edges before subsequent painting. Alternate coats shall be tinted for colour contrast using 1B black.

ii) Aluminium paint shall be applied by spraying at a maximum coverage of 500 square feet per U.S. gallon per coat. The paint shall be prepared by mixing two pounds of aluminium paste per U.S. gallon of mixing varnish and only enough paint for each day's use shall be prepared at one time. The first coat shall be tinted for colour contrast using 2A blue.

iii) Machinery paint shall be applied at a maximum coverage of 500 square feet per U.S. gallon per coat.

iv) Rust-preventative compound shall be applied by any convenient method to ensure complete coverage with a heavy uniform coating.

v) Coal-tar epoxy coating shall be applied at a maximum coverage of 110 square feet per U.S. gallon per coat (2.37 m^2/l), Alternate coats shall be of different colours and the final coat shall be a colour other than black, the colour being subject to approval by the Engineer. Surface preparation, application and thinning shall all be done in

accordance with the manufacturer's instructions.

vi) Vinyl-resin Paint VR-6

Coat	Alternate Colours of	Apply by	Max. coverage Ft^2/US gal (m^2/l)	Min. drying time
Prime	Dark Gray Brush	250(5.38)	4 hours	
Body	3 of more coats alternated red	Spray	120(2.58) each coat	12 hours each coat
Seal		Spray	200(4.30) each coat	12 hours between coats & at least 10 days before placing in service

Note: Figure in brackets in m^2/l.

e) Materials

All pigmented paints and primers shall be purchased in sealed containers packaged by the manufacturer and shall be delivered with the seals unbroken. Colours of finish paints shall match colour samples furnished to the Engineer unless colour requirements are specifically stated otherwise. Materials shall be in accordance with the following specifications:

i) Federal Specifications

1) Red lead priming paint, TT-P-86a, Type II
2) Zinc dust zinc-oxide primer, TT-P641b, Type II
3) Mixing varnish for regular aluminium paint, TT-V 8 lb. Type II, Class B
4) Aluminium paste, TT-A-468a, Type II, Class B
5) Machinery enamel, TT-E-489, Class A
6) Pigment-in-oil (tinting colours), TT-P-38 lb Colours IB black and 2A blue
7) Mineral spirits TT-T-29la, Grade 1
8) Xylol (xylena), TT-X-961, Grade A or B

ii) United States Maritime Administration Specifications

Rust preventative compound, 52-MA-602A, Type B, Medium, except that equally effective inhibitors in suitable quantities, may be used in lieu of the specified percentage of chromates

iii) Military Specifications

Vinyl-resin paint, VR-6 aluminium paste thinner

iv) U.S. Bureau of Reclamation Specifications

v) Certification of Materials

The Contractor shall furnish manufacturer's certificates of compliance with specifications for all paint material being furnished. The Engineer reserves the right to test materials accepted on certification when, in the opinion of the Engineer, such tests are necessary.

Measurement and Payment

19.12.10 (a) Measurement for payment for miscellaneous metalwork will be made of the actual quantity of the miscellaneous metalwork furnished, galvanized or painted and installed in Kilograms (Kgs) in accordance with the Drawings and as directed by the Engineer. The weight shall be determined in the most practicable manner using actual weights measured at the Site, calculated weights or manufacturer's weights. Net weights only will be paid for. The weight of all tare packing and blocking will not be included.

(b) Payment for miscellaneous metalwork will be made at the unit rate per kg tendered in the Bill of Quantities.

(c) The amount tendered shall be full payment for completion of the work specified herein and elsewhere in these Specifications and on the Drawings.

19.13 ELASTOMERIC BEARING PADS

Scope of Work

19.13.1 The work to be done under elastomeric bearing pads consists of providing all materials for elastomeric bearing pads of required size and shape and placing in position as shown on the Drawings, in accordance with the stipulations stated herein or as directed by the Engineer.

Material

19.13.2 Elastomeric bearings pads as specified herein shall include plain bearings (consisting of elastomer only) and laminated bearings (consisting of layers of elastomer restrained at their interfaces by bonded laminates). The elastomer portion of the elastomeric compound shall be 100 percent Virgin Chloroprene (neoprene) meeting the requirements of the AASHTO Standard Specifications (1983) for Highway Bridges. Laminates shall be rolled mild steel sheets conforming to ASTM A36 unless otherwise specified. Neoprene bearing pads shall be furnished by the Contractor and installed at the locations shown on the Drawings. All operations of the Contractor in storing and installing the neoprene bearing pads, shall be in strict accordance with the manufacturer's instructions and as directed by the Engineer.

Measurement and Payment

19.13.3 (a) Measurement of elastomeric bearing pads shall be made in the cubic cm of the bearing pads.

(b) Payment for elastomeric bearing pads will be made

according to the unit rate per cubic inch tendered in Bill of Quantities for elastomeric bearing pads. The rate for bearing pad shall include supplying, fixing and all other work related to the BOQ item for providing and fixing bearing pads.

19.14 3-PLY BITUMENASTIC FELT PAPER

Scope of Work

18.14.1 The work to be done under the item "3-ply bitumenastic felt paper" includes providing, placing and installing as shown on the Drawing and or as directed by the Engineer.

Material and Construction Method

19.14.2 Bearings for bridge decks shall consist of 3-ply bitumen paper laid over two coats of hot bitumen using 0.35 lbs/sft blinding with sand at 0.01 cft/sft. The concrete surfaces on which the bitumen paper is to be placed shall be wood float finished to a level plane which shall not vary more than 0.1 inches from a 10 feet straightedge placed in any direction across the area. The finished plane shall not vary more than 0.1 inches from the elevation shown on the Drawings or that required by the Engineer.

Measurement and Payment

19.14.3 (a) Measurement for payment of 3-ply bitumenastic felt paper will be made at the unit rate sq.m. tendered in the Bill of Quantities.

(b) The amount tendered shall be full payment for completion of the work specified herein and elsewhere in these Specifications and on the Drawings for the respective BOQ items for

3-ply bitumenastic felt paper including all costs of furnishing and installing.

19.15 ENAMELED IRON GAUGE

Scope of Work

19.15.1 The work to be done under the item "enameled iron gauge" includes providing, placing and installing as shown on the Drawing and or as directed by the Engineer.

Material and Construction Method

19.15.2 (a) Gauges to be made of No.18 gauge mild steel plate and to be covered with vitreous enamel with a minimum thickness or 12 mils on numerical side and 3 mils on the reverse side and on edges where plate, has been cut, punched or drilled.

(b) All cutting, drilling and punching of the plates shall be completed before the vitreous enamel is applied.

(c) The face of the gauge shall be white and all numerals and graduations shall be black.

(d) Graduations shall be sharp and accurate to the dimensions shown.

(e) In case a greater length than shown on the drawings required, the details shall be similar to details shown for

shorter lengths.

Measurement and Payment

19.15.3 (a) Measurement for payment of enameled iron gauge will be made at the unit rate of number tendered in the Bill of Quantities.

(b) The amount tendered shall be full payment for completion of the work specified herein and elsewhere in these Specifications and on the Drawings for the respective BOQ items for enameled iron gauge including all costs of furnishing and installing.

19.16 EXPANSION JOINTS IN BRIDGE DECK SLABS

Scope of Work

19.16.1 The work covered in this item shall consist of furnishing all plant, equipment, materials and labour in performing all operations in connection with furnishing and placing (in concrete structures) all deck expansion joints and seals, in accordance with the specifications, the Drawings, and or as required by the Engineer.

Material Requirements

19.16.2 <u>Concrete Joint Filler:</u>

a) Neoprene Rubber Sheet
Unless otherwise directed by the Engineer, neoprene rubber sheets ¼ inch in thickness, meeting the requirements given below, shall be used as a joint filler covered with joint sealer as shown in the Drawings.
Neoprene rubber sheet shall be of neoprene or of polyvinyl chloride (PVC), at the option of the Contractor. Neoprene shall be manufactured from a vulcanized elastomeric compound containing neoprene as the sole elastomer and shall have the following physical characteristics in accordance with ASTM Method D15, Part B.

Hardness, Durometer A, ASTM D 2240	45 ± 5 points
Tensile Strength, ASTM D 412	127 Kgs/square centimeter min
Elongation at Break	400 percent min.
Compression Set, 22 Hours at 70 degree C. ASTM 395, Method B.	20 percent max.
Low Temperature, ASTM D746	Not brittle at 40 degree C.
Ozone Resistance, Exposure to 100 PPHM Ozone for 70 hours at 38 degree C. Sample under 20 percent. ASTM D 1149	No cracks
Oil Deterioration – Volume increase after soaking in ASTM oil No.3 for 70 hours at 100 degree C	

ASTM D 470 120 percent max.

b) Joint Sealer
The joints sealer shall conform to the requirements of item 18.3.2 of the Specifications.

Measurement and Payment

19.16.3 (a) Measurement of Expansion joints shown on the Drawings and as described herein above, shall be made in linear meter of the joints acceptably formed according to the length shown on the Drawings.

(b) Payment for expansion joint shall be made according to the rate tendered in the Bill of Quantities per linear meter of the joint which shall be deemed to cover all costs including supplying and installing the joint filler, joint sealer and all other works related to the BOQ item for providing and filling expansion joints.

19.17 RCC PIPES

Scope of Work

18.17.1 The work to be done under this item consists of providing and placing Reinforced Cement Concrete Pipes of specified diameter in outlets according to size, lines and grades shown on the Drawings and in accordance with the Specifications hereunder and directions of the Engineer.

RCC Pipes for Outlets

19.17.2 Pipes for outlets are reinforced concrete pipes for conveying the water from canal to outside sump. The sizes, slopes and other details of RCC pipes are shown on the Drawings. All materials, methods of manufacture and strength requirements for the RCC concrete pipe shall conform to the requirements of ASTM Designation C-76 and shall be subject to inspection and approval by the Engineer. The cement used in the manufacture of the pipes shall be Ordinary Portland Cement.

The ends of RCC pipe shall be spigot and socket type and of such design that when laid, the joints shall form a continuous conduit with a smooth and uniform interior surface. The concrete used in joints of pipes shall conform to the Specifications given in Section “Concrete General”, Drawing and direction of the Engineer.

Unless otherwise shown on the Drawings, pipe lines shall be straight and each pipe shall be laid accurately within 0.25 inch tolerances to the lines and levels shown on the Drawings or ordered by the Engineer.

provided always that there shall be no reverse gradient on any pipe or on the line as a whole.

Excavation and Backfill of Trenches for RCC Pipes and Sumps

19.17.3 Trenches for outlets shall be excavated after compaction of canal banks upto their design levels. The trenches shall be excavated only to that widths shown on the Drawings and no excess excavation shall be allowed. The trenches excavated wider than the specified widths shall not be accepted and shall be refilled, compacted and re-excavated by the Contractor at his own cost. After placing and laying the RCC pipes to satisfaction of the Engineer, the trenches shall be backfilled as soon as possible with suitable material

in two stages.

(a) First Stage
First stage would involve compaction to have a minimum cover of 12 inches above the crown of the pipe. The backfill material shall be evenly placed and compacted in layers not exceeding 4 inches thick after compaction. The layers shall be compacted in such a way as will not disturb the alignment or grade of the pipe. The compaction shall be achieved as specified under Section – "Earthwork".

(b) Second Stage
The remainder of the trench shall then be filled with excavated material evenly placed and compacted in layers not exceeding 6 inches thick after compaction. The method of compaction shall be achieved as specified under Section – "Earthwork".

Measurement and Payment

19.17.4 (a) Measurement for payment of RCC pipes shall be made in running meter of pipes provided and placed as per drawings, Specifications and approved by the Engineer.

(b) Payment shall be made per R.meter at rates quoted for respective diameter pipes in BOQ and shall be deemed to be the full compensation for all material and labour for the work including jointing, complete in all respects.

19.18 PRECAST CONCRETE BLOCK APRON

Scope of Work

19.18.1 The work to be done under Precast Concrete Block Apron consists of constructing precast concrete block apron at the end of downstream floor of the weir and elsewhere as shown on the Drawings or as directed by the Engineer. The work includes manufacturing, storing, handling, transporting and placing of the precast concrete blocks; furnishing and placing a filter of screened sand and aggregates; and all incidental operations necessary to construct the precast concrete block aprons in accordance with these Specifications.

Alternative proposal for constructing the precast concrete block aprons, such as casting of the concrete blocks in place, may be submitted to the Engineer for consideration, however, approval of any such alternatives proposed by the Contractor shall not waive or modify his responsibility for constructing the concrete block aprons in accordance with all other requirements of these Specifications.

Precast Concrete Blocks

19.18.2 (1) <u>Material</u>

(a) All concrete materials and the producing, forming, placing curing and repairing of concrete under these Specifications shall be in accordance with the provisions of and in complete conformity with the stipulations and requirements for class B concrete specified in the section, "Concrete General".

(b) All cement, sand and aggregates for concrete for

precast concrete block aprons shall be furnished by the Contractor in accordance with the provisions of, and in complete conformity with the stipulations and requirements specified in the section, “Concrete General”. The filter material shall be as per specification designated under sub-section, Construction.

19.18.2 (2) Concrete Blocks

Precast concrete blocks shall have a minimum plan dimension and thickness as specified on the Drawings. The blocks shall be cast on level platform having adequate foundations to prevent settlement during casting and curing operations. Casting in tiers will be permitted when approved by the Engineer. Forms shall be arranged to provide ample working room and easy for carrying out all operations required for the proper placing, consolidating and finishing of the concrete. Side forms shall remain in place at least 24 hours after the concrete is placed. Each block thoroughly worked into the corners of the forms and compacted by the internal vibrating, spading and rodding during the concrete placing operation.

Blocks shall remain undisturbed after casting until completion of a 3-day curing period. Storing, handling and placing of the precast concrete blocks shall be accomplished by methods that will not damage the blocks, using suitable bridles, slings or other approved means. Blocks which are damaged in any way during casting, curing or handling will be rejected and shall be removed from the Site by the Contractor and disposed of in a manner approved by the Engineer.

19.18.2 (3) Construction

Precast concrete block aprons shall be constructed on firm foundations or on filter blanket and to the lines and grades shown on the Drawings or established by the Engineer. Depressions in the foundation shall be filled with suitable material and compacted in 6-inch layers. The precast concrete blocks shall be laid with the top surface reasonably level and with uniform spacing of 2-inches between blocks. Alternate transverse courses shall be offset one-half the standard block width such that longitudinal joints will not be continuous. All spaces between precast concrete blocks shall be filled with ½ inch aggregate.

Measurement and Payment

19.18.3 (a) Measurement for payment for precast concrete block aprons will be made to the dimensions of the areas of the precast concrete block aprons calculated cubic meter volume and constructed in accordance with the Drawings and the Specifications excluding filter, which will be measured separately.

(b) Payment for precast concrete block apron will be made at the unit rate per cubic meter tendered in the Bill of Quantities for Precast Concrete Block Apron.

The amount tendered shall be full payment for completion of the work specified herein and elsewhere in these Specifications and on the Drawings for Precast Concrete Block Apron except filling depressions or excavation for foundation which will be paid for under

Items Excavation from Borrow Areas and Excavation for Structures.

Filter Blanket/ Under Concrete Blocks Apron

19.18.4 (1) Material

The contractor shall furnish all materials for the complete construction of the filter including fine aggregates and coarse aggregates in conformity with the stipulations and requirements specified in the section 10 “Stone Pitching and Stone Apron”.

19.18.4 (2) Foundation Preparation

Sub-grade on which filter blanket is to be placed shall be firm and if necessary be lightly tamped or rolled to conform to levels on the Drawings. Where such areas are below or above grade, these will be brought to the required grade by filling with suitable material and compacted in 6 inch layers or by excavating as the case may be.

19.18.4 (3) Filter Blanket and its Construction

After the foundation has been satisfactorily prepared, the Contractor shall place thereon a filter material blanket 18 inch thick or as per thickness on the drawing. When approved by the Engineer, the 18-inch thick filter shall consist of a bottom 6-inch layer of local screened sand followed by a 6-inch layer of ¾ inch aggregate and a top 6 inch layer of 1½ inch aggregate. The bottom layer shall have sufficient water content (3 to 10%) during placement. Any damage to the surface of the filter base during placing the filter shall be repaired before proceeding with the work. The filter shall provide a firm foundation for the precast concrete blocks and be finished to a reasonably smooth and even surface, such that the average elevation of each precast concrete block will not vary more than 2-inches from the elevation shown on the Drawings or established by the Engineer, nor more than 2-inches with respect to any adjacent block.

Measurement and Payment

19.18.5 (a) Measurement for payment will be made in cubic meter of filter blanket to the required thickness and specification and approved by the Engineer.

(b) Payment for furnishing transporting and placing filter blanket will be made at the unit price per cubic meter bid in the Bill of Quantities. The amount bid shall be full payment for completion of the work specified herein as filter blanket under concrete blocks.

Payment for filling depressions or excavation for foundation will be made under Items Excavation from Borrow Areas and Excavation for Structures.

19.19 --- Not Used ----

19.20 --- Not Used ----

19.21 --- Not Used ----

19.22 DAMP PROOFING

Scope

19.22.1 The work covered under this section shall consist of damp proofing concrete surface or brick/block masonry surface, in accordance with these specifications and at the location shown on the Drawings or as directed by the Engineer.

General

19.22.2 The concrete surface shall be damp proofing with bitumen by the absorptive method where as brick/block masonry surfaces shall be first treated with a horizontal layer of Portland cement concrete and then covered with bitumen damp proof cover with Hessian base. Vertical faces of walls likely to come in contact with earth shall be first plastered with sulphate resisting cement plasterin1:2 cement sand mortar and then treated with bitumen by the absorptive method. Damp proofing shall not be applied when the temperature is below 39° F and falling. The work shall be done by workmen experienced in the application of damp-proofing. Damp proofing shall be applied as shown on the Drawings.

damp-proofing materials

19.22.3 All asphaltic materials shall be delivered in sealed containers bearing the manufacturer's original labels as provided under relevant Clauses of these Specifications and shall conform to the designated Specifications and be approved by the Engineer. Damp proofing materials shall conform to the following requirements along with the requirements shown on the Drawings.

Asphalt primer

19.22.4 The asphalt primer shall consist of an asphaltic base thinned to a suitable brushing consistency, with a volatile solvent, and shall conform to the requirements set forth under ASTM 41-73 or latest revision.

Asphalt

19.22.5 Asphalt for damp proofing shall meet the requirements of ASTM D 449-73, Type C or latest revision.

Preparation of surfaces

19.22.6 Surfaces to receive damp proofing shall be smooth, clean and dry. Holes, joints and cracks shall be painted flush with mortar and high spots ground level with the surrounding surface. Before damp proofing, surfaces shall be swept clean of all foreign matter and shall be inspected and approved.

Placement procedures

19.22.7 The selection of various waterproofing and damp proofing materials for different locations shall be as shown on the drawings or as directed by the Engineer. Unless otherwise directed or approved by the Engineer, the following procedures shall be adopted:

Damp Proofing under Brick Masonry walls

19.22.8 The damp proofing shall comprise of:

1 ½" thick layer of plain cement concrete Class B shall be placed over the area to be damp proofing.

A priming coat of asphalt primer confirming to BS specification 1097 October 1973 before the application of asphalt coating.

An asphalt coat using not less than 30 lbs per 100 sq. ft.

19.23 ROOF INSULATION

Scope

19.23.1 The work consists of insulation with brick tiles of sizes 9”x4/2”x 1 ½” or any other approved size laid in cement mortar (1:3) over rammed mud laid to grade as shown on drawings after applying two coats of bitumen on the R.C.C. roof slab surface at 30/25 lbs, respectively for first and second coats at specified heat.

Materials

19.23.2 The brick tiles shall comply with the standards set in “Section Bricks” except for their thickness and strength. The cement, sand and water shall meet the requirements as given in Sections “CONCRETE, CEMENT AND GENERAL”

Bitumen shall be PB3 or PB4

The clay for making mud shall be clean, free of all organic and other injurious matters.

Application

19.23.3

Bitumen Painting
Bitumen heated to the specified temperature and applied on R.C.C roof slab cleaned and dried surface including sanding at 1 ½ cu.ft per hundred sq.ft of surface.

Laying Mud
The clay shall be mixed with reasonable quantity of water thoroughly kneaded to from a tick paste to which copped straw at the rate of 10 lbs. per cu.ft of mud shall be added. It shall be laid and thumped with wooden trowels to from the slope as shown on the Drawings.

Laying of tiles
The Brick tiles shall be laid in cement mortar (1:3) in fall/slope as shown on drawings.

Pointing
The brick tiles shall then be flush pointed in cement mortar (1:2)

Curing
The tiles laid shall be cured properly for ten days.

19.24 STEEL DOORS AND WINDOWS WITH MS SHEET OR MS GRATING

Scope

19.24.1 The Section of specification consists of furnishing all plant, labor, equipment and materials in performing all operations in connection with providing and fixing metal windows and doors, all metal windows and doors including painting shall be according to the Schedule specified on drawings and manufactured by a firm to be approved by the Engineer. They shall be handled with care, shall be

staked on edge on level bearers and be supported evenly against a wall or vertical bearers, under cover.

Contractor to fix

19.24.2 The Contractor shall fix the windows, doors as described. He shall be responsible for storing windows etc., and carrying to their respective positions, assembling composites, bedding and jointing with matic at the mullions and transoms, fixing lugs and screws to frames, placing in the openings and bedding with cement and pointing externally with mastic.

Building in

19.24.3 Where applicable metal windows, doors shall be built in, set to plumb and line and cement mortar shall be grouted into the channel of the frame as brickwork proceeds. Fixing lugs shall be grouted in at the jambs, head and sill. When screwing up lugs or fixing screws, care shall be taken to ensure that windows etc. are not distorted.

Fixing into prepared openings

19.24.4 Windows to be fixed into prepared openings shall have at least 1/8 inch to tolerance all round. Window frames shall be grouted with cement mortar into the channel of the frame joints between building openings and window etc. frames shall be chalked with mastic cement of an approved make.

Fabrication of doors, windows

19.24.5
The steel section shall be thoroughly strengthened in the shape by methods that will not injure it before being laid off or worked in any way.

All members shall be so cut and formed that they can be accurately assembled with out being unduly cracked strained or forced into position.

The jointing of the different parts of the members of mild steel shall be carried out by welding process in conformity with the requirements of American Welding Society fore such joints. Welding points shall be made quite smooth by filing them and making smooth.

Putty

19.24.6 The putty shall be of a type specially prepared for use with metal work in tropical conditions.

Protection of Fittings

19.24.7 Fittings shall be wrapped and protected from damage until all rough trades have been completed.

Glazing

19.24.8 Glazing shall be fixed in metal windows by proprietary PVC or neoprene molded soling strips as provided by the manufacturers of the windows, or as may be directed by the Engineer.

All windows shall be glazed with 5 mm thick glass.

The contractor shall be responsible for protecting and maintaining all glazing in its prime condition. On completion all glass shall be cleaned inside and out and all cracks and broken glass shall be replaced, all to the satisfaction of the Engineer.

Painting preparation of the metal work

19.24.9 Iron and steel surface shall be cleaned by means of solvents approved methods., cleaned surfaces shall be primed as soon as practicable after cleaning.

Paint Application

19.24.10 Unless otherwise specified or instructed the Contractor shall apply paints as follows:

Internal Surface of Steel Work

2 coats Zinc Chrome primer
2 under coats
1 glass finish coat

External Surfaces of steel Work

2 coats Zinc Chrome primer
1 aluminium bitumastic under coat
1 aluminium bitumastic finish coat

All painting coats up to and including the first undercoats, shall be applied under cover at “WORKS” before despatch to the Site.(the second undercoat and the finishing coat shall be applied after erection on Site). Extreme care shall be taken to protect paint coats during transit.

Paint

19.24.11 The paints for any painting sequence shall be mutually compatible and of the same approved manufacture. All paints shall be supplied in small sealed containers each not exceeding one gallon capacity.

Wire gauze

19.24.12 Unless otherwise specified the wire gauze shall be of best quality as approved by the Engineer uniformly woven wire webbing of 12x12 meshes to 645 mm (one sq.inch) made from 22 guage galvanized iron wire. All panel shall be in one piece and no joints shall be allowed in the guaze.
Wire guaze shall be fixed as shown on the drawings or as directed by the Engineer. The guaze shall remain right to the full width and without any sag.

Measurement and Payment

19.24.13 Measurement will be made for square meter of MS Sheet gate provided and installed complete in all respects.

Payment will be made per square feet of MS Sheet gate as measured at the contract unit price and shall constitute full compensation to provide stiffners, lock & paints complete.

19.26 Cast Iron Pipe and Fittings

General

Cast Iron Pipes and Fittings shall comply with BS 78 for spigot and socket vertically cast pipes BS 1211 for Spigot and Socket Spun Iron

Pipes and BS 2035 for Flanged Pipes.

19.27 Mild Steel Pipes

General

The mild steel pipes shall conform to ASTM A53/A 53M for steel pipes.

Measurement and Payment

Measurement will be made for linear feet of Pipe provided and installed complete in all respects.

Payment will be made for linear feet of Pipe work as measured at the contract unit price and shall constitute full compensation to provide, handle lay and jointing Pipes complete.

19.28 ---- Not Used -----

19.29 ---- Not Used -----

19.30 ---- Not Used -----

19.31 ---- Not Used ----

19.32 Two Layers of 8 gauge G.I sheets used as bearing pad with bitumen in-between

Measurement and Payment

Measurement and Payment for providing and installing two layers of 8 guage G.I Sheets combined in one unit with in-between bitumen in Super Passages over pile cap shall be made in square meter of combined sheets actually placed as per drawings and shall constitute full compensation for procurement of materials, installation and all other costs involved therein.

19.33 Two G.I Sheets of 1/16 inch thickness each for Roof Felt Packing

Measurement and Payment

Measurement and Payment for providing and installation of two G.I Sheets of 1/16 inch thickness each for Roof Felt packing used along side of pile caps for Super Passages shall be made in square meter of such sheets actually installed as per drawings and shall constitute full payment for procurement, installation and all operations involved therein.

19.34 Providing Rainwater Outlets for Bridges

Measurement and Payment

Measurement for providing rainwater outlets for road bridges shall be made in number of rainwater outlets installed as per drawings.

Payment for rainwater inlets measured as above shall be made as per unit rate tendered in BOQ and shall constitute full payment for all the materials and operations required to complete the work.

19.35 Operator's hut and Septic Tank

Measurement and Payment

Measurement and payment for constructing operator's hut along with septic tank shall be made on lump sum basis against the amount tendered in the BoQ.

The Contractor shall submit the breakup of this lump sum item such that the proportion of payment at any time shall correspond reasonably with the value of work done at that stage. The payment schedule shall be approved by the Engineer.

Payment against this item shall constitute full payment for providing material, labour, operations and equipment for completion of Operator's hut and septic tank as per drawings and specifications complete in all respects.

20 – QUALITY CONTROL (QC) AND QUALITY ASSURANCE (QA)

Scope of Work

20.1 (1) The Contractor shall be responsible for providing all QC measures to ensure compliance of the works with the Drawings and/or as stated in the Contract Documents.

(2) The Engineer may himself perform independently or ask the Contractor to perform under his supervision all such tests and analysis as are necessary for the verification of the QC tests results and analysis under his Quality Assurance (QA) programme.

(3) In case of any difference between the QA and QC results, the QA results/analysis shall be considered valid and final.

QC Testing Facilities

20.2 (1) The Contractor shall ensure that proper representative samples are taken from each lot and sub-lot, identify the tests and analysis required, and ensure that the tests and analyses conducted are in accordance with internationally accepted procedures and standards. The Engineer may himself perform such independent tests and analysis as are necessary to verify the QC tests results conducted by the Contractor.

(2) As a part of the construction materials QC programme, the Contractor shall set up a field laboratory at his own cost. The field laboratory shall be in full working order suitably equipped and staffed to carry out all routine sampling and testing necessary for successful and timely completion of the works according to these specifications. A list of routine tests to be performed in the field laboratory or any laboratory specified by the Engineer is given below and Table 20.1 provides details regarding frequency of testing.

Routine Tests:

a) Soil
- Auger sampling, ASTM D-1452
- Plasticity Index test, ASTM D-4318
- Grain size analysis, ASTM D-422
- Moisture density relationship, ASTM D-698 and 1557
- Visual identification classification, ASTM D-2488
- Classification of soils for engineering purposes, ASTM D-2487
- Max. and Min. index densities, ASTM D-4253 and ASTM D-4254
- Proctor needle penetration, ASTM D-1558
- Moisture content of soils, ASTM D-2216
- In-place density, ASTM D-1556, ASTM D-2167 and ASTM D-2937
- Specific gravity, ASTM D-854
- California Bearing Ratio, CBR AASHTO T193 or ASTM D1883
- Water Soluble Chloride (CL), B.S. 1377

- Water Soluble Sulfate (SO_3) B.S. 1377

b) Aggregates and Concrete

- Sampling of aggregates, ASTM D-75
- Sampling of fresh concrete, ASTM C-172
- Sieve analysis of aggregates, ASTM C-136
- Specific gravity and absorption of aggregates, ASTM C-127 and ASTM C-128
- Slump of concrete, ASTM C-143
- Unit weight of fresh concrete, ASTM C-138
- Unit weight of aggregates, ASTM C-29
- Making and curing of concrete cylinders, ASTM C-31
- Compressive strength of concrete cylinder ASTMC39
- Water Soluble Chloride (Cl) ASTM C1812 or BS 812
- Water Soluble Sulfates (SO_3) BS 1377

Submittals

20.3 (1) QC Program:

The Contractor shall submit his QC programme to the Engineer for his review and approval prior to the commencement of work. The QC programme shall include, but not be limited to, the following; detailed location of facilities, type, number and capacity of equipment, staff, vehicles, procedures, and schedule.

(2) Method Statements:

Within 30 days before starting any work, the Contractor shall submit to the Engineer for his approval a detailed description of the QC programme which should include, but not be limited to:

- Setting out the work,
- Care of water,
- Surveying,
- Excavation (main canal/structures),
- Piling,
- Backfilling around structures,
- Procuring concrete aggregates,
- Proportioning of concrete mix.,
- Post tensioning systems.

(3) Source Approval

The Contractor will obtain source approval; submittals will include the name and address of all manufacturers and suppliers, test results showing complete compliance with the Specifications and specified Standards, the date of manufacture and storage condition, shelf life if appropriate. In addition, the Contractor shall provide representative samples of the materials of sufficient size such that the Engineer may perform all specific tests. Once source approval has been granted by the Engineer all deliveries of the material to the site must in turn be submitted for approval accompanied by all relevant test reports to show full compliance of the material with the Specifications.

Where the required tests cannot be performed at the site laboratory, then the Contractor shall arrange for independent testing at a laboratory approved by the Engineer, to be performed to show that the material complies with the Specifications. Cost of such testing shall not be reimbursed.

Contractor's QC Test Results

20.4 All QC tests results shall be submitted to the Engineer for his review and acceptance. The test results must show full compliance with the Specifications, in order for the works to be approved. The materials and test reports submitted to the Engineer shall include, but shall not be limited to the following:

a) Soil reports showing locations, material source, material type, density, moisture content, density-moisture content relationship, degree of compaction (RC) and relative density where applicable.

b) Concrete reports showing source of all constituents, testing of source material, date of manufacture, testing of material after processing, including determination of moisture content of aggregates and testing manufactured concrete, concrete slump, compressive strength, temperature during placement etc. Certification of all cement supplies, and storage records.

c) Aggregates reports for filters, base course, showing source of material, test results showing compliance with the specification and placing location.

d) Ancillary reports for materials such as steel, pre-stressing strand, jointing compound, sealant etc., showing name of source, date of manufacturers' shelf life, storage conditions, place of storage, test results showing compliance with the specification and placing records.

QA Tests

20.5 The Engineer may himself perform or ask the Contractor to perform under his supervision such independent tests and analysis as are necessary to verify the results and analyses conducted under the Contractor's QC programme. In addition, cross check tests will be performed in the Engineer's laboratory or by the Engineer's testing crew at the site to verify compliance with the Specifications.

TABLE 20.1

Test Frequencies for Different Tests to be run by the Contractor under QC Programme

Material	Test	Designation	Testing Frequency
SOIL			
	Grain Size Analysis	ASTM D-422	1 for 30,000 cft
	Liquid Limit	ASTM D-4318	1 for 30,000 cft
	Plastic Limit	ASTM D-4318	1 for 30,000 cft
	Shrinkage Limit	ASTM D-427	1 for 30,000 cft
	Moisture Density Relationship	ASTM D-698	1 for 30,000 cft
	Moisture Density Relationship	ASTM D-1557	1 for 10,000 cft
	Field Density for Embankment	ASTM D-1556	1 for 7,500 cft
	Field Density for Backfill	ASTM D-1556	1 for 5,000 cft
	Moisture Content	ASTM D-566 or ASTM D-2216	1 for 7,500 cft (min. 2 for each layer)
	Specific Gravity	ASTM D-854	Min. 3 per source or type of material or as directed by the Engineer
	Relative dry density	ASTM D-4253 & ASTM D-4254	1 for 10,000 cft or as required by the Engineer
	CBR	AASHTO T193	As required
COARSE AGGREGATE			
	Sieve Analysis	ASTM C-136	1 for 7,000 cft
	Material Passing # 200 Sieve	ASTM C-117	1 for 7,000 cft
	Unit Weight	ASTM C-29	1 for 17,500 cft
	Specific Gravity and Absorption	ASTM C-127 & ASTM C-128	1 for 17,500 cft
	Moisture Content	ASTM C-566	1 for 17,500 cft
	Soundness	ASTM C-88	1 for 70,000 cft
	Los Angles Abrasion	ASTM C-131	1 for 70,000 cft
	Clay Lumps & Friable Particles	ASTM C-142	1 for 70,000 cft
	Petrographic Analysis	ASTM C-295	3 for each source
	Lightweight Particles	ASTM C-123	1 for 70,000 cft
	Water Soluble (Cl) Water Soluble (SO_3)	ASTM C-1812, or BS 812 BS 1377	1 per lot / source or as directed by the Engineer
FINE AGGREGATE			
	Sieve Analysis	ASTM C-136	1 for 3,500 cft
	Material Passing #200 Sieve	ASTM C-117	1 for 3,500 cft
	Unit Weight	ASTM C-29	1 for 8,750 cft
	Specific Gravity and Absorption	ASTM C-128	1 for 8,750 cft
	Moisture Content	ASTM C-566	1 for 3,500 cft

	Soundness	ASTM C-88	1 for 35,000 cft

Material	Test	Designation	Testing Frequency
	Clay Lumps & Friable Particles	ASTM C-142	1 for 35,000 cft
	Sand Equivalent	ASTM C-2419	1 for 35,000 cft
	Organic Impurities	ASTM C-40	5 per each source
	Lightweight Particles	ASTM C-123	1 for 35,000 cft
	Petrographic Analysis	ASTM C-295	3 for each source
	Water Soluble at Water Soluble SO_3	ASTM C-1812, or BS 812 BS 1377	1 per lot / source or as directed by the Engineer
CEMENT			
	Setting Time	ASTM C-191	1 per lot or 2500 bags
	Mortar Strength	ASTM C-109	1 per lot or 2500 bags
	Complete Chemical Analysis	ASTM C-114	As required
REINFORCEMENT			
	Size and weight	ASTM 615	As required by the Engr.
	Elongation	ASTM 615	As required by the Engr.
	Bending	ASTM 615	As required by the Engr.
	Tensile Strength	ASTM 615	As required by the Engr.
	Complete Chemical Analysis	ASTM 615	As required by the Engr.
WATER			
	Complete Chemical Analysis		Once a month/Source
CONCRETE	Making and curing concrete specimen	ASTM C-31	As required
	Compressive Strength	ASTM C-39	1 for 2,000 cft
	Slump	ASTM C-143	1 for 2,000 cft
	Air Content	ASTM C-231	1 for 2,000 cft
	Temperature		1 for 1,000 cft
	Fresh Density	ASTM C-138	1 for 5,000 cft
ADMIXTURES			
	Air Entraining	ASTM C-260	As required by the Engr.
	Chemical Admixtures for Concrete	ASTM C-494	As required by the Engr.
	Curing Compound	ASTM C-309	As required by the Engr.
OTHERS			
	Joint Filler	ASTM D 1752-84	As required by the Engr.
	Joint Sealant	ASTM C 920-98	As required by the Engr.
	Waterstop	US Federal Test Method Standard No.601	As required by the Engr.

21 – CLEANING AND CLEAN-UP

Scope of Work

21.1 The work to be done under Cleaning and Clean-up covers furnishing of all labour, materials, equipment and services and performing all operations necessary for and incidental to clean-up during construction and final cleaning of structures and the site prior to acceptance of the Works by the Employer as specified herein and elsewhere in the Contract.

Clean-up during Construction

21.2 It is required that the entire site be kept in a neat and orderly condition and the Engineer may, at any time during construction, order a general clean-up of the site as part of the work under this section.

Contractor shall dispose of waste, trash, and debris in an acceptable manner, in accordance with applicable laws and as prescribed by the Engineer or authorities having jurisdiction. Burying of waste material on the site and/or burning of trash and debris on the site will not be permitted, unless approved by the Engineer.

Location of dump of trash and debris and its haul will be Contractor's responsibility.

Final Cleaning of Structures and Equipments

21.3 Prior to final inspection by the Engineer and Employer and after all construction work is essentially complete, the Contractor shall thoroughly clean structures and equipment as required or appropriate.

The Contractor shall follow the recommendations of the manufacturers of materials, equipment and items to be cleaned, for all cleaning and other recommended treatments.

Final Site Clean-up

21.4 Also prior to final inspection, the Contractor shall thoroughly clean the entire site and put it into a neat, acceptable condition. He shall remove from the entire site all construction waste and unused materials, loose rock and stones, waste earth and debris of any description resulting from the work.

Measurement and Payment

21.5 No separate measurement or payment will be made for work required under this Section. All costs in connection with the work specified herein shall be included in the various items of work in the Bill of Quantities.

22 – CONTRACT CLOSE-UP

Scope of Work

22.1 The work to be done under Contract Close-up covers performing all operations necessary for and incidental to closing up the Works or portions of the Works and assisting in the Employer's final inspection.

Close-up Schedule and Procedure

22.2 Requirement Preparatory to Final Inspection:

a) The Contractor shall request the Engineer/Employer to perform a preliminary final inspection for the purposes of determining the state of completion. He shall notify the Engineer and Employer at least seven (7) days in advance of when this inspection is to be performed. From the information gathered from this inspection, the Engineer will prepare a "punch list" of work to be performed, corrected, or completed before the Works will be accepted. All work on the "punch list" shall be completed by the Contractor prior to final inspection.

b) All temporary facilities shall be removed from site, unless directed otherwise by the Engineer.

c) The site and all applicable appurtenances and improvements shall be cleaned as specified.

d) All operating instructions for equipment shall be properly mounted and posted as specified or required.

e) All guarantees and warranties shall be submitted to the Employer in care of the Engineer, as specified in the various sections of the Specifications, along with required or printed maintenance instructions and manuals.

(1) Final Inspection

a) After all requirements preparatory to the final inspection have been completed as hereinbefore specified, the Contractor shall notify the Engineer and Employer to perform the final inspections.

b) The Contractor, or his authorized Representative, shall accompany the Engineer/Employer on the final inspection, together with any Subcontractors that the Engineer or Employer may request to be present.

c) If the works have been completed in accordance with the Contract Documents, and no further corrective measures are required the Engineer will issue a Taking-over certificate and the Employer will accept the Works. Subject to the provisions of Clause 48 of the Conditions of Contract.

d) If the works have been substantially completed in accordance with the Contract Documents, and only minor corrective measures are required, the Employer will conditionally accept the Works and the Engineer will issue a Taking-over Certificate based upon the Contractor's assurance that the corrective measures will be completed within the shortest practicable time within the Defects Liability Period-Clause 49 of the Conditions of Contract.

23 – DISMANTLING OF EXISTING STRUCTURES

Scope of Work

23.1 (1) The work to be done under item - Dismantling of existing structure consists of dismantling of existing structures (constructed of plain and reinforced concrete, brick and stone masonry) required to be dismantled such as canal lining, bridges, culverts, syphons, aqueducts, outfall structure drainage junctions, drainage inlets etc. Whether in part or as a whole as shown in drawings or specified or as directed by the Engineer.

(2) Work also includes dismantling of stone pitching and stone apron upto the extent and levels as directed by the Engineer.

General

21.2 (1) All gates and embedments for the structure shall be dismantled without hazard and cleared upto level as approved by the Engineer. The dismantled material shall be removed and disposed off within the right of way / specified point for storage as directed by the Engineer.

(2) The Contractor to the extent possible shall extract salvage material without any loss. The Employer shall require that material should be stored typewise properly and handed over to him.

(3) Useful retrieved material from brick work, stone pitching and stone apron shall be removed, stacked at approved locations or re-used as directed by the Engineer.

Measurement and Payment

23.3.1 (a) Measurement for payment for the reinforced concrete part of structure shall be part made per M^3 (cum), within outlines of the reinforced concrete in place and on the basis of their thickness shown on the Drawings. No separate measurement for payment shall be made for excavating and preparing trough, dewatering if required and all costs on their account shall be deemed to be included in the unit rate for the BOQ item including cost of separation the reinforcement as per instruction of Engineer.

(b) The BOQ rate shall constitute full compensation for completion of work specified herein and elsewhere in these specifications and on Drawings for dismantling of reinforced concrete part of structure.

(c) The amount tendered shall be full payment for completion of the work specified herein and elsewhere in these specifications and on the Drawings for dismantling reinforced concrete part of the structure and all work related thereto.

23.3.2 (a) Measurement for payment for the plain concrete part of structure shall be part made in M^3 (cum), within outlines of the plain concrete in place and on the basis of their thickness shown on the Drawings. No separate measurement for payment shall be made for excavating and preparing trough, dewatering if required and all costs on their account shall be deemed to be included in the unit rate for the BOQ item.

(b) The BOQ rate shall constitute full compensation for completion of work specified herein and elsewhere in these specifications and on Drawings for dismantling of plain concrete part of structure.

(c) The amount tendered shall be full payment for completion of the work specified herein and elsewhere in these Specifications and on the Drawings for dismantling plain concrete part of the structure and all work related thereto.

23.3.3 (a) Measurement for payment for the brick masonry part of structure shall be part made per M^3 (cum), within outlines of the brick masonry in place and on the basis of their thickness shown on the Drawings. No separate measurement for payment shall be made for excavating and preparing trough, dewatering if required and all costs on their account shall be deemed to be included in the unit rate for the BOQ item.

(b) Unit rate tendered in BOQ shall constitute full compensation for completion of work specified herein and elsewhere in these specifications and on Drawings for dismantling of brick masonry part of structure.

(c) The amount tendered shall be full payment for completion of the work specified herein and elsewhere in these Specifications and on the Drawings for dismantling brick masonry part of the structure and all work related thereto.

23.3.4 (a) Measurement for payment for the stone masonry part of structure shall be part made in per M^3 (cum), within outlines of the stone masonry in place and on the basis of their thickness shown on the Drawings. No separate measurement for payment shall be made for excavating and preparing trough, dewatering if required and all costs on their account shall be deemed to be included in the unit rate for the BOQ item.

(b) Unit rate tendered in BOQ shall constitute full compensation for completion of work specified herein and elsewhere in these specifications and on Drawings for dismantling of stone masonry part of structure.

(c) The amount tendered shall be full payment for completion of the work specified herein and elsewhere in these Specifications and on the Drawings for dismantling stone masonry part of the structure and all work related thereto.