

KINGDOM OF THAILAND ROYAL IRRIGATION DEPARTMENT MINISTRY OF AGRICULTURE AND COOPERATIVES

TENDER AND CONTRACTING DOCUMENTS FOR THE FLOOD PREVENTION PROJECT OF EAST SIDE OF THE PASAK RIVER IN AYUTTHAYA

VOLUME I

TENDER AND CONTRACTING REQUIREMENTS

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OCTOBER 2012

CTI ENGINEERING INTERNATIONAL CO., LTD. TOKYO, JAPAN

SECTION 1

INVITATION TO TENDER

INVITATION TO TENDER

Royal Irrigation Department, Ministry of Agriculture and Cooperatives, acting on behalf of the Government of the Kingdom of Thailand hereby invites the prequalified Japanese Tenderers to tender for the Flood Prevention Project of East Side of the Pasak River in Ayutthaya (hereinafter referred to as "the Project") in accordance with the Tender and Contracting Documents.

The Project will be financed by a grant extended by Japan International Cooperation Agency (hereinafter referred to as "JICA") based upon the Grant Agreement signed between the Government of the Kingdom of Thailand and JICA on the 15th day of August, 2012 for the Project.

The Tender Documents are available at CTI Engineering International Co., Ltd. who has been appointed as the Consultant for the executing agency of the Project, at the following address at the non-refundable cost of Japanese Yen 60,000.

CTI Engineering International Co., Ltd. Tachibana Annex Building 2-25-14 Kameido Koto-ku, Tokyo, 136-071, Japan Tel. 03-3638-2585

All inquiries relative to this tender shall be directed to the Consultant's office at the address written above as specified and stipulated in the Instruction to Tenderers.

The tender and all accompanying documents shall be prepared in accordance with Tender Documents and shall be delivered by hand to the Consultant's office at the above mentioned address at **** on the **th day of ****, **** (Japan Standard Time: JST) in sealed envelopes, as specified in the Instructions to Tenderers.

The tender shall be opened at the same place immediately after the closing time on **th day of ****, **** and all tenderers shall be requested to be present at this time.

Royal Irrigation Department Ministry of Agriculture and Cooperatives The Kingdom of Thailand

SECTION 2

INSTRUCTION TO TENDERERS

INSTRUCTION TO TENDERERS

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INSTRUCTION TO TENDERERS

Chapter 1: Introduction

1. The Purpose of Tender

- (1) For the purpose of contributing to the execution of the Flood Prevention Project of East Side of the Pasak River in Ayutthaya (hereinafter referred to as "the Project") by the Government of the Kingdom of Thailand, Japan International Cooperation Agency (hereinafter referred to as "JICA") will extend a grant to the Government of the Kingdom of Thailand in accordance with the Grant Agreement (hereinafter referred to as "G/A"), signed on the 15th of August, 2012.
- (2) On behalf of the Government of the Kingdom of Thailand, as the Client, the executing agency, Royal Irrigation Department, Ministry of Agriculture and Cooperatives, will invite the eligible tenderers provided in Clause 2 of this Chapter to the tendering for the Project.

2. Qualification of Tenderers

Eligible tenderers shall be Japanese nationals who satisfy the following requirements. The term Japanese nationals whenever used in these tender documents means Japanese physical persons or Japanese juridical persons who are controlled by Japanese physical persons. Any firms, who fall under any of the items of Article 26, paragraph 1 of the Foreign Exchange and Foreign Trade Act (Gaikokukawase-oyobi-Gaikokuboeki-Ho, Law No.228 of 1949, Japan), shall not be regarded as being controlled by Japanese physical persons.

Eligible tenderers shall be the ones who have been pre-qualified prior to the tendering.

3. Description of the Project

- (1) The executing agency, Royal Irrigation Department, Ministry of Agriculture and Cooperatives, takes overall responsibility for implementing the Project, with the consultation services by CTI Engineering International Co., Ltd., (hereinafter referred to as the Consultant).
- (2) The Project will contribute to reduce flood damage at the left bank (East side) of the Pasak River in Ayutthaya and the industrial estates located in the left bank of the Chao Phraya River through construction of floodgates & bank protection, and provision of drainage pump vehicles.

4. Scope of Work

The scope of works covered by this tendering (hereinafter referred to as "the Work") of

(2)

the Project consists of the followings:

(1) Construction of the facilities

- Kra Mang Floodgate	1 site					
- Han Tra Floodgate	1 site					
- Bank Protection of Han Tra Canal	484m					
Procurement of the Equipment						
- Drainage Pump Vehicle (30m ³ /min)	10 sets					

Details of the Work shall be stipulated in due conformity with the Specifications of the Tender Documents.

5. Japan's Grant Aid Scheme

Since the Project will be implemented with the use of Japan's Grant Aid, the tenderers should be well aware of and conform to the procedures practiced in the Japan's Grant Aid Scheme.

6. Misprocurement

JICA requires that, under contracts funded by the Grant, tenderers and Contractors observe the highest standard of ethics during the procurement and execution of such contracts. In this regard, JICA will not verify the contract if it determines that the Contractor has engaged in corrupt or fraudulent practices in competing for the contract in question. JICA will recognize a Contractor as ineligible, for a period determined by JICA, to be awarded a contract funded by the Grant if, at any time, it determines that the Contractor has engaged in corrupt or fraudulent practices in competing for, or in executing any other contracts funded by the Grant or other Japanese ODA.

7. Period of Execution of the Work

"The Work" shall be completed on or before the day of the ** day of ****, ****. The period may be extended by mutual agreement between the Government of the Kingdom of Thailand and the Contractor if unpredicted circumstances require any extension of the period. In order to extend the period, the Government of the Kingdom of Thailand and the Contractor shall obtain prior consent of JICA. The extended period shall not exceed the term of validity of the Grant as prescribed in the G/A (or documents exchanged for the purpose of extending the term described in the G/A).

8. Acquaintance with Local Conditions

(1) The Project sites are located in both Ayutthaya city and Ayothaya town, Phra Nakhon Si Ayutthaya District, Phra Nakhon Si Ayutthaya Provence, the Kingdom of Thailand.

- (2) On-site orientation will not be held at the site of the Project. The tenderers are, however, advised to visit and to examine the Project site and its surroundings and to obtain for themselves, on their own responsibilities and expenses, all information that may be necessary for preparing the tender, if any.
- (3) To the extent which is practicable (taking into account of cost and time), the tenderers shall be deemed to have obtained all necessary information as to risks, contingencies and other circumstances which may influence or affect the tender or the Work. To the same extent, the tenderers shall be deemed to have inspected and examined the Project site, its surroundings, the above data and other available information, and to have been satisfied before submitting the tender as to all relevant matters, including (without limitation).
 - 1) the form and nature of the Project site, including sub-surface conditions,
 - 2) the hydrological and climatic conditions,
 - the extent and nature of the Work and goods necessary for the execution and completion of the Work and remedying of any defects,
 - 4) the laws, procedures and labor practices of the country, and
 - 5) the Contractor's requirements for access, accommodation, facilities, personnel, power, transport, water and other services,
- (4) No claim whatsoever shall be made as a result of ignorance of local conditions on the part of the tenderers and such ignorance shall be a responsibility of the tenderers.

9. Eligible Source Countries

The Equipment to be supplied under this tendering (See the list of the Equipment in the Specification attached), shall be the product of Japan or the Kingdom of Thailand.

Chapter 2: Tender Documents

1. Composition of Tender Documents

The tender and contracting documents are composed of the followings:

- 1) Volume I Tender and Contracting Requirements
 - Section 1 Invitation to Tender
 - Section 2 Instruction to Tenderers
 - Section 3 Form of Tender
 - Section 4 Form of Contract
 - Section 5 Conditions of Contract

Section 6 Tentative Implementation Schedule Section 7 Specifications Appendices

2) Volume II Tender Drawings

The documents are to be taken as mutually explanatory of one another. If an ambiguity or discrepancy is found in the documents, the interpretation shall be done in accordance with the above-mentioned sequence of the priority.

2. Responsibility of Tenderers

- (1) Tenderers shall examine carefully the Tender Documents to understand fully the content of the Work including the amounts, and the difficulties and restrictions affecting the execution and completion of the Work.
- (2) Tenderers shall be liable to any failure or negligence to obtain reliable and necessary information for successful execution or completion of the Work.

3. Clarification of Tender Documents

- (1) Any inquiries of the Tender Documents or any doubts as to interpretation shall be written in attached form in English and sent to the Consultant by mail or facsimile on or before ****. on the ** day of ****, **** (Japan Standard Time; JST).
- (2) The Consultant shall respond in writing to the inquiry and/or doubt as to the interpretation stated above. The responses will be sent by facsimile to all prospective tenderers who purchased the Tender Documents on or before the ** day of ****, **** (Japan Standard Time; JST).
- (3) All the prospective tenderers shall send a facsimile to the Consultant for the confirmation of the receipt.
- (4) The responses shall constitute a part of the Tender Documents provided in Chapter 2 Clause 1.

4. Addenda of Tender Documents

- (1) The Client may, for any reason, whether at his own initiative or in response to a clarification requested by prospective tenderers, modify the Tender Documents.
- (2) The Consultant will notify the addenda indicating the modification by facsimile to all prospective tenderers on or before the ** day of ****, **** in English, at least 7 calendar days before the day of tender opening.
- (3) The prospective tenderers shall send the confirmation of receiving the addenda

stated above to the Consultant by facsimile.

 (4) The addenda shall constitute a part of the Tender Documents provided in Chapter 2 Clause 1.

Chapter 3: Preparation and Submission of Tender

1. Preparation of Tender

- (1) The tender shall be prepared and submitted by filling out the forms and documents provided on the Forms of Tender. Each of the forms shall be completely filled in indelible ink or typewritten or computer printouts. No interlinings, erasures (or crossing out), addition, or alteration may be allowed. If the documents submitted by the tenderer do not meet the requirements mentioned above, the tenderer may be disqualified.
- (2) The tenderer shall submit the followings:
 - 1) Power of Attorney (duly signed by the legal representative of the tenderers)
 - 2) Certificate of Signature of the issuer of the said Power of Attorney (authenticated by the Chamber of Commerce and Industry in Japan)

[Envelop A]

- 3) Implementation Schedule (Form C)
- 4) Personnel Dispatch Schedule (Form D)
- 5) Schedule of Major Construction Plants (Form E)
- Supply Guarantee Certificate by Manufacturer(s) as Subcontractor for Hydraulic Gate Works (Form F)
- Supply Guarantee Certificate by Manufacturer(s) as Subcontractor for Drainage Pump Vehicles (Form G)
- Certificate of After Sales Services by Manufacturer(s) as Subcontractor for Hydraulic Gate Works (Form H)
- Certificate of After Sales Services by Manufacturer(s) as Subcontractor for Drainage Pump Vehicles (Form I)
- 10) Certificate of After Sales Services by Local Agent for Hydraulic Gate Works (Form J)
- 11) Certificate of After Sales Services by Local Agent for Drainage Pump Vehicles (Form K)
- 12) Certificate of Country of origin for Hydraulic Gate Works (Form L)
- 13) Certificate of Country of origin for Drainage Pump Vehicles (Form M)

- 14) Specification Sheets of Drainage Pump Vehicle (Form N)
- 15) Catalogues/Brochures of Hydraulic Gate Works and Drainage Pump Vehicles

[Envelop B]

- 16) Form of Tender (Form A)
- 17) Tender Price Schedule (Form B)
- (3) All entries in the tender including attachment shall be written in English. All units in the tender shall be in the metric system unless otherwise specified in the Specifications or Drawings.
- (4) Incomplete, vague or conditional tenders will not be considered.

2. Tender Prices

- All prices shall be quoted in Japanese Yen without exception. The tender price shall be stated on the basis of lump sum price.
- (2) Tender prices shall be firm and final, and not subject to escalation.

3. Term of Validity of Tender

The tender shall remain valid and irrevocable for a period of 60 days on and after the day of the tender opening.

4. Submission of Tender

- (1) The tenderers shall prepare one (1) original and one (1) copy of their tender. The tenderers shall submit the tender in the envelopes that are properly sealed and duly marked as "Envelope A" or "B", "ORIGINAL" or "COPY", the name of tenderer, and the name of Project. Therefore, the tenderers shall submit two sets (ORIGINAL and COPY) of Envelope A and Envelope B respectively.
- (2) The tender shall be submitted to the address specified in the Invitation to Tender hereof, not later than the closing time for submission of tender specified in the same.
- (3) The tender shall be submitted in person. The tenders through other means such as telex, telegraph, facsimile, e-mail or mail shall not be accepted.
- (4) Any tender received after the closing time shall be returned unopened.
- (5) Alternative tender shall not be allowed.
- (6) The tenderer is neither allowed to modify nor withdraw his tender after the closing time.

5. Interpretation of Tender

- (1) Should there be any discrepancy between the "ORIGINAL" and the "COPY", the "ORIGINAL" shall prevail. In case there is a difference between the figures entered in words and in numerals in the tender, the figures entered in words shall prevail.
- (2) Should there be any discrepancy between the Tender Price Schedule and the Tender Price, the Tender Price shall prevail.

Chapter 4: Opening of Tender

1. Introduction

- (1) All tender shall be opened on the date, time and place specified in the Invitation to Tender hereof, immediately after the closing time, in the presence of the Client, the Consultant and the tenderers.
- (2) At least one (1) authorized person with Power of Attorney of tenderer who submitted the tender documents shall attend the tender opening.

2. Tender Opening Procedures

- (1) All participants in the tender opening shall register their signatures in an attendant list prepared by the Client before the tender opening.
- (2) The Client shall confirm the validity of each "Power of Attorney" of the tenderers. In case the document is incomplete or inappropriate, the tenderer shall forfeit his right to participate in the tender opening any further and the tender shall be returned unopened.
- (3) Envelope-A will be opened and availability of the documents in Envelope-A required in Chapter 3 Clause 1 (2) shall be examined. In case the document is incomplete or inappropriate, the tenderer shall forfeit his right to participate in the tender opening any further and Envelope-B shall be returned unopened. The appropriateness of each document shall be examined carefully and thoroughly afterwards in the stage of tender evaluation.
- (4) Envelope-B will be opened and the tender price offered by each tenderer shall be read aloud and recorded. The tenderer who submits the lowest tender price within the ceiling price set forth by the Client shall be designated as the prioritized negotiator for the contract. In the event that the prioritized negotiator is rejected as a result of the evaluation of the tender, the Client will invite the next lowest tenderer to enter into negotiation for the contract. This procedure will be followed until the Client reaches agreement with a tenderer.

- (5) In the event that all tender prices offered exceed the ceiling price, the tenderers are requested to submit the prices again immediately after the first tender opening. In this case, tenderers shall be requested to submit the Form of Tender only. The Form of Tender will be prepared by the Client and distributed to each of tenderers before the second tender. The representative of each of tenderer who attends the tender opening shall, therefore, be duly authorized by his firm or company to submit the tenders for these second offers, as provided in Chapter 4 Clause1(2).
- (6) In the second tendering, the tenderer who submits the lowest tender price within the ceiling price set forth by the Client shall be designated as the prioritized negotiator for the contract. In the event that the prioritized negotiator is rejected as a result of the evaluation of the tender, the Client will invite the next lowest tenderer to enter into negotiation for the contract. This procedure will be followed until the Client reaches agreement with a tenderer.
- (7) If the tender prices in the second tendering are exceeding the ceiling price, the tenderer submitting the lowest price on the second tender will be asked to enter into price negotiation in the stage of the tender evaluation for price reduction into the ceiling price.
- (8) In case the negotiation with the lowest tenderer is not successful, the Client will invite the next lowest tenderer to enter into price negotiation. This procedure will be followed until the Client reaches agreement with a tenderer. When no tenderer reaches agreement in this procedure, re-tendering may be considered.
- (9) In case there are two or more tenders at the same price within the ceiling price, a prioritized tender shall be determined by drawing lots.

Chapter 5: Evaluation of Tender and Award of Contract

1. Evaluation of Tender

- (1) The Client will ascertain, examine and evaluate the tenders that;
 - 1) computations are free of material errors,
 - 2) the submitted documents are substantially responsive to the Tender Documents,
 - 3) the required certificates have been provided,
 - 4) the required securities have been provided,
 - 5) documents have been properly signed, and
 - 6) the tenders are otherwise generally in order.

- (2) If a tender does not substantially conform to the Specifications, or contains inadmissible reservation or otherwise not substantially responsive to the Tender Documents, it shall be rejected.
- (3) If the tender of the prioritized tenderer is incomplete, the Client will negotiate for the contract with the next lowest price tenderer and this procedures will be followed until the Client reaches agreement with a tenderer.

2. Clarification or Alteration of Tender

In the examination, evaluation and comparison of the tenders, the Client may, at his discretion, ask any tenderer for a clarification of his tender. All responses to the requests for clarification shall be in writing, and no change in the total price or the substance of the tender shall be offered or permitted.

3. Process to be Confidential

Information relating to the examination, clarification, and evaluation of tenders, and recommendations for the award of the Contract shall not be disclosed to tenderers or any other persons who are not officially concerned with such process until the notification of award defined in Chapter 5 Clause 5.

4. Contact with the Client

- (1) Except for the clarification of the tender as provided in this Chapter Clause 2, no tenderer shall contact with the Client on any matter related to the tender, from the time of the tender opening to the time of the Contract awarding.
- (2) Any effort by a tenderer to influence the Client's processing of tendering or award decisions may result in the disqualification of the tenderer.

5. Notification of Award

- (1) The tenderer whose offer substantially conforms to the Specifications and other conditions of the Tender Documents, and who offers the lowest price within the ceiling price, shall be designated as the successful tenderer.
- (2) After completion of evaluation of the tender, the Client shall issue a notification of award to the successful tenderer within the period of validity of tenders stated in Chapter 3 Clause 3 hereof by facsimile or registered letter.

6. Signing of Contract

(1) At the same time that the Client notifies the successful tenderer that his tender has been accepted, the Client will send the tenderer the Forms of Contract provided in the Tender Documents, incorporating all arrangements between the parties.

- (2) The following documents shall be considered as the integral part of the Contract:
 - 1) Contract Agreement
 - 2) Tender of the successful tenderer
 - 3) Particular Conditions of Contract
 - 4) General Conditions of Contract
 - 5) Specifications
 - 6) Drawings
 - 7) Schedule
 - 8) Instruction to Tenderer and such other documents intended to form the Contract

The documents of the Contract are to be taken as mutually explanatory of one another. If an ambiguity or discrepancy is found in the documents, the interpretation shall be done in accordance with the above-mentioned sequence of the priority.

The successful tenderer shall submit the breakdown of lump sum price to the Consultant within **** (**) days after the conclusion of the Contract. The breakdown of lump sum price does not constitute a part of the Contract, but the Consultant is to use the breakdown as a reference material for the following purposes such as,

- (1) confirmation of the work amount for an interim payment, and
- (2) confirmation of the adjusted contract price in case of early termination.

7. Performance Security

The successful tenderer who receives the notification of award shall provide a performance security amounting to ten (10) % of the total contract price within fourteen (14) days after the date of award. The Consultant shall have the custody of the performance security.

8. Notification of the Result of Tender

Upon the receiving the performance security from the successful tenderer, the Client shall promptly notify the other tenderers in writing that their tenders have been unsuccessful.

Chapter 6: Common Conditions

1. Safety Procedure

The Contractor shall:

- (1) comply with all applicable safety regulations.
- (2) take care for the safety of all persons entitled to be on the Site,

- (3) use reasonable efforts to keep the Site and the Work clear of unnecessary obstruction so as to avoid danger to these persons,
- (4) provide fencing, lighting, guarding and watching of the Work until completion and taking-over, and
- (5) provide any temporary works (including roadways, footways, guard and fences) which may be necessary, because of the execution of the Work, for the use and protection of the public and of owners and occupiers of adjacent land.

2. Quality Assurance

- (1) The Contractor shall institute a quality assurance system to demonstrate compliance with the requirements of the Contract. The system shall be in accordance with the details stated in the Contract.
- (2) Compliance with the quality assurance system shall not relieve the Contractor of any of his duties, obligations or responsibilities under the Contract.

3. Protection of the Environment

The Contractor shall take all reasonable steps to protect the environment (both on and off the Site) and to limit damage and nuisance to people and property resulting from pollution, noise and other result of his operations.

SECTION 3

FORM OF TENDER

FORM OF TENDER

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"Form A"

FORM OF TENDER

To: Director General Royal Irrigation Department Kingdom of Thailand

The Flood Prevention Project of East Side of the Pasak River in Ayutthaya

Dear Sir;

 Having carefully examined the Tender Documents consisting of Instruction to Tenderers, Form of Tender, Form of Contract, Conditions of Contract, Tentative Implementation Schedule, Specifications, Appendices, Tender Drawings and other documents relevant to the execution of the above-mentioned Project, and agreeing to the provisions therein, we, the undersigned, offer to execute and complete the whole of the Work in the required period, and remedy defects, if any, strict inconformity with the Specifications for the following fixed lump sum amount of

<u>******</u> billion <u>******</u> million <u>******</u> thousand Japanese Yen (JPY<u>***</u>,***,000).

- 2. We undertake, if our Tender is accepted, to commence the Work within fourteen (14) calendar days from the date of the receipt of the Notice of the Commencement issued by the Consultant and to complete the whole of the Work comprised in the Contract within the date stipulated in the Instruction to Tenderers.
- 3. We provide, if our Tender accepted, a Performance Security in accordance with the requirements in the Tender Documents.
- 4. We agree to be bound by this Tender for a period of sixty (60) calendar days from the date of Tender Opening, and this Tender shall remain binding upon us and may be accepted by you at any time before the expiration of the period.
- 5. Unless and until a formal Contract is prepared and executed, this Tender, together with your written acceptance thereof, shall constitute a binding contract between us.
- 6. We understand that you are not bound to accept the lowest Tender or any Tender you may receive.
- 7. We acknowledge that all appendices hereto form part of this Tender.

Dated this <u>**th day of ******, 20**</u> at ********

Name:

(Printed in Capital Letters)

Signature:

In the capacity of

(Official Designation)

Duly authorized to sign this Tender for and on behalf of:

(Name of Contractor Submitting Tender Printed in Capital Letter)

Address:

"Form B"

TENDER PRICE SCHEDULE

Date: <u>**th day of ******, 2013</u>

To: Director General Royal Irrigation Department Kingdom of Thailand

The Flood Prevention Project of East Side of the Pasak River in Ayutthaya

<u>ltem</u>

Total Amount (Japanese Yen) in Numerals

A. Civil and Hydraulic Gate Works

A.1 Direct Construction Cost

- 1) Civil Work of Kra Mang Floodgate
- 2) Civil Work of Han Tra Floodgate
- 3) Civil Work of Bank Protection of Han Tra Canal

Notes: prices of the above include temporary works such as cofferdams, accesses and shoring.

- 4) Procurement and Installation of Hydraulic Gates of Kra Mang Floodgate
- 5) Procurement and Installation of Hydraulic Gates of Han Tra Floodgate

Notes: prices of the above include packing, transportation, insurance, temporary works, commissioning test, O&M training and drainage gate (for Kra Man).

A.2 Indirect Construction Cost

Notes: price of the above includes site office, stock yards, and land letting for temporary works.

A.3 Overhead

TOTAL OF A

- B. Procurement of Drainage Pump Vehicles
- B.2 Commissioning test and O&M training
- B.3 Overhead

TOTAL OF B

TOTAL TENDER PRICE OF (A+B)

"Form C"

IMPLEMENTATION SCHEDULE

Date: **th day of ******, 2013

To: Director General Royal Irrigation Department Kingdom of Thailand

The Tenderer shall complete the spaces of the following table in a form of bar chart to propose implementation schedule regarding the major works of the Project.

	Calendar Y	20)12						20)13						Г		20)14		
	Japanese FY			2012	2							20)13							2014	ł
Work Item	Month	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6
1. Preparatory work																					
2. Kra Mang Floodgate																					
2.1 Temporary work																					
2.2 Civil work																					
2.3 Design and manufacture of hydraulic ga	tes																				
2.4 Transportation of hydraulic gates																					
2.5 Installation of hydraulic gates																					
2.6 Commissioning test and O&M training																					
3. Han Tra Floodgate																					
3.1 Temporary work																					
3.2 Civil work																					
3.3 Design and manufacture of hydraulic ga	tes																				
3.4 Transportation of hydraulic gates																					
3.5 Installation of hydraulic gates																					
3.6 Commissioning test and O&M training																					
4. Bank Protection of Han Tra Canal																					
4.1 Temporary work																					
4.2 Civil work																					
5. Demobilization																					
6. Procurement of Drainage Pump Vehicles																					
6.1 Design, manufacture and transportation																					
6.2 Commissioning test and O&M training																					

Specimen Signature:

(Signature)

Name of Signer:

-

Title of Signer:

Name of Tenderer:

"Form D"

PERSONNEL DISPATCH SCHEDULE

Date: **th day of ******, 2013

To: Director General Royal Irrigation Department Kingdom of Thailand

The Tenderer shall provide the following details concerning the key staff members to be employed for assuming the Work of the Project.

Assignment

- 1. Project Manager
- 2. Civil Engineer
- 3. Hydromechanical Engineer
- 4. Electrical Engineer
- 5. Others

Description

- Proposed Period of Services at Site
- Name
- Nationality
- Age
- Education
- Qualification
- Relevant Experience in Major Projects
- Employment History

Specimen Signature:	(Signature)
Name of Signer:	
Title of Signer:	
Name of Tenderer:	

"Form E"

SCHEDULE OF MAJOR CONSTRUCTION PLANTS

Date: **th day of ******, 2013

To: Director General Royal Irrigation Department Kingdom of Thailand

The Tenderer shall list up and describe as below major construction plants to mobilize to the work sites of the Project.

Names	Brands	Capacity	Quantity	Present Locations	Mobilization Time

Specimen Signature:	(Signature)
Name of Signer:	
Title of Signer:	
Name of Tenderer:	

"Form F"

SUPPLY GUARANTEE CERTIFICATE BY MANUFACTURER(S) AS SUBCONTRACTOR FOR HYDRAULIC GATE WORKS

Date: <u>**th day of ******, 2013</u>

To: Director General Royal Irrigation Department Kingdom of Thailand

The Flood Prevention Project of East Side of the Pasak River in Ayutthaya

Dear Sir;

We, <u>(Name of Manufacturer(s))</u> as Subcontractor, <u>(a)</u> manufacturer<u>(s)</u> dully organized and existing under the law of Japan and having its principal place<u>(s)</u> of business at <u>(Address of Manufacturer(s))</u>, hereby agree that we will supply and install to <u>(Name of Tenderer)</u> the following proposed in this Tender for the captioned Project.

Full set of Hydraulic Gate Works composed of;

 Stainless steel fixed wheel gate leaves Stainless steel fixed wheel gate guides Motorized wire rope winched gate hoists Steel maintenance gate leaves 	3 sets each for Kra Mang and Han Tra - ditto - - ditto - 3 leaves × 2 for Kra Mang 5 leaves × 2 for Han Tra
 Stainless steel maintenance gate guides Steel telpher rails Manual chain hoists and lifting beams Electric wirings and boards Lighting facilities Lightning arresters 	6 sets each for Kra Mang and Han Tra 2 sets each for Kra Mang and Han Tra - ditto - 1 set each for Kra Mang and Han Tra - ditto - - ditto -
 Engine generators Water level meters and data loggers Stainless steel fixed wheel gate leaf Stainless steel fixed wheel gate guide Manual racked gate hoist Spare parts 	 ditto - 2 sets each for Kra Mang and Han Tra 1 set for drainage channel at Kra Mang ditto - ditto - As specified in the Specifications

Authorized Signature of Manufacturer:	(Signature)
Name of Signer:	
Title of Signer:	
Name of Manufacturer:	
Authorized Signature of Manufacturer:	(Signature)
Name of Signer:	
Title of Signer:	
Name of Manufacturer:	

"Form G"

SUPPLY GUARANTEE CERTIFICATE BY MANUFACTURER(S) AS SUBCONTRACTOR FOR DRAINAGE PUMP VEHICLES

Date: <u>**th day of ******, 2013</u>

To: Director General Royal Irrigation Department Kingdom of Thailand

The Flood Prevention Project of East Side of the Pasak River in Ayutthaya

Dear Sir;

We, <u>(Name of Manufacturer(s))</u> as Subcontractor, <u>(a)</u> manufacturer<u>(s)</u> dully organized and existing under the law of Japan and having its principal place<u>(s)</u> of business at <u>(Address of Manufacturer(s))</u>, hereby agree that we will supply to <u>(Name of Tenderer)</u> the following Equipment proposed in this Tender for the captioned Project.

- Drainage Pump Vehicles (30m³/min)

- Spare parts

10 sets As specified in the Specification

Authorized Signature of Manufacturer:	(Signature)
Name of Signer:	
Title of Signer:	
Name of Manufacturer:	
Authorized Signature of Manufacturer:	(Signature)
Name of Signer:	
Title of Signer:	
Name of Manufacturer:	

"Form H"

CERTIFICATE OF AFTER SALES SERVICES BY MANUFACTURER(S) AS SUBCONTRACTOR FOR HYDRAULIC GATE WORKS

Date: **th day of ******, 2013

To: Director General Royal Irrigation Department Kingdom of Thailand

The Flood Prevention Project of East Side of the Pasak River in Ayutthaya

Dear Sir;

This is to certify that we, <u>(Name of Manufacturer(s))</u> as Subcontractor, <u>(a)</u> manufacturer<u>(s)</u> dully organized and existing under the law of Japan and having its principal place(s) of business at <u>(Address of Manufacturer(s))</u>, hereby accept to cooperate with <u>(Name of Tenderer)</u> in providing after sales services and maintenance of the following for at least two (2) years after the Guarantee Period regarding the captioned Project.

Full set of Hydraulic Gate Works composed of;

- Stainless steel fixed wheel gate leaves
- Stainless steel fixed wheel gate guides
- Motorized wire rope winched gate hoists
- Steel maintenance gate leaves
- Stainless steel maintenance gate guides
- Steel telpher rails
- Manual chain hoists and lifting beams
- Electric wirings and boards
- Lighting facilities
- Lightning arresters
- Engine generators
- Water level meters and data loggers
- Stainless steel fixed wheel gate leaf
- Stainless steel fixed wheel gate guide
- Manual racked gate hoist

Authorized Signature of Manufacturer:	(Signature)
Name of Signer:	
Title of Signer:	
Name of Manufacturer:	
Authorized Signature of Manufacturer:	(Signature)
Name of Signer:	
Title of Signer:	
Name of Manufacturer:	

"Form I"

CERTIFICATE OF AFTER SALES SERVICES BY MANUFACTURER(S) AS SUBCONTRACTOR FOR DRAINAGE PUMP VEHICLES

Date: **th day of ******, 2013

To: Director General Royal Irrigation Department Kingdom of Thailand

The Flood Prevention Project of East Side of the Pasak River in Ayutthaya

Dear Sir;

This is to certify that we, <u>(Name of Manufacturer(s))</u> as Subcontractor, <u>(a)</u> manufacturer<u>(s)</u> dully organized and existing under the law of Japan and having its principal place(s) of business at <u>(Address of Manufacturer(s))</u>, hereby accept to cooperate with <u>(Name of Tenderer)</u> in providing after sales services and maintenance of the following Equipment for at least two (2) years after the Guarantee Period regarding the captioned Project.

Drainage Pump Vehicles (30m³/min)

Authorized Signature of Manufacturer:	(Signature)
Name of Signer:	
Title of Signer:	
Name of Manufacturer:	
Authorized Signature of Manufacturer:	(Signature)
Name of Signer:	
Title of Signer:	
Name of Manufacturer:	

"Form J"

< Letterhead of Local Agent >

CERTIFICATE OF AFTER SALES SERVICES BY LOCAL AGENT FOR HYDRAULIC GATE WORKS

Date: <u>**th day of *****</u>, 2013

To: Director General Royal Irrigation Department Kingdom of Thailand

The Flood Prevention Project of East Side of the Pasak River in Ayutthaya

Dear Sir;

This is to certify that we, <u>(Name of Local Agent)</u>, dully organized and existing under the law of the Kingdom of Thailand with its principal place of business at <u>(Address of Local Agent)</u>, hereby accept to cooperate with <u>(Name of Tenderer)</u> in undertaking after sales services and maintenance of the following for at least two (2) years after the Guarantee Period regarding the captioned Project.

Full set of Hydraulic Gate Works composed of;

- Stainless steel fixed wheel gate leaves
- Stainless steel fixed wheel gate guides
- Motorized wire rope winched gate hoists
- Steel maintenance gate leaves
- Stainless maintenance gate guides
- Steel telpher rails
- Manual chain hoists and lifting beams
- Electric wirings and boards
- Lighting facilities
- Lightning arresters
- Engine generators
- Water level meters and data loggers
- Stainless steel fixed wheel gate leaf
- Stainless steel fixed wheel gate guide
- Manual racked gate hoist

Authorized Signature of Local Agent:	(Signature)
Name of Signer:	
Title of Signer:	
Name of Local Agent:	

"Form K"

< Letterhead of Local Agent >

CERTIFICATE OF AFTER SALES SERVICES BY LOCAL AGENT FOR DRAINAGE PUMP VEHICLES

Date: **th day of ******, 2013

To: Director General Royal Irrigation Department Kingdom of Thailand

The Flood Prevention Project of East Side of the Pasak River in Ayutthaya

Dear Sir;

This is to certify that we, <u>(Name of Local Agent)</u>, dully organized and existing under the law of the Kingdom of Thailand with its principal place of business at <u>(Address of Local Agent)</u>, hereby accept to cooperate with <u>(Name of Tenderer)</u> in undertaking after sales services and maintenance of the following Equipment for at least two (2) years after the Guarantee Period regarding the captioned Project.

Drainage Pump Vehicles (30m³/min)

Authorized Signature of Local Agent:	(Signature)
Name of Signer:	
Title of Signer:	
Name of Local Agent:	

"Form L"

CERTIFICATE OF COUNTRY OF ORIGIN FOR HYDRAULIC GATE WORKS

Date: **th day of ******, 2013

. . . .

To: Director General **Royal Irrigation Department** Kingdom of Thailand

The Flood Prevention Project of East Side of the Pasak River in Ayutthaya

Dear Sir;

We, (Name of Manufacturer(s)) as Subcontractor, hereby submit to you the following list on the country of origin for the components to be supplied under the captioned Project.

	Please tick \Box for your choice.	
Components	Country of Origin	
Stainless steel fixed wheel gate leaves	🗆 Japan 🛛 Thailand	
Stainless steel fixed wheel gate guides	🗆 Japan 🛛 Thailand	
Motorized wire rope winched gate hoists	🗆 Japan 🛛 Thailand	
Steel maintenance gate leaves	🗆 Japan 🛛 Thailand	
Stainless steel maintenance gate guides	🗆 Japan 🛛 Thailand	
Steel telpher rails	🗆 Japan 🛛 Thailand	
Manual chain hoists and lifting beams	🗆 Japan 🛛 Thailand	
Electric wirings and boards	🗆 Japan 🛛 Thailand	
Lighting facilities	🗆 Japan 🛛 Thailand	
Lightning arresters	🗆 Japan 🛛 Thailand	
Engine generators	🗆 Japan 🛛 Thailand	
Water level meters and data loggers	🗆 Japan 🛛 Thailand	
Stainless steel fixed wheel gate leaf	🗆 Japan 🛛 Thailand	
Stainless steel fixed wheel gate guide	🗆 Japan 🛛 Thailand	
Manual racked gate hoist	🗆 Japan 🛛 Thailand	

Authorized Signature of Manufacturer:	(Signature)
Name of Signer:	
Title of Signer:	
Name of Manufacturer:	
Authorized Signature of Manufacturer:	(Signature)
Name of Signer:	
Title of Signer:	
Name of Manufacturer:	

"Form M"

CERTIFICATE OF COUNTRY OF ORIGIN FOR DRAINAGE PUMP VEHICLE

Date: **th day of ******, 2013

To: Director General Royal Irrigation Department Kingdom of Thailand

The Flood Prevention Project of East Side of the Pasak River in Ayutthaya

Dear Sir;

We, <u>(Name of Manufacturer(s))</u> as Subcontractor, hereby submit to you the following list on the country of origin for the Equipment to be supplied under the captioned Project.

	Please tick for your choice.	
Components	Country of Origin	
Chassis with cab	Thailand	
Drainage pump	🗆 Japan 🛛 Thailand	
Control panel	🗆 Japan 🛛 Thailand	
Lighting apparatus	🗆 Japan 🛛 Thailand	
Power generator	🗆 Japan 🛛 Thailand	

Authorized Signature of Manufacturer:	(Signature)
Name of Signer:	
Title of Signer:	
Name of Manufacturer:	
Authorized Signature of Manufacturer:	(Signature)
Name of Signer:	
Title of Signer:	
Name of Manufacturer:	

"Form N"

SPECIFICATION SHEETS OF DRAINAGE PUMP VEHICLE

Date: <u>**th day of *****</u>, 2013

To: Director General Royal Irrigation Department Kingdom of Thailand

The Flood Prevention Project of East Side of the Pasak River in Ayutthaya

Dear Sir;

We, <u>(Name of Manufacturer(s))</u> as Subcontractor, hereby state and submit to you the technical specifications of the following Equipment to be supplied under the captioned Project.

Drainage Pump Vehicles (30m³/min)

Authorized Signature of Manufacturer:	(Signature)
Name of Signer:	
Title of Signer:	
Name of Manufacturer:	
Authorized Signature of Manufacturer:	(Signature)
Name of Signer:	
Title of Signer:	
Name of Manufacturer:	

CODE NO. EQUIPI	MENT: Drainage Pump Vehicle	Qty: 10 unit	Consultant
	CLIENT'S SPECIFICATIONS	TENDERER'S SPECIFICATIONS	Evaluation
Thailand. The origin of the compon	ent in the completed shape shall be limited to the Kingdom of ents, except for the chassis, of the Equipment shall be limited to n of Thailand while the origin of the chassis of the Equipment gdom of Thailand.	Manufacturer : Model :	
 MAIN COMPONENTS Drainage Pumps Chassis with Cab Power Generator Control Panel Lighting Apparatus Other Accessories 			
 (1) Working Condition (a) Drainage operating time (b) Temperature (c) Atmospheric pressure (d) Relative humidity 	 to each set of the Drainage Pump Vehicle. Drainage operating time 48 hours or more in continuous operating time Temperature 5 to 40 °C Atmospheric pressure 980 hPa or more Relative humidity 85 % or less neans the number of pump.) 30 m³/min (at 10 m of total head) Submergible motor driving pump 6 units or less (Same specifications for all units) 200 mm 40 kgf/unit or less Dry type submergible synchronous motor 3 phase x 440 V x 60 Hz Cablie cable 40 m/unit or more (with waterproof connector) Cable band 1 set/unit Diameter 200 mm × Length 25 m x 3 (discharge side) /unit Pressure-tight 0.2 MPa or more Drainage pump shall be controllable of rotation speed in each unit. Each drainage pump shall be equipped with metal fixers for attaching float. 1 no./unit Attaching rope or rod 1 set/unit Casing Special lightweight material(s) Casing liner Stainless steel or stainless cast steel Impeller 		

	IENT: Drainage Pump Vehicle	Qty: 10 unit	Consul
	CLIENT'S SPECIFICATIONS	TENDERER'S SPECIFICATIONS	Evaluat
(m) Accessories	: Tool for pumps1 set: Mooring rope for pump1 set/unit: Mooring anchor for pump1 set/unit: Float push-out bar1 no.		
(3) Chassis with Cab			
(a) Country of origin	: Kingdom of Thailand		
(b) Gross Vehicle Weight	: Around 10,000 kgf or less : Necessary minimum size of Gross Vehicle Weight capable to accommodate the required equipment and apparatus with 500kgf of allowance shall be selected		
(c) Drive	: Rear-wheel drive		
(d) Steering position	: Right-hand drive with power steering		
(e) Crew	: 2 or more		
(f) Transmission	: Manual or automatic		
(g) Engine	: Water-cooled diesel		
(h) Engine emission	: Euro 3 or later		
(i) Rear body (Bed)	 Apparatus and equipment shall be functionally arranged on the rear body for easier operation and maintenance. Side guards shall be equipped in the lower part of the rear body. 		
	 Floor material of the rear body shall be antirust. Metal fixers shall be equipped on the rear body for 		
(j) Loudspeaker	fastening devices and equipment. : Output Around 30 W		
(k) Accessories	: Output Around 30 W : Seat belt 1 set for all crew		
(k) Accessones	: AM/FM radio 1 set		
	: Air conditioner 1 set		
	: Spare tire with wheel 1 no.		
	: Spare tire fitting 1 no.		
	: Floor mat 1 set		
	: Maintenance tool 1 set		
	: User manual of chassis 1 no. in Thai or English		
(4) Power Generator			
(а) Туре	: Low noise with control panel		
(b) Number	: 1 unit		
(c) Capacity	: 1 phase 220 V / 3 phase 440 V × 60 Hz 125kVA or more		
	: Power necessary to run all drainage pumps, all lighting apparatus and control panel etc. shall be supplied.		
(d) Engine	: Water-cooled diesel		
(e) Fuel tank	: 200 liter or more		

(6) Control Panel (a) Condition (b) Type	CLIENT'S SPECIFICATIONS : Lighting apparatus shall be provided to light up surrounding area of the vehicle. : Floodlights : High intensive discharge (HID) lamps : Cabtire cable 20 m/lamp or more (with waterproof connector) onal device : Manually shrinkable to up & down and rotational to right & left : There shall be stored inverter devices for start and rotation speed control of drainage pumps, and operating control of each drainage pumps and on-off of lighting apparatus shall be possible. : Power supply connectors to drainage pumps shall be waterproof and easy to connect power cables of drainage pumps. : Outdoor weatherproof	TENDERER'S SPECIFICATIONS	Evaluati
 (a) Condition (b) Type (c) Lamps (d) Cable (e) Shrinkable and rotation (6) Control Panel (a) Condition 	 Lighting apparatus shall be provided to light up surrounding area of the vehicle. Floodlights High intensive discharge (HID) lamps Cabtire cable 20 m/lamp or more (with waterproof connector) Manually shrinkable to up & down and rotational to right & left There shall be stored inverter devices for start and rotation speed control of drainage pumps, and operating control of each drainage pumps and on-off of lighting apparatus shall be possible. Power supply connectors to drainage pumps shall be waterproof and easy to connect power cables of drainage pumps. 		
 (b) Type (c) Lamps (d) Cable (e) Shrinkable and rotation (6) Control Panel (a) Condition 	 Floodlights High intensive discharge (HID) lamps Cabtire cable 20 m/lamp or more (with waterproof connector) Manually shrinkable to up & down and rotational to right & left There shall be stored inverter devices for start and rotation speed control of drainage pumps, and operating control of each drainage pumps and on-off of lighting apparatus shall be possible. Power supply connectors to drainage pumps shall be waterproof and easy to connect power cables of drainage pumps. 		
 (c) Lamps (d) Cable (e) Shrinkable and rotation (6) Control Panel (a) Condition (b) Type 	 High intensive discharge (HID) lamps Cabtire cable 20 m/lamp or more (with waterproof connector) Manually shrinkable to up & down and rotational to right & left There shall be stored inverter devices for start and rotation speed control of drainage pumps, and operating control of each drainage pumps and on-off of lighting apparatus shall be possible. Power supply connectors to drainage pumps shall be waterproof and easy to connect power cables of drainage pumps. 		
 (d) Cable (e) Shrinkable and rotation (6) Control Panel (a) Condition (b) Type 	 Cabtire cable 20 m/lamp or more (with waterproof connector) Manually shrinkable to up & down and rotational to right & left There shall be stored inverter devices for start and rotation speed control of drainage pumps, and operating control of each drainage pumps and on-off of lighting apparatus shall be possible. Power supply connectors to drainage pumps shall be waterproof and easy to connect power cables of drainage pumps. 		
 (e) Shrinkable and rotation (6) Control Panel (a) Condition (b) Type 	 Manually shrinkable to up & down and rotational to right & left There shall be stored inverter devices for start and rotation speed control of drainage pumps, and operating control of each drainage pumps and on-off of lighting apparatus shall be possible. Power supply connectors to drainage pumps shall be waterproof and easy to connect power cables of drainage pumps. 		
(6) Control Panel(a) Condition(b) Type	 There shall be stored inverter devices for start and rotation speed control of drainage pumps, and operating control of each drainage pumps and on-off of lighting apparatus shall be possible. Power supply connectors to drainage pumps shall be waterproof and easy to connect power cables of drainage pumps. 		
(a) Condition (b) Type	 control of drainage pumps, and operating control of each drainage pumps and on-off of lighting apparatus shall be possible. Power supply connectors to drainage pumps shall be waterproof and easy to connect power cables of drainage pumps. 		
(a) Condition (b) Type	 control of drainage pumps, and operating control of each drainage pumps and on-off of lighting apparatus shall be possible. Power supply connectors to drainage pumps shall be waterproof and easy to connect power cables of drainage pumps. 		
	 pumps and on-off of lighting apparatus shall be possible. Power supply connectors to drainage pumps shall be waterproof and easy to connect power cables of drainage pumps. 		
	easy to connect power cables of drainage pumps.		
	· Outdoor woothorproof		
	unit" means the number of pump.)		
	: Pump start switch 1 no./unit		
	: Pump stop switch 1 no./unit		
	: Pump rotation control switch 1 no./unit		
	: Emergency stop button 1 no.		
	: Display recovery button 1 no.		
	: Voltmeter 1 no.		
	: Ammeter 1 no./unit		
	: Frequency meter 1 no.		
	: Tachometer 1 no./unit		
	: Hour meter 1 no./unit		
	: Others needed		
(d) Display language	: Thai or English		
(7) Paint Color	: To be specified by the Client		
(8) Accessories	: Grounding electrode 1 set		
	: Test and inspection record in Thai or English 1 no.		
	: User manual in Thai or English 2 nos.		
	: Parts list in Thai or English 1 no.		
	: Shop drawings (Overall installation diagram, Component		
	installation diagram, Wiring diagram etc.) in Thai or English		
	2 nos.		
SPARE PARTS			
The following shall be app	pplied to each set of the Drainage Pump Vehicle.		
(1) Working Condition			
(a) Drainage pump	: 1 unit		
(b) Drainage hose	: Diameter 200 mm × Length 25 m × 3		

(For reference only)

POWER OF ATTORNEY

Date: **th day of ******, 2013

To: Director General Royal Irrigation Department Kingdom of Thailand

Dear Sir;

I, the undersigned, hereby constitute and appoint <u>(Name and Title)</u>, whose specimen signature appears at the lower left corner of this document, to sign the tender and all other related documents thereof which are subject of the Invitation to Tender for the Flood Prevention Project of East Side of the Pasak River in Ayutthaya, on behalf of the undersigned.

This Power of Attorney shall remain in force until the completion of afore-mentioned purpose.

(Signature)

(Name of Signer) (Title of Signer) (Name of Tenderer) (Address of Tenderer)

Designated Person

(Signature)

(Name of Signer) (Title of Signer) (For reference only)

CERTIFICATE OF SIGNATURE

Date: <u>**th day of ******, 2013</u>

We hereby certify that the signature of the under-mentioned person, affixed to the accompanying documents, is genuine and authentic.

Name of Person:Title:Name of the Company:

THE TOKYO CHAMEN\BER OF COMERECE & INDUSTRY

SECTION 4

FORM OF CONTRACT



CONTRACT

BETWEEN

ROYAL IRRIGATION DEPARTMENT MINISTRY OF AGRICULTURE AND COOPERATIVES

THE KINGDOM OF THAILAND

AND

(NAME OF THE CONTRACTOR)

JAPAN

FOR

THE FLOOD PREVENTION PROJECT OF EAST SIDE OF THE PASAK RIVER IN AYUTTHAYA

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CONTRACT

THIS CONTRACT, made and entered into this <u>**th</u> day of <u>******</u>, 2012 by and between Royal Irrigation Department, Ministry of Agriculture and Cooperatives, the Kingdom of Thailand (hereinafter referred to as "the Client") and <u>(name of the contractor)</u>, duly organized and existing under the laws of Japan, having its principal office of business at <u>(address of the contractor)</u>(hereinafter referred to as "the Contractor"),

WITNESSETH:

WHEREAS, the Japan International Cooperation Agency (hereinafter referred to as "JICA") extends a grant to the Government of the Kingdom of Thailand on the basis of the Grant Agreement signed on the 15th day of August, 2012 between the Government of the Kingdom of Thailand and JICA concerning the Flood Prevention Project of East Side of the Pasak River in Ayutthaya (hereinafter referred to as "the Project "); and

WHEREAS, the Client, as a competent authority for the Project, is desirous of having the works for the Project carried out by the Contractor; and

WHEREAS, the Contractor is willing to execute the works on the terms and conditions as set forth in this Contract;

NOW, THEREFORE, in consideration of the mutual covenants hereinafter contained, the parties agree as follows:

Article 1. Definitions

In interpreting or construing this Contract, the following expressions shall have the meanings hereby assigned to them except where the context otherwise requires:

"The Exchange of Notes" means the notes exchanged between the Government of the Kingdom of Thailand and the Government of Japan on the 5th day of July, 2012 (hereinafter referred to as "the E/N") in connection with the Grant Aid from the Government of Japan concerning the Flood Prevention Project of East Side of the Pasak River in Ayutthaya.

"The Grant Aid" means a scheme of Japanese official development assistance.

"The Grant" means the amount for the implementation of the Flood Prevention Project of East Side of the Pasak River in Ayutthaya, which is stipulated in the Grant Agreement.

"The Grant Agreement" means the agreement signed on the 15th day of August, 2012 between the Government of the Kingdom of Thailand and JICA (hereinafter referred to as "the G/A") in connection with the execution of the Grant for the implementation of the Flood Prevention Project of East Side of the Pasak River in Ayutthaya.

"The Project" means the Flood Prevention Project of East Side of the Pasak River in Ayutthaya in conformity with the G/A and to be implemented by the Government of the Kingdom of Thailand. The Project sites are located in both Ayutthaya city and Ayothaya town, Phra Nakhon Si Ayutthaya District, Phra Nakhon Si Ayutthaya Provence, the Kingdom of Thailand (hereinafter referred to as "the Project Site").

"The Client" means Royal Irrigation Department, Ministry of Agriculture and Cooperatives, the Kingdom of Thailand. The Client shall include any person or persons authorized by the Client.

"The Consultant" means CTI Engineering International Co., Ltd., having its principal office at Tachibana Annex Building, 2-25-14 Kameido, Koto-ku, Tokyo 136-0071, Japan, which shall be appointed by the Client for the execution of this Contract, shall provide professional services for design, assistance of tendering and supervision of the progress of the Project under the Agreement with the Client. The Consultant shall include any person or persons authorized by the Consultant.

"The Contractor" means <u>(name of the contractor</u>). The Contractor shall include any person or persons authorized by the Contractor.

"JICA" means an agency which was established based on the Japanese Act on Incorporated Administrative Agency - Japan International Cooperation Agency promulgated in 2002. JICA makes the Grant available for the Project based on the E/N and the G/A.

"The Work" means the construction and procurement for the Project to be rendered by the Contractor as described in Article 3 of this Contract.

"**The Construction Work**" means the construction works for the Project to be rendered by the Contractor as described in Article 3 of this Contract.

"The Procurement Work" means the procurement works of the equipment for the Project as described in Article 3 of this Contract.

"The Equipment" means all the equipment and materials to be procured for the Project, which shall be manufactured, equipped and completed in accordance with the provisions of the Contract Documents, except for construction materials.

"The Contract" means this contract concluded between the Client and the Contractor.

"The Contract Documents" means the documents consisting of the following and are incorporated in and made part of this Contract, as though fully written out and set forth herein.

- Contractor's Proposed Tender
- General Conditions of Contract
- Specifications
- Drawings
- Schedule
- Instruction to Tenderer
- Addenda

"**The Party**" means the Client or the Contractor, as the case may be, and "the Parties" means both of them.

"The Third Party" means any natural person or legal entity or unincorporated entity other than the Client or the Contractor.

"**The Contract Price**" means the price defined in Article 7 hereof and includes adjustments in accordance with the Article 8 hereof.

Words importing the singular only also include the plural and vice versa where the context requires. Words indicating one gender include all genders.

Article 2. Basis of Contract

Any and all stipulations of this Contract shall be consistent with the content

of the G/A. Should any of the stipulations of this Contract be in conflict with the G/A, such stipulations shall be rectified to be consistent with the G/A.

Article 3. Scope of Work

- 3.1 The Contractor's works to be rendered under this Contract shall consist of the following items specified in the Contract Documents.
- 3.1.1 Construction Work

	- Kra Mang Floodgate	1 site	
	- Han Tra Floodgate		
	- Bank Protection of Han Tra Canal	484m	
3.1.2	Procurement Work		
	- Drainage Pump Vehicle (30m³/min)	10 sets	

- 3.2 The scope of the Work prescribed in Sub-Paragraph 3.1 above shall include site survey, design and supply for temporary works, permanent installation of the equipment and materials, performance test, transportation, insurance and all other things required in and for the Project implementation in due conformity with the Contract Documents.
- 3.3 The scope of the Work prescribed in Sub-Paragraph 3.1 may be amended and modified pursuant to mutual agreement in writing under this Contract.

Article 4. Period of Execution of Work

4.1 The Contractor shall commence the Work within fourteen (14) days from the date of receipt of the notice of the commencement of the Work issued by the Consultant. 4.2 The Contractor shall complete the Work on or before the 31st day of May, 2014 unless the available period of execution under this Contract between the Client and the Contractor is extended by mutual agreements within the available period of the Grant stipulated in the G/A. The available period of the Grant may also be extended by mutual agreements between the authorities concerned of the Government of the Kingdom of Thailand and JICA within the available period of the E/N.

Article 5. Shipment and Packing

- 5.1 The Equipment procured in the Kingdom of Thailand shall be delivered to Ayutthaya Irrigation Project Office of Royal Irrigation Department, Phra Nakhon Si Ayutthaya District, Phra Nakhon Si Ayutthaya Provence, the Kingdom of Thailand by the Contractor on or before the 31st day of January, 2014.
- 5.2 The Contractor shall be responsible for the carriage of the Equipment to Ayutthaya Irrigation Project Office of Royal Irrigation Department, Phra Nakhon Si Ayutthaya District, Phra Nakhon Si Ayutthaya Provence, the Kingdom of Thailand and for the coverage of the shipping charges, freight, and insurance premiums.
- 5.3 Partial shipments are allowed.Transshipment is also allowed.
- 5.4 The Contractor shall securely pack the Equipment so as to avoid damage in transit.

Article 6. Country/Area of Origin

The origin of the Equipment in the completed shape shall be limited to the Kingdom of Thailand.

The origin of the components, except for the chassis, of the Equipment shall be limited to Japan and/or the Kingdom of Thailand while the origin of the chassis of the Equipment shall be limited to the Kingdom of Thailand.

Article 7. Remuneration

The Client shall remunerate the Contractor from the Grant with a total amount of <u>******* million ******* thousand *******</u> Japanese Yen (JPY<u>***,***</u>) as the Contract Price for the Work, in accordance with the payment schedule stated in Article 8, 8.2 of this Contract.

The breakdown of the Contract Price is shown as follows:

- (1) The Construction Price
 <u>******** million ******** thousand ********</u> Japanese Yen
 (JPY<u>***,***,***)</u>

Article 8. Payment

8.1 Terms of Payment

In accordance with the G/A, the Client shall make a Banking Arrangement (B/A) with a bank in Japan (hereinafter referred to as "the Bank") to authorize the Bank to pay the Contract Price to the Contractor under this Contract. The payment to the Contractor under this Contract shall be

made in Japanese Yen through the Bank under an irrevocable Authorization to Pay (A/P), which shall be issued by the Client to the Bank.

- 8.2 Payment schedule
- 8.2.1 Payment for the Construction Work
- (1) Advance Payment

The request for the advance payment shall be submitted together with a photocopy of the certificate of verification of this Contract by JICA and with an original of the certificate of the receipt of the advance payment security of this Contract issued by the Consultant.

(2) First Interim Payment

<u>******* million ******* thousand Japanese</u> Yen (JPY<u>***</u>,***,000), which corresponds to thirty percent (30%) of the Construction Price, shall be paid upon completion of fifty percent (50%) or more of the Construction Work. The request for the first interim payment shall be submitted together with the certificate of completion of the above-mentioned works issued by the Consultant and approved by the Client.

(3) Second Interim Payment

<u>******* million ******* thousand</u> Japanese Yen (JPY<u>***</u>,***,000), which corresponds to twenty percent (20%) of the Construction Price, shall be paid upon completion of eighty five percent (85%) or more of the Construction Work.

The request for the second interim payment shall be submitted together with the certificate of completion of the above-mentioned works issued by the Consultant and approved by the Client.

(4) Final Payment

<u>******** million ******* thousand *******</u> Japanese Yen (JPY<u>***,***</u>), which corresponds to ten percent (10%) of the Construction Price, shall be paid upon completion of the Construction Work under this Contract.

The request for the final payment shall be submitted together with the certificate of completion of the Construction Work issued by the Consultant and approved by the Client.

In case any amendments and/or modifications of the Construction Price are necessary in accordance with Article 20, the payment shall be adjusted accordingly.

8.2.2 Payment for the Procurement Work

Payment for the Equipment procured in the Kingdom of Thailand <u>******* million ****** thousand *******</u> Japanese Yen (JPY<u>***,***</u>), which corresponds to one hundred percent (100%) of the Equipment Price for the Equipment procured in the Kingdom of Thailand, shall be paid upon delivery to the Client and the inspection by the Consultant of the said Equipment under this Contract.

The request for this payment shall be submitted together with the following delivery documents of the said Equipment.

- Signed Commercial Invoice.....in triplicate
- Receipt of the Equipment issued by the Client..... one original

When the said Equipment is delivered in more than one delivery, a partial payment is acceptable for each delivery.

In case any amendments and/or modifications of the Equipment Price for the Equipment procured in the Kingdom of Thailand are necessary in accordance with Article 20, the payment shall be adjusted accordingly.

Article 9. Client's Responsibilities

- 9.1 The Client shall carry out the following works in time for the commencement of the Work or according to the progress of the Work:
 - 1) To provide cleared, embanked and leveled land for the Project prior to the commencement of the Work,
 - 2) To provide land for a temporary site office, warehouse and stock yard near the Project Site during the implementation period,
 - 3) To prepare the graded access road to the construction site,
 - 4) To provide electric power,
 - 5) To provide the telephone lines to the main terminal board,
 - 6) To provide city water to the main terminal point at the Project Site,
 - 7) To provide a disposal area for the surplus soil during the construction period,
 - 8) To obtain right-of-way, if necessary, for construction works, and
 - 9) To control traffic and pedestrians during inland transportation of the equipment and materials for the Project, if necessary.
- 9.2 The Client shall accord the Contractor such facilities as may be necessary for their entry into the Kingdom of Thailand and their stay therein for the Work.
- 9.3 The Client shall in conformity with the G/A take necessary measures to exempt the Contractor from customs duties, internal taxes and other fiscal levies which may be imposed in the Kingdom of Thailand with respect to the supply of the products, services, and equipment necessary for the Work.
- 9.4 The Client shall take necessary measures to ensure prompt unloading and customs clearance at the points of disembarkation in the Kingdom of Thailand and internal transportation therein of the equipment and materials purchased for the execution of the Work.

- 9.5 The Client shall cooperate with the resident representative of the Contractor in the negotiations and procedures with the various authorities concerned and public and private organizations for the execution of the Work.
- 9.6 The Client shall provide data and information necessary for the execution of the Work.
- 9.7 The Client shall bear the following commissions to the Bank for the banking services based upon the Banking Arrangement.
 Advising Commission of Authorization to Pay
 Payment Commission
- 9.8 If the Contractor suffers damage as a result of a default by the Client in the execution of its obligations under the Contract, the Contractor shall discuss the solution with the Consultant, give a written notice to the Client and send its copy immediately to JICA. Then the Client and the Contractor shall consult mutually to settle such matters. The Contractor shall properly inform JICA of its progress. If the Parties can not reach agreement within thirty (30) days from the date of the notice, the Parties shall comply with the dispute settlement process stipulated in Article 18 hereof.

Article 10. Contractor's Obligations

- 10.1 The Contractor shall perform the Work in accordance with the Contract Documents.
- 10.2 The Contractor shall prepare shop drawings, progress schedules, and other technical documents required by the Consultant.

- 10.3 The Contractor shall submit to the Consultant the list of country/area of origin of the equipment and materials which the Contractor proposes to purchase for the Work.
- 10.4 The Contractor shall be responsible for the implementation means, methods, techniques, sequences or procedures, and safety control in connection with the Work.
- 10.5 The Contractor shall be responsible for the acts or omissions of the Contractor's subcontractors, or any of Contractor's agents or employees, or any other persons performing any part of the Work for the Contractor.
- 10.6 The Contractor shall furnish one (1) resident representative with sufficient faculty to execute the Work at the Project Site.
- 10.7 The Contractor shall bear the handling charges, customs clearance charges, storage charges, and transportation expenses related to the importation of the equipment and materials for the Work.
- 10.8 The Contractor shall, at his own expense, take necessary measures in accordance with the Contract Documents and relevant laws, ordinances and regulations to prevent damage to the Work, construction materials, adjacent structures, or the Third Parties, until the completion and delivery of the Work.
- 10.9 The Contractor shall carry out a necessary inspection and testing of the Equipment prior to the shipment in order to ensure that the Equipment has been manufactured in accordance with the Contract Documents.
- 10.10 If the Client suffers damage as a result of a default by the Contractor in the execution of its obligations under the Contract, the Client shall

discuss the solution with the Consultant, give a written notice to the Contractor and send its copy immediately to JICA. Then the Client and the Contractor shall consult mutually to settle such matters. The Client shall properly inform JICA of its progress. If the Parties can not reach agreement within thirty (30) days from the date of the notice, the Parties shall comply with the dispute settlement process stipulated in Article 18 hereof.

Article 11. Inspection and Delivery

- 11.1 Upon completion of the Construction Work for each interim payment, the Contractor shall request an inspection by the Consultant for each interim payment.
- 11.2 Upon completion of the Construction Work, the Contractor shall request a final inspection for the Construction Work by the Consultant.When the Construction Work has passed the final inspection of the Consultant with the certificate of completion of the Construction Work issued by the Consultant and approved by the Client, the Construction Work shall be delivered to the Client.
- 11.3 When the certificate of receipt of the Equipment is issued by the Client or issued by the Consultant and approved by the Client, after passing all the required inspections, the Equipment shall be delivered to the Client.

Article 12. Warranty against Defects

12.1 The Contractor shall warrant the Construction Work to be executed in accordance with the Contract Documents for a period of one (1) year from the date of issue of the certificate of completion of the Construction

Work.

- 12.2 The Contractor shall warrant the Installation Work to be executed in accordance with the Contract Documents for a period of one (1) year from the date of issue of the certificate of completion of the Installation Work.
- 12.3 Warranty period for the Equipment is twelve (12) months from the date of issue of the certificate of receipt of the Equipment. Details of warranty for the Equipment are defined in the Contract Documents.
- 12.4 The Client shall notify the Contractor in writing, as stipulated in Article 27 hereof, of any defects for which a claim is made under this warranty as promptly as possible after discovery thereof.The Client's written notice shall describe the nature and extent of the defects. The Contractor shall have no obligation for any defects discovered subsequent to the expiry date of the said one (1) year period, unless notice of such defects is received by the Contractor not later than twenty one (21) days after such expiry date.
- 12.5 The Contractor shall remedy, at his own expense, any defects against which the Work is warranted under this Article, by making all necessary repairs or replacements except in the case that such defects result from the Client's negligence or failure.

Article 13. Performance Security

13.1 The Contractor shall provide a performance security issued by a Japanese financial institution, which secures the proper execution of all the Contractor's obligations during the period from the date of signing of this Contract to the date of issue of certificate of completion of the Work

of this Contract. The Consultant shall have the custody of the performance security.

- 13.2 The amount of the performance security shall be ten percent (10%) of the Contract Price.
- 13.3 The performance security shall be released immediately after the issue of the certificate of completion of the Work by the Consultant with the approval by the Client.

Article 14. Advance Payment Security

- 14.1 The Contractor shall provide an advance payment security issued by a Japanese financial institution, which secures the repayment of any sum advanced by the Client upon the Contractor's defaults from the date of the advance payment to the date of the issue of certificate of completion of the Construction Work.
- 14.2 The amount of the advance payment security shall cover the amount to be paid as the advance payment for the Construction Work.
- 14.3 Prior to requesting the advance payment, the Contractor shall provide the advance payment security and the Consultant shall have the custody of the advance payment security. Such security shall be returned to the Contractor immediately after the issue of the certificate of completion of the Construction Work.
- 14.4 In making a claim under the advance payment security, the Client shall notify the Japanese financial institution in writing, stating the nature of the default and the amount of damages in respect of the claim.

14.5 The amount to be paid under the claim shall be the amount of the actual damage incurred, and in no case shall it exceed the amount of the advance payment security.

Article 15. Assignment and Subletting

Neither of the Parties hereto shall assign this Contract or any part thereof to any Third Party without prior written consent of the other Party. The Contractor shall not sublet the whole of the Work or a major part of the Work to any Third Party together with its responsibility.

Article 16. Force Majeure

16.1 Definitions

Neither Party shall be deemed to be in default or in breach of this Contract if he is unable to perform his obligations under this Contract owing to the circumstances beyond his reasonable control. Such circumstances (hereinafter referred to as "Force Majeure") shall include, but shall not be limited to, the following:

- a) acts of God, including extreme weather phenomena, earthquake, flood, or any other such operation of the forces of nature that the Party affected could not reasonably foresee or provide against.
- b) war (declared or undeclared), hostilities, invasion, act of any foreign enemy, threat of or preparation for war; terrorism, riot, insurrection, civil commotion, rebellion, revolution, usurped power, civil war; and labor troubles or other industrial troubles, strikes, embargoes, blockades, and sabotage of labor.

16.2 Monetary Obligations

Notwithstanding the foregoing, the occurrence of Force Majeure shall not prejudice nor otherwise affect either Party's liability to pay remuneration or reimbursement of expenses to which the other Party is entitled on or before the date of occurrence.

16.3 Notice

The Party affected by Force Majeure shall give the other Party a written detailed account of the circumstances of Force Majeure as soon as practicable, but not later than fourteen (14) days from the occurrence.

16.4 Expatriate Staff

In the event that Force Majeure is likely to endanger the safety of any expatriate staff members of the Contractor, they shall be allowed to leave the Project site and/or office, giving notice to a staff member of the Client responsible for the management of the Project as soon as possible.

16.5 Suspension

Upon occurrence of Force Majeure, the Party affected may be allowed to temporarily suspend the performance of his duties under this Contract for so long a period as Force Majeure continues and as his performance is prevented thereby. In such instance, he shall make all reasonable efforts to mitigate the effect of Force Majeure upon his duties.

16.6 Damage

If the Contractor suffers damage due to Force Majeure, the Contractor shall discuss the solution with the Consultant, give a written notice to the Client and send its copy immediately to JICA. Then the Client and the Contractor shall consult mutually to settle such matters. The Contractor shall properly inform JICA of its progress. If the Parties can not reach agreement within thirty (30) days from the date of the notice, the Parties shall comply with the dispute settlement process stipulated in Article 18 hereof.

Article 17. Applicable Laws

This Contract shall be governed by and interpreted in accordance with the laws of Japan.

Article 18. Disputes and Arbitration

- 18.1 This Contract shall be executed by the Parties hereto in good faith, and in case any doubtful point is raised or any dispute occurs concerning the interpretation or performance of this Contract, such matters shall be settled through consultation of the Parties and the Consultant. Unless the Contract has already been abandoned, repudiated or terminated in accordance with Article 23 hereof, the Contractor shall continue to perform the Work in accordance with this Contract. If the Parties can not reach agreement within thirty (30) days from the date of the notice informing the occurrence of such matters, JICA will offer its suggestion for the settlement of the matter.
- 18.2 In the event that an amicable settlement cannot be reached through consultation referred to in the Sub-Paragraph 18.1 above, the matter shall be referred to arbitration. The arbitration shall be conducted in accordance with the Rules of Arbitration of the International Chamber of Commerce.
- 18.3 The arbitration shall be conducted in English.
- 18.4 The place of arbitration shall be Tokyo, Japan.

- 18.5 The arbitral award shall be final and binding upon the Parties hereto and the Parties shall comply in good faith with the decision. Judgment upon the award may be entered in any court having jurisdiction or application may be made to such court for juridical acceptance of the award or order of enforcement as the case may be.
- 18.6 As for fees for all proceedings for arbitration, each Party shall bear the costs of his own arbitrator's service and an equal share of the costs for the third arbitrator.

Article 19. Language and Measurement System

- 19.1 All correspondence between the Parties including notices, requests, consents, offers, and demands shall be made in English. All drawings, specifications, reports, and other documents shall also be prepared in English.
- 19.2 All documents made under this Contract shall adopt the metric system and the Gregorian calendar day.

Article 20. Project Modifications

- 20.1 In case the Client considers any modifications of the Work necessary, the Client shall discuss the solution with the Consultant, and the modifications can be made subject to the prior consent by JICA. Each modification may include:
 - (a) obvious change in appearance of the building or facilities,
 - (b) change of the Project Site,
 - (c) change of major structure and/or strength of the building or facilities,
 - (d) change of dimensions of the building or facilities,

- (e) change in quality or quantity of major equipment,
- (f) change of the period of execution of the Work,
- (g) change of terms and/or amount of the Contract Price,
- (h) change that requires amendment of the verified contract, and
- (i) other changes for which JICA requires the Client to obtain its prior consent.

In addition to the changes mentioned above, modifications can be made on an ex-post fact report to JICA within the criteria of minor modifications set by JICA.

20.2 Proposal by the Contractor

In case the Contractor considers any modifications of the Work necessary, the Contractor shall discuss the solution with the Consultant, and the Contractor can propose the modifications to the Client. This proposal may include the changes from (a) to (i) mentioned in Sub-Paragraph 20.1.

20.3 Procedures

Modifications shall be agreed upon by the Parties and JICA's consent shall be obtained for the modifications. Details of the procedures for such modifications are advised by JICA.

Article 21. Amendments and Modifications

Any amendments and/or modifications, if necessary, may be negotiated between the Parties hereto and shall be agreed by a written document signed by the Parties. The Consultant shall support the process of the amendments and/or modifications.

Article 22. Verification of Contract

This Contract and any amendments or modifications shall be verified by JICA to be eligible for the Grant in accordance with the G/A.

Article 23. Early Termination

- 23.1 Should either Party default in the execution of his obligations under this Contract, the other Party shall give the defaulting Party notice in writing to remedy such default promptly.
- 23.2 Failure of the defaulting Party, to take corrective measures as required by the other Party within thirty (30) days of the receipt of such notice, shall constitute a sufficient cause for the other Party to terminate this Contract.
- 23.3 Either Party may terminate this Contract without prejudice, should the performance of his obligations under this Contract not be resumed within a cumulative period of one hundred and twenty (120) days of suspension due to Force Majeure stipulated in Article 16 hereof.
- 23.4 The early termination of this Contract under this Article shall be subject to the approval of the competent authorities of the Client and the approval of JICA.
- 23.5 In the event of early termination for reasons stated in Sub-Paragraphs 23.2 and 23.3, the Contractor shall, with the approval of JICA, be paid by the Client, within the Grant, a fair and reasonable proportion of the Contract Price that is calculated on the basis of the Contractor's works carried out up to the termination date, instead of the payment schedule stipulated in Article 8 hereof.

Article 24. Patents, Trademarks and Copyrights

- 24.1 The Equipment may bear patent numbers, trademarks, or trade names of the manufacturers thereof. Nothing contained herein shall be construed as transferring any patent or trademark right or copyright for such Equipment and all such rights are hereby expressly reserved to the true and lawful owners thereof.
- 24.2 The Contractor shall defend the Client and hold the Client harmless from patent liability or claim of patent infringement of any nature or kind, including costs and expenses for, or on account of, any patent or unpatented invention made or used in such Equipment, including the costs and expenses of litigation, if any.

Article 25. Interpretation

- 25.1 All general language or requirements embodied in the specifications are intended to amplify, explain and implement the requirements of this Contract. However, in the event that any language or requirements so embodied permit an interpretation inconsistent with any provisions of this Contract, then in each and every such event, the applicable provisions of this Contract shall prevail and govern.
- 25.2 The specifications and drawings are also intended to explain each other, and anything shown on the drawings and not stipulated in the specifications or vice versa shall be deemed and considered as if embodied in both. In the event of conflict between the specifications and drawings, the specifications shall prevail and govern.

Article 26. Entire Agreement

This Contract sets forth the entire agreement between the Parties in respect of the subject matter hereof and supersedes and cancels any and all previous agreements, negotiations, commitments, and writings in respect of the subject matter thereof.

Article 27. Notice

All notices pertaining to this Contract between the Client and the Contractor shall be sent in writing by registered airmail, facsimile, electronic mail or shall be handed to the addresses so stated herein. Such notices shall take effect from the date of receipt by the other Party. In case either Party hereto changes the address, the Party concerned shall give such notice to the other Party beforehand.

The Client:

Name	:R	oyal Irrigation Department, Ministry of Agriculture and									
Address	:	Cooperatives Samsen Road Dusit, Bangkok 10300, Kingdom of Thailand									
Telephone	:	+66-2-241-2688									
Facsimile	:	+66-2-241-2688									
E-mail address	:										

The Contractor:

Name	:
Address	:
Telephone	:
Facsimile	:
<u>E-mail address</u>	:

IN WITNESS WHEREOF, the Parties hereto have caused this Contract to be signed, as of the day and year first above written, in their respective names in duplicate, each Party retaining one (1) copy thereof.

The Client

The Contractor

(Signature)

(Name of the signer)

(Status of the signer)

Royal Irrigation Department

Ministry of Agriculture and Cooperatives Kingdom of Thailand

(Signature)

(Name of the signer) (Status of the signer) (Name of the Contractor)

SECTION 5

CONDITIONS OF CONTRACT

CONDITIONS OF CONTRACT

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1. General

The Work means the construction and procurement for the Flood Prevention Project of East Side of the Pasak River in Ayutthaya in the Kingdom of Thailand.

The Conditions of Contract stipulate the specific conditions on the Contract required to the execution of the Work.

2. Liquidation or Settlement of Fiscal Levies, Duties, Taxes and Other Similar Charges

- (1) The Client will assume all duties and related fiscal charges which may be imposed in the Kingdom of Thailand on Japanese nationals with respect to the importation of the products and/or services supplied under the Contracts.
- (2) The Client will assume all fiscal levies and taxes imposed in the Kingdom of Thailand on Japanese nationals with respect to the payment carried out for the income accruing from the supply of the products and/or services under the Contracts.
- (3) In connection with sub-paragraphs (1) and (2) above, the Client will be responsible for the prompt liquidation or settlement of such fiscal levies, duties, taxes and other similar charges.
- (4) The Consultant will issue certification to the Client regarding the temporary imported plant, materials and other goods which will be needed for the Work.

3. Visa

The Client shall provide Entry Visa to the expatriate staff of the Contractor, including his Subcontractors prequalified in the prequalification, with such assistance as may be necessary for the entry of his staff into the Kingdom of Thailand, and Multiple Visa for the stay therein and leave there from for the performance of the Work under the verified Contract.

4. Identification Cards for Employees

The Contractor shall ensure that all of his employees carry their respective identification cards at all times during the period of the construction and procurement.

5. Lump Sum Price

The total price quoted in the Tender for the Work shall be fixed lump sum price for the period of the Contract. This shall be held fixed and firm from the award of the Contract until the end of the Contract.

Price escalation of local or imported materials and manpower shall not be considered as a claim in the Contract price.

6. Implementation Program and Schedule

The Contractor shall submit a detailed implementation program for the approval of the Consultant, within thirty (30) days after the date of signing the Contract, in such form and

detail as the Consultant reasonably prescribes, for the execution of the Work, inclusive of detailed schedule on cost estimate of his own.

If at any time it should appear to the Consultant that the actual progress of the Work does not conform to the program to which approval has been given, the Contractor shall produce, at the request of the Consultant, a revised program showing the modification to such program necessary to ensure completion of the Work within Time for Completion.

7. Safety Measurement against Flood and Stormwater Damage

The Contractor shall design and construct temporary cofferdams, and also design and arrange dewatering work in the Canals of Han Tra and Kra Mang for assuring the work safety against both floodwater from Pasak River and stormwater of the Canal side. Deign of the cofferdams and dewatering work shall be verified by the Consultant.

The top elevations of the cofferdams for two (2) floodgates shall not be lower than the following,

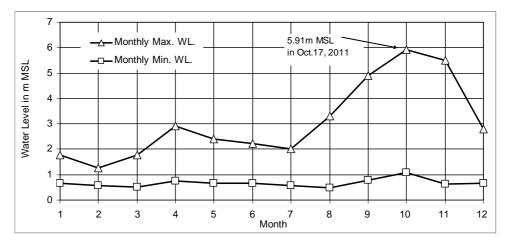
-	Pasak River side:	+4m MSL
-	Canal side:	+3.5m MSL

The drainage pumps for the dewatering work during wet season shall be the following capacity,

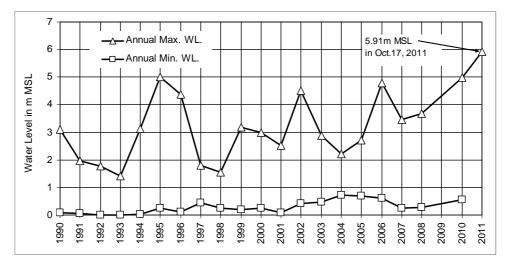
- Capacity of drainage pumps: Not lower than 1m³/sec in total
- (1) Cofferdams

The following tables show the water levels recorded at RID S5 gauging station of Pasak River in Ayutthaya since 1990 just after the completion of Pasak Dam. In October 17, 2011, the S5 gauging station recorded +5.91m MSL which is the overwhelmingly highest since the start of level gauging in 1950.

The water levels exceeding +4m MSL at S5 gauging station have been ever recorded in September to November of 1995, 1996, 2002, 2006, 2010 and 2011 since 1990.



Month-water level relation since 1990 at S5 gauging station of Pasak River in Ayutthaya



Annual max. and min. water level since 1990 at S5 gauging station of Pasak River in Ayutthaya

The Cofferdams shall be raised up, by piling up soil bags on the tops for instance, as per augmentation of the water levels in order to protect the industrial and residential zones situated to the east against direct floodwater intrusion to the cabals of Han Tra and Kra Mang.

(2) Dewatering work

The dewatering work shall be required to drain the stormwater into Pasak River from the local catchment area enclosed by the existing floodgates and the cofferdams for the Work.

The existing Suan Plu floodgate, which is managed by Ayothaya town, has the operational rule to be closed when the water level at Supachai Pumping station, which is also managed by Ayothaya town, reaches +2.6 m MSL.

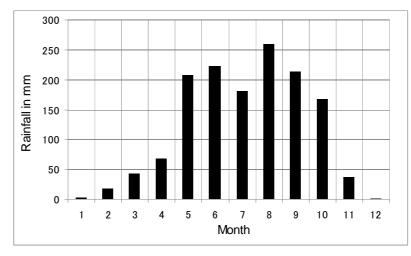
As for existing Khao Mao flood gate managed by RID, the upstream side thereof, which means Rojana Industrial Park side, keeps not exceeding +3.5 m MSL by controlling the opening of the three gate leaves.

The local catchment area dominated inside Han Tra floodgate, Kra Mang floodgate, Khao Mao floodgate, and Suan Plu floodgate is estimated to be 6.9km².

Of this catchment size, Han Tra floodgate and Kra Mang floodgate, which are situated downstream the canals, dominate the following catchment size respectively.

-	Han Tra floodgate	3.7km ²
-	Kra Man flood gate	3.2km ²
-	Total	6.9km ²

The following table shows the monthly average rainfall in Ayutthaya city



Monthly average rainfall in Ayutthaya city

When the water levels of the work sites exceed +4m MSL at Pasak River side and +3.5m MSL at Canal side respectively, the Consultant shall request the Client to temporally suspend the Work for the safety of the Contractor in conformity with Section 4 "FORM OF CONTRACT", Article 16. "Force Majeure".

For further solution on the resume of the Work, the Consultant shall technically intermediate among the Client, JICA and the Contractor.

8. Possession of Sites

The Client shall expropriate and make available the Sites directly occupied by the structures of the Kra Man and Han Tra Floodgates and the Bank Protection of Han Tra Canal which are respectively specified in the Tender Drawings on or before the date(s) when the Sites are deemed to become necessary for the execution of the Work.

Should there be any delay of the possession of the Sites caused by the Client, this may constitute a justifiable reason for the extension of the period of execution of the Work stipulated in Article 16 of the Form of Contract.

As for sites for the temporary works, including a temporary site office, warehouse, stock yard and temporary access, proposed and required by the Contractor, the Contractor himself shall be required to negotiate with the landowners for letting during the Construction Work in total assistance of the Client. The rents for such letting shall be born by the Contactor himself.

9. Relocation of Utilities

(1) Oil pipeline

High-pressured oil pipeline of PTT Public Company Limited is buried crossing Kra Man Canal between the railway bridge and the prefectural road bridge, where the pipeline is 5m away off the road bridge, situated just downstream Kra Man Floodgate. There, no relocation of the pipeline will be required. However, the Contractor shall be requested to pay special attention for not giving any damage to the oil pipeline when a temporary cofferdam is constructed.

(2) Water distribution pipes

Downstream Han Tra Floodgate, PVC-made water distribution pipe of Dia.100-80mm is

buried down the right bank of the canal to the last house standing at the canal mouth. The pipe is coming down from the PVC-made Dia.100mm water distribution pipe attached on the prefectural road bridge.

Moreover, along the bank slope of the prefectural road, the exposed water distribution pipe of PVC-made Dia.100mm, which is branched from the steel-made Dia.200mm pipe attached on the said road bridge, is running to the north.

The above-mentioned PVC-made water distribution pipes have been agreed for relocation to due places so as not to be affected by the Work between Thetsaban Nakhon Phra Nakhon Si Ayutthaya Waterworks and the Client at the cost of the Client.

On the other hand, no water pipe is served at the Site of Kra Mang Floodgate.

(3) Low voltage wires

Single phase 220V incoming wires are aerially installed at both the Sites of Kra Mang and Han Tra, including the Bank Protection, Floodgates.

These wires have been agreed have been agreed for relocation to due places so as not to be affected by the Work between Provincial Electricity Authority in Ayutthaya and the Client at the cost of the Client.

(4) Communication wires of SRT

The communication wires of State Railway of Thailand (SRT) are aerially installed crossing Kra Mang Canal between Kra Mang Floodgate and the railway bridge. The communication wires shall be temporally detoured during the Work at the cost of the Client so as not to be affected by the Work, and such agreement has been made between the Client and SRT.

10. Supply of Electricity

One (1) unit of 3 phase transformer of $22kV/400V-230V \times 50Hz \times 250kVA$, inclusive of 22kV wires and concrete poles, shall be installed newly at both the Sites of Kra Mang and Han Tra Floodgates respectively at the cost of the Client.

The electric power required for the hoists, lighting apparatus and water level gauges of the Floodgates shall be supplied from the above-said transformers.

11. Entrusting or Subcontracting as a Whole

The Contractor shall not be entitled to entrust or subcontract the entire Work or a major part thereof to any third party except for the Subcontractors prequalified in the prequalification.

12. Assignment, etc. of Rights and Obligations

- (1) Neither party to the Contract shall assign to any third party or let him succeed to his rights or obligations arising from the Contract.
- (2) Neither party to the Contract shall assign or lend to any third party, or place for mortgage or any other security, any part of the Work or approved construction materials thereof.

13. Consultant

(1) The Consultant shall act on behalf of the Client as specified below. When any different provision is made, the Client shall notify the Contractor in writing thereof:

- a. Check and approve the implementation program and schedule and other related documents submitted by the Contractor;
- b. Check and approve shop drawings, samples, catalogues, etc. prepared and/or submitted by the Contractor;
- c. Give instructions and attend to the execution of the Work in general;
- d. Approve construction materials and working method, and attend to tests;
- e. Approve the performance based design, manufacturing methods, shop & field tests and the O&M training of the Hydraulic Gate Work in conformity with the requirement in the Specifications;
- f. Approve the performance based design, manufacturing methods, shop & field tests and the O&M training of the Equipment in conformity with the requirement in the Specifications;
- g. Inspect the progress of the Work and make inspection of the Work in conformity with the Contract Documents, and attend at the acceptance of the Work;
- h. Technically check applications for interim payments submitted by the Contractor as to their compliance with the actual work done; and
- i. Technically check applications for extension of Time for Completion, if any required.
- (2) The Consultant shall respond to requests made by the Contractor as for negotiation, instruction, inspection, checking, attendance, opinion, or approval, without unreasonable delay.
- (3) All communications of technical nature in respect of the Work between the two parties, namely the Client and the Contractor, shall be made through the Consultant.
- (4) The Consultant shall inform the Contractor of the name of his representative in writing, after the approval of the Client.
- (5) When the Consultant appoints his assistants for the inspection and attendance, the Consultant shall inform the Contractor of the names of such assistants in writing.
- (6) The instruction or approval given by the Consultant to the Contractor shall be effective when it is in writing. However, any approval given to the Contractor as above does not relieve the Contractor from any of his responsibilities under the Contract.

14. Project Representative and Engineer-in-Charge, etc.

The Contractor shall inform the Consultant in writing the names of the engineers responsible for the Work both on Site and in Japan.

The qualifications required for the engineers of the Contractor and his Subcontractors

prequalified in the Prequalification are listed hereunder;

- Project Manager Be qualified as First-Class Civil Engineering Works Execution Managing Engineer in Japan or its equivalent.
- Other Engineering staff Be qualified as due license and/or working experience holders.

15. Disagreement between the Consultant and the Contractor

- (1) The Consultant or his representative may request the Contractor to take necessary measures for replacement of any of the Contractor's employees including his subcontractors assigned on the Project by clarifying the reason in writing.
- (2) If the Contractor deems measures requested by the assistant of the Consultant's representative to be extremely unreasonable, he may require the Consultant to take necessary measures by clarifying the reason in writing. The Consultant shall clarify the matter without delay upon the receipt of such request from the Contractor.

16. Construction Materials and Equipment

- (1) The Contractor, including his Subcontractors prequalified in the Prequalification, shall use the construction and manufacturing materials which have passed the due inspections and/or tests attended by the Consultant, or those which bear authoritative manufacturer's certificate as required in the Tender and Contracting Documents. However, in the latter case, the Consultant retains the right to request the Tender and to have any of the materials tested if necessary, with required expenses to be borne by the Contractor.
- (2) Expenses directly needed for the inspections or tests mentioned in the preceding paragraph (1) shall be borne by the Contractor. However the expenses needed for those inspections or tests in addition to (1) above, which are not specified in the Contract Documents and other exceptional expenses, shall be borne by the Client.
- (3) The Contractor shall remove the materials from the Site when rejected by the Consultant.
- (4) When the quality of construction materials is not specified, such materials shall be first class quality.
- (5) If the Consultant deems construction equipment to be improper, he is entitled to direct the Contractor to replace it.
- (6) Construction material or equipment delivered to the Site for the Work shall not be removed from the Site without the prior written approval of the Consultant.

17. Attendance at Work

The Contractor shall request the attendance of the Consultant when the Contractor including his Subcontractors prequalified in the Prequalification executes any work under ground or water, or any other work invisible after completion.

18. Doubts as to Drawings and Specifications

The Contractor shall notify the Consultant as for doubts and discrepancies in the Tender and Contracting Documents including Tender Drawings.

Upon receipt of such notification as mentioned above, the Consultant shall give clarification to the Contractor without delay.

19. Care of the Work

From the commencement of the Contractor's, including his Subcontractors prequalified in the Prequalification, field work on the Site and shop work to the date of completion for the whole of the Work, the Contractor shall take full responsibility for the proper care for the Work. For damage caused on the Work in this period, except those due to the Force Majeure as stipulated in Article 16 of the Form of Contract, usual tear and wear and other minor damage that do not affect the function of the existing road seriously, the Contractor shall repair, replace, make good or reconstruct all of these damage at his own cost, with the extension of time of completion not to be allowed for, unless otherwise approved by the Client and verified by JICA.

The Contractor shall also be held responsible for the damage caused after the issue of completion certificate, if the certificate is issued on partial completion basis, with any portion of the Work remaining uncompleted, unless the damage fall within the category as described in the previous paragraph as exceptions.

After the date of completion of the Work, the Work shall be delivered to the Client with the period of guarantee for twelve (12) months commencing from the date of handing over of the Project. Usual type of care and maintenance work in this period, however, shall rest upon the Client in accordance with the Grant Agreement between the Government of the Kingdom of Thailand and JICA.

Should any defects in the Work were found during the period of guarantee as they are derived from the use of materials or workmanship not in accordance with the Contract, or due to negligence or failure on the part of the Contractor to comply with any obligation, expressed or implied under the Contract, the resulting costs for repair, replacing, making good or reconstruction shall be borne by the Contractor.

20. Work not in Compliance with the Contract

Any part of the Work found during the period of construction and manufacturing not to be in compliance with the Drawings or Specifications, either in its workmanship, construction and manufacturing materials or methods, shall be promptly reconstructed and/or remanufactured by the Contractor, including his Subcontractors prequalified in the Prequalification, at his own expense in accordance with the instructions of the Consultant. In such cases, the Contractor is not entitled to request any extension of Time for Completion, or compensation for it.

21. Prevention of Damage and Accident

- (1) The Contractor, including his Subcontractors prequalified in the Prequalification, shall, at his own expense, take necessary and adequate measures on the work, in accordance with the Contract Documents and relevant laws, ordinances and regulations in the Kingdom of Thailand, in order to prevent damages to the work, construction and manufacturing materials, adjacent structures or to any third party, from the commencement of his field work to the completion and delivery of the Work.
- (2) The Contractor shall, whenever he considers it especially necessary for the

prevention of accidents, take appropriate measures, asking in advance for the opinion of the Consultant.

(3) Whenever the Consultant considers it necessary to take measures for the prevention of accident and has requested the Contractor to do so, the Contractor shall comply therewith.

22. Damage to Third Party

If any damage has been caused to a third party by the execution of the Work, the Contractor shall compensate the third party for such damage.

The Contractor shall provide insurance adequately to cover damages to the third party under the name of the Contractor and the Client.

23. Insurance of the Work

Without limiting his obligations and responsibilities under Clause 18 of this Conditions of Contract, the Contractor, including his Subcontractors prequalified in the Prequalification, shall insure against all loss or damage from whatever cause arising, other than the excepted risks during the period of construction and manufacturing for:

- (1) The works to the full value of such work executed from time to time.
- (2) The materials, equipments, construction plant and other things brought on the Site and/or workshop(s) by the Contractor to the full value thereof.

Such insurance shall be effect with an insurer and in terms approved by the Client, which approval shall not be unreasonably withheld, and the Contractor shall, whenever required, provide the policy or policies of insurance and the receipts for payment of the current premiums to the Consultant or the Consultant's representative.

The insurer shall be a Japanese or Philippines Insurance Company.

24. Insurance against Accident or Injury to Workmen

The Contractor before starting the work shall secure and maintain such insurance from an insurance company approved by the Client as will protect himself, his Subcontractors, his local contractors and the Consultant from claims for bodily injury, death or property damage which may arise from operations under this Contract. Bodily injury and death insurance shall provide coverage for all persons of any age.

25. Extension of Period of Execution of the Work

In case of Force Majeure or other unavoidable and justifiable causes, the Contractor may request the Client to extend Period of Execution of the Work, clearly stating the reason therefore. The number of days for extension shall be determined by negotiation among the Client, the Consultant and the Contractor and verified by JICA.

26. Client's Right to Suspend Work or Terminate Contract

The Client may, when necessary, suspend the Work within thirty (30) days of the issue of written notice to the Contractor and terminate the Contract in any of the following cases, and

in such cases the Client may demand of the Contractor compensation for damages of which the Client suffered.

- a. If the Contractor fails, without justifiable reason, to commence the Work after the elapse of the date of commencement;
- b. If the Contractor violates the provision of Clause 18 of this Conditions of Contract;
- c. If the Contractor violates the Contract in any way and if the objective of the Contract is deemed not attainable because of such violation.

27. Contractor's Right to Suspend Work or Terminate Contract

- (1) The Contractor may, when necessary, suspend the Work within thirty (30) days of the issue of written notice to the Client and terminate the Contract in any of the following cases in accordance with the Article 23 Early Termination of the Form of Contract.
 - a. If the Client fails, without justifiable reason, to comply with the Contractor's request for solving issues arising out of the execution of the Work, seriously affecting the Contractor's progress of the Work.
 - b. If the execution of the Work is impossible because of the failure of the Client to give the possession of the Site as mentioned in Clause 7 of this Conditions of Contract or elsewhere in the Contract Documents, or because of the nature or state of the Site of the Work having been changed by Force Majeure.
 - c. Suspension of the Work or Termination of this Contract under this Clause shall be subject to the approval of the competent authorities of the Client and approval of JICA.

28. Completion and Inspection

- (1) On completion of the Work, the Contractor shall request the Consultant for final inspection, and the Consultant shall promptly comply in the presence of the Contractor. And if the work are found in all respects in accordance with the Contract, the certificate of completion stating the date on which the Work were completed in accordance with the Contract shall be issued by the Consultant.
- (2) If the Work fails to pass, the Contractor shall repair, reconstruct or remanufacture the Work and/or the Equipment within Time for Completion or within such time as may be designated by the Consultant, and shall have the said Work re-inspected by the Consultant.
- (3) The Contractor shall, in compliance with the Consultant's instructions, remove temporary construction facilities, clean up the Site, borrow area and others, and perform other tasks within Time for Completion or within such time as may be designated by the Consultant.
- (4) If, in case of unreasonable delay in taking the measures mentioned in the preceding

paragraph (3), the Contractor fails without justifiable reason take such measures in spite of the Client's notices to do so, the Client may take measures in lieu of the Contractor and charge the expenses thereof to the Contractor.

29. Partial Use

- (1) The Client may use parts of the Work or the Equipment during the progress of the execution of the Work and/or manufacturing upon obtaining the written consent of the Contractor. In such case, the Client shall be responsible for custody of such parts.
- (2) If any damage has been caused to the Contractor due to partial use mentioned in the preceding paragraph (1), the Contractor may demand indemnification to the Client.

30. Supplementary Provisions

Any and all matters not provided for in the Contract Documents shall be determined by negotiation among the Client, the Consultant and the Contractor whenever necessities arise.

31. Import and Re-export of Plant

The Contractor, including his Subcontractors prequalified in the Prequalification, shall be allowed to import construction & manufacturing materials, plants and equipments free of customs duty, in case of importation from limited to Japan, for the sole purpose of the Work. In order to facilitate prompt mobilization by the Contractor and expedite the progress of the Work, the Client shall assist the Contractor where required in procuring any necessary government consent to import such materials, plants and equipments.

32. Ownership and Copyright

The drawings, specifications and other documents, as instruments of service, are the property of the Consultant and shall not be used other than the Work without prior written approval of the Consultant. The copyright of all drawings, specifications and other documents prepared by the Consultant in connection with this Agreement rests with the Consultant.

33. Reporting

In order to approve, verify and certify that the Contractor, including his Subcontractors prequalified in the prequalification, performs the Work in conformity with the Specifications, Drawing, Contract and other documents regarding the Work, the Contractor shall prepare and submit reports as shown below to the Consultant at each stage of the progress.

- 1) Overall Implementation Plan
- 2) Report on Detailed Design of the Hydraulic Gate
- 3) Notice of Completion of Piecework
- 4) Notice of Completion
- 5) Notice of Delivery
- 6) Report on Output Record for Use of Construction Plant
- 7) Accident Report
- 8) Detailed Work Schedule
- 9) Shop Drawings

- 10) Monthly Report
- 11) Daily Report
- 12) Minutes of Meeting
- 13) List of Country/Area of Origin of Proposed Equipments and Materials
- 14) Quality Assurance Certificate of Procured Equipments and Materials
- 15) Report on Performance / Shop Test of Procured Equipments
- 16) Request for Inspection of Procured Equipments and Materials
- 17) Request for Work Inspection
- 18) Quality Inspection Report
- 19) Diagram of Contractor's Site Organization for Safety
- 20) Record of Concrete Quality Assurance Tests
 - Mixture
 - Material Features
 - Result of Concrete Quality Assurance Tests
- 21) Report on Commissioning Tests
- 22) Report on Operational and Maintenance Trainings
- 23) As-built Drawings
- 24) Others as instructed by the Consultant

SECTION 6

TENTATIVE IMPLEMENTATION SCHEDULE

TENTATIVE IMPLEMENTATION SCHEDULE Flood Prevention Project of East Side of the Pasak River in Ayutthaya

Calendar Year					2012										2013												2014								
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ပိ		Contract for the Project									4																								
		Manufacture and transportation of materials and equipment														- 33																			
		Preparatory and temporary work																																	
		Kra Mang Floodgate																																	
		Cofferdam work																																	
		Foundation work																																	
		Earth work																						_											
		Concrete work																						_											
		Design and manufacture of hydraulic gate structures																																	
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		Removal of cofferdam																																	
		Adjustment, commissioning test, O&M training, inspection and handover																									_								
		Demobilization																											-						
		Environment monitoring										-	-		-		• •	•																	
		Land acquisition at Kra Mang and Han Tra sites																																	
	side	Relocation of communication lines of SRT at Kra Mang site																																	
		Relocation of water supply pipes at Han Tra site																																	
	Thailand	Relocation of low voltage incoming lines at Kra Mang and Han Tra sites																																	
	Ĩ	Installation of distribution lines and transformers at Kra Mang and Han Tra sites																						Tr	o be c	ontir	nued	l till	May,	201	6				
		Environment monitoring											-		-								-	1 🔳 1											
ient s		Drainage Pump Vehicle																																	
Procurement Process		Design, manufacture, transportation, customs clearance and installation																						_											
Pro		Adjustment, commissioning test, O&M training, inspection and handover																						-	-										

SECTION 7

SPECIFICATIONS

1. CIVIL WORKS

2. HYDROMECANICAL WORKS

3. DRAINAGE PUMP VECHICLE

SECTION 7-1

CIVIL WORKS

7-1 CIVIL WORKS

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1. GENERAL

1.1 **Project Description**

(1) Background

The Kingdom of Thailand suffered unprecedented big flood to wreak havoc in more than 61 provinces throughout country because the heavy rainfall estimated such as more than 100 year probability continued intermittently since July, 2011.

According to the Government of Thailand's official announcement made in November 5, 2011, some 1,200,000 households (3,200,000 people) were left inundated, 446 persons were killed and some 17,000km2 of farmlands got inundated in 25 provinces inside Chao Phraya River Basin.

Bangkok metropolitan area, Phra Nakhon Si Ayutthaya province that owns a collection and distribution center of industrial products, urban areas in Nonthaburi and Pathum Thani provinces located at north of Bangkok, suffered extensively serious flood damage.

Kha Mao canal, which is located upstream Han Tra and Kra Mang canals connecting to Pasak River, is used to function as drainage channel to lead drainage water to the Pasak River from lowland area at the left bank of the Pasak River. During year 2011 flood, the gate leaves of Kha Mao floodgate were closed because the flood water from the Pasak River came to enter into both Han Tra and Kra Mang canals. The existing gate height was not enough against the river side flood water level at the floodgate location. Then, the floodgate came to be hazardous to the destruction and then the gate leaves of the floodgate were judged to open. The flood water flowed upstream Kha Mao canal and overtopped extensively the dikes. Finally, the southern area of Kha Mao canal including lots of industrial estates came to be inundated.

In above-mentioned background, the Government of Japan decided to carry out the Food Prevention Project of East Side of the Pasak River in Ayutthaya in order to assist the Government of Thailand to take measures for preventing recurrence of the same magnitude of flood damage for the safety of dwellers in this area and industrial parks located downstream.

(2) Scope of Contract

The works to be carried out under the Contract shall, unless otherwise stated in the Contract, include furnishing all materials, labor, equipment, constructional plant, transportation and others, for execution, completion, commissioning and maintenance of Works in strict accordance with the Contract, as required by the Consultant and as specified herein.

The Project will consist of the following work items to be carried out by the Contractor under this Contract but are not limited to:

1 site

- Construction of Kra Mang Floodgate 1 site
- Construction of Han Tra Floodgate
- Construction of Bank Protection of Han Tra Canal 484m
- Procurement of Drainage Pump Vehicle 10 sets

(3) Works to be Carried Out by the Client

The assistance of the Government of the Kingdom of Thailand is to be extended on the following matters prior to and during the execution of the Works:

a. To take necessary measures to ensure prompt unloading and Customs clearance upon entry into the Kingdom of Thailand and transportation inside the Kingdom of Thailand for the goods procured for the implementation of the Project.

- b. To take necessary measures to exempt the contractor and the consultant from Customs duties, internal taxes and other fiscal levies imposed in the Kingdom of Thailand for their supply of goods, services, and equipment.
- c. To open an account in a designated bank in Japan for the Banking Arrangement (B/A), and issue the Authorization to Pay (A/P), bear the advising commission of the A/P and the payment commissions to the bank.
- d. To secure the necessary lands for the construction work and execute necessary negotiations with landowners for the due relocations of the lands and properties, and make due compensation to the affected landowners in conformity with the applicable laws in the Kingdom of Thailand.
- e. To obtain construction approval from the authorities concerned for the construction work.
- f. To cut and uproot trees to clear the construction areas of the flood gates and bank protection and also to take necessary measures to recover the vegetation in consultation with due experts and agencies concerned.
- g. To relocate existing utilities such as electric power lines, railway telecommunication cables, and water supply pipes, etc. that otherwise might be affected during the construction works of the captioned project. To be also responsible for damages to the above utilities except those caused by negligence of the contractor.
- h. To extend the electric power lines and install the transformers with the necessary capacity for the floodgates of Han Tra and Kra Mang, and also relevant temporary stockyards.
- i. To obtain permission for the use of frequency band for the telemetry system for well operation.
- j. To provide land for the temporary stockyards and access way for setting-up the site offices and storage of construction materials and equipment during the construction work.
- k. To conduct environmental and social impact monitoring in conformity with the ENVIRONMENTAL MONITORING CHECKLIST instructed by the Royal Irrigation Department of the Kingdom of Thailand and advised by Japan International Cooperation Agency.

1.2 Drawings

(1) Contract Drawings

The Drawings attached to the Tender and Contracting Documents accompany and form part of the Contract Documents after the Contract Agreement has been signed. In addition to the attached Drawings, the design drawings showing additional information about the Works may be delivered by the Consultant to the Contractor and during the progress of work, further drawings will be issued by the Consultant as necessity arises to supplement, supersede or further set forth details shown on the Drawings here, such drawings shall thereupon become part of the Contract Documents.

(2) Drawings to be furnished by the Contractor

(a) General

All of such various types of drawings as stated hereunder shall be prepared in a form approved by the Consultant and shall be submitted far enough in advance so that the Consultant can review and/or approve them without any delay being caused to the field work. The Contractor shall provide sufficient number of qualified engineers and draftsmen for producing all drawings required. All costs incurred by the Contractor in complying with the requirements of this clause shall be born by the Contractor. It is to the Contractor's advantage to submit all drawings at the earliest possible time, but the Contractor shall submit them for review and/or approval not less than thirty (30) calendar days prior to the time he plans to start construction of any particular item of the Works.

After the Contractor's drawings have been reviewed and/or approved by the Consultant, they will become part of the Contract Documents.

(b) Shop Drawings

The Contractor shall use the Contract Drawings as a basis for preparation of Shop Drawings. Shop drawings shall be made for all items of permanent work, and where applicable, shall show concrete outlines, reinforcement bars arrangement including bending/cutting schedules and layout and bar list, types of material to be used, grades, exact dimensions, etc. Further, such drawings shall present the full details of items not to be incorporated into the permanent work such as timber or steel forms, steel scaffolding, etc. All construction drawings must be approved by the Consultant prior to the time the Contractor plans to perform the work.

(c) Drawings for the Temporary Works

Within thirty (30) days after the contract has become valid, the Contractor shall submit to the Consultant for his review and approval three (3) sets of drawings which show the features of the Temporary Works.

These drawings shall show the locations and other pertinent details of the principal components of the constructional plants, offices, storage buildings, housing facilities, storage areas access and intra roads and drain systems thereof, etc. which the Contractor proposes to construct at the Site or other authorized areas. In addition, the drawings shall show the unloading facilities for the materials and equipment and the capacity of each major plant which the Contractor proposes to use at the Site.

If any change is made concerning the above-mentioned items during erection or after the items become operational, the Contractor shall submit revised drawings showing such changes to the Consultant for his review and approval.

Two (2) sets of the reviewed Drawings for the Temporary Works will be retained by the Consultant and one (1) set will be returned to the Contractor.

(d) As-Built Drawings

Throughout the period of construction, the Contractor shall maintain and up-to-date set of As-Built Drawings for the various items of work which have been completed. Such drawings shall show any authorized changes which may have been made to the Contract Drawings, to the extent that they correctly portray the true "as-built" condition of each item of the permanent Works. The format of the As-Built Drawings shall be as approved by the Consultant.

The whole part of the permanent work delineated on each Contract Drawing is completed, the pertinent As-Built Drawings, after approval by the Consultant shall be mutually signed

by the Consultant and the Contractor or their representatives.

The As-Built Drawings shall be made on high-quality reproducible paper so that clearly readable copies can be made. The finished set of As-Built Drawings must be submitted to the Consultant for his review and approval at the time of completion of the works.

(e) Other Drawings

Drawings other than those mentioned above, which are of general nature such as proposed construction methods, schematic diagrams outlines of how various types of work are to be performed, etc. shall be submitted to the Consultant for his review and/or approval.

(3) Submittal and Review or Approval of Contractor's Drawings

It is to the Contractor's advantage to prepare his drawings and submit them to the Consultant at the earliest possible time in order to avoid delaying the field work because of no availability of the reviewed or approved drawings in hand by the construction crews.

The Contractor shall submit his Shop drawings to the Consultant for approval or review as the case may be at least thirty (30) calendar days prior to the commencement of construction of any particular item of work. Shop Drawings for a particular item (such as the steel gates) which has to be fabricated outside of the Site and transported to the Site must be submitted early enough, earlier than that specified above, to allow adequate time of review, approval, fabrication, transporting and receiving at the Site.

Three (3) copies of clearly readable blue print copies of each drawing shall be submitted to the Consultant by means of a standard transmittal sheet. The format of the transmittal sheet shall be approved by the Consultant. Within twenty (20) working days after the receipt of the prints of the drawing(s) submitted by the Contractor, the Consultant will return one copy marked and signed with his intention and comments hereon depending upon whether the drawing must be "approved" or "reviewed".

Upon receipt of any approved drawing, the Contractor will be authorized to proceed with the work covered by such drawings, subject to making any correction(s) if indicated thereon by the Consultant; however, he shall first submit by logged transmittal sheet four (4) blueprints of each drawing, with corrections if any, to the Consultant. All approved and reviewed drawings shall be maintained at the Contractor's site office in proper order.

When the revision is requested on the Contractor's submitted drawings, the Contractor shall make the necessary corrections and/or revisions to the drawings in a timely manner and shall resubmit them to the Consultant in the same manner as for a new drawing, i.e. three (3) copies. When the returned drawings have been re-submitted for approval, the Consultant will try to complete his review and/or approval of the drawing within ten (10) working days; however, this will depend on the number and complexity of the corrections/revisions which have to be checked. This procedure will continue until the drawings have been finally approved.

If any revisions have been made to a drawing with the Consultant's approval, the Contractor shall resubmit three (3) prints to the Consultant for further approval. The Consultant shall have the right to make requests for any additional details and to ask the Contractor to make any changes in the drawings which are necessary to conform to the provisions and intent of the Specifications, without additional cost.

Any work done prior to the Consultant's approval of drawings shall be at the Contractor's risk. Approval by the Consultant of the Contractor's drawings shall not relieve the Contractor of any of his obligations in complying with the Specifications, the responsibility

for the correctness of the Contractor's drawings, the responsibility for the adequacy of the method of construction, etc.

(4) Right to Change Design and Drawings

When additional information regarding foundation, or other conditions becomes available as result of excavation work, further testing or otherwise, and if it may be found desirable to make changes in the alignment, cross sections, dimensions or design of the canal or appurtenant structures to conform to such conditions, the Client reserves the right to make such unavoidable changes as in the opinion of the Consultant are necessary or desirable.

The Contractor shall not be entitled to raise claims against such unavoidable changes, adjustment on or deviation from the original.

1.3 Standard and Testing

(1) Standards

All materials to be furnished under the Contract shall conform to JIS, (Japanese Industrial Standards), so far as applicable. Other national or international standards may be accepted provided that the requirements therein are equivalent to the current issue of the said Standards, JIS. The Contractor shall request the Consultant's approval for any items of materials that he wishes to bring in to the Site, based on standards other than JIS. In this case, however, the Consultant's approval may be based on condition that some sort of testing will have to be made on the material in the Kingdom of Thailand, and in this case all the costs and expenses accruing there from shall be borne by the Contractor, irrespective of the results of testing.

(2) Test of Materials at the Site

Not withstanding any previous inspections and tests, all materials delivered to the Site shall be subject to examinations and tests, if so requested by the Consultant. Should such test be desired by Consultant or the Client, the Contractor will be advised in sufficient time to permit such testing.

- All such examinations and tests shall be carried out by the Contractor at his cost in the presence of the Consultant in accordance with the normal practice in respect of such examinations and tests if the same may be carried out by the Contractor with his staff and equipment available at the Site.
- Otherwise, the tests shall be made at another laboratory approved by the Consultant at the cost of the Contractor.

The Consultant shall be at liberty to reject any materials which do not comply with the requirements of the Contract notwithstanding any previous approval thereof.

The Contractor shall not be entitled to any extra payment or extension of time for completion of the Works on account of the rejection of materials due to their non-compliance with the requirements of the Contract or of the waiting time reasonably required for carrying out the examinations and tests.

The Contractor shall furnish test samples as requested and shall provide reasonable assistance and cooperation as necessary to permit tests to be performed on materials or work in place including reasonable stoppage of Work during testing.

(3) Tests and Testing Laboratory

The Consultant will supervise such testing in the Contractor's laboratory as testing of concrete aggregate, soil, etc. for the purpose of adequate and sufficient quality control of the Works during the execution of the Works. The Contractor shall provide a laboratory with necessary testing apparatus in his construction site. The Contractor shall provide the sufficient number of volume of testing sample and perform the testing in accordance with the Standards and Specifications, and shall furnish qualified staff and sufficient numbers of laboratory assistants, capable of carrying out required tests specified in the Contract.

The Contractor shall carry out any field tests, such as field compaction test, concrete workability test, etc. in accordance with a manner and frequency prescribed in the Specifications and shall provide testing equipment and apparatus, and all testing staff, labor and consumables necessary for carrying out his field testing. The Contractor shall prepare schedules of his field testing and supply of testing samples to the Consultant for the laboratory tests taking into account the work progress schedules.

All costs incurred by the Contractor in complying with the requirements of this sub-clause shall be deemed to be included in Contract Price.

1.4 Implementation Program and Reports

(1) Implementation Program

Within ten (10) days after the contract has become valid, the Contractor shall submit to the Consultant the Implementation (construction) time schedule detailed for the whole of the Works and Temporary Works to be carried out under the Contract by means of CPM network or another approved method. Activities shown on the schedule shall consist of not only the actual construction sequence but also the time allowances necessary for the preparation and approval of drawings and samples procurement and shipping of materials and equipment, installation of special items, possible delays caused by floods or inclement weather conditions, religious holidays, etc.

The schedule shall be prepared so that all the works are to be completed in compliance with the Payment Conditions stated in the FORM OF CONTRACT AND ANNEXTURES. The construction time schedule submitted shall be subject to due modifications and changes as necessary, and approved by the Consultant within a reasonable time. This revised time schedule agreed and signed by the Consultant and the Contractor shall be deemed to be an authorized construction time schedule and become part of the Contract Documents.

The authorized time schedule shall be closely monitored and kept current, and it shall be formally updated by the Contractor once every two (2) months, or as directed by the Consultant, and submitted to the Consultant for his review and approval.

If during the course of construction of the Works, the rate of progress of the Works falls behind the schedule agreed in the opinion of the Consultant, and the Contractor shall not be able to complete any one section of the Works by the time agreed, then the Consultant will instruct the Contractor to increase his work force or supplement the Constructional Plant on Site to expedite the rate of progress in that section.

(2) Progress Report

The Contractor shall, before the tenth (10th) day of the each month or at any time designated by the Consultant, submit five (5) copies of a monthly progress report in a form acceptable to the Consultant detailing the progress of the Works during the

preceding month. The report shall contain the following but is not limited to:

- The total overall percentage of work completed up to the reporting month as well as total overall scheduled percentage by the CPM method (or other method previously approved by the Consultant) as of the end of the reporting period with appropriate comments on progress,
- The actual percentage of each main work item completed as well as the scheduled percentage for them with appropriate comments on their progress,
- The schedule of activities to be started within the succeeding two (2) months with forecast starting and completion dates,
- A list of local manpower by trade and expatriate personnel by position employed during the reporting period,
- A list of constructional plant, equipment and materials on Site used in the execution of the Works including those arrived at and removed from the Site,
- The total work quantities to be incorporated into the permanent Works but not limited to:
- The main items of Temporary Works performed during the reporting period,
- The environmental monitoring results
- The activities and events relating to the safety and health management
- Any other matters which may be required under the Contract or statement concerning the matter arisen from or relating to the execution of the works during the reporting month.

(3) Daily, Weekly and Monthly Schedules

The Contractor shall submit two (2) copies of a weekly schedule in a form approved by the Consultant at the end of each week for the succeeding week. The schedule shall contain, but not be limited to, the following items; earthwork, concrete work, and other construction work related to the execution of the Works, procurement of materials, transportation of materials and equipment, and other schedules required by the Consultant.

The Contractor shall submit two (2) copies of a written daily working schedule and progress in a form approved by the Consultant everyday for the succeeding day. The schedule shall contain, but shall not be limited to, earthwork, concrete work, and other activities related to the execution of the Works.

The Contractor shall prepare a monthly bar chart type schedule at the end of each month for the succeeding month. This schedule shall show the time span from the start to the end by each main activity with the anticipated work quantities. The schedule shall be submitted to the Consultant by the 3rd day of each month for his review and comments. The submission to and approval by the Consultant of such program or schedule or furnishing of any particulars thereof shall not relieve the Contractor of any of his obligations or responsibilities under the Contract.

(4) Joint Meeting to Discuss Progress

A regular meeting between the key personnel of the Consultant and the Contractor shall be held once per week at a time agreed to by both parties. The purpose of this meeting will be to discuss the progress being made, the work proposed for the forthcoming week and any problems having a direct bearing on the immediate to near-term work activities.

(5) **Progress Photos**

The Contractor shall furnish to the Consultant color photographs (not less than 8 cm x 12 cm) of the work in progress, at locations directed by the Consultant throughout the Contract period. The photographs shall be taken at the start and completion of each major component of the work and at other times as instructed by the Consultant. The photographs to be furnished to the Consultant shall be attached to the applicable monthly progress report specified in Clause (2) hereinabove and shall be in five (5) prints for each photograph. A brief description and date of each photograph will be included. The cost of such photographs shall not be paid separately and shall be the property of the Client and no print from these negatives shall be supplied to any person or persons unless so authorized by the Client.

(6) Completion Report

The completion report shall be submitted within twenty-one (21) calendar days after completion of the Work. The report shall contain, but not limited to, the total work volume completed and the activities in the construction period. The completion photographs shall have brief descriptions together with the dates they were taken. The completion report shall also include the List of supplied Equipment (indicating name of Equipment, quantities, manufacturers' name, model and type, and delivery date and site), Record of inspections and performance test of the Equipment, Record of training and the certificate (including dates and name of trainees) signed by the Client, and List of supplied manuals for Equipment (indicating the locations where they are placed) for the Procurement of Equipment.

1.5 Materials and Plant to be Furnished by the Contractor

(1) General

The Contractor shall furnish all plant and materials required for the completion of the Works. Unless otherwise specified, all plant and materials which form part of the permanent Works shall be new and shall conform to the standard provided in the Specifications or Standards.

When he proposes to supply plant and materials not conforming to such standards as above mentioned, the Contractor shall inform the Consultant of his intention and shall obtain the Consultant's written approval of such other standards.

(2) Constructional Plant

The Contractor shall supply necessary constructional plant required for the sufficient execution and completion of the Works. All plant and equipment to be furnished by the Contractor shall be complete with all spare parts and the Contractor shall maintain sufficient stock of such spare parts for their Plant and equipment to ensure the sufficient execution of the Works.

(3) Substitute Materials

The Contractor shall make diligent efforts to procure the specified materials, but when the materials specified are unavailable for reason beyond the control of the Contractor,

substitute materials may be used, provided that no substitute materials shall be used without prior written approval of the Consultant.

(4) Inspection of Plant and Materials

Plant and materials furnished by the Contractor shall be subject to inspection in accordance with the Contract at any one or more of the following locations as determined by the Consultant.

a) the place of production or manufacture

- b) the shipping point
- c) the Site

The Contractor shall submit to the Consultant any information covering plant and materials required by the Consultant for the purpose of inspection which shall in no way relieve the Contractor of his responsibility for furnishing plant and materials complying with the Specifications.

(5) **Programs and Notices of Transportation**

Concurrently with submitting a construction schedule, the Contractor shall furnish the Consultant with a complete transportation program for plant, materials, and the constructional plant, showing in detail the sequence of transportation and delivery on Site to comply with his proposed construction schedule.

The Contractor shall keep the Consultant informed of the arrival of plant, materials and the Constructional Plant at the Site.

(6) Specifications, Pamphlets and Data to be Supplied by the Contractor

The Contractor shall submit to the Consultant for approval three (3) sets of complete specifications, pamphlets and data for materials and plant to be supplied under the Contract prior to the work commencement.

The approval of such specifications, pamphlets and data, however, shall not relieve the Contractor of any responsibilities in connection with the Contract.

1.6 Survey and Measurement of the Works

(1) Bench Mark

The basic bench marks for the Project will be shown on the Reference Drawings, which will be supplied by the Consultant after the contract has become valid, together with their locations and elevations of these bench marks. The other bench marks and reference points will be also shown on the Drawings. Before using such bench marks and reference points other than the basic bench mark for setting-out the Works, the Contractor shall carry out a check survey therefore and satisfy himself as to their accuracy. The Consultant shall not bear any responsibility for the accuracy of such other bench marks and reference points.

The Contractor may establish additional temporary bench marks for his own convenience but each temporary bench mark so established shall be of a design and in a location approved by the Consultant, and shall be accurately related to the bench marks established by the Consultant.

(2) Setting Alignment of Pipes and Demarcation of Right-of-Way

The Contractor shall be responsible for setting of alignment of pipes and demarcation of right-of-way on the ground in accordance with the Drawings and information supplied by the Consultant. Points to be staked on the ground shall be all the intersection points, center-line points at 50 m intervals on an average, and the beginning, intermediate and end points of curvatures. All costs incurred by the Contractor in complying with the requirements of this sub-clause shall not be paid separately and shall be deemed to be included in the Contract Price.

(3) Original Surface Levels for Use of Measurement

The ground surface and river bed levels shown on the Contract Drawings shall be deemed to be correct under the Contract. If, however the Contractor is in doubt of the correctness of such levels the Contractor shall, at least thirty (30) days before starting the Works, notify the Consultant in writing of his intent to confirm and perform re-survey of such levels. In all cases before commencing the earthworks and dredging, the Contractor shall survey and take levels over the areas to be occupied by the Works using the bench marks or reference points approved by the Consultant in the presence of the Consultant's Representative. The ground surface or river bed levels so determined shall be subject to the Consultant's approval.

(4) Assistance to Consultant's Staff for Survey

The Contractor shall cooperate with the Consultant in checking the setting-out and in performing the measurement surveys for record and payment purposes. The Contractor shall render all necessary assistance to the Consultant and shall provide, as required by and for the sole use of the Consultant, sufficient quantities of pegs, poles, straight edges, staging, moulds, templates, profiles and all other requisite items for checking the Contractor's setting-out and measurement of the Works.

The cost of all labor and materials required by the Consultant for said purposes shall be borne by the Contractor. No payment shall be made for the costs incurred by the Contractor in complying with the requirements of this sub-clause, which cost shall not be paid separately and shall be deemed to be included in the Contract Price.

1.7 Security and Health Control

(1) General

All security and health controls necessary for the execution of the Works such as but not limited to, sanitary arrangement, land clearing of Site, explosives and fuel, temporary fencing, safety precautions and fire prevention, shall be established and maintained by the Contractor at his own expense. The Contractor shall make himself responsible for all security and health controls and shall submit to the Consultant for his approval the organization and the regulations for these purposes.

(2) Security Control System

The Contractor shall establish the security control system and its organization for the Works and submit the program to the Consultant for his approval. The security control system shall have a sufficient capacity of equipment, facilities and persons to avoid accidents and damages to the persons and properties concerned.

The security control system shall be operated in accordance with the approved program which shall be established on the basis of the Kingdom of Thailand n laws and regulations.

The Consultant or the Consultant's Representative shall have the right to instruct the

Contractor in the operation of the system from time to time, if it is deemed necessary in the opinion of the Consultant.

(3) Sanitary Arrangement and Clearing of Site

The Contractor shall keep the Site in a clean and sanitary condition and shall provide and maintain sanitary convenience for the use of persons employed in the Works to the extent and in the manner and at such places as approved by the Consultant and by any local or other authorities concerned, and all persons connected with the Works shall be obliged to use these conveniences.

The Contractor shall also post notices and take such other precautions as may be necessary to keep the Site clean.

(4) Explosives and Fuels

The Contractor shall make arrangements to transport, store and handle explosives, if any, and fuels in a safe manner for protecting the public in accordance with the laws and security regulations in force.

The Contractor shall obtain all necessary licenses and shall pay all fees and charges in respect of the same as may be necessary for the purpose of moving explosives and fuels from place to place and storing the same, and shall carry out all applications to obtain the approvals from the concerned authorities of the Government of the Kingdom of Thailand.

The Contractor shall supply and install an efficient warning system so that adequate warning may be given for all persons that may be endangered when explosive charges or group of charges are to be fired.

The Contractor shall ensure, prior to discharging an explosive, that the area to be blasted in clear of all residents, pedestrians and vehicular traffic. In addition he shall post flagmen on each of the roads entering to the said area so as to stop and prevent any traffic from entering into that area until the "all clear" notification is given.

The locations of explosive magazines shall be approved by the Consultant. Aboveground gasoline and liquefied petroleum gas storage tanks shall not be located within the limits of the camp site or closer than 100 meters to any building in the Site. The contractor shall not make use of any explosives without the written approval of the Consultant. Approval by the Consultant shall not relieve the Contractor of his obligations and responsibilities for all blasting operations, if any.

(5) **Precautions for Safety**

The Contractor shall take all necessary precautions against risks of loss of life or of injury to any person employed on the Works or to employees of the Client and the Consultant or to visitors or to persons having good and sufficient reasons to be about the Works, and to this end shall properly safeguard the Works to the satisfaction of the Consultant.

The Contractor shall furthermore take all necessary precautions against damage to the property of the Client or of others located at or adjacent to the Site. The Contractor shall at all times comply with any accident prevention regulations and any safety regulations of any local or national authorities in the Kingdom of Thailand.

The Contractor shall appoint a Safety Officer and hold periodical safety meetings with the Consultant and with his own supervisor and foremen. The Contractor shall report promptly to the Consultant all accidents involving the death of or serious injury to any person on the Site, resulting from the Contractor's operations.

(6) **Protection of Existing Structures and Utilities**

The Contractor shall assume full responsibility for the protection of all buildings, structures and utilities, public or private including poles, signs, services to buildings, utilities in the street, water pipes, hydrants, drains and electric and telephone ducts and conduits, whether or not they are shown on the drawings.

The Contractor shall carefully support and protect all such structures and utilities from injury of any kind. Any damage resulting from the Contractor's operations shall be repaired at his own expense.

The Contractor shall bear full responsibility for obtaining all locations of underground structures and utilities. Services to buildings shall be maintained and any costs or charges resulting from damages there to shall be paid by the Contractor.

1.8 **Project Billboards**

The Contactor shall install and maintain billboards through the whole construction period to the public on the project content including finance source, purpose of the project and brief content of the works.

The billboard shall face to the public road and/or to the public area written in both English and the Kingdom of Thailand.

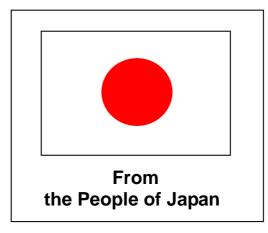
The location and content of the billboards shall be approved by the Consultant before installation.

1.9 Sticker and Inscription Plates

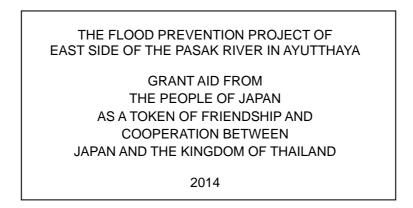
Sticker and Inscription plates in both English and the Kingdom of Thailand shall be provided by the Contractor in adequate sizes. Examples of the plates are shown as illustrated in the following figures for reference. The Contractor shall design the plates based on these examples and submit the design drawing to the Consultant. The final specifications of the plates shall be approved by the Consultant. The places to install the plates shall be as decided by the Consultant.

The Contractor shall take photographs showing the sticker and inscription plates on permanent work for submission to the Consultant at completion of the Work.

Example 1: Sticker of the National Flag of Japan



Example 2: Inscription Plate



Example 3: Inscription Plate with the National Flags



2. TEMPORARY WORKS

2.1 General

All Temporary Works shall be provided, installed, operated, maintained and subsequently removed by the Contractor, except as otherwise provided in the Contract.

The Contractor shall submit to the Consultant for approval, within thirty (30) days after the Contract becomes valid, the details including scale, capacity, layout, installation program and schedule and foundations for the Temporary Works except insofar as provided for in respective sub-clauses. The Consultant shall have the right to direct to the Contractor to modify or change the Contractor's proposals if it is deemed necessary in the opinion of the Consultant. Such direction of the Consultant shall not relieve the Contractor of his obligations and responsibilities under the Contract.

If the Contractor intends to locate some of the Temporary works outside the Site shown on the drawings, such proposal shall be optional but all costs required for doing so, including right-of-way, rent of land and like, shall be borne by the Contractor and shall be deemed to be included in the Contract Price. Any delay or restriction caused by such matters shall not relieve the Contractor of his obligation to meet the requirements of the Contract. No extension of time shall be allowed for any delay caused thereby.

Except otherwise provided for in the Bill of Quantities, no separate payment will be made for complying with the provisions of this Clause and all costs shall not be paid separately and shall be deemed to be included in the Contract Price.

2.2 The Site

The Site as shown on the Drawings shall be the land or space to be used for the execution of the Works. The Contractor shall as far as practical layout the Temporary Works on such land or spaces so designated on the Drawings or directed by the Consultant.

The Contractor shall limit the movement of his crews and equipment on the right-of-way including access routes approved by the Consultant so as to minimize damage to crops and property, and shall endeavor to avoid marrying the land. Ruts and scars shall be obliterated and damage to land shall be corrected. Before acceptance of the Works by the Client the land shall be restored as nearly as practicable to its original conditions.

The Contractor shall be responsible directly to the Client for any excessive or unnecessary damage or injury to crops or land resulting from his operations whether in the possession of the Client or any other person, and shall indemnify the Client against all losses and claims for such damage and injuries.

2.3 Mobilization and Demobilization

Mobilization shall be understood to mean transportation of Constructional Plants and equipment, based on the construction schedule to be submitted, from the original areas of possession of them to the sites where they are to be used. Mobilization of the proposed supervisory personnel, labors, office staff, etc., according to the schedule submitted, is also included under the mobilization.

The Contractor may, always subject to the authorization of the Consultant, at any time during the works, make any alternation, reduction and/or improvements to the constructional plant and personnel.

Demobilization shall include the removal of constructional plants from the site and

departure of personnel who have completed their work.

All costs incurred by the Contractor in complying with the requirements of this sub-clause shall not be paid separately and shall be deemed to be included in Contract Price.

2.4 Contractor's Office, Client's/Consultant's Field Office, etc.

The Contractor shall provide, maintain, and operate such buildings as Contractor's office, Client's/Consultant's field office, staff quarters, stores, workshops, labor camps and other temporary buildings necessary for the execution of the Works and remove them upon the completion of the work. The Contractor shall submit site plans and general particulars of the temporary and permanent buildings to the Consultant for his approval within the prescribed period. The construction of the buildings shall not be started until his proposals have been finally approved by the Consultant.

The Contractor's staff quarters and labor camps shall be provided with all necessary services for drainage, lighting, roads, paths, parking places, fencing, sanitation, cookhouses, fire prevention and firefighting equipment.

The Contractor shall also provide a heating system, an adequate water supply system and make arrangement for electric power supply and maintenance to the Contractor's Office, Client's/Consultant's field office, staff quarters, labor camps, workshops and other places of the Work on the Site.

The Consultant's field office shall be heated in winter and provided with the suitable furniture and office equipment listed in the table below.

Furniture	 Meeting table with 6 chairs : 1 set Desk with chair : 5 sets Filing cabinet : 5 units White board : 2 unit
Equipment	 Desktop computer : 2 units Specifications Processor: Intel Core i5 or more Hard disk: 500GB or more RAM: 8GB or more Optical drive: Super multi drive or equivalent Monitor: 21.5 inch class liquid crystal monitor Software in English version to be provided Microsoft Windows 7 Professional 64bit Microsoft Office Professional latest version Virus protection program latest version Adobe Acrobat 32V liquid crystal TV set : 1 no. Air conditioner 6.3 kW class : 1 no. Cool and hot water server : 1 no. Refrigerator 200 liter class : 1 no.

Requirements for Consultant's Field Office

The cost of the construction, maintenance and subsequent removal of the Contractor's office, Client's/Consultant's field office, Stores, Workshops, Labor Camps provided under the Contract shall not be paid separately and shall be deemed to be included in Contract Price.

2.5 Temporary Fencing

If required, the Contractor shall erect and maintain at his own expense suitable and approved temporary fencing to enclose such area of the Works to be carried out and all areas of land occupied as may be necessary to implement his obligations and to the satisfaction of the Consultant.

The cost of the erection, maintenance and subsequent removal incurred by the Contractor in complying with the obligations under this sub-clause shall not be paid separately and shall be deemed to be included in Contract Price.

2.6 Temporary Access Roads

The Contractor shall construct and maintain temporary access roads including associated drainage and stream crossing facilities necessary for the execution of the Works. Demolition and removal of this temporary work shall be subject to the approval of the Consultant.

The existing roads to be used as access roads shall for his own convenience be rehabilitated, improved, and maintained by the Contractor.

Not less than thirty (30) days before the Contractor intends to commence construction of any part of the temporary access roads the Contractor shall submit to the Consultant for his approval a detailed construction for access roads including:

- Design of the temporary access roads including associated drainage and stream crossing facilities.
- The gradient of temporary access road shall not exceed 10% for the safety.
- Construction method and Construction time schedule of such temporary access roads.

The Contractor shall not commence the construction of any temporary access road until the Consultant's approval thereto has been obtained. However, such approval shall not relieve the Contractor of any of his duties or responsibilities under the Contract.

The Contractor shall construct such temporary access roads in accordance with the approved drawings and construction program. The Contractor shall be responsible for and repair at his own expense any drainage to the access roads including the existing roads on the access routes caused by traffic of heavy equipment and trucks used by the Contractor for the execution of the Works. On the completion of the Works, such temporary access roads shall be removed and left in the original condition to the satisfaction of the Consultant. Especially, in bank protection work of Han Tra Canal, the aggregate for temporary access road shall be completely removed before the commencement of embankment.

The Cost of the construction, maintenance and removal of the temporary access roads provided under the Contract shall not be paid separately and shall be deemed to be included in Contract Price.

2.7 Temporary Traffic Ramps/Roads and Detour

In cases where it is necessary or required by the Consultant, the Contractor shall construct and maintain, and remove temporary traffic ramps/roads and detour through or around the Works, and shall furnish all the labor and materials required therefor.

2.8 Temporary Traffic Control

In order to facilitate traffic through or around the Works, or wherever instructed by the Consultant, the Contractor shall erect and maintain at prescribed points on the work and at the approaches to the work, traffic signs, lights, flares, barricades and other facilities as required by the Consultant for the direction and control of traffic.

Where required, or where instructed by the Consultant, the Contractor shall furnish and station competent flagmen whose sole duties shall consist in directing the movement of traffic through or around the work.

In addition to the requirements of the paragraphs above, the Contractor shall furnish and erect, within or in the vicinity of the project area, such warning and guide signs as may be instructed by the Consultant.

2.9 Maintenance and Protection of Traffic

It is the intent of Sections 2.7, 2.8 and 2.9 wholly or in part, that the Contractor shall keep open to traffic any existing road during the performance of the works, provided that when approved by the Consultant the Contractor may bypass traffic over a detour.

The Contractor shall take necessary care at all times to ensure the convenience and safety of residents along and adjacent to the road.

The cost of the maintenance and protection of traffic provided under the Contract shall not be paid separately and shall be deemed to be included in Contract Price.

2.10 Trafficability for the Heavy Equipment

Where the heavy equipment or dump truck is used on soft ground after the dewatering in canal, the Contractor shall carry out the necessary countermeasure such as soil replacement, use of steel plate, to keep the trafficability.

2.11 Water Control and Dewatering

(1) General

This Clause covers all the work to be performed by the Contractor during the Execution of the Works to ensure that the Works will be carried out in dry condition.

The Contractor shall furnish, install, operate and maintain all the necessary pumps, wellpoints and other equipment as may be necessary to ensure the removal of surface and subsurface water from the various parts of the Works. After having served their purpose, all pumping equipment or any other temporary dike, ditch, discharge or protective weir shall be removed and the grounds shall be restored to their original or required lines and levels.

Nothing in this Clause shall relieve the Contractor from full responsibility for the adequacy of the Temporary Works or equipment to be provided for water control and dewatering.

The type of dewatering plant, the design (drawings and calculation) and arrangement of dewatering and protective works shall be subject to the approval of the Consultant.

(2) Method of Water Control

The Contractor shall choose the appropriate protective works e.g. earth dikes or double sheet pile cofferdam, etc., judging from the existing soil condition or existence of existing utilities, etc.

Especially, in Kra Mang canal, the Contractor shall ensure the minimum clearance 5m from the existing oil pipe, which is located between the road bridge and railway bridge.

The Contractor shall ensure the proper maintenance of dewatering system by the provision of watchman or mechanician to avoid the damage to the permanent structure or temporary structure due to the stop of dewatering system.

The Contractor shall not interfere nor interrupt the flow of natural canal or of existing irrigation or drain ditches. Where necessary, temporary flumes temporary drainage pump shall be installed by the Contractor.

The Contractor shall ensure 30m³/min of the minimum discharge capacity to Pasak River in both Han Tra Canal and Kra Mang Canal during the construction period.

(3) Care of Surface Waters

At any location where the control of surface water is required ,the Contractor shall provide for the construction of ditches, weirs, sumps, dikes and other protective works to ensure that surface waters of any origin be kept away from the site of construction of Permanent Works. Appropriate and adequate pumping equipment shall be installed at the sumps, and the pumped water shall be channeled away from the Works.

(4) Care of Sub-Surface Waters

The subsurface waters that may affect the construction of the Permanent Works, with special regard to structures and structure foundations shall be controlled by means of area-dewatering systems of the wellpoint type or similar. At any site where control of subsurface waters is required, the Contractor shall install a sufficient number of wellpoints, operate and maintain them during execution of the Works and provide for their removal after construction. This equipment and dewatering system shall be subject to prior approval of the Consultant

(5) Care of the Upstream of the Construction Area

The Contractor shall ensure the necessary protection measure against the flood, i.e., prevention of the flood from Pasak River during the construction in the both construction area and its upstream area..

(6) Canal or Drain Diaphragms

To accommodate the requirement of the irrigation program, the Contractor may be required not to excavate certain sections of canal or drain in this manner creating protective diaphragms, which will be typically 30 m. wide at natural ground level. This will apply anywhere along the canals or drain as instructed by the Consultant.

The diaphragms will be excavated during a second stage of the excavation, and this work will have, if necessary, to be partially conducted underwater. The Contractor shall supply the appropriate equipment to excavate the diaphragms, obtaining the required lines and grades.

(7) Temporary Flume or Pump

Where the canals or drains will cross existing irrigation or drainage ditches or other small watercourses whose flow cannot in the opinion of the Consultant be interrupted but for short lengths of time the Contractor shall supply the materials for and erect temporary flumes or temporary pumps that have appropriate capacity.

The temporary flumes shall be typically made galvanized iron sheets, supported by the wooded frames and trestles and made watertight. The Contractor shall be responsible for their maintenance and removal and according to the satisfaction of the Consultant.

2.12 Prevention of Water Pollution

The Countermeasure such as installation of silt fence against the water pollution in water course due to construction activities shall be properly taken by the Contractor.

3. EARTH WORKS

3.1 Site Clearing and Top Soil Removal

(1) General

This Clause covers all work required for the clearing, grubbing and stripping the areas utilized for the construction of the Permanent Works.

(2) Clearing

The Contractor shall remove all obstructions above ground surface, including trees, stumps, down timber, snags, brush, logs, fencing and similar debris.

No trees shall be cut outside the areas mentioned above without specific approval and all trees designated by the Consultant shall be protected from damage by the Contractor's construction operations.

(3) Grubbing

Grubbing shall consist of the total removal of tree stumps, jungle growth, brush, roots, buried timber and other objectionable material below the clearing zone, within the foundation limits of all permanent construction, and from borrow areas, quarry areas, stockpile sites and elsewhere as instructed by the Consultant. Except in areas to be excavated stump holes and other holes shall be backfilled with suitable material.

(4) Stripping of Top Soil

Top soil is any layer of soil within a depth of 30 cm. or as instructed by the Consultant at the existing surface on the Site, which contains and/or is discolored by the roots of vegetation or any other organic material.

Top soil which in the opinion of the Consultant should be stripped is to be removed from the area concerned before any excavation or filling is commenced. In general, stripping shall be limited to a depth of 30 cm, but the Consultant may require deeper stripping in points of penetration of roots or other objectionable material. No payment above the Unit Price shall be made for the occasional stripping over the 30 cm. depth.

(5) Demolition of Hard Obstacles

The Contractor shall totally demolish and remove from the Works all eventual hard obstacles, including plain or reinforced concrete, stonemasonry, brickwork and the like. The demolition can be accomplished by means of giant breaker, compressed air tools, etc as the circumstance will allow. All debris shall be removed and dumped in areas designated by the Consultant.

(6) Disposal of Material

The material removed in clearing operations shall be disposed to the designated disposal site, as approved by the Consultant.

The stripped top soil shall be disposed in the right-of-way, in the strip between the toe of embankments and the limit of the easement, and leveled by bulldozer blade.

Where this strip of the right-of-way is to be used for/excavation borrow material for embankments, then the Contractor shall stockpile the top soil on the land adjacent to the right-of-way, and then push it back into the borrow pits. All arrangements with the owners or users of the land outside the right-of-way utilized for stockpiling the top soil and the borrow areas shall be care of the Contractor, and all relevant cost shall be borne by the Contractor and cover by the Unit Price.

(7) Extent

The detailed limits and extent of the areas to be cleared and stripped shall be determined case by case, by the instruction of the Consultant.

(8) Measurement and Payment

The Works relating to site clearing and top soil removal shall be considered to be included in the Contract Prices.

3.2 Temporary Cofferdams

(1) General

Suitable and practically watertight cofferdam shall be used wherever water-bearing strata are encountered or wherever the maximum water level in the stream or canal shall be above the elevation of the bottom of excavation. Cofferdam or cribs to be placed for foundation, canal or drain protection construction shall, in general, be carried well below the bottom of the footings and shall be well braced and as nearly watertight as practicable. In general, the dimension of cofferdams shall be such as to give sufficient clearance, for the construction and the inspection works, and to permit pumping outside of the forms. Cofferdams or cribs, which are tilted or moved laterally during pumping and excavation operations shall be righted or enlarged so as to provide the necessary clearance.

Notwithstanding the approval for the temporary cofferdam by the Consultant, nothing shall relieve the Contractor from full responsibility on temporary works.

No separate payment will be made to the works described in this Clause. The Contractor shall include the cost in the unit prices for excavation or lump sum price of the related works.

(2) Design of Temporary Cofferdams

Prior to the commencement of site works, the Contractor shall submit the design of temporary cofferdam, i.e. design drawings, calculation, etc.

The Contractor shall consider the appropriate methods for the temporary cofferdam to minimize the displacement of the cofferdam and the adjacent existing ground for the avoidance of the damage of the existing houses.

(3) Monitoring of Temporary Cofferdams

In addition to the design of temporary cofferdam, the Contractor shall submit the detailed monitoring plan of temporary cofferdam to the Consultant for the approval.

(4) Placing of Seals

When conditions are encountered which, in the opinion of the Consultant, render it impracticable to dewater the foundation before placing the footing, the Consultant may require the construction of a concrete foundation seal of such dimension as he may consider necessary and of such thickness as to resist any possible uplift.

The concrete for such seal shall be placed as directed by the Consultant. The foundation shall then be dewatered and the footing placed.

(5) **Protection of Concrete and Masonry**

Cofferdam shall be constructed so as to protect green concrete or masonry against damage from sudden rising of the stream and to prevent damage to the foundation by erosion. No timer or bracing shall be left in cofferdams or cribs in such a way as to extend into sub structure masonry without written permission from the Consultant.

(6) Removal of Cofferdam or Crib

Unless otherwise provided, cofferdams or cribs, with all sheeting and bracing involved therewith, shall completely be moved by the Contractor after the completion of the sub structure built at the area protected by the cofferdam or crib. Removal shall be effected in such manner as not to disturb or mar finished work.

3.3 Excavation

(1) General

This Clause covers all excavation works required in connection with the Contract and shown in the shop drawings based on the Contract Drawings and/or instructed by the Consultant.

Excavation shall be carried out as indicated in this Clause, by suitable means, selected by the Contractor and in a manner approved by the Consultant.

The work includes, but is not limited to, the following: excavation for structures and structure foundations, revetment and trenches for pipe laying, U-shape girder.

The Contractor shall notify in advance the Consultant of the commencement date for any excavation, so that cross-sections and measurements may be taken of the undisturbed ground surface. The natural ground adjacent to the proposed excavation shall not be disturbed without the consent of the Consultant. Where the foundation material is soft or mucky or otherwise unsuitable, in the opinion of the Consultant, the Contractor shall remove the unsuitable materials and replace it as specified.

Excavation shall be performed as far as practicable and where required in the dry. For this purpose the Contractor shall take, according to the needs and after approval of the Consultant, the measures contemplated in these Specifications and any other necessary step to avoid excavations being carried out in wet conditions.

Excavation shall be carried out so that the final dimensions of the excavations (lines, slopes and grades) conform to those shown in the approved Shop Drawings and/or those established by the Consultant. All excess excavation for the convenience of the Contractor for any purpose or reason, except as may be approved by the Consultant and shall be at

the expense of the Contractor. All such excess excavation shall be back-filled with materials supplied and placed entirely at the expense of and by the Contractor and as instructed by the Consultant.

During the progress of the Works, 'but before the executions, it may be found necessary to vary the slopes or the dimensions of the excavations from those shown on the approved Shop Drawings by the Consultant, and the Contractor shall be entitled to no additional payment by reason of such changes.

If the material from quarries or borrow pits is in excess of that needed the surplus material shall be stock-piled in approved areas near those borrow pits until its use is authorized. So far as practicable and as determined by the Consultant, all suitable material from required excavations shall be used in the Permanent Works as required under these specifications, and all unsuitable and excess materials shall be disposed to designated disposal area. The Contractor shall conduct the cleaning of the public road if the condition of the road becomes muddy due to the transportation of the excess soil to the designated disposal area.

Where practicable and as determined by the Consultant, suitable materials shall be excavated separately from materials to be wasted suitable materials shall be segregated by loads during excavation operations and shall be placed in the designated final locations directly from the excavation or shall be placed in temporary stockpiles, and later placed in final location, if approved or directed by the Consultant.

(2) Classification of Material

The Contractor shall not simply decide the excavation method based on the boring data provided by the Consultant.

The Contractor shall draw his own conclusions from the investigation such as boring or trial excavation, etc as to which excavation methods will be required for the removal of material to be excavated.

(3) Excavation Requirement

Excavations shall be based on the approved construction drawings and/or as instructed by the Consultant

Excavations shall be those carried out from the natural ground level to the require lines and levels. Excavation of embankments for trenches, structures and foundations shall not be considered for payment, should the Contractor elect to construct the embankments before constructing the structures affecting the embankments themselves. The procedure contemplated in this Contract shall be to proceed with the construction of structures first and then follow with the embankments.

The Contractor shall remove from the entire areas to be excavated all topsoil and other objectionable material as determined by the Consultant and in accordance with Subclause 3.1.

(4) Trench Excavation

Trench excavation shall include excavation for laying precast reinforced concrete pipes U-shape ditch, etc.

The trench shall be of sufficient width to permit the placing of pipes to the full length shown in the Shop Drawing.

(5) Excavation from Borrow Areas Prepared and Provided by the Contractor

All material required for fill in the Works, which is not available from the required excavation for the Works shall be obtained from designated borrow areas prepared by the Contractor's expenses. There are each two borrow area in both Lopburi province and Nakhonnayok province.

The Contractor need to arrange the joint sampling with the Consultant at the borrow area and submit the subsequent laboratory test results for the sampling material to the Consultant for the approval.

Construction site shall be cleared and grubbed as stated in Sub-clause 3.1. Material suitable for topsoil shall he selected during stripping operations and stockpiled adjacent to the areas for future use. Unsuitable material shall be disposed under the Consultant's instruction.

If at any location in the borrow pits, before or during excavation operations, excessively moist material is found, steps shall be taken to reduce the moisture by selective excavation, by constructing drainage ditches, by allowing adequate time for drying, or by any other methods.

Borrow operation shall be carried out and determined so as to, borrow suitable and uniform material. The material shall be hauled in equipment, which will not unduly damage service road and will not cause segregation of material.

(6) Disposal of Excess and Unsuitable Material

Excavated materials that are unsuitable for, or are in excess of, permanent construction requirements shall be disposed by dump filling to the designated disposal area. This material shall not be compacted but trimmed by dozer blade.

(7) Re-handling Excavated Material from Stockpiles

Stockpiling and re-use of excavated material shall not be permitted unless authorized by the Consultant.

Stockpiled materials shall be reloaded and placed in embankments as soon as practicable. After completion of re-handling operations, the stockpile areas shall be made neat and clean to the satisfaction of the Consultant.

(8) **Protection of Excavation Surfaces**

If contact surfaces are formed of materials which on exposure suffer alternation, loosening, cracking or any other form of disintegration, or where it may be necessary in the Consultant's opinion, the excavation shall not be taken beyond 0.20 m from the final line and the remaining 0.20 m of material shall not be removed until immediately before the placing of the embankment fill or the revetment.

The bottom and side slopes of excavation shall be protected from cracking or weathering with such material as jute mats, plastic sheets or others methods approved by the Consultant

The operation of excavation and protecting in these areas in large structures shall be performed in a continuous manner so that the time elapsed since the excavation of the last 20 cm until the placement of the protection shall not be greater than two (2) hours and so that the finished surfaces without cover be exposed to the air the least possible time, not exceeding twenty (20) minutes, provided that during this time they shall be maintained damp.

In no case shall a surface be left covered for a period exceeding twenty (20) days.

(9) Slides

If slides occur in the excavation before final acceptance of the work, and the responsibility for such occurrence rests with the Contractor due to improper work practices, then the Contractor shall remove the material from the affected area and shall reconstruct that part of the excavation at his own expense

3.4 Embankment and Backfill

(1) General

This Clause contains the Technical Specifications governing the execution for all the operations of forming and compacting embankment for the platform, roads and foundation surfaces and backfills around structures, etc.

Embankments shall be constructed in accordance with the alignments, slopes and cross section shown on the approved construction drawings, or as instructed by the Consultant.

Embankments shall be carried out so that variations in dimensions, alignment and grades of any finished surface from the dimensions, locations and grade as shown on the approved construction drawings, or required by the dimensions, locations and be within the tolerances specified in the following table.

The lines for fill and backfill shown on the approved Shop Drawings shall not be interpreted as indicating with accuracy the actual lines of embankment and backfill.

The Consultant may require that the Contractor repair or remove at Contractor's own expense items that exceed the limits above specified.

The Contractor shall remove embankment material placed outside the prescribed profiles if as instructed by the Consultant.

The Contractor shall remove from the embankment any material which in the opinion of the Consultant is unsuitable, and shall transport it to a prescribed disposal area, as instructed.

(2) Definitions

The term "backfill" as used in these Specifications defines excavation refill and the material that will be placed around or near structures when a certain time has elapsed after their completion.

The term "foundation surfaces" as used in these Specifications is defined as the earthfill surfaces prepared for placing structures of all kind.

The term "embankment" as used in these Specifications is defined as the earthfill portions of the platform around structures, roads, etc. above the original ground elevation. Compacted embankment includes all fill deposited in layers and consolidated by rolling or tamping.

(3) Source of Embankment Material

Materials for compacted embankment in platform, roads, and for compacted backfill of structure excavations shall be obtained from the excavation of the Works and/or from borrow areas prepared by the Contractor under the approval of the Consultant.

(4) **Preparation of Foundation Surfaces**

(a) General

Before commencing the placing of any fill, masonry or concrete, the surface of the excavation shall be properly trimmed, cleaned and treated or compacted as hereinafter specified.

Commencement of placing of fill, masonry and/or concrete on such surfaces shall be subject to the approval of the Consultant. All excavations made for subsurface investigations and all other existing cavities found within the area to be covered by embankments shall be restored with compacted fill material as specified in Clause 8 hereafter and/or as instructed by the Consultant. The surface of each portion of the foundation, immediately prior to placing the fill masonry or concrete, shall have all water removed from depressions, shall be properly cleaned or where necessary moistened to obtain a good bond with the fill.

(b) Foundation for Masonry and Concrete Structures

Loose materials and organic residues shall be removed from the surface of contact with masonry or concrete. The excavation shall be in accordance with the dimensions, levels and grades shown on the approved Shop Drawings. Where called for on the approved Shop Drawings or by the Consultant, the surface of foundations excavation shall be adequately protected. Any depression in the excavation shall be filled with random fill material, as instructed by the Consultant. The fill shall be placed in layers, moistened and compacted in accordance with Clause 8 hereafter.

Material which cannot be compacted by rollers because of inadequate clearances shall be spread in layer of 20 cm and compacted with power tampers to a density equal to that specified for compaction with roller. After filling of depression and immediately prior to concreting, the entire surface of the foundation shall be compacted as instructed by the Consultant.

(c) Foundation for Drain Structures

The areas which drains are to be placed shall be trimmed and made smooth to agree with the lines and grades shown on the approved Shop Drawings or as instructed by the Consultant and shall be compacted as specified hereafter.

The drain material shall be placed directly on the excavated surface. Immediately prior to placing such material, the prepared surface must be inspected and approved by the Consultant.

(d) Foundation for Embankment

After clearing, grubbing and stripping in accordance with Sub-clause 3.1, ground surfaces shall be scarified, plowed, disked or otherwise broken up, pulverized, moistened or aerated as necessary, and thoroughly mixed and compacted, with the top fifteen (15) centimeters having a dry density of ninety-five percent (90%) of the maximum dry density.

If, during compaction of the first layers of fill, settlement occurs, which may indicated the presence of unstable soils below foundation level, this area shall be excavated to remove the loose material and backfilled with sand or fill similar to adjacent natural soils, and

compacted in layers not exceeding 20 cm. Removal, backfilling and compaction of visually observed soft spots shall also be performed.

(5) Placing of Material for the Embankments

No material shall be placed until the foundation have been inspected and approved; before placing a layer, the compaction of the proceeding one shall have been completed and its surface prepared, as instructed by the Consultant, with the object of increasing adherence.

Unless otherwise ordered, the whole of an embankment under construction shall be kept at the same level along its length during the entire construction time. Material shall be placed in such a way that free and easy drainage of surface water will be possible.

The grading and distribution of material in compacted embankment shall be such that the embankment is free from dense and agglomerations and so that the layers of material do not differ substantially in texture and grading from adjacent material within the same area.

If in the opinion of the Consultant the embankment surface is too dry to permit proper adherence with the next layer, the dried surface material shall scarified to the Consultant, adequately dampened and compacted in accordance with the applicable specification in order to provide a satisfactory bonding surface, before the next layer of fill material is placed.

Material shall be dumped in rows parallel to the center line of the embankment, or as instructed by the Consultant.

Materials of different characteristics shall be placed in such manner that contamination is avoided.

If hauled by dump truck, the material after tipping shall be spread over the area of the embankment by means of bulldozers and graders, or other approved means in approximately horizontal layers of uniform thickness.

Concentration of over-sized material will not be permitted. If in the opinion of the Consultant any stone or lump interfere with good compaction such stone or lump shall be removed from the layer. Stones or lumps with their major dimension greater than 15 cm shall not be allowed or be crushed.

The surface of the embankment shall, in the course of construction be maintained in such a condition that the construction equipment can travel over the whole of the embankment.

(6) Moisture Content

(a) General

The moisture content of the fill material prior to and during compaction in the embankment shall be in accordance with this Clause. As far as practicable, the material shall be condition to the correct moisture content at the borrow pit, excavation site or stockpiles.

(b) Embankment Material

The moisture content shall range from 2 percent below to 2 percent above optimum.

The "optimum" moisture content is to permit the achievement of the maximum apparent dry density as defined by the Standard Compaction Test ASTM-D 698-Method A or other equivalent standards.

As far as practicable, the materials shall be delivered and spread on the embankment within the required moisture range. Only such moisture control as needed for minor adjustment of changes caused by evaporation during handing and placement or from rain fall shall be accomplished on embankments.

Humidifying after tipping and spreading shall be carried out by Spraying, to ensure a greater uniformity on the distribution of the water. After spraying, the layer shall be mixed scarifying with disc harrows or the equipment approved by the Consultant.

The amount of water to be added to each layer of the embankment shall be carefully controlled to avoid excessive moisture on the surface during or after compaction.

Should be the addition of water to the embankment increase the moisture content to levels greater than acceptable and the material become too damp to achieve good compaction, all work shall stop in that section of the embankment until the moisture content has been reduced to the required value.

Material which is too wet shall be removed or spread over the embankment and allowed to dry, working it with disc harrows or scarifies until the moisture content is reduced within the specified limits.

(c) Material for Filters

There are no limitations for the moisture content of this material.

(7) Subgrade Material

The following laboratory tests shall be carried out for the subgrade material.

- Standard compaction test		ASTM-D698 Method A or other equivalent
- CBR test	ASTM D1883	

The CBR value of the subgrade material imported from borrow pit shall be not less than 3.

(8) Compacting Equipment

(a) General

The compacting equipment shall comply with the following requirements; its use shall be in accordance with the Specifications specified in the following and/or as determined and instructed by the Consultant as a result of the tests conducted during construction of the embankment.

The type and operation of the rollers shall be submitted to the approval of the Consultant who shall be entitled at all time during the progress of the Works to instruct repairs, minor alterations or variations which may be necessary for better compaction.

(b) Sheep-foot or Tamping Foot Roller

The rollers of the sheep-foot or tamping foot type shall consist of drum 1.50 m in diameter and at least 1.50 m in length. The drums shall be so ballasted to reach a weight not less than ten (10) metric tons.

The rollers shall be provided with cleaning bars designed and placed so as to prevent the accumulation of material between the tampers. The tampers shall have a net length of approximately 20 cm and their net head area shall be between 100 and 200 cm².

The rollers shall be self propelled or towed by a prime mover of sufficient capacity to tow the roller at a speed of approximately 2.5 km/h when at work. The contractor may submit to the Consultant's approval other types of rollers.

(c) Rubber-Tired Roller

Rubber-tired rollers shall have a minimum of four wheels equipped with pneumatic tires. The tires shall be of such size and ply as required to maintain tire pressure between 5.5 and 7.0 kilograms per square centimeter for 11,500 kilogram wheel load during rolling operations. The wheels shall be located abreast and so designed that each one will carry approximately an equal load in traversing uneven ground. The spacing of the wheels shall 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 11,500 kilogram wheel load. The roller shall have a rigid steel frame provided with a body suitable for ballast loading such that the load per wheel may be varied, as instructed by the Consultant, from 8,000 to 11,500 kilograms. The roller shall be towed or self-propelled at working speeds not exceeding 15 kilometers per hour. The Contractor may propose to the Consultant for his approval other types of rubber tired rollers.

(d) Vibrating Roller

The vibrating roller shall be equivalent to a 10-ton static roller. It shall be self propelled or towed, at working speed not above 2.5 km/h.

The Contractor shall submit the manufacturer's specifications, for the approval of the roller type by the Consultant.

(e) Special Compactors

Compaction of material in areas where it is impracticable to use a roller as provided above shall be performed by tamping compactors of the heavy duty power-driven type. They shall be capable of producing densities at least equal to those produced by the equipment specified in this Clause. All such equipment will be subject to approval by the Consultant. Compactors which do not obtain the required density with a reasonable amount of coverage of each layer and at a production rate consistent with the adjacent embankment, shall not be used in the work. Compacted layer thickness by this equipment will be subject to approval.

(f) Water Spraying Equipment

Spraying equipment shall consist of tank trucks, pressure distributors, or other equipment designed to apply water uniformly and in controlled quantities to variable widths of surface, Tank trucks shall be equipped with shut off valves so that no leakage will result from the nozzles when equipment is not operating, Leakage shall be repaired immediately and any material rendered too wet because of faulty equipment shall have to be removed or reconditioned,

(9) Compaction

(a) Compaction of Embankment / Backfill Material

After spreading, and when moisture content is within the allowable limit the fill material shall be compacted,

All layers shall be compacted before the next layer is spread; the area of compaction during construction shall be maintained at a uniform level. The material shall be spread and compacted in layers covering as great an area as possible.

Each compaction pass shall overlap the adjacent one by at least 40 cm. Before spreading a new layer on a compacted one, the compacted layer shall be scarified by approved means to a depth of 10 cm, in order to achieve optimum layer adherence,

The embankment material shall be normally spread in layers 30 centimeters thick after compaction in order to obtain a uniform density throughout the full depth of the compacted embankment.

The Contractor shall consider the particular care in case of the following conditions.

- The embankment or backfill around pipe or small structure shall be proceeded from both sides to avoid the uneven pressure.
- In case of the embankment above the original ground exceeding a gradient of 1 in 4, the bench-cut of the existing slope shall be carried out to avoid the slippage.
- In case of the embankment beside concrete structure or the narrow area, small equipment for the compaction such as tamping rammer shall be used.

(b) Dry Density Test

The dry unit weight of the compacted material shall be tested by means of samples obtained from each layer: 100% of the samples shall equal or exceed 95% of the "optimum dry density" for the material placed in the embankment.

The "optimum" dry density is taken to be the maximum reached in the Test-ASTM D-698 Method A or the equivalent, applying the correction for the presence of particles retained on the No.4 sieve in accordance with the USBR Earth Manual, Chapter 1, Article 14 or the equivalent.

For tests necessary to determine the optimum dry density, the contractor shall conduct the joint sampling with the Consultant at the designated disposal area. The sampling shall be conducted in any case wherever is apparent change in the soil characteristics.

The laboratory and subsequent tests on compacted embankment shall be carried out by the Contractor in the presence of the Consultant.

The Consultant shall take at least two samples for each day of work and for each layer compacted in the day.

In the event that the degree of compaction is not satisfactory, the Consultant shall require additional compaction.

(c) The Finishing of Subgrade

After the finishing of subgrade by using motor grader and tire roller, the Contractor shall conduct the field dry density test and also proof rolling test. In case of subgrade embankment, which is 1m thickness below the pavement, in-situ dry density test shall equal or exceed 90% of optimum dry density. The proof rolling test shall be conducted by using 10t dump truck fully loaded with soil or equivalent. In the proof rolling test, the deflection shall be less than 1 inch (25mm). If the deflection exceeds 1 inch (25mm), the Contractor shall remove the soft subgrade material to the area and depth determined by the Consultant and replace with suitable material.

The tolerance of the finishing of subgrade is as follows.

- Elevation: ±50mm - Width: - 25mm

(10) **Protection of Embankments**

The Contractor shall carry out normal protection and maintenance works to keep the embankments in a satisfactory condition until completion.

In the case of impending rain the surface of the embankment shall be smoothened, compacted and when applicable sealed by the passage of rubber tired equipment.

In order to reduce the effect of rain, the surface of embankments shall have a cross fall of approximately 4%. In case of work interruption, the surface of the embankment shall be sealed to protect it from the effects of rain, by transit of pneumatic tired rollers.

(11) Backfill

Fill around structures and excavation refill designated as "Backfill" shall be placed where shown on the approved Shop Drawing or as instructed by the Consultant.

Material designated as "pervious backfill" shall be coarse sand or a free draining mixture of sand and broken rock wastes. The material designated as "backfill" shall be similar to that used in the embankments and shall be compacted in accordance with the provisions of Clause 8.1 above. Backfill materials shall be reasonably well graded, free from organic matter and when placed against walls or over drains shall not contain stones or rock greater than 5 cm in maximum dimension. In so far as practicable, backfill material shall be obtained from structure excavations, but when sufficient suitable material is not available from this source additional material shall be obtained from borrow pits prepared by the Contractor.

The material shall be placed in approximately horizontal layers not more than 0.2 m in thickness. Care shall be taken to avoid damage to any concrete structures adjacent to the backfill.

No backfill or other load, shall be placed on or against concrete surfaces before expiration of one day after the removal of formwork of concrete. Rollers will not be permitted to operate within 1.0 meter of structure walls. Within this restricted area, and other areas where rollers cannot be used, the backfill shall be compacted by means of tamping rammer or plate compactor.

When a structure is constructed before the adjacent roadway is completed the Consultant reserves the right to limit the amount of compacted backfill to be placed against the structure above the original ground surface to the minimum that is determined to be necessary for proper protection of the structure and to require the remaining fill to be placed as roadway embankment.

(12) Tests

In order to properly check and follow construction of the embankment, the Consultant during the course of the work shall execute tests to check grading, moisture content, insitu dry density, relative density and any other test or measurement as required.

The Contractor shall provide the necessary test equipment and personnel to conduct these tests, as required by the Consultant.

(13) Slides

If slides occur in the embankment protection before the final acceptance of the Work, the Contractor shall remove the material from the area affected and shall re construct that part of the protection at his own expense.

4. ROAD WORKS

4.1 Base Course

(1) General

Base course for road pavement shall be constructed in accordance with the details shown on the approved shop Drawing or as instructed by the Consultant.

(2) Samples, Tests and Materials

(a) Samples

Samples of Pavement, Base course materials shall be furnished free of charge by the Contractor in the quantities required by the Consultant. The samples shall be submitted for approval sixty days prior to start the work on pavement construction, and thereafter at regular interval during construction, if required by the Consultant. These samples shall be obtained at the source from test pits borings, stockpiles, or from other locations designated by the Consultant.

Samples for grading, liquid limit determination, plasticity index and wear tests shall comply with ASTM Designation D75 or Equivalent "Standard Method of sampling stone, slag, sand,. Samples for density tests shall be taken after the material has been placed and compacted, as specified in AASHTO T147 or equivalent, "Standard Method of Test for Field Determination of Density of Soil in Place." Extraction of samples will be supervised by the Consultant.

(b) Tests

Test on the laterite pavement, sub-base and base course materials will be performed by the Contractor and testing results shall submit to the Consultant for approval.

(c) Materials

Material for base course shall consist of a natural or artificial mixture of hard, durable gravel or crushed stone and binder, free from soft particles and excess clay.

(3) Properties

Sieve Size (ASTM-E 11 or Equivalent)	Percent Passing by Weight	
1 ^{1/2} "	100	
1"	70-100	
3/4"	50-85	
No.4	30-60	
No. 40	10-30	
No. 200	0-12	

- Base course material shall be graded in accordance with the following table:

- Minimum dry density: shall be 95% of the maximum

⁻ Clay content: 0-5%

Dry density as determined by ASTM D-1557 Method: D or equivalent

- Liquid limit: not greater than 25
- Plasticity index: not greater than 6
- Material passing The No. 200 sieve shall not be more than one-half of the fractions passing the No. 40 sieve,

(4) **Preparation of the Subgrade**

Prior to constructing the base course, the previously' constructed subgrade shall be cleaned for adequate compaction and accuracy, ruts or soft, yielding spots that may appear in subgrade areas having inadequate compaction, and deviations of the surface from the requirements set forth therein shall be corrected to line and grade and to all Specifications requirements.

(5) Placement of Base Course

The coarse aggregates and binder materials shall be spread in layers of uniform thickness from spreader boxes or moving vehicles. Aggregates shall be placed in a layer of uniform thickness on the subgrade without segregation of sizes, followed by placing thereon layers of the other materials to such loose thickness and proportions that, when mixed together and compacted, the finished layer will conform to the specified gradation, liquid limit, plasticity index, and designated thickness. Alternate placement of aggregates and binder materials in windrows shall also be permitted. The material shall then be spread in a layer of uniform thickness. The material shall be mixed with mechanical mixers, blade graders, harrows, disks, or other approved equipment, in such manner as not to disturb or mix material from the underlying subgrade into the overlying layer. Initial mixing shall continue until the mixture is uniform throughout, adding water to the extent necessary to prevent segregation during mixing by the sprinkling equipment specified above. Mixing shall continue until the water is uniformly distributed throughout, as determined by the Consultant. Following this mixing procedure the approved mixture shall be leveled to the required contour and grades with blade graders. Unsatisfactory areas shall be removed and replaced with satisfactory materials, or the material shall be re-mixed in the area, as instructed.

(6) Placement of Shoulders

Where shown on the approved Shop Drawings, the shoulders be constructed. The material shall conform to the requirements of subgrade material. The shoulders shall be carried out on a previous subgrade in a way that courses of material are not mixed with base course and finished surface shall be such that water drains away from the pavement freely and evenly.

(7) Compaction

Each layer of the base course shall be compacted by an approved roller. Water shall be maintained during the compacting procedure at optimum value or at the percentage specified by the Consultant. The Compaction shall continue until each layer is compacted through the depth to at least 95% of the maximum dry density determined by D-1557 Method D or equivalent. The Compaction shall be carried out from edges towards the center of the layer being compacted.

The Contractor shall make such adjustment in rolling of procedures as may be instructed by the Consultant to obtain the true grade, minimize segregation and degradation, to reduce or accelerate loss or of water, and to insure a satisfactory base course. Any materials found be unsatisfactory shall be removed and replaced with satisfactory material or reworked to produce a satisfactory material.

(8) Accuracy

The elevations of the finished base course shall be within plus or minus 1 cm of the elevation shown on the approved Shop Drawings. Any deviation in excess of this amount shall be corrected by the Contractor by removing material and replacing with new material, or by reworking existing material and compacting, as directed.

(9) Maintenance of Subgrade

The elevation of the finished subgrade shall be maintained until the Base course has been placed thereon. On paved roads the surface of the Base course shall be maintained until the surface course has been placed thereon. Any damage to either course shall be restored to a condition suitable for receiving the following course or application.

4.2 Concrete Pavement

The Concrete Pavement shall be carried out on the base course as indicated in the approved Shop Drawings.

(1) Quality of Plain Concrete Slab

Properties of concrete slab with wire mesh shall be as follows.

Allowable bending strength	4.4 MPa (45kgf/cm ²)	
Maximum size of coarse aggregate	20 mm	
Slump	2.5 cm	

Under the conditions that the dairy average temperature is exceeding 25° C, the Contractor shall apply summer concreting. To avoid initial crack after concrete casting, the Contractor shall consider the countermeasure to control concrete temperature below 35° C during the pavement.

(2) Expansion Joints, Shrinkage Joints

Expansion Joints in transversal direction shall be set up at an interval of 40m in longitudinal direction to make a separation of slabs. And these shall be composed of joints with a width of 20mm and shall be installed dowel bar assemblies through joints and also be filled with joint fillers and joint sealing compounds in them. Expansion joints shall be a type of isolation joint that separate the pavement from each slab, and allow independent movement of the concrete slabs that would cause damage.

In addition, Shrinkage joints in transversal direction, in which the concrete slab is continuous, shall be set up at an interval of 8m in longitudinal directions.

In this joint, the dowel bar assemblies shall be installed and joint sealing compound shall be filled at the 40m depth.

(3) Joint Filler

Joint Filler shall be of elastic plate with a thickness of 20 mm.

(4) Joint Sealing Compound

Properties of joint sealing compounds for joints filling shall be as follows.

Construction Method	Hot construction method	
Туре	Low elasticity type	
Penetration	Less than 6mm	
Expansion at tension	More than 3mm	
Flow	Less than 5mm	

(5) Wire Mesh

The wire mesh is a type as shown on the approved Shop Drawings.

(6) Construction

Concrete slabs shall be constructed carefully so that the requirements for qualities and shapes are obtained

(a) Spread, Compacting and Finishing

- Spread of concrete shall be done by workforce uniformly with a shoot after unloading from an agitator truck.
- Compacting shall be done by workforce or a finisher installing with vibrators inside concrete and shall be done immediately after placing.

Finishing shall be done through 3 stages: (1) making rough surface with a finisher or by workforce with template tampers, (2) making flat surface with a surface finisher or by workforce with floats, and (3) making rough surface with equipment or by workforce with brooms and brushes.

(b) Surface Texture

Surface textures shall be made during construction by dragging various materials or tools across the fresh concrete before hardening, and shall be the type that can reduce skidding and hydroplaning accidents caused by wet or frozen weather. The Contractor shall submit the texture patterns to the Consultant, and the making of surface texture shall be done after the Consultant's approval.

(c) Curing

Curing for concrete slab shall be required until the strength of test cores at hardening period reaches 3.4 MPa (35 kgf/cm²) or until 2 weeks passed over since placing. A variety of curing methods like with wet burlap sheets and wet blankets shall be available to maintain temperature and moisture of the concrete.

(7) Tolerance

Allowable tolerances in concrete pavement from given dimensions shall be as follows.

Level of surface	±6mm	
Thickness of layer	- 7mm	
Width	- 25mm	
Flatness	± 6mm	Parallel to the centerline
T latitess	± 6mm	Perpendicular to the centerline

5. CONCRETE WORKS

5.1 Concrete

(1) General & Type of Concrete

This Clause covers all requirements for:

- the supply of all materials for the building of concrete structures;
- testing and control;
- mixing to the required composition;

- form work;
- transporting, placing and vibrating;
- preparation of joints;
- curing of concrete;
- repair of damages;
- finishing of exposed and formed surfaces;
- clean-up of working areas

and all any other operations incidental and auxiliary to the works on concreting. The insertion of water stops and joint seal fillers shall be in accordance with the appropriate Clause of these Specifications.

The workmanship for all structural concrete shall generally be in accordance with the latest issue of the American Concrete Institute Building Code for Reinforced Concrete, ACI 318, and, other equivalent standards.

The concrete to be produced and placed according to these specifications shall be of required quality and uniformity. The Contractor in all phases of his operations will be subject to strict inspection to assure concrete of the required quality. Special emphasis will be placed on the uniformity of the concrete aggregates, water-cement ratio, consistency, air content and the temperature control of the concrete at the time of placement in the formwork, as well as on density and finishing when placed.

Type of Concrete

Following three (3) types of concrete shall be used for the concreting structures in this project.

Туре	Allowable Compressiv e Strength (N/mm ²)	Max. Diameter of Aggregates (mm)	Maximum Water- Cement Ratio	Structure Name
A-1 A-2	21 21	25 38	0.60 0.60	Reinforced Concrete Mass Concrete
В	18	25	0.60	Concrete pavement with wire mesh Lean(Leveling) concrete under structure, Leveling concrete with wire mesh

Refer to the pre-stress concrete in factory, the allowable compressive strength shall be used in the Standard allowable compressive strength under the Department of Highway as follows:

The 28 days minimum ultimate compressive strength based on 15 x 15 cm. Cube samples, of 40 N/mm², and maximum slump of 8 cm. for the concrete of Multi-beam.

(2) Superintendency

During the whole of the time that concrete is being placed the concreting operation shall be under the direct control of a qualities superintendent acceptable to the Consultant.

(3) Records

A complete daily record shall- be kept of all concrete work for the structures, which shall cover the class and quantity of concrete, the placing of reinforcing steel, if any, the stripping of forms and the curing of the concrete. The position of all construction joints not shown on the Shop Drawings shall be recorded. A record of starting and completing time for minor structures shall also be kept.

The maximum and minimum daily temperatures, when placing concrete shall be recorded.

All the above records shall be available at any time during the progress of this work for inspection by the Consultant. For the duration of the Contract, a copy of all the records shall be delivered weekly to the Consultant.

(4) Composition

The concrete shall be composed of fine and coarse aggregate, water, cement and possible admixtures.

The mix will be designed by the Contractor to obtain a workable mass, suitable for the specific conditions of placement and a product which, after proper curing and adequate hardening time will have a durability, impermeability and strength in accordance with the requirements of these specifications.

(5) Contractor's Plant, Equipment and Construction Procedures

Prior to the installation of the Contractor's plant and equipment for processing, handing, blending, transporting, storing and proportioning concrete ingredients, and for mixing, transporting and placing concrete, the contractor shall submit drawings, for approval by the Consultant, showing the proposed general plant arrangement, together with a description of the equipment he proposes to use in sufficient detail so that an adequate review can be accomplished. The approved Shop Drawings and descriptions of plant equipment shall be submitted at least thirty (30) days before plant erection. After erection at site, the plant and equipment shall again be subjected to the approval of the Consultant. Where these provisions require specific types of equipment to be used or specific procedures to be followed, the Contractor may propose alternative types of equipment or procedure if he can demonstrate to the satisfaction of the Consultant that equal results will be obtained by the use of such alternatives. Approval of plant and equipment or of any construction procedure shall not waive or modify the requirement contained in these specifications governing the quality of the materials or finished work.

(6) Notice of Intention to Place Concrete

The Contractor shall give the Consultant notice at least twenty-four (24) hours in advance of his intention to place concrete in a particular section of the works, and to allow a reasonable time for inspection before placing begins. Concrete placing shall not be started until all formwork, reinforcement, installation of embedded parts, and preparation of the surfaces, and inspected by the Consultant.

(7) Tests and Controls

All tests and controls on component materials and mixed concrete will be made by the Contractor.

The Consultant will be entitled to witness all the tests carried out by the Contractor.

The requirements for, and the methods of, taking samples and testing all constituents and finished concrete, shall be in compliance with technical standard herein indicated or, in the absence of these, in compliance with standards indicated by the Consultant.

The laboratory of the Contractor will:

- conduct preliminary tests and investigation to determine suitability of materials to be used in concrete;
- conduct tests, during the progress of the work, to determine the continuing suitability of materials;
- determine by tests, as the work progresses, that concrete of the required strength and uniformity is being obtained.

Slump tests shall be made daily at every agitator truck when concrete placement is in progress. The first slump test shall be made before concreting is commenced on any section.

(8) Materials

(a) Cement

<u>Types</u>

Unless otherwise specified the cement shall be Normal Portland Cement complying with ASTM C150 or TIS-15-2547 Type I or other equivalent standards.

The blending of cements will not be permitted.

<u>Delivery</u>

The cement is to be obtained from approved manufacturers. For each consignment, the Contractor shall provide one copy of the invoice stating the quantity delivered for each type, the number of bags or other units, if any together with the address of the manufacturer and the manufacturer's certificate of tests performed by him on the batch or batches.

Transport of cement to the site may be either in bulk or in multi-wall paper bags. When bulk transport and storage of cement is employed, the Contractor shall ensure that no contamination by foreign material occurs and that moisture is excluded.

Bulk cement shall be unloaded by the Contractor from primary carried directly into weather tight hoppers at the batching plant, or into storage silos.

Storage

Immediately upon arrival at Site the cement shall be stored. All storage facilities shall be subject to the approval of the Consultant and shall be so arranged as to permit easy access for inspection and identification.

Any cement which has been stored at the Site for more than 120 days may be sampled by the Consultant and if test results are not satisfactory, the cement will be rejected.

The Contractor shall endeavor to obtain all cement supplies from the same factory. He shall always have at his disposal on the site a stock of cement sufficient for two (2) weeks normal work. Cement transported in bags shall be stored in solidly constructed weatherproof sheds, of sufficient capacity, provided with damp proof floors at least 40 cm above ground level and covered by tarpaulins. The cement bags shall be closely stacked to a height not exceeding twelve (12) bags and shall not be packed against outside walls.

Tile stacking arrangement shall be such that the cement is used in the order in which it is received. Under no circumstances shall defective or set cement be used. Cement in bags if transported to Site in truck or other vehicles, shall be properly covered during transit with tarpaulins or other effective waterproof coverings. No concreting of the Permanent Works shall commence until the Consultant is satisfied that the above mentioned requirements are complied with. Storage of cement in bags on the ground will not be permitted under any circumstance, and will be sufficient reason for rejection.

Once a bag or container has been opened, tile cement is to be completely used and no cement is to be stored in open bags or containers.

No split or loose unused cement lying on floors or hard standings areas shall be used in the Works.

Bulk cement will be kept in airtight silos which will be emptied for cleaning at regular intervals not exceeding four months or as otherwise directed by the Consultant.

Cement of tile different quality shall be stored in separate section of the store, or in separate silos, according to its origin or type.

The cement shall neither contain lumps nor present alterations at the moment of use. Cement which has become stale, or otherwise unsuitable through absorption of moisture from the atmosphere or otherwise, shall be rejected and immediately removed.

(b) Admixture

<u>General</u>

This Article covers materials for use as chemical admixtures to be added to concrete during the mixing stage.

The use of admixtures in concrete by the Contractor is subject to the approval by the Consultant.

The admixture shall have a uniform quality in the different stocks, and will be accepted on the basis of the manufacturer's test certification proving that the products are within the prescribed limits of acceptance. However, all consignments of admixture shall be accompanied by certified statement showing manufacturer's name, brand and type of admixture, date of manufacture and certificate of compliance with the specifications.

Before starting the preliminary tests on concrete the Contractor shall submit the samples of the admixture to the Consultant for the approval.

Liquid or powdered admixture for concrete shall be stored under cover and protected against deterioration; storage shall be so arranged that the materials will be used in the same sequence of their delivery to the Site.

Powdered admixtures shall be measured by weight; liquid admixture can be measured by weight or by volume, with a tolerance not exceeding 3 percent.

Admixture shall be added to the batch in solution, in a portion of the mixing water, in such a manner that will ensure a uniform distribution of the admixture throughout the batch, during the specified mixing period.

Admixture which has been in storage at the site longer than six months shall not be used until satisfactorily tested.

No admixture containing calcium chloride shall be permitted.

Definition Admixtures

(i) Air Entraining - Air entraining agent is an admixture that has the purpose of entraining air in concrete. It shall be in accordance with the general requirements ASTM Designation C 260 or equivalent.

(ii) Water-reducing - Water - reducing agent is an admixture that will reduce the quantity of mixing water required to produce concrete of a given consistency. It shall be in accordance with the general requirements of ASTM Designation C 494 or equivalent.
(iii) Retarding - Retarding agent is an admixture that will retard the setting of concrete. It shall be in accordance with the general requirements of ASTM Designation C 494 or equivalent.

(c) Aggregates

General

The Contractor shall provide all aggregates required for the Works, and shall be responsible for the specified quality of all material used for aggregates.

The Contractor can choose any sources, on condition that the aggregates conform with the requirements of these specifications in all respects.

Existing or new quarries for aggregates chosen by the Contractor shall be approved by the Consultant. Such approval will not relieve the Contractor from his responsibility for the selection of sources of suitable materials, and he shall be entirely responsible for all risks arising from the selection and exploitation of such sources,

Within one month of the Contractor's request to use any quarry the Consultant will approve or reject such request. The Consultant will reject a quarry proposed by the Contractor unless the Contractor has drilled a sufficient number of holes and made other investigations and a complete range of laboratory tests on the materials has been made. The tests of aggregates shall include specific gravity, absorption, abrasion test, soundness by sodium sulfate, petrographic analyses, alkali aggregate reaction, organic impurities and any other tests which may be necessary to demonstrate that concrete of acceptable quality can be produced from the materials proposed.

Approval of a source of aggregate shall not be construed as approval of all materials obtained from the source and the Consultant can at any time withdraw approval if laboratory tests establish that the material is no longer suitable.

When crushed and uncrushed aggregates are mixed, they shall be blended uniformly and the crushing and blending operations as well as the amount of crushed material blended shall at all times be subject to the approval of the Consultant.

The Contractor shall carefully clear, at the Contractor's expense, the area of the quarry or deposit from which the aggregates are to be produced.

Preparation of quarry area shall be performed in accordance with Sub-clause 3.1.

Developing Alluvial Aggregate Deposit

The Contractor shall carefully clear the area from which aggregates are to be procured, of trees, roots, brush, sod, soil, unsuitable sand, gravel and other objectionable matter. The deposit shall be exploited without causing damage to any adjacent property, or endangering the safety of third parties. If necessary, the Consultant may instruct the

fencing of the pit. Waste materials removed from aggregate borrow areas shall be disposed of in approved locations.

Particle Shape

The shape of the particles in the fine and coarse aggregate shall be generally spherical or cubical.

Storage of Aggregates

Fine and coarse aggregates shall be stored separately at the site of the work, in such a way to prevent inclusion of foreign matter, or the / intermixing of various sizes.

Sufficient aggregate shall be maintained at the site at all times, to permit continuous placement and completion of any part of the works once started, avoiding unnecessary construction joints.

Methods of stockpiling, which permit the aggregate to roll down the slope as it is added to the pile, or which permit hauling equipment to operate over one area at the same level repeatedly, or which permits the free fall of material from a stacker, allowing fine material to be blown away from coarse material, will not be allowed. Stackers, if used, shall have an adjustable discharge height so that high drops are prevented.

Aggregate Processing Plant

Should the Contractor produce its own aggregates, a modem and dependable plant, capable of producing satisfactory concrete aggregates in sufficient quantity, and at the rate necessary to meet the construction schedule, shall be furnished, installed, operated and maintained at a location approved by the Consultant. Complete facilities shall be provided for proper crushing, scrubbing, screening, washing, classifying, storing, reclaiming, and delivering the aggregate to the mixing plant.

The plant shall include facilities for washing aggregates after separation into the various size groups, to remove any fine material and organic matter before delivery to the concrete mixing plant. Before procuring the equipment for processing aggregate, the Contractor shall submit to the approval of the Consultant a description and drawings in sufficient detail to indicate layout, type and capacity of the components.

The description shall show rates of flow of material at the various crushing and separation points, as well as the volumes of stock piles and the type of equipment to be used in moving the aggregates from the aggregate plant to the mixing plant.

Rescreening facilities for the coarse aggregate prior to delivery to the mixing plant shall be provided. The rescreen installation shall be located, arranged and operated in a manner that will assure delivery to the mixers of coarse aggregate meeting the specified grading. Rock ladders shall be provided in handling the two coarse size groups of coarse aggregates where the drop exceeds 3 meters. Aggregates, as delivered to the mixers, shall consist of clean, hard and uncoated particles.

The aggregate plant shall be installed and tested sufficiently in advance of the dates set for first placement of concrete, to permit the taking of samples and the making of the necessary tests, as required in Clause 7 above.

Testing of Aggregates

All sampling of fine and coarse aggregate shall conform to the appropriate requirements of Section 12 of ASTM C 33 or equivalent. Unless otherwise specified all samples shall be

taken under the supervision of the Consultant to permit adequate testing and evaluation of results sufficiently in advance of their use in concrete.

The contractor shall provide such facilities as the Consultant may consider necessary for the ready procurement of representative samples.

The methods and procedures for testing aggregates will include but not necessarily be restricted to those prescribed in the following standards:

Grading	ASTM-C136 or equivalent
Organic impurities	ASTM-C40 or equivalent
Soundness (sulphate test)	ASTM-C88 or equivalent

Sieves used in making the tests. for undersize and oversize shall conform to ASTM Designation E2I or the equivalent to the metric system sizes after approval of the Consultant, with respect to permissible variation in average openings.

The Contractor will test the aggregate and if they are found to be unsuitable, the Contractor shall make at his expense such changes or additions to his processing plant as the Consultant instructs.

(d) Fine Aggregates (Sand)

Definition

The term fine aggregate is used to indicate that part of the aggregates having as maximum dimensions 3/16"(4.8 mm).

The contractor shall exercise every possible precaution in the transporting, washing and screening operations to prevent the contamination of the sand particles. The fine aggregate shall conform to the following specific requirements:

<u>Quality</u>

The sand shall be clean, strong, hard, compact, unalterable, without flaky fragments of rock, and shall be free from coating, clay, loam, alkali, organic material or other unwanted substances.

The sand shall meet the current requirements of ASTM-C33 or equivalent, except as directly specified herein.

The maximum quantity of deleterious substance in the sand, at the time of its discharge into the mixing plant, must not exceed the following values:

	Percent, by Weight
Material Passing No. 200 Screen (ASTM-C117 or equivalent)	3
Light Weight Material	1
Clay lumps (ASTM-C142 or equivalent)	1
Total of other deleterious substance (Such as alkali, mica, soft, flaky particle and silt)	2

The total of all the deleterious substances must not exceed 5% by weight.

Sand will be rejected if:

- it contains impurities (ASTM-C40 or equivalent)
- it has a specific gravity (on the basis of weight of saturated surface-dry basis) below 2.60 (ASTM-C128 or equivalent)
- when, submitted to 5 cycles of tests of resistance to the sodium sulfate action (ASTM-C88 or equivalent, the part retained by sieve NO.50 has suffered a loss greater than 10% in weight.

Grading

The sand used for concrete mixes shall be graded according to ASTM C136 or equivalent, and shall conform to the following requirements as delivered to the mixers;

No.4 (4.75mm) No.8 (2.36mm) No.16 (1.18mm) No.30 (0.6mm) No.50 (0.3mm) No.100 (0.15mm)	Material finer than No.200 sieve (0.075mm) 95 to100 80 to 90 60 to 80 30 to 60 10 to 30
· · · · ·	10 to 30 2 to 5

The sand fineness modulus must be comprised between 2.3 and 3.2, as determined considering sieves Nos. 4, 8, 16, 30, 50 and 100.

The grading of the sand shall also be controlled so that the fineness modulus, in not less than nine out of ten Jest samples, shall not vary more than 0.20 from the average fineness modulus of all samples previously taken. If the fineness modulus for the sand varies more than 0.2, the Contractor shall modify concrete mix design.

Sands may be separated into two or more sizes of classifications but the resulting combined sand shall be of uniform grading within the limits specified above.

The Contractor should submit the sieve analyzing data of fine aggregate to the Consultant for approval.

(e) Coarse Aggregates

Definition

The term "coarse aggregate" refers to aggregates with a minimum dimension of 3/16" (4.75 mm) and maximum dimension of $1^{1/2}$ " (37.5 mm).

Coarse aggregate shall be reasonably well graded within the nominal size ranges hereinafter specified. Coarse aggregates shall consist of crushed rock, gravel or a mixture of both.

Crushed coarse aggregates containing more than 15 percent elongated or flat particles shall not be used. An elongated or flat particle is defined as a particle having a maximum average dimension of more than 5 times its minimum average dimension.

Quality

The coarse aggregates shall consist of hard, strong, clean, compact, unalterable, not flaky rock, free of foreign matters.

It shall have no adherent coating, and shall be free of lumps of clay, loan, roots, sticks and other organic matter, alkali or other deleterious substances, and except for gradation, shall meet the current requirement of ASTM-C33 or other equivalent standards.

The percentage of deleterious substances in each portion of coarse aggregate, when delivered to the batching plant, must not exceed the following:

	Percent, by Weight
Material passing No.200 screen	0.5
(ASTM C 117 or equivalent)	
Light weight material	1.0
Clay lumps (ASTM C1I42 or equivalent)	0.5
Other deleterious substance	1.0

The total of deleterious substances in each potion to be delivered to the mixer must not exceed 2% by weight. The coarse aggregates will be rejected if failing to meet with the following requirements:

- Abrasion test, Los Angles type (ASTM-C 131 or equivalent)
- if the loss, using the standard gradation (type A0) exceeds either 10% by weight for 100 revolutions or 40% by weight for 500 revolutions;
- if the average loss by weight, after 5 cycles of the sodium sulphate test (ASTM-C88 or equivalent) exceed 10%;
- if the specific gravity of the material (on a surface dry basis) is below 2.60 (ASTM C127 or equivalent)

<u>Grading</u>

The grading of the coarse aggregate within the separated size groups shall conform to the following requirements when delivered to the mixer:

<u>Sieve Size</u>	Perce	ent by Weight Passing Individual Sieves
ASTM-E11 or equivalent	No.4 to 1 in	3/8 in to 2 in
2 inches (50mm)	-	100
1 ^{1/2} inches (37.5mm)	-	90 -100
1 inch (25mm)	100	20 -45
3/4 inch (19mm)	90 -100	0 -10
3/8 inch (9.5mm)	30 -55	0 -5
No.4 (4.75mm)	0 – 5	-

The Contractor should submit the sieve analyzing data of coarse aggregate to the Consultant for approval.

(f) Water

Water used for mixing, jetting and curing concrete and/or processing concrete aggregates, shall be clean and free from oil, salt, alkali, silt, organic matter or other deleterious substance, clay and mud, and shall be as cool as is practicably obtainable. The water turbidity shall not exceed 2,000 parts per million.

Coarse and fine aggregates moisture content shall be taken into account when determining the volume of mixing water. ASTM-C70 or equivalent standards will apply in establishing the aggregates moisture content.

The water sulphate content shall not exceed 0.3% by weight provide that the aggregates are free of sulfates. If the aggregates contain sulphate the maximum permissible sulphate

content in the water shall be reduced as directed by the Consultant having regard to the total sulphate content of the combined concrete ingredients.

If water, from local natural sources should contain quantities of impurities in exceed of allowable limits, the Contractor will be required to make arrangements for ensuring its purity before use.

The Contractor shall submit the water quality testing results to the Consultant for approval.

(9) Classification and Requirements for Acceptance of Concrete

(a) Mix Design

<u>General</u>

The mix designs necessary to produce concrete of the required compressive strengths after 28 days shall be the responsibility of the Contractor, and shall be submitted to the Consultant.

In order to approve the mix designs prior to beginning the concreting operation, the Consultant shall conduct trial mix to confirm compressive strength tests on the different classes of concrete.

The tests shall be made on materials to be used in the works: the Contractor, before starting concreting operations, shall furnish to the following materials:

- 1. Rock for aggregate or natural aggregates, cement, and admixtures required by Consultant;
- 2. Crushed fine and coarse aggregates, and water;
- 3. Batches of each class of concrete produced by the mixing plants to be used at Site.

No concreting will be permitted until the results of these tests are available, and allowance shall be made for the curing of the test cylinders prior to crushing after 28 days.

After successfully completing the tests, the Consultant will approve the mix design proposed for the different concrete classes. The Contractor shall be completely responsible to produce and maintain a quality of concrete with compressive strength not inferior to that specified unless different instructions are given by the Consultant.

The net water content of all concrete mixtures shall be the minimum necessary to obtain required slump.

Mixing water shall include all water present that is in surface moisture in the aggregates, and the water added in the mix.

Surface moisture content in the aggregates shall be determined in accordance with ASTM-C70 or equivalent.

The water/cement ratio shall be determined by the requirements for specific compressive strength, durability, plasticity and impermeability.

Once the proportion of a mix, including its W/C ratio, has been determined and specified for use in a structure, it shall be maintained constant during the placing.

(b) Changes in Proportions or Materials

If the tests or the Contractor's own tests show that the requirements of Clause 9.1 are not being met, the Contractor shall make such changes in materials or proportions as may be necessary, in the opinion of the Consultant, to meet these requirements.

If at any time the Contractor desires to use other materials or proportions than those originally approved, he shall provide evidence to the satisfaction of the Consultant that such changes will produce concrete meeting the requirements of Clause 9.1 and will not cause objectionable changes in the appearance or other characteristics of the concrete, before such changes can be approved.

(c) Changes in Requirements

The Consultant shall at any time have the right to change of the requirements specified in the table of Clause 9.1.

(10) Consistency and Slump

Concrete shall be of a consistency and workability suitable for the conditions on the Works. For most concrete a "plastic" mix is required, which will not crumble, but will flow sluggishly when vibrated, without segregation.

The concrete shall be of such consistency and composition that it can be readily worked into the corners of forms and around reinforcement without segregation or bleeding, using such compaction methods as specified in Clause 17

Whenever, in the opinion of the Consultant, the consistency of the concrete is such that excessive bleeding or segregation occurs in the concrete, the Consultant may instruct the preparation of trial mixes to determine new mix proportions such that excessive bleeding or segregation does not occur.

The slump test is a practical test to determine the consistency of concrete, and it shall be used and made in accordance with ASTM Designation C 143 or the equivalent standards.

Concrete, as delivered for placing, except when instructed otherwise by the Consultant, shall have the following working slump limits:

Type of Concrete	<u>Slump (cm)</u>
Reinforced Concrete	10±2.5
Pavement Concrete	7.5±2.5
Leveling Concrete	7.5±2.5

The Consultant has the right to require a lesser slump wherever such stiffer concrete can be poured and consolidated readily in place by means of vibration.

If those tolerances for working limits are exceeded, the concrete shall be rejected and disposed of.

Addition of water to compensate for stiffening of the concrete before placing will not be permitted.

(11) Tests on Concrete

(a) Test

Concrete which is being placed in the Works will be sampled, cured and tested by the Consultant in accordance with the appropriate ASTM or other equivalent standards, as required.

The Contractor shall however conduct independent tests to ensure that the minimum strength and quality control requirements are being met.

The number of required samples and tests will be established by the Consultant. As a guide they will be made according to the following:

	No. of Cylinder		Testing Age	
		7-day	14-day	28-day
- First test of each mix design	12	4	4	4
- For each concrete pouring:				
From 0 to 50 m^3	8	3	0	3
From 50 to 100 m ³	8	3	0	3
Every additional 100 m ³ or part thereof	8	3	0	3

However the Consultant shall be entitled to test the compressive strength of concrete from every individual concreting operation and from as many batches as required, and the concrete so used will not be included in any measurements for payment purposes. The workability shall also be testes at different intervals during a concreting operation to ensure that the requirements of Clause 10 are met. The Contractor shall provide the necessary sampling facilities required by the Consultant.

The method used in sampling, making curing and testing of concrete cylinders, either in the field or in the laboratory will be in accordance with the appropriate ASTM or equivalent standards and will include, but not necessarily be restricted to the following ASTM or equivalent standards:

ASTM-C172	Method of Sampling Fresh Concrete;
ASTM-C31	Method of Making and Curing Concrete Compression
	and Flexure Test Specimens in the Field;
ASTM-C192	Method of Making and Curing Concrete Compression
	and Flexure Test Specimens in the Laboratory;
ASTM-C39	Method of Test for Compressive Strength of Molded
	Concrete Cylinders.

Except for samples taken to check uniformity from the mixing plant, all samples taken in the field will be made from concrete taken from the form.

For any mix a correlation between 7-day, and 28-day strengths may be made in laboratory. Soon after a job starts, a similar correlation will evolve for concrete samples taken from the form. After such correlation has been established, the results of the 7 -day tests may be used as an indicator of the compressive strengths which could be expected after 28 days.

If the compressive strength of 7-day old test cylinder indicate that the 28- day strength may not satisfy the minimum strength requirement, the Contractor will be directed to remove the concrete concerned at his own expense and to suspend work on the particular section, or he may continue concreting at his own risk while waiting for the results of the 28-days tests.

(b) Prescriptions for Concrete below Required Strength

When test results do not comply with the specifications, the Consultant require that one or more of the following measures be taken:

- a) Test the two reserve cylinder at 60 days to verify if the specified strength can be attained.
- b) Extract concrete samples (cores drilled from hardened concrete from the structure for which a compressive test, or group of compressive tests, have given unsatisfactory results. These samples shall be tested according to ASTM-C42 or equivalent.
- c) Perform load tests, where possible, on the structure for which the compressive tests were found unsatisfactory.
- d) Perform other tests as instructed.

If, after such testing, the Consultant is of the opinion that the concrete in the structure has failed to meet the specified requirements he may instruct the Contractor, at his own expenses, to perform any of the following

- i. Change materials, proportions placing and/or compaction methods.
- ii. Extend the curing period until such time as cores drilled from the portions of the structure represented by the particular test cylinder and conform to ASTM-C42 or equivalent shall show, the concrete in those portion has satisfied the strength requirements provided that in no case shall the cores be drilled out more than fifty six (56) days after casting of the concrete concerned. The Contractor shall repair and make good at his own expense the portions of structures from which cores have been taken.
- iii. In the event that the results of tests on cores as specified in (ii) above indicate that despite the additional curing, the concrete has not satisfied the specified strength requirements, the Contractor shall, if instructed by the Consultant, perform full scale load tests on the portions of the structure represented by the test cylinder. The tests shall be of such a nature and duration and the behavior of the structure under load shall be such as to satisfy the Consultant that the design loads can be carried with a load factor of two (2) and without undue cracking of large deflections. When load tests are impracticable or where the portions of the structure subjected to such tests fail in the opinion of the Consultant, the Contractor shall either strengthen or replace those portions of the structure concerned at his own expense.

(12) Batching Plant

The Contractor can choose either the commercial batching plant or on-site batching plant set by him, and he shall submit a full documentation covering and describing the details for the approval by the Consultant.

Batching plants shall be of recent construction, in good working order and capable of ensuring a steady production of uniform quality concrete, in agreement with the requirements of the Specifications. The equipment shall be such to determine and control accurately the prescribed amounts of the various components, including admixtures.

The amounts of bulk cement, fine and coarse aggregates shall be determined by separate weighing and the amounts of water and admixtures shall be determined by separate weight or volume measurements.

Bins, hoppers and conduits shall be constructed so as to prevent the unwanted infiltration of rain waters and the spillage of concrete components.

(a) Accuracy Limits

Delivery of materials from the batching equipment shall be within the following limits of accuracy:

Material	By Weight
-Cement	1%
-Aggregates of sizes up to 1 ^{1/2} " -Water -Admixtures (Liquid)	2% 1% (or by volume) 3% (or by Volume)

a) General

Mixers shall be mechanically operated stationary mixers, of either the tilting or non-tilting type, and shall be generally in accordance with ASTM-C94 and other equivalent standards.

Mixers shall not be charged in excess of the capacity recommended by the manufacturer: the Consultant may instruct a reduction in batch size when mixer performance tests indicate the necessity to do so. Mixers shall be capable of combining the materials into a uniform mixture, without segregation.

b) Mixing Time

The mixing time, starting when all solid material are in the mixer drum, and provided that all of the mixing water be introduced before one-fourth of the mixing time has elapsed, shall be as follows:

Capacity of Mixer (m ³)	Min. Mixing Time
1 or less	1 ^{1/2} " minutes
from 1 to 2	2 minutes
from 2 to 3	2 ^{1/2} " minutes

The mixing time will be increased when necessary to ensure the required uniformity and consistency of the concrete of when test samples of concrete taken from front, center and back of the mixer show a difference of more than 10 percent in sand-cement or water cement ratio. Excessive over mixing, requiring addition of water will not be permitted.

c) Mixing Efficiency

The Consultant will perform mixer efficiency tests for each class of concrete, and for each mixer to be utilized in the Contract. At the end of the prescribed mixing period, three samples of concrete shall be taken; one at each one-quarter point of the batch.

These samples shall conform to the following units of uniformity:

- variation from the average of air content shall not exceed 0.5 percent;
- variation from the average of the water-cement ratio shall not exceed 10 percent;
- variation from the average of the unit weights shall not exceed 0.8 percent;
- variation in the weights of coarse aggregate retained on the number four screen shall not exceed 5 percent.

Mixer performance test shall be in accordance with USBR Concrete Manual, 7 the Edition, Designation 26 or Equivalent.

d) Maintenance

The mixers shall be maintained in good operating condition and mixer drums shall be kept free of hardened mortar. The mixing blades of the part mixers shall be maintained to the tolerances specified by the manufacturer and shall be replaced when exceeding the tolerance limits. Should any mixer, at any time, produce unsatisfactory results, or cause wastage of materials, its use shall be promptly discontinued until it is repaired.

The Contractor shall take out of service any pan or drum mixer which has excessively worn blades, excessive build-up of mortar or is leaking prior to change of mix or type of cement or after the mixer has been out of use for 30 minutes or more than pan drum shall be thoroughly cleaned.

(b) Rejected Concrete

When more than one and a half hour have elapsed between the start of mixing operation and the actual placing of the concrete, the Consultant shall have the right to reject the concrete.

The Consultant has the right to specify shorter times if hot weather or other conditions cause quick stiffening of the concrete."

The concrete rejected by the Consultant shall not be utilized in any part of the Permanent Works.

The re-tampering of concrete which has partially hardened, that is remixing with or without additional cement, aggregate or water, will not be permitted.

(c) Precautions in Hot weather

In hot weather the Contractor shall take precautions to ensure that the temperature of the mixing water; aggregates and cement is kept as low as possible, and that the temperature of freshly placed concrete is less than 35°C.

If the method used by the Contractor involves spraying of coarse aggregates, then steps shall be taken to prevent excessive variation in the moisture content of the stock pile. A sufficient number of moisture content tests shall be carried out to ensure that the weight of water for each batch is in accordance with the prescribed Water/Cement ratio.

(d) Precautions in Wet Weather

In wet weather the Contractor shall take necessary precaution to prevent the seepage of water into storage or weighing hoppers, the contamination of any of the materials and excessive variation in the moisture content of aggregates.

(13) Transportation

(a) General

Concrete shall be conveyed from the mixer to the place of final deposit, to be poured as rapidly as practicable, by approved methods, which will prevent segregation, loss of ingredients or damage by exposure to the weather. Concrete shall be conveyed either by buckets, pneumatic tired buggies, agitator trucks, concrete pumps, conveyors, shutes or in case of short hauls by approved dump trucks. Conveying equipment shall be of such size,

design and condition to ensure a practically continuous supply of concrete at the point of placement, and the placing of concrete in approximately horizontal layers while the previous layer is still soft. The maximum height from which the concrete shall be dropped shall not exceed one and a half meters, except where the use of suitable equipment, to confine and control the concrete being discharged, is specifically authorized by the Consultant.

All conveying equipment shall be supported independently of the formwork. The conveying equipment shall be kept free from hardened concrete and foreign materials, and shall be cleaned at frequent intervals.

Should the concrete show signs of segregation when it reaches the placing point, and provided the maximum permissible time has not elapsed, it shall be remixed by mechanical means in the vicinity of the placing; otherwise it shall be rejected.

In particular, the Contractor shall take appropriate measures to avoid excessive loss of moisture by evaporation, during the transportation and placing of the concrete. Increases in the water content of the mixture to make up for the evaporation losses shall not be permitted.

(b) Truck Mixers and Agitators

Truck mixers may be used for mixing, agitating and transporting concrete, and agitators may be used for transporting ready mixed concrete to the point of delivery, provided that provision for the batching and mixing of all concrete ingredients and admixtures specified in Clause 12 have been met.

Truck mixers and agitators shall be capable of discharging the concrete with a satisfactory degree of uniformity as indicated in Clause 12.3 above.

When concrete is mixed completely in a stationary mixer, and truck mixer or agitators are used for transporting the concrete to the placing point, the concrete shall be mixed in accordance with Clause 12.3 above, and mixing during transport shall be in accordance with the manufacturer's instructions.

The mixers and agitators shall be operated within the limits of capacity indicated by the manufacturers of the equipment.

(c) Bottom-Dump Buckets

The buckets shall be capable of prompt discharge of low slump lean mix concrete. The dumping mechanism shall be capable of controlling the discharge at a slow rate, and of discharging a relatively small portion of concrete in one place. Dumping of buckets on the swing, or in any manners which result in separation of ingredients or disturbances of previously concrete will not be permitted.

(d) Truck

The conveying of concrete by truck without agitation equipment, will be permitted provided the time elapsed between mixing of the concrete and its placing in the final position does not exceed the limits indicated in Clause 12.4 above.

Trucks used for transporting concrete, shall be of a type specially designed for such duty, unless the trucks are used for conveying concrete in approved concrete buckets.

Bodies of non-agitating trucks shall be smooth water-tight metal containers equipped with gates that will permit control and ready discharge of the concrete:

(e) Chutes and Drop Pipes

Chutes and pipes shall be of such design that segregation will not occur in the concrete. The chutes shall have a smooth, mortar-tight metal lining and sufficiently high sides to prevent the concrete from spilling over. A vertical drop at the end of chutes and pipes shall be provided, preferably in the form of metal drop chutes, to prevent segregation. Drop pipes and chutes shall be protected from direct exposure to sun and rain, and shall be less than 10 meters in total length. Chutes and pipes shall have grades not steeper than 1 to 2.

(f) Belt Conveyors

Belt conveyors used for the transportation or pouring of concrete, shall have a shape, size and speed able to prevent the loss of the concrete transported, and their slops shall be such as to avoid segregation. At the terminal, the belts shall be furnished with scraper blades, to remove the mortar from the belt.

Segregation at transfer points and ends shall be avoided by the use of suitable hoppers and drop chutes. The conveyers shall be protected from direct sunrays and rain.

The maximum transport distance shall not exceed 50 meters.

(g) Concrete Pumping Equipment

Concrete pumps can be used for the transportation and pouring of concrete with a slump of 4" or more. The structures and equipment necessary for the operation of the pumps shall be constructed independently from the scaffolding and formwork, so as not to transmit vibrations to the same, and cause alterations in concrete already place.

The equipment shall be located as close as practicable to the point of placing and the discharge nozzle shall be horizontal or titled upwards. The operation of the pump shall be such that a continuous flow of concrete without air pockets is produced, high velocity discharge resulting in separation of aggregates will not be permitted. When pumping is completed, and the concrete remaining in pipe line is to be used, it shall be ejected in such manner that contamination of concrete or segregation will not occur, and the equipment shall be thoroughly washed and cleaned.

It shall not be permitted to add water to the mixture after discharge from the mixer, neither at the loading of the pump, nor at the discharge point

The joints between the various pipe elements shall be perfectly tight, to avoid water leakage and loss of fines.

Discharge outlets shall be arranged to provide sufficient delivery points, so that concrete shall be uniformly placed in the formwork.

(14) Formwork

(a) General

Formwork shall be used whenever necessary to confine the concrete and shape it to required lines, grades and dimensions shown on the drawings. Formwork shall have sufficient strength to withstand the pressure resulting from placement and vibration of the concrete, shall be maintained rigidly in position, and shall provide concrete surfaces conforming to the requirements of the Construction Tolerance specified in Clause 22 and to the finished specified in Clause 21 hereafter. Forms shall be sufficiently tight to prevent

the loss of fines from the concrete. Where re-usable forms are adopts, the original strength, rigidity tightness and surface smoothness of the forms shall be maintained throughout their use.

The Contractor shall submit to the Consultant, for approval prior to the start of any concrete construction, the detailed design, i.e. drawings and calculation he proposes to adopt for formwork and support, but approval of the drawings shall not relieve the Contractor of his responsibility for their adequacy.

Surface of the formworks which is in contact with the concrete shall be treated or protected to avoid chemical reactions or discoloring of the concrete surface.

The use of forms with bruises, irregularities and incrustations shall not be permitted, and should an element show signs of deformation during pouring, it shall immediately be straightened and stiffened.

If formwork displacement occurs when pouring concrete, with consequent modification of the structure, as compared with the lines shown in the construction drawings, the prescriptions set forth in the following clauses 22 "Construction Tolerance" and 23 "Repair of concrete Surface" shall be applied.

Forms shall be placed so that the joint marks on concrete surfaces are, as much as possible, in alignment both horizontally and vertically.

(b) Materials for Formwork

The formwork materials shall be such as to give the concrete surface the appropriate finish, as specified in Clause 21 hereafter.

The lumber used in formwork shall be free from warp, and the boards shall be of uniform thickness and width, free from knots, decay, or other defect. Steel formwork shall be defined as a steel plate of approved thickness supported by structural steel shapes. Steel lining shall be defined as thin steel sheets, supported by a backing of wood boards.

(c) Forms for Curved Surfaces

Forms for curved surfaces and transition sections shall be constructed to conform accurately to the required curvatures. Dimensions from horizontal and vertical base lines will be given at several sections throughout the length of the curved or transition section. The Contractor shall interpolate intermediate sections as necessary for the type of form construction being used, and shall construct and erect the forms so that the curvature will be continues between sections. Erection templates shall be used on all curved framework where necessary to meet requirements for curvature. The form sheathing shall be built up of laminate spline cut to make tight, smooth form surface after the forms have been constructed, all surface imperfection shall be corrected, and any roughness and all angles on the surface of the forms caused by matching the form material shall be dressed to the required curvatures.

(d) Cleaning and Lubricating

At the time of concrete placing, the inner surface of the forms and the contacts and connections shall be free of any incrustation, mortar, grout or other foreign matter that would contaminate the concrete, Prior to placing, the surface of the forms shall coated with a bond breaking compound such as emulsified oil, or with refined mineral paraffin oil, designed to prevent sticking of concrete on the form. The treatment of the forms shall not cause harmful effects, or stains, on the concrete surface, or on the reinforcement system. Bond breaking compounds shall be applied before reinforcement is placed.

Oil treatment shall be made in such a manner to avoid spillage on previously placed concrete. All excess oil on the form surfaces, and any oil on the concrete, metal or other parts to be embedded in the concrete, shall be carefully removed.

(e) Form Ties and Bolts

The design of from ties shall be such that no metal shall be within 2 cm of any exposed surface. Wire ties will be permitted only where Finish F1 and F2 is specified, (refer to 21.2 Classification of Surface Finish) provided that the wire is cutback to a depth of 2 cm from the concrete surface after stripping of formwork, and the holes dressed with mortar.

Sufficient form ties and bolts shall be used on both sides and within a few centimeters of construction joints so that the forms fit snugly against the concrete previously placed, and remain in tight contact during pouring.

The ties shall be constructed so that removal of the end fasteners can be accomplished without causing appreciable spalling of the concrete face.

After completion of the concreting the Contractor shall withdraw the bolts and securely fill up the holes with cement mortar.

Possible damage to the concrete due to the aforementioned operations shall be repaired in accordance with the contents of Clause 23 "Repair of Concrete Surface".

(f) Chamfer Strips

Chamfer strips shall be placed in corners of the forms so as to produce beveled edges on permanently exposed concrete surfaces and exposed joints except where specifically indicated by the Consultant. Re-entrant comers will not require beveling, unless such requirement is indicated on the Drawings. Unless otherwise specified, chamfering strips for exterior beveled corners shall be from 2 to 5 centimeters, side measurement.

(g) Stripping of Formwork

The removal of formwork shall be carried out when the concrete has reached a sufficient strength, so that no damage can be caused to concrete. No forms shall be stripped before 24 hours after concrete placing has elapsed.

The minimum compressive strength of concrete between the completion of pouring and the stripping of forms shall be as follows.

Formwork of footing; 3.5N/mm² Formwork of column, wall, side of beam; 5.0N/mm² Formwork of slab, bottom of beam; 14.0N/mm²

After authorization for removal, the forms shall be stripped as soon as practicable, to avoid delay in curing of concrete, and also to enable the earliest practicable repair to surface imperfections. Method of form removal likely to cause overstressing of the concrete, or injury to the concrete surface, shall not be used. Forms and their supports shall be removed in such a manner to allow the concrete to take the stresses due to its own weight uniformly and gradually. Provision shall be made by means of suitable wedges, sand boxes or oilier devices, for the gradual relaxation of the support given by false work and struts.

(15) Concrete Placing

(a) General

All concrete placing equipment and methods shall be subject to the approval of the Consultant.

(b) Method of Placing

The concrete shall be deposited generally in horizontal layers, in such a manner as to maintain, until completion of a unit, a plastic surface approximately horizontal. The thickness of each layer shall range from 30 to 50 cm, and the placement shall be carried out at such a rate that no concrete surface can reach an initial set, before additional concrete is placed thereon.

The Contractor shall, however, obtain the Consultant's prior approval for lift heights and time intervals between lifts before commencing to place concrete, Concrete shall be deposited, as practicable, in its final position; flowing of concrete with vibrators, or by other means will not be permitted, For locations where direct placement is not possible or in narrow forms, then hoppers and trunks must be provided, Once commenced, concreting shall be done in a continuous operation except if an emergency occurs and interruption is unavoidable. The Contractor shall have readily available suitable prefabricated forms as stop ends to form emergency vertical construction joints and in the event of such an interruption occurring, the concrete already placed shall be properly finished up to the stop end to a horizontal surface as instructed by the Consultant,

Concrete that is of excessive slump, segregated, partially hardened, or unworkable shall not be placed in forms, or if placed, shall be removed as instructed by the Consultant,

Each layer of concrete shall be worked with suitable equipment, until the concrete is consolidated to the maximum practicable density, is free of pockets of coarse aggregate, and fits tightly against all form surfaces and embedded materials.

Equipment used for spreading, vibrating or other operation must absolutely not spill fuel oil or grease on the concrete,

(c) Placing in Reinforced Structures

When concrete has to be dropped through reinforcement, care shall be taken that no segregation of concrete or displacement of bars occurs. Closed chutes, trunks or tremies shall be used to place concrete in deep forms, around reinforcement, or other places not readily accessible for direct placing.

(d) Placing around Embedded Parts

Before placing concrete, care shall be taken to determine that all ducts, recesses, rebates, holes and any other embedded items are firmly secured in their correct location as indicated on the Shop Drawings or as required by the Consultant. Anchor bolts and anchor plates shall be precisely located and molded into the concrete where specified. All embedded items shall be thoroughly clean and free of oil and other foreign matter such as loose coating of rust, paint and scale, and encrustations of grout or mortar.

Extreme care shall be exercised when placing concrete around the various embedded parts, to ensure that unbalanced loading and impact from placing concrete, will not cause distortion or dislocation of the parts. Both during and after placing, careful checks shall be made by the Contractor to see that all the embedded parts requiring accurate setting have not been displaced.

The lifts of concrete shall be limited to the depth shown on the approved Method Statement. A minimum of seventy-two (72) hours shall elapse between the placing of each successive lift. Any placing restriction deemed necessary by the Consultant to maintain alignment of the embedded parts, shall be promptly complied with by the Contractor. Lifts may be terminated at any time, to allow the adoption of any remedial action necessary to maintain the accuracy requirements. Any air or water lines or other materials embedded in structures used as construction expedients authorized by the Consultant, shall conform to the above requirements and upon completion of their use be stoppered with concrete or grout as directed.

Mechanical vibrators shall not be used for placing concrete around movable embedded parts, except as approved by the Consultant: in this case concrete shall be consolidated thoroughly by tamping.

Opening in floors and walls shall be formed before the concrete is placed. Blockouts might be necessary to provide for installations of handrail posts, batch frames, permanent equipment and other metalwork, and the cost for the blockouts shall be included in the Contract Prices.

If the completed filling under embedded pipes or opening does not result the Contractor shall fill the void with mortar in an approved manner.

(e) Placing on Slopes

The low slump concrete for slope slabs shall be placed starting from the bottom and proceeding upwards. The concrete will be spread and completed by mean of an appropriate straightedge resting on wooden guides that shall be removed before final setting of the concrete.

(f) Placing under Rain

Outdoor concreting shall not be started during rainfalls unless the concrete is protected, as approved by the Consultant, against the harmful effects of such exposure. If concreting is under way, it shall be suspended if the rain is sufficiently heavy or prolonged to wash mortar from the coarse aggregate.

(g) Placing under Water

No concreting shall be carried out under water, unless authorization has been obtained from the Consultant.

Any such proposal made by the Contractor shall have due regard for the following requirements and shall be modified as necessary to meet the approval of the Consultant.

The method of depositing concrete under water shall prevent the washing out of cement, segregation of the mix, or the formation of a honeycombed structure.

Where a tremie is used the pipe shall be smooth bored and water tight. The pipe shall extend from above the water level to slightly below the surface of the fresh concrete, in which the pipe shall remain immersed during the placing, being raised in increments corresponding to the rising concrete surface. The concrete shall be fed into pipe by means of a hopper or other approved means and a full column of fresh concrete shall be maintained in the pipe as the concrete is flowing out of the bottom.

When commencing the operation the bottom of the pipe shall be sealed with an expendable watertight plug, fixed in such a manner that the weight of concrete filling the pipe (placed in the dry) will break the seal as the pipe is lifted slowly from the formation to

be concreted. Tremie pipes and hoppers must be so equipped that they can be rapidly raised and lowered.

The surface of the construction joints shall be jetted free from silt or any other material immediately prior to placing any subsequent concrete.

Concrete shall neither be placed in running water nor be exposed to action off the same before it is sufficiently set.

(16) Concrete Temperature

The Contractor shall make the necessary provisions in the concrete materials storage, handling and batching facilities, to comply with hot weather concreting requirements.

Hot weather conditions shall be considered to be in effect when the temperature of concrete is near 30°C and is expected to rise.

During hot weather, the temperature of fresh concrete shall not exceed 35° C, when placed in the formwork. To meet these requirements, the Contractor shall prepare to undertake any, or all, of the following steps:

i supply cool mixing water, or add ice to the concrete during mixing;

- ii. cool fine and coarse aggregates before mixing;
- iii. spray the coarse aggregate stockpile with cool water;
- iv. prevent exposure of batching, mixing and conveying equipment to direct sunlight.

Should the Contractor elect to use ice in the mixing water or to replace the latter with ice entirely, the mixing time shall be extended as approved by the Consultant to allow complete ice melting before mixing is completed. All methods adopted by the Contractor shall be subject to the prior approval of the Consultant.

The application of iced water to the fine aggregate will not be permitted.

Refrigerating units and cooling plants, if used, shall be dimensioned so as to secure continuity of concreting.

Temperature readings of the freshly placed concrete shall be made at regular intervals by the Contractor to be approved by the Consultant.

(17) Vibration and Compaction

Concrete shall be compacted with mechanical vibrating equipment, supplemented by hand spading and tamping to a maximum practicable density, so that it is in complete contact with form-work, reinforcement and other embedded parts.

The vibration shall be carried out by means of immersion type high frequency vibrators, of the electrically driven or compressed air types, or by means of engine driven vibrators. For the consolidation of concrete where immersion vibrators would prove impracticable, vibrators rigidly attached to the forms shall be adopted subject to the approval of the Consultant.

The size and number of vibrators, at each pour, shall be sufficient to thoroughly compact concrete, at the rate and conditions of placement.

When vibrating a layer of fresh concrete, the vibrator shall be held in a near-vertical position. The immersion of the vibrator shall be sufficient to vibrate the entire depth of the

concrete layer: the vibration should penetrate several centimeters into the layer below, to ensure thorough union of the layers.

No new layer of concrete shall be placed before the underlying one has been thoroughly vibrated. The vibrator's immersion points shall be adequately spaced, to make sure that every part of the concrete has been properly vibrated. Care shall be taken to prevent contact of vibrators against reinforcement steel, especially when initial set of concrete has begun in the underlying layer of concrete. Vibrators shall not be allowed to come in contact with the formwork.

Care shall be taken to ensure a good adhesion of concrete with the water stops.

Excessive vibration, causing segregation, and tending to bring laitance to the surface, shall be avoided.

The vibrators used shall be of an approval make and of a type best suited for the class of work. Standby equipment is to be provided at the concreting site to ensure that operations are not interrupted due to break-downs. Vibration shall be carries out by competent operators,

Necessary traffic over fresh concrete shall be through independently supported timber walkways, so that concrete is not disturbed.

The evaluation of the satisfactory degree of vibration of the concrete shall be based on the criteria outlined in Section 112 of the Concrete Manual USBR, latest Edition or equivalent.

(18) Second Stage Concrete

Concrete in blockouts the Contractor shall construct blockouts in concrete structures for installation of Permanent Equipment and other equipment shown on the approved construction drawings and/or as directed by the Consultant.

The blockouts shall be filled by the Contractor with concrete or mortar after the equipment has been installed.

Prior to filling concrete or mortar in blockouts, the concrete surface of large blockouts shall be roughened by chipping or other methods and shall be in such condition as to ensure a good bond between the existing and the second stage concrete or mortar. The roughened surface of concrete shall be clean and the surface shall be dampened after the cleaning before filling with concrete or mortar. Filling of blockouts shall proceed after approval by the Consultant.

Second stage concrete shall be placed, packed and compacted to ensure satisfactory bond with the installed equipment or metalwork and shall be free of voids. The exposed surfaces of concrete shall be smoothly finished.

Concrete or mortar to be placed in blockouts shall be of the same strength as the concrete of the structure where the blockouts are located.

(19) Joints

(a) Construction Joints

Wherever concrete is to be bonded to other concrete which has completed its initial setting the surface of contact between the sections shall be considered as a construction joint. Construction joints shall be such that the last concrete bonds firmly to the concrete cast previously. The Contractor shall submit the drawings which indicate all construction joints, i.e. horizontal, vertical joints, to the Consultant and obtain the written approval from

the Consultant prior to start the concrete works. The Contractor shall consider the following to determine the location of construction joints.

- To avoid the location where the shear strength is big.
- To avoid the inclined construction joints
- To limit the area or legth of concrete casting to avoid big crack due to thermal stress or Shrinkage Max. area of Base slab; approx.15m×15m
 - Max. length of Wall; approx. 15m
- To limit the height of wall; less than 4m height

Whenever work is suspended on any section for more than two hour, concrete surfaces shall be considered as a construction joint. In such a case, the contractor is not allowed to continue the concrete casting to avoid cold joints.

Construction joints shall be arranged so as to reduce to a minimum the effects of shrinkage in the concrete after placing, and shall be located in the most advantageous positions with regard to stresses in the structure. Feather edges of concrete at joints shall be avoided.

The intersections of horizontal construction joints and the exposed faces of concrete shall appear as straight lines. In the initial stage of setting, but before the final setting of the concrete, the surface of the joint shall be washed with water and compressed air jets, with the purpose of eliminating the mortar from the surface, removing loose parts, and laying bare the coarse aggregates, without however removing them. After the proper time interval has elapsed and prior to pouring of the following lift, the joint shall be cleaned again with air and water jetting.

If the surface of a lift is congested with reinforcement steel, and is relatively inaccessible, or if, for any other reason, it is considered undesirable to disturb the surface of a lift before it is hardened, surface cutting by means of air-water jets will not be permitted and the use of wet sandblasting will be required, and shall be performed immediately before placing the following lift.

The operation shall be continued until all unsatisfactory concrete, and all laitance, coatings, stains, debris, and other foreign materials are removed.

When jetting is used, the air pressure shall be not less than 6 kg/cm², and water pressure shall be just sufficient to bring the water into the effective influence of the air pressure.

In case of vertical construction joints, the Contractor shall carry out the chipping after stripping the formwork to ensure the rough surface of joints.

(b) Fine Mortar Layer

A layer of Mortar with a thickness of about 3 cm, shall be placed over horizontal construction joints before pouring operation start. Accumulations or puddles of mortar shall not be allowed to settle in depressions.

Mortar shall be placed within a quarter hour after mixing, and shall be covered with the class of concrete specified before the mortar begins to set.

Any portion of the mortar layer that begins setting before the coarse concrete is placed upon it shall be removed at Contractor's expense.

Where it is impracticable to apply such a mortar coating or considered unnecessary by the

Consultant, special precautions shall be taken to insure that the new concrete is brought into intimate contact with the surface of the joint by carefully compacting the concrete by means of suitable tools.

(c) Expansion and Contraction Joints

All joints that allow possible displacement of a concrete structure, with respect to an adjacent one, due to expansion, shrinkage and differential setting of the respective foundation, are to be considered expansion or contraction joints.

Joints shall be provided at the locations indicated on the approved Shop Drawings or as otherwise directed or approved by the Consultant and shall be in accordance with the details shown. In no case shall any metal fixture embedded in the concrete be continuous through an expansion or contraction joint, except as shown on the Shop Drawings, or instructed by the Consultant. The opposite faces which from the joint shall be completely separate.

The Contractor shall undertake the pouring of the second surface, only after the first one is thoroughly hardened.

When so prescribed by the drawings or instructed by the Consultant, expansion or contraction joint shall be coated with an approved bond breaking compound to prevent bonding or approved filler materials may be inserted. The surface of contraction joints shall be cleaned thoroughly of accretions of concrete or other foreign matter by scraping, chipping or other means satisfactory to the Consultant before any fresh concrete is placed against such a joint.

(20) Curing of Concrete

(a) General

The following provisions shall be applied so that:

- concrete does not lose moisture during the early stages of hardening;
- concrete is not cracked or damaged by high temperature or rapid changes in temperature;
- surface of concrete are not damaged by traffic, nor discolored by chemical agents.

All equipment needed for adequate curing and protection of a concrete pour shall be ready to install before actual concrete placement begins.

Curing shall commence as soon as concrete has set, and shall be continued for a minimum period of seven (7) days after casting, on unformed surfaces or on surfaces where the forms are removed before the end of the curing period.

The method of curing shall be approved by the Consultant.

(b) Water Curing

Concrete, if water cured, shall be kept wet by covering with an approved water saturated material, or by a system of perforates pipes, mechanical sprinkles or porous hose, or by any other approved method which will keep all surfaces to be cured continuously wet. Water used for curing shall be supplied by the Contractor and shall not obtain substances harmful to concrete.

(c) Membrane Curing

Concrete and precast concrete members may be membrane cured with an approved pigmented curing compound in lieu of water cured, if so approved by the Consultant. Membrane curing shall be by application of a sealing compound which forms a water-retaining membrane on the surface of the concrete curing compound shall conform to ASTM-C309 or equivalent. The compound shall be of uniform consistency and quality within each container and from shipment to shipment.

The compound shall be sprayed on the concrete surfaces to provide a continuous, uniform coating overall areas. Coverage shall not exceed four (4) square meters per liter and on rough surfaces coverage shall be decreased as necessary to obtain the required continuous membrane.

Mortar encrustation and fine on surfaces designated as surface finish F3 shall be removed prior to application of sealing compound. The repair of all other surface imperfections shall be made before application of sealing compound, unless the repair work cannot be completed within 4 hours from the stripping of formwork, in which case the repairs shall be executed as indicated here below.

When sealing compound is to be used on formed concrete surfaces, the surfaces shall be moistened with a light spray of water immediately after stripping of forms and shall be kept wet until the surface will not absorb more moisture. As soon as the surface film of moisture disappears but while the surface is still damp, the sealing compound shall be applied. Special care shall be taken to insure good compound coverage at the edges and after application of the sealing compound has been completed and the coating is touch-dry required repair of concrete surfaces shall be performed. Each repair, after being finished, shall be moistened and coated with sealing compound in accordance with the foregoing requirements.

Equipment for applying sealing compound and the method of application shall be in accordance with the provisions of Chapter VI of the latest edition for the Concrete Manual USBR or equivalent. Traffic and other operations by the Contractor shall be such as to avoid damage to applied sealing compound for a period of not less than twenty-one (21) days. Scaling compound will be accepted on the manufacturer's certification of compliance with specification but permission to ship on certification shall in no way relieve the Contractor of the responsibility for supplying a compound meeting the specification requirements. Sealing compounds shall be sampled and tested. The Contractor shall provide, without charge to the Consultant, such facilities and assistance as may be necessary for procurement of samples. Sampling will be in accordance with Designation 38 of the least edition of the Bureau of Reclamation Concrete manual, JIS, TIS or equivalent.

Any sealing members that is damaged or that peels from concrete surfaces within fourteen (14) days after application shall be repaired without delay and in an approved manner.

(d) Protection

After casting, all freshly placed concrete shall be protected from direct exposure to the sun for a period of at least seventy-two (72) hours or the minimum time interval between the lifts whichever is the longer. Adequate protection in the period between casting and commencing of curing is especially important.

Concrete shall be protected against abrasion, vibrations, or any other damages during the curing period, by independently supported walkways, on an effective cover of sand, or other types of covering.

Where it is impossible to avoid traffic over surfaces coated with sealing compound, the members shall be protected by a covering of sand or earth or by other effective means. The protective covering shall not be placed until the sealing membrane is completely dry.

(21) Surface Finishes

(a) General

The surface of the finished concrete shall be smooth, uniform in colour and texture, free from projections, irregularities, holes, honeycomb and encrustation.

Unless instructed otherwise by the Consultant, the surface finish of concrete shall conform to the following Specifications.

The Shop Drawings and Technical Specifications indicate the type of concrete surface finish required for the formed and unformed surface in the major structure, through the use of the symbols F1, F2, and F3.

(b) Classification of Surface Finish

a) General

Except for the construction tolerances, covered by the prescriptions of Clause 22, the surface of concrete, both formed and unformed, shall be smooth and shall not present abrupt or gradual irregularities outside the surface finish tolerances herein described. Abrupt irregularity is defined as a change in a surface that takes place without any transition whatsoever; gradual irregularity is defined as a change that takes place over a transition distance.

b) Classification of Surface Finish

Surface finish shall be governed by the nature of formwork materials by the finishing tools employed in uniformed surfaces, and by the maximum allowable irregularities. Surface finish shall be classified as follows:

- F1: as produced by sawn timber form work, or finished by wood trowel with abrupt irregularities up to 2 cm and gradual irregularities up to lover 100. This finish is for surfaces against which backfill or further concrete will be placed.
- F2: as produced by dressed timber formwork, or finished by wood trowel; with abrupt irregularities up to I cm and gradual irregularities up to lover 100. This finish is for surfaces which are permanently exposed to view generally for canal lining/canal structures, wall and slab of building, unless otherwise noted on the construction drawing.
- F3: as produced by plywood formwork, or finished by steel trowel with abrupt irregularities up to 0.3 cm and gradual irregularities up to lover 250. This finished is for surfaces which will be in contact with water flowing at high velocity, and for surfaces prominently exposed to view where good appearance is of special importance, unless otherwise shown on the construction drawing.

(c) Approval of Finishes

The degree of surface finish of the concrete shall be inspected and approved by the Consultant for each day's work or immediately after stripping the formwork. Any necessary correction will be carried out immediately.

(22) Construction Tolerance

The variation in dimensions, alignment, and grades, or any concrete from the dimensions, locations and grades shown on the Shop Drawings, or required by the Consultant, shall be within the tolerance specified in the following table.

No confusion shall however be made between the irregularities described in the Clause 14 above and those which are the object of this Clause.

Structure	Tolerance in millimeters
a. All structures except as specified in c. and d.	± 20
b. Floor and wall openings	± 20
c. Exposed columns, thin walls, sluice ways	± 10
d. Structure with guides or which will be in contact with items of the Permanent Equipment having close tolerances	± 5
e. Lining	± 5

The Consultant may require that the Contractor repair, or remove and replace at his own expense, any concrete work that exceeds the limits specified above.

The thickness of concrete lining, as indicated on the approval construction drawing should be considered the minimum thickness.

(23) Repair of Concrete Surface

Immediately after the removal of the formwork, the Contractor shall inspect the concrete and shall report all defects to the Consultant

Any irregularity outside the specified tolerance, or any voids, honeycombs or other damage shall be repaired. All repairs of such defects shall be performed only by skilled workman and at the expense of the Contractor. The Contractor will inform the Consultant before starting the repair work. Materials, procedures and operations used in the repair of concrete shall be done subject to the approval from the Consultant.

All repairs shall be immediately after removal of the forms and never longer than twentyfour (24) hours after exposure. Concrete damaged from any cause and concrete that is honeycombed, fractured or otherwise defective, and concrete which, because of excessive surface depressions must be cut back and rebuilt, shall be replaced with mortar or concrete as hereinafter specified or as otherwise instructed by the Consultant.

The defective concrete shall be cut down to sound concrete, and at least down to a depth behind the reinforcement steel sufficient to provide complete bonding of the reinforcement steel to the concrete replacement. Voids to be filled shall be provided with anchors, keys, welded wire mesh, or dovetail slots, whenever necessary, to attach the new material securely in place. Cut out areas shall be thoroughly cleaned.

The holes left by the removal of tie rods and/or cones shall be thoroughly moistened and filled with dry patching mortar, thoroughly tamped into place. The color of replacement concrete and patching mortar shall match that of the surrounding concrete.

Concrete and mortar used for patching and repairs, shall be cured in the same manner specified for general concrete work. Where specifically authorized by the Consultant bulges may be removed by grinding procedures. Other methods to be used in such repair work shall be those detailed in Chapter VII of the Concrete Manual USBR, latest Edition or equivalent.

Water-retaining concrete structures shall be watertight up to the full design head of water and' the Contractor shall repair at his own expense all leaks that may develop prior to or during the Guarantee Period.

(24) Precast Alternatives to Cast-in situ Concrete

The Contractor may elect to precast some type of structures that are shown as cast-in-situ in the Shop Drawings or as directed by the Consultant. This will be acceptable provided the following conditions are met:

- a) The general dimensions and shape of the structures are not altered;
- b) If the Contractor alters the concrete strength, the structure thickness and/or the reinforcing steel with respect to the contract drawings, the revised design and shop drawings shall be submitted to the approval of the Consultant.

5.2 Reinforcing Steel

(1) General

The Contractor shall furnish, cut, bend and place all steel reinforcement including bars and fabric necessary for the completion of the Works as indicated on the shop drawings or as instructed by the Consultant.

The cutting, bending and placing of the steel reinforcement shall be in compliance with ACI 318 Standards, except when otherwise provided by the approved construction drawing.

Reinforcement bars shall be embedded in the concrete as shown in the Shop Drawings or as instructed.

(2) Materials

The quality of the reinforcement steel shall comply with TIS-20 for round bars, TIS-24 for deformed bars, ASTM-A416 for uncoated seven wire stress and JIS or equivalent.

(3) Delivery

Steel bars shall be delivered in bundles firmly secured and tagged or marked in accordance with the applicable standards. Reinforcing bar mats shall be delivered flat and not in rolls. Welded wire fabric when delivered in rolls shall lay out flat from the roll. Reinforcing steel shall not be bent or straightened in a manner that will injure the material. Any use of such injured reinforcing steel will not be permitted.

(4) Test Certificates

Manufacturer's test certificates shall be provided as confirmation that the materials have been tested in accordance with and meet the requirements of the specifications.

(5) Storage

Steel bars shall rest on timbers, away from the ground and shall be protected from rusting, damage or contamination. Bars of different diameter and/or grade of steel are to be kept separate.

(6) **Preparation of Reinforcement Drawings**

The Contractor will prepare all construction reinforcement drawings or sheets, unless otherwise specified.

- Spacing details between form work and reinforcing bar.

- Cutting and bending schedules of the reinforcement system.

(7) Checks and Measurements

Unless otherwise indicated, the distance between bars is measured between the center lines.

After the steel has been placed the Consultant shall check spacing, quantity, diameters, shape, length and overlaps.

(8) Hooks

Hook shall be required for the round bar and for the deformed bar as specified in the Shop Drawing or as instructed by the Consultant.

All smooth reinforcement rods shall terminate with a hook at both ends, unless otherwise shown on the approved Shop Drawings or as indicated by the Consultant.

Hooks shall be doubled over 180°, with an internal bend diameter of between 6 to 8 times the diameter of the rod, the curve terminating in a straight piece of length equal to at least 4 times the diameter of the rod, but not less than 6.5 cm. (see ACI-318 Standards).

(9) Bending and Cutting

Bar reinforcement shall be bent to the shapes shown on the approved Shop Drawings. All bars shall be bent cold without applying heat. Cutting and bending of reinforcement bars may be done in a shop or at the job site. All bending shall be in accordance with standard practice and by approved machine methods. No bar partially embedded in concrete shall be bent in place without the express approval of the Consultant. Bar reduced in section or with kink or twist will not be accepted.

The inside radius of the bend shall be as specified in American Concrete Institute Building Code for Reinforced Concrete ACI 318 Section 7.1.2

(10) Splices

(a) General

No splice shall be situated at points of highest bending moment of the structures.

The splices shall be overlapped or welded, in accordance with the approved Shop Drawings or as instructed by the Consultant.

(b) **Overlapping Splices**

The length of overlap for tension lap splices with standard hook shall be at least 30 times of diameters of the bigger bar for deformed bar and 50 time of diameters of bigger bar for plain round bar.

The minimum overlap length for compression lap splices with standard hook shall be 20 times of diameters of the bigger bar for deformed bars and 40 times of diameters of the bigger bar for plain round bar.

(c) Welded Splices

Welding of reinforcement bars in lieu of overlapping shall not be permitted unless approved by the Consultant.

If approved by the Consultant, all welding shall conform to "REINFORCED STEEL WELDING CODE" of AWS (American Welding Society) D12.1, JIS and other equivalent standards.

All welders employed shall show proof of their welding qualifications to the Consultant. All welding shall be done using metal-arc welding or pressure gas welding. Electrodes shall be acceptable to the Consultant. Coverings of low hydrogen electrodes must be thoroughly dry when used. The surfaces to be welded shall be clean and free from rust and dirt. All welds shall develop the full strength of the bar or of the smaller bar where two different sizes are welded. Tests will be required on not more than 5 percent of the welds.

(d) Mechanical Splices

The use of Mechanical Splices Coupler will be subject to the approval from the consultant. The torque wrench shall be used to test the moment of force.

(e) Dowels

The contractor shall furnish and place the dowels as shown on the approved Shop Drawings or as instructed by the Consultant.

The dowels shall be smooth round bars, unless otherwise specified.

Dowels will be inspected for compliance with requirements as to size, shape, length, position and quantity after they have been placed.

Before the dowels are embedded in concrete, the dowel surfaces shall be cleaned of all dirt, grease, or other foreign substances which, in the opinion of the Consultant, are objectionable.

The dowels shall be secured in position so that they will not be displaced during the placing of the concrete.

(11) Placing

Before the reinforcement is placed, the surfaces of the bars and the surfaces of any metal bar supports shall be cleaned of heavy, flaky rust, loose scale, dirt, mud, grease or other foreign substances which, in the opinion of the Consultant, are objectionable. After being placed, the reinforcement bars shall be maintained in a clean condition until completely embedded in the concrete.

The bars shall be placed and fixed in such a manner that they cannot move out of place during the pouring process. In the event of reinforcing bars being bent or distorted in any way while concreting is taking place, these bars shall be straightened and reinstalled properly, before placing the next lift of concrete. The Contractor shall use spacing devices or other methods approved by the Consultant to maintain the reinforcement bars in the proper position. Reinforcement exposed for future concreting shall be protected from corrosion or other damage in an approved manner. The protection shall be of such nature that the reinforcement can be thoroughly cleaned without difficulty prior to subsequent easement in concrete.

(12) Concrete Protection for Reinforcement

The reinforcement shall be covered by the thickness of concrete indicated on the approved Shop Drawings. Where not shown, the clear concrete cover shall be as follows:

- a. All stair slabs and landings, use 2.5 cm.
- b. At underside of bridge slabs exposed to weather, use 2.5 cm.
- c. Structures exposed to weather or backfill or submerged, use 5 cm.
- d. Face of concrete exposed to scour, use 6 cm. for fresh water.
- e. Concrete placed directly against earth or rock or surface subjected to corrosive liquid, use 8 to 10 cm.

(13) Tolerances

- a. Tolerance in the thickness of concrete covering: ± 0.6 cm, if the concrete cover is less than 10 cm, 0 to 2 cm. if the concrete cover is more than 10 cm.
- b. Tolerance in the spacing between bars provided this is not systematic: ± 10% of spacing.

(14) Approval of Reinforcement

The Contractor shall obtain the approval of the Consultant for the reinforcement when placed and before any concrete is deposited in the forms.

5.3 Water Stops

(1) General

This Clause covers the supply and installation of the water-stops used water seals in construction joints of concrete structures.

Water-stops shall be placed in joints of the structures where shown on construction drawings and elsewhere as instructed by the Consultant.

(2) Material

The water-stop shall be extruded from an elastomeric plastic compound, the basic resin of which shall be polyvinyl chloride (PVC). The compound contain those additional resins, plasticizers, stabilizers, or other material needed ensure that when the material is compounded, it is durable and resistant decomposition.

The water-stop material shall meet the following main requirement:

Requirements	Method of Test
 a. Tensile strength: not less than 120 kg/cm² b. Ultimate elongation: not less than 33% c. Stiffness in flexure, 6 mm. span : not less than 28 kg/cm² d. Specific density: not less than 1.30 gm/cm³ 	ASTM-D 412 or equivalent ASTM-D 412 or equivalent ASTM-D 747 or equivalent ASTM-D 792 or equivalent

The Contractor shall supply water-stop samples and certificate of physical properties for Consultant's approval. He shall also perform required laboratory tests on specimens sampled on site to verify that the material supplied meets the requirements specified.

Each manufacturing batch lot or every 100-m. of water-stop certified by the manufacturer and the lot marked with the batch number.

The extruded PVC shall be dense, homogeneous, and free from holes, scratches and other imperfections. The cross-section of water-stops shall be along its length and shall be transversely symmetrical so that the thickness at given distance from either edge of the band is uniform.

(3) Type

The water-stops required shall be of the central hollow bulb type as follows:

Туре	Width (cm)	Central hollow bulb
۸	20-23	Yes
B	15	Yes
С	15	No
D	10	Yes

The Contractor shall protect the central hollow bulb from concrete intrusion, so that the function of the flexible seal shall be preserved. The water-stop which will remain exposed for more than ten (10) days shall be protected from the sun.

(4) Splices

Splices in the run length or at the intersection of runs of water-stops shall be performed by heat-sealing adjacent surfaces in accordance with the supplier's recommendations. A thermostatically controlled electric source of heat shall be used to make all splices. The correct temperature at which splices should be made will differ with the seal material, and shall be sufficient to melt but not char the plastic. All splices shall be neat with the edges of the joined materials in true alignment.

All intersection splices shall be prefabricated by the manufacturer or by the Contractor in the field shop.

A milter box and a proper saw shall be used to cut the ends to be joined to ensure good alignment and contact between joined surfaces.

The number of splices in the water-stops shall be kept to a minimum. The equipment used for making splices in PVC sealing and splicing method shall be approved by the Consultant.

The Contractor shall make the splices in such a manner as to insure that the splices have a tensile strength not less than 80 percent of the unspliced material.

(5) Installation

Care shall be taken to ensure that the water-stops are correctly positioned during installation. Adequate provisions must be made to support the water-stops during the installation and to ensure their proper embedding in the concrete. The symmetrical halves of the strip shall be equally divided between the adjacent concrete structures.

Maximum density and imperviousness of the concrete shall be ensured thorough vibration of the concrete in the vicinity of the seal.

Suitable guards shall be provided to protect exposed projecting edges the ends of partially embedded water-stops from mechanical damage. Water-stops shall be thoroughly cleaned of all foreign material before concrete is placed.

(6) Alternatives of Water-Stops

In case of the change from PVC to rubber type on water-stop, Contractor should submit following data for the Consultant approval.

- Manufacturer's catalogue with technical specification
- Laboratory testing results by the manufacturer
- Sample of water-stop
- Joint (Lapping) details and fixing method of water-stop

5.4 Joint Fillers

(1) General

The Contractor shall supply and install joint filler at the locations and of the thickness shown on the approved shop drawings or as instructed by the Consultant.

(2) Joint Filler

Where joints are shown on the approved Shop Drawings as having elastic joint filler, or Celotex with coal tar, the joint shall be filled with preformed joint filler and sealed with joint sealer. The Contractor shall cut the material to cover the entire contact surface of the joints, and to the fit around the opening. The exposed edges of joint filler sheet placed on a joint shall be at least One (1) centimeter back from the finished surface of concrete, to allow joint sealer material to seal the gap.

(3) Materials

(a) **Preformed Joint Filler**

Shall consist of a bituminous (asphalt or tar) mastic composition. The mastic shall comprise mineral filler and reinforcing fibers, formed and encased between two layers of bituminous impregnated felt.

When the filler has to be placed against vertical concrete surfaces, it shall be glued on the contraction joint by means of coal tar or asphalt material.

(b) Joint Sealer

Shall consist of a mixture of fifty (50) parts by weight of bituminous binder and 50 parts by weight of sand. Mixture will become sufficiently fluid when heated to approximately 150°-200°C, so as to flow freely without mechanical manipulation. Application of the mixture shall be done whilst hot. For vertical joints a proprietary brand of sealer may be used if approved by the Consultant.

The material shall conform to the requirements of ASTM D170, ASTM D171, JIS and other equivalent Standards.

All joint surfaces to be filled shall be clean, dry and fully cured.

6. PRECAST CONCRETE WORKS

6.1 General

The Contractor shall furnish and erect precast reinforced concrete member for installation in those parts of the works as shown on the approved Shop drawings and/or instructed by the Consultant.

Precast concrete units shall include prestressed concrete (PC) piles, prestressed concrete (PC) corrugated sheet piles, and/or similar items.

They shall be made with concrete mixed, placed and curved accordance with the provisions set forth in the Clause 5 "Concrete Works" as the specific provisions of the following Clauses.

No element in precast concrete may be handled and transported before it reaches the strength necessary to prevent cracking.

Precast concrete units may be supplied by a manufacturer approved by the Consultant or may be manufactured by the Contractor at a location approved by the Consultant.

Thirty days before commencing manufacture of the precast concrete the Contractor shall submit to the approval of the Consultant all details of the methods to be used in manufacture, curing and handling, transport, storage and erection of the precast elements the Contractor shall submit all details to the Consultant for approval.

Repair of damaged elements will not be permitted except damage and repair, in the opinion of the Consultant, will not impair the function or appearance of the elements.

6.2 Precast Concrete Pile

(1) Materials

(a) Reinforcement

The requirements of Sub-clause 5.2- Reinforcing Steel shall apply to specifications of the reinforcement.

Reinforcement shall not be assembled in the moulds. Main bars shall be securely tied to hoops, stirrups or binders to give rigidity, and temporary stiffening or bracing shall be provided during handling and placing necessary to ensure that correct spacing of all bars are maintained. Cages are to be fixed straight and parallel to the moulds and spacer blocks concrete shall be used to ensure that specified cover is maintain throughout. The ends of all tie wire or clips shall be turned into the body of the concrete.

(b) Formwork and Finish

All precast units shall be manufactured under conditions which will ensure that:

- a. The formwork is not subjected to remove, displacement or differential settlement during and after concreting.
- b. The concrete is protested from the direct rays of the sun, rain or drying winds;
- c. The finish shall be that indicated in the approved Shop Drawings.

(c) Concrete

- a. Concrete for all types of precast members shall conform to the provision of Clause 5, except where noted or shown on the approved construction drawings.
- b. The maximum size of coarse aggregate shall not exceed 3/4".
- c. The slump of concrete, after the concrete has been deposited but before it has been consolidated, shall not exceed 2 ^{1/2}".
- d. The percentage of entire air in the concrete, as discharged from the mixer, shall be 3 to 5 percent by volume of concrete.

(2) Casting

Precast concrete units shall be cast in individual forms. Each unit is to be cast in one continuous operation and no construction joints will be permitted.

(3) Vibration

Unless otherwise approved by the Consultant shutter vibrators or vibrating tables used to achieve optimum compaction, Care shall be taken to avoid over vibration.

(4) Marking

Precast concrete units shall not be marked or branded in any position can be seen in the finished work or against which any concrete is to be placed. The lifting points shall be marked on two opposite faces of the elements.

(5) Removal of Forms

The sides of moulds shall be struck in such a sequence and after such period as is necessary to ensure that precast unit is not subjected to damage, distortion or overload.

(6) Handling

Precast concrete units shall be handled, transported and stored in such a manner as to avoid damage to the unit. The Contractor shall be responsible for provision of suitable lifting devices. The handling devices and procedures proposed by the Contractor shall be compatible with the design of the precast elements.

Particular care shall be taken to prevent surface abrasion or other damage during handling and transport to place of installation.

Precast units shall be adequately braced and protected during transportation and such further bracing or supports provided during installation ensure proper alignment until the work is completed.

(7) Curing

The members shall be cured by water or by membrane methods as instructed by the Consultant or as hereinafter specified and/or as provided in Clause 5.

The members shall be cured until concrete test cylinders, made and cured with the members, have attained a compressive strength of at least 75% of required strength. At the start of manufacture, at least six cylinders will be made cured with each member. These cylinders will be tested in pairs, at appropriate intervals during the curing period, to

establish the time necessary to produce minimum strength required. After the curing method and period have been established, two cylinders obtained from each work shift will be tested at the end the curing period and, if they meet the specified minimum strength, curing of elements produced during that shift shall be terminated. If the strength of cylinder is less than that required, the elements concerned shall be cured for a longer period, as directed by the Consultant.

(8) Tolerances

The dimension of the finished precast elements shall be within the following limits, at the time of placement of these units in the structure, unless otherwise shown on the approved Shop Drawings:

The following tolerances will apply to precast units:

Cross Section in any Direction Dimension	<u>Tolerance</u>
Up to 50cm	± 6mm
50 cm -75 cm	± 9mm
Straightness or Deviation from Intended Line Up to 3m	
Up to 3m	± 6mm
3 m-6m	± 9mm
Over 6m	±12mm

The visual inspection for the piles to check defects shall be conducted by the Consultant upon carrying in the site by the Contractor.

(9) Precast Concrete Piles for Structural Foundation

The Contractor shall supply precast reinforced concrete or prestressed concrete piles, where indicated, of sufficient section and length to provide the design load capacity. Calculations showing the adequacy of plies will be based on use of <u>Hiley's Formula</u> for bearing of soil but shall be confirmed by pile-load test at the commencement of the piling work as prescribed in Sub-clause 13.6 unless otherwise decided by the Consultant.

Before the commencement of piling works, the contractor shall submit the method statement for the piling works including pile-load test to the Consultant.

(10) Subsurface Soil Conditions

Logs of boring are available for the contractor's information However, the Consultant does not guarantee the accuracy of the information to be used.

(11) Pile Driving and Preparation

(a) Driving Equipment

Precast concrete piles shall be driven to the required depth accurately to the vertical by means of appropriate rigs and pile driving hammers of an approved type.

Hammers shall be either of gravity, single acting steam or pneumatic type.

Gravity hammers shall not weight less than 60% of the combined weight of the pile and driving head and that weight shall not be less than 2,000 kg. The fall shall be adjusted so as to avoid injury to the pile and shall in no case exceed 2.0 m unless otherwise specified or approved by the Consultant.

The plant and equipment used for steam hammers shall have sufficient capacity to maintain, under working conditions, the pressure at the hammer as specified by the manufacturer. The boiler pressure tank and the hammer intake shall be equipped with accurate pressure gages.

Piles while being driven shall be supported in line and position appropriate leads. Pile driving leads shall insure rigid lateral to the pile well free movement of the hammer for both vertical and batter pile leads shall be of sufficient length. The use of follower for the pile driving is subject to the approval from the Consultant.

(b) Pile Driving

Precast concrete piles shall be driven in such manner as not to subject them to excessive and undue abuse, producing serious injuries as crushing and spalling of the concrete. Manipulation of piles to force them in the proper position, considered to be excessive by the Consultant, will not be permitted.

Each pile shall be driven without interruption until the specific penetration is obtained. The use of water jet to assist in driving the piles will not be permitted.

Pulling and pushing the pile cap to the required position by any means will not be permitted.

(c) Construction Tolerance for Precast Concrete Pile

The tolerance in each pile top shall be as follows.

- a. EL (cut-off level); ±50mm
- b. Eccentricity within 100mm
- c. Inclination within 3 degree

The Contractor shall submit the drawings and records which indicates the actual EL, eccentricity, and inclination of all piles to the Consultant.

If the welding for joints is necessary, the welding shall be done by the eligible skilled welders. After the completion of welding, the Contractor shall request the Consultant to conduct the visual inspection and penetrant inspection.

(d) Piles Incorrectly Driven

Precast concrete piles incorrectly driven or damaged in driving to such an extent as to unsuitable, as determined by the Consultant, or whenever the eccentricity of pile top exceeds 10 centimeters from the designed location shall be corrected at the expenses of and by the Contractor using the approved method by the Consultant.

Piles found to have heaved shall be re-driven to the established elevation.

Piles driven below the elevation specified in the Construction drawing shall be corrected at the expenses of and by the Contractor using a method subject to the satisfaction of the Consultant.

(e) Pile Head Preparation

Where necessary, pile heads shall be extended by using concrete prepared with high early strength cement, after the reinforcement cages have been jointed by arc welding. Welding of reinforcement shall comply with the prescription of Sub-clause 5.2.

The heads of precast concrete piles to be incorporated in the foundation of concrete structures shall be demolished by means of compressed air equipment, exposing the reinforcement for a length as shown in the approved Shop Drawings or instructed by the Consultant.

The Concrete debris occurred by the demolition shall be disposed to the designated disposal area.

(f) Pile Records

The Contractor shall keep records of all piles driven, including test piles, and a copy of the record shall be given to the Consultant within two days after piling works at each structure.

The record form to be used shall be approved by the Consultant and shall give full information on the following:

- structure to which the pile belongs;

- pile identification number, type and dimensions;
- date of casting and date of driving;
- driving equipment data (type, weight of hammer and drop height or efficiency and frequency of blows, etc.);
- depth driven and tip elevation;.
- pile top elevation immediately after driving;
- penetration for the last 10 blows and rebounds or whenever required by the Consultant;
- details of any interruption of driving, details on re-driving and any other information which may be useful for pile behavior knowledge.]
- -period of welding

-testing of welding joints (if necessary)

(g) Test Piles

Test piles may be required by the Consultant, whenever more detailed information is needed on foundation pile behavior in difficult subsoil condition, to select pile dimension and length.

Test Piles (Han-Tra – one pile, Kra-Mang – one pile) shall be chosen from the foundation piles by the Contractor.

Test piles shall generally be driven with the same equipment to be used for the foundation piles to be built. Pile top elevation will be 0.5m to 1.0m above the ground level to ease the subsequent preparation works. Exact location, pile type and possible driving procedure shall be provided to the Contractor by the Consultant.

Test piles which conform to the foundation piles requirements as specified by and with the approval of the Consultant may be cut off and be used for structure.

Test piles which are found unsatisfactory for utilization in the structure shall be either removed or cut off below the footing ground line, as instructed by the Consultant.

Calibration tests for driving equipment may be required by the Consultant. If deemed necessary for completeness and better performance of driving procedures.

The Contractor shall keep records of all test piles as specified in Clause 13.5 hereinabove, including all additional data the Consultant may be required.

(h) Method of Test Piles

The method for static axial compressive load test shall be carried out in accordance with JGS 1811(The Japanese Geotechnical Society) or otherwise approved by the Consultant.

The pile load test shall be commenced after the friction force is recovered. The minimum curing period for the recovery of friction force is 5days for sandy soil and 14days for cohesive soil, respectively.

The maximum testing load is twice of design load.

The reaction force shall be selected from (a) reaction piles (b) ground anchors (c) kentledge and (d) a combination of the above devices.

Standard load step sequence

Number of steps	10 steps
Number of cycles	not less than 4 cycles
Rate of loading	During loading : (planned maximum load/number of steps) /min
Rate of loading	During unloading : Twice the rate used for loading stage
	New loading stage : a constant period not less than 30min.
Holding time for each loading step	Unloading or reloading steps : a constant period not less than 2min
	Unloading to zero load : a constant period not less than 15min

Standard sampling periods and intervals

New Loading steps	Data samplings are conducted at 0,1,2,5,10 and 15min from the start of load holding for each new holding step. Data samplings are repeated at 15 min intervals after the elapsed time of 15 min.
Unloading or reloading steps	Data samplings are conducted at 0 and 2 min from the start of load holding for each new unloading or reloading step, and at a time just before proceeding the next step.
Unloading to zero load	Data samplings are conducted at 0,5 and 15min. from the start of loading holding at zero load. Data samplings are repeated at 15min intervals after the elapsed time of 15min.

After the completion of test piles, the Contractor shall submit the report of test piles.

The report shall include the following items.

- The purpose of the test
- The test site conditions, and soil profile
- The test procedure
- The pile dimensions and the test pile installation method
- The test equipment
- The loading and measuring methods
- The test results

The following relationships shall be graphed.

- Load-Time relationship
- Displacement-Time relationship

- Load-Displacement relationship
- Load- Elastic Rebound relationship
- Load- Residual Displacement relationship
- Others
- Characteristic values of the vertical bearing capacity such as the first limit resistance, the second limit resistance, vertical stiffness
- Diagrams for the distributions of the axial strains and axial forces
- The characteristics of the frictional resistance on the pile surface

(12) Alternative to Cast-in Situ Concrete

The Contractor may elect to construct some type of structures that are as cast-in situ in the approved shop drawings. This will be acceptable provided that the following conditions are met:

- a) The general dimensions and shape of the structures are not altered;
- b) If the Contractor alters the concrete strength, the structure thickness, and/or the reinforcing steel with respect to the Construction Drawing, the revised design and drawings shall be submitted to the Consultant for the approval;
- c) The general conditions of this Clause 6 are complied with;

6.3 Prestressed Concrete (PC) Corrugated Sheet Piles

Prestressed concrete (PC) corrugated sheet pile shall be used for the revetment of canal, retaining wall for access road, platform to both Han Tra and Kra Mang flood gate. The Material shall conform to JIS 5334 or other equivalent approved by the Consultant. Prior to the commencement of site works, the Contractor shall submit the necessary information on the material and also the detailed method statement for the installation of PC corrugated sheet piles to the Consultant for the approval.

The Contractor shall consider the following point in his planning. The Contractor shall consider the adequate installation method such as the use of vibratory hammer, silent piler and water jet, etc.

- Installation of PC corrugated sheet pile and subsequent works for the revetment of canal shall be completed during the dry season.
- Where the Contractor use the PC corrugated sheet pile as earth-retaining member without using temporary sheet pile due to space constraint, the Contractor shall examine the construction methods to minimize the displacement.
- The special care shall be taken in case the sheet piles will drive beside existing houses, railway, public road and utilities to avoid the damage or accident.
- The Contractor shall consider the necessary protection or keep out for the residents
- In case of the works beside railway, the Contractor shall check the train schedule in advance and avoid the site works in operation hours.
- Elastic vinyl Chloride sealing materials can be used in the gap between sheet piles to ensure the water tightness.
- The Contractor shall use the guide beam to keep the proper alignment and verticality of PC corrugated sheet piles.
- In case that the standard precast sheet piles cannot be used due to insufficient space, cast in-situ concrete shall be used to fill the gap.
- The Contractor shall consider the monitoring plan such as displacement of top of sheet pile, crack of adjacent ground.

The tolerance on the installation of PC corrugated sheet piles shall be as follows.

- a) Top EL:±50mm
- b) Displacement at the top of sheet piles: $L \times 3\%$
 - (L: self-standing height above ground level)
- c) Embedment Length: not less than design length

Where the PC corrugated sheet piles cannot be driven due to unexpected hard soil condition, the Contractor shall cut the sheet pile at the design level by using concrete cutter after obtaining the approval from the Consultant.

6.4 Reinforced Concrete Pile

(1) General

The Contractor shall supply and lay precast concrete pipes and materials, including pipe jointing material, in those structures where the installation of R.C. pipes is shown on the Shop Drawing or as instructed by the Consultant. The pipes shall be reinforced concrete low-head pressure pipe to be furnished and laid in accordance with Thai Industrial Standard 128, class of Reinforced concrete pipes, Class 2 and Class 3, which conform to reinforced concrete pipes Class IV A and Class III A of ASTM Designation C76 or equivalent. The pipe diameter to be used in each location is on the approved Shop Drawings or shall be as specified by the class of reinforced concrete pipes shall be as indicated in the approved Shop Drawings.

(2) Materials

The materials used in the manufacture of reinforced concrete pipes conform to the following requirements:

- a. Cement. In accordance with Sub-Clause 5.1
- b. Water. In accordance with Sub-clause 5.1
- c. Additives. All concrete used for the manufacture of pipes shall contain an entrainment of not more than 2.5 percent (%) of air, by volume, in the concrete as discharged from the mixer. Calcium chloride shall not be used except when approved by the Consultant.
- d. Aggregates. Fine and coarse aggregates for concrete shall be in accordance with Subclause 5.1, except that other grading may be used. The maximum size of coarse aggregate for each size of pipe shall be the largest size compatible with satisfactory placing of the concrete.
- e. Reinforcement Steel In accordance with Sub-clause 5.2.

(3) Pipe Installation

(a) General

During manufacturing, transporting, storing, and laying of concrete pipes, the pipes shall not be dropped or handled in a way that might crack the wall or otherwise cause damage. The pipes shall not be moved until after the specified curing period. Any length of pipe that, in the opinion of the Consultant is damaged beyond repair shall be removed from the site of the work and replaced by the Contractor at his expense.

(b) Bedding of Pipe

Excavation of pipe trench shall be done to the grade and line shown on the Shop Drawings. The pipe shall be supported firmly through its entire length.

Bedding of reinforced concrete pipes shall conform to the requirement given below for compacted earth cradle or concrete cradle, whichever is called for on the Shop Drawings or as instructed by the Consultant.

If the type of bedding is not shown, concrete cradle shall be provided, under the Consultant's direction.

- a. Compacted earth cradle : shall be constructed by bedding the pipe in shallow trench cut in compacted earth layers to a depth of not less than 20cm. and shall be accurately shaped by a template to fit the lower pipe exterior for the specified embedment.
- b. Concrete cradle; concrete cradle for pipe shall consist of a continuous concrete cradle constructed of Class B concrete in conformity with the details shown on the Shop Drawings or as instructed by the Consultant.

(c) Laying

The method of lowering the pipes into the trench and laying them in position shall be such as to prevent dirt from entering the pipe and couplings and to prevent damage to the pipe. Before and during execution of the joints, all surfaces shall be clean and free from mud, oil or grease.

The pipe shall be aligned straight with ends squared, and the joining of pipe section shall be such as to produce watertight joints.

(d) Joints and Collars and Pipe Bend Joint

<u>Joint</u>

Pipe joints shall conform to the type as shown on the approved Shop Drawing. Cement mortar shall be used in jointing.

Collar and Pipe Bend Joint

The collar and pipe bend joints shall be constructed where shown on the approved Shop Drawings..

(e) Water Testing

Where required by the Consultant, sections of pipeline shall be tested for leakage before backfilling.

(4) Backfill

As each unit of pipe is laid, sufficient backfill material shall be tamped about the pipe to hold it rigidly in place until the joints are completed. After the have been completed, the backfilling shall be proceeded as specified in Sub-clause 3.4. Design loading of AASH H-20 or equivalent will not be permitted to travel over pipes until backfill and embankment material have been placed to a thickness of at least 0.50 m. over the top of the pipe. This minimum requirement is not always adequate during construction when equipment heavier design traffic loads is routed over or close to the installed culverts. The Contractor shall be responsible for providing the additional cover necessary to avoid damage the pipes due to such loads.

7 METAL WORKS

7.1 General

The work covered by this Section shall include, but shall not be limited to, the supply of material, fabrication, installation and painting or hot-dip galvanizing of items of miscellaneous metal work such as :- anchorages, ladders, flanges, pipe hand railing, frames, supports, pipes, drainage outlets, sliding door, steel sheet pile and any other items not included in this Clause.

(1) Materials

Materials shall conform to TIS, ASTM, JIS or equivalent, the following ASTM Designations are for reference:

Material and Products	ASTM Designation
Steel shapes	A 283, A 306 and A 36 or TIS-107 and 116
Hot-rolled steel bars	A 575 and A 576 or TIS-55
Cold finished steel bars	A 108
Steel pipes, black or galvanized	A 120 or TIS-26
High strength bolts and nuts	A 325
Standard bolts and nuts	A 307
Galvanizing	A 123 or A 153
Steel plate	A 283
Anchor bolts	A 307
Welding electrodes	A 233 or TIS-49
Steel sheet pile	A 328

(2) Fabrication

(a) General

Fabrication of metalwork shall be in accordance with the best modern practice in the manufacture and fabrication of materials of the type covered by this Specification, and in accordance with the approved Shop Drawings. Built-up metalwork shall be completely assembled in the shop and matched for correct field erection. All frames shall be suitably braced as required, to maintain alignment during shipment and erection. All joints shall be filed, milled or machined as necessary to secure close and perfect connection.

All exposed bolts, projecting beyond the nut, shall be penned.

(b) Welding of Steel

Welded work shall be in accordance with the requirements of AWS, JIS or other equivalent standards.

(c) Painting

Miscellaneous metal work to be painted shall be treated as indicated in the Specifications hereafter, except that parts which are continuously or occasionally submerged or partly submerged.

(d) Hot-dip Galvanizing

Metalwork to be galvanized shall receive an adherent, smooth and continuous zinc coating, free from bubbles, porosities or other irregularities that may affect the soundness of the protective layer. The thickness of the zinc layer shall be such that the rate of deposited metal corresponds to a minimum of 600 gm/m².

(3) Installation and Erection

(a) General

The work shall include all cutting, fitting and drilling required for proper installation, and to make all the required connection with adjoining work.

All anchors sockets, pipe sleeves and expansion bolts required for securing the metalwork to the construction shall be furnished by the Contractor except where specifically stated otherwise.

(b) Embedded Metal

All embedded metal shall be accurately set in place before the concrete is poured or, subject to the approval of the Consultant, recesses may be left in the concrete and the metal work placed, anchored and blocked in place after the concrete of the structure has set.

Where it is impracticable to place anchors or anchor bolts required for the installation of step ladders, stairways, frames, or other miscellaneous metal work before concrete is built, holes shall be drilled in the structures and expansion bolts shall be installed.

7.2 Step Ladders

Step Ladders shall be pre-fabricated material in accordance with the Shop Drawings and the provisions of these Specifications.

The ladder is hole in anchor type, which is installed at 300mm interval after the completion of concrete structure. The holes for anchoring will be made by using hard drill.

The material of ladders is SWCH12R(Steels for Machine Structural Use). The dimensions of ladders are as follows.

Diameter: 19mm Width : 400mm Length from Concrete Surface: 180mm Embedment Length: 80mm

The Contractor shall obtain the material approval from the Consultant.

7.3 Stainless Steel Pipe Hand Railing

The Contractor shall furnish and install all pipe hand railing and posts as shown on the approved Shop Drawings or as instructed by the Consultant. The Contractor shall furnish and install all brackets, wall flanges, nuts, bolts and expansion anchors required for installation. Hand railing sections shall be installed to true line and level to the satisfaction of the Consultant,

The galvanized pipe for double bar hand railing and posts shall be standard 50-millimeter (2-inch,) nominal size stainless steel pipe. The necessary height of hand railing shall be 1,100mm.

7.4 Impervious Steel Sheet Pile

Impervious Steel Sheet Pile, which is use for permanent works, shall be provided under the structural foundation for both Han Tra and Kra Mang Flood gate.

Materials, which shall confirm to TIS1390 or JIS A5528 or equivalent, are type III sheet pile (Grade SY295) as shown on the contract drawings.

The detailed method statement for the installation of sheet pile shall be provided by the Contractor for approval.

The tolerance for the installation of sheet pile is as follows.

- a) EL (Top level) : ±50mm
- b) Eccentricity(Alignment): within 100mm
- c) Embedment Depth : Not less than the dimension shown in the Contract Drawings

If the sheet pile can not be installed due to unexpected soil condition, sheet pile length will be adjusted by cutting subject to the approval by the Consultant.

The Contractor shall comply with the following condition on the installation of sheet pile.

- a) The use of guide beam to keep the proper alignment and verticality of sheet pile
- b) The use of prefabricated corner sheet pile at the corners.
- c) The gap between sheet piles or lap joints of sheet piles is not allowed.

7.5 Anchor Piles

To avoid the big displacement of PC corrugated sheet piles which may be occurred by the future scouring of canal, the anchor piles connected to PC corrugated sheet pile through tie rods shall be provided at two meter intervals.

Materials of anchor piles are steel shapes H-400×400×13×21. Prior to the start of site works, the Contractor shall submit the method statement for the installation of anchor piles for consultant's approval.

During the installation works, the Contractor shall keep proper position, alignment, elevation and verticality of anchor piles so that tie rods can be kept in proper position and direction.

The tolerance for anchor piles is as follows.

- a) EL (top level): ±50mm
- b) Eccentricity at the center point: within 100mm
- c) Embedment depth: not less than the dimension shown in the Contract Drawings

7.6 Tie Rods

(1) Material

Material for Tie Rods for the connection between PC corrugated sheet piles and anchor piles shall conform to BS 5950 or equivalent, and comply with the following limits.

- a) Grade of bar : Grade355 or equivalent
- b) Diameter : not less than 50mm
- c) Yield Strength : not less than 295N/mm2
- d) Ultimate Tensile Strength : not less than 450N/mm2
- e) Elongation : not less than 17%

The Contractor shall submit the documents for material approval to the Consultant.

(2) Installation

The Contractor shall submit the method statement and the Shop Drawings for the installation of tie rods for the approval by the Consultant.

In the Shop Drawings, the Contractor shall show the connection details between PC corrugated sheet piles and tie rods, and also the details between anchor piles and tie rods.

For the connection with PC corrugated sheet piles, the bearing plate at the edge of tie rod system shall be fixed into the coping concrete at the back of PC corrugated sheet piles. The penetration of tie rods to the canal side and fixing by the walling (H-beam) is not allowed from the point of landscape.

For the connection with anchor pile, tie rods can be connected through the use of prefabricated T-plate or Nut. The T-plate is inserted through a slot cut on a pile flange and the tie rods can be connected with this T-plate by the use of a pin. Alternatively, the penetration hole can be made for the insertion of tie rods and connection by the use of nut. In case of nut, enough thread cutting length of tie rod bar shall be kept.

The adjustment for the length of tie rods shall be carried out properly by rotating the turnbuckle to avoid the sagging on the tie rod assembly.

The welding or heating of the tie rod is not allowed without the approval by the Consultant.

The Contractor shall keep the minimum cover for the tie rods during the embankment not to cause the damage by the heavy equipment to the tie rod.

The dimension of tie rod shall keep right angles to the alignment of PC corrugated sheet piles.

7.7 Column, Roof for Operation Rooms

The columns and the roof structure shall be made by various steel shapes as shown in Contract Drawings.

The Contractor shall submit to the Consultant the documents for material, shop drawings, and the method statement for approval.

The Contractor shall consider the following in his planning.

- The casting of mortar between base-plate of column and floor slab of operation room shall be proceeded after the confirmation of proper elevation and verticality of columns.
- The all connection for the columns and roof structures shall be carried out by the welding.
- The colors of painting shall be finally confirmed by the Client.
- The method statement shall include the plan for the installation procedure of fiber cement corrugated roof sheet and also the scaffolding.

8. MISCELLANEOUS WORKS

8.1 Gabion Mattress

(1) General

The gabion mattress shall be used for the protection of erosion on the bed of existing canal.

(2) Dimensions of gabion mattress

Dimensions	:	2.00 m. length x 1.00 m. width x 0.50 m. height
Mesh type	:	80 mm. x 120 mm.
Wire		Galvanized steel wire x 2.7 mm. diameter BS
		443/1969 or equivalent
Bending wire	:	2.1 to 23 mm. diameter wire
Selvage wire	:	3.4 - 3.5 mm. diameter wire

Weight

14.6 kg in approximate

:

(3) Installation Manner

(a) Assembly

Prior to assembly, the gabion material shall be opened out flat on the ground and stretched to remove all kinks and bends.

The gabion boxes shall then be assembled individually, by raising the sides, ends and diaphragms, ensuring that all creases are in the correct position and that the tops of all four sides are even.

The four corners of the gabion boxes shall be laced first, followed by the edges of internal diaphragms to the sides.

In all cases, lacing shall commence at the top of the box by twisting the end of the lacing wire around the selvage. It shall then be passed round the two edges being joined, through each mesh in turn and securely tied off at the bottom. The ends of all lacing wires shall be turned to the inside of box on completion of each lacing operation.

(b) Erection

Only assembled boxes, or groups of boxes, shall be positioned in the structure. The side, or end, from which work is to proceed, shall be secured either to completed work or by rods or stakes driven into the ground at the corners. These must be secured and reached at least on the top of the gabion box.

Further gabion boxes shall then be positioned in the structure as required, each being securely laced to the proceeding one at all comers and diaphragm points.

(c) Stretching

Final stretching of the gabion boxes shall be carried out using a wire strainer or winch of at least one ton capacity, firmly secured to the free end of the assembled gabion boxes.

Whilst under tension the gabion boxes shall be securely laced along all edges, (top, bottom and sides) and at diaphragm points, to all adjacent boxes. Tightness of mesh, well packed filling and secure lacing is essential in all structures.

(d) Filling

Filling will be carried out by using excavator.

Filling material shall not be less than 100 mm. or larger than 250 mm. and shall be so placed to produce a neat face and line, with a minimum of voids.

(e) Final Wiring

Closing and wiring down of lids shall proceed as soon as practicable after filling operations and certainly in the likelihood of storms or floods during construction.

Lids shall be stretched tight over the filling with bars and wired down securely through each mesh along all edges, ends and diaphragms. The ends all tying and bracing wires shall be turned into the gabion box on completion of all lacing operations. Tightness of mesh, well packed filling and secure lacing is essential in all structures.

(f) Cutting and Folding Mesh

Where shown on the drawings or otherwise directed by the consultant, the gabion mesh shall be cut, folded and wired together to form miter joints, angles, curves or slopes which are not possible to obtain in the structures with the standard rectangular gabions. The mesh must be cleanly cut, and the surplus mesh cut completely out, or folded back or on to, and neatly wired to an adjacent gabion face. The cut edges of the mesh shall be securely laced together with binding wire in the manner specified under assembly above.

8.2 Geotextile Sheet

(1) General

For the protection of scoring of canal, the geotextile shall be fixed under gabion mattress on the sand/clay ground surface.

(2) Technical Specifications

ASTM D 1777	2.9 mm.
ASTM D 4595	24 kN/m
ASTMD 4595	80 - 40%
ASTMD 4632	1400 N
DIN 54307	3850 N
	117 1/sq.ms
ant.	27 1sq.ms
	ASTM D 4595 ASTMD 4595 ASTMD 4632 DIN 54307

Before the installation or sheeting of geotextile on the ground surface, the inspection shall be carried out by the Consultant.

Splicing of geotextile sheet is necessary with 15cm width by using stapler.

Sharp stone or crashed cobble/stone should be taking out at the ground surface by the Contractor before the inspection.

8.3 Timber Pile

(1) Description

This work shall consist of furnishing, driving and trimming timber piles under the foundation of structures or gabion mattress in accordance with details shown on the Contract Drawings and requirements specified herein, or as instructed by the Consultant.

(2) Materials

The kind of timber for piling shall be as shown on the Drawings. All timber piling shall be cut from the trunks of sound live trees, and shall be close-grained, solid, free from such defects as ring shakes, large and loose knots, decay, infestation, and other deformities likely to diminish its strength. Sound knots will be permitted provided the diameter of such knots does not exceed 10 centimeters, or 1/3 the diameter of the pile where the knot occurs. Round piles shall be cut above the ground swell and shall taper from butt to tip. A line drawn from the center of the tip to the center of the butt shall not fall outside of the cross-sectional center of the pile at any point more than 1 per centum of the length of the pile. In short bends, the distance from the center of the pile to a line stretched from the center of pile above the bend to the center of pile below the bend shall not exceed 4 per centum of the length of bend, and in no case exceeding 6-1/2 centimeters. All piles shall be peeled of all rough and inner bark. All knots shall be trimmed close to the body of the

pile. Pile dimensions shall conform to the following requirements:

Length of Pile	Diameter at 1-meter from Butt (cm)	<u>Minimum Tip</u> Diameter (cm)
Not less than 3m	Min. 15 – Max. 18	15

Piles shall be measured for diameter in peeled condition. When the pile is not exactly rounding, the average of three measurements shall be used. For any structure, the butt diameter of piles having the same length shall be as uniform as possible. Square piles shall have the dimensions shown on the Drawings.

(3) Installation

Timber piles will be installed by using excavator or other approved equipment. Driving equipment that damages the piling shall not be used. Piles driven materially out of line and position as indicated on the Shop Drawings shall be pulled and replaced. Deviations in excess of 8 inches out of position shall be rejected.

Cutting off and trimming of timber piles shall be done at the designated elevations. Splicing of timber piles shall not be permitted except by written permission of the Consultant. Piles inaccurately cut off shall be replaced. The sawed heads of all treated piles which are not embedded in concrete shall be brush-coated with 3 applications of hot creosote and covered with hot roofing pitch. The sawed heads of all treated piles to be encased in concrete need not be treated further.

8.4 Stone Masonry (Wet Masonry)

The Contractor shall construct stone walls, headwalls, protections and similar work where shown in the drawings or as instructed by the Consultant. Material for stone masonry shall be sound, durable rock split to true size with parallel, reasonably flat faces : the stones shall be accurately laid covered and bound by means of a 3: 1 sand to cement mortar or concrete –B-. The mortar shall be struck, cleaned of surplus mortar and smoothed by steel trowel or other approved tool. Prior to laying, the stones shall be wetted and cleaned of surfaces dust.

8.5 Filters and Stone Masonry

(1) General

The contractor shall furnish and place stone masonry and material to the prescribed lines and thickness as shown on the Shop Drawings for the protection of the Works and/or elsewhere if required by the Consultant.

Stone masonry and filter material shall be durable stone, gravel and sand. Gypsum, anhydrite, chert, shale and soft or weathered rock will not be acceptable.

(2) Filter

a) Material

Filter underneath weepholes shall be a continuous layer of gravel and shall be placed in separate layers. The gravel shall be composed of tough durable particles, shall be reasonably free from thin, flat and elongated pieces, and shall contain no organic matter or soft, friable particles.

Gravel or crushed stone and sand shall be in accordance with the table below-

Gradation of Filter Materials										
Filter Materials	No.	No.	No.	No.	No.	NO.	No.	3/8"	3/4"	1 1/2,,
Filler Materials	200	100	50	30	16	16 8 4 ^{3/8}		3/0	3/4	1
Coarse Aggregate	-	-	-	-	0-5	10-25	20-40	40-60	65-80	100

Gradation of Filter Materials

b) Subsurface Preparation

Areas on which filter layers are to be placed shall be trimmed and dressed to conform to cross sections shown on the drawings within an allowable tolerance of plus or minus 5 cm. from the theoretical lines and grades.

Areas that are below the allowable minus tolerance limit shall be brought to grade by filling with material similar to the adjacent material and well compacted and no additional payment will be made for any material thus required. Immediately prior to placing the filter material the prepared subsurface will be inspected by the Consultant and no material shall be placed thereon without his approval. Material of the grading or in accordance with the above Table may be produced by screening and processing river gravel or by blending gravel with crushed rock.

(c) Placement

Filter material shall be spread uniformly on the prepared base, to the lines and grades indicated on the drawings or as instructed. Placing of filtering material by methods, which tend to segregate particle sizes, will not be permitted. Any damage to the subsurface caused during placing of the filter shall be repaired before proceeding with the work. Compaction of the filter layers will not be required, but the top surface shall be finished free from mounds or windrows.

8.6 Non-Shrink Mortar

(1) General

Non-shrink mortar shall be used where shown on the drawings or as instructed by the Consultant, for the installation of machinery, equipment, anchor blocks second stage filling and similar works.

The non-shrink filling shall be prepared with Embeco type compound produced by Master Builders Co., or equivalent compound approved by the Consultant.

The Contractor may use both a pre-mixed grout compound and a job mixed compound. In the latter ease the cement and the sand shall comply with the requirement set forth in the Specifications.

The non-shrink mortar shall be composed of sand, cement, non-shrink compound and water.

(2) **Proportioning and Tests**

The Contractor shall proportion the mixtures so as to guarantee a design compressive strength of not less than 270 kg/cm² after 28 days and an absolute non-shrinkage.

The mixtures, the compressive strength tests and non-shrink tests shall be submitted to the Consultant for approval 30 days before using the filling.

The quality of the mixtures will be checked as provided for concrete except for the compressive strength tests. Non-shrink tests shall be carried out according to the instructions supplied by the manufacturer of the non-shrink compound.

(3) Mixing and Placing

Mixing and placing operations including transport, preparation of surfaces, forms, finishing and curing, shall be in accordance with both the general prescriptions in the Specifications of this Volume and the instructions supplied by the manufacturer of the non-shrink compound under the Consultant's approval.

8.7 Gravel Surfacing

(1) Description

The Work under this item shall consist of gravel surfacing placed on the prepared surface for concrete structures and other areas as shown on the Shop Drawings or instructed by the Consultant.

(2) Materials

Gravel shall be crushed stone, crushed slag, or crushed or natural gravel.

The surfacing material shall be free from flat and elongated particles, and generally, particles of the material shall be spherical or cubical in shape. Unless otherwise specified, the maximum size of the material shall be 50 millimeters.

(3) Requirement

The areas where the gravel surfacing to be applied shall be compacted and completed and be subject to the approval to proceed the work by the Consultant.

The gravel surfacing when thoroughly compacted shall conform to the grades and dimensions shown on the Contract Drawings or otherwise established. After the material has been spread, it shall be adjusted in the water content to attain optimum moisture content.

Rolling of the material shall be performed with suitable compaction equipment which shall be subject to the approval of the Consultant. The material shall be compacted to a density of not less than 90% of the maximum dry density.

8.8 Drain Works

(1) General

The work shall consist of the provision of concrete U-shape ditches, catch basins and drain pipes for draining rain water in Han Tra Canal as shown in the Contract Drawings.

(2) Material

U-shape ditch is reinforced concrete structure with dimension of 300 mm×300 mm or 300 mm×300 mm. Concrete for this items shall confirm to Sub-clause 5.1, Class A-1 concrete.

Catch basin is the reinforced concrete tank with dimension of 840mm \times 1,240mm \times 1,620mm.

Drain pipes is precast reinforced concrete pipes as specified in Clause6.4..

In U-shape ditches and catch basins, the Contractor can choose either precast concrete or cast-in situ concrete.

The Contractor shall obtain the material approval relating to the drainage work and submit the method statement prior to site works.

(3) Construction Method

Before the placing U-shape ditches or drain pipes, the leveling by using bulldozer shall be carried out to make the proper gradient towards the drain ditch. The adverse gradient of drain ditches and drain pipe, which prevent the proper function of drain, is not allowed. The gap in construction joints for drain ditches, catch basins and drain pipes shall be properly filled by mortar.

8.9 Sodding

(1) General

Sodding shall be placed on the slopes as shown in the drawings or as instructed by the Consultant. The slope surface shall be lined with square blocks or cuttings of dense grass growth of species approved by the Consultant. The system of sodding required shall be as specified here below.

The sod shall be handled carefully during transportation and placing so that a minimum amount of soil shall be lost from the root mass. The time interval between cutting of sods and placing shall be kept to the practical minimum, and sods shall not be allowed to dry out.

Placement of sod shall begin from the lower portion of the slope and continue upwards.

Immediately after placing, the sodded surface shall be wetted thoroughly and then watered until the grass growth has been reestablished.

Sodding shall be carried out immediately after the finishing of slopes to avoid the erosion by a rainfall. Areas where grass growth will not be reestablished through lack of proper watering on part of that area shall be stripped and new sod will be placed and nursed as described above.

(2) Strip Sodding for Canal Works

The square blocks, with sides of approximately 30 cm, or the strips, approximately 30 cm wide, shall be placed side by side in horizontal rows on the embankments, having a 20 cm free space between rows. This space shall be filled with top soil free of roots, stones or other objectionable matter, the top soil being carefully tamped in place. Strip sodding shall be adopted only on the wider canals on the embankment side a way from the canal and on the slope beside U-shaped gutter as shown on the Contract drawing or as instructed by the Consultant.

8.10 Weepholes

The Contractor shall provide P.V.C. weepholes at the locations shown on the construction drawings or as instructed by the Consultant. All weepholes shall be placed and held accurately in position prior to placing of concrete.

Care shall be taken to avoid clogging the weepholes during the progress of the work and should any weep hole become clogged or obstructed from any cause before the final acceptance of the Works, it shall be cleaned out in an approved manner or replaced by and at the expense of the Contractor.

8.11 Painting

(1) General

This Clause covers all work in connection with the preparation of surfaces and the application of paint in the structure.

No painting shall be applied to stainless steel, copper, bronze, chromium, nickel or brass surface, unless specified or directed by the Consultant.

(2) Definitions

(a) Paint

The term "Paint", as used herein, includes emulsions, enamels, stains, varnishes, sealers and organic protective coating, including all of prime, intermediate, and finishing coats.

(b) Shop Painting

"Shop painting" refers to the coats of paint to be applied in the shop prior to delivery of fabricated items to site of erection or installation.

(c) Field Painting

"Field Painting" as referred to herein covers the application of coats of paint at the construction site. Field painting shall be normally accomplished after erection, except for those surfaces which will be inaccessible after erection.

(d) Touch-up Painting

"Touch-up painting" refers to the application of paint to small areas of painted surfaces to repair mars or scratches ~and restore the coating to an unbroken condition.

(3) Requirements

Work in connection with painting shall include the following:

a) Surface preparation;

b) Cleaning and touch-up of shop applied paint damaged during shipment or installations;

c) Painting of permanent equipment and miscellaneous metalwork.

d) Painting of exposed concrete and wood surfaces, where required.

(4) Cleaning and Preparation of Surfaces

All surfaces shall be cleaned free of rust, grease, dirt and other substances that would prevent adhesion of the paint coating to be applied.

(a) Metal Surfaces

Weld spatter, burrs or other objectionable surface irregularities shall be carefully removed or repaired before cleaning. Any grit or dust shall be brushed or blown off. All oil grease and dirt shall be removed from the surfaces by the use of clean mineral spirits, xylol or white gasoline.

(b) Wood Surfaces

Wood surfaces shall be thoroughly dry, smoothed, and sanded prior to painting. Filling of holes, cracks, and imperfections shall be performed after the first application of undercoat.

(c) Concrete and Plaster Surfaces

All concrete and plaster surfaces for which painting is required shall be cleaned of all dirt, efflorescence, oil, grease and stains, or other foreign substances by means of wire brushing and/or other approved means to provide good adhesion of paint. New concrete surfaces receiving a base coating should be allowed to age for a minimum of 30 days before being painted.

(5) Materials

(a) General

All paints, supplies, and articles furnished shall be the standard products of recognized reputable manufacturers. All constituent materials shall conform to the applicable provisions of ASTM, JIS and other equivalent.

The Contractor shall submit to the Consultant for approval the brand, type and quality certificates of all materials which he proposes to use. Samples of the various materials shall be supplied to the Consultant as requested before materials are delivered to the project.

(b) Colors

All colors shall be factory-mixed pigments which are non-fading, non-bleeding and finely ground. Selection of colors shall be as determined by the Consultant.

(c) Coats

Paints shall be applied in accordance with the following number of prime and finish coats:

Steel:	2 red primers; 2 enamel finish
Wood:	2 undercoats; 2 enamel finish
Concrete Outdoor:	1 masonry filler; 2 catalyzed epoxy fixatives
Plaster & Concrete Indoor:	2 paint finish of ordinary and waterproof paint

Each coat will have a minimum thickness of 100 microns.

The miscellaneous metalwork to be painted will leave the fabricating shop fully painted or protected at least with a coat of primer paint.

After erection the Contractor shall thoroughly clean the damaged areas of shop-painted surfaces and shall touch-up the paint.

Steel which is to be embedded in concrete and metal surfaces against which concrete is to be placed will not be painted but shall be perfectly cleaned prior to embedding.

(6) Paint Application

Except if otherwise specified herein, all paint shall be applied in accordance with the paint manufacturer's recommendations and also client's confirmation. Paint shall not be applied over a previous coat until the surface is dry and hard, and has been approved by the Consultant. All coats shall be applied in such a manner as to produce an even film of uniform thickness completely coating corners and crevices. Each coat of different type of paint shall have a variation in color to identify it from the preceding coat. Paint shall be spread evenly and flow on smoothly without runs, sags, brush marks, or skips. Paints shall also be thoroughly stirred, strained, and kept at a uniform consistency during application. The first coat on surfaces shall be applied by brush. Subsequent coats may be applied by spray or brush. In no case shall any surface be painted upon which moisture condensation is evident.

All exposed concrete surfaces to be painted shall be treated first by brushing with a solution made from a mixture of three (3) pounds zinc sulfate crystals to one (1) gallon of water. After the surface has dried, excess crystal deposits shall be brushed off.

9. SAFETY AND HEALTH MANAGEMENT

9.1 General

(1) Purpose of Safety and Health Management

This specification covers all requirements to achieve safety works which might protect health and lives of workers, and might preserve site materials, equipments and social properties of residents around the site. Such safety management must eventually proceed with project as scheduled.

(2) **Preliminary Survey**

The Contractor shall investigate preliminarily all factors which affect the safety of construction inside and outside of site and shall submit it to the Consultant and the Client; these factors would be the geography, discursion, traffic, surrounding environment, meteorological phenomenon and some other factors.

(3) Safety Management Plan

Safety Management Plan shall consist of a result of preliminary survey, a regime in an association of the Contractor and the authorities concerned, and safety practices in each construction works to avoid accident.

9.2 Regime

(1) Information Network in an Emergency

The Contractor shall set up an information network in an emergency, which includes a chain of order, related parties and related persons with their names, addresses on mobile - or fixed-line telephones, and mobiles or emails of offices and homes.

(2) Expedient Measures

If anticipated the danger, the Contractor shall stop the works, shall evacuate the workers, shall contact with related organizations and shall take necessary measures for safety.

(3) Safety Activity

Safety activities required for the Contractor to implement on daily and monthly basis shall

be as follows.

(a) Morning Assembly

The Contractor shall explain the work descriptions to workers on the day before starting of works at 8 o'clock and call attention to carry on the work safely.

(b) Safety Meeting

The Contractor shall strive to promote the safety management and shall have a meeting for calling attention of safety with not only the Contractor's employees and workers but also the Consultant and the Client's related persons once in every month.

(c) Patrol by a Director and Safety-duty Persons

The contractor, the Consultant and the Client shall make a tour together once in 2 weeks, and inspect sites, shall check on works and shall have meetings for the safety progress of the works. And if the Consultant saw a person working under anti-safety activities like with no helmet or no shoe, shall report it to the Contractor immediately and urge him to improve it. Depending on the situation, the Consultant may issue a site instruction to the Contractor to ensure the implementation of innovation.

(d) Safety Training

The Contractor shall select one of all practice items as shown below, shall allocate a half day for safety training and shall practice this item every month.

- Visual education on safety activities
- Notification of law in connection with safety
- Notification of details of construction works
- Obtaining of methods for safety activities
- Review and evaluation of safety and health activities on last month
- Notification of works and goal on present month and instruction
- Training for disaster in site
- Measures against accidents
- Check of equipments before starting of works
- Safety process meeting
- Supervising in site
- Preparation of works on next day
- Cleaning up of site
- Reporting after works

9.3 General Requirement

(1) Working Outfit

Every worker shall wear a helmet, working uniform and glove. Cuffs of working uniform and hems of trouser shall be fastened up while at work.

(2) Consideration of Environment at Work

The Contractor shall give consideration to working environments for workers so as to be far from bad ventilation, big noise, operation of equipment in small space, lack of oxygen and working in danger area.

(3) Temporary Fencing

The Contractor shall check on the preventive measures from neighborhood residents' and passengers' invasion of the site by setting up temporary fencings and sign boards which can make clear a construction area with temporary construction yards. A height of temporary fence shall be higher than 1.8m.

(4) Gateway

The Contractor shall employ gate keepers to keep safety at entrances and exits from vehicles passing through.

(5) Allocation of Watchers and Traffic Guides

The Contractor shall allocate the watchers to watch out for work conditions and the traffic guides to draw on vehicles in the sites in correspondence with the progress and the condition of construction works.

(6) **Prevention of Fall Accident**

The Contractor shall set up nets, sheets and pipes to prevent fall accidents of workers and tools from heights. In case of working in heights the workers shall strap in safety belts with ropes fixed to safety facilities.

(7) Clearing up of Site

The Contractor shall tidy up materials, tools and equipments with zoning for them in sites not to cause accidents.

(8) Taking Measures against Bad Weather

The Contractor shall take necessary measures against bad weather: collecting of information, notifying to workers, checking sites, managing to prevent from damage and, if necessary, stopping the works.

(9) Taking Measures against Fire

The Contractor shall appoint a person in charge of fire protection, and shall check a site office, rest houses and other facilities at fixed interval.

(10) Hazardous Material Management

The Contractor shall appoint a person in charge of hazardous material management.

(11) **Protection of Existing Houses and Utilities**

The Contractor shall carry out the necessary protection works against the possible damage to existing houses and utilities, roads and railways. In addition, the Contractor shall carry out the monitoring such as measurement of crack, displacement, and settlement during the construction activities.

9.4 Management in Site

(1) Notification of a Construction Plan and Chain of Command.

The Contractor shall notify a construction plan and chain of command to workers early on.

(2) Emergency Treatment

The Contractor shall notify an information network in an emergency and methods to treat the problems.

(3) Underground Installation

The Contractor shall grasp the accurate information about underground installations to achieve safety excavation and shall make sure of a profile of a new pipeline. The underground installations shall be protected from excavating.

(4) Equipment

The Contractor shall use cautions for workers to work in operation of equipments.

(5) Unloading and Loading of Large Equipments

The Contractor shall select a flat, hard and wide area for unloading and loading of large equipments from a board to avoid accident due to turnover.

(6) Transportation

The Contractor shall fix large equipments tightly on a carrier to avoid tumbling down while passing by rough roads.

The Contractor shall check the road conditions and areas along the roads, and shall set up sign boards necessary for the safety at transportation in and out of the site.

(7) Setting Up of Lighting Facility

The Contractor shall set up sufficient lighting facilities in night work.

9.5 Operation of Movable Crane

(1) Selection of Movable Crane

The Contractor shall select a movable crane carefully with a performance chart, and operate the crane after checking the bearing capacity of ground or the deformation of a temporary bridge based on. The movable crane shall be set flatly and its outriggers shall be stretched at the maximum range. The plate underneath the outriggers shall be set to avoid falling down.

(2) Signal

The Contractor shall appoint a person in charge of signal. He shall check the weights of all hanging tools and a beam, and shall confirm the stability of beam and the safety of person and facilities when the crane swirls around with a signal.

(3) Sling Work

The Contractor shall compute the weight that a sling hangs on, and shall check the safety of ropes and sling facilities.

(4) Correspondence to Bad Weather

The Contractor shall prepare the operation-stop baseline depending on the conditions of bad weather like big wing, heavy rainfall and heavy snow and shall submit it to the Consultant.

9.6 Temporary Work

(1) Grasp of Surrounding Environment

The Contractor shall grasp the conditions such as site, construction requirements, surroundings environment and buried objects (underground installations) to reflect on a temporary work plan.

(2) Qualities of Materials

The Contractor shall check the qualities of materials using for the temporary works.

(3) Berm

In case of excavation exceeding the height of 5.0 m, the Contractor shall make a berm of 1.0 m width to resist earth pressures and prevent collapse of slope. If the Contractor found some abnormalities while working including excavating, he shall evacuate all workers nearby to outside immediately.

(4) After Bad Weather

The Contractor shall check the face of slope after bad weather, and shall restart the construction works after verifying the safety.

(5) Scaffolding

Scaffoldings is necessary at the place where the height of structure exceeds 2.0m.

Scaffoldings shall be designed for workers not to fall down, and the Contractor shall make known maximum loads of them to workers. Prior to the commencement of the works where the scaffolding is necessary, the Contractor shall prepare the detailed drawings for the scaffoldings.

The Contractor shall maintain the handrail or safety rope during the erection or dismantling of scaffolding.

In addition, the countermeasure against the ground settlement shall be taken by using timber board beneath the scaffoldings.

(6) Safety Approach

The Contractor shall install safety approaches at the area which leads to work places or at work places. Safety ladders shall be installed at the place where the height or depth exceeds 1.5m.

(7) Temporary Closure

The Contractor shall review the Drawings of temporary closures from a view point of safety from living watercourses and their water levels. After the temporary closure, the Contractor shall conduct the monitoring of displacement periodically.

9.7 Earthwork/Piling Works

(1) Grasp of the Geography and Geology

The Contractor shall grasp the conditions of the geography and geology, and shall check on the

gradient of excavation slope in earthwork.

(2) Plan for Safety

The contractor shall make a plan of the procedure of excavation, the arrangement of equipments and workers, and the way of transportation of soil and equipments to insure safety in construction.

(3) Watching of Slope Face

The Contractor shall watch the condition of slope face to avoid accident due to collapse of slope. If there is some possibility of collapse, the Contractor shall report to the Consultant and shall cope with the issue appropriately.

(4) Gradient of Excavation of Slope

The Contractor shall keep the safe gradient of excavation slope based on the actual soil condition.

(5) Temporary Storage Space

In storage of excavated soil at the top of slope, the Contractor shall take care of the collapse of slope and the fall of soil.

(6) Machinery Excavation

The Contractor shall take care of an operation area of equipments, and shall forbid some workers to enter the area, and shall not place the equipment beside the top of slope.

(7) The Works Adjacent to Railway and Roadway

The Contractor shall not carry out the piling works near railway during the operation hour. The Contractor shall choose the method to avoid the displacement of railway. The Contractor shall carry out the monitoring of railway.

The Contractor shall arrange the traffic guards during the piling works near existing public roads. Traffic flow shall be temporarily stopped at the time of turn and setting of piles by using vibratory hammer.

9.8 Concrete Work

(1) Notification of Dangerous Place

In case of concrete placing with a bucket using a crane, the Contractor shall take care for workers not to enter under the moving bucket.

(2) Reinforcing Work

A long bar shall be carried at least by two workers. While carrying, workers shall take care not to touch other workers.

(3) Form Work

Numbers of Joint of a pipe support shall not exceed 2. A joint shall be fixed tightly with 4 or more bolts, or specific clasps. Materials used for forms shall be standard products, and the Contractor shall check these materials.

The Contractor shall check on the hardness of form and support structures before

concrete placing.

The Contractor shall dismantle the forms safely and shall take off nails immediately from forms.

(4) Concrete Placing

The Contractor shall allocate a pump truck with outriggers stretched to avoid the turnover of a truck and the swing of a hose.

The Contractor shall check the forms and supports before concrete placing.

The ways of sending signals between a pump truck operator, a director and workers shall be made clear before concrete placing.

The Contractor shall place concrete uniformly and gradually not to happen eccentric pressures on the forms.

9.8 Road Work

(1) Investigation of Environment

The Contractor shall investigate 4 items and shall report to the Consultant before road works: traffic, an environment, a carry-in route and a storage place of materials.

(2) Allocation of Guards and Traffic Guides

The Contractor shall allocate the guards to protect workers and pedestrians from traffic accident, and the traffic guide to draw on vehicles in the sites. The Contractor shall set up information signs to well know the construction works and area to passengers before starting of works, and road traffic signs to draw on vehicles.

The Contractor shall set up security lightings along the road or the related area, which has a height of some 1 m at an interval of some 2 m.

(3) Off-Limit Display Sign

The Contractor shall set up off-limit display signs for passengers not to enter the working area in pavement work.

(4) Safety Vest

Workers shall wear safety vests in night work.

SECTION 7-2

HYDRAULIC GATE WORKS

7-2 HYDRAULIC GATE WORKS

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1. GENERAL

1.1 Scope of Works

The Scope of Works to be done under this Contract shall consist of the detailed design, manufacture, anti-corrosive protection, shop tests and inspection, packing, ocean & inland freight, customs clearance, site storing, field erection and installation, field tests and inspection, adjustment, commissioning (acceptance tests), operational & maintenance training, defect remedy during warranty period, defect inspection, and after-sales services of the Hydraulic Gates to be provided in the Project.

The Hydraulic Gate Works for the new construction of Kra Mang and Han Tra Floodgates consist of the following components;

- Stainless steel fixed wheel gate leaves	3 sets each for Kra Mang and Han Tra
- Stainless steel fixed wheel gate guides	- ditto -
- Motorized wire rope winched gate hoists	- ditto -
- Steel maintenance gate leaves	3 leaves \times 2 for Kra Mang
	5 leaves × 2 for Han Tra
- Stainless steel maintenance gate guides	6 sets each for Kra Mang and Han Tra
- Steel telpher rails	2 sets each for Kra Mang and Han Tra
- Manual chain hoists and lifting beams	- ditto -
- Electric wirings and boards	1 set each for Kra Mang and Han Tra
- Lighting facilities	- ditto -
- Lightning arresters	- ditto -
- Engine generators	- ditto -
- Water level gauges and data loggers	2 sets each for Kra Mang and Han Tra
- Stainless steel fixed wheel gate leaf	1 set for drainage channel at Kra Mang
- Stainless steel fixed wheel gate guide	- ditto -
- Manual racked gate hoist	- ditto -
- Spare parts	As specified in this Specifications

The components or equipment of the hydraulic gates shall be designed to endure long periods of operation without substantial repair or replacement of the parts. Hence, the components or equipment of the hydraulic gates shall be products of the manufacturer(s) that have professional engineers, workshops and successful experiences in the business.

It shall be understood that all works associated with the Hydraulic Gate Works which are not particularly prescribed or specified on the Tender Drawings or Specifications herein, but which are reasonably inferred as necessary or indispensable for the complete, safe, and satisfactory operation thereof in the Project, shall be included in the Contract.

1.2 Location of the Project Sites

The Project sites are located as follows;

- Han Tra Floodgate

Ayothaya town, Phra Nakhon Si Ayutthaya District, Phra Nakhon Si Ayutthaya Provence.

- Kra Mang Floodgate

Ayutthaya city, Phra Nakhon Si Ayutthaya District, Phra Nakhon Si Ayutthaya Provence

1.3 Country of Origin and Standards

The components of the Hydraulic Gate Works to be procured under this Contract shall be the products of Japan and/or Thailand. The manufacturer(s) as Subcontractor(s), for the Hydraulic Gate Works, of the Contractor assuming the whole Work shall be limited to Japanese juridical persons who are prequalified in the prequalification.

Hereafter, the Contractor shall include his Subcontractor(s) who shall manufacture and install the components and equipment of the Hydraulic Gate Works.

All the components or equipment of the Hydraulic Gate Works shall conform to the following standards wherever applicable.

- Thai Industrial Standards (TIS)
- Japanese Industrial Standards (JIS)
- Japan Association of Dam & Weir Equipment Engineering
- International Electrotechnical Commission (IEC)
- Japan Electrical Manufacturers' Association (JEM)
- Japanese Electrotechnical Committee (JEC)
- International Organization for Standardization (ISO) 9001
- Other relevant and applicable codes and standards of Thailand and Japan

Other internationally prevailing standards such as EN, BS, ANSI and DIN are accepted for the components or equipment, unless otherwise indicated. All dimensions and performance of the components or equipment shall be generally in metric system, unless otherwise specified in these Specifications.

1.4 Working Specifications, Detailed Design Calculations, Shop Drawings and Work Schedule to be Submitted

Before commencement of manufacturing the component or equipment of the Hydraulic Gate Works, the Contractor shall submit three (3) copies of the documents including the Working Specifications, Detailed Design Calculations, Shop Drawings, Work Schedule, and other necessary information for approval of the Consultant.

These documents shall be permitted correction and/or modification to be made, if such are deemed to be necessary and /or are instructed by the Consultant, without delay of the completion of the Work.

The components or equipment of the Hydraulic Gate Works to be furnished under this Specification shall be essentially the standard products in regular works by the Contractor.

1.5 Operational Rule of the Floodgates

(1) Tentative idea of operational rule

Water levels of the Canals upstream Han Tra and Kra Man Floodgates shall be respectively controlled not to exceed +3.5m MSL as HWL.

The gate openings of Han Tra and Kra Man Floodgates will be proposed to maneuver as following tentative idea.

Full close at +2.6m MSL in rising stage —> Partial open and close not to exceed +3.5m MSL—> Full open at +2.6m MSL in descending stage

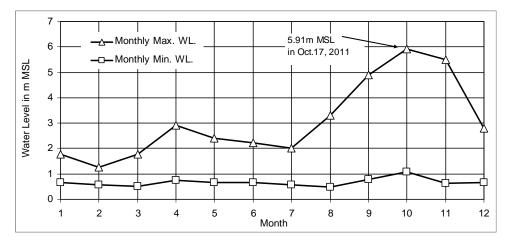
The operational rule of Han Tra and Kra Man Floodgates and Drainage Pump Vehicles procured under this Contract, linking with the existing Suan Plu Gate and Supachai Pumping Station, shall be discussed and established involving the officers of Phra Nakhon Si Ayutthaya District in the Management Guidance of the Consulting Services under the Project

(2) Design water levels

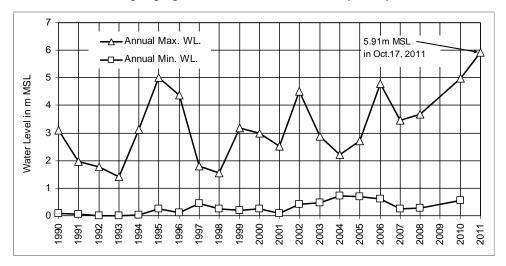
The design water levels for Han Tra and Kra Mang Floodgates are as follows,

Water levels at upstream (Canal side)					
High Water Level (HWL):	EL. +3.5 m MSL				
Low Water Level (LWL):	EL. +0.5 m MSL				
Water levels at downstream (Pasak Rive	er side)				
Height Water Level (HWL):	EL. +6.0 m MSL				
Low Water Level (LWL):	EL. +0.5 m MSL				
Sill elevation					
Han Tra Floodgate:	EL2.5 m MSL				
Kra Mang Floodgate:	EL0.5 m MSL				

The following tables show the water levels recorded at RID S5 gauging station of Pasak River in Ayutthaya since 1990 just after the completion of Pasak Dam. In October 17, 2011, the S5 gauging station recorded +5.91m MSL which is the overwhelmingly highest since the start of level gauging in 1950.



Month-water level relation since 1990 at S5 gauging station of Pasak River in Ayutthaya



Annual max. and min. water level since 1990 at S5 gauging station of Pasak River in Ayutthaya

1.6 Erection, Installation, Tests, Inspection, Commissioning and Training

The Contractor shall submit three (3) copies of the Operation and Maintenance Manual including individual components and equipment of the Hydraulic Gate Works.

The Contractor shall assign mechanical engineers and electrical engineers to the sites for the supervision of the field erection and installation of the components and equipment furnished under the Contract, and for the field tests & inspection, adjustment, and commissioning (acceptance tests). The number of the supervisory engineers and their assignment periods are necessary for Consultant's approval.

The Contractor shall also be responsible for the training on the operation & maintenance to the concerning personnel of the Client during their supervisory period.

1.7 Name Plates and Stickers

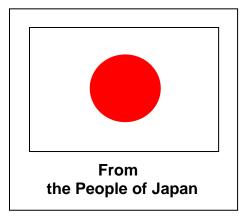
(1) Name Plates

Each components and equipment (hoist motors, speed reducers, brakes, racked hoists, chain hoists, lifting beams, control panels, switchboards, distribution boards, lighting fixtures, etc.) shall have a standard name plates securely affixed thereto in a conspicuous place, showing the name, type and model of equipment, production serial number, date of manufacture, the manufacturer's name and all other necessary information to complete identification, in English or Thai.

(2) Stickers

The Contractor shall provide stickers as shown below for each component of the Equipment, except for small parts and materials. The stickers shall be made of aluminum. It should be an adequate size considering the dimension of each product. The design, material and dimensions of the stickers shall be submitted to the Consultant for prior approval.

Type of font: Futura Bold Component of color: DIC156 (red), black, white



1.8 Packing and Shipment

(1) Packing

The components and equipment of the Hydraulic Gate Works imported from Japan to the Kingdom of Thailand shall be packed as per the following during ocean and inland freight.

Contents of each shipping package for the parts of the components and equipment shall be itemized on a detailed list showing the exact weight and extreme outside dimensions (length, width and height).

- (a) One (1) copy of the detailed packing list shall be enclosed in each package. There shall also be enclosed in one (1) package a master packing list summarizing and identifying each individual package.
- (b) The box number in which the master packing list is contained should be shown on each packing list.
- (c) All parts shipped must be legibly identified by tags, labels or inscription in indelible ink, strictly in accordance with the reference mark or parts number of the components and equipment or the assembly drawings.

(d) On wood, plywood, veneer cases, barrels or kegs, all marks shall be applied by stencil with waterproof inks or oil paints and these marks shall be protected against weathering by clear water resistant varnish.

Marking on each package shall consist of the following information.

- Consignee: The Contractor and/or his Subcontractor(s)
- Final user: Royal Irrigation Department (RID)
- Name of the Project:
- Port of disembarkation:
- Item number, package number in sequence, and quantity per package:
- Description of item:
- Net and gross weight and cubic measurement:
- Shipper's name (and Supplier's name, if Shipper is different from Supplier):
- Caution marks, if applicable:
- Other markings required by the Client:
- (2) Shipment and Delivery
 - (a) The Contractor shall ship and deliver all components and equipment of the Hydraulic Gate Works to the Sites in adequate time for its preparation, erection and installation according to the approved implementation plan.
 - (b) No part of the components and equipment shall be shipped and delivered to the Sites until approval in writing by fax and/or electronic mail has been obtained from the Consultant for such delivery.
 - (c) Notification of such shipping and delivery shall be given to the Consultant in writing not later than 7 days prior to the scheduled shipping date for any components and equipment to be shipped.

Shipping advice for the parts of the components and equipment imported from Japan shall be sent by courier, electronic mail or be handed to the Consultant prior to the on-board date of the Bill of Lading, containing such information as loading and unloading port, date of departure and arrival, name of vessel, and one (1) photocopy of the following documents.

- Clean On Board Ocean Bill of Lading
- Signed Commercial Invoice
- Packing List
- Insurance Policy

1.9 Insurance

All components and equipment of the Hydraulic Gate Works to be supplied under the Contract shall be fully insured against loss or damage incidental to manufacture or acquisition, transportation, storage and delivery.

The insurance shall cover the full period of shipment and transportation from Japan to the Project sites until the Client approves the Certificate of Completion of the Work to the Contractor.

1.10 Import Charges

The Contractor shall bear import charges from Japan to the Kingdom of Thailand such as shipping charge, customs clearance charge, terminal handling charge, port charge, crane charge, storage charge, ocean freight and inland transportation etc. except for internal taxes, such as customs duty and value added tax, imposed in the Kingdom of Thailand.

All taxes and duties imposed outside the Kingdom of Thailand shall be born by the Contractor, if any.

1.11 Maintenance Tools

One (1) set of maintenance tools such as the following required for the installation, overhauling and assembly of the equipment in this Contract shall be furnished by the Contractor.

-	Open-end wrenches	1 set
-	Screw drivers	1 set
-	Hex keys	1 set
-	Pliers	1 no.
-	Socket wrench and sockets	1 no.
-	Adjustable wrench	1 no.
-	Hand hammer	1 no.
-	Flat file	1 no.
-	Round file	1 no.
-	Flat chisel	1 no.
-	Grease gun	1 no.
-	Oilcan	1 no.
-	Others necessary	
-	Tool box to house the above	1 no.

1.12 Spare Parts

Spare parts listed below, which are necessary for repair, shall be supplied stowing in the longlife spare parts box. Furthermore, electronic parts shall be put in a moisture-proof box.

(1) Han Tra Floodgate

Main gate

 Indicating lamps 	100% of actual number
- Control circuit fuses	100% of actual number
- Auxiliary relays	1 piece per type
- Breakers and contactors	1 piece per type
- Space heater	1 set for one (1) local control panel
- Rubber seals	1 set for one (1) gate leaf
- Bolts, nuts and washers to	1 set for one (1) gate leaf
fasten rubber seals	
- Wire ropes	1 set for one (1) hoist system

- Hoist motor with electromagnetic brake 1 set for one (1) hoist system - Grease nipples and cups 1 set for one (1) hoist system - Spare parts box 1 set Stoplog (maintenance gate) - Rubber seals 1 set for five (5) gate leaves - Bolts, nuts and washers to 1 set for five (5) gate leaves fasten rubber seals (2) Kra Mang Floodgate Main gate - Indicating lamps 100% of actual number - Control circuit fuses 100% of actual number - Auxiliary relays 1 piece per type - Breakers and contactors 1 piece per type - Space heater 1 set for one (1) local control panel - Rubber seals 1 set for one (1) gate leaf - Bolts, nuts and washers to 1 set for one (1) gate leaf fasten rubber seals - Wire ropes 1 set for one (1) hoist system - Hoist motor with electromagnetic brake 1 set for one (1) hoist system - Grease nipples and cups 1 set for one (1) hoist system - Spare parts box 1 set Stoplog (maintenance gate) - Rubber seals 1 set for three (3) gate leaves - Bolts, nuts and washers to 1 set for three (3) gate leaves fasten rubber seals Gate for drainage channel - Rubber seals 1 set for one (1) gate leaf - Bolts, nuts and washers to 1 set for one (1) gate leaf fasten rubber seals 1.13 Tests, Inspection, Adjustment, Commissioning and Training

The following works on the tests, inspection, adjustment, commissioning and training shall include in the Contract.

(a) Shop Tests and Inspection

The components and equipment of the Hydraulic Gate Works shall be tested and

inspected by the Contractor and/or his Subcontractor(s) prior to their shipment and delivery. Shop inspection shall be required in the presence of the Consultant and also the Client when it deemed necessary by him and is conducted in the Kingdom of Thailand. Manufacturers' shop inspection results and their certificates shall be submitted by the Contractor to the Consultant before shipment and delivery.

If the components and equipment fail to conform to the Specifications as a result of such inspections, the Consultant may reject them and the Contractor shall either replace the rejected components and equipment, or make all alterations necessary to meet the requirements.

(b) Adjustment

The components and equipment shall be brought into suitable conditions by the Contractor and/or his Subcontractor for giving the specified performance at site. The Contractor and/or his Subcontractor shall make proper adjustment to settle the components and equipment into specified conditions for performance. All works must be done to the satisfaction of the Client, and the Contractor and/or his Subcontractor shall carry out his work in a neat and proper workmanlike manner. The adjustment shall be planned and carried out in no way to damage the components and equipment. All tools, fuel, materials, labors, logistics etc. shall be provided by the Contractor and/or his Subcontractor.

(c) Commissioning (Acceptance Tests)

The Contractor and/or his Subcontractor shall check all components and equipment to ensure that their conditions are good and adequate for giving the specified function. Commissioning (acceptance tests) at sites shall be required in order to check the function of the Hydraulic Gates in the presence of the Client and the Consultant before finally handing over to the Client.

The Contractor shall submit the commissioning plan and result report to the Client through the Consultant's approval thereof.

All tools, fuel, materials, labors, logistics etc. shall be provided by the Contractor and/or his Subcontractor.

After completion of the commissioning with satisfactory results, the Client shall approve the Certificate of Completion of the Contractor, and then one (1) year warranty period will starts.

(d) Operational and Maintenance Training

The Contractor shall provide operational and maintenance training work with a target to the concerning personnel of the Client in order to transfer the technical knowledge on operation and maintenance of the Hydraulic Gates.

The period for the operational and maintenance training shall total five (5) days including the commissioning.

The program and materials thereof shall be prepared in Thai or English and provided by the Contractor with approval by the Consultant. All tools, fuel, materials, labors, logistics etc. shall be provided by the Contractor and/or his Subcontractor.

1.14 Warranty and After-Sales Services

The Contractor shall make necessary arrangement with eligible agent(s) who have sufficient stock of spare parts and after-sales service facilities.

In order to provide satisfactory maintenance service even after one (1) year warranty period, the Contractor shall keep a close contact with his Subcontractor and submit a list of the maintenance service agent(s) for the following services.

- (a) The Contractor through his Subcontractor(s) shall remedy, at his own expense, any defects against which the Work is warranted, by making all necessary repairs or replacements except in the case that such defects result from the Client's negligence or failure during the one (1) year warranty period.
- (b) The Contractor shall guarantee to supply the spare parts of the components and equipment used for the Hydraulic Gates Works under the Contract through the agent(s) upon request by the Client at cost basis for a period of two (2) years after the one (1) year warranty period.
- (c) In case of major breakage, which is hard to repair by the local agent(s), the Contractor shall send his Subcontractor or manufacturer's engineer(s) to the site designated by the Client within one (1) week after the request by the Client to repair such breakage at cost basis. Such services shall be guaranteed for a period of two (2) years after the one (1) year warranty period.

2. DESIGN CRITERIA AND PARTICULARS

2.1 Design Loads

2.1.1 General

The Hydraulic Gate Works shall be designed with the worst possible combinations of the acting loads. The combination of loads for each equipment and structure under normal and over loading conditions shall be described in details in this Section according to the frequency or occurrence of load and probability of their coincidence.

The loads specified herein shall be considered as minimum and essential requirements and the loads and their combinations other than the specified shall be examined by the Contractor in the detailed design of the Hydraulic Gate Works.

2.1.2 Gate Leaf, Gate Guide and Stoplogs

The gate leaves, gate guides and stoplogs (or maintenance gates) shall be designed for the combination of the following loads:

(1) Hydrostatic load

The components and equipment of the Hydraulic Gate Works shall be designed to function against hydrostatic load due to the water level difference between upstream and downstream sides of the gates.

(2) Sedimentary pressure load

Sedimentary pressure load is not considered.

(3) Wave height during earthquake

Wave height during earthquake is calculated by Dam facility technical standards in Japan Page 52.

$$he = \frac{kh \times \tau}{2\pi} \sqrt{g \times H}$$

where,

he	:	Wave height	(m)
Kh:		Horizontal seismic intensity in Ayutthaya	0.1
т	:	Earthquake period	1.0 (sec)
Н	:	From sill elevation to design water level	(m)

Kra Mang

$$he = \frac{kh \times \tau}{2\pi} \sqrt{g \times H} = \frac{0.1 \times 1.0}{2 \times 3.14} \times \sqrt{9.8 \times \{6.0 - (-0.5)\}} = 0.13m$$

<u>Han Tra</u>

$$he = \frac{kh \times \tau}{2\pi} \sqrt{g \times H} = \frac{0.1 \times 1.0}{2 \times 3.14} \times \sqrt{9.8 \times \{6.0 - (-2.5)\}} = 0.15m$$

(4) Wind load

The wind load shall be at the basic wind pressure of 1.5 kN/m^2 (150kgf/m^2) for a vertical projected area with its multiplication shape factors as below:

- For plane surface: 1.2
- For a cylindrical surface: 0.7
- For lattice member, at front side: 1.6
- For lattice member, at rear side: 1.2

2.1.3 Hoist

The stationary type hoist shall be designed for the combination of the following loads:

- (a) Dead weight of the gate leaf and ballast weight, if any
- (b) Friction force due to rotating and/or sliding parts
- (c) Friction force due to rubber seals
- (d) Friction force due to sediment if any
- (e) Buoyancy
- (f) Uplift force and down-pull force
- (g) All loads imposed by gate jammed condition during raising operation

Closing force of all gates except for those operated by spindle type hoist shall have an allowance of more than 25 percent against all upward forces such as friction forces and buoyancy, etc., in any gate openings under any water level. If there is a lack of the closing force, the ballast may be provided to the leaf. The ballast shall be made of the steel or other approved materials by the Consultant.

2.1.4 Loadings

- (a) Staircase : 3.5 kN/m² crowd load
- (b) Service load : T-14 tf vehicle load
- (c) Handrail : 2.5 kN/m² horizontal thrust

2.2 Materials

2.2.1 General

All materials to be used for the Hydraulic Gate Works covered in this Clause shall be new and of high quality, selected particularly to meet the duties required for the proper operation of the Hydraulic Gate Works, and indicated fully in the Contractor's detailed drawings for approval.

The materials shall meet with the requirements in the latest Japanese Industrial Standards (JIS), American Society for Testing and Materials (ASTM), Thailand Industrial Standards (TIS) listed herein or equivalent and/or better in quality or as approved in advance by the Consultant, unless otherwise specified.

2.2.2 Materials to Be Used

Materials to be used for the Hydraulic Gate Works shall be equivalent or superior to those tabulated below.

Components	Parts used	Names of material (symbols)		
	Skin plate	SUS304		
Gate	Girder	SUS304		
leaves	aves Main wheel SUS630 or other SUSs with HB of 250			
	Main wheel shaft	SUS304		
	Main wheel bearing	Oil less metal		
	Side wheel	SUS304		
	Sheave	SCS13		
	Seal rubber	Synthetic rubber		
	Seal clamp bar	SUS304		
	Bolt, nut and washer	SUS304		
	Others	As approved by the Consultant		
	Removable gate guide	SUS304		
Gate	Wheel rail	SM400		
guides	Sill beam	SM400		
	Lintel beam	SM400		
	Seal plate	SUS304		
	Guide plate	SUS304		
	Main wheel track	SUS630		
	Bolt, nut and washer	SUS304		
	Others	As approved by the Consultant		

(1) Main gates of Kra Mang and Han Tra Floodgates

	Drum	SM490
Hoists	Drum gear	SCM435
	Pinion gear	SCM440
	Sheave	FC250
	Shaft	S45C
	Machine frame	SS400, SM400
	Wire rope	SUS304
	Others	As approved by the Consultant

(2) Stoplogs (maintenance gates) of Kra Mang and Han Tra Floodgates

Components	Parts used	Names of material (symbols)
Gate leaves	Skin plate Girder Seal rubber Seal clamp bar Bolt, nut and washer Others	SM400 SM400 Synthetic rubber SUS304 SUS304 As approved by the Consultant
Gate guides	Sill beam Seal plate Side gate guide Side plate Bolt, nut and washer Others	SM400 SUS304 SUS304 SUS304 SUS304 As approved by the Consultant
Lifting beams	Girder Shaft Others	SM400 S45C As approved by the Consultant
Telpher rails	Girder Bolt and nut	SS400 SS400
Chain hoists	Load chain	Anti-corrosive special alloy

(3) Gate for drainage channel at Kra Mang Floodgate

Components	Parts used	Names of material (symbols)
Gate leaf	Skin plate Girder Main wheel Main wheel shaft Main wheel bearing Side wheel Hanger Seal rubber Seal clamp bar Bolt, nut and washer Others	SUS304 SUS304 SUS304 Oil less metal SUS304 SUS304 SUS304 Synthetic rubber SUS304 SUS304 As approved by the Consultant
Gate guide	Removable gate guide Wheel rail Sill beam Seal plate Guide plate Side guide	SUS304 SS400 SUS304 SUS304 SUS304 SUS304

	Main wheel track Bolt, nut and washer Others	SUS304 SUS304 As approved by the Consultant
Hoists	Rack bar Rack bar coupling Center guide Others	SUS304 SUS304 SUS304 As approved by the Consultant

2.2.3 Castings

All castings weighing 226.8 kilograms (500 pounds) or more shall have test coupons attached from which test specimens may be prepared. The number, size and location of the test coupons shall be to the approval of the Consultant. Faulty material or materials found to be inferior to that specified shall be rejected and removed at once, and shall not be used in any part of the Hydraulic Gate Works.

All castings shall be dense, sound and true to pattern, of workmanlike finish and of uniform quality and condition, free from blowholes, porosity, hard spots, shrinkage, cracks or other injurious defects, and shall be satisfactorily cleaned for their intended purpose. All castings shall be checked for defects before final machining.

Casting shall not be repaired, plugged, or welded without permission of the Consultant. Such permission will be given only when the defects are small and do not adversely affect the strength, use or machinability of the castings. Excessive segregation of impurities or alloys at critical points in a casting will be cause for its rejection. The largest fillets compatible with the design shall be incorporated wherever a change in section occurs.

Surfaces which do not undergo machining and are exposed in the final installation shall be dressed to provide a satisfactory appearance so that they will not require surface smoothing at Site prior to painting.

2.2.4 Forgings

The ingots from which the forging are made shall be cast in metal moulds. The workmanship shall be first-class in every respect and the forging shall be free from all defects affecting their strength and durability, including seams, pipes, flaws, cracks, scales, fins, porosity, hard spots, excessive nonmetallic inclusions and segregation.

The largest fillets compatible with the design shall be incorporated wherever a change in section occurs. All finished surfaces of forging shall be smooth and free from tool marks.

The forging shall be clearly stamped with the heat number in such location as to be readily observed when the forging is assembled in a complete unit.

2.2.5 Standard for Steel Plates, Bars and Pipes, etc.

(a)	Steel plates for skin plate, structural main parts, except for rolled steel shape of gate leaves	JIS G 3106, SM400 B, SM490 B or JIS G 3101 SS 400 or ASTM A516 Grade 60,70 or SNI 0552-89-A or equivalent
(b)	Steel plates for general structures	JIS G 3101, SS400 or ASTM A 36 or SNI 0552-89-A or equivalent
(c)	Steel shapes	JIS G 3192 and JIS G 3101 SS400 or ASTM A 6 or SNI 0945-89-A or equivalent
(d)	Steel bolts, nuts and washers	JIS B 1180, B 1181 and B 1256 or

- (e) High-strength steel hexagon bolts, hexagon nuts and plain washers
- (f) Corrosion-resisting steel bolts, nuts and washers
- (g) Corrosion-resisting steel plates, bars etc.
- (h) Corrosion-resisting clad steel plates
- (i) Spring lock washers
- (j) Steel pipe for air and water piping (galvanized)

2.2.6 Standard for Castings

- (a) Gray iron castings
- (b) Steel castings
- (c) High tensile strength carbon steel castings and low alloy steel castings
- (d) Bronze castings
- (e) Phosphor bronze castings
- (f) Corrosion-resisting cast steels for general applications
- (g) Steel castings for welded structures

2.2.7 Standard for Forgings

(a) Carbon steel forgings JIS G 3201, SF490A or ASTM A 668, Class E 50 or SNI 1855-90-A or equivalent

2.2.8 Rubber Seals for Gates

Seals shall be designed and mounted in such a manner that they are adjustable, water tight and shall be readily removed and replaced. Seals shall be molded. Extruded seals will not be permitted. Where seals are installed curved, they shall be clamped in a jig which will form them to the proper radius before the holes are laid out and drilled, and the ends trimmed. Holes in related parts of the seal assemblies shall be carefully drilled, using a template, to assure proper matching when the seal units are assembled. The seals shall be spliced at the corners to provide effective continuity of sealing of the gates. The tensile strength of all splices shall not be less than 50 percent of tensile strength of the un-spliced material.

JIS B 1186 or ASTM A 325 or SNI 0541-89-A or equivalent

JIS G 4303, 4304, 4305, 4306 and G 4307 or ASTM A 276, Type 316 or equivalent

JIS G 4303, 4304, 4305, 4306 and G 4307 or ASTM A 167 or equivalent

JIS G 3601 or ASTM A 264 Type 304 or equivalent

JIS B 1251 or SNI 0571-89-A or equivalent

JIS G 3452 SGP or JIS G 3454 STPG or equivalent

JIS G 5501, FC 200 or ASTM A 48, class 30 or SNI 0813-89-A or equivalent

JIS G 5101, SC450 or ASTM A27/A (to be fully annealed), U - 60 - 30 or SNI 1812-90-A or equivalent

JIS G 5111, SCMnCr 3B or ASTM A 148/A and 148/M or equivalent

JIS H 5111, BC3 or ASTM B 584, C 90500 or equivalent

JIS H 5113, PBC2 or ASTM B 505, C 90700 or equivalent

JIS G 5121, SCS13 or ASTM A 743/A CA-15 or equivalent

JIS G 5102, SCW 410 or ASTM A 216/A216 M-93 or equivalent

All adjusting/setting screws, bolts and washers for securing the seals and seal assembly in place shall be of corrosion-resisting steel.

Seals shall be made of natural or synthetic rubber suitable for the temperature ranges and conditions at the Site and shall be of a material that has proven successful in similar applications. Seal materials shall have the following physical properties as determined by tests made in accordance with the relevant standards:

	<u>Property</u>	<u>Limits</u>
-	Tensile strength	14.7 N/mm ² minimum
-	Ultimate elongation	300 percent minimum
-	Durometer hardness (Shore, Type A)	40 to 80
-	Specific gravity	1.1 to 1.3
-	Water absorption (70 C° for 48 hour)	5 percent maximum by weight
-	Compression set (as a percent	30 percent maximum
	of total original deflection)	
-	Tensile strength after oxygen	80 percent minimum
	bomb aging (70 C° for 48 hours)	

of tensile before aging

2.2.9 Miscellaneous Materials

(a)	Self-lubricating bearing	JIS H 5102, HBsC4 high strength brass casting, incorporated with the solid lubricant or ASTM B 22, Alloy E, Min. HB 210 with solid lubricant
(b)	Stainless wire rope	JIS G 3557, Stainless steel wire ropes for general purposes
(c)	Steel conduit for electric wiring (galvanized)	IS C 8305 or ANSI C 80.1 or equivalent

2.3 Painting

2.3.1 General

Painting to prevent the corrosion of the components and equipment of the Hydraulic Gates Works shall be premised as followings,

- Airless spray painting shall be applied,
- Painting specifications of the instruments, purchased and electronic goods shall be the manufacturer's standards,
- Painting color shall be determined in consultation with the Client, and
- In principle, the manufacturer of Paints shall be the same from under coat to top coat.

Surface preparation ahead of the painting shall be as classified as below.

(a) ISO Sa2 1/2, Very through blast cleaning

When viewed without magnification, the surface must be free from visible oil, grease and dirt and from most of the mill scale, rust, varnish coating and foreign matter. Any remaining traces of contamination shall show only as light stains in the form of spots or stripes.

(b) ISO St3, Very thorough hand and power tool cleaning

When viewed without magnification, the surface must be free from visible oil, grease and dirt and from poorly adhering mill scale, rust, varnish coating and foreign matter. The surface must appear very thoroughly treated to give a metallic sheen arising from the steel surface.

2.3.2 Painting at Shops

Painting specification at shops shall be tabulated as below,

Components	Materials	Process	Names of paint	No.of painting	Film thickness (µm)	
Gate leaves,	SS, SM	First primer	Non-organic zinc-rich primer	1	15	
Gate guides	SUS	Pickling	Oxidizing solution	-	-	
Hoists	SS, SM	Surface preparation	Blast cleaning ISO Sa2 1/2	-	-	
		Under coat (1)	Non-organic zinc-rich paint	1	75	
		Mist coat	Epoxy resin paint under coat 160g/m ² + Thinner 80g/m ²	1	-	
		Under coat (2)	Weak solvent type modified epoxy resin paint under coat (air-exposed)	1	80	
		Under coat (3)	Weak solvent type modified epoxy resin paint under coat (air-exposed)	1	80	
			Intermediate coat	Weak solvent type intermediate coat for fluoropolymer paint	1	40
		Top coat	Weak solvent type fluoropolymer paint top coat	1	30	
			Total	6	305	
	SUS	Pickling	Oxidizing solution	-	-	

(1) Main gates of Kra Mang and Han Tra Floodgates

(2) Stoplogs (Maintenance gates) of Kra Mang and Han Tra Floodgates

Components	Materials	Process	Names of paint	No.of painting	Film thickness (µm)
Gate leaves	SS, SM	Surface preparation	Blast cleaning ISO Sa2 1/2	-	-
		Under coat (1)	Non-organic zinc-rich paint	1	75
		Mist coat	Epoxy resin paint under coat 160g/m ² + Thinner 80g/m ²	1	-
		Under coat (2)	Epoxy resin paint under coat (underwater)	1	100

		Under coat (3)	Epoxy resin paint under coat (underwater)	1	100
		Under coat (4)	Epoxy resin paint under coat (underwater)	1	100
			Total	5	375
Gate guides	SS, SM	First primer	Non-organic zinc-rich primer	1	15
	SUS	Pickling	Oxidizing solution	-	-
Telpher	SS, SM	Surface preparation	Blasting ISO Sa2 1/2	-	-
rails,		Under coat (1)	Non-organic zinc-rich paint	1	75
Lifting beams		Mist coat	Epoxy resin paint under coat 160g/m ² + Thinner 80g/m ²	1	-
		Under coat (2)	Weak solvent type modified epoxy resin paint under coat (air-exposed)	1	80
		Under coat (3)	Weak solvent type modified epoxy resin paint under coat (air-exposed)	1	80
		Intermediate coat	Weak solvent type intermediate coat for fluoropolymer paint	1	40
		Top coat	Weak solvent type fluoropolymer paint top coat	1	30
			Total	6	305
	SUS	Pickling	Oxidizing solution	-	-

(3) Gate for drainage channel at Kra Mang Floodgate

Components	Materials	Process	Names of paint	No.of painting	Film thickness (µm)
Gate leaves,	SS, SM	First primer	Non-organic zinc-rich primer	1	15
Gate guides	SUS	Pickling	Oxidizing solution	-	-
Hoists	SS, SM	Surface preparation	Blast cleaning ISO Sa2 1/2	-	-
		Under coat (1)	Non-organic zinc-rich paint	1	75
		Mist coat	Epoxy resin paint under coat 160g/m ² + Thinner 80g/m ²	1	-
		Under coat (2)	Weak solvent type modified epoxy resin paint under coat (air-exposed)	1	80
	Under coat (3) epoxy resin pair		Weak solvent type modified epoxy resin paint under coat (air-exposed)	1	80
	Int	Intermediate coat	Weak solvent type intermediate coat for fluoropolymer paint	1	40
		Top coat	Weak solvent type fluoropolymer paint top coat	1	30
			Total	6	305
	SUS	Pickling	Oxidizing solution	-	-

2.3.3 Painting for Joint Areas Welded at Sites

Painting specification for joint aeas welded at sites shall be tabulated as below,

(1) Main gates of Kra Mang and Han Tra Floodgates

Components	Materials	Process	Names of paint	No.of painting	Film thickness (µm)
Gate leaves,	SS, SM	First primer	Non-organic zinc-rich primer	1	15
Gate guides	SUS	Pickling	Oxidizing solution	-	-
Hoists	SS, SM	Surface preparation	Power tool cleaning ISO St3	-	-
		Under coat (1)	Organic zinc-rich paint	1	75
		Under coat (2)	Weak solvent type modified epoxy resin paint under coat (air-exposed)	1	80
		Under coat (3)	Weak solvent type modified epoxy resin paint under coat (air-exposed)	1	80
		Intermediate coat	Weak solvent type intermediate coat for fluoropolymer paint	1	40
		Top coat	Weak solvent type fluoropolymer paint top coat	1	30
			Total	5	305
	SUS	Pickling	Oxidizing solution	-	-

(2) Stoplogs (maintenance gates) of Kra Mang and Han Tra Floodgates

Components	Materials	Process	Names of paint	No.of painting	Film thickness (µm)
Gate leaves	SS, SM	Surface preparation	ration Power tool cleaning ISO St3		-
		Under coat (1)	Non-organic zinc-rich paint	1	75
		Under coat (2)	Epoxy resin paint under coat (underwater)	1	100
		Under coat (3)	Epoxy resin paint under coat (underwater)	1	100
		Under coat (4)	Epoxy resin paint under coat (underwater)	1	100
			Total	4	375
Gate guides	SS, SM	First primer	Non-organic zinc-rich primer	1	15
	SUS	Pickling	Oxidizing solution	-	-
Telpher	SS, SM	Surface preparation	Cleaning ISO St3	-	-
rails, Lifting		Under coat (1)	Non-organic zinc-rich paint	1	75
beams		Under coat (2)	Weak solvent type modified epoxy resin paint under coat (air-exposed)	1	80
		Under coat (3)	Weak solvent type modified epoxy resin paint under coat (air-exposed)	1	80

	Intermediate coat	Weak solvent type intermediate coat for fluoropolymer paint	1	40
	Top coat	Weak solvent type fluoropolymer paint top coat	1	30
		Total	5	305
SUS	Pickling	Oxidizing solution	-	-

(3) Gate for drainage channel at Kra Mang Floodgate

Components	Materials	Process	Names of paint	No.of painting	Film thickness (µm)
Gate leaves,	SS, SM	First primer	Non-organic zinc-rich primer	1	15
Gate guides	SUS	Pickling	Oxidizing solution	-	-
Hoists	SS, SM	Surface preparation	Power tool cleaning ISO St3	-	-
		Under coat (1)	Non-organic zinc-rich paint	1	75
		Under coat (2)	Weak solvent type modified epoxy resin paint under coat (air-exposed)	1	80
			Weak solvent type modified epoxy resin paint under coat (air-exposed)	1	80
		Intermediate coat	Weak solvent type intermediate coat for fluoropolymer paint	1	40
		Top coat	Weak solvent type fluoropolymer paint top coat	1	30
			Total	5	305
	SUS	Pickling	Oxidizing solution	-	-

2.4 Design Stresses

2.4.1 Gate Leaves, Gate Guides and Other Steel Structures

The working stresses for structural steel members shall not exceed the allowable design stress as shown in the following table under normal loading condition:

(a) Steel materials (with a plate thickness of 40 mm or less)

	Steel mate	erial	SS 400 and SM 400 Thickness ≤ 40 mm	SM 490 Thickness ≤ 40 mm
1.	Axial tensi	le stress	120 N/mm ²	160 N/mm ²
	(for net sectional area)			
2.	Axial compressive stress (for gross sectional area)		On condition of (I/r) ≤ 20, 120 N/mm ²	On condition of (I/r) \leq 15, 160 N/mm ²
	Compress	ive members	On condition of 20 < (I/r) ≤ 93, 120 – 0.75 ((I/r) – 20)	On condition of 15 < (I/r) ≤ 80, 160 – 1.12 ((I/r) – 15)
			On condition of 93 < (l/r) , 10,000,000/ $(6,700 + (l/r)^2)$	On condition of 80 < (l/r) , 10,000,000/ $(5,000 + (l/r)^2)$
	where;	I: buckling length of men r: radius of gyration of g	nber (mm) ross sectional area of member	(mm)
	Compress	ive splice member	120 N/mm ²	160 N/mm ²
3.	-	tress at tensile side ctional area)	120 N/mm ²	160 N/mm ²
	-	tress at compressive side sectional area)	On condition of (I/b) \leq (9/K), 120 N/mm ²	On condition of (I/b) \leq (8/K), 160 N/mm ²
			On condition of (9/K) < (l/b) \leq 30, 120 - 1.1((Kl/b) - 9)	On condition of (8/K) < (I/b) ≤ 30, 160 − 1.6((KI/b) − 8)
	b: width of compressiv $K = \sqrt{3 + \frac{Aw}{2Ac}}$ Aw: gross sectional ar AC: gross sectional ar			(mm)
		on that compressive irectly welded to skin	120 N/mm ²	160 N/mm ²
4.	Shear stre (for net se	ss ctional area)	70 N/mm ²	90 N/mm ²
5.	Bearing st	ress	180 N/mm ²	210 N/mm ²

- Notes 1) In case the thickness exceeds 40 mm, the allowable stresses for normal loading condition of the structural steel members shall be adjusted that the stress is 0.92 time that of the allowable stress as mentioned above in the case of steel materials SS 400 and SM 400, and 0.94 time for steel material SM 490.
 - 2) When steel material other than those mentioned in the above table is used, its allowable tensile stress for normal loading condition shall not exceed 50 percent of the yield point strength or proofing strength of the steel material used whichever is the least. All other allowable stresses shall proportionally be computed according to the above table based on the allowable tensile stresses.

(b) Stainless steel materials

(D)	Stainless steel materials						
	Stainless steel material	SUS 304	SUS 304L				
1.	Axial tensile stress	100 N/mm ²	90 N/mm ²				
	(for net sectional area)	or net sectional area)					
2.	Axial compressive stress (for gross sectional area)	On condition of (I/r) \leq 19, 100 N/mm ²	On condition of (I/r) ≤ 21 , 90 N/mm ²				
	Compressive members	On condition of 19 < (I/r) ≤ 96, 100– 0.53 ((I/r) – 19.0)	On condition of $21 < (l/r) \le 104$, 90 - 0.47 ((l/r) - 21.0)				
		On condition of 96 < (I/r) , 980,000/ $(7,200 + (I/r)^2)$	On condition of 104 < (I/r), 980,000/ $(8,400 + (I/r)^2)$				
	where; I: buckling length of r: radius of gyration	member (mm) of gross sectional area of mem	nber (mm)				
	Compressive splice member	100 N/mm ²	90 N/mm ²				
3.	Bending stress at tensile side (for net sectional area)	100 N/mm ²	90 N/mm ²				
	Bending stress at compressive s (for gross sectional area)	side On condition of (l/b) \leq (10/K), 100 N/mm ²	On condition of (I/b) \leq (10/K), 90 N/mm ²				
		On condition of (I/b)> (10/K), 100– 0.9 ((KI/b) – 10)	On condition of (I/b)> (10/K), 90 – 0.70 ((KI/b) – 10)				
	b: width of compres $K = \sqrt{3 + \frac{1}{2}}$ Aw: gross sectional	Aw 2 Ac area of web plate (mm ²) area of compressive flange (mr					
	On condition that compressive flange is directly welded to skin plate, etc.	100 N/mm ²	90 N/mm ²				
4.	Shear stress (for net sectional area)	60 N/mm ²	30 N/mm ²				
		150 N/mm ²	135 N/mm ²				

(unit of stresses: N/mm^2)

- Note When stainless steel material other than those mentioned in the above table is used, its allowable tensile stress for normal loading condition shall not exceed 50 percent of the yield point strength or proofing strength of the steel material used whichever is the least. All other allowable stresses shall proportionally be computed according to the above table based on the allowable tensile stresses.
- (c) Steel casting and forging

			(unit c	, sucsses. N/mm)
	Allowable Stress	SF440A/SC450	S45C	SCS13
1.	Axial tensile stress	110	170	90
2.	Axial compressive stress	110	170	90
3.	Bending stress	110	170	90
4.	Shear stress	65	95	50
5.	Bearing stress	165	255	135

Note:

When steel material other than those mentioned in the above table is used, its allowable tensile stress for normal loading condition shall not exceed 50 percent of the minimum yield point strength or proofing strength of the steel material used, whichever is the least. All other allowable stresses shall proportionally be computed according to the above table based on the allowable tensile stresses.

			HB: Brine	ll hardness, HV: Vi	ckers hardness
Steel type	SUS304	SUS316	SUS304N2	SUS329J1	SUS329J4L
Design HB	150	150	200	220	230
JIS spec. HB	187 or less	187 or less	248 or less	277 or less	302 or less
Steel type	SUS410	SUS630S	SUS630H900	SUS630H1025	SUS630H1075
Design HB	N/A	N/A	N/A	N/A	N/A
JIS spec. HB	201 or less	363 or less	375 or more	331 or more	302 or more
Steel type	SUS630H1150	SUS631S	SUS631 RH950	SUS631 TH1050	
Design HB	N/A	N/A	N/A	N/A	
JIS spec. HB	277 or more	HV 200 or less	HV 392 or more	HV 345 or more	

(d) Brinell hardness of stainless steel

2.4.2 Machine Parts

The allowable design stresses of all mechanical parts of the hoists shall have the following factors of safety (FS) against the ultimate strength of the steel material for the rated hoist capacity in normal loading condition:

Material	FS for tensile stress	FS for compressive stress	FS for shearing stress
Rolled steel for general or welded structure	5	5	8.7
Carbon steel forgings	5	5	8.7
Carbon steel for machine structure use	5	5	8.7
Corrosion-resisting steel	5	5	8.7
Carbon steel castings	5	5	8.7
Gray iron casting	10	3.5	17
Bronze castings	8	8	10

Note:

Unit stress shall in no case exceed ninety (90) percent of the minimum yield point strength or proofing strength of the material used whichever is the least under the load resulting from the breakdown or locked-rotor torque of the hoist motor, whichever is greater.

2.4.3 Second Stage Concrete and Non-Shrinkage Mortar

(1) Second stage concrete

The standard of second stage concrete used in the Hydraulic Gate Works shall be the same as that of the first stage concrete.

The allowable stresses and standards of the second stage concrete in 28 day aging to be adopted for the detailed design of the Hydraulic Gate Works are as follows,

- Design strength	21 N/mm ²
- Allowable compressive stress	5.1 N/mm ²
- Allowable shear stress	0.4 N/mm ²
- Allowable bending tensile stress	0.3 N/mm ²
- Allowable bearing stress	5.9 N/mm ²
- Max.size of coarse aggregate	25 mm
- Slump	8±2.5 cm
- Air content	4±1.5 %
- Total chloride content	0.3 kgf/m ³ or less

Water-tightness between the first stage and second stage concrete shall be secured.

(2) Non-shrinkage mortar

Non-shrinkage mortar shall be used to avoid deformation & shrinkage of the bases of the equipment of hoists that is caused by the loads from them and assure the installation accuracy of the equipment on them.

Mix design of standard type non-shrinkage mortar shall be as follows.

Materials	Produced		
Cement type non-shrinkage grout agent	Sand	Water	mixture (liter)
20	20	7.2	21

The standards of non-shrinkage mortar shall be as shown below or equivalent approved by the Consultant.

Test Item	Standard	
Setting time	Start time Finish time	: 1 hour or more : 10 hours or less

Bleeding	2 hours later after mixing: 2% or less	
Liquidity by J14 funnel test	8±2 second	
Compressive stress	3day aging : 25 N/mm ² or more 28day aging : 45 N/mm ² or more	
Bond stress	28day aging : 3 N/mm ² or more	
Shrinkage	Not allowed at 7 day aging	

2.4.4 Combined Allowable Stress and Overloading Condition

The allowable stresses in case of overloading condition may be increased by 50 percent than those for normal loading condition. In no case, however, shall any stress exceed 90 percent of the minimum yield point strength or proofing strength of the material used, whichever is the least.

The combined stress shall be examined by the following formula as developed by Mises, Hencky and Huber:

$$fg = \sqrt{(fx^2 + 3 \times fq^2)}$$

$$fg = \sqrt{(fx^2 + fy^2 - fx \times fy + 3 \times fq^2)}$$

Where:

- fg: Combined stress (N/mm²)
- fx: Direct stress (tension is considered as positive) (N/mm²)
- fy: Direct stress acting perpendicular to axis of fx

(tension is considered as positive) (N/mm²)

fq: Shearing stress (N/mm²)

The allowable stresses for the combined stresses of biaxial or triaxial principal stresses shall not exceed 110 percent of the allowable axial tensile stress for normal loading condition.

2.5 Minimum Thickness

The thickness of the major structural members shall not be less than the following value inclusive of corrosion allowance, unless otherwise particularly specified herein:

Parts	Min. thickness(mm)
- Gate leaves	
Steel plate	6.0
Shaped steel	5.0
- Gate guides	
Steel plate	6.0
Shaped steel	5.0
- Embedded and fixed parts	
Steel plate	6.0
Shaped steel	5.0
- Skin plates	8.0
 Cover and protection plates for hoist equipments 	and panels 2.0

2.6 **Critical Slenderness Ratio**

The critical slenderness ratio for major compression members shall be less than 120, and 150 for secondary members. The said ratio for tension members may be increased up to 200 and 240 respectively.

2.7 **Maximum Deflection**

The ratio of deflection against the supporting span of each component of the Hydraulic Gate Works shall not exceed the following value under the normal design condition:

Component	Max. deflection
Main horizontal beams of gate leaves	1/800
Main horizontal beams of maintenance gate leaves	1/600
Frame for hoisting equipment	1/2,000
Telpher rails	1/1,000
Other beam materials such as inspection stages, etc.	1/600

Corrosion Allowance 2.8

The corrosion allowance for the equipment and structures shall be as follows:

Equipment/Structure	Corrosion Allowance (mm)
Stainless steel Gates	
- skin plate	0.0
- all other gate leaf members	0.0
Stoplogs	
- skin plate	1.0
- all other gate leaf members	1.0

2.9 **Coefficient of Friction**

For the purpose of designing the Hydraulic Gate Works, the coefficient of friction shall not be less than the following value:

Item	Friction confident
Rolling friction of wheel at support part	1.0mm
Sliding friction of plain bearing at support part	0.2
Rolling friction of rolling bearing at support part	0.01
Sliding friction between water-tight rubber and stainless steel plate in wet condition	0.7
Sliding friction between water-tight rubber and stainless steel plate in dry condition	1.2
Sliding friction between steels at water-tight part or support part	0.4
Sliding friction between steel and sediment mud	0.4

Helicoids of spindle	0.2
Helicoids of worm gear at starting	0.06 to 0.10
Helicoids of worm gear in operation	0.03 to 0.06
Friction surface between cast iron and cast iron/cast steel for brake in dry condition	0.10 to 0.20
Friction surface between cast iron and cast iron/cast steel for brake in wet condition	0.08 to 0.12
Friction surface between steel plate and cast iron/cast steel for brake in dry condition	0.15 to 0.20
Friction surface between steel plate and cast iron/cast steel for brake in wet condition	0.10 to 0.20
Friction surface between bronze and cast iron/cast steel for brake in wet/dry condition	0.10 to 0.20

2.10 Mechanical Efficiency

For the purpose of designing the gates hoists, the mechanical efficiency shall not be more than the following value:

Parts	Mechanical Efficiency
Sheave with plain bearing	0.95
Sheave with rolling bearing	0.98
Drum with plain bearing	0.95
Drum with rolling bearing	0.98
Spur or Bevel gear with plain bearing per set (open type)	0.95
Spur or Bevel gear with plain bearing per set (oilbath type)	0.97
Cyclo speed reducer	
- 1 stage reduction ratio 1/59 - 1/11	0.80 to 0.85
- 1 stage reduction ratio 1/121 – 1/87	0.65 to 0.75
Worm speed reducer	
- 1 stage reduction	0.37 to 0.59
- 2 stage reduction	0.35 to 0.57
- 3 stage reduction	0.34 to 0.56
Helical speed reducer	
- 3 stage reduction	0.82 to 0.96
- 4 stage reduction	0.80 to 0.94
- 5 stage reduction	0.77 to 0.93
Sprocket by chain driving	0.95
Rack and pinion gear	0.90

Total mechanical efficiency of sheaves shall be calculated by the following formula:

(a) In case that the number of sheaves is odd

$$Ef = \frac{k^{n+1} - 1}{(n+1) \times k^n \times (k-1)}$$
$$T = \frac{Q}{(n+1) \times Ef}$$

(b) In case that the number of sheaves is even

$$\mathsf{E}\mathsf{f} = \frac{\mathsf{k}^{\mathsf{n}} - \mathsf{1}}{\mathsf{n} \times \mathsf{k}^{\mathsf{n}} \times (\mathsf{k} - \mathsf{1})}$$

 $T = \frac{Q}{n \times E}$

where,

Ef	:	total mechanical efficiency of sheaves
----	---	--

n	:	number of sheaves

- k : 1/e
- e : mechanical efficiency of each sheave
- Q : design hoisting load (kN)
- T : winding load of wire rope (kN)

2.11 Mechanical Equipment and Parts

The mechanical equipment and parts for the Hydraulic Gate Works shall conform to the following requirements unless otherwise specifically mentioned:

2.11.1 Gearing

All gears shall be machine cut by hobbing, from solid blanks and, wherever possible, they shall be a forced fit on their shafts. The minimum requirements for materials are as follows:

Wheels	Rolled or forged steel
Pinions	Rolled or forged steel
Worm Wheels	Steel with bronze rims
Worms	Steel or forged steel

Where worm gearing is used as a first motion drive, it shall be designed to have the same load and time rating as the driving motor and to have oil tight removable housings with lubrication oil plug, drain cock, vapor outlet and oil level indicator. The temperature rise of the oil bath, when measured by thermometer, shall not exceed 40 degrees Celsius.

All gear wheels and pinions shall be completely covered by steel or other metal guards, unless effectively guarded by adjacent structures for safety.

Keys in gear trains shall be so fitted and secured that they cannot work loose.

2.11.2 Wire Ropes, Drums and Sheaves

The hoisting wire rope, except where otherwise noted, shall be of stainless steel S304, flexible and JIS G 3557 6 x 37 SB or equivalent.

The hoisting wire rope shall be processed with pretension/stretching. In the pretension process, the wire ropes shall be retained by 40% of the breaking strength during 30 minutes and this process shall be repeated twice.

The factor of safety of the hoisting wire ropes to the rated hoisting load of stationary hoist, including gantry crane, and commercial telpher hoist shall be not be less than eight (8) and five (5) respectively in normal loading conditions. The hoisting rope shall withstand the load due to maximum hoist motor torque, without exceeding ninety (90) percent of the breaking strength. The rope systems shall be equalized and arrangements entailing reverse bends shall be avoided wherever possible.

Rope drums shall be cast steel or fabricated steel with machined grooves. Paired rope drums shall have the same diameter to the bottom of the groove. The peak edges of grooves shall be rounded and the surface of groove shall be smooth machined with an adequate depth. Drums shall have sufficient width to wrap the full length of rope, and have approximately one (1) groove spare when the gate is in the highest possible position, and three (3) dead wraps when the gate is in fully closed position.

The rope end shall be secured to the outside of the drum by means of a clamp or other approved means. The fastening shall be easily accessible to facilitate rope removal or replacement.

The minimum pitch circle diameter of rope drums and sheaves shall be 19D and 17D for 6 x 37 construction rope, respectively, where D is the diameter of the rope. The minimum pitch diameter of equalizer sheave shall be not less than 10D. Number of wound layer of the hoisting rope on drum shall not exceed two (2). Fleet angles for grooved rope drums and sheaves shall not exceed four (4) degrees for first wound layer and two (2) degrees for multiple wound layers.

Rope sheaves shall be Vee-grooved with an included angle of fifty-two (52) degrees and groove depth equal to 1.5 times the rope diameter. The groove diameter shall be slightly in excess of the rope diameter to prevent pinching.

Spring and striker type slack rope detecting switches shall be provided for each wire rope end of all stationary type hoists, including gantry crane.

Drums of hoists shall be completely covered by steel or other metal guards, unless effectively guarded by adjacent structures for safety.

2.11.3 Couplings

Flexible chain or gear type couplings with means for field adjustment shall be provided where drive shafts are required to be connected.

2.11.4 Bearings

Bronze bushed bearings shall be used for all low speed shafts, and high speed ball or wheel bearings shall be used for all other locations.

Shafts and bearings shall be proportioned so that the length does not exceed one and one half times the shaft diameter for bronze bearings not so as to exceed an allowable bearing stress at the projected area.

2.11.5 Keys and Keyways

Keys and keyways shall be designed in accordance with the relevant standards. Where taper keys are used, they shall be provided with a gig head or other suitable provisions to facilitate withdrawal. Feather keys shall be secured in position by means of counter-sunk screws through the key.

2.11.6 Dowels

Gear boxes and bearings which have to align accurately shall be retained in position by means of fitted dowels during assembly.

2.11.7 Manual Operating Devices

The manual operation device shall be provided to stationary type gate hoists. The operation force on the manual operating device shall be less than 100 N under normal design condition.

The diameter of the handle shall be 600 millimeters in maximum which shall be located at approximately 0.90 meter in height from the operation deck.

2.11.8 Structural Base Frames of Hoist

The structural base frame of hoist shall be of all welded steel construction using rolled structural shapes and plates. Necessary anchor bolts and nuts for the base frames shall be supplied by the Contractor.

2.11.9 Torque Shafts

The torque shafts shall be finished commercial steel shafting. The diameter of the shafts shall not be less than 50 millimeters. The distortion angle shall not exceed 0.25-deg./m for the rated design torque.

2.11.10 Hoist Spindles

The spindles shall have a round shape with minimum diameter of 50 mm or rack shape and shall be made of corrosion resisting steel which shall be machine-cut with square or trapezoidal thread or rack gear shape or welded with pin rack shape at the necessary length. Spindle covers shall be provided to protect spindles from dust, dirt and rain.

2.11.11 Spindle Supports

The spindle supports for each hoist mechanism shall be provided at proper position(s) to avoid the buckling of spindle due to over-lowering force of hoists under the gate jammed in fully closed position. The support shall be removable to permit drawing out the gate from hoist deck opening. Corrosion resisting steel bolts, nuts and washers shall be used for fixture of the support.

2.11.12 Mechanical Position Indicators

The mechanical type position indicators, except where otherwise noted, shall be mounted on each hoist mechanism, and shall be of an easily readable dial type to rotate about 300 degrees for full travel. The dial plate shall be of stainless steel or brass with engraved graduation, and main parts of the indicators shall be made of anti-corrosive materials which shall be housed in a dust-tight and weather-proof enclosure. The indicators shall be capable of reading accurate vertical height of the equipment opening by 1.0 cm. The mechanical position indicators

equipped on the hoist shall be of the two-pointers type for the gate with its hoisting height more than 6.5 meters.

The rope end shall be secured to the outside of the drum by means of a clamp or other.

2.11.13 Floor and Cover Plate

Floor and cover plate shall be of an approved raised pattern. All edges of plate shall be planed and joints shall be cut so as to maintain continuity of pattern.

2.12 Electrical Equipment and Parts

The electrical equipment and parts for the Hydraulic Gate Works shall conform to the requirements herein unless otherwise specifically mentioned.

2.12.1 Electric Motors for Hoists

All motors for hoists shall be of $380V \times 3$ phase $\times 50Hz$ horizontal shaft, high starting torque, low starting current, squirrel cage, induction type, designed for full voltage starting, weather-proof and totally enclosed. Wound rotor motors will be accepted only if a squirrel cage type would not be satisfactory for the duty.

The insulation for the motors shall be decided by the capacity in accordance with JIS C 4210 or other equivalent standard, and its rating shall be continuous for stationary hoist, including gantry crane and minimum thirty (30) minutes for the others at 40 degrees Celsius ambient temperature. The cable terminal boxes shall be provided with stud-type connectors.

The capacity of motor shall be examined with the following equation, and the rated motor capacity shall be more than 100 percent of that calculated based on the maximum hoisting loads, which will occur during starting, raising and lowering operation of the gate or equipment. The starting torque of the motor shall be 200% or more of its rated torque while the maximum torque thereof shall be 300 % or less of its rated torque.

$$\mathsf{Pm} = \frac{\mathsf{W} \times \mathsf{V}}{60.0 \times \eta}$$

where,

- Pm : Output of motor (kW)
- W : Maximum hoisting load (kN), selected under the most adverse combination of loads which shall be calculated with the given friction coefficients and operating conditions
 - V : Hoisting speed (m/min.)
 - η : Total efficiency of hoist

Windings and connections shall be suitably impregnated to render them moisture-proof, nonhygroscopic and unaffected by conducting dust.

All motor bearings shall be of the ball or wheel type with an inner grease seal to prevent grease from entering the winding. Bearing housings shall be fitted with a "ball in head" grease fitting and a removable plug for the escape of grease.

2.12.2 Brakes for Wire Rope Winched Hoists.

Two (2) systems of brake shall be provided for all wire rope winched hoists.

Electromagnetic brakes shall be mounted on all hoisting motors. The braking torque shall not be less than 150 percent of the rated torque of the motor. The brakes shall actuate automatically when the power supply is cut off and shall allow hand liberation upon power failure. The brake enclosure shall be weather-proof with convenient access for maintenance.

Electro hydraulic thruster brakes shall be provided for all hoists in addition to the motor brakes unless the self-lock speed reducers are incorporated into the hoists. The electro hydraulic thruster brakes shall be housed within a dust/rain proof steel box.

2.12.3 Electric Cables and Wiring

All cables/wiring between the distribution panel, control cubicles, motors, limit switches etc., shall be with multi-core copper, cross-linked polyethylene insulated, PVC sheathed (Type CV), 600-volt grade cable. There shall be no splices in the wires or cables and all connections shall be made only at terminal blocks or studs.

All power and control cable conductors shall be of copper and have a minimum cross-sectional area of 2.0 square millimeters unless otherwise specifically specified in these Specifications. Single strand conductor shall not be accepted.

Compression type terminal shall be used and ring number identification shall be put at both ends of the cables.

2.12.4 Motor Starters

All starters shall be suitable for direct-on-line starting of motors, provided with 3-phase over current relays with manual resetting, open-phase relays and reverse-phase release feature. Over current relays shall be field adjustable to correspond with the rated full load currents of the motors. Backup protection shall be provided with high rupturing capacity molded case circuit breakers with operating handles lockable in "off" position.

The magnetic contactors for motors shall have the rated current capacity more than 150% against the rated current of motors, and have the life of switching operations more than 1 million times in electrical and more than 10 million times in mechanical.

2.12.5 Control Cabinets and Panels

Control cabinet and panels shall be of sheet steel with minimum thickness of 2.3 millimeters, of rigid, self-supporting construction and supplied with channel bases.

All indicators such as meters and lights shall be visible from outside without opening the doors and/or windows which shall have integral lock and master key. Cabinets and panels shall be completely enclosed and shall be of weather, dust and vermin-proof construction for outdoor use, while dust and vermin-proof construction for indoor use.

The cables and wiring shall enter from bottom side of cabinets and panels. Removable gland plates shall be supplied and located to provide adequate working clearance for the termination of cables. Under no circumstances the floor/roof plate shall be used as a gland plate.

Space heating elements with thermostatic control switch shall be included in each cabinet/panel.

The instrument and control wiring including all electrical interlocks and interconnecting wiring between sections, shall be completely installed and connected to terminal blocks by the Contractor.

The arrangement of control and protection devices on the cabinets/panels and the exterior finish of the panels shall be subject to the approval of the Consultant.

2.12.6 Power Distribution Boards and Panels

Power distribution boards and panel shall be of sheet steel with minimum thickness of 2.3 millimeters, of rigid, self-supporting or wall mounted construction.

The board/panel shall be completely enclosed and shall be of weather, dust and vermin-proof construction for outdoor use, while dust and vermin-proof construction for indoor use. The cables and wiring shall enter from bottom side of the board/panel.

Space heating elements with thermostatic control switch shall be included in each board/panel.

The distribution boards/panels shall contain the molded case circuit breakers adequate in capacity and in numbers required for the equipment, including spares.

The source pilot lights shall be provided and visible from outside without opening the doors and/or windows which shall have integral lock and master key.

2.12.7 Electrical Conduits

Steel rigid and/or flexible conduits shall be used for the cable/wiring between the control panels and electrical equipment. The steel rigid conduits shall be galvanized inside and outside and of a minimum thickness of 2.3 millimeters and have a minimum inside diameter of 16 millimeters.

2.12.8 Enclosures

Motor enclosures shall be weatherproof and totally enclosed. Enclosures for all other equipment shall dust-proof, weatherproof and vermin-proof.

2.12.9 Convenience Outlets

Convenience outlets shall be of 2-pin with scraping earth or 3-pin type rated for 15 amps at 230 volts, suitable for American pattern plug. Outlets shall be in weatherproof enclosure or suitably protected from weather.

2.12.10 Limit Switches

The limit switches shall be of arm deflection detecting type with weatherproof enclosures and shall be mounted suitable for easy adjustment and protection from vandalism, and for rigidly locking in position after being adjusted. They shall be of heavy-duty rating and shall have corrosion-resisting steel rotating parts and permanently lubricated bearings. They shall allow the arm to be fully deflected by the operator without damage to the switch.

The limit switches shall have the life of switching operations more than 0.5 million times in electrical and more than 5 million times in mechanical.

2.12.11 Indicating Lamps

All indicating lamps shall be of light emitting diode (LED) with square shape colored plastic lenses type for long life and service under conditions of shock, vibration and rough handling. All indicating lamps on outdoor cubicles shall be visible under daylight. The name plates shall be indicated on the colored plastic lenses with transparent plastic films.

The indicating lamps shall be grouped into normal, trouble and other status indications and neatly be arranged on the panels.

2.12.12 Lighting Fixtures

Fluorescent lighting fixtures with complete fittings for A.C. 230 volt, 50 Hz sources and a ballast or ballasts of high power factor shall be provided within the control and distribution panels other than wall mounted panels.

Incandescent lighting fixtures shall have lamp holders in accordance with the local standards.

Special care shall be exercised on selection of fixtures so that illumination of the lamp is not obstructed by accumulation of insects and dust.

2.12.13 Electrical Relays

Electrical relays for controls and alarm purposes and auxiliary relays for protection circuits shall be of the plug-in type and the plug-in connections shall be made and broken by pressure contacts. Alternatively, the Consultant may approve the use of plug-in trays containing groups of relays.

Relays shall be provided with non-flammable dust and moisture-proof cases.

Relay contacts shall be adequately rated for the service conditions. Relay coils shall be continuously rated whether the control scheme requires them to be continuously energized or not. The relays shall have the life of switching operations more than 1 million times in electrical and more than 10 million times in mechanical.

At least one spare normally open contact and one spare normally closed contact shall be provided on each relay in addition to the contacts required by the control scheme.

2.12.14 Terminal Strips

Terminal strips shall be of double stud and 2-hole solid link design with the studs molded into an insulating base. Pinch-type terminal blocks and slotted links are not acceptable. Studs shall be of brass and 6 millimeters diameter except that studs of 4.7 millimeters diameter in corrosion-resisting steel or phosphor-bronze may be approved.

Terminal strips shall be arranged in vertical rows not less than 225 millimeters above floor level. Sufficient terminals shall be provided on each item of equipment to permit the connection of all incoming cable cores plus 10 percent spare terminals.

Removable transparent insulating covers shall be provided over all terminals. An insulating barrier shall be provided between adjacent pairs of studs.

2.12.15 Indicating Instruments

All instruments and meters shall have approximately 110 millimeters dial and shall be heavyduty, dust-proof, industrial type suitable for extreme shock and severe vibration applications.

Instruments on cabinets shall be flush mounted and provided with narrow bezels. The bezels shall have a uniform high grade finish.

All instruments scales shall be of wide angle type clearly printed in black figures and divisions on white background. The figures and units shall be clearly marked on the instrument dial in black capital letters. The names or marks of the instrument's manufacturer and other printing which may interfere with the clear observation of the reading shall not be printed on dials. Initials or similar markings may however be acceptable in case they are indicated unobtrusively on dial plates, subject to approval of the Consultant. Unless otherwise specified or approved, all instruments shall have circular scales with a total deflection of not less than 240 degrees.

Normal working indication shall be at a point corresponding to approximately 75 percent of full scale deflection. Scales shall be provided with red-colored marks at points corresponding to the normal working values (or full-load current of the equipment in case of ammeters) and as approved.

The scales for ammeters in motor circuits shall be suppressed so that 20 percent of full scale deflection (F.S.D.) occurs at about 40 percent full load current (F.L.C.) and 90 percent of F.S.D. at about 120 percent F.L.C. The scale shall be approximately linear in the range 40 percent to 120 percent and compressed above 90 percent F.S.D. to indicate 6 times F.L.C. at 100 percent F.S.D.

Devices for routine checking, zero adjustment and re-calibration shall be easily accessible from the front of the cabinets. Where such devices are not included in the instrument case they shall be flush mounted on the cabinets adjacent to the associated instruments, so that adjustments can be made conveniently while watching the indicator.

2.12.16 Equipment Wiring and Wiring Accessories

All connections within equipment enclosures and all inter-cabinet wiring voltages shall not greater than 600 V nominal. All wiring shall be carried out in accordance with wiring diagrams so that the arrangement of the wiring is consistent throughout the equipment and identical for those parts of the equipment performing the same duties.

Wiring diagrams shall be drawn viewing from the wiring side of the cabinet and shall show all terminals on selector switches, relays, contactors, terminal blocks, etc., in their correct relative positions. Terminal blocks shall be arranged to show in vertical rows and all wiring to those blocks shall be arranged to run in numerical order from top to bottom.

Wiring shall be neatly and securely bunched or cleated, and enclosed in ducts, or conduits or supported on trays and run in the most efficient manner from point to point. The bunching of wiring shall be kept in bunched condition by means of strips of special plastic ribbon material at suitable intervals. Lacing or wire bunches with textile plastic cord or metal buckle type clips will not be accepted. Wherever wiring is cleated to metal surfaces, it shall be insulated from the metal surface and shall be cleated by means of insulated straps. All wiring shall be left sufficiently long and neatly looped to allow a fresh termination to be made in case of original termination device being broken off.

Circuit of similar nature shall be grouped together and terminal block terminals in A.C. circuit shall be segregated and fully shrouded to prevent accidental contact with live parts.

All secondary wiring shall employ conductors having a minimum cross-sectional area of 2.0 mm² and consisting of tinned copper wire. Internal wiring of miniaturized and solid state equipment may use flexible conductors having a minimum size of 50/0.18 mm where wiring is made off clamping type terminals and 30/0.18 mm where the termination is made by soldering.

Current transformer secondary circuits shall be run with the conductor route length as short as possible. The burden of the leads associated with current transformers and protective relays shall be sufficiently low to ensure correct operation of the protection under all conditions and this may require a cross-section of conductor greater than 2.0 mm².

The standard phase arrangement when facing the front of the panel shall be R-S-T-N, and R-N-S from left to right, from top to bottom, and front to back for A.C. three-phase and single-phase circuits and N-P from left to right, P-N from top to bottom and front to back for D.C. polarity. All relays, instruments, other devices, buses and equipment involving three-phase circuit shall be arranged and connected in accordance with the standard phase arrangement where possible.

Phase and Polarity	Description	Color
Three phase 4 wire	First phase	Red
	Second phase	Black
	Third phase	Blue
	Neutral phase	White
Single phase 2 wire	First phase	Red
	Grounding side second phase or Neutral phase	White
	Non-grounding second phase	Black
Ground conductor		Green, or yellow-green
Direct current	Positive	Red
	Negative	Blue
	-	
ltem	Description	Color
Main circuit		Yellow and black
Control circuit	A.C.	Yellow
	D.C.	Yellow
Voltage transformer		Yellow
Current transformer		Yellow
Ground conductor		Green

All wires shall be colored as follows in order to identify phase and polarity.

3. FIXED WHEEL (ROLLER) GATES AND HOISTS

3.1 General

Three (3) complete sets of plate-girder structure stainless steel fixed wheel (roller) gate leaves, stainless steel gate guides, motorized gate hoists, controls and appurtenant equipment complete with all the necessary accessories shall be designed, manufactured, transported, erected, installed and tested in the Canals of Han Tra and Kra Mang by the Contractor under this Contract.

The new floodgates shall be used for preventing the reverse flow from the Pasak River during flood season while these gates keep opened during non-flood season.

The general data for the design of the fixed wheel gates are given in Sub-clause 3.3 "Design Data" herein and these data shall be fixed and may not be altered.

The overall arrangement of the floodgates shall be as shown on the attached Drawings.

3.2 Design Stresses

The design stresses shall conform to those specified in Clause 2 "Design Criteria and Particulars" of the specifications.

3.3 Design Data

The gate leaves, gate guides and hoists shall be designed by the Contractor for the following design conditions.

3.3.1 General Data

Kra Mang Floodgate

(1) Quantities to be procured

Gate leaves:	3 sets
Gate guides:	3 sets
Hoists:	3 sets
Control and wiring:	1 lot

(2) Gate

		Туре:	Plate-girder structure stainless steel fixed wheel gate
		Clear span:	6.0 m
		Effective height:	5.1 m
		Water levels at upstream	
		High Water Level (HWL):	EL. +3.5 m MSL
		Low Water Level (LWL):	EL. +0.5 m MSL
		Water levels at downstream	
		High Water Level (HWL):	EL. +6.0 m MSL
		Low Water Level (LWL):	EL. +0.5 m MSL
		Sill elevation:	EL0.5 m MSL
		Design head	
		Downstream water level:	EL. +6.0 m MSL
			High Water Level (HWL)
		Upstream water level:	EL. +0.5 m MSL
			Low Water Level (LWL)
		Sealing method:	Curtain-walled four (4) sided watertight at upstream
		Sedimentation:	Not considered in Kra Mang canal
		Ground subsidence:	Not considered
(3)	Hois	t	
		Туре:	Wire rope winched 1 motor 2 drum type hoist

Water level at opening operation	
Downstream water level:	EL.+2.5 m MSL
Upstream water level:	EL.+3.5 m MSL
Water level at closing operation	
Downstream water level:	EL. +6.5 m MSL
Upstream water level:	EL. +3.5 m MSL
Hoisting speed:	0.3 m/min at ordinary time
	1.5 m/min at emergency closing
Hoisting height:	5.0m at ordinary time
	6.5m at maintenance and emergency
Operation method:	Local
Power source:	380V × 3 phase × 4 wire × 50Hz
Motors:	Weather-proof 380V × 3 phase × 50Hz squirrel-cage induction motors not less than 2.2kW
Controls and lightings:	220V × single phase × 50Hz
Speed reducer:	Helical or type approved by the Consultant
Brakes (2 systems):	Electromagnetic motor brakes,
	Electro hydraulic thruster brakes or Self-lock built in speed reducer
Wire rope:	SUS304 6 x 37 SB or equivalent

Han Tra Floodgate

(1) Quantities to be procured

Gate leaves:	3 sets
Gate guides:	3 sets
Hoists:	3 sets
Control and wiring:	1 lot

(2) Gate

Туре:	Plate-girder structure stainless steel fixed wheel gate
Clear span:	6.0 m
Effective height:	7.1 m
Water levels at upstream	

High Water Level (HWL):	: EL. +3.5 m MSL	
Low Water Level (LWL):	EL. +0.5 m MSL	
Water levels at downstream		
Height Water Level (HWI	L): EL. +6.0 m MSL	
Low Water Level (LWL):	EL. +0.5 m MSL	
Sill elevation:	EL2.5 m MSL	
Design head		
Downstream Water Leve	el: EL. +6.0 m MSL	
	High Water Level (HWL)	
Upstream water level:	EL. +0.5 m MSL	
	Low Water Level (LWL)	
Sealing method:	Curtain-walled four (4) sided watertight at upstream	
Sedimentation:	Not considered in Han Tra canal	
Ground subsidence:	Not considered	

(3) Hoist

Туре:	Wire rope winched 1 motor 2 drum type hoist
Water level at opening operat	ion
Downstream water level	: EL.+2.5 m MSL
Upstream water level:	EL.+3.5 m MSL
Water level at closing operation	on
Downstream water level	: EL. +6.5 m MSL
Upstream water level:	EL. +3.5 m MSL
Hoisting speed:	0.3 m/min at ordinary time
	1.5 m/min at emergency closing
Hoisting height:	7.0m at ordinary time
	8.5m at maintenance and emergency
Operation method:	Local
Power source:	$380V \times 3$ phase $\times 4$ wire $\times 50Hz$
Motors:	Weather-proof 380V × 3 phase × 50Hz squirrel-cage induction motors not less than 3.0kW
Controls and lightings:	220V × single phase × 50Hz

Speed reducer:	Helical or type approved by the Consultant
Brakes (2 systems):	Electromagnetic motor brakes,
	Electro hydraulic thruster brakes or Self-lock built in speed reducer
Wire rope:	SUS304 6 x 37 SB or equivalent

3.3.2 Design Loads for Gates

(1) Normal loading condition

Hydrostatic loads

Downstream Water Level:	EL. +6.0 m MSL
Upstream Water Level:	EL. +0.5 m MSL

Dead weight of the gate leaves

Operating load of hoist

(2) Overloading condition during earthquake

Wave height during earthquake at downstream

Kra Mang Floodgate:	0.13 m
Han Tra Floodgate	0.15 m

Han Tra Floodgate

Dead weight

Dynamic water pressure during earthquake

Inertia force during earthquake

3.3.3 Design Loads for Gate Guides

The load on the gate guides shall be wheel loads and all other loads due to the most adverse operation of the gate and hoist. The gate guides and anchors shall be capable of transferring the load of the wheels, seals, side wheels of the gate to the concrete structure.

3.3.4 Design Loads for Hoist

The hoist shall be designed to raise, lower and hold the gate in any position between fully closed position and fully raised position.

The rated capacity of the hoist shall be adequate to raise and lower the gate at the specified speed under the following combination of loads:

(1) Normal loading conditions

Dead weight of the gate

Frictional force of main wheel if any

Friction force of rubber seals

Down-pull force acting on the gate bottom

Buoyancy

(2) Overloading conditions

The load resulting from the breakdown or locked rotor torque of the hoist motor, or resulting from the manual operation on the operating handle.

3.4 Details of Gates

3.4.1 General

The gates shall consist of skin plate, main beams, main wheels, side wheels, seals, sheaves and all other necessary components. The gate leaf shall properly be divided into several blocks by vertical and horizontal joints to meet the limits of transportation. The blocks shall be assembled into a few horizontal sections at erection site or field shop by welding or high tensile strength reamer bolt connection.

Seal weld shall be made at the vertical joints of skin plate. Each horizontal section shall be connected by hinge pins at end beam and vertical girders to form one gate leaf assembly. The horizontal joint of skin plate shall be sealed by means of welding or O-type rubber seals or other type of seals to complete water tight. The gates shall be of all continuous welded construction except the horizontal joints between each horizontal unit and high tensile strength reamer bolt connection.

All cuttings, chamfering and other necessary preparations of each part for field connection purpose shall be done at the Contractor's workshop.

The centralized lubrication system shall be provided so as to lubricate all bearings from each grease nipple mounted on the top of gate leaf by means of grease gun.

Adequate temporary jigs and steel frame works shall be provided to hold the gates rigidly in proper positions during field erection.

The details of construction of the gates, not specified herein, shall be made by the Contractor upon approval of the Consultant.

3.4.2 Skin Plate

The skin plate shall be at the upstream side of the gate. The skin plate shall be of stainless steel SUS 304 and welded to the main beams, vertical girders, end beams, etc., by continuous welding.

3.4.3 Main Beams

The main horizontal beams shall be of shape steel or built-up plate girder construction.

Provision shall be made to drain water from the main beams.

3.4.4 Main Wheels

Each wheel assembly shall be of saddle support construction and consist of wheel, shaft, bearing and other necessary components. The wheel shall be stainless steel SUS 630 or other approved materials by the Consultant.

The contact surface of wheel shall be slightly crowned to accommodate gate deflection under loading condition. The wheels shall be machine finished and have the hardness value rather lower than that of the main track plate surface of the gate guides.

The wheel shaft shall be stainless steel SUS 304 or other approved materials by the Consultant with lubricating system. The shaft shall have an eccentricity of 3.0 millimeters to allow easy adjustment of wheel alignment at the site to ensure that all wheel treads bear the hydraulic loads equally on the wheel tracks.

3.4.5 Side Wheels

Two (2) side wheels shall be provided on each end beam to limit the lateral movement of the gate. The side wheels shall be of SUS 304 and provided with corrosion-resisting steel pins and self-lubricating metal bushing with lubricating system and location washers. If the wheels are flanged to restrain the gate from moving in watercourse direction, bushings inserted in the wheels shall have an integral thrust shoulder to transmit the resulting load.

Each wheel and pin shall be designed to the load of ten (10) percent of the gate weight and shall withstand the imposed load due to the gate becoming jammed in the gate frame.

3.4.6 Seals

The gate seals shall be of the flat bar shapes clamped to the upstream surface of the skin plate using stainless steel bars, bolts, nuts and washers. The P-type (or J-type) rubber seals shall be provided on the downstream surface of the gate leaf so as to minimize water leakage while water level at the downstream is higher than the one at upstream. The seals shall be spliced at the corners to provide a single continuous seal. The tensile strength of all splices shall not be less than fifty (50) percent of tensile strength of the unspliced material.

3.4.7 Sheave Assembly

The sheave assembly comprising a corrosion-resisting steel pins, Vee-grooved sheave and selflubricating bearings with lubricating system shall be furnished on top of the gate leaf. The attachments shall be provided to ensure that the wire ropes cannot detach from the sheave grooves in case that the wire rope goes slack.

3.4.8 Tolerances

The gate leaf shall be accurately fabricated and installed with the following tolerances:

Points to be measured	Tolerances (mm)
Gate width	<u>+</u> 5
Gate height	<u>+</u> 5
Gate depth	<u>+</u> 3
Diagonal length difference	10
Distance between side wheel treads	<u>+</u> 5
Distance between main wheel centers	<u>+</u> 5
Distance between sheave centers	<u>+</u> 5
Distance between seal rubbers	<u>+</u> 5
Position of side wheels	<u>+</u> 5
Distance between lifting pins	<u>+</u> 5

Flatness of skin plate bottom edge

<u>+2</u>

The tolerances not specified herein shall be determined by the Contractor, subject to approval by the Consultant.

3.5 Detail of Gate Guides

3.5.1 General

The gate guide shall consist of wheel rails, wheel tracks, sealing plates, sill beams, side wheel tracks, guide plates and all other necessary components for satisfactory operation of the gates. The stainless steel plates shall be attached to all exposed surfaces of the gate guide to avoid excessive wear thereof. The gate guides shall be provided up to the position at elevation as shown on the Drawings.

The details of construction of the gate guides, not specified herein, shall be made by the Contractor upon approval of the Consultant.

3.5.2 Sill Beams

The sill beams shall be straight and true flat for providing a close fit with the bottom of the gate leaf. The sill beams shall consist of H-shape beam and stainless steel seal plate.

The sealing surface of the sill beams shall be connected to the side guide plates at the bottom corners to form a continuous seal with the seal rubbers of gate leaf. The seal weld shall be made for the seal plates at the corners and shall be ground finish.

3.5.3 Wheel Rail and Wheel Track

The wheel rails shall be provided at the upstream side of the gate slots to transfer the wheel loads to the concrete structures. The wheel rails shall be provided with the wheel tracks made of stainless steel, and its surfaces shall be machine finished to true flat. The wheel rails shall be I or H-shape steel or built-up plate girder construction.

The wheel tracks shall have the hardness rather higher than that of the contact surface of main wheels of the gate to prevent excessive wear.

3.5.4 Side Wheel Track

The side wheel tracks, which are otherwise as the guide plates, shall be provided at the downstream side of the gate slots to transfer the wheel loads of the side wheels to the concrete structures.

The side wheel tracks shall have ample strength to resist the load from the side wheels of the gates. The assembled side wheel track shall be straight over their entire length and no offset shall exist at joints. The side wheel tracks shall be square shape and made of stainless steel SUS304.

3.5.5 Lintel Beams

The lintel beams shall be embedded in the second stage concrete made on the curtain wall. The lintel beams shall be true to form and free from twist and warp to provide a complete watertight with the gate rubber seal. The lintel beams shall be I or H-shape of steel with stainless steel guide plate.

3.5.6 Tolerances

Points to be measured	Tolerances (mm)
Clear span	<u>+</u> 5
Sealing span	<u>+</u> 5
Distance between sealing and wheel track face	<u>+</u> 1
Distance between centers of main wheel tracks	<u>+</u> 5
Height of gate guides	<u>+</u> 5
Distance between centers of side wheel tracks	<u>+</u> 5
Flatness of seal plate surface	<u>+</u> 0.5/m
Straightness of seal plates	<u>+</u> 1
Flatness of main wheel track surface	<u>+</u> 0.5/m
Straightness of main wheel tracks	<u>+</u> 1
Flatness of guide plate surface	<u>+</u> 0.5/m
Straightness of guide plates	<u>+</u> 1

The gate guide shall be accurately fabricated and installed within the following tolerances:

The tolerances not specified herein shall be determined by the Contractor, subject to approval by the Consultant.

3.6 Hoists

3.6.1 General

The hoist shall be of the 1-drum and 2-motor of wire rope lift stationary type suitably mounted on the hoist base frames at the floodway structure, to raise, lower and hold the floodgate.

3.6.2 Hoists

The hoist shall consist of steel base framework and steel housing, mechanical equipment, i.e., stainless steel wire ropes, rope sheaves, rope ends with detecting devices, a hoist drum, open speed reduction gear sets, speed reducer, bearings, torque shafts, couplings, supporting brackets, manual operating device, mechanical position indicator, central lubrication system, and electrical equipment such as electromagnetic brake mounted motor, limit switches, and all other necessary components for safe, proper and efficient operation of the gate.

Hoist drum and open gears shall be enclosed in the steel plate housing to protect operator from the danger. Provision shall be made on the steel housing for supply of lubricant and for visual inspection without removal of the steel plate housing.

The closed speed reducer shall be of helical gear reducer or other type, approved by the Consultant, which is rationally arranged on the operation deck and gives the performance set for in these Specifications. The electric motor shall be provided with electro-magnetic brake.

The frame works shall of all welded construction using rolled structural shapes or built-up shapes, and rigidly be fixed to the anchors set by other contractor in primary concrete on the hoist deck.

The hoist shall be designed to withstand the maximum hoisting load at the specified allowable unit stresses and the factor of safety.

The mechanical and electrical components shall conform to those specified in Sub-clauses 2.11 "Mechanical Equipment and Parts" and 2.12 "Electrical Equipment and Parts".

The details of construction of the hoists, not specified herein, shall be made by the Contractor upon approval of the Consultant.

3.7 Wiring and Control Panels

3.7.1 General

Each hoist for the gate shall be operated through a local control panel. The hoist shall be capable of raising, lowering and holding the gate by the corresponding push button switches on the control cabinet. A safety-interlock system shall be considered by the Contractor to limit the gate operation to condition only a gate can be started while another gate is running.

The following limit switches shall be provided on each hoist for proper operation of the gate:

- "Fully Opened" and "Fully Closed" limit switches to stop the gate at the respective restricted positions,
- "Over torque" limit switch to stop the hoist if the torque exceed the rated torque in opening and closing operation
- "Manual operation" interlocking limit switch to de-energize the electric control circuit
- "Wire rope slag" limit switches to stop the gate

3.7.2 Wiring

The power and control cables and/or wires with all necessary conduits and accessories from the main distribution panel in the control house to the respective electrical equipment, which are necessary for the required proper operation of the gates, shall be supplied and installed by the Contractor. The main distribution panel shall be supplied and installed by the Contractor in another clause in the Specifications.

3.7.3 Control Panels

(1) General

The Contractor shall supply and install a local control panel for each floodgate on the hoist deck and two (2) sets of water level detectors at up and downstream sides of the Barrage. The local control panel shall be weather proof construction of outdoor type.

(2) Local control panel

The following instruments, meter, switches shall be provided on or inside the local control panel, but shall not be limited to;

- Earth leakage relay,
- Surge absorber for incoming main power source,
- Incoming supply molded case circuit breaker (MCCB) lockable in "OFF" position,
- Starter of motor,
- Motor protection relay,
- MCCBs to protect the motor and other circuits,

- Source volt meter,
- Load ampere meter,
- Starter for motor with protection relays,
- 220V convenience outlet,
- Space heater with thermostat control switch and main on-off switch,
- Fluorescent light with door switch and main on-off switch,
- Push button switches for:
 - Gate open
 - Gate close
 - Gate stop
 - Test lamp for inspection of all indicating lamps
- Indicating lamps for:
 - Power source
 - De-energized
 - Gate full opened
 - Gate full closed
 - Gate full opening
 - Gate full closing
 - Earth leakage
 - Motor overload
 - Motor over-torque
 - Rope slack indication
- Other necessary MCCBs, relays, magnetic contactors, switches and miscellaneous wiring components.

All indicators such as meters and lamps shall be visible from outside without opening the keyed doors or windows.

(3) Gate position indicators

One (1) electric gate position indicator shall be provided as following table on each gate hoist in order to read the gate opening respectively.

- Quantity	1 set per gate hoist
- Opening detection method	by detecting the rotation of hoist
- Туре	Synchro transmitter
- Display in receiver	Analog
- Measurement range	Gate sill elevation to gate maintenance elevation
- Accuracy	±5 cm or higher
- Power source	220V × single phase × 50Hz

The synchro transmitter and receiver shall be housed in a weather-proof enclosure.

(4) Water level detectors and paperless data logger with memory card

Two (2) sets of pressure type water level detectors with connector terminal and hollow cable, and one (1) set of paperless data logger with memory card shall be provided for Kra Mang and Han Tra Floodgates respectively.

The connector terminal shall be housed in a steel made box against vandalism.

The pressure type water level detector and its hollow cable shall be installed in the corrosion-resisting wave protective steel pipe.

The paperless data logger with memory card shall be housed in one (1) of the local control panel.

The water levels detected by the water level detectors shall be indicated by "EL. m MSL" with the paperless data logger and its data shall be saved in the memory card. The data logger shall be capable of reading the exact water level by 1.0 cm with an accuracy of plus or minus 1.0 cm against full range.

Floodgates	Particular	Gauging range in m MSL	Diameter of wave protective steel pipe
Kra Mang	Upstream side	-0.5 to +6.5	100 mm
	Downstream side	-0.5 to +6.5	100 mm
Han Tra	Upstream side	-2.5 to +6.5	100 mm
	Downstream side	-2.5 to +6.5	100 mm

The water level detectors shall have the following requirements:

(5) Alarm Equipment

One (1) set of alarm equipment consisting of buzzer and reset button, etc. shall be provided on the local control panel, so that due warning could be given to the gate operators, when the following relays or limit switches, etc. are actuated:

- Electrical control de-energized
- Earth leakage relay
- Motor protection relay
- Motor over-torque limit switches
- Over raised and over lowered limit switches,
- Slack rope limit switch
- Sediment trap water level
- Water levels over EL. +6.0 m MSL at downstream and over EL. +3.5 m MSL at upstream

The setting water levels for giving buzzer alarm shall readily be adjustable from the front face of water level indicator and the setting water levels shall be indicated on the front face with digital figures.

3.8 Shop Assembly and Tests

3.8.1 Gates and Gate Guides

Each gate including wheels, flap gate, seals, sheaves and side wheels, etc. shall be assembled at the shop in the approximate position that it will have after installation at the site. While assembled, the gates shall be checked for dimension, tolerances and accuracy of alignment. Any error and misalignment discovered shall be promptly corrected.

The main wheel tracks, sill beams, guide plates, side wheel tracks and removable gate guides with saddles shall be assembled at the shop and all dimensions, flatness, straightness, etc., of the gate guides shall be checked and any error and misalignment discovered shall be corrected promptly.

3.8.2 Hoists and Controls

Each hoist shall be completely shop assembled and test for smooth and proper performance. All units shall be tested at the normal operating speed with the rated load, and closely checked to ensure that all necessary clearance and tolerance have been provided and that no binding occurs in any moving part.

All bearing shall be carefully checked up to their saturated temperature rise under the normal loading condition. All equipment/facilities including temporary wire ropes, power cables, lubricating grease and oil required for the performance test shall be furnished by the Contractor. The Contractor shall prepare temporary test tower and dummy loads for such test.

The following items, at least, shall be checked under the rated hoisting load during operation test of the hoists:

- Raising and lowering speeds,
- Voltage and current of electric motor
- Temperature rise of bearings, motor, and gear reducer,
- Gear tooth contact,
- Existence of abnormal noise and vibration,
- Manual operation of hoist,
- Operation of limit switches,
- Accuracy of gate position indicator, and
- Insulation resistance of control panels.

Any defect, or improper operation discovered shall be corrected and the entire test shall be repeated to the satisfaction of the Consultant.

In case that the Contractor fabricates the hoist and control panels in different country, tests of hoists and control panels may be conducted separately.

3.9 Erection, Installation and Tests at Site

3.9.1 Erection and Installation

(1) Gate Guides

The gate guides shall be assembled in the blockouts in accordance with the "Approved drawings" and the approved installation procedures, and brought to line and grade within

the tolerances specified and firmly fastened in place.

Necessary devices shall be used to install the gate guides at corresponding accurate position. Connection between gate guides, anchor materials and the alignment devices shall be adjustable and firmly tightened to hold the gate 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 wheel paths and sealing surfaces lie in a true plate within the tolerances specified for their entire length. Placement of concrete in the blockouts shall not proceed until the gate guides have been completely assembled and secured. During and after concrete placing, alignment and tolerances shall be checked and remedial action taken if readings indicate that displacement has occurred.

(2) Gates

The gate complete with seals shall be assembled and erected in accordance with the "Approved drawings" within the tolerances specified. Joints shall be water tight where required. The rubber seals shall be fixed on each gate leaf and adjusted to have effective water tightness on the sealing frames of the gate guide.

(3) Hoists and Control

Before assembly, all bearing surfaces, journals, 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 the approved lubricant furnished by the Contractor.

Each hoist, completes with all accessories, shall be assembled and installed in accordance with the "Approved drawings" within the tolerances specified. The hoist drums shall be located and adjusted so that they are in true alignment with the gate sheaves and lifting lugs of the gate.

Control panels shall be installed in accordance with the "Approved drawings".

3.9.2 Field Tests and Inspection

After completion of erection and installation work at the site, the Contractor shall perform the tests to prove satisfactory erection and installation works, in accordance with the approved test procedures. The test and inspection shall include, but not be limited to:

- Visual inspection of position and assembly sequence of parts, edge preparation, size, length and location of welds, and overall finishing,
- Inspection of satisfactory installation of all components,
- Inspection of welds by radiographic testing for detecting inner flaws and defects of welded parts including gate leaves, gate guides and hoists,
- Inspection by feeler gauge measurement of satisfactory sealing of all seals,
- Insulation resistance tests of all wiring and electrical connections made at site,
- Insulation resistance tests of lightning arresters,
- Check of limit switches, wire rope slack detectors, overload detecting devices, gate position indicators and control equipment,
- Check of gear tooth contact,
- Check of appearance and performance of brakes for hoists,
- Check of appearance and arrangement of wire ropes,

- Existence of abnormal noise and vibration during operation of hoist,
- Check of looseness and loss of bolts and nuts,
- Temperature rise of bearings, motor and speed reducer,
- Measurement of rising and lowering speeds of gates,
- Check of voltage and current of hoist motor,
- Check of water level detectors, transmitter and data loggers,
- Check of appearance and on-off of lighting fixtures, and
- Check of manual operating of hoist.

Acceptance criteria of the radiographic testing shall be in conformity with 2nd class or higher stipulated in JIS Z 3104 and 3106 or equivalent such as ISO, EN, BSI and ASTM approved by the Consultant.

Any defects or improper operation discovered during the test shall be corrected and the entire test shall be repeated to the satisfaction of the Consultant.

3.10 Commissioning (Acceptance Tests)

After the tests at site have been completed and approved by the Consultant and relevant structures under other contracts are fully erected and installed, the following inspection shall be conducted by the Contractor for assessment of their performance as commissioning (acceptance tests) in the presence of the Client.

Commissioning shall be conducted launching the completed shape of the civil works and the hydraulic gate works into water of the canals.

- (1) Discharging tests
 - Measurement of vibration on the piers, columns, operation deck and wing walls
 - Measurement of noise around the gate leaves
- (2) Water tightness tests
 - Leakage measurement through gate seals in wet conditions by filling with water the room between the maintenance gate leaves and the main gate leaves

Leakage volume exceeding 0.1 liter/meter of sealing/second shall not de accepted.

- (3) Operation and control tests
 - Free opening, closure and stop of gates in any position
 - Total closing from totally open position
 - Functioning of hand drive mechanism
 - Functioning of limit switches, wire rope slack detectors, overload detecting devices, gate position indicators and control equipment
 - Functioning of water level detectors, transmitter and data loggers
 - Check of voltage and current of hoist motors at the time gate operation tests
- (4) Back-up power source tests

Following item shall be tested when the power supply changes over to the engine generator.

- Free opening, closure and stop of gates in any position
- Total closing from totally open position
- Functioning of water level detectors, transmitter and data loggers
- Check of voltage and current of hoist motors at the time gate operation tests

Any defects or improper operation discovered at the commissioning shall be corrected by the Contractor and the entire tests shall be repeated to the satisfaction of the Client and the Consultant.

4. STOPLOGS (MAINTENANCE GATES) AND HOISTS

4.1 General

Telpher rails, plate-girder structure steel slide gate leaves, stainless steel gate guides, lifting beams, chain hoists and appurtenant equipment with all the necessary accessories, shall be designed, manufactured, transported, erected, installed and tested at Han Tra and Kra Mang Floodgates by the Contractor under this Contract.

The stoplogs (or otherwise maintenance gates) are used for the purpose of inspection, maintenance and repair of the main gates & equipments and the stoplogs shall be usually stored in place designated by the Client.

The stoplogs shall be mounted by the manual-type chain hoist through a lifting beam.

The general data for the design of the stoplogs are given in Sub-clause 4.3 herein and those data shall be fixed and may not be altered.

The Contractor shall take special care in the design of the stoplogs to avoid any water leakage in due mounted position.

The arrangement of the telpher rails, stoplogs, gate guides and chain hoists for Kra Mang and Han Tra floodgates shall be as shown on the attached Drawings.

4.2 Design Stresses

The design stresses shall conform to those specified in Clause 2 "Design Criteria and Particulars" of the specifications.

4.3 Design Data

The gate leaves, gate guides, lifting beams and telpher rails shall be designed by the Contractor for the following design conditions.

4.3.1 General Data

Kra Man Floodgate

(1) Quantities to be procured

Gate leaves:

3 sets \times 2 (upstream and downstream sides)

Gate guides:	6 sets
Lifting beam:	2 sets
Telpher rails:	2 sets
Chain hoists:	2 sets

(2) Stoplog (Maintenance gate)

Туре:	Plate-girder structure steel slide gate
Clear span:	6.0 m
Effective height:	1.0 m x 3
Design head	
Downstream water level:	EL. +2.0 m MSL
Upstream water level:	EL. +2.0 m MSL
Water level on the sill:	EL0.50 m MSL (Water depth = 0m)
Sill elevation:	EL0.50 m MSL
Sealing method:	Three (3) sided watertight at non-pressure side
Sedimentation:	Not considered in Kra Mang canal
Ground subsidence:	Not considered

(3) Telpher rail

Rail:	l shaped steel 450mm × 175mm × 13mm × 26mm
Length:	8 m × 3 + 8.5 m = 32.5 m/side
Pier:	H shaped steel 250mm × 250mm × 9mm × 14mm
Height:	4.153m × 2

(4) Chain hoist

Туре:	Manual geared trolley
Hoisting height:	10 m
Hoisting load:	5 ton

Han Tra Floodgate

(1) Quantities to be procured

Gate leaves:	5 sets \times 2 (upstream and downstream sides)
Gate guides:	6 sets

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Lifting beam:	2 sets
Telpher rails	2 sets
Chain hoists:	2 sets

(2) Stoplog (Maintenance gate)

Туре:	Plate-girder structure steel slide gate
Clear span:	6.0 m
Effective height:	1.0 m x 5
Design head	
Downstream water level:	EL. +2.0 m MSL
Upstream water level:	EL. +2.0 m MSL
Water level on the sill:	EL2.5 m MSL (Water depth = 0m)
Sill elevation:	EL2.5 m MSL
Sealing method:	Three (3) sided watertight at non-pressure side
Sedimentation:	Not considered in Han Tra canal
Ground subsidence:	Not considered

(3) Telpher rail

Rail:	I shaped steel 450mm × 175mm × 13mm × 26mm
Length:	8.5 m +8.0m × 2 + 8.5 m = 33.0 m/side
Pier:	H shaped steel 250mm × 250mm × 9mm × 14mm
Height:	6.153m × 2

(4) Chain hoist

Type:	Manual geared trolley
Hoisting height:	14 m
Hoisting load:	5 ton

4.3.2 Design Loads for Stoplogs

Hydrostatic loads

Normal Water level: EL. +2.0 m MSL

Dead weight of the gate leaves

4.3.3 Design Loads for Gate Guides

The gate guides shall conform to those specified in Clause 3.2 of this section.

4.3.4 Design Loads for Lifting Beam

The lifting beam shall be designed to withstand the rated hoisting capacity of the chain hoist.

4.4 Details of Stoplogs

4.4.1 General

The stoplogs shall consist of skin plate, main horizontal beams, vertical members, bearing plates, side shoes, seals, sealing plate, lifting lugs and all other necessary components. The stoplogs shall be of the slide gate type and of welded constructions.

All stoplogs leaves shall be identical in their design, construction and strength, and shall be interchangeable.

The details of construction of the stoplogs not specified herein will be left to the Contractor, subject to the approval of the Consultant.

4.4.2 Skin Plate

The skin plate shall be at the non-pressure side of the stoplogs. No corrosion allowance of the skin plate may be considered. The skin plate shall be of steel SM400 and welded to the main beams, vertical girders, end beams, etc., by continuous welding.

4.4.3 Main Beams

The horizontal main beams shall be of built-up girder .

4.4.4 Seals

The seals shall be of the music note and flat bar shapes clamped to the downstream surface of the stoplogs by means of steel bars and corrosion-resisting steel bolts, nuts and washers. The seals shall be spliced at the corners by shop vulcanizing to provide a single continuous seal. The tensile strength of all shop splices shall not be less than fifty (50) percent of the tensile strength of the unspliced materials.

4.4.5 Side Shoes

Side shoes shall be provided on both longer side of each gate leaf to limit movement of four (4) lateral sides of the stoplogs. The side shoes shall be made of stainless steel.

Each side shoe shall be designed to withstand the rated hoisting capacity of the chain hoist.

4.4.6 Lifting Lug

Each gate leaf shall be fitted with two (2) lifting lugs on the top of it. The lugs shall be designed to ensure that the hooks of the lifting beam can catch and release the lifting lugs smoothly.

4.4.7 Tolerances

Each gate leaf shall be accurately fabricated and installed with the following tolerances:

Point to be Measured	Tolerances (mm)
Stoplog width	<u>+</u> 6
Stoplog height	<u>+</u> 4
Stoplog depth	<u>+</u> 3
Diagonal length difference	<u>+</u> 6
Distance between side wheel treads	<u>+</u> 6
Distance between bearing plates	<u>+</u> 6
Distance between lifting lug	<u>+</u> 6
Distance between side seal rubbers	<u>+</u> 6
Flatness of top sealing plate	<u>+</u> 0.5 / m

The tolerances not specified herein shall be defined by the Contractor, subject to approval of the Consultant.

4.5 Details of Gate Guides

4.5.1 General

Each gate guide shall consist of the sill beams, sealing plates, side gate guides, guide plate, and all other necessary components.

The details of construction of the gate guides not specified herein shall be designed by the Contractor subject to approval of the Consultant.

4.5.2 Sill Beam

The sill beams shall be embedded in the bottom of the maintenance gate leaves. The sill beams shall consist of H-shape beam and stainless steel seal plate.

The sealing surface of the sill beams shall be connected to the side gate guides at the bottom corners to form a continuous seal with the rubber seals of the gate leaves. The seal weld shall be made for the seal plates at the corners and shall be ground finish.

4.5.3 Side Gate Guide

The side gate guides shall be provided to both pressure and non-pressure sides to be capable of transmitting the hydraulic loads from the side shoes of the stoplog leaf to the concrete structures.

The side gate guides shall be stainless steel channels and shall have ample strength to resist the load from the side shoes of the stoplog leaf.

Top of the side gate guides shall be chamfered so as to facilitate the stoplog to insert with the lifting beam.

4.5.4 Side Plate

The side plates shall have ample strength to resist the perpendicular load from the side shoes of the stoplog leaf.

The side plates shall be of stainless steel.

4.5.5 Tolerances

The gate guides shall be accurately fabricated and installed with the following tolerances:

Point to be Measured	Tolerances (mm)
Clear span	<u>+</u> 6
Sealing span	<u>+</u> 6
Distance between centers of side gate guides	<u>+</u> 6
Distance between side rails	<u>+</u> 6
Height of gate guides	<u>+</u> 6
Flatness of seal plate surface	<u>+</u> 0.5 / m
Straightness of seal plates	<u>+</u> 1
Flatness of side gate guide surface	<u>+</u> 0.5 / m
Straightness of side gate guides	<u>+</u> 1
Flatness of side plate surface	<u>+</u> 1 / m
Straightness of side plates	<u>+</u> 2

The tolerances not specified herein shall be defined by the Contractor, subject to approval of the Consultant.

4.6 Telpher Rail System

4.6.1 General

The telpher rail system shall consist of manual chain hoists, telpher rails, lifting beam and all other necessary components.

4.6.2 Lifting Beam

A lifting beam shall be supplied and installed to handle the stoplog leaves.

The lifting beam shall consist of two (2) lifting hooks, counter weight with operation handles, linkage, sheave blocks on the linkage, side wheels and all other necessary components for operation.

The lifting beam shall be capable of catching and releasing the lifting lugs of each gate leaf automatically by the function of counter weights.

The lifting beams shall of all welded construction or of a latticed girder construction.

The details of construction of the lifting beams not specified herein shall be made by the Contractor subject to approval of the Consultant.

4.6.3 Telpher Rail

The telpher rail system shall be provided at both upstream and downstream sides of the main gates for traveling the chain hoists with the lifting beams.

The telpher rail system shall consist of SS400 steel I-shape rails and H-shape piers.

Stoppers to prevent overrun of the chain hoist shall be provided at both ends of the rails.

4.7 Shop Assembly and Tests

4.7.1 Stoplogs and Gate Guides

Each complete stoplog leaf including seals and side shoes shall be assembled at the shop in the approximate position that they will have after installation at the site. While assembled, each leaf shall be checked for dimensions, tolerances and accuracy of alignment. Any error and misalignment discovered shall be corrected promptly.

The side gate guides, sill beams, seal plates, and side plates composing the gate guide of the stoplog leaves shall be assembled at the shop and all dimensions, flatness, straightness, etc., of the gate guide shall be checked and any error and misalignment shall be corrected promptly.

Parts shall be clearly match-marked before disassembly for transportation.

4.7.2 Lifting Beam

The lifting beam shall be completely shop assembled and tested for smooth and proper performance. If any defect or improper operation is discovered, it shall be corrected and the entire test shall be repeated to the satisfaction of the Consultant.

4.8 Erection, Installation and Tests at Site

4.8.1 Erection and Installation

(1) Gate Guides

The gate guides shall be assembled in the blockouts in accordance with the "Approved drawing" and approved installation procedures, brought to line and grade within the tolerances specified and firmly secured in place.

Alignment bolts or other necessary devices shall be used to install the gate guides at corresponding accurate position. Connections between gate guide and anchor materials and the alignment devices shall be adjustable and firmly tightened to hold the gate 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 bearing and sealing surfaces lie in a true plane within the tolerances specified for their entire length. Placement of concrete in the blockouts shall not proceed until the gate guides have been completely assembled and secured. During and after concrete placing, alignment and tolerances shall be checked and remedial action taken if readings indicate that displacement has occurred.

(2) Stoplogs

Each gate leaf complete with seals, wheels and bearing plates shall be assembled and erected in accordance with the "Approved drawings" and approved installation procedures.

Joints shall be watertight where required. The rubber seals shall be so fixed to each g leaf and adjusted that the stoplog, when set in the guide slots, have effective water tightness on the sealing frames of the gate guides.

(3) Telpher rail and Lifting Beam

The Telpher and lifting beam complete with all accessories shall be assembled and installed in accordance with the "Approved drawings" and approved installation procedures.

The rails of telpher rail shall be fixed with J-shaped anchor bolts of M20, in suspension, to the reinforced concrete cantilevers with which are provided the operation deck. The joint surface of the rail shall be enough grooved and butt-welded throughout the perimeter. The joint shall be made under the cantilevers where the rails of telpher rail are fixed. After welded, upper and lower surface of the bottom flange, which are travelling surface for the wheels, shall be finished with sander. The travelling surface of the beams shall not be allowed to paint.

The piers of telpher rail shall be fixed with L-shaped anchor bolts of M24, through the welded base plates of 22mm in the bottom, to the reinforced concrete foundation. The rail shall be fixed to the piers, with F10T class high tension bolt of M20, through the H-shape beam which is installed on the top of two (2) piers.

The telpher rails shall be coated to be anticorrosive in conformity with Clause 2.3 "Painting".

4.8.2 Field Tests and Inspection

After completion of erection and installation work at the site, the Contractor shall perform the tests to prove satisfactory erection and installation works, in accordance with the approved test procedures. The test and inspection shall include, but not be limited to:

- Visual inspection of position and assembly sequence of parts, edge preparation, size, length and location of welds, and overall finishing,
- Inspection of satisfactory installation of all components,
- Inspection of welds by radiographic testing for detecting inner flaws and defects of welded parts including stoplog leaves, gate guides and telpher rails,
- Inspection by feeler gauge measurement of satisfactory sealing of all seals,
- Inspection by feeler gauge measurement of satisfactory sealing of all seals,
- Check of looseness and loss of bolts and nuts, and
- Existence of abnormal noise and vibration during hoisting and travelling of chain hoists.

Acceptance criteria of the radiographic testing shall be in conformity with 2nd class or higher stipulated in JIS Z 3104 and 3106 or equivalent such as ISO, EN, BSI and ASTM approved by the Consultant.

Any defects or improper operation discovered during the test shall be corrected and the entire test shall be repeated to the satisfaction of the Consultant.

4.9 Commissioning (Acceptance Tests)

After the tests at site have been completed and approved by the Consultant and relevant structures under other contracts are fully erected and installed, the following inspection shall be conducted by the Contractor for assessment of their performance as commissioning (acceptance tests) in the presence of the Client.

Commissioning shall be conducted launching the completed shape of the civil works and the hydraulic gate works into water of the canals.

- (1) Discharging tests
 - Measurement of vibration on the piers, columns, operation deck and wing walls
 - Measurement of noise around the stoplog leaves

(2) Water tightness tests

- Leakage measurement through stoplog seals in wet conditions by filling with water the room between the stoplog leaves and the main gate leaves

Leakage volume exceeding 0.1 liter/meter of sealing/second shall not de accepted.

(3) Setting tests

- Inserting and removing of the maintenance gate leaves
- Hoisting and travelling of chain hoists with lifting beam and maintenance gate leaf.

Any defects or improper operation discovered at the commissioning shall be corrected by the Contractor and the entire tests shall be repeated to the satisfaction of the Client and the Consultant.

5. FIXED WHEEL GATE AND HOISTS FOR DRAINAGE CHANNEL

5.1 General

One (1) complete set of plate-girder structure stainless steel fixed wheel (roller) gate leaf, stainless steel gate guide, manual racked gate hoist and appurtenant parts complete with all the necessary accessories shall be designed, manufactured, transported, erected, installed and tested in the drainage channel at Kra Mang Floodgate by the Contractor under this Contract.

The fixed wheel gate is used for the purpose of avoiding floodwater to enter the drainage channel which is coming to the canal at the right bank just downstream Kra Mang floodgate.

The general data for the design of the fixed wheel gate for drainage channel are given in Subclause 5.3 herein and those data shall be fixed and may not be altered.

The arrangement of the fixed wheel gate, gate guide and hoist shall be as shown on the attached Drawings.

5.2 Design Stresses

The design stresses shall conform to those specified in Clause 2 "Design Criteria and Particulars" of the specifications.

5.3 Design Data

The gate leaf, gate guide and hoist shall be designed by the Contractor for the following design conditions.

5.3.1 General Data

(1) Quantities to be procured

Gate leaf:	1 set
Gate guide:	1 set
Hoist:	1 set

(2) Gate

Туре:	Plate-girder structure stainless steel fixed wheel gate	
Clear span:	2.0 m	
Effective height:	1.5 m	
Water levels at upstream (Drainage channel side)		nnel side)
High Water Level (H	IWL):	EL. +3.5 m MSL
Low Water Level (LWL):		EL. ±0.0 m MSL
Water levels at downstream (Kra Mang canal side)		
High Water Level (HWL): EL. +6.0 m MSL		
Low Water Level (LWL):		EL. +0.5 m MSL
Sill elevation:		EL. ±0.0 m MSL
Sealing method:	Curtain-walled four (4) sided watertight at upstream	
Sedimentation:	Not considered in Kra Mang canal and drainage channel	
Ground subsidence:	Not considered	

(3) Hoist

Туре:	Manual racked hoist
Water level at opening operation	
Downstream water level:	EL. +3.5 m MSL
Upstream water level:	EL. ±0.0 m MSL
Water level at closing operation	
Downstream water level:	EL. +6.5 m MSL
Upstream water level:	EL. +3.5 m MSL
Hoisting height:	1.6 m
Hoisting capacity:	40 kN

5.3.2 Design Loads for Gates

- (1) Normal loading condition
 - Hydrostatic loads

Downstream Water Level:	EL. +6.0 m MSL
Upstream Water Level:	EL. +0.5 m MSL

Dead weight of the gate leaf

Operating load of hoist

(2) Overloading condition during earthquake

Wave height during earthquake at downstream

Kra Mang Floodgate:	0.13 m
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Han Tra Floodgate 0.15 m

Dead weight

Dynamic water pressure during earthquake

Inertia force during earthquake

5.3.3 Design Loads for Gate Guides

The load on the gate guides shall be wheel loads and all other loads due to the most adverse operation of the gate and hoist. The gate guides and anchors shall be capable of transferring the load of the wheels, seals, side wheels of the gate to the concrete structure.

5.3.4 Design Loads for Hoist

The hoist shall be designed to raise, lower and hold the gate in any position between fully closed position and fully raised position.

The rated capacity of the hoist shall be adequate to raise and lower the gate at the specified speed under the following combination of loads:

Dead weight of the gate

Frictional force of main wheel if any

Friction force of rubber seals

Down-pull force acting on the gate bottom

Buoyancy

5.4 Details of Gate

5.4.1 General

The gate shall consist of skin plate, main beams, main wheels, side wheels, seals, pin and all other necessary components. The gate leaf shall properly be divided into several blocks by vertical and horizontal joints to meet the limits of transportation. The blocks shall be assembled into a few horizontal sections at erection site or field shop by welding or high tensile strength reamer bolt connection.

Seal weld shall be made at the vertical joints of skin plate. Each horizontal section shall be connected by hinge pins at end beam and vertical girders to form one gate leaf assembly. The horizontal joint of skin plate shall be sealed by means of welding or O-type rubber seals or other type of seals to complete water tight. The gates shall be of all continuous welded construction except the horizontal joints between each horizontal unit and high tensile strength reamer bolt connection.

All cuttings, chamfering and other necessary preparations of each part for field connection purpose shall be done at the Contractor's workshop.

The details of construction of the gates, not specified herein, shall be made by the Contractor upon approval of the Consultant.

5.4.2 Skin Plate

The skin plate shall be at the drainage channel side of the gate. The skin plate shall be of stainless steel SUS 304 and welded to the main beams, vertical girders, end beams, etc., by continuous welding.

5.4.3 Main Beams

The main horizontal beams shall be of shape steel.

Provision shall be made to drain water from the main beams.

5.4.4 Wheel Assemblies

Each wheel assembly shall be of saddle support construction and consist of wheel, shaft, bearing and other necessary components. The wheel shall be stainless steel SUS 304.

The contact surface of wheel shall be slightly crowned to accommodate gate deflection under loading condition. The wheels shall be machine finished and have the hardness value rather lower than that of the main track plate surface of the gate guides.

The wheel shaft shall be stainless steel SUS 304. The shaft shall have an eccentricity of 3.0 millimeters to allow easy adjustment of wheel alignment at the site to ensure that all wheel treads bear the hydraulic loads equally on the wheel tracks.

5.4.5 Side Wheels

Two (2) side wheels shall be provided on each end beam to limit the lateral movement of the gate. The side wheels shall be SUS 304 and provided with corrosion-resisting steel pins and self-lubricating metal bushing. If the wheels are flanged to restrain the gate from moving in watercourse direction, bushings inserted in the wheels shall have an integral thrust shoulder to transmit the resulting load.

Each wheel and pin shall be designed to the load of ten (10) percent of the gate weight and shall withstand the imposed load due to the gate becoming jammed in the gate frame.

5.4.6 Seals

The gate seals shall be of the L and flat bar shapes clamped to the upstream surface of the skin plate using stainless steel bars, bolts, nuts and washers. The P-type (or J-type) rubber seals shall be provided on the downstream surface of the gate leaf so as to minimize water leakage while water level at the downstream is higher than the one at upstream. The seals shall be spliced at the corners to provide a single continuous seal. The tensile strength of all splices shall not be less than fifty (50) percent of tensile strength of the unspliced material.

5.4.7 Tolerances

The gate leaf shall be accurately fabricated and installed with the following tolerances:

Points to be measured Toleran	ces (mm)
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Gate width	<u>+</u> 5
Gate height	<u>+</u> 5
Gate depth	<u>+</u> 3
Diagonal length difference	10
Distance between side wheel treads	<u>+</u> 5
Distance between main wheel centers	<u>+</u> 5
Distance between seal rubbers	<u>+</u> 5
Position of side wheels	<u>+</u> 5
Distance between lifting pins	<u>+</u> 5
Flatness of skin plate bottom edge	<u>+</u> 2

The tolerances not specified herein shall be determined by the Contractor, subject to approval by the Consultant.

5.5 Detail of Gate Guide

5.5.1 General

The gate guide shall consist of wheel rails, wheel tracks, sealing plates, sill beams, side wheel tracks, guide plates, side plate and all other necessary components for satisfactory operation of the gates. The stainless steel plates shall be attached to all exposed surfaces of the gate guide to avoid excessive wear thereof. The gate guide shall be provided up to the position at elevation as shown on the Drawings.

The details of construction of the gate guide, not specified herein, shall be made by the Contractor upon approval of the Consultant.

5.5.2 Sill Beam

The sill beam shall be straight and true flat for providing a close fit with the bottom of the gate leaf. The sill beam shall consist of H-shape beam and stainless steel sealing plate.

The sealing surface of the sill beam shall be connected to the side plates at the bottom corners to form a continuous seal with the seal rubbers of gate leaf. The seal weld shall be made for the sealing plates at the corners and shall be ground finish.

5.5.3 Wheel Rail and Wheel Track

The wheel rails shall be provided at the drainage channel side of the gate slots to transfer the wheel loads to the concrete structures. The wheel rails shall be provided with the wheel tracks made of stainless steel, and its surfaces shall be machine finished to true flat. The wheel rails shall be I or H-shape steel.

The wheel tracks shall be of stainless steel SUS 304.

5.5.4 Side Wheel Track

The side wheel tracks, which are otherwise as the guide plates, shall be provided at the canal side of the gate slots to transfer the wheel loads of the side wheels to the concrete structures.

The side wheel tracks shall have ample strength to resist the load from the side wheels of the gates. The assembled side wheel track shall be straight over their entire length and no offset

shall exist at joints. The side wheel tracks shall be square shape and made of stainless steel SUS304.

5.5.5 Lintel Guide Plate

The lintel guide plate shall be provided on the second stage concrete made on the curtain wall. The lintel guide plate shall be of stainless steel SUS 304.

5.5.6 Tolerances

The gate guide shall be accurately fabricated and installed within the following tolerances:

Points to be measured	Tolerances (mm)
Clear span	<u>+</u> 5
Sealing span	<u>+</u> 5
Distance between sealing and wheel track face	<u>+</u> 1
Distance between centers of main wheel tracks	<u>+</u> 5
Height of gate guides	<u>+</u> 5
Distance between centers of side wheel tracks	<u>+</u> 5
Flatness of seal plate surface	<u>+</u> 0.5/m
Straightness of seal plates	<u>+</u> 1
Flatness of main wheel track surface	<u>+</u> 0.5/m
Straightness of main wheel tracks	<u>+</u> 1
Flatness of guide plate surface	<u>+</u> 0.5/m
Straightness of guide plates	<u>+</u> 1

The tolerances not specified herein shall be determined by the Contractor, subject to approval by the Consultant.

5.6 Hoist

The hoist for the fixed wheel gate to be supplied under this Contract shall be of steering wheeloperated manual racked hoist. The racked hoist shall be pin racked or rack geared of stainless steel SUS 304 single stem with 40kN of hoisting capacity. The gate leaf shall fall with its own weight by releasing self-rock system. The falling speed of the gate leaf shall be controlled by the centrifugal brake and the suspension thereof in the course shall be made fastening clutch by manipulation of the lever. Gate position indicator shall be equipped to indicate the opening height of the gate leaf. Center guide shall be provided on the curtain wall to fasten the position of the hoisting stem.

5.7 Erection, Installation and Tests at Site

5.7.1 Erection and Installation

(1) Gate Guide

The gate guide shall be assembled in the blockouts in accordance with the "Approved drawings" and the approved installation procedures, and brought to line and grade within the tolerances specified and firmly fastened in place.

Necessary devices shall be used to install the gate guide at corresponding accurate position. Connection between gate guide, anchor materials and the alignment devices shall be adjustable and firmly tightened to hold the gate guide 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 wheel paths and sealing surfaces lie in a true plate within the tolerances specified for their entire length. Placement of concrete in the blockouts shall not proceed until the gate guide has been completely assembled and secured. During and after concrete placing, alignment and tolerances shall be checked and remedial action taken if readings indicate that displacement has occurred.

(2) Gate

The gate complete with seals shall be assembled and erected in accordance with the "Approved drawings" within the tolerances specified. Joints shall be water tight where required. The rubber seals shall be fixed on each gate leaf and adjusted to have effective water tightness on the sealing frames of the gate guide.

(3) Hoist

Before assembly, all bearing surfaces, journals, grease and oil grooves shall be carefully cleaned and lubricated with an approved oil or grease. After assembly, the lubricating system shall be filled with the approved lubricant furnished by the Contractor.

The hoist, completes with all accessories, shall be assembled and installed in accordance with the "Approved drawings" within the tolerances specified. The hoisting stem shall be located and adjusted so that it is in true alignment.

5.7.2 Field Tests and Inspection

After completion of erection and installation work at the site, the Contractor shall perform the tests to prove satisfactory erection and installation works, in accordance with the approved test procedures. The test and inspection shall include, but not be limited to:

- Visual inspection of position and assembly sequence of parts, edge preparation, size, length and location of welds, and overall finishing,
- Inspection of satisfactory installation of all components,
- Inspection of welds by radiographic testing for detecting inner flaws and defects of welded parts including gate leaf, gate guide and hoist,
- Inspection by feeler gauge measurement of satisfactory sealing of all seals,
- Check of performance of self-rock system of hoist,
- Check of appearance and movement of hoisting stem,
- Existence of abnormal noise and vibration during operation of hoist, and
- Check of looseness and loss of bolts and nuts,

Acceptance criteria of the radiographic testing shall be in conformity with 2nd class or higher stipulated in JIS Z 3104 and 3106 or equivalent such as ISO, EN, BSI and ASTM approved by the Consultant.

Any defects or improper operation discovered during the test shall be corrected and the entire test shall be repeated to the satisfaction of the Consultant.

5.8 Commissioning (Acceptance Tests)

After the tests at site have been completed and approved by the Consultant and relevant structures under other contracts are fully erected and installed, the following inspection shall be conducted by the Contractor for assessment of their performance as commissioning (acceptance tests) in the presence of the Client.

Commissioning shall be conducted launching the completed shape of the civil works and the hydraulic gate works into water of the canals.

- (1) Discharging tests
 - Measurement of vibration on the piers, columns and operation deck of the drainage gate
 - Measurement of noise around the gate leaf
- (2) Water tightness tests
 - Leakage measurement through gate seals in wet condition

Leakage volume exceeding 0.1 liter/meter of sealing/second shall not de accepted.

- (3) Operation and control tests
 - Free opening, closure and stop of gates in any position
 - Total closure from totally open position
 - Functioning of gate position indicator

Any defects or improper operation discovered at the commissioning shall be corrected by the Contractor and the entire tests shall be repeated to the satisfaction of the Client and the Consultant.

6. ELECTRIC POWER SUPPLY SYSTEM

6.1 General

This Clause shall be included the following electrical items works and all other electrical works relevant to gate operation will be included to Hydraulic Gate Works. In design of electrical works, the Contractor shall also refer to Sub-clause 2.12.

The design, manufactures, materials, inspection and performance of electrical and electromechanical equipment shall be made according to the following standards and regulations.

- a. Provincial Electricity Authority (PEA)
- b. Thai Industrial Standards (TIS)
- c. International Electrotechnical Commission (IEC)
- c. JIS or other standards approved by the Consultant
- (1) Power supply system at the Project sites

The power distribution lines, with $22kV \times 3$ phase $\times 50Hz$, at the area of the Project are being managed by Provincial Electricity Authority in Ayutthaya.

Two (2) units of Low Voltage Transformer with a capacity of $22kV/400-230V \times 3$ phase $\times 4$ wire $\times 50Hz \times 250kVA$ shall be installed at kra Mang and Han Tra sites respectively at the cost of the Client.

Hoist system of the hydraulic gates shall work in 380V \times 3 phase \times 50Hz while the lighting facilities work in 230V \times single phase \times 50Hz.

(2) Power supply system from diesel engine generator

Two (2) units of 20 kVA Diesel Engine Generator for the gate operation and the lighting facilities, during the time of power failure of the commercial power supply, shall be procured for Han Tra and Kra Man Floodgates respectively.

(3) All electrical cabling/wiring and necessary attachment.

6.2 Local Distribution Panels

(1) General

The following items shall be designed and provided under this Contract as work items in this Clause.

- Two (2) complete sets of local distribution panel for the Hydraulic Gate Works for Han Tra Floodgate and Kra Man Floodgate.
- (2) Panels
 - Panel shall be made of as specified in Sub-clause 2.12.5.
 - Out door distribution panels shall be of weatherproof type, sealed and painted.
 - The cables and wiring shall enter from bottom side or top as approved or directed by the Consultant.
 - All required instruments shall be mounted on or inside the panel but shall not be limited to all indicating lamps.
- (3) Cabling and wiring

The following shall be referred in panel design.

- (a) Materials
 - Various types at cables are to be applied for the work by each type of services and functions. The Contractor shall be carefully check the Drawings and submit detailed cable schedule showing origin and destination of cables by each type, size and service to the Consultant for approval.
 - The Contractor shall responsible for wiring, laying and furnishing of control and power cables and or wires which are necessary for the required operation.
 - All wiring in the control panel shall be of PVC insulated stranded copper conductor, formed neatly into groups and properly supported. There shall be no splices in the wires or cables and all connections shall be made only at terminal blocks or studs.

- All external wiring between the control cubicles, motor, limit, switches, etc., shall be with multicore copper cross linked polyethylene insulated, PVC sheathed (type CV), 600 V grade cable.
- All wiring shall be carry out III accordance with wiring diagrams so that arrangement of the wiring is consistent through out the equipment and identical for those parts of the equipment performing the same duties.
- Wiring diagrams shall be drawn as seen from the back (i.e., wiring side) of the Panel (except for front connected equipment) and shall show all terminals on selector switches, relays, contractors, terminal blocks, etc., in their correct relative positions.

Terminal blocks shall be arranged to run in numerical order from top to the bottom.

- Wiring shall be neatly and securely bunched or cleat, and enclosed in ducts, or conduits or supported on trays and run in the most efficient manner from points to point. The bunching of wiring shall be kept in bunched condition by means of strips of special plastic ribbon material at suitable intervals. Lacing or wire bunches with textile or plastic cord or metal buckle type clips will not be accepted.
- All power and control cable conductor shall be of copper and have minimum cross sectional area of 2.0 mm². Single strand conductor shall not be accepted except for lighting indoor installation.
- Compression type terminal shall be used and ring number identification shall be put at both ends of the cables.
- All cables except "BC" listed bellow shall have evidence of approval by LMK, SPLN or SII clearly labeled on insulation surface of cables. Following list shows the general description of cables to be used for the work.

<u>Type</u>	Description
NYY	 0.6/1 kV, copper, for indoor and outdoor installation in wet or dry location. In case of underground installation, the proper protection shall be adopted.
NYA	: 1000 V, copper, single core, for indoor installation for lighting
BC	 Bore Copper conductor for grounding and lightning protection connection, with minimum cross sectional area 50mm²

- (b) Installation
- Cables and wires shall be run into conduit pipe, installed in cable tray and trench, embedded underground and exposed or specified, in a manner specified herein.
- No cable connection shall be permitted in conduit and the jointing fixtures shall be suitable to accommodate the cables.
- (c) Phase and color of cables

The standard phase arrangement when facing the front of the panel shall be R- S-T-N and R-N- S from the left to right, from top to bottom and front to back for AC three (3) phase and single phase circuits and N-P from left to right, P-N from top to bottom and front to back for DC polarity.

The following colored ferrules shall be provided on each wire in order to identify phase and polarity.

Phase and Polarity	Description	Color
Three phase 4 wire	First phase	Red
	Second phase	Black
	Third phase	Blue
	Neutral phase	White
Single phase 2 wire	First phase	Red
	Grounding side second phase or Neutral phase	White
	Non-grounding second phase	Black
Ground conductor		Green, or yellow-green
Direct current	Positive	Red
	Negative	Blue

Sample of the secondary wiring, terminations and terminal blocks shall be submitted by the Contractor for approval before commencement of the works, if requested by the Consultant.

- (d) Conduit
 - Rigid steel conduit shall be galvanized inside and outside. It shall be of a minimum thickness of 2.3mm and have a minimum inside diameter of 16mm.
 - The end of all conduits shall be well reamed to remove burrs and rough edges. Field cuts shall be made square and true so that the ends will butt or come together for the full circumference thereof.
 - All steel conduit shall be cut square and all joints shall butt together tightly in order to ensure maximum electrical continuity.
 - Conduit and accessories shall be kept clean during construction. Clogged conduit shall be replaced.
- (e) Pull box

Pull boxes shall be installed at the locations as necessary and as shown on the shop drawings and at such additional points as ordered by the Consultant. The Contractor may install, at his own expense, such additional boxed as may be desired to facilitate the work. All pull boxes shall be marked with checkered plate cover painted.

- (f) Cable tray
 - Cable tray shall be made of steel angle, bar and strips hot dip galvanized and shall be installed at along concrete girders.
 - Hanger and supports shall be properly fixed to ensure that the tray can carry the load without causing any deformation.
 - Cables on tray shall be clamped at 2.0 m intervals with 3 strip plates using special straps for this purpose.

(g) Underground cables

- (i) Underground cable installation shall be carried out in compliance with the regulations at the local authorities and in a manner prescribed below.
- A trench of I (one) m deep and 50 cm wide shall be prepared, then filled and stamped with 10 cm thick bed sand.
- Cables shall be laid down on the bed sand and must not be subject to stress.
- Sand shall be filled thereafter up to 10 cm above the largest cables.
- On the sand level above location at each cable, concrete tiles shall be placed continuously along the direction of the cable.
- All steps of excavation, filling sand, laying down cables and final filling shall be inspected by the Consultant and approved prior to proceeding subsequent step.
- (ii) When an underground connection is unavoidable and approved by Consultant, a jointing box using 3 m cast resin should be applied. Above ground a sign stating "MOF KABEL" shall be placed in a manner directed by the Consultant.
- (iii) Cables crossing under the road, if occurs, shall be installed in a manner shown on the drawings or on the approved shop drawings.

6.3 Diesel Engine Generator

(1) General

Two (2) complete sets of diesel engine generator sets for new floodgates shall be provided with other necessary equipment. The generator set with necessary accessories shall be designed, supplied and installed in Diesel Generator House of the new spillway gates by the Contractor.

The diesel engine generator shall be neatly arranged and mounted on a common skid base with vibration absorber. The capacity of a diesel engine generator set shall be of 20 kVA.

The required capacity of diesel engine generator shall be made by the Contractor subject to review and approval of the Consultant.

(2) Diesel engine details

The diesel engine shall be of the full compression ignition vertical cylinder, single acting, 4 cycle, 1500rpm, solid injection and provided with a radiator type cooler. Engine cylinder liners shall be of the full length replaceable type.

The diesel engine and generator shall be mounted on a common skid base. Proposed continuous output of diesel engine generator set shall be guaranteed under the conditions at the Site.

The diesel engine shall be designed to use light diesel oil for fuel. The diesel engine shall be mounted the sealed type DC batteries have ample capacity for diesel engine starting. Starting method of diesel engine shall be of DC motor starter by key switch and stopped automatically when fault occurs.

In addition to the above, the following items shall be provided for the diesel engine:

- Radiator for engine cooling water with flexible type radiator hood and louver to atmosphere.

The forced lubricant system shall cover main bearings, crank pin bearings, piston pins, timing gears, camshaft bearings, valve locker mechanism and governor.

- Filter for fuel oil and lubricating oil
- Lubricating oil cooler
- Common skid base, foundation bolts and nuts
- Reamer bolts with nuts
- All piping materials with valves and cocks
- Air suction strainer
- Expansion of flexible joint for exhaust pipe
- Special maintenance tools for repairs
- A test pump with a pressure gauge for fuel injection valve
- 150 % of the quantity of lubricating oil required
- Two (2) drum cans (180 litter per drum can) of light diesel oil for fuel.
- Silencer and exhaust pipe with thermal insulation to atmosphere
- Rating plate
- Two (2) Fire extinguishers
- Any additional accessories of manufacturer's standard
- (3) Generator details

The generator shall be of 3 phase, 4 wires, revolving field type brush-less with damper winding, self-excited, a self-ventilated open type single wiring synchronous alternator. The rating of the generator shall be continuous output 400/230 V, 50 Hz, 0.8 lagging and shall be directly connected to the engine.

Insulation shall be Class "B" of IEC-85.

The automatic voltage regulator shall be provided for the excitation system, which shall be capable to control voltage within ± 2 % from no load to full load.

The neutral point of armature winding shall be connected to neutral bus of the main distribution board, and solidly grounded.

The maximum temperature rise of the generator shall not exceed the following:

- The stator winding (by thermometer) : 60°C
- Rotor field winding (by resistance) : 75°C
- Iron core and other parts (by thermometer) : 75°C

The following accessories shall be supplied:

- Rating plate
- 150 % of the quantity of lubricating oil

- Other necessary accessories of the manufacturer's standards
- (4) Engine generator control panels details

The control Panels for the engine generator control shall consist of one (1) diesel engine and one (1) generator control Panel.

The control panels shall be of indoor type, and self-standing for generator panel and skid base mount for diesel engine control Panel. Equipment and devices to be mounted on the panel shall include, but not limited to the following:

- (a) Diesel engine control panel
 - One (1) starter switch
 - One (1) battery switch
 - One (1) speed controller
 - One (1) cooling water temperature gauge
 - One (1) lubricating oil temperature gauge
 - One (1) fuel oil level gauge
 - One (1) oil pressure gauge
- (b) Generator control panel
 - One (1) 380 V circuit breaker with interlocking mechanism with another generating unit for each main and sub generators
 - One (1) AC ammeter with selective switch
 - One (1) AC voltmeter with selective switch
 - One (1) frequency meter
 - One (1) regulating switch for governor motor
 - One (1) group annunciater
 - One (1) lot of single phase, dry type potential transformers
 - Three (3) single phase, dry type current transformers of 100/5 A
 - One (1) set of cable terminals, back wiring, terminal boards and name plates
 - One (1) set of test terminals
 - One (1) under-voltage relay
 - Three (3) over-current relays One (1) set of alarm and automatic shut down devices with fault indication of:
 - Excessive temperature rise of cooling water
 - · Pressure drop of lubricating oil
 - Over-speed
 - One (1) set of AC exciter with automatic voltage regulator and necessary accessories
- (5) Shop test
 - (a) Combine tests

The following tests combined the generator and engine shall be carried out before

delivery at manufacturer's shop:

- Operation test (starting and stop tests)
- Load test including temperature rise and fuel and lubrication oil consumption measurement
- Governor test
- Over-speed test (120 percent 1 minute)
- (b) Test for generator
 - The following tests of generator only shall be carried out at manufacturer's shop:
 - Plotting of characteristics
 - Wave form test
 - Temperature rise test
 - High voltage test
 - Stator coil 1500 V for 1 min.
 - Rotor coil $10 \times$ voltage of exciter (min. 1500 V) for 1 min.
 - Test of the Panel and cubicle including relay test and metering calibration check
- (6) Test on completion

After completion of installation work at the Site, the following tests shall be performed by the Contractor as Tests on Completion in accordance with the approved test procedure, but shall not confined to:

- Insulation resistance tests
- Grounding resistance tests
- High voltage test
- Stator winding and 400 V bus line to earth: AC 500 V for 1 minute
- Starting test
- Operation test
- Governor test

SECTION 7-3

PROCUREMENT OF DRAINAGE PUMP VEHICLE

7-3 PROCUREMENT OF DRAINAGE PUMP VEHICLE

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7-3 PROCUREMENT OF DRAINAGE PUMP VEHICLE

1. GENERAL

1.1 Scope of Works

The Equipment to be procured shall be as follows:

• Drainage Pump Vehicle (30m³/min) 10 sets

The works to be done under this Contract shall include (1) manufacture of the Equipment, (2) transportation of the Equipment to the designated location, (3) adjustment and commissioning (acceptance tests) of the Equipment, and operational and maintenance training to the concerning personnel of the Client, and (4) after-sales services.

1.2 Location of Delivery

The Equipment in the completed shape and ready to work shall be delivered to Ayutthaya Irrigation Project Office of Royal Irrigation Department, Phra Nakhon Si Ayutthaya District, Phra Nakhon Si Ayutthaya Province, the Kingdom of Thailand.

The delivery of the Equipment shall be made under full responsibility of the Contractor in accordance with the Project Implementation Schedule.

1.3 Country of Origin and Standards

The origin of the Equipment in the completed shape shall be limited to the Kingdom of Thailand.

The origin of the components, except for the chassis, of the Equipment shall be limited to Japan and/or the Kingdom of Thailand while the origin of the chassis of the Equipment shall be limited to the Kingdom of Thailand.

All the Equipment and services shall conform to the following standards wherever applicable.

- Thai Industrial Standards (TIS)
- Japanese Industrial Standards (JIS)
- International Electrotechnical Commission (IEC)
- Japan Electrical Manufacturers' Association (JEM)
- Japanese Electrotechnical Committee (JEC)
- International Organization for Standardization (ISO) 9001

• Other relevant and applicable codes and standards of Thailand and Japan

Other internationally prevailing standards such as EN, BSI, ANSI and DIN are accepted for the Equipment, unless otherwise indicated. All dimensions and performance of the Equipment shall be generally in metric system, unless otherwise specified in these Specifications.

1.4 General Requirements

(1) Detailed Specifications

Minimum requirements of the Equipment are described in Clause 2. The Equipment to be procured under this Contract shall be brand-new and unused, and each identical item shall be in equal quality and performance.

(2) Installation Work

Installation work of the components onto the chassis of the Equipment shall be made in conformity with the Specifications. The installation work shall be done at due workshop(s) in the Kingdom of Thailand under full responsibility of the Contractor and/or his Subcontractor(s). Hereafter, Subcontractor(s) mean(s) Japanese juridical person(s) who shall manufacture the Equipment and prequalified in the Prequalification ahead of the Tender.

(3) Import of Parts

If the parts of the Equipment are not available in the market of the Kingdom of Thailand, the Contractor and/or his Subcontractor(s) shall be required to import the necessary parts of the Equipment from Japan to the Kingdom of Thailand in compliance with due trade laws enforced by the respective government.

(4) Working Condition

The Equipment shall be suitable under ambient temperature, humidity and climates in the Kingdom of Thailand in anticipated conditions.

1.5 Name Plates and Stickers

(a) Name Plates

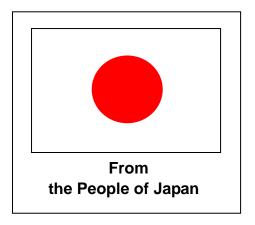
All the Equipment shall be equipped with name plates described as shown below in English or Thai on a suitable place of the Equipment. Descriptions and notes shall be in English.

- Equipment Name
- Type and Model
- Manufacturer's Name
- Production Serial Number
- Date of Production

(b) Stickers

The Contractor shall provide stickers as shown below for each component of the Equipment, except for small parts and materials. The stickers shall be made of aluminum. It should be an adequate size considering the dimension of each product. The design, material and dimensions of the stickers shall be submitted to the Consultant for prior approval.

Type of font: Futura Bold Component of color: DIC156 (red), black, white



1.6 Packing and Shipment

(1) Packing

The parts of the Equipment imported from Japan to the Kingdom of Thailand shall be packed as per the following during ocean and inland freight.

Contents of each shipping package for the parts of the Equipment shall be itemized on a detailed list showing the exact weight and extreme outside dimensions (length, width and height).

- (a) One (1) copy of the detailed packing list shall be enclosed in each package. There shall also be enclosed in one (1) package a master packing list summarizing and identifying each individual package.
- (b) The box number in which the master packing list is contained should be shown on each packing list.
- (c) All parts shipped must be legibly identified by tags, labels or inscription in indelible ink, strictly in accordance with the reference mark or parts number of the Equipment or the assembly drawings.

(d) On wood, plywood, veneer cases, barrels or kegs, all marks shall be applied by stencil with waterproof inks or oil paints and these marks shall be protected against weathering by clear water resistant varnish.

Marking on each package shall consist of the following information.

- Consignee: The Contractor and/or his Subcontractor(s)
- Final user: Royal Irrigation Department (RID)
- Name of the Project:
- Port of disembarkation:
- Item number, package number in sequence, and quantity per package:
- Description of item:
- Net and gross weight and cubic measurement:
- Shipper's name (and Supplier's name, if Shipper is different from Supplier):
- Caution marks, if applicable:
- Other markings required by the Client:
- (2) Shipment

Shipping advice for the parts of the Equipment imported from Japan shall be sent by courier, electronic mail or be handed to the Consultant prior to the on-board date of the Bill of Lading, containing such information as loading and unloading port, date of departure and arrival, name of vessel, and one (1) photocopy of the following documents.

- Clean On Board Ocean Bill of Lading
- Signed Commercial Invoice
- Packing List
- Insurance Policy

1.7 Insurance until Delivery

The Equipment, including the parts to be installed and mounted onto the chassis at workshop(s), shall be fully insured, until the Client issues the Receipt of the Equipment to the Contractor, against loss or damage incidental to manufacture, installation, mounting, transportation, storage and delivery.

1.8 Import Charges

The Contractor shall bear import charges from Japan to the Kingdom of Thailand such as shipping charge, customs clearance charge, terminal handling charge, port charge, crane charge, storage charge, ocean freight and inland transportation etc. except for internal taxes, such as customs duty and value added tax, imposed in the Kingdom of Thailand.

All taxes and duties imposed outside the Kingdom of Thailand shall be born by the Contractor, if any.

1.9 Tests, Inspection, Adjustment, Commissioning and Training

The following works on the tests, inspection, adjustment, commissioning and training shall include in the Contract.

(a) Shop Tests and Inspection

The Equipment including the major and important parts shall be tested and inspected by the Contractor and/or his Subcontractor(s) prior to their shipment and delivery. Shop inspection shall be required in the presence of the Consultant and also the Client when it deemed necessary by him and is conducted in the Kingdom of Thailand. Manufacturers' shop inspection results and their certificates shall be submitted by the Contractor to the Consultant before shipment and delivery.

The Equipment in the completed shape shall be required to inspect at due workshop designated by the Contractor and/or his Subcontractor for all sets to procure.

If the Equipment including the major and important parts fails to conform to the Specifications as a result of such inspections, the Consultant may reject them and the Contractor shall either replace the rejected Equipment, including the major and important parts, or make all alterations necessary to meet the requirements.

(b) Adjustment

The Equipment shall be brought into suitable conditions by the Contractor and/or his Subcontractor for giving the specified performance at site. The Contractor and/or his Subcontractor shall make proper adjustment to settle the Equipment into specified conditions for performance. All works must be done to the satisfaction of the Client, and the Contractor and/or his Subcontractor shall carry out his work in a neat and proper workmanlike manner. The adjustment shall be planned and carried out in no way to damage the Equipment. All tools, fuel, materials, labors, logistics etc. shall be provided by the Contractor and/or his Subcontractor.

(c) Commissioning (Acceptance Tests)

The Contractor and/or his Subcontractor shall check all components of the Equipment to ensure that their conditions are good and adequate for giving the specified function. Commissioning (acceptance tests) at site shall be required in order to check the function of the Equipment in the presence of the Client and the Consultant before finally handing over to the Client. Time to spend the commissioning is assumed to be one (1) hour for each set of the Drainage Pump

Vehicle.

The Contractor shall submit the commissioning plan and result report to the Client through the Consultant's approval thereof.

The Equipment shall be required to test at site designated by the Client for all sets to hand over.

All tools, fuel, materials, labors, logistics etc. shall be provided by the Contractor and/or his Subcontractor.

After completion of the commissioning with satisfactory results, the Client shall issue the receipt of the Equipment to the Contractor, and then one (1) year warranty period will starts.

(d) Operational and Maintenance Training

The Contractor shall provide operational and maintenance training work with a target to the concerning personnel of the Client in order to transfer the technical knowledge on operation and maintenance of the Equipment.

The period for the operational and maintenance training shall total five (5) days including the commissioning.

The program and materials thereof shall be prepared in Thai or English and provided by the Contractor with approval by the Consultant. All tools, fuel, materials, labors, logistics etc. shall be provided by the Contractor and/or his Subcontractor.

1.10 Warranty and After-Sales Services

The Contractor shall make necessary arrangement with eligible agent(s) who have sufficient stock of spare parts and after-sales service facilities.

In order to provide satisfactory maintenance service even after one (1) year warranty period, the Contractor shall keep a close contact with his Subcontractor and submit a list of the maintenance service agent(s) for the following services.

- (a) The Contractor through his Subcontractor(s) shall remedy, at his own expense, any defects against which the Work is warranted, by making all necessary repairs or replacements except in the case that such defects result from the Client's negligence or failure during the one (1) year warranty period.
- (b) The Contractor shall guarantee to supply the spare parts of the Equipment through the agent(s) upon request by the Client at cost basis for a period of two (2) years after the one (1) year warranty period.
- (c) In case of major breakage, which is hard to repair by the local agent(s), the Contractor shall send his Subcontractor or manufacturer's engineer(s) to the

site designated by the Client within one (1) week after the request by the Client to repair such breakage at cost basis. Such services shall be guaranteed for a period of two (2) years after the one (1) year warranty period.

2. DRAINAGE PUMP VEHICLE

2.1 Composition

The Drainage Pump Vehicle is mainly composed of chassis with cab, drainage pumps, control panel, generator and lighting apparatus.

2.2 Specifications

The following specifications shall be applied to each set of the Drainage Pump Vehicle.

(1) Working Condition

	(a)	Drainage operating time	48 hours or more in continuous operating time
	(b)	Temperature	5 to 40 °C
	(c)	Atmospheric pressure	980 hPa or more
	(d)	Relative humidity	85 % or less
(2) Drainage Pumps ("unit" means the number of pump.)			ans the number of pump.)
	(a)	Total drainage discharge	30 m ³ /min (at 10 m of total head)
	(b)	Model	Submergible motor driving pump
	(c)	Number	6 units or less (Same specifications for all units)
	(d)	Bore	200 mm
	(e)	Unit weight of pump	40 kgf/unit or less
	(f)	Type of motor	Dry type submergible synchronous motor
	(g)	Power source	3 phase × 440 V × 60 Hz
	(h)	Cable	Cabtire cable40 m/unit or more(with waterproof connector)Cable band1 set/unit
	(i)	Drainage hose	Diameter 200 mm × Length 25 m × 3 (discharge side) /unit Pressure-tight 0.2 MPa or more
	(j)	Configuration	Drainage pump shall be controllable of rotation speed in each unit. Each drainage pump shall be equipped with metal fixers for attaching float.

((k)	Pump float	1 no./unit Attaching rope or	rod	1 set/unit
((I)	Major materials	Casing Casing liner Impeller Main shaft	Stainles Stainles	lightweight material(s) s steel or stainless cast steel s steel or stainless cast steel s steel or titanium alloy
((m)	Accessories	Tool for pumps Mooring rope for Mooring anchor for Float push-out ba	or pump	1 set 1 set/unit 1 set/unit 1 no.
(3)	С	Chassis with Cab			
((a)	Country of origin	Kingdom of Thail	and	
((b)	Gross Vehicle Weight	Around 10,000 kg	gf or less	
	capable to accommoda		nmodate	ze of Gross Vehicle Weight e the required equipment and f allowance shall be selected.	
((c)	Drive	Rear-wheel drive		
((d)	Steering position	Right-hand drive	with pow	er steering
((e)	Crew	2 or more		
((f)	Transmission	Manual or autom	atic	
((g)	Engine	Water-cooled die	sel	
((h)	Engine emission	Euro 3 or later		
((i)	Rear body (Bed)	arranged on the r maintenance. Side guards shall rear body. Floor material of	ear body be equip the rear b be equip	shall be functionally for easier operation and oped in the lower part of the body shall be antirust. ped on the rear body for ipment.
((j)	Loudspeaker	Output		Around 30 W
((k)	Accessories	Seat belt AM/FM radio Air conditioner Spare tire with wh Spare tire fitting Floor mat Maintenance tool		1 set for all crew 1 set 1 set 1 no. 1 no. 1 set 1 set

		User manual of chassis	1 no. in Thai or English
(4) F	Power Generator		
(a)	Туре	Low noise with control pane	əl
(b)	Number	1 unit	
(c)	Capacity	1 phase 220 V / 3 phase 44 125kVA or more Power necessary to run all o apparatus and control pane	drainage pumps, all lighting
(d)	Engine	Water-cooled diesel	
(e)	Fuel tank	200 liter or more	
(5) L	ighting Apparatus		
(a)	Condition	Lighting apparatus shall be surrounding area of the veh	
(b)	Туре	Floodlights	
(c)	Lamps	High intensive discharge (H	ID) lamps
(d)	Cable	Cabtire cable 20 m/lam (with waterproof connector)	p or more
(e)	Shrinkable and rotational	device	
		Manually shrinkable to up & right & left	down and rotational to
(6) (Control Panel		
(a)	Condition	There shall be stored inverter rotation speed control of dra operating control of each dra lighting apparatus shall be p Power supply connectors to waterproof and easy to come drainage pumps.	ainage pumps, and ainage pumps and on-off of possible. drainage pumps shall be
(b)	Туре	Outdoor weatherproof	
(c)	Panel equipment ("unit" m	eans the number of pump.)	
		Pump start switch Pump stop switch Pump rotation control switch Emergency stop button Display recovery button Voltmeter	1 no./unit 1 no./unit n 1 no./unit 1 no. 1.no. 1 no.

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		Ammeter	1 no./un	it
		Frequency meter	1 no.	
		Tachometer	1 no./uni	it
		Hour meter	1 no./un	it
		Others needed		
(0	d) Display language	Thai or English		
(7)	Paint Color	To be specified by the Client		
(8)	Accessories	Grounding electrode		1 set
		Test and inspection record in Thai o	r English	1 no.
		User manual in Thai or English		2 nos.
		Parts list in Thai or English		1 no.
		Shop drawings (Overall installation	diagram,	
		Component mounting diagram, Wir	ing diagr	am etc.) in
		Thai or English		2 nos.

2.3 Spare Parts

The following shall be applied to each set of the Drainage Pump Vehicle.

(a)	Drainage pump	1 unit
(b)	Drainage hose	Diameter 200 mm × Length 25 m ×

APPENDICES

- 1. EXCHANGE OF NOTES
- 2. GRANT AGREEMENT



Embassy of Japan Bangkok

Bangkok, July 5, 2012

Sir,

I have the honour to refer to the recent discussions held between the representatives of the Government of Japan and of the Government of the Kingdom of Thailand concerning Japanese economic cooperation to be extended with a view to strengthening friendly and cooperative relations between the two countries, and to propose on behalf of the Government of Japan the following understanding:

1. (1) For the purpose of contributing to the implementation of the Flood Prevention Project of East Side of the Pasak River in Ayutthaya (hereinafter referred to as "the Project") by the Government of the Kingdom of Thailand, the Government of Japan has decided that a grant up to two billion five hundred and fifty million Japanese Yen (¥2,550,000,000) (hereinafter referred to as "the Grant") will be extended to the Government of the Kingdom of Thailand, in accordance with the relevant laws and regulations of Japan.

(2) The Grant will be made available by concluding a grant agreement between the Government of the Kingdom of Thailand or its designated authority and the Japan International Cooperation Agency (JICA) (hereinafter referred to as "the G/A").

(3) The terms and conditions of the Grant as well as the procedures for its utilization will be governed by the G/A within the scope of the present understanding.

2. The Grant will be available during such period as may be specified in the G/A, provided that the period will be between the date of entry into force of the G/A and February 28, 2016.

Mr. Piroon Laismit Director-General Thailand International Development Cooperation Agency Ministry of Foreign Affairs BANGKOK 3. The Grant shall be used by the Government of the Kingdom of Thailand properly and exclusively for the purchase of such products and services necessary for the implementation of the Project as may be specified in the G/A (hereinafter respectively referred to as "the Products" and "the Services").

4. The Government of the Kingdom of Thailand or its designated authority shall enter into contracts in Japanese Yen with Japanese nationals for the purchase of the Products and the Services. Such contracts will be verified by JICA to be eligible for the Grant (The term "Japanese nationals" whenever used in the present understanding means Japanese physical persons or Japanese juridical persons controlled by Japanese physical persons.).

5. The Grant will be executed by JICA, in accordance with the provisions of the G/A, by making payments in Japanese Yen to an account to be opened in the name of the Government of the Kingdom of Thailand at a bank in Japan designated by the Government of the Kingdom of Thailand or its designated authority.

6. (1) The Government of the Kingdom of Thailand shall take necessary measures:

(a) to secure lots of land necessary for the implementation of the Project and to clear the sites;

(b) to provide facilities for distribution of electricity, water supply and drainage and other incidental facilities necessary for the implementation of the Project outside the sites referred to in (a) above;

(c) to ensure prompt unloading and customs clearance at ports of disembarkation in the Kingdom of Thailand and to assist internal transportation therein of the Products;

(d) to ensure that customs duties, internal taxes and other fiscal levies which may be imposed in the Kingdom of Thailand with respect to the purchase of the Products and the Services be exempted;

(e) to accord Japanese nationals and/or nationals of third countries, whose services may be required in connection with the supply of the Products and the Services such facilities as may be necessary for their entry into the Kingdom of Thailand and stay therein for the performance of their work (the term "nationals of third countries" means physical or juridical persons of third countries.);

(f) to ensure that the facilities constructed / rehabilitated under the Grant and the Products be maintained and used properly and effectively for the implementation of the Project;

(g) to bear all the expenses, other than those covered by the Grant, necessary for the implementation of the Project; and

(h) to give due environmental and social consideration in the implementation of the Project.

(2) Upon request, the Government of the Kingdom of Thailand shall provide the Government of Japan with necessary information on the Project.

(3) With regard to the shipping and marine insurance of the Products, the Government of the Kingdom of Thailand shall refrain from imposing any restrictions that may hinder fair and free competition among the shipping and marine insurance companies.

(4) The Products shall not be exported or re-exported from the Kingdom of Thailand.

7. The two Governments shall consult with each other in respect of any matter that may arise from or in connection with the present understanding.

I have further the honour to propose that this Note and Your Note in reply confirming on behalf of the Government of the Kingdom of Thailand the foregoing understanding shall constitute an agreement between the two Governments, which shall enter into force on the date of your Note in reply.

I avail myself of this opportunity to extend to you the assurance of my high consideration.

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Seiji Kojima

Ambassador Extraordinary and Plenipotentiary Embassy of Japan

Grant Agreement No.1161660

GRANT AGREEMENT

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For

THE FLOOD PREVENTION PROJECT OF EAST SIDE OF THE PASAK RIVER IN AYUTTHAYA

Between

JAPAN INTERNATIONAL COOPERATION AGENCY

And

THE GOVERNMENT OF THE KINGDOM OF THAILAND

Dated August 15, 2012

On the basis of the Exchange of Notes between the Government of Japan and the Government of the Kingdom of Thailand dated July 5, 2012 (hereinafter referred to as "the E/N") concerning the Japanese grant assistance for the Flood Prevention Project of East Side of the Pasak River in Ayutthaya (hereinafter referred to as "the Project") by the Government of the Kingdom of Thailand, the Japan International Cooperation Agency (hereinafter referred to as "JICA") and the Government of the Kingdom of Thailand have agreed to conclude the following grant agreement referred to in sub-paragraph (2) of paragraph 1 of the E/N:

Article 1 Amount and Purpose of the Grant

For the purpose of contributing to the implementation of the Project, JICA shall extend a grant of the amount up to two billion five hundred and fifty million Japanese Yen ($\frac{2}{550,000,000}$) (hereinafter referred to as "the Grant") to the Government of the Kingdom of Thailand in accordance with the relevant laws and regulations of Japan and within the scope of the E/N.

Article 2 Availability of the Grant

The Grant shall be made available by concluding the present grant agreement (hereinafter referred to as "the G/A") during the period between the date of entry into force of the G/A and April 30, 2015, unless the period is extended by mutual consent between JICA and the Government of the Kingdom of Thailand or the designated authority (hereinafter referred to collectively as "the Authority").

Article 3 Use of the Grant

- (1) The Grant shall be used by the Government of the Kingdom of Thailand properly and exclusively for the purchase of such products of Japan or the Kingdom of Thailand and such services of Japanese or Thai nationals necessary for the implementation of the Project as listed below (The term "nationals" whenever used in the G/A means Japanese physical persons or Japanese juridical persons controlled by Japanese physical persons in the case of Japanese nationals and Thai physical or juridical persons controlled by Thai physical persons in the case of Thai nationals.):
 - (a) products and services necessary for the construction of floodgates (hereinafter referred to as "the Facilities");

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- (b) vehicles and services necessary for the procurement and / or the installation thereof;
- (c) services necessary for the transportation of the products referred to in (a) and (b) above to ports in the Kingdom of Thailand and those for internal transportation therein; and
- (d) services necessary for the guidance in managing the Facilities.
- (2) Notwithstanding the provisions of sub-paragraph (1) above, when JICA and the Authority deem it necessary, the Grant may be used for the purchase of the products of the kind referred to in (a) and (b) of sub-paragraph (1) above, which are products of countries other than Japan or the Kingdom of Thailand and the services of the kind referred to in (a), (b), (c) and (d) of sub-paragraph (1) above, which are services of nationals of countries other than Japan or the Kingdom of Thailand.

Article 4 Procurement Guidelines

The Authority shall ensure that the products and / or the services referred to in Article 3 are procured in accordance with JICA's Procurement Guidelines of the Japanese Grant Aid (Type I-G) (hereinafter referred to as "the Procurement Guidelines").

Article 5 Verification of Contracts

The Authority shall enter into contracts in Japanese Yen with Japanese nationals for the purchase of the products and services referred to in Article 3. Such contracts shall be verified by JICA to be eligible for the Grant.

Article 6 Payments

JICA shall execute the Grant by making payments in Japanese Yen to cover the obligations incurred by the Authority under the contracts verified in accordance with Article 5 (hereinafter referred to as "the Verified Contracts") to an account to be opened in the name of the Government of the Kingdom of Thailand at a bank in Japan designated by the Authority (hereinafter referred to as "the Bank").

Article 7 Banking Arrangement

The sole purpose of the account referred to in Article 6 is to receive the payments in Japanese Yen from JICA and to pay to the Japanese nationals who are parties to the

Verified Contracts. The procedural details concerning the credit to and debit from the account referred to in Article 6 will be agreed upon through consultation between the Bank and the Authority.

Article 8 Authorization to Pay

The payments referred to in Article 6 shall be made when payment requests are presented by the Bank to JICA under an authorization to pay issued by the Authority.

Article 9 Modification of the Project

When the plan and / or design of the Project is to be modified, the Authority shall have a prior consultation with and obtain the consent to the modification of JICA, in accordance with the Procurement Guidelines.

Article 10 Obligations of the Government of the Kingdom of Thailand

- (1) The Government of the Kingdom of Thailand shall take necessary measures:
 - (a) to secure lots of land necessary for the implementation of the Project and to clear the sites;
 - (b) to provide facilities for distribution of electricity, water supply and drainage and other incidental facilities necessary for the implementation of the Project outside the sites referred to in (a) above;
 - (c) to ensure prompt unloading and customs clearance of the products referred to in Article 3 at ports of disembarkation in the Kingdom of Thailand and to assist internal transportation of the products referred to in Article 3 therein;
 - (d) to ensure that customs duties, internal taxes and other fiscal levies which may be imposed in the Kingdom of Thailand with respect to the purchase of the products and the services referred to in Article 3 be exempted;
 - (e) to accord Japanese nationals and / or nationals of third countries whose services may be required in connection with the supply of the products and the services referred to in Article 3 such facilities as may be necessary for their entry into the Kingdom of Thailand and stay therein for the performance of their work (the term "nationals of third countries" means physical or juridical persons of third

countries.);

- (f) to ensure that the Facilities and the products referred to in Article 3 be maintained and used properly and effectively for the implementation of the Project;
- (g) to bear all the expenses, other than those covered by the Grant, necessary for the implementation of the Project; and
- (h) to give due environmental and social consideration in the implementation of the Project.
- (2) Upon the request of JICA, the Government of the Kingdom of Thailand shall provide JICA with necessary information on the Project.
- (3) With regard to the shipping and marine insurance of the products referred to in Article 3, the Government of the Kingdom of Thailand shall refrain from imposing any restrictions that may hinder fair and free competition among the shipping and marine insurance companies.
- (4) The products referred to in Article 3 shall not be exported or re-exported from the Kingdom of Thailand.
- (5) The Government of the Kingdom of Thailand shall ensure that any official of the Government of the Kingdom of Thailand does not undertake any part of the Japanese nationals' work on the purchase of the products and the services referred to in Article 5.

Article 11 Applicable Laws

The validity, interpretation and performance of the G/A shall be governed by the relevant laws and regulations of Japan.

Article 12 Amendments

The G/A may be amended within the scope of the E/N by written agreement between JICA and the Government of the Kingdom of Thailand. The amendment to the G/A shall enter into force on the date of signature of such written agreement by JICA and the Government of the Kingdom of Thailand.

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Article 13 Consultation

JICA and the Government of the Kingdom of Thailand shall consult with each other in respect of any matter that may arise from or in connection with the G/A.

Article 14 Effectiveness and Termination

- (1) The G/A shall enter into force on the date of signature by JICA and the Government of the Kingdom of Thailand, provided that the E/N is in force.
- (2) When JICA recognizes any of the following situations, JICA may, by notification to the Government of the Kingdom of Thailand, suspend in whole or in part the rights of the Government of the Kingdom of Thailand and / or require the Government of the Kingdom of Thailand to remedy the situation. When the Government of the Kingdom of Thailand will not remedy the situation within the period of thirty (30) days from the date of receipt of such notification, JICA may, with the consent of the Government of Japan, terminate the G/A:
 - (a) default of the Government of the Kingdom of Thailand in fulfillment of any obligations or in compliance with the terms and conditions under the E/N or the G/A;
 - (b) a fundamental change of circumstances relating to the Authority which has occurred with regard to those existing at the time of the entry into force of the G/A; and
 - (c) any emergency, unforeseen circumstances or force majeure, such as war, civil war, earthquake and flood which cause serious difficulties in implementing the Project.

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Bangkok, August 15, 2012

For

JAPAN INTERNATIONAL COOPERATION AGENCY

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Kazuhiro Yoneda Chief Representative JICA Thailand Office

For

THE GOVERNMENT OF THE KINGDOM OF THAILAND

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Lertviroj Kowattana Director General Royal Irrigation Department Ministry of Agriculture and Cooperatives

Record of Discussions

With reference to the Grant Agreement between the Japan International Cooperation Agency (hereinafter referred to as "JICA") and the Government of the Kingdom of Thailand dated August 15, 2012 concerning the Japan's grant assistance for the Flood Prevention Project of East Side of the Pasak River in Ayutthaya, the representative of JICA and of the Government of the Kingdom of Thailand wish to record the following:

1. With regard to the Article 10 (1)(f) and (2) of the said Grant Agreement, the representative of JICA stated that the Government of the Kingdom of Thailand will submit to JICA annual reports on the use of the facilities constructed and the vehicles procured under the said grant each year by filling in the form attached hereto.

2. The representative of the Government of the Kingdom of Thailand stated that the Government of the Kingdom of Thailand has no objection to the statement by the representative of JICA referred to above.

Bangkok, August 15, 2012

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Kazuhiro Yoneda Chief Representative JICA Thailand Office

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Lertviroj Kowattana Director General Royal Irrigation Department Ministry of Agriculture and Cooperatives

Annual Report on the Use of Japan's Grant Assistance (submitted on 000)

- 1. Outline of the Project
- (1) Name of Country:
- (2) Name of the Project:
- (3) Date of the Grant Agreement:
- (4) Name of the Executing Organization:

2. General Situation (how the facilities and the vehicles are used in general)

3. Detailed Explanation

Facilities	How they are being used;	In case they haven't been used as planned	
and vehicles;		Reason for it; (Please specify the reason such as budgetary problems and problems in employing appropriate staffs etc.)	

4. Photos (please attach photos of the facilities and the vehicles)

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