

PENJELASAN PENGADAAN (AANWIJZING)

PROYEK CONSTRUCTION OF KSCS PACKAGE I JOP 55%

PT Waskita Karya (Persero) Tbk
JANUARI 2026



Uraian Pengadaan

Nomor	Uraian	Keterangan
1	Nama Proyek	KARIANDAM –SERPONGWATER CONVEYANCE SYSTEM (KSCS) PROJECT PACKAGE 1
2	Paket Pengadaan	Pengadaan Pompa Booster (Packaged)
3	Jenis dan Tipe Kontrak	Fix Unit Price - SPPM
	Hirarki Dokumen Kontrak	Surat Perjanjian Pemesanan Material (kontrak)
		Bill of Quantity
		Spesifikasi Teknis / TBE / Rencana Kerja dan Syarat
		Gambar
		Schedule Pekerjaan & Dokumen – dokumen administrasi
4	Jangka Waktu Kontrak	Januari 2026 – Oktober 2026
5	Lokasi Pekerjaan	KABUPATEN LEBAK –KABUPATEN TANGERANG, BANTEN
6	Pengakuan Progres	Progress Payment : MoS 90%, Setelah Test Comm 10%
7	Sistem Pembayaran	Tanpa Uang Muka, Reguler 90 Hari Setelah tagihan diterima lengkap dan benar
8	Catatan Pengadaan	- Exclude PPN - Include Pph dan Perpajakan Lainnya sesuai aturan perpajakan yang berlaku
	Alamat Email PIC	Email : procurement.scm@waskita.co.id

LOKASI PEKERJAAN

Karian Dam – Serpong Water Conveyance System (KSCS)



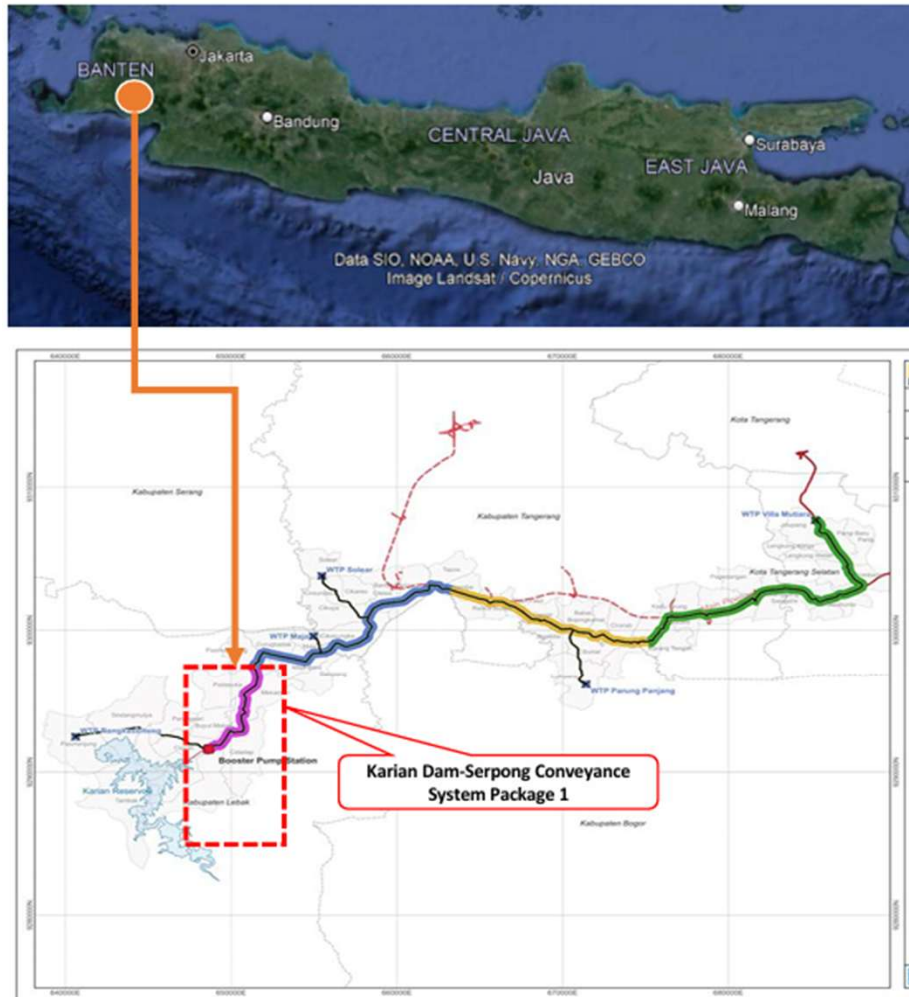
Karian Dam – Serpong Water Conveyance System (KSCS) is a continuation of the Karian Dam Project, designed to distribute 12.40 m³/sec of raw water to Banten, West Java, and DKI Jakarta through an efficient pipeline system.



The Benefits of KSCS :

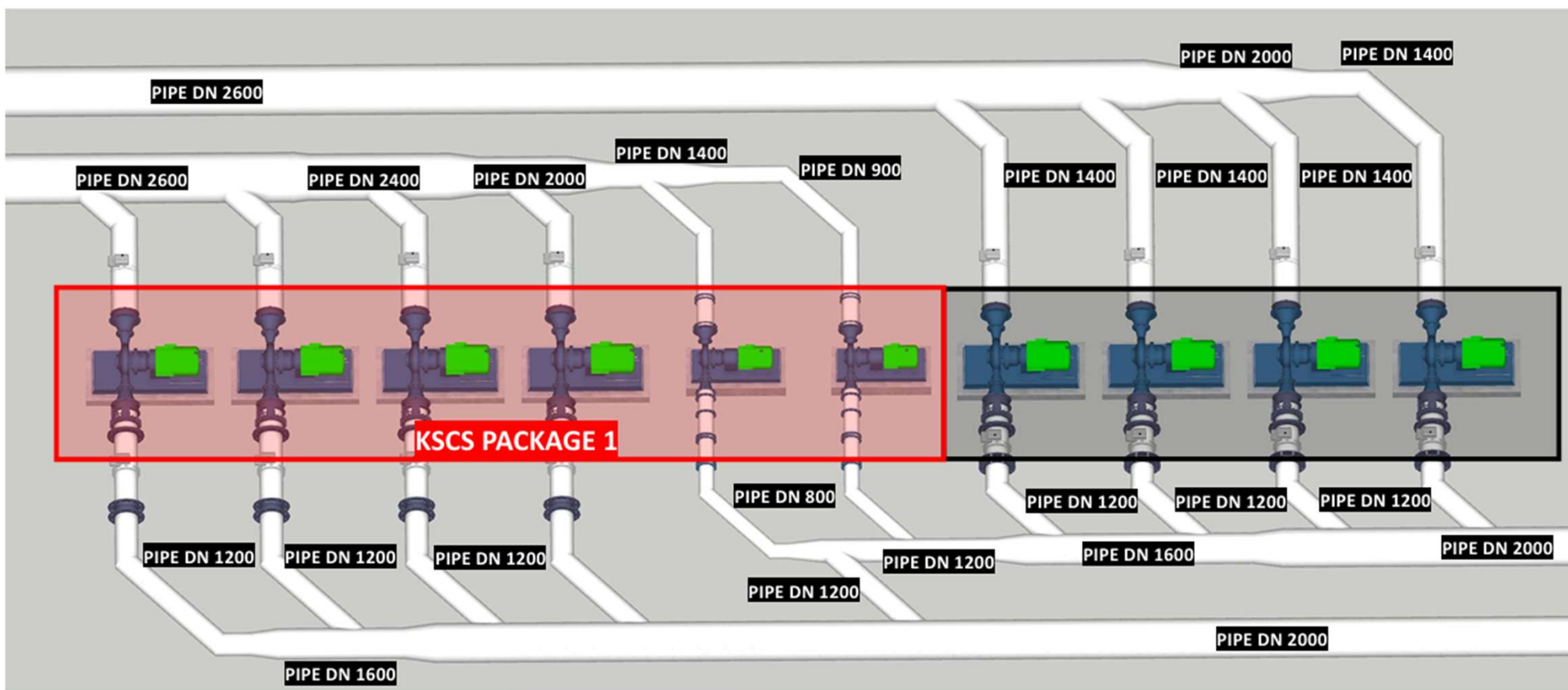
- Provision of Bulk Water for Banten Province is 9,5 m³/sec
- Provision of Bulk Water for DKI Jakarta Province is 3,45 m³/sec
- Provision of Bulk Water for West Java Province is 0,95 m³/sec

LOKASI PEKERJAAN



Lokasi Karian Dam-Serpong Conveyance System

LAYOUT BOOSTER PUMP

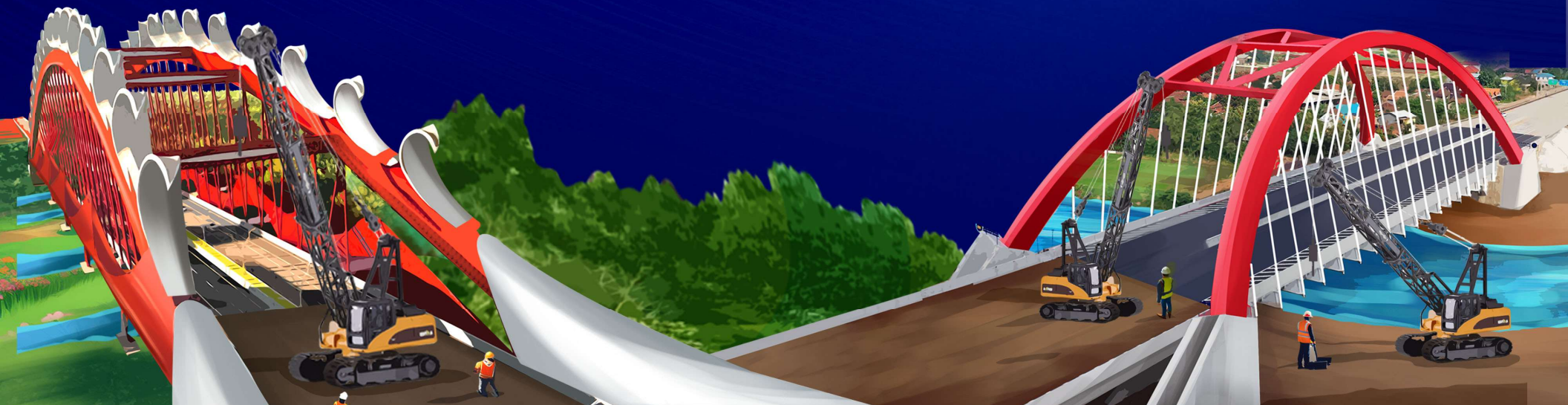


Lingkup Pekerjaan

1. Pengadaan Pompa Booster Sesuai dengan RKS, Matrix / TBE, Gambar, dan BoQ sampai dengan On Site Diatas Pedestal
2. Termasuk Leveling, Aligmen, dan Mounting & Setting Bolt, Lifting Tools, Shimplate, Temporary Support, dan Alat Bantu Lainnya
3. Wajib melampirkan brosur beserta grafik performance
4. Wajib melampirkan Desain Pompa berikut dimensinya
5. Termasuk melampirkan COO Asal
6. Wajib Melampirkan Schedule Fabrikasi, Couple, Pengiriman
7. Include Pengetesan Performance test dan Test Commisioning (Keseluruhan Sistem)
8. Pengadaan Panel Control Pompa + (VSD) Inverter Sesuai dengan RKS, Matrix / RKS, dan Gambar
9. Include kabel kontrol ke pompa
10. Menyediakan Supervisi dari Pabrikan saat MoS, Test Comm dan Trainning End user
11. Termasuk Trainning End User
12. Termasuk Manual Book (Bilingual)
13. Termasuk FAT (Fisik Pompa & Witness Test) & Factory Visit (Performance Test)
14. Melampirkan Jaminan Ketersediaan Spare Part minimal 20 tahun
15. Penyediaan Sparepart selama 2 Tahun
16. Termasuk Garansi Pompa beserta panelnya selama 24 bulan dari BAST 1
17. Termasuk Surat Keagenan Resmi dari Pabrikan

Persyaratan Dokumen Penawaran

Syarat Dokumen Wajib di Upload Pada We
Proc



PERSYARATAN DOKUMEN PENAWARAN

1. Surat Penawaran Harga
2. SA TKDN / Sertifikat TKDN Kemenperin
3. Schedule Fabrikasi, Couple, dan Pengiriman
4. Surat Dukungan Pabrikan Asal (Resmi)
5. Brosur Pompa
6. Brosur Performance Grafik Pompa
7. Brosur Panel Control + VSD
8. Technical Bid Evaluation / Matrix
9. Pakta Integritas Rekanan
10. Surat Pernyataan Kesanggupan (PB02)
11. Surat Bebas konflik Keberpentingan
12. Komitmen SMAP
13. Kebijakan Anti Penyuapan
14. Berita Acara Penjelasan Pengadaan

Catatan : Dokumen – dokumen tersebut akan di Upload pada system WE PROC, secara lengkap dan benar serta tidak diperbolehkan meng – upload dokumen kosong.

Jadwal Pengadaan

Jadwal sesuai dengan Schedule di We Proc



JADWAL PROSES PENGADAAN

Jadwal Pengadaan



Pendaftaran Rekanan



Tgl. Dimulai 7 Jan 2026, 16.00 WIB — Selesai 8 Jan 2026, 12.00 WIB



Penjelasan Pengadaan (Aanwijzing)



Tgl. Dimulai 8 Jan 2026, 13.30 WIB — Selesai 8 Jan 2026, 13.59 WIB



Pemasukan Dokumen Penawaran



Tgl. Dimulai 8 Jan 2026, 14.00 WIB — Selesai 9 Jan 2026, 16.00 WIB

Jadwal Pengadaan



Jadwal Negosiasi



Tgl. Dimulai 12 Jan 2026, 09.00 WIB — Selesai 12 Jan 2026, 23.59 WIB



Jadwal Pengumuman Pemenang



Tgl. Dimulai 13 Jan 2026, 08.00 WIB — Selesai 13 Jan 2026, 17.00 WIB



Jadwal Sanggahan



Tgl. Dimulai 14 Jan 2026, 08.00 WIB — Selesai 15 Jan 2026, 23.59 WIB

[illegible]

Data Teknis



TECHNICAL BID EVALUATION / MATRIX

POMPA BOOSTER KAPASITAS 2 M3/SEC		
Booster Pump	Type : Double Suction Volute Pump (Horizontal Type) Quantity : 4 Units Rated Capacity : 2,0 m3/s (172.800 m3/day) Rated Head : 90 m Speed : Approx. 745 rpm to 995 rpm Guarantee Efficiency : Not less than 87 percent at duty point Flange Class : PN16 for Suction, PN 16 for discharge (ISO 7005/2/3. AWWA C 207 Casing : Horizontal split Impeller : Enclosed type Shaft : Replaceable sleeve Bearing : withstand axial and radial loads B/G Lubrication : Grease or oil Coupling : Rigid or Flexible Shaft sealing : Mechanical seal Flange : PN16 (ISO 7005/2/3, AWWA C 207) Casing : Gray iron casting (ASTM A 48 Grade 35) Impeller : Stainless Steel Casting (ASTM A 351) Shaft : stainless steel (ASTM A 582) Brosur : Ada	WILO, ANDRITZ, KSB, SPP PUMPS, HANSUNG

TECHNICAL BID EVALUATION / MATRIX

Motor	Type : 3 phase horizontal wound rotor induction motor Quantity : 4 Units Motor Output : 2.350 Kw (reference) x 3 phase x 6.660 V x 50 Hz Pole : 6P or 8 PS Driving Method : VSD Enclosure : CACA Motor Enclosure Protection : IP 55 Insulation Class : F class Motor Efficiency : Higher than 90% Power Factor : Higher than 80% Slip : Less than 3% Bearing : withstand axial and radial loads B/G lubrication : Grease or oil Heaters for anti-condensation : 240 V AC $\pm$ 10% Terminal Box : for frequency converter use (VSD connection) Installation : Indoor Brosur : Ada Supporting Letter : Ada	TMEIC, XMEC, KSB, MARATHON, HYUNDAI
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TECHNICAL BID EVALUATION / MATRIX

Variable Speed Driver	Capacity : 2,350kW Required Frequency : 25 - 60Hz Electric source : 3Ph x 6,600V x 50Hz Aux. Power Supply : 1Ph x 230V x 50Hz Cooling system : Air fan Cooling : 3Ph x 400V x 50Hz Software : For monitoring and control Efficiency : Min. 96% at 100% speed & 100% load Power factor : 0.95 at load range of 30 ~ 100% Display panel : Integral monitoring Input/output : Digital Audible alarm : Metering / Indicating communication mod : connection to SCADA Enclosure : IP21, stainless steel Control / Operation : On/off/faultLocal/remoteSpeed increase / decrease Brosur : Ada	SCHEINEDER, DANFOSS, DELIXI, INVT KOREA
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TECHNICAL BID EVALUATION / MATRIX

POMPA BOOSTER KAPASITAS 1 M3/SEC		
Booster Pump	Type : Double Suction Volute Pump (Horizontal Type) Quantity : 2 Units Rated Capacity : 1,0 m3/s (86.400 m3/day) Rated Head : 90 m Speed : Approx. 745 rpm to 995 rpm Guarantee Efficiency : Not less than 85 percent at duty point Flange Class : PN16 for Suction, PN 16 for discharge (ISO 7005/2/3. AWWA C 207) Casing : Horizontal split Impeller : Enclosed type Shaft : Replaceable sleeve Bearing : withstand axial and radial loads B/G Lubrication : Grease or oil Coupling : Rigid or Flexible Shaft sealing : Mechanical seal Flange : PN16 (ISO 7005/2/3, AWWA C 207) Casing : Gray iron casting (ASTM A 48 Grade 35) Impeller : Stainless Steel Casting (ASTM A 351) Shaft : stainless steel (ASTM A 582) Brosur : Ada	WILO, ANDRITZ, KSB, SPP PUMPS, HANSUNG

TECHNICAL BID EVALUATION / MATRIX

Motor	Type : 3 phase horizontal wound rotor induction motor Quantity : 2 Units Motor Output : 1.250 Kw (reference) x 3 phase x 6.600 V x 50 Hz Pole : 6P (reference) Driving Method : VSD Enclosure : CACA Motor Enclosure Protection : IP 55 Insulation Class : F class Motor Efficiency : Higher than 90% Power Factor : Higher than 80% Slip : Less than 3% Bearing : withstand axial and radial loads B/G lubrication : Grease or oil Heaters for anti-condensation : 240 V AC $\pm$ 10% Terminal Box : for frequency converter use (VSD connection) Installation : Indoor Brosur : Ada Supporting Letter : Ada	TMEIC, XMEC, KSB, MARATHON, HYUNDAI
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Kriteria Pelaksanaan Pekerjaan

Variable Speed Driver	Capacity : 1,250kW Required Frequency : 25 – 60Hz Electric source : 3Ph x 6,600V x 50Hz Aux. Power Supply : 1Ph x 230V x 50Hz Cooling system : Air fan Cooling : 3Ph x 400V x 50Hz Software : For monitoring and control Efficiency : Min. 96% at 100% speed & 100% load Power factor : 0.95 at load range of 30 ~ 100% Display panel : Integral monitoring Input/output : Digital Audible alarm : Metering / Indicating communication mod : connection to SCADA Enclosure : IP21, stainless steel Control / Operation : On/off/faultLocal/remoteSpeed increase/decrease Brosur : Ada	SCHEINER, DANFOSS, DELIXI, INVT KOREA
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GENERAL SPESIFIKASI

Mechanical Works & Commissioning Requirements

The Contractor shall supply, install, test, start up, and commission **booster pumps, valves, cranes, air chambers, and flowmeters**, including operator training during the maintenance period.

 *Ref: pp. 440–441*

The Contractor is responsible for providing **all labor, materials, equipment, tools, safety gear, transportation, and testing facilities** required to complete the mechanical works.

 *Ref: p. 440*

All equipment must comply with the **latest applicable international and national standards**; where conflicts occur, **the more stringent requirement shall govern**.

 *Ref: p. 440*

Equipment manufacturers must demonstrate:

- Minimum **five (5) similar installations**
- At least **five (5) years of successful operation**
- Proven performance under similar conditions

 *Ref: pp. 440–441*

Contract drawings are diagrammatic; the Contractor shall prepare and submit **general arrangement, shop, and construction drawings** and is responsible for coordination with other disciplines.

 *Ref: pp. 441–442*

GENERAL SPESIFIKASI

All equipment shall be **new**, of standard manufacture, and from manufacturers experienced in similar works; modified equipment must fully meet performance specifications.

 *Ref: p. 441*

Any deviation from contract drawings or specifications requires **prior written approval** from the Engineer, at the Contractor's cost.

 *Ref: p. 441*

Vendor documentation must include **data sheets, performance curves, design calculations, drawings, manuals, spare parts lists, and Inspection & Test Plans (ITP)**; procurement without approval is prohibited.

 *Ref: pp. 442–443*

Installation shall strictly follow **manufacturer recommendations and good engineering practice**, supervised by factory-trained representatives when required.

 *Ref: pp. 452–453*

Safety guards, labeling (English & Indonesian), corrosion protection, proper storage, and packaging are mandatory to ensure safe operation and long-term reliability.

 *Ref: pp. 446–457*

GENERAL SPESIFIKASI

Mandatory inspections and tests include:

- Factory Acceptance Test (FAT)
- On-site delivery inspection
- Installation inspection
- Start-up tests
- Commissioning

 *Ref: pp. 462–464*

No equipment shall be delivered to site without **successful FAT**, unless formally waived by the Employer.

 *Ref: p. 462*

Commissioning shall be conducted in accordance with an **approved commissioning plan**, with full-load operation and retesting until performance meets specifications.

 *Ref: p. 464*

Manufacturer-led training shall be provided for operators, **minimum 8 hours per equipment**, covering operation and maintenance.

 *Ref: pp. 454–455*

All equipment shall be covered by a **one-year warranty** from the Taking Over Certificate, with **single-source responsibility** by the manufacturer.

 *Ref: p. 445*

GENERAL SPESIFIKASI

Quality Assurance Requirements

- Equipment must be **new**, from an **experienced manufacturer** with:
 - Minimum **5 years successful operation** in similar installations
 - Reference installations with verifiable performance
 - **ISO 9001 certification** (p.467)

Bill of Quantity

(Untuk detail BoQ akan disampaikan
file BoQ pada We Proc)

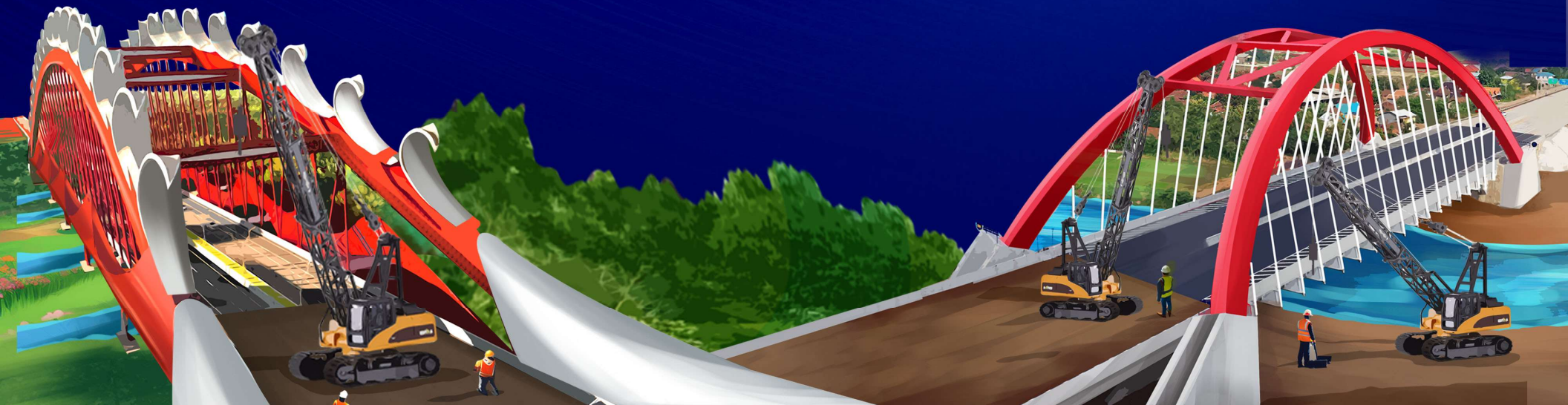


BOQ PROCUMENT & INTALLATION PUMP WORKS

Item Number	Description	Unit	Unit Price	Quantity	Total Amount
IX.1.1	Procurement and Installation of Pump 2 m3 with 90 meters head with Digital Control Panel	nos		4,00	Rp -
a	Booster Pump				
	Type : Double Suction Volute Pump (Horizontal Type)				
	Quantity : 4 Units				
	Rated Capacity : 2,0 m3/s (172.800 m3/day)				
	Rated Head : 90 m				
	Speed : Approx. 745 rpm to 995 rpm				
	Pump GD2 :				
	NPSHreq :				
	Guarantee Efficiency : Not less than 87 percent at duty point				
	Flange Class : PN16 for Suction, PN 16 for discharge (ISO 7005/2/3. AWWA C 207				
	Casing : Horizontal split				
	Impeller : Enclosed type				

Catatan : Detail BoQ ada pada We Proc

Bobot Penilaian



KRITERIA BOBOT PENILAIAN PENAWARAN AWAL & AKHIR REKANAN

Pembobotan



Total Bobot: 100 %

Evaluasi Komersial, Administratif, dan Teknikal

No. 1 Umum

> Rincian Aspek Pembobotan

Kriteria	Umum	Bobot	22
Tipe Evaluasi	Non Komersial		

No. 2 Biaya

> Rincian Aspek Pembobotan

Kriteria	Biaya	Bobot	27
Tipe Evaluasi	Komersial		

No. 3 Garansi/Jaminan

> Rincian Aspek Pembobotan

Kriteria	Garansi/Jaminan	Bobot	10
Tipe Evaluasi	Komersial		

No. 4 Teknis

> Rincian Aspek Pembobotan

Kriteria	Teknis	Bobot	12
Tipe Evaluasi	Non Komersial		

KRITERIA BOBOT PENILAIAN PENAWARAN AWAL & AKHIR REKANAN

No. 5 Struktur Organisasi Lapangan

[> Rincian Aspek Pembobotan](#)

Kriteria	Struktur Organisasi Lapangan	Bobot	3
Tipe Evaluasi	Non Komersial		

No. 6 Dukungan

[> Rincian Aspek Pembobotan](#)

Kriteria	Dukungan	Bobot	6
Tipe Evaluasi	Non Komersial		

No. 7 Quality Health Safety Environment (QHSE)

[> Rincian Aspek Pembobotan](#)

Kriteria	Quality Health Safety Environment (QHSE)	Bobot	12
Tipe Evaluasi	Non Komersial		

No. 8 Waktu

[> Rincian Aspek Pembobotan](#)

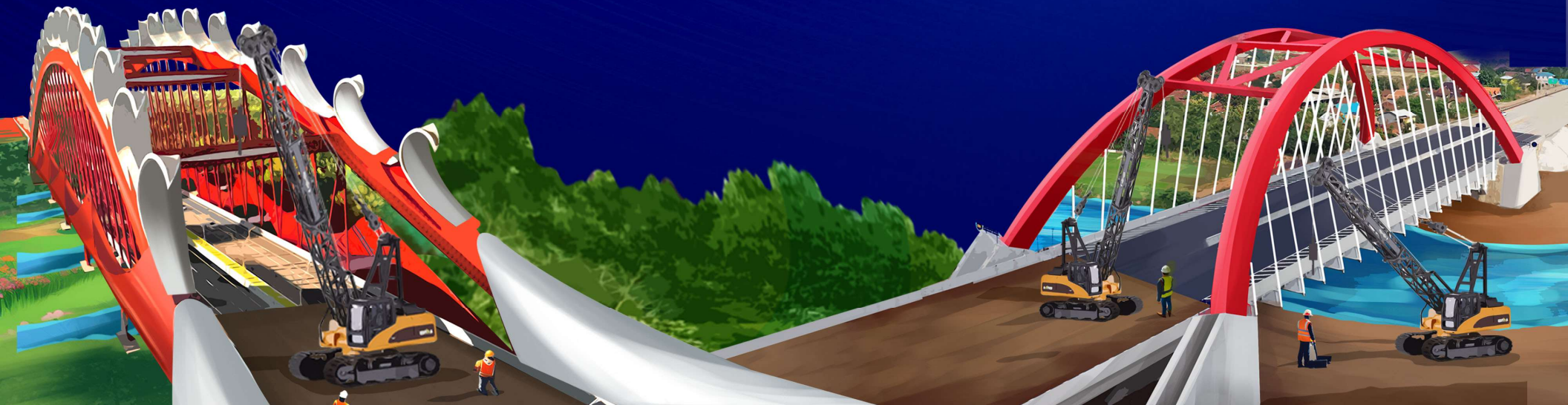
Kriteria	Waktu	Bobot	4
Tipe Evaluasi	Non Komersial		

No. 9 Tingkat Komponen Dalam Negeri (TKDN)

[> Rincian Aspek Pembobotan](#)

Kriteria	Tingkat Komponen Dalam Negeri (TKDN)	Bobot	4
Tipe Evaluasi	Komersial		

Syarat Pengajuan Sanggahan



SYARAT PENGAJUAN SANGGAHAN

Untuk penyedia lain yang ingin mengajukan sanggahan apabila menemukan :

1. Tim Pengadaan salah dalam melakukan evaluasi
2. Terindikasi penyimpangan
3. Rekayasa/persekongkolan

Pengajuan sanggahan paling lambat diajukan 2 (dua) hari kerja setelah surat ini dikeluarkan disertai dengan jaminan berupa Bank Garansi senilai 10% dari nilai penawaran. Jaminan akan dikembalikan apabila terbukti dan akan menjadi milik PT Waskita Karya (Persero), Tbk apabila tidak terbukti.

Contoh Dokumen Kontrak dan Proses E Sign



CONTOH KONTRAK SPPM & ISI PASAL SPPM



SURAT PERJANJIAN PEMESANAN MATERIAL (SPPM)

Nomor: 00473/SPPM/WK/SCM/WAA/2025

Tanggal: 19 September 2025

Nomor PO: 4100066757

Antara

PT WASKITA KARYA (Persero) Tbk

Departemen Gedung

Divisi Operasi I

Dan

Untuk melaksanakan

Pekerjaan Unit AC (Chiller, AHU Hygiene, AHU non Hygiene, VRF)

**PROYEK PENINGKATAN KELAS RSUD KUBU RAYA
1125007**



Perjanjian Pemesanan Material Nomor: 00473/SPPM/WK/SCM/WAA/2025

Daftar Isi

PASAL 1 DEFINISI	5
PASAL 2 MAKSUD DAN TUJUAN	6
PASAL 3 JENIS, ESTIMASI VOLUME, HARGA SATUAN DAN NILAI JUAL BELI	6
PASAL 4 SPESIFIKASI DAN KUALITAS	7
PASAL 5 JANGKA WAKTU PENGADAAN MATERIAL	7
PASAL 6 SYARAT DAN CARA PEMBAYARAN	8
PASAL 7 PAJAK, CUKAI DAN PUNGUTAN	9
PASAL 8 JAMINAN PENGADAAN MATERIAL	9
PASAL 9 KLAIM KENAIKAN HARGA	10
PASAL 10 PEMERIKSAAN MUTU	10
PASAL 11 SANKSI	10
PASAL 12 TINGKAT KOMPONEN DALAM NEGERI	11
PASAL 13 KEADAAN MEMAKSA / FORCE MAJEURE	11
PASAL 14 RISIKO	12
PASAL 15 PEKERJAAN TAMBAH/KURANG	12
PASAL 16 PENYUAPAN DAN KORUPSI	13
PASAL 17 PENYELESAIAN PERSELISIHAN	13
PASAL 18 PEMUTUSAN PERJANJIAN	14
PASAL 19 PEMBERITAHUAN DAN KORESPONDENSI	15
PASAL 20 KESELAMATAN DAN KESEHATAN KERJA, LINGKUNGAN, MUTU DAN PENGAMANAN (K3LMP)	16
PASAL 21 KERAHASIAAN	17
PASAL 22 LAIN-LAIN	17
PASAL 23 PENUTUP	18



Perjanjian Pemesanan Material Nomor: 00473/SPPM/WK/SCM/WAA/2025

PASAL 23 PENUTUP

Para Pihak sepakat dan mengakui Perjanjian ini berikut lampiran-lampirannya adalah merupakan satu kesatuan yang tidak terpisahkan dan mengikat kedua belah pihak.

Perjanjian ini dibuat asli ditandatangani secara elektronik dengan materai elektronik oleh kedua belah pihak dan mempunyai kekuatan hukum yang sama serta dapat dipergunakan sebagaimana mestinya.

**PIHAK PERTAMA
PT. WASKITA KARYA (PERSERO), TBK**

PIHAK KEDUA

[Signature]

[Signature]



Kepala Divisi Supply Chain
Management

Kepala Departemen Gedung
Divisi Operasi I

Direktur

Proses Reviewer & Approval Rivewer E - Contract

Contract Parameter Contract Items Review & Discussion Approval Monitoring Contract Finalization Contract

CONTRACT / PENGADAAN POMPA PLUMBING DAN PEMADAM KEBAKARAN

Overview

Contract Number 00044/SPPM/WK/SCM/WAA/2025
Contract Name Pengadaan Pompa Plumbing dan Pemadam Kebakaran
Contract Value 928.460.000
Contract Type Supplier
Created Date 2025-03-05
Start Job 2025-03-05
End Job 2025-05-31

PO Number 4100062691
Purchasing Organization Waskita
Purchasing Group WAA - SCM MEEP
Incoterm FRANCO
Division Building
ID Project 1124017
Project Description Pembangunan Mako Paspampres

Vendor Data

Vendor JUVANTEE INDONESIA
BOD Vendor Hendie Swanto
Vendor Contract Signature Hendie Swanto
Contract Guarantor Name Hendie Swanto
Bid Bond Amount From Date
Bid Bond Amount Thru Date
Deed of Establishment 19
Issued Date of Deed 2009-06-26
Notary Issuer of Deed C-134-HT.03.02 - Tahun 1999
Notary Domicile Jakarta

Bank Name Bank Mandiri
Bank Account Name JUVANTEE INDONESIA, PT
Bank Account Number 1180078800777
Contact Hendie Swanto
Contact Number 021 54340074
Postal Address Green sedayu bizpark, Jl. Daan mogot KM.18 51 H-i
SK KEMENKUMHAM AHU-AH.01.03-0415968
Number
Issued Year of SK KEMENKUMHAM 2021
Issued Date of SK KEMENKUMHAM 03 Juli 2021

Information

Letter Number of Award Announcement 000123/WK/WeProc/PNT/000018-WAA-2025
Letter Number of Announcement 000123/WK/WeProc/PNM/000018-WAA-2025
SCM Division Phone Number 021-850 8520

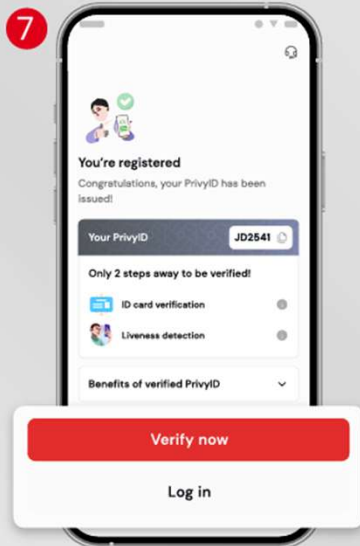
Bussiness Unit Phone Number 021-8515521
Bussiness Unit Official Email div-gedung@waskita.co.id
Bussiness Unit Address . MT Haryono Kav. No. 12-13 Bidaracina, Jatinegara, Jakarta Timur 13330
Gedung Waskita Rajawali Tower Lantai 8 Departemen Gedung Divisi Operasi I

Proses Tanda Tangan Kontrak Menggunakan E Sign



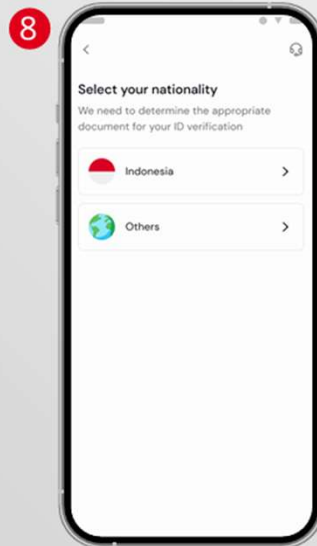
Catatan : Kontrak dengan e-Sign Privy

1. ID Privy Signer (wewenang SCM: Kadiv SCM, KadepOp)
2. ID Privy Direktur yang ttd di kontrak dari Vendor (pastikan sudah subscribe personal plan agar bisa membubuhkan e-meterai)



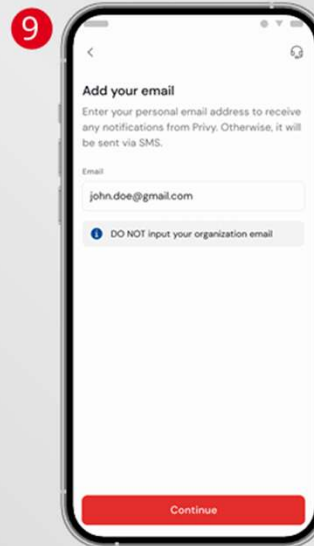
Lanjutkan verifikasi.

Continue to verify.



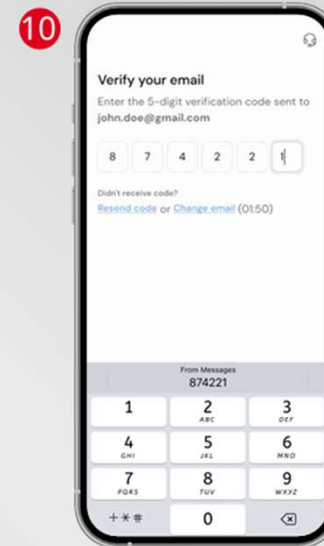
Pilih kewarganegaraan Anda.

Choose your nationality.



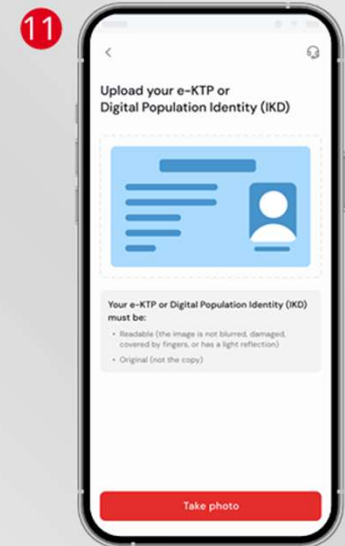
Masukkan email Anda.

Input your email.



Masukkan kode OTP yang sudah dikirimkan ke email Anda.

Input OTP code that has been sent to your email.



Ikuti petunjuk foto KTP dan unggah file.

Take a photo of your ID according to the guides and upload the file.



TERIMA KASIH

XXXVI. MECHANICAL

1 Scope Of Work

The specifications of mechanical and electrical work includes the procurement, installation and commissioning of all mechanical and electrical equipment in Karian-Serpong Water Conveyance System (KSCS) and testing and experimenting of all installations carried out. The scope which this specification is applied include.

- a. Booster Pump, Valves in pump station and pipeline, Crane
- b. PLN electrical power incoming substation
- c. Emergency generator set
- d. Switchboard
- e. Lighting and lightning arrester
- f. Cathodic protection

2 Standard Reference

Reference to standards in this tender document is intended to provide an overview of the type and quality of the requested material. The materials offered can use other standards, provided that the overall quality is at least the same as what is specified in this tender document. Acceptable standards in principle are:

SNI – Indonesian National Standard

ANSI - American National Standard Institute

AS - Australian Standard

ASTM - American Society for Testing and Materials

AWS - American Welding Society

AWWA - American Water Work Association
BS - British Standard
ISO - International Organization for Standardization

PUIL - General Electrical Installation Regulations
NEC - National Electric Code

3 Mechanical Work

The number and type of mechanical equipment that must be provided and installed in this work is in accordance with the equipment listed in the planning drawings and or in the RAB. Specifications and installation of mechanical equipment must be in accordance with the planning drawings and or technical specifications. The installation of this mechanical equipment must be in such a way as to facilitate the operation and maintenance of the equipment.

3.1 Scope of work

The scope of work includes, among others:

- a) Supply, installation, startup and commissioning of booster pump
- b) Supply, installation, startup and commissioning of butterfly valve for pump inlet, pump discharge and pump maintenance and non-slam check valve
- c) Supply, installation, startup and commissioning of cranes
- d) Supply, installation, startup and commissioning of air chamber and accessories for water hammer prevention
- e) Supply, installation, startup and commissioning of butterfly valve for isolation, branch and inter-connection of pipeline
- f) Supply, installation, startup and commissioning of flowmeter for pipeline
- g) The above includes the testing and operation as well as guidance and training to prospective operators by experts during the maintenance period.

3.2 General Provisions

3.2.1 Scope of Work

The Contractor shall provide all the required labor, project equipment and materials, tools, construction equipment, safety equipment, transportation, and test equipment (unless otherwise specified) for furnishing, installation, adjustment, and full test loading of all the mechanical work shown on the Drawings and included in these Specifications.

3.2.2 Quality Assurance

- (1) Published specifications, standards, tests, or recommended methods of trade, industry, or governmental organizations apply to work of these Specifications were cited by abbreviations on the plans and below. In every situation, the latest specifications, standards, tests, etc., shall apply unless otherwise noted. In instances where two codes are at variance, the more restrictive requirements shall apply.
- (2) The Contractor shall provide, for the approval of the Engineer, the equipment/material country of origin, together with clear evidence to demonstrate that it has been successfully manufactured at that facility and has been installed and operating successfully, in a number of similar projects in type and size, under similar conditions to those pertaining to its specified application. The manufacturer must have installed, and had in satisfactory use, for a period

of not less than five years a minimum of five installations of similar size and type comparable to the units specified. The Contractor shall provide data on installations of the manufacturer which shall include, but not be limited to, the following:

- a. name and location of installation,
 - b. name of person in direct responsible charge for the equipment,
 - c. address and phone number of person in direct responsible charge,
 - d. month and year the equipment was placed in operation,
 - e. brief Purview of equipment.
- (3) The equipment to be furnished here under shall be new and shall be a standard product of a manufacturer experienced in the design, fabrication and construction of specific equipment. Equipment which is a “standard product” with the manufacturer shall be modified, redesigned from the standard mode, and shall be furnished with special features, accessories, materials of construction or finishes as may be necessary to conform to the quality mandated by the technical and performance requirements of the specification. The manufacturer shall demonstrate to the Engineer from operating installations of equal or larger capacity utilizing equipment specified, that all the mechanical features and appurtenances of the equipment will operate satisfactorily for the purposes intended. All the equipment furnished under these specifications shall be demonstrated to the satisfaction of the Engineer that the quality is equal to equipment made by the manufacturers specifically named therein.

3.2.3 Drawing

- (1) The Contract drawings are diagrammatic and show the general layout of the complete construction work. Locations of equipment, inserts, anchors, motors, panels, conduits, stub- ups, fittings, fixtures, air, water, power and process inlets, unless specifically dimensioned on the Drawings, shall be determined to suit field conditions encountered, and the Contractor shall be responsible for ensuring clearance between pipes, equipment, and similar appurtenances, without extra cost to the Employer. The Contractor shall review the Drawings and Specifications of other trades and shall include the mechanical work shown thereon that will be required for the installations as described in the specification. The Contractor shall be responsible for preparing, and submitting to the Engineer for review, all general arrangement drawings showing the inter-relationship with the civil construction work and with all mechanical, electrical and instrumentation equipment to be installed. Should there be a need to deviate from the Contract drawings and Specifications, the Contractor shall submit

written details and reasons for all changes to the Engineer for approval before making such changes. All extra costs to make the changes will be borne by the Contractor. In the event of varying interpretations of the Contract Documents, the Engineer's interpretation shall govern.

- (2) Prior to fabrication, the Contractor shall prepare the general arrangement drawings and shall obtain, from the manufacturer, shop drawings for all equipment. Shop drawings shall include fabrication, assembly, foundation and unit support drawings, installation drawings, and wiring diagrams together with detailed specifications and data covering materials used, power drive assembly, parts, devices, and other accessories forming a part of the equipment to be furnished. The Contractor shall submit certified performance or certified test curves, as specified for all pumps, blowers and other equipment required by the Engineer and furnished under this Contract. The Contractor shall notify the Engineer three weeks prior to all testing should the Engineer elect to witness the tests. The Contractor shall submit general arrangement and shop drawings and material lists for approval as specified in applicable specifications and in conformance with the requirements of Submittals and the Particular Specifications.

- (3) Construction Drawings

All construction drawings and documents shall be subject to the Engineer's Approval and the Contractor shall not commence construction until drawings have been approved.

The Contractor shall prepare all required construction drawings giving full and complete details to enable the Employer/Consultant to properly consider the execution of the works.

All construction drawings shall be prepared in accordance with the Instructions contained in technical specifications of respective disciplines. These shall also be prepared in conjunction with all other disciplines concerned and after coordinating the requirements of openings, inserts, bases, foundation bolts, etc.

The drawings to be produced shall include, but not be limited to, the following:

- General site layouts
- Pump building layouts
- Piping general arrangement drawings
- Piping details

- Thrust and Anchor block details
- Piping supports and attachments
- Pipeline installation details
- Pipeline Profiles and Pipeline Routes
- Piping isometrics

3.2.4 Adaption of Equipment

Should any alternate equipment selected require any revision to the structure, piping, electrical, or other work shown on the Drawings, the Contractor shall include the cost of such revisions in his bid for the equipment and no extra payment shall be made for such revision. All such revisions shall be subject to the approval of the Engineer.

3.2.5 Vendor Documents

The Contractor shall be responsible for submitting Vendor documents with details to the Employer/Consultant for review/approval. The submittals shall include full and complete details to enable the Employer/Consultant to fully analyze the type and characteristics of the equipment/materials proposed.

The vendor documents shall be supplemented by Vendor Catalogues, Vendor Data Sheets and actual samples where appropriate or when required by the Employer/Consultant.

No materials or equipment shall be purchased by the Contractor without the written Approval of the Employer/Consultant.

The Vendor documents to be submitted shall include but not be limited to the following:

- Data sheets and performance curves
- Design calculation
- Assembly and components drawings with electric wiring & control logic and foundation
- Accessories list, spare parts list and maintenance tool list
- Lubrication instruction
- Coating and painting plan
- Inspection and test plan

- Packing and shipping plan
- Installation manual
- Startup manual
- Operation and maintenance manual
- Catalogue and reference technical documents

3.2.6 Documents Submittal Procedures

- (1) Only the Contractor shall make submissions to the Engineer. All data and correspondence prepared by subcontractors and suppliers shall be submitted through the Contractor. All submittals shall be in English. The Contractor shall prepare submittals with sufficient information, and in such a manner, that no more than two resubmittals are necessary to obtain the Engineer's approval. If more than two resubmittals are required, the Employer reserves the right to deduct the cost of the Engineer's time to review all additional resubmittals (after re-submittal no. 2) from moneys due to the Contractor.
- (2) The Contractor shall make all corrections and changes to submittals as required by the Engineer and resubmit until approved. The Contractor shall review submittals returned by the Engineer and shall determine if changes requested by the Engineer result in extra costs. The Contractor shall notify the Engineer in writing within five days of receiving a submittal if the Contractor believes extra costs are incurred and indicate in his submittals to the Engineer. Failure of the Contractor to notify the Engineer of the extra costs, or if the Contractor proceeds with the work, waives the Contractor claim for compensation.
- (3) The Contractor shall not perform any work until drawings or data have been submitted to, and approved by, the Engineer.
- (4) Reviewed submittals will be returned to the Contractor with the Engineer's comments, if any. The Engineer's review is for general conformance with the contract requirements only and all work is still subject to the detailed requirements of the Contract. The Engineer's review is to help the Contractor to discover errors and omissions. The Engineer's review does not relieve the Contractor of the obligation and responsibility to coordinate and plan the details of the Work and fulfill the intent and purpose of the Contract. The Engineer's review shall not relieve the Contractor of the responsibility for accuracy, proper fit, or proper functioning and performance of the work.

The Engineer reserves the right to request written confirmation from the Contractor that the comments placed on submittals stamped "Approved As Noted" will actually be implemented. The Engineer will make every reasonable effort to process and return each submittal within 30 calendar days after its receipt in the Engineer's office, but with the following qualifications:

- a. large or multiple submittals may require additional time,
 - b. the Contractor may prioritize submittals, and Engineer will review and return them in the order of the highest priority,
 - c. if requested by the Contractor, individual drawings from large submittals with numerous drawings may be returned as they are reviewed rather than waiting for the entire review to be completed,
 - d. the need for re-submissions or delays in obtaining the Engineer's review or approval shall not entitle the Contractor to a time extension for contract completion.
- (5) The categories used by the Engineer to evaluate submittals are defined below:
- a. "Approved": no discrepancies have been identified,
 - b. "Approved As Noted": the submittal is acceptable subject to incorporation of the comments listed,
 - c. "Disapproved": the submittal is unacceptable for the reasons cited,
 - d. "Noted": the submittal is not required by the contract documents, or the Engineer will include it in the project files for information only.
- (6) Incomplete submittals including those not correctly transmitted, incorrectly titled and identified, or not bearing the Contractor's review and approval stamp may be returned to the contractor without review.

3.2.7 Utility Service and Process Interruption

All utility service and/or process interruptions initiated by the Contractor in the prosecution of his work shall be scheduled in advance and approved by the Employer.

3.2.8 Operation and Maintenance Manuals

The Contractor shall submit to the Engineer operation and maintenance manuals on all equipment in accordance with the requirements of Specification and the

Particular Specifications. The draft manuals shall be submitted for approval not later than the date of shipment of the equipment. The final approved copies shall be available to the Employer's personnel at least two weeks prior to training and start-up for each piece of equipment

3.2.9 Installation Manuals

In addition to operation and maintenance manuals, the Contractor shall submit to the Engineer twelve copies of all installation manuals for each piece of equipment. These manuals shall be submitted at the same time as the draft operation and maintenance manuals. The installation of equipment shall not be performed until installation manuals are received.

3.2.10 Warranty

- a. Each piece of equipment shall be warranted to be free from defects in materials and workmanship when properly installed, maintained and operated under normal operating conditions for a period of one year from the date of Taking Over Certificate.
- b. Warranties and guarantees by the suppliers of various components in lieu of single-source responsibility by the equipment manufacturer will not be accepted. The equipment manufacturer shall be solely responsible for the warranty. In the event a component fails to perform as specified or proven defective in service during the warranty period, excluding items normally expended during operation, the Contractor shall furnish and install a replacement part without cost to the Employer. In addition to performance guarantees, all processes or systems shall comply with the requirements of applicable portions of the Specifications of these Specifications describing those systems.
- c. The Contractor shall furnish the Employer with the manufacturer's guarantee and warranty certificates for all equipment, duly registered with the manufacturer.

3.2.11 Materials and Workmanship

- a. All equipment furnished under this Specification shall be new and guaranteed free from defects in materials, design, and workmanship. These Specifications, to the extent possible, identify service conditions and requirements for all equipment; however, it shall be the manufacturer's responsibility to ascertain, to his satisfaction, the conditions and service under which the equipment will operate and to warrant that operation under those conditions will be successful. All parts of the equipment shall be

amply proportioned for all stresses that may occur during fabrications, erection, and intermittent or continuous operation.

- b. All equipment shall be designed, fabricated, and assembled in accordance with the best modern engineering and shopping practice. Individual parts shall be manufactured to standard metric sizes and gauges so that repair parts, furnished at any time, can be installed in the field. Like parts of duplicate units shall be interchangeable. Equipment should not have been in service at any time prior to delivery, except as required by tests. Materials shall be suitable for service conditions.
- c. Except where otherwise specified, structural and miscellaneous fabricated steel used in items of equipment shall conform to the Standards of the American Institute of Steel Construction, Korea Industrial Standards and British Standards. All structural members shall be considered as subject to shock or vibratory loads. Unless otherwise specified, all steelworks shall have a minimum nominal thickness of 6mm. The location of the fabricator and his shop schedule shall be furnished to the Engineer prior to the beginning of fabrication so that the Engineer can schedule shop inspection if so desired.

3.2.12 Safety Guards

All belt or chain drives, fan blades, couplings, exposed shafts and other moving or rotating parts shall be covered on all sides by safety guards which shall be free of all sharp edges and corners. Safety guards shall conform to the requirements of the local safety regulations and appropriate safety agencies, such as OSHA. Safety guards shall be fabricated from 1.6mm, or heavier, galvanized or painted, aluminum-clad sheet steel, stainless steel or 12mm mesh, galvanized expanded metal. Each guard should be designed for easy installation and removal.

All necessary support and accessories shall be provided for each guard. Supports and accessories, including bolts, shall be hot dip galvanized or stainless steel. All safety guards in outdoor locations should be designed to prevent the entrance of rain and dripping water.

3.2.13 Nameplates

- a. Unless otherwise specified, all equipment furnished shall have a data plate fabricated of stainless steel with a minimum thickness of 2mm and embossed or preprinted lettering and fastened to the frame with corrosion-resisting pins. Nameplates shall have stamped on them the manufacturer,

serial number, model number, type, operating and performance data, and other pertinent data. Letters and numerals shall not be smaller than 5mm high.

- b. Where the size of the equipment prevents the fastening of data plates, name tags shall be provided and attached to the equipment and device item to identify it. The name tags shall have a rectangular configuration with square corners and shall be approximately 40mm by 75 mm in size. They shall be made from brass or stainless-steel sheet metal and have a minimum thickness of 2mm. Letters and numerals shall be engraved or etched in the name tags by a professional engraver and shall not be smaller than 3mm high in size. The name and number for each item of equipment, as designated in the Drawings, shall appear on the name tag for the item. Valve tag information shall conform to the Plans and Specifications. A 5mm diameter hole shall be provided in the upper left-hand corner of each name tag and shall be used to attach the name tags to the equipment and device items with 3mm stainless steel cable.

3.2.14 Equipment Bases and Bedplates

A heavy cast-iron or welded steel base shall be provided for each item of equipment which is to be installed on a concrete foundation. Equipment assemblies, unless otherwise specified, or shown on the Drawings, shall be mounted on a single, heavy, cast-iron or welded steel bedplate. Bases and bedplates shall be provided with machined support pads, tapered dowels for alignment of mating, or adjacent items, adequate openings to facilitate grouting, and openings for electrical conduits. All seams and contact edges between steel plates and shapes shall be continuously welded and ground smooth. All pump bedplates must include a drip lip and provision for directing accumulated gland leakage to a single disposal drain point. Pipe accumulated gland and seal water leakage and spent cooling water to a floor drain provided adjacent to each piece of equipment. Floor drains may be provided for more than one piece of equipment provided the equipment drain line does not create a safety or tripping hazard.

3.2.15 Jacking Screws and Anchor Bolts

Jacking screws shall be provided in the equipment bases and bedplates to aid in levelling prior to grouting. Equipment suppliers shall furnish anchor bolts, nuts, washers, and sleeves of adequate design as required for proper anchorage of the bases and bedplates to the concrete bases. Sleeves shall be a minimum of 1-1/2

times the diameter of the anchor bolts. Unless otherwise shown or specified, anchor bolts for items of equipment mounted on baseplates shall be long enough to permit 25mm of grout beneath the baseplate and to provide a minimum of adequate anchorage into structural concrete. Anchor bolts, together with templates or setting drawings, shall be delivered sufficiently early to permit setting the anchor bolts when the structural concrete is placed. Anchor bolts shall be 304 stainless steel which conforms to ASTM A-276 or JIS 4303.

3.2.16 Drives

- a. All drive units shall have an AGMA or equivalent rating and service factor suitable for 24-hour per day operation under the specified maximum, or "worse case" operating load. Drive unit housing shall be constructed of high-grade cast iron, welded steel, or other suitable material.
- b. The thermal rating of each unit shall exceed the design load or proper cooling devices shall be provided. All drives should be designed especially for the service for which they are to operate.
- c. All electric motors supplied under this Contract shall conform to all requirements specified in Specification. Additional or superseding requisites for certain motors may be found in various Specifications, and to a lesser extent, in other Divisions wherein electric motor driven equipment is specified. The Contractor must coordinate the work of all trades, and the functional, safety and Code requirements for each installation, to comply with these Specifications.
- d. Where motors are mounted above the driven machine on a pedestal, the belt tensioning shall be accomplished by four studs which are double nutted to the motor plate to raise and lower the motor plate. Hinges with a jacking screw to tension the belts shall not be used. Where motors are mounted horizontally adjacent to the driven equipment, belt tensioning shall be accomplished by utilization of sliding rail type motor mount, with manual adjustment of motor location, and thereby, belt tension, through a manual, permanently mounted hand crank mechanism. All V-belt tensioning devices shall be such that under no circumstances will it be possible for any device, once set to the desired adjustment, to go out of the adjustment due to the load being imposed upon the drive at that setting. This requirement shall not be construed to mean that a seat belt tension may not go out of adjustment due to gradual stretching of belts, but shall mean that no portion of any device or devices used to accomplish belt

tensioning may slip, become loose, or otherwise move from the desired set point, once selected, except when manually reset by operating personnel by use of the adjustment device or devices.

3.2.17 Lubrication

The lubrication of equipment shall ensure constant presence of lubricants on all wearing surfaces. Lubricant fill and drain openings shall be readily accessible. Easy means of checking the lubricant level shall be provided. Prior to testing and/or operation, the equipment shall receive the prescribed amount and type of lubricant as required by the equipment manufacturer. The Contractor shall provide to the Employer a two-year supply of lubricants for each piece of equipment installed. All lubricants shall be properly packaged, labelled, and delivered to the Employer concurrent with equipment installation. An inventory listing of lubricant types by equipment and quantities shall be provided.

3.2.18 Gears

- a. Oil-lubricated totally enclosed gear reducers and increases shall be provided.
- b. Each gear shall have a nameplate service power rating equal to the nameplate rating of the driving motor. Each gear shall have mechanical and thermal capacity equal to, or greater than, an equivalent power determined by multiplying the service power rating by the specified service factor recommended by AGMA, or equivalent for heavy duty service, except each set of worm gears shall have a minimum service factor of 1.20 and all other gears shall have a minimum service factor of 1.50.
- c. Thermal rating for the equivalent power shall be obtained without auxiliary cooling equipment such as heat exchangers. Units shall be designed to operate continuously for the conditions specified in a location where ambient temperatures vary from (0o C to 55o C). If a cooling coil is required, it shall be minimum 25mm diameter tubing with a 25mm solenoid supply water valve with the gear.
- d. Anti-friction bearings shall be provided throughout, designed to give a minimum 50,000 hours B10 life for the specified power in continuous operation, of proportions, mountings, and adjustment consistent with acceptable modern practices for applied radial and thrust loads at speeds involved. Thrust bearing rates shall be at 1-1/2 times the maximum thrust loadings involved.

3.2.19 Gauges

Gauges shall be installed in the suction and discharge of each pump and blower. The gauges shall be 100 mm diameter and in accordance with Specification and shall include a petcock between the pump/blower and the gauge. For solids bearing or corrosive fluids a diaphragm gauge isolator or tubular isolator shall be provided. Suction gauges shall be of the compound type and shall have a range of 750mm of mercury to 1 bar. Discharge gauge ranges shall be a standard commercially available range with a maximum reading not less than 5 bars greater than the pump rated shut off pressure and shall be equipped with snubbers.

3.2.20 Stainless Steel

Unless otherwise specified all Stainless steel shall be SS 304 or ASTM A-276.

3.2.21 Dissimilar Metals

All dis-similar metals shall be insulated from each other unless the Contractor can show that galvanic corrosion will not occur.

3.2.22 Spare Parts

Spare parts shall be provided as detailed in the individual specifications. The Contractor shall deliver the spares to the Employer's storage warehouse in accordance with a program to be agreed with the Employer and Engineer. The Contractor shall provide the lists and details of the spares in a format acceptable to the Employer.

3.2.23 Special Tools and Accessories

Any special tool provided for maintenance of the Plant shall be identified within the tender and supplied and handed over to the Employer on completion of the Works. Prior to handover the Employer and Contractor shall examine tools which have been used during plant erection to ensure that they are not damaged and are in good condition.

The recommended optional tools, including any special tools, gauges, jigs or extractors which may be required for maintenance of the Plant shall be set out in the appropriate schedule. A suitable lockable box shall be provided for each town to contain all the tools provided.

3.2.24 Co-ordination

- a. The Drawings show, in a diagrammatic form, the arrangements desired for the principal apparatus, piping, and similar appurtenances, and shall be followed as closely as possible. Proper judgment must be carried out in

carrying out the work to secure the best possible headroom and space conditions throughout, to secure neat arrangement of piping, valves, fixtures, hangers, and similar appurtenances, and to overcome local difficulties and interferences of structural conditions wherever encountered.

- b. The Contractor shall take all measurement for his work at the installation sites, verify all Drawings prior to required submittal and be responsible for the proper installation, within the available space, of the apparatus specified and shown on the Drawings. The Contractor must secure the approval of the Engineer for all variations and/or substitutions before making any changes.

3.2.25 Protection

- a. All equipment shall be boxed, created, or otherwise completely enclosed and protected during shipment, handling and storage. All equipment shall be protected from exposure to the elements and shall be always kept thoroughly dry and clean. Pumps, blowers, motors, electrical equipment, and other equipment having anti-friction or sleeve bearings shall be stored in weather-tight storage facilities such as warehouses. All materials and equipment showing evidence of rust, dirt contamination, or other surface or subsurface deterioration shall be cleaned and restored to the Engineer's satisfaction prior to installation.
- b. Painted surfaces shall be protected against impact, abrasion, discoloration, and other damage. All painted surfaces which are damaged prior to acceptance of equipment shall be repainted in accordance with the requirements of Specification to the satisfaction of the Engineer.
- c. Electrical equipment, controls, and insulation shall be protected against moisture or water damage.
- d. The Contractor shall maintain equipment storage facilities in accordance with the provision of Specification and all equipment shall be stored in the designated storage facilities from delivery until installation.
- e. All mechanical equipment, whether in the Contractor's designated storage facility prior to final installation, or whether installed, but not yet placed into service or accepted by the Employer, shall be periodically exercised at intervals, and in accordance with procedures prescribed by each manufacturer, if such a recommendation is included in the manufacturer's

installation, operation and maintenance instructions.

3.2.26 Temporary warehouse to storage equipment and materials, Workshops

The Contractor shall remain responsible for the protection of all equipment and materials until the completed Works are handed over to the Employer.

The Contractor shall provide and maintain all necessary temporary weatherproof warehouse for storage and protection of equipment, goods and materials from on-site delivery until installation. All sheds shall have floors raised above the ground. Especially the equipment included precision or electronic components such as pumps and valves shall be stored in a waterproof warehouse. On-site incoming inspection of equipment which is not stored in the warehouse is not allowed.

The contractor should also provide the workshop to assemble the equipment for installation and make the pipe spools for convenient piping work at site. within or adjacent to the site of the Works as approved by the Engineer of Employer.

The areas on the site or adjacent areas permitted for the use of the Contractor shall be used under conditions as approved by the Engineer. All such areas shall be restored, as approved by the Engineer, at the completion of the Works.

3.2.27 Installation Check

- a. The Contractor shall have an experienced, competent, and authorized representative of the manufacturer or supplier of each major item of equipment (defined as equipment for which there is an individual Specification in these Specifications) visit the site of the work and inspect, check, adjust if necessary, and approve the equipment installation. In each case, the equipment supplier's representative shall be present when the equipment is placed in operation. The Contractor shall have the equipment supplier's representative revisit the job site as often as necessary until all problems are corrected and the equipment installation and operation is satisfactory to the Engineer.
- b. Each equipment supplier's representative shall furnish to the Employer, through the Contractor, a written report certifying that the equipment: (1) has been properly installed and lubricated; (2) is in accurate alignment; (3) is free from all stress imposed by connecting piping or anchor bolts; and (4) has been operated successfully under full load conditions.
- c. Equipment manufacturers shall furnish the services of competent, factory-trained personnel during the warranty period specified to inspect, service, and repair the equipment where required. Service requests shall be answered and acted upon

promptly. This requirement shall not include normal maintenance and service of equipment, which will be the responsibility of the Employer.

3.2.28 Equipment Installation

All equipment shall be installed in full accordance with the equipment manufacturer's recommendations and good practice. Where specified in other Specifications, factory-trained service personnel shall be on-site to supervise the installation. Sufficient notice shall be given to the Engineer prior to equipment installation in order that the Engineer or his representative may be present during installation. In general, the following installation practices shall be followed:

- a. examine equipment for damage in shipping and handling. The examination shall include checking for corrosion, poor workmanship, dirt or deleterious substances, and poor fits,
- b. level the base plate or bedplate,
- c. install equipment,
- d. check alignment of couplings,
- e. if grout has been used, check alignment and levelness after the grout has set,
- f. check direction of rotation and correct, if necessary, to ensure proper operation,
- g. provide drain lines from all equipment, gland leakage housings, seal water openings, spent cooling water outlets, and strainers to nearest floor drain or point of disposal. Blow-down valves shall be provided on all strainers whether or not shown on the drawings,
- h. ensure that all submerged, or intermittently submerged, powered equipment does not have power and control cable splices of any kind inside wells or pits.

3.2.29 Placing in Operation

Prior to being placed in operation, equipment shall be inspected by the manufacturer's factory-trained personnel. All defects discovered during this inspection shall be corrected prior to initial equipment start-up. Internal coatings applied at the factory shall be removed if required. Lubricants shall be applied in the proper places and levels shall conform to the manufacturer's recommendations. In the presence of the Engineer, full-load operational testing

shall be performed, and the results of such tests shall be recorded. Unsatisfactory performance should be corrected, and tests shall be repeated until the equipment's performance meets the Specifications. The Contractor shall furnish all power, materials, services, test equipment and labor required to successfully complete all full load equipment testing specified. The Contractor shall certify in writing to the Engineer, in triplicate, that all tests were conducted in accordance with these Specifications and that all components within each system successfully function as required. The Contractor shall notify the Engineer ten calendar days in advance of the time when the equipment will be placed into operation. During the initial operation, the Contractor shall instruct the Employer's personnel in the proper operation and maintenance of the equipment, as specified herein.

3.2.30 Instruction

After the equipment specified in this specification has been installed, tested, adjusted, and placed in satisfactory operating condition, services of representatives of each equipment manufacturer shall be provided to instruct the operating personnel in the use and maintenance of the equipment. The instruction period shall be scheduled at a time mutually agreed upon with the Employer. The manufacturer's representatives shall fully instruct the Employer's personnel regarding the use and maintenance of the equipment. During this instruction period, it shall be the responsibility of the manufacturer to answer all questions from the Employer's operating personnel. The manufacturer shall also demonstrate lubrication, disassembly, adjusting, routine parts replacement, and other "hands-on" activities related to maintenance of the equipment. Provide a minimum of not less than eight hours for this instruction for each piece of equipment or set of identical pieces of equipment provided unless otherwise specified. More days shall be provided if called for in the individual equipment specification. Each manufacturer should include the service in the price of his equipment. Training session schedules shall be coordinated with the Employer and Engineer and under no circumstances shall more than two training sessions be scheduled for the same day. The Contractor shall designate an individual through whom manufacturer's training will be coordinated. This individual will coordinate all training sessions through the Employer's designated training coordinator.

3.2.31 Shop Painting

- a. Except as specifically supplemented or superseded by requirements herein, shop painting shall conform to requirements in this specification. Electric

motors, gears, starters, and other similar self-contained or enclosed components shall be shop primed and finished with a high- grade oil-resistant acrylic enamel. Surfaces which will be inaccessible after assembly shall be painted or otherwise protected before assembly by a method which provides protection for the life of the equipment.

- b. Surfaces to be painted at the project site shall be shop painted with one or more coats of a primer which will adequately protect the equipment until finishes are applied at the project site. Primers shall be as specified in this specification. All equipment shall be primed with primer compatible with the coating system selected by the Contractor, and if not, the Contractor shall re-prime the equipment such that it is compatible and in conformance with this specification.
- c. Machined and polished metallic surfaces which are not to be painted shall be coated with a rust preventive compound as specified in this specification.

3.2.32 Damaged Products

The Contractor shall notify the Engineer if any equipment or material is damaged subsequent to receipt at the job site, and prior to acceptance of the installation by the Employer. Repairs of damaged products in lieu of replacement shall not be made without prior approval by the Engineer.

3.2.33 Plant Fixing

All fixings shall be sized to suit the loading and duty of the attached item.

Fixing brick work or block work shall be made in the bricks or blocks and not in the joints. In external and damp situations equipment shall be secured to brick work and block work by round headed stainless steel woodscrews and plastic wall plugs. Other indoor fixings shall be secured with stainless steel anchor bolts. Mounting fixings shall comprise straps or external lugs. Accessories mounted in fixed equipment shall incorporate slotted fixing holes.

All equipment should be fixed with purpose-made clamp brackets, or proprietary fixing bolts. Plugs or shot bolts shall not be used without the written approval of the Employer.

No structural steelwork shall be drilled for any purpose without the written approval of the Employer. In general, all fixings to steelwork shall be by means of studs welded to the steelwork or by clamp-brackets or hook bolts. All the foundation bolts, nuts and washers should be made of stainless steel. The

foundation bolts used for installing stationary equipment on the wall and ceiling should be chemical anchors, and the other foundation bolts used for installing rotational machinery and other stationary equipment on the floor should be hook anchors. Machinery shall be mounted on flat steel packing of thickness selected to take up variations in level of the concrete foundations. One packing only of selected thickness shall be used at each location which shall be adjacent to each holding down bolt. The number of shims used with each packing shall not exceed two at each location and the thickness of each shim shall not exceed 3 mm.

Grouting holding down bolts shall be carried out before the Plant has been run and checked by the Employer for stability and lack of vibration. Final grouting of shims etc. shall be carried out only after the aforementioned run and check by the Employer has been completed, approval given, and the grouting area cleaned.

3.2.34 Labeling

All labelling shall be in English, Indonesian language. Each main and auxiliary item of a Plant shall have permanently attached to it in a conspicuous position a rating plate of weather-resistant material. The Manufacturer's name, type and serial number of Plant, details of the loading and duty at which the item of Plant has been designed to operate shall be engraved on each plate. Where the Plant may have its rating plate in an inconvenient position (e.g. submersible pumps) then the Contractor shall supply an additional plate summarizing the particulars, which shall be fixed in a suitable location on the operating platform.

The labels shall be of non-corrode metal embossed with the lettering or trifoliate engraved type with black letters on white background and shall be fixed with brass or stainless-steel screws. The labels should be conspicuous and consistently located relative to the equipment to which they apply so that they can be read from the normal operating positions.

The label character sizes shall be selected with regard to the maximum distance at which the label must be read and the ambient lighting conditions.

All safety signs shall comply with ISO 3864 or equivalent.

Plant which may start automatically shall carry labels (minimum size 200mm x 100mm) incorporating a hazard warning symbol and the following wording and the English or Bengali language translation in black letters with yellow background:

“WARNING - THIS PUMP IS REMOTELY/AUTOMATICALLY CONTROL AND MAY START AT ANY TIME”

3.2.35 Protection & Packaging

(1) Cleaning and Protection at Place of Manufacture

Parts shall be cleaned prior to testing at the Manufacturer’s Works. Parts subject to hydraulic test shall be tested before any surface treatment. After testing all surfaces shall be thoroughly cleaned and dried out prior to surface treatment.

Bright parts and bearing surfaces shall be thoroughly polished and protected from corrosion by the application of rust preventative lacquer or high melting point grease before the parts are packed. A sufficient quantity of the correct solvent for removal of the protective compounds shall be supplied and packed with each particular part.

(2) Protection. Packing and Transportation

Before any Plant is dispatched from a manufacturer’s works it shall be properly prepared and packed and the Contractor shall give the Employer at least 14 days’ notice that these preparations are to commence.

Prior to dispatch from the Contractor or Manufacturer’s premises all Plant shall be adequately protected by painting or by other approved means for the whole period of transit storage and erection, against corrosion and incidental damage.

The flanges of the pipes, valves and fittings shall be protected by wooden discs attached by means of service bolts (which shall not be used at Site) or by other approved means. The sleeves and flanges of flexible couplings shall be securely tied. Cases containing rubber rings, bolts and other small items shall not normally weigh more than 50kg gross.

All items of the Plant shall be clearly marked for identification against the packing list.

Every crate or package shall contain a packing list in a waterproof envelope. A duplicate copy of the packing lists shall be sent to the Employer.

All crates, packages etc., shall be clearly marked with a waterproof material to show the weight and where the slings should be attached and shall also have an indelible identification mark relating them to the packing lists.

The Contractor shall be responsible for making all the arrangements necessary for the transportation of equipment and plants to site including investigation of the route for bridge clearances, loading etc.

(3) Spare Parts

All spare parts supplied shall be treated and packed for long storage in an unheated and uncooled store in a humid atmosphere. Each spare part shall be clearly marked or labelled on the outside of its packing with its description and purpose and when more than one spare part is packed in a single case a general description of its contents shall be shown on the outside and a detailed list enclosed.

3.3 Equipment components

a. Shafts, Couplings & Gearboxes

The allowable maximum rotation speed is 1450 rpm. In the case of optimum selection requiring 3000 rpm drive, an alternative selection running at 1450 rpm (if possible) shall also be priced using duplicates of the schedules and questionnaires.

The drive coupling shall be rated to transmit the maximum rated motor power output. All transmissions and couplings shall be erected true to line. The coupling shall correct minor angular and positional misalignment without allowing resultant “strain energy” stressing of either driver or driven shaft. The coupling shall be key located on each shaft, and easily removable.

Shafts shall be of high tensile steel or stainless steel. To reduce stress concentrations, in this Specification changes on the shaft shall be properly radiused at the root of any step and keyways shall be internally radiused or gradually run out. The shaft shall have the first critical speed well above maximum operating speeds. Where separate items of interconnected plant such as motors, couplings, gearboxes and similar items depend upon correct alignment for satisfactory operation then each and every item shall be positively located in its correct operational position by means of dowels, locating pins, fitted bolts or other approved means to ensure that correct realignment can be easily achieved when reassembling the items after removal for overhaul.

Where fitted bolts, spigots or other means for precise location are not employed in the assembly of the plant, locating dowels shall be fitted on completion of erection and alignment. Fitted bolts shall be identified by means of stainless-steel tags installed under the bolt head.

Standard-enclosed gear boxes for machines shall be obtained from an approved manufacturer. Couplings shall be of the flexible multi-pin and bush type. Bosses shall be a tight fit on the shafts and secured with hand fitted stainless steel keys.

Belt and chain drives shall be provided with separate independent means for adjustment of tension and alignment.

All gear boxes shall be suitable for outdoor installation and shall be derated to take account of continuous operation and heavy shock loads. Service factor shall not be less than 2 for a 40°C ambient temperature.

Gear box housings shall be of rigid high-strength close grained cast iron and shall be complete with ventilation opening and oil level gauge.

The transmission of power shall be achieved by means of precision helical gears and the gearbox designed for a guaranteed life span of at least 100,000 hours.

The gear box shafts shall be solid forgings of parallel type, precision ground and made from heat treated hardened and tempered chrome-molybdenum alloy steel.

b. Vibration

Mechanical vibration levels at duty point conditions shall be in accordance with the requirements of ISO 2372 for range of vibration severity.

c. Guarding of Shafts

Mechanical vibration levels at duty point conditions shall be in accordance with the requirements

All rotating shafts, couplings, gears, flywheels, bolts, drives etc. shall be fully guarded. Guards should be designed to provide ready access to bearings, greasing points and other check points to allow routine observations to be made by the operating staff without danger or the need to dismantle any part of the guard. Hinged doors let into the guards with adequate fastening shall be provided where necessary to facilitate access to the check points.

d. Bearings

Bearings must be capable of taking all radial and axial loads resulting in normal and extreme conditions. Class of fit, bearing clearance classification shall be indicated in the technical schedules.

e. Materials

All materials utilized in the Plant shall be the most suitable for the duty concerned and shall be new and of first-class commercial quality.

Particular attention shall be paid to material selection to minimize corrosion due to atmospheric conditions, contact with or submersion in corrosive liquids,

electrolytic action of dissimilar metals, or any other causes which may reasonably be associated with the overall performance of the Works.

The use of organic materials shall be avoided whenever possible but where they have to be used, they shall be treated to make them fire resistant and non-flame propagating.

The use of wood is to be avoided wherever possible but where this has to be used, all woodwork shall be treated to protect it against damage by fire, moisture, fungus, bacteria or chemical effect, unless it is naturally resistant to these causes of deterioration.

f. Castings

All castings shall be of standard grey close grained cast iron and be sound and free from defects, non-metallic inclusions or blowholes. All non-machine surfaces shall be carefully fettled, and all foundry irregularities removed.

Details of any remedial action it is proposed to utilize for the repair of castings must be submitted to the Employer in writing for approval.

g. Forgings

All major stress-bearing forging shall be made to a standard specification, and be subject to internal examination, non-destructive tests for the detection of flaws and heat treated fix the relief of residual stresses. Color Coding for Water Supply

Pipes, valves, pumps, tanks etc. shall be color coded in accordance with the requirement of Engineer. The coding shall indicate the contents of the pipelines, purposes of the valves etc., and show whether or not the fluids being handled are dangerous.

Tape banding of pipes, of the appropriate color, shall be spaced at 3 m intervals and at every valve or junction, direction of flow arrows shall be provided together with process stream contents.

Lagged pipework shall be color coded prior to lagging. Lagging surface shall be continuously color coded.

Stainless steel shall not have any paint system applied to its surface, but imperfections and heat affected zones shall receive a suitable treatment to give a high-quality uniform surface appearance.

3.4 Motors

(1) Materials, Workmanship and Test

Materials, Workmanship and test shall be in conformity with current standards and specifications dust tight and hose proof construction to IP 54 to IEC 529, The temperature condition is 55 degrees.

(2) Low Voltage Motor

Low tension motors shall comply with the following specifications for motors from 0.1kW and through 150kW except where specified otherwise:

- ① Type: The motor shall be of squirrel cage, induction, direct starting or reduced voltage starting type.
- ② Power source: The motor shall be rated for 400V 3Phase, 50Hz operation.
- ③ Insulation: The motor shall be provided with class E of the said standards or equip insulation.
- ④ Enclosing and protective: The motor shall be given drip-proof for indoor service and totally enclosed fan cooled for outdoor serviced fan-cooled for outdoor service unless otherwise specified.

(3) High Voltage Motor

High tension motors shall comply with the following specifications for motors from 160kW and bigger except where specified otherwise:

- ① Type: The Motor shall be squirrel cage, induction, reduced voltage starting type.
- ② Power source: The motor shall be rated for 3.3kV / 6.6kV 3phase, 50 Hz operation.
- ③ Insulation: The motor shall be provided with class B of the said standards or equal insulation.
- ④ Enclosing and Protective: The motor shall be given drip-proof unless otherwise specified.

(4) Single-Phase Motor

The single-phase motor shall comply with the following specifications except where specified otherwise:

- ① Type: The motor shall be of split-phase induction type or capacitor-start induction type.
- ② Power source: The motor shall be rated for 230V,50Hz operation.
- ③ Insulation: The motor shall be provided with the class E or equal insulation.

- ④ Enclosing and Protective: The motor shall be given drip-proof for indoor service and totally enclosed fan-cooled for outdoor service unless otherwise specified.

3.5 Inspection and Test

(1) General

All complete mechanical equipment shall be subject to testing and inspection before dispatch from their place of manufacture, with all tests arranged to represent the working conditions as closely as possible. No equipment item shall be delivered to the site without the Factory Acceptance Test having been carried out or waived in writing by the Employer.

The Contractor shall submit a program of tests. Before every unit inspection and test, the Contractor shall submit the ITP (Inspection and Test Plan).

The Contractor shall supply all equipment necessary to test the Contract Works. Equipment required for site testing shall include proprietary diagnostics, equipment and simulators. A list of test equipment shall be supplied by the Contractor prior to commencement of testing.

The minimum required inspections and tests shall include the following

- a. Factory Acceptance Test (FAT)
- b. On-site delivery inspection
- c. Site-installation Inspection and Tests
- d. Start-up Tests
- e. Commissioning

When every unit inspection and test is finished with the satisfaction of the Employer, the Contractor shall prepare the ITR (Inspection and Test Report) with the signature of Engineer of Employer.

(2) Factory Acceptance Test

- a. The Engineer or his representative may inspect fabricated equipment at the factory. Factory inspection shall be made only after the manufacturer has performed satisfactory checks, adjustments, tests and operations.
- b. The Contractor shall notify the Engineer in official writing with ITP (Inspection and Test Plan) at least 30 days beforehand of the date and place at which any equipment shall be available for tests to be made

according to the provisions of the Contract. The Engineer shall notify the Contractor of his intentions to attend the test 15 days beforehand.

- c. The Contractor shall provide for tests to be made in the premises of the Contractor or any Sub-Contractors or suppliers (Country of origin of the factory).
- d. The Contractor shall afford any assistance, labor materials, electricity, fuel supplies, equipment and instrument required, and which can be reasonably requested for these tests.
- e. The Contractor shall carry out the Factory Acceptance Test for all equipment before delivery. The equipment shall be delivered from the factory only after approval of the test certificates by the Employer.
- f. The Contractor shall make necessary arrangements so that the tests and inspections can be performed promptly and smoothly at the cost of the Contractor. All costs for the factory tests including expenses for the Engineer shall be borne by the Contractor and shall be included in the Bid Price.
- g. The Contractor shall send the Engineer duly certified copies of ITR (Inspection and Test Report). The Engineer will indicate on return of the approved submittal each item requiring factory acceptance test.
- h. Each major component of equipment shall be subjected to a complete factory acceptance test as specified herein, witnessed by the Employer and Consultants if so desired. All costs for the factory acceptance tests shall be borne by the Contractor.
- i. The factory acceptance test was attended by minimum 10 (ten) people from the board of directors, consultants, and contractors.

(3) On-site delivery inspection

Equipment and Materials brought to the site shall be stored in the weatherproof warehouse and inspected for the quantity and damages. Equipment and materials which are not stored in the weatherproof warehouse may not be allowed for the on-site delivery inspection.

(4) Site Installation Tests

During erection of the plant the Employer will inspect the installation from time to time in the presence of the Contractor's Representative to establish conformity with the requirements of the specification.

During installation, tests and inspections shall be carried out to ensure that pipework systems are installed such that the pump flanges, pressure vessels, pipe flanges etc. are relieved of all external loadings from the pipework. If requested by the Employer, this shall be demonstrated by testing with dial test indicators during connection of pipework flanges.

A visual inspection shall be carried out by the Employer or his Representative and the Contractor to ensure compliance with the Specification and in particular the following:

- a. All plants comply with engineering standards.
- b. Workmanship is acceptable.
- c. Labeling is correct.

Any plant which is not in compliance shall be identified by the Contractor and he shall carry out the remedial action, prior to a re-inspection taking place.

(5) Start Up Test

On completion of erection and before any disinfection, internal surfaces of vessels, pipework, tanks and sumps etc. shall be cleaned thoroughly in such a way as to remove all oil, grit and other deleterious matter.

When supply to the control panels has been energized testing shall continue in the following manner.

- a. Each item of plant shall be tested to ensure correct rotation.
- b. Each Manual and Actuated valve shall be tested under normal system conditions to ensure correct operation. This shall include the setting of torque and limit switches where appropriate.
- c. Each instrumentation loop shall be tested to ensure correct operation.
- d. Each item of plant shall be functionally tested to ensure “Manual Control”, “Remote Control” and “Automatic Control” functions.

All the above tests shall be completed to the satisfaction of the Employer or his Representative prior to any Tests on Completion taking place.

(6) Commissioning

Equipment and facilities shall be tested in accordance with the commissioning plan.

4 Booster Pumps

4.1 Scope of Work

This part specifies the particular requirement for Contractors to design, manufacture, construct, install, test and commissioning the horizontal or vertical double suction volute pumps for booster pumps complete with motors and VSD (Variable Speed Driver) and appurtenances as shown on the drawings and as specified herein.

4.2 Design requirements

(1) Main booster pumps (for phase 1)

1) Pump

Type	: Double Suction Volute Pump (Horizontal type)
Quantity	: 4 units
Rated capacity	: 2.0 m ³ /s (172,800 m ³ /day)
Rated head	: 90m
Speed	: Approx. 745rpm or 995rpm
Guarantee Efficiency	: Not less than 87 percent at duty point
Flange Class	: PN16 for Suction, PN16 for Discharge (ISO 7005/2/3, AWWA C 207)

2) Motor

Type	: 3-phase horizontal wound-rotor induction motor
Quantity	: 4 units
Motor output	: 2,350 Kw (reference) x 3 Phase x 6,600 V x 50 Hz
Pole	: 6P or 8PS
Driving method	: VSD
Enclosure	: CACA
Motor encl. protect	: IP 55
Insulation class	: F class
Motor efficiency	: Higher than 90%
Power factor	: Higher than 80%
Slip	: Less than 3%
Terminal Box	: for frequency converter use (VSD connection)

Installation : Indoor

(3) VSD (Variable Speed Driver)

Rated electricity : 6.6kV / 50Hz

Required frequency range : 25 – 60Hz

Aux. power supply : 230V / 1PH / 50Hz

Cooling : Air fan (400V / 3PH / 50Hz)

Monitoring and Control software is inside.

(2) Flow control pump (for phase 1)

1) Pump

Type : Double Suction Volute Pump
(Horizontal type)

Quantity : 2 units

Rated capacity : 1.0 m³/s (86,400 m³/day)

Rated head : 90m

Speed : Approx. 745rpm or 995rpm

Guarantee Efficiency : Not less than 85 percent at duty point

Flange Class : PN16 for Suction, PN16 for Discharge (ISO 7005/2/3, AWWA C 207)

B. Motor

Type : 3-phase horizontal wound-rotor induction motor

Quantity : 2 units

Motor output : 1,250 kW (reference) x 3 Phase x 6,600 V x 50 Hz

Pole : 6P (reference)

Driving method : VSD

Enclosure : CACA

Motor encl. protect : IP 55

Insulation class	: F class
Motor efficiency	: Higher than 90%
Power factor	: Higher than 80%
Slip	: Less than 3%
Terminal Box	: for frequency converter use (VSD connection)
Installation	: Indoor

C. VSD (Variable Speed Driver)

Rated electricity	: 6.6kV / 50Hz
Required frequency range	: 25 – 60Hz
Aux. power supply	: 230V / 1PH / 50Hz
Cooling	: Air fan (400V / 3PH / 50Hz)

Monitoring and Control software is inside.

4.3 Quality assurance

The equipment to be furnished shall be new and shall be the standard product of a manufacturer experienced in the design, fabrication and construction of pumping equipment. The pumps shall be the product of an experienced manufacturer and:

- 1) must demonstrate equal or larger capacity installations using similar equipment and equipment installed and successfully operating for at least 5 years;
- 2) provide names and phone numbers of contacts at referenced installations to verify performance;
- 3) demonstrate to satisfaction of Engineer that equipment to be provided is equal to that specified;
- 4) the pump manufacturer's machining and assembly shops must be ISO 9001 certified in order to assure conformance to the highest quality standards.

4.4 General

Requirements not specified below follow the international reference standards and

may be modified as necessary with the manufacturer's standard according to the requirements of each section.

1. Pumps and electric motors must be suitable for intermittent and continuous operation and must be able to operate in the full range of specifications without surging, cavitation, or vibration.
2. Rotating parts must be statically and dynamically balanced to prevent vibration, and the load and load distribution must be free of resonance under normal operating conditions.
3. The performance curve of the pump must be a gentle efficiency curve at the highest efficiency point, and the efficiency at the specification point (value measured in factory inspection) must be higher than the guaranteed efficiency.
4. Pump parts must be compatible with existing pumps of the same standard and must have sufficient strength and rigidity.
5. The pump must be easy to disassemble and repair.
6. Even if the pump reverses 120% of the rated rotation speed for 5 minutes, no abnormality should occur in the pump, motor, power supply, or control panel.
7. The required NPSH shall be less than the available NPSH under any operating conditions.
8. Except as otherwise specified, the pump and motor must be directly connected through a flexible coupling, and protective devices must be installed on rotating parts such as shafts and couplings, taking safety measures into account.

4.5 Pump Structure and Fabrication

1. General

- Performance curve: All centrifugal pumps must have a continuous performance curve. In any case, the required horsepower at any point on the performance curve must not exceed the rated horsepower of the motor or engine or encroach on the service factor.
- Material: The material of all pumps must be suitable for the intended use. If the material is not specified separately, it must be a high-grade standard material without any defects or imperfections that may affect the usability of the product for its intended use.

- Casting, fabrications, machined parts and drives shall conform to the industry standards for strength and durability and shall be rated for continuous duty over the entire operating range. Service factors, where applicable, shall be assumed to be 1.0.

2. Casing

- The upper and lower pump casings can be horizontally divided parallel to the axis, and the joint surfaces must be precisely machined and assembled with dowel pins.
- The upper casing shall be equipped with eye bolts or lifting hooks, and there shall be piping connectors for shaft seal water and exhaust. The lower casing shall have a drain and an Ito valve.
- Unless otherwise specified, the wear ring is made of STS cast steel (SSC14) and is fixed to the casing and the rotary wheel, respectively. The gap between both ends is small due to pressure difference and is replaceable in the labyrinth type or L type, which can be used to rotate the rotary wheel. It must be firmly fixed with a set key or appropriate structure to prevent movement regardless of direction.

3. Impeller

- The impeller shall be tightly mounted on the pump shaft with a key so that it will not become loose.
- The impeller shall be of the enclosed double suction type, of one-piece construction made of stainless-steel casting finished smooth and statically balanced.
- The Contractor shall submit the balancing test report during the factory acceptance test to prove the stable dynamic balancing of impeller.

4. Pump shaft and sleeve

- The shaft shall be of ample size and rigidity to ensure low working stress under all conditions of operation.
- The sleeve shall extend from the rotary wheel to the stuffing box, be firmly fixed to the shaft with a key, etc. to prevent slipping between the shaft and the sleeve and must be replaceable.
- The sleeve shall be firmly installed at the center of the rotary car and a reliable sealing device must be installed to prevent air intake or water

leakage between the sleeve and the rotary car during operation.

5. Bearings

- The pump bearing housing shall be split or cast as one piece and bolted to the lower casing.
- The bearing shall be an anti-friction ball bearing, and a suitable lubrication system shall be provided. For horizontal pumps there shall be a deflector fastened to the shaft at the inner end of each bearing housing. For vertical pumps a water deflector shall be provided at the inner end of the upper bearing housing and a gland drain pan shall be provided at the inner end of the lower bearing assembly.
- It is a ball or cylindrical roller bearing for medium load and must be able to be used for a long time without external cooling.
- It shall withstand axial and radial loads that may occur when starting, stopping, or operating the pump.
- The contractor shall submit a bearing life calculation and specify the replacement period.

6. Coupling

Power transmission between pumps and electric motors shall be done in a manner that has high power transmission efficiency and can withstand load impacts.

7. Mechanical seal

The mechanical seal shall be installed where the main shaft passes through the casing. The construction shall allow easy adjustment and replacement of mechanical.

8. Bolts and Nuts

All bolts and cap screws shall be of high strength zinc plated and chromated steel. All anchor bolts, nuts, and washers shall be stainless steel.

4.6 Motor

1. General

- a. The continuous rated output of each motor shall be at least 15% in excess of the maximum power required by the driven unit under all specified operating conditions.

- b. The initial starting current of the motor must not exceed 600%. Switching/closing surge protection measures by circuit breaker closing and blocking operations shall be prepared. (when necessary).
- c. Motors connected to a variable speed drive (VSD) should be manufactured for frequency converter use.
- d. Lifting lugs capable of supporting the motor weight must be provided on all motors.

2. Bearings and Lubrication

- a. The bearings must be of modern design, of rolling or plain (anti-friction) type and ample capacity for carrying all thrust and radial loads. All bearings must be readily available in metric sizes, lubricated efficiently and capable of long service without maintenance.
- b. All bearing housings shall be fitted with seals and shall be grease or oil lubricated. Grease nipples with captive screw caps shall be provided for all grease lubricated bearings and where practicable, capillary tubing shall be run from the bearings and grouped at a convenient accessible location. Where grease lines are fitted, they shall not be attached to removable parts. It shall be possible to grease the bearings with the machine running without danger to the operator or damage to the seals. Bearing housing shall be fitted with pressure relief devices to prevent over pressure.

3. vibration

- a. Vibration levels of industrial machines shall be evaluated in accordance with the international code. As a minimum, under steady state operating conditions at any speed within the machine operating range the vibration level shall not exceed the zone boundary vibration rms velocity.
- b. If peak rather than rms value of vibrations is measured, equivalent max. vibration levels shall be determined by the manufacturer in accordance with international code.

4. Anti-condensation heaters

Anti-condensation heaters must be included in all HV motors. The auxiliary supply voltage for anti-condensation heaters must be 240 V AC $\pm$ 10%.

5. Thermal protection

All HV motors will incorporate thermal protection. Two RTDs shall be embedded into each winding. Two additional RTDs shall monitor the drive end (DE) and the Non-Drive End (NDE) bearing. RTDs shall be wired to individual DIN rail-mounted protection relays with a digital display showing instantaneous temperature. These relays should be wired to provide a common alarm output for motor over temperature.

6. Motor cooling

- a. All motors must be totally enclosed fan cooled CACA (Closed Air Circuit Air-cooled) unless otherwise stated.
- b. A winding temperature sensor shall be installed on the opposite side of the motor bus terminal box for each phase, and it shall be able to be blocked by a temperature relay when the abnormal temperature rises. (when necessary)
- c. A drain and stopper shall be provided at the lowest point of all shields to discharge condensed water. (when necessary)

7. Identification and labelling

- a. All electrical equipment forming part of the HV Motor must be readily identified in the English language by a label in accordance with the relevant standard and this Specification.
- b. The electric motor should be equipped with a stainless-steel nameplate listing all ratings and bearing specifications.

8. Terminal box and cable termination

- a. The terminal box shall be equipped with standard wires and a tab device for opening.
- b. The motor terminals shall be designed for HV cable termination using either bolted air insulated connections or plug and socket connections. The high voltage cable terminations, including all necessary accessories, must withstand the voltage impulse test applied to the motor.
- c. The high voltage cable terminations shall be designed to ensure thermal, mechanical, electrical and dielectric compatibility with the motor. Cable entries for single core cables must be designed to minimize the possibility of eddy current heating.

- d. Motor terminal boxes must have the capability of rotating to suit installation requirements.

9. Earthing & earth connections

The frame of the motor shall be provided with reliable earth connections to a common connection point. An earthing stud shall be fitted to the frame of each motor additionally to a stud in the motor control box.

4.7 VSD (Variable Speed Driver)

(1) Standard

- International Electrotechnical Commission (IEC) 61800-5 AC Drives Standard
- European Directives for Safety and EMC
- Guide for Harmonic Control and Reactive Compensation of Static Power Converters (IEEE 519-1992)

(2) General

A. Power supply

- Input Voltage

The Drive shall accept nominal input voltage up to 6.6kV 50Hz. The *supply input voltage tolerance shall be +/- 10% of the nominal line voltage.*

- Output Voltage

Whatever the power supply voltage in the plant, the driver will be able to supply 6.6kV asynchronous induction motor (directly without transformer). Further the drive shall be capable of running permanent magnet motors and synchronous motors with the corresponding exciter control.

- Auxiliary Voltage

VSD shall support various control voltage supply from 110VAC to 240VAC (+/- 10%) or 120VDC to 370VDC.

Auxiliaries (e.g. light, space heaters, etc.) will be supplied with single phase 230V. 400V 3phase is available on site for external supply of auxiliaries like VSD cooling fan.

B. Environmental Conditions

- Operation

The VSD shall operate indoor, in an ambient temperature range of 0°C to 40°C (32°F to 104°F) without de-rating, with a relative humidity of 90% (non-condensing). Up to 95% (non-condensing) as an option.

For environmental conditions up to 50°C, the drive shall be used with de-rating according manufacturers specification. The environment shall be an industrial, non-hazardous, safe area.

- Environmental Standards for Operation

Supplier shall design VSD to fulfil classification of environmental conditions according to IEC60721-3-3 as following:

Climatic conditions: 3K3

Mechanical conditions: 3M1

Biological conditions: 3B1

Mechanically active substances 3S1

Chemical conditions: 3C2

Pollution Degree according to EN 61800-5-1: 2

- Storage

The equipment shall be capable of being stored in an environment with an ambient temperature range of 0°C to 50°C.

- Transport

The equipment shall be capable of being shipped under an environment with an ambient temperature range of -25°C to 70°C.

- Installation Altitude

The equipment shall operate at altitudes from 0 to 1000 m (3,300 ft.) above sea level, without de-rating. For applications above 1000 m, VSD shall be de-rated according to the manufacturer's specification.

Unless otherwise stated, the VSD will include a multi winding, dry type minimum 18 pulses isolating transformers as an integral part.

1. Low voltage VSD with step-down step-up transformer will not be accepted.
2. The VSD shall be of modular design to provide ease and speed of maintenance. Metal or plastic barriers shall be provided between each

vertical section and between the low voltage compartment and the power cell. Personnel shall have access to the low voltage compartment, with the VSD energized, without being exposed to any medium voltage live parts.

3. The VSD shall produce a variable voltage and variable frequency output to provide continuous operation over the speed range. The VSD shall be capable of operating with the output short circuited at full current or with the output open circuited at rated voltage.
4. The VSD system shall provide controlled speed over the specified range. Speed accuracy within this range, expressed as a percentage of top speed, shall be within 0.5% without encoder or pulse tachometer feedback.
5. The VSD shall have a “normal duty” rating of 100% continuous current with a short-time duty rating of 150% overload for one minute.
6. The supply voltage harmonics produced by VSD shall not exceed the requirements stated in IEEE 519.
7. The VSD shall have the self-protection function from the overload, over speed, over voltage, over current, and etc

(3) Motor Compatibility

1. The VSD shall provide near sinusoidal voltage and current waveforms to the motor at all speeds and loads. Output current THD shall be according to IEEE519.
2. Standard induction motors shall not require de-rating or upgraded turn-to-turn insulation and shall not require additional service factor.
3. The VSD shall provide stable operation of the motor, without compromising the motor insulation system. The motor power cable shall be armored three-core.
4. Motor cable length will be stated in the data sheet. Vendor shall clearly state the limitations in motor cable distance with the proposal. If an output filter is required to mitigate reflected waves, or to meet any special requirements of the application, it must be integral to the VSD controller.
5. When output filters are used in the VSD, they must eliminate a potential harmonic resonance within the operating speed range.

6. VSD induced torque pulsations to the output shaft of the mechanical system shall be less than 1% to minimize the possibility of exciting a resonance.

(4) Efficiency

1. VSD system efficiency shall be a minimum of 96% at 100% speed & 100% load.
2. System efficiency shall include VSD, input transformer, line reactor, harmonic filter (if applicable) power factor correction unit (if applicable), and output filter (if applicable), control power supplies, control circuits, cooling fans or pumps, shall be included in all loss calculations.

(5) Audible Noise Level

1. Maximum audible noise from the VSD and its associated system shall be at a maximum of 80 dB (A) at one meter from the front of the equipment with doors closed.
2. The above limit will prevail at any speed or load condition.

(6) Power Factor

1. The VSD shall be capable of maintaining a minimum true power factor (displacement PF x Distortion PF) of 0.95 at load range of 30-100%.

(7) Operator Interface and Communication

1. The VSD shall be provided with an integral Monitoring and indications display panel. All measurements, faults, events and status indicators shall be shown on this panel.
2. The manufacturer will offer his standard metering, indicators and alarms. The panel of the VSD shall indicate the alarms accompanied by audible notifications:
3. The VSD will be supplied with a communication modem for remote control and monitoring, and local connection to SCADA. Communication protocols shall not be propriety one, but Modbus TCP or/and Modbus RTU.

(8) Control and Operations

The panel of the unit shall be the manufacturer's standard and will

include, at least, the functions of Alarm/Fault Reset, Emergency Power off, Local Start/stop, Settings of parameters and Raise/Lower speed

(9) Inputs and Outputs

1. The VSD will be controlled either by communication link, input digital and analogue signals, or locally from the control panel, which will include an emergency stop push button, local/remote selector switch, direction of rotation, and speed reference.
2. The programmable isolated digital inputs and outputs shall be available as standard on the VSD, rated from 12V to 220V AC and 110V DC.

(10) Cooling System

1. The VSD system should be air cooled. The VSD shall be provided with a cooling fan, mounted integral to the VSD enclosure.
2. The VSD should include air flow pressure switches and temperature detectors to monitor proper operation of the air-cooling system. If a fan fails, the system must generate an alarm indication of the fan failure.

(11) Enclosure and Cabling

- 1) VSD enclosures shall be IP21. Door vents shall consist of louver-panel assemblies that can be removed from the front to replace air filters. Safety screens should be located behind each louver panel. Cabinets and doors shall be fabricated using a minimum of 2mm stainless steel for sturdy construction. All doors shall be gasketed to provide environmental protection and a secure fit.
- 2) Door latches shall be heavy-duty units which are operated with a standard key. The converter cabinet door and cabling cabinet door shall be interlocked with up-stream isolators or breakers with a key lock. Interlocking shall be fully coordinated to prevent access to all medium voltage compartments.
- 3) The VSD should be designed for front access only to allow for installation with no rear access.
- 4) The VSD shall contain a power cable termination cabinet designed for easy termination and access to line and load cables. The termination

assembly cabinet shall allow for bottom entry and exit of line and load cables.

- 5) All power and control terminations and termination strips shall be identified in accordance with all schematics and wiring diagrams.

4.8 Materials

- 1) Casing: gray iron casting (ASTM A 48 Grade 35) or equivalent or higher
- 2) Impeller: Stainless Steel Casting (ASTM A 351) or equivalent or higher
- 3) Shaft: stainless steel (ASTM A 582) or equivalent or higher

4.9 Accessories, Tools and Spare Parts

Accessories, spare parts and maintenance tool list shall be furnished with, but not limited to, the equipment as follows for each pump:

- (1) Accessories for each pump.

Couplings with guards	1 set
Bed plate	1 set
Compound gauge for suction valve and piping)	1 complete set (incl.
Pressure gauge for discharge valve and piping)	1 complete set (incl.
Bolt, nut and gasket for flange joint (stainless steel)	1 set
Counter flange (Stainless steel)	1 set
Foundation bolts and nuts (stainless steel)	1 set
Air vent with piping	1 set
Thermometer of pump bearing (incl. transmitters)	1 set for all bearing
Thermometer of motor bearing (incl. transmitters)	1 set for all bearing
Temperature sensor of motor winding phase (incl. transmitters)	each 1 set per R.S.T
Space heater for motor	1 set

(2) Spare parts for each pump

All spare parts shall be properly preserved and packed for a long period of storage in a hot humid climate and shall be properly marked in the English language on the outside to permit easy identification of the contents without opening and exposing the contents.

Other items not mentioned below shall be provided as recommended by the Manufacturer as spares for 2 years operation.

Pump bearings	1 complete set
Motor bearings	1 complete set
Compound gauge	1 complete set
Pressure gauges	1 complete set
Wearing rings	2 sets
Gaskets	2 sets
Mechanical seal	1 set
Shaft sleeves	1 set
Bolts, screws and nuts	2 sets
Impeller	1 set for all main pump and 1 set for all flow control pump
Pump shaft	1 set for all main pump and 1 set for all flow control pump

(3) Maintenance tool

Maintenance tools required for normal operation and maintenance shall be furnished with the equipment.

4.10 Installation

In particular, the alignment of the pump shaft shall be carefully inspected to ensure that it operates smoothly and that there is no vibration, shaft protrusion, or other defects.

4.11 Inspection and test

The procedure of inspection in pump test are as follows:

(1) Factory acceptance tests

1. Each assembled pump shall be shop tested by the manufacturer to determine the following characteristics for the minimum and maximum speed and two intermediate speeds at which the pumps will be operated. All tests shall be performed in accordance with the latest Hydraulic Institute Standards or Korea standard.
 - a. head-capacity curve,
 - b. power curve,
 - c. efficiency curve
 - d. NPSH curve
2. Pump performance test grade will be 1U or 1E on ISO 9906:2012
3. Each motor shall be tested at the factory by the manufacturer in accordance with the applicable requirements and/or specifications of IEC.
4. The VSD tests shall be carried out in accordance with applicable requirements and/or specifications of IEC.
 - a. Functional checks, inspection and continuity checks shall be made.
 - b. The hi-pot dielectric withstand test shall be performed on all bus work and cables from phase-to-phase and phase-to-ground (except solid-state components, low voltage controls and instrument transformers). The voltage level used for this test depends on the product's nominal AC voltage.
 - c. Components and devices shall be functionally operated in circuits as shown on electrical diagrams or as called for by specific test instructions.
 - d. All inputs and outputs simulated and tested.
 - e. Communication test.
 - f. Instruments, meters, protective devices and associated controls shall be functionally tested by applying the specified control signals, current and/or voltages.
 - g. Load Tests

(2) Start-Up Test

- a. In order to physically prove that excessive noise, vibration, cavitation, or

overheating of bearings operate satisfactorily, start-up tests at site shall be carried out after installation is completed, and analysis measures shall be taken if the results differ from the result of factory acceptance test.

- b. Each power lead to the motor shall be checked for proper current balance.
- c. Bearing temperatures shall be determined by a contact type thermometer. Alternatively, lubricant temperature may be measured. A running time or at least twenty minutes shall be maintained for this test.
- d. The pump shall be visually and manually checked for excessive vibration. If the pump vibration is excessive, it shall be checked and recorded. The vibration amplitude measured at any point on the pump and motor when operating at full speed and minimum speed shall not exceed the H.I Standards.
- e. The maximum noise measured by the method of KS B 6360 must be less than 85 dB at a distance of 1m horizontally and 1.5m vertically from the pump installation location.
- f. If pumps fail to meet specified requirements, adjustments shall be made and the test re-run until performance meets the requirements. Test results shall be recorded for each pump for each test and full reports shall be submitted to the Engineer. The costs of re-testing and reporting shall be borne by the Contractor.

5 Submersible Pumps

5.1 Scope of Work

This part specifies the particular requirement for Contractors to design, manufacture, construct, install, test and commissioning of submersible sump pump to be installed at the bottom of the booster pump room and valve chambers of pipelines to drain water accumulated in the sump. Submersible sump pumps shall be complete with drives, motors, and appurtenances and as specified herein.

5.2 Design requirements

Type	: Submersible Pump
Discharge capacity	: 0.2 m3/minutes
Total head	: 10 m
Reference speed	: Approx. 2900 rpm
Motor output (reference)	: 0.7 kW x 1 Phase x 220 V x 50 Hz
Flange Class	: PN10
Motor encl. protect	: IP 68
Installation	: Indoor/Outdoor

5.3 Quality assurance

The equipment to be furnished shall be new and shall be the standard product of a manufacturer experienced in the design, fabrication and construction of pumping equipment. The manufacturer shall demonstrate to the Engineer from operating installations of equal or larger capacity utilizing equipment such as herein, that all the mechanical features and appurtenances of the equipment will be operated satisfactorily for the purposes intended. All pumping equipment furnished under this Specification shall be demonstrated to the satisfaction of the Engineer that the quality is sufficient.

5.4 General

Pumps and drives shall be rated for continuous duty and shall be capable of pumping the specified flow range without surging, cavitation, or vibration. The pumps shall not overload the motors for any point on the maximum speed pump performance characteristic curve within the limits of stable pump operation as recommended by the manufacturer to prevent surging, cavitation, and vibration, as well as throughout the entire pump operating range.

The service factors for the motors shall not be applied when sizing the motors. To ensure vibration-free operation, all rotating components of each pumping unit

shall be statically and dynamically balanced. The mass of the unit and its distribution shall be such that resonance at normal operating speeds is avoided.

In any case, the amplitude of vibration as measured at any point on the pumping unit shall not exceed the limits set forth in the latest edition of the Hydraulic Institute or Korea Industrial Standards. Excessive vibration shall be sufficient cause for rejection of the equipment.

All parts of each pump shall be designed to withstand the stresses that will be imposed upon them during their handling, shipping, erection, and operation. The completed units, when assembled and operating, shall be free of cavitation, vibration, noise, and water leaks over the range of operation. All units shall be so constructed that dismantling and repairing can be accomplished without difficulty.

5.5 Materials

- 1) Pump Casing: Polypropylene, or equivalent.
- 2) Impeller: Polybutylene Terephthalate or equivalent
- 3) Shaft: Carbon Steel + Stainless steel 410, or equivalent
- 4) Frame: Stainless Steel 304, or equivalent
- 5) Cable: PVC
- 6) Motor Housing: Stainless Steel (EN 1.4301, AISI 304), or equivalent.

5.6 Pump Fabrication

- 1) Provide submersible, corrosion resistant, industrial quality pump complete with electric motor, discharge piping, mercury switch actuated controls, power cord, control panel, vent flange, cover, and other accessories required for proper installation and operation.
- 2) The impeller shall be semi-open statically, dynamically, and hydraulically balanced, accurately machined and filed for smoothness.
- 3) Shaft:
 - a. Double mechanical seal.
 - b. Tungsten-Carbide carbon ring with stainless steel parts.
 - c. Oil filled chambers to lubricate running faces.
- 4) Motors:
 - d. Hermetically sealed, squirrel cage induction type in oil filled chamber.
 - e. 220V, 1 phase, 50 Hz.

- f. Motor and pump shaft to be integral
- g. Provide waterproof, oil resistant, grounded, flexible power cord.
- h. Non-overloading throughout entire pump curve.
- i. Capable of running dry for extended periods without damage to the motor or seal.
- j. Provide motor of totally submersible design, enclosure IP 68 or equivalent.

5.7 Accessories for unit

- a. Foundation bolts/ nuts (Stainless steel), 1 set
- b. Terminal box and submersible cable up to terminal box 1 set
- c. Auto-setter for pump removal, guide pipe (STS304) and lifting chain (STS304) 1 set
- d. Pressure gauge 1 set
- e. Air vent and other piping 1 set
- f. Monitoring unit: motor leakage sensor, motor temperature sensor and bearing temperature sensor 1 set
- g. Bolt, nut, gasket for flange joint (stainless steel) 1 set
- h. Counter flange (stainless steel) 1 set

5.8 Maintenance Tools and Spare parts

All special tools required for normal service and maintenance shall be provided. In addition, spare parts shall be furnished for each pump as follows, and supply other items as recommended by the Manufacturer as spares for 2 years operation:

- a. One set of complete bearings.
- b. One set of wear rings.
- c. One set of gaskets and O-Rings
- d. Two sets of upper and lower seals

5.9 Installation and Start-up

The Contractor shall arrange to have the manufacturer or supplier of the equipment furnished under this Specification, furnish the services of competent factory-trained personnel to supervise the installation, field testing and initial

operation. Installation and erection of all assemblies and components shall be in accordance with the details indicated on the approved shop drawings and the printed instructions of the manufacturer.

5.10 Testing

The manufacturer's representative shall operate each pump after installation and shall monitor vibration and noise as well as specified performance parameters. All values shall be as specified; or if not specified, as recommended by the manufacturer. Systems should be operated in both hand and automatic modes. Flow pacing signals, if used, shall be operating and systems shall operate as specified.

6 Hoist and Crane

6.1 Scope of Work

This part specifies the particular requirement for Contractors to design, manufacture, construct, install, test and commissioning of crane installed at the top of the booster pump room and others, and shall be used for the installation, assembly, and maintenance of the pump system, as specified herein.

6.2 Design requirements**Hoist Crane Type 1**

Type	: Motorized Overhead Double Girder Crane
Rated load	: 20 ton
Hoist Lifting speed	: Approx. 4.5 m/ min
Crane Traveling speed	: Approx. 16 m/ min
Hoist Traveling speed	: Approx. 16 m/ min
Hoist motor output (: reference)	: 17 kW x 3 Phase x 400 V x 50 Hz
Trolley motor output (: reference)	: 1.5 kW x 3 Phase x 400 V x 50 Hz
Runaway motor output (: reference)	: (2.2 x 2) kW x 3 Phase x 400 V x 50 Hz
Motor encl. protect	: IP 54
Installation	: Indoor
Lifting height	: Approx.10 m
Trolley span	: Approx.23.5 m
Runaway length	: Approx.90 m
Lifting Height	: 10 m
Span	: 13,5 m
Long Travel	: 100 m

Hoist Crane Type 2

Type	: Motorized Overhead Double Girder Crane
Rated load	: 35 ton
Hoist Lifting speed	: Approx. 2.5 m/ min
Crane Traveling speed	: Approx. 12,8 m/ min
Hoist Traveling speed	: Approx. 12,8 m/ min
Hoist motor output (: reference)	: 17 kW x 3 Phase x 400 V x 50 Hz
Trolley motor output (: reference)	: 1.5 kW x 3 Phase x 400 V x 50 Hz
Runaway motor output (: reference)	: (2.2 x 2) kW x 3 Phase x 400 V x 50 Hz
Motor encl. protect	: IP 54
Installation	: Indoor

Lifting height	: Approx.7 m
Trolley span	: Approx.23.5 m
Runaway length	: Approx.90 m
Lifting Height	: 10 m
Span	: 20 m
Long Travel	: 59 m

6.3 Reference Standards

Applicable standards referred to in this lifting equipment:

ASME B30.1-2020: Jacks, Industrial Rollers, Air Casters, And Hydraulic Gantries

ASME B30.2-2022: Overhead and Gantry Cranes (Top Running Bridge, Single or Multiple Girder, Top Running Trolley Hoist)

ASME B30.3-2019: Tower Cranes

ASME B30.4-2020: Portal and Pedestal Cranes

ASME B30.5-2021: Mobile and Locomotive Cranes

6.4 Submittals

The following data shall be furnished by the Contractor:

- 1) Complete structural calculations of crane and monorail member and component sizing and design, shall be submitted, as required by BS 2573, BS 2853.
- 2) Manufacturer drawings shall be submitted as required by submittal. Lay-out drawings should clearly show the lifting height of the equipment and clearances in relation to other equipment and structures where the largest items are lifted.
- 3) The Contractor shall include all the documentation required by submittal on the lifting equipment in the operation and maintenance manuals. A copy of the design data, factory and site tests shall be included in the manuals.

6.5 General

- 1) Hoist monorails, bridge cranes, davits and 'A' frames shall include all equipment, appurtenances and auxiliaries to make the lifting equipment fully operational and capable of performing under the specified load conditions.
- 2) Lifting systems, including hoists, as far as feasible, shall use the standard components of one manufacturer to simplify maintenance.

- 3) Nameplates shall be permanently attached to the monorail hoist and bridge crane hoist assemblies. The lifting capacity shall be stenciled in tones on each side and shall be clearly legible from the working level.
- 4) Warning signs shall be provided to the approval of the Engineer and affixed to the bottom lift blocks or pendant controllers.

6.6 Cranes

- 1) Cranes shall comprise end carriages and bridge units to be bolted together on site, during erection.
- 2) Cranes shall be single girder or double girder as designated.
- 3) All exposed moving parts of the drive mechanisms shall be fitted with safety guards wherever possible.
- 4) The bridge girders, end carriages and crab structures of the crane shall be designed and constructed in accordance with all the relevant requirements of BS 466 and BS 2573. With the crane operating under maximum service load, the stress in any operating component shall not exceed the permissible values stipulated in Part 1 of BS 2573. The crane manufacturer shall supply all the information required in Appendix B of BS 466.
- 5) The main bridge girders shall be plate or box girder designed as compound beams with the rails for the crab track secured on the top flange.
- 6) Jacking points and tie downs shall be provided for both bridge and crab.

6.7 Electrically operated Rope Lifting Hoist

- 1) The hoist rope drum shall be of high-quality cast iron with left- and right-hand spiral grooves to accommodate the hoist rope in one layer. As far as possible, the drive gearing should be fixed directly to the rope drum to obviate high torsional stress in the drum shaft. The rope shall be securely clamped to the drum.
- 2) The hoist drum shall incorporate a wire rope rewind system and guides to prevent the hoist rope skipping and damaging the lay.
- 3) The hoist braking system shall be of the automatic electro-mechanical fail-safe type which, when the current is cut off or fails will automatically arrest the motion and hold at rest any load up to and including the rated load. The system shall safely control the lowering of the same load from the highest to the lowest point of lift and shall not allow any slippage of the suspended load to occur when the 'Raise' motion is initiated.

- 4) The hoist rope shall be a flexible wire rope specially designed for usage with cranes and in accordance with BS 302, with a safety factor of not less than six times the maximum tension induced by the safe working load.
- 5) The crane hook shall be of high-grade forged steel trapezoidal specification in accordance with BS 2903, 'C' type. The hook shall be supported on a ball thrust bearing to allow free swiveling under full loads and shall also be fitted with a safety catch. The safe working load shall be marked in the hook in accordance with BS 2903.
- 6) The sheaves of the hook block shall be guarded to prevent a hand or fingers from being trapped between the sheaves and the in-running rope.
- 7) A limit switch shall be fitted to prevent over hoisting. This shall be self-resetting, closing automatically when the hoist motor is put in reverse.
- 8) Brakes shall be well protected from oil and grease leakage or spillage, and from adverse effects of atmospheric condensation or dust. A simple and easily accessible means of carrying out adjustment for wear of the shoes or linings shall be provided for all brakes.
- 9) Automatic brakes, operating when the drive motor stops, shall be supplied for the long and cross travel motions.

6.8 Mechanical Components

- End Carriage (End truck/ Saddle)
 - 1) Both end carriages of electrically operated cranes shall be powered either by a duplicate geared motor drive, or by a single motor unit and a lay-shaft system. Longitudinal and cross traverse motions shall be provided on the crane such that the operation is speedy without impairing safety in working. The hook and load chain shall be such that the hook will reach to the lowest floor level.
 - 2) The runner wheels shall be of cast steel, with double flanges, mounted on roller bearings, or fitted with phosphor-bronze bushes running on hardened steel axles.
- Crab Unit(s)
 - 1) The crab frame shall be in accordance with BS 466 and shall provide a strong rigid framework for the hoist and cross-travel machinery mounted thereon. The placement and layout of mechanical and electrical items shall facilitate easy inspection, service and maintenance of the motors, reduction

gearing and braking system

- 2) The runner wheels shall be of cast steel with double flanges and mounted on roller bearings. Gearing shall be of totally enclosed type with machine cut gears. Bearings shall be ball or roller.
- The end stops. Resilient or spring type buffers shall be provided on all runway/cross beams and crane rails. Where carriages are equipped with electric travel the end stops shall be provided with limited switches at the end of each direction of travel.
 - Crane Rails. These shall comply with BS 449 and BS EN 10155. The line of the rails shall not vary by more than 3 mm, horizontally and vertically, throughout the whole length of travel. Whenever possible, rails shall be one piece. Where rails are to be joined this shall be by electrical induction welding.
 - Access Platforms and Ladders
 - 1) Safe means of access shall be provided for examination and maintenance of the crane or other equipment only accessible from the crane. Guards shall be fitted where possible under the crab and long travel motor and gearbox assembly to prevent persons on the ground being endangered by falling objects during maintenance
 - 2) All ladders, platforms and access ways shall comply with Specification. Open mesh flooring shall not be used. Access ways shall be not less than 800mm wide. The platforms and access ways shall be securely fenced with double tiered guard rails and steel 'toe boards' or 'kicking plates.
 - Materials

Steel used for the fabrication of the lifting equipment shall comply with BS 449, BS 7613, BS 7668, BS EN 10113, BS EN 10155 and BS EN 10210 as applicable. Welding procedures shall comply with BS EN 287 and BS EN 288

6.9 Electrical Components

(1) Motors

Motors shall be rated for 150 starts per hour (Duty type S7) for not less than one hour with a shaft output power at least 15% greater than the maximum power which will be required for operation and testing of the crane in the ambient temperature specified, at the maximum rated load.

(2) Control Gear

- a. A triple pole isolating switch with HRC fuses shall be provided at ground level for each lifting assembly. This switch shall be lockable in the 'OFF' position only and shall be provided with a Yale type lock and three keys. The switch shall have a label marked 'CRANE ISOLATING SWITCH'.
- b. Starters and controllers for the crane motors shall be designed and constructed in accordance with the requirements of BS 466, BS 4941, BS EN 60947.
- c. Mechanically and electrically interlocked reversing contactors shall be provided for each motion including speed control of the hoist. Accelerating contactors shall cut out the rotor circuit resistance of the motor in steps with suitable delays. Contacts shall be adjustable and renewable
- d. controller and resistors shall be rated such that temperatures do not exceed the limits specified in BS 4941 during operation of the crane under maximum temperature conditions. Starting resistors shall have not less than a 'ten minutes' rating. Speed control resistors should be one hour rated
- e. Control gear and cabling shall be suitable for 'inching' i.e. many repeated small movements at both creep and normal speed, in any direction of motion
- f. Starters and controllers shall be housed in well-constructed sheet steel panel cabinets of not less than 2mm thick, sprayed and painted with an anti-condensation paint. The enclosures shall be protected against dust and damp to classifications IP 54. Starting resistors shall be mounted in a ventilated specification of each control cubicle. The resistors should all be fitted with terminal bars. The control cubicles shall be provided with lockable hinged access doors, also interlocked with the main isolating switch.

(3) Controls

- a. Long-travel, cross-travel and slow and normal speed hoist motions of each crane shall all be controlled from the lowest level by a pendant push button station. The controls shall operate on a low voltage system supplied by a double wound isolating transformer. Both primary and secondary sides of the transformer shall have HRC fuse protection. One pole of the secondary winding shall be effectively earthed
- b. Push button controls shall be of the pendant type with 'hold-on' type push buttons automatically returning to the 'off' state on release of the button. Push buttons shall be provided for 'SLOW UP', 'SLOW DOWN', 'NORMAL UP', 'NORMAL DOWN', 'LEFT', 'RIGHT', 'FORWARD' AND 'REVERSE'. A larger size red 'Emergency Stop' button shall initiate tripping of the control

gear main circuit breaker and automatic application of the brakes on all motions. Reclosure of the main circuit breaker shall be initiated by a separate 'Reset' button also on the pendant. The pendant shall be oil tight polyethylene, totally enclosed to IP65, shockproof, and shall be suspended from the crab unit. The voltage at the pendant shall not exceed 55 volts to earth

- c. Limit switches shall be provided for all motors at the end of each direction of travel
- d. Infrared or radio remote control shall be provided, where specified, or if necessary for safe operation of the crane. Two battery packs with battery charger, sensors, sensor connecting cables with clips, receiver and decoder shall be provided. Adequate sensors shall be provided at each level (minimum three) to ensure continuous control in all zones of operation. If radio control is used then approval shall be obtained by the Contractor for the frequencies used.

(4) Cables wiring and earthing

- a. An insulated conductor system shall be provided for electrically powered cranes supply. The insulated conducted system shall be of the type where each phase is individually insulated and supported on a metal support. The type where all conductors are contained within a single extruded or molded insulation will not be permitted. A 'festoon' insulated cable system shall be provided for the cross-travel supply
- b. Wiring and earthing of the cranes shall conform to BS 466. Cables and wiring shall be of 600/1,000volt grade PVC insulated cables in accordance with BS 6231 and BS 6346. Wherever possible, the cables shall be run in screwed heavy gauge galvanized steel conduit. All cable ends shall be clearly labelled with identification of the appropriate terminals
- c. The selection installation and testing of cables and wiring shall be in accordance with BS 7671 except that maximum current ratings shall be raised by a factor of 1.4 times the rating for continuous duty obtained (after applying all necessary derating factors for high ambient temperature, grouping and disposition form of installation, etc). The up-rating factor of 1.4 is based on the one-hour motors specified for crane operation
- d. The crane structure, tracks, motor frames and metal cases of all electrical equipment, including metal conduit and cable guards, shall be earthed in accordance with BS7671.

6.10 Accessories, Spare Parts and Tools

Two (2) year's supply of spare parts and lubricants shall be supplied for each lifting device supplied. Maintenance tools should be also provided.

(1) Accessories

Trolley bar	1 set
Main switch box	1 set
Remote handy controller	1 set

(2) Spare parts

Transformer (400V/110V x 100VA)	1 set
Fuse	3 Nos.
Lamp	1 set
Brake lining (For hoisting, Travelling and Traversing)	1 set

(3) Special tools

Oil injector	1 set
Grease injector	1 set
Maintenance tool	1 set

6.11 Installation

Crane and hoist shall be installed in accordance with the requirements and instructions of the manufacturer. The support I-beam of runaway rails shall be included in the accessories which will be installed by the contractor.

6.12 Site Tests

After erection cranes and hoists shall be inspected, tested and certification provided by a qualified independent crane testing specialist in accordance with the requirements of Clause 54 of BS 466 and the tests witnessed by the Engineer. Test loading is 125% of rated capacity. (Test load will be 25 tons for 20-ton crane)

7 Air chamber and Surge Control Systems

7.1 Scope of Work

This part specifies the particular requirement for Contractors to design, manufacture, construct, install, test and commissioning of air chamber system, if necessary to protect facilities from water hammer, including flywheels, surge vessels, compressors, air valves and necessary accessory items, as specified herein.

7.2 Design requirements

Type	: Vertical Cylinder tank
Quantity	: 1 LS
Volume	: Approx.. 42 m3/min (D3.5m x H4.5m)
Pressure	: 1 MPa
Motor output (compressor)	: 11 kW x 3Phase x 400V x 50Hz
Motor encl. protect	: IP55
Installation	: Indoor
Flange Class	: PN16

7.3 Reference Standards

All materials and workmanship shall comply with the latest edition of the applicable standards and codes which shall include but not be limited to the following:

ASME Sec. II Part C Welding Rods, Electrodes and Filler Metals

ASME Sect. V Non-Destructive Examination

ASME Sect. VIII Div. 1 Pressure Vessels

ASME Sect. IX Welding and Brazing Qualifications

API 5L Specification for Line Pipe

ASTM A 516 Specification for Plate Material

ASTM A105 Standard Specification for Forgings, Carbon Steel for Piping Components

ASTM A106 Seamless Carbon Steel Pipes for High Temperature

ASTM A234 Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperature

ASTM A193 Alloy Steel and Stainless-Steel Bolting for High Temperature Service

ASTM A194 Carbon and Alloy Steel Nuts for Bolts for High Pressure and High Temperature Service

ANSI/ASME B16.9 Factory Made Wrought Steel Butt Welded Fittings

ANSI/ASME B16.10 Dimensions and Weights of Seamless and Welded Steel Pipes

BS 4504 Sect. 3.1 Circular Flanges for Pipes, Valves and Fittings (PN designated) Specification of Steel Flanges

ISO 8501 Preparation of Steel Surfaces before Application of Paints and Related Products

ISO 9000 Quality Management and Quality Assurance Standards - Guidelines for Selection and Use

7.4 System Purview

- (1) The Contractor shall Perform surge & transient analysis study to confirm the surge protection equipment design requirements for the complete piping system comprising of piping, reservoirs and pumping station shown on tender drawings as well as other related existing and future pipelines systems connected to this contract piping to the approval and satisfaction of the Engineer. The study shall be comprehensive attached with all required recommendations and conclusions, recommending suitable equipment to be installed on piping system to protect from surge effects like surge vessels or surge anticipation valves, air valves or bypass lines etc. The surge analysis carried out shall include analysis and recommendations for surge protection measures for the ultimate system. The surge protection measures recommended and provided initially shall be capable of simple expansion, or extension to meet the ultimate requirements. The study should take into consideration Disturbances in water distribution systems that can be induced by the following situations.

- a. Pump startup or shutdown

- b. Sudden Valve opening or closing (variation in flow area)
 - c. Changes in transmission conditions
- (2) For new transmissions or rising mains lines, the Contractor shall provide if required, air/water interface type surge vessels, air valves, control valves and other control and surge protection equipment, complete with isolation valves, fittings and accessories, as determined by the Contractor's surge analysis and as per below specifications. The supply for the surge vessels shall include an electrically driven reciprocating air compressor system arranged to automatically charge the vessel with oil free air. The vessels and connecting pipework shall be located with adequate access for operation and maintenance. Means shall be provided for draining each vessel and connecting pipework for inspection and maintenance purposes. The Contractor shall undertake surge analyses to determine the extent of surge pressures or other adverse hydraulic conditions that may occur during the operation of the pumping facilities.
- (3) The Contractor shall undertake the following tasks as an integral part of the surge analysis for each system
 - a. Construct a mathematical model of the system using network fluid flow simulation computer software.
 - b. List the steady state condition under which the system will operate.
 - c. List, with reasons, the most adverse surge conditions under which the system will operate.
 - d. Determine maximum and minimum surge pressures along the system that can occur due to system operation.
 - e. Identify possible surge suppression options listing their advantages and disadvantages for the system analyzed.
 - f. Recommend the preferred option giving details of the maximum and minimum pressures to which the system will be subjected with the surge suppression equipment installed. Full details of the surge suppression equipment and ancillary equipment shall be given.
 - g. Prepare a Surge Analysis Report providing full details of tasks 1) to 6), including sufficient data sheets, figures and analysis output, etc. from the network fluid flow simulation software to allow the Engineer to undertake a detailed review of the Surge Analysis Report
- (4) As a result of the Engineer's review, where revisions to the Surge Analysis Report

are agreed between the Engineer and Contractor, the Contractor shall incorporate these into the report and reissue the report.

The format of the Surge Analysis Report shall be agreed with the Engineer after tasks 2) and 3) have been completed and before analyses are commenced. A summary of the findings from tasks 2) and 3) shall be presented with the proposed report format

7.5 Submittals

The following data shall be submitted by the Contractor.

(1) Design Data:

a. Hydraulic Calculations

The Contractor shall submit a complete computer based hydraulic transient analysis showing the performance of the surge control system under various model scenarios. Normal operating modes and the sudden shutdown of the pump following a power failure shall be simulated. The program shall have the facility to model the characteristics of the different manufacturers' air and reflux valves, and any other proprietary equipment

b. Structural calculations.

Structural calculations for the design of the pressure vessel and its support shall be provided.

(2) Shop drawings shall be provided for the fabrication and erection of the whole system, including air compressors, air valves, and surge vessels. Layout drawings, pressure vessel calculations, schematic drawings and electrical drawings shall be provided. Catalogue pages, manufacturers' detailed instructions, templates and installation methods shall be provided.

(3) Tests as described below shall also be included. Documentation for the compressors in accordance with BS 1571 shall be provided

7.6 Quality Assurance

Both the Company carrying out the surge analysis and the software used for the computer transient analysis shall have a proven record in surge analysis. The software used shall be a recognized water industry standard. The out-surge analysis shall be carried out on the force main on the basis of data of rotating element, characteristic of reflux valve and force main to ensure if moment of inertia of the rotating elements has to be increased or not. If the moment of inertia has to be increased, a flywheel shall be added between pump and motor with shaft and plummer block. The magnitude of

flywheel and detailed construction of the plummer block shall be proposed by the pump manufacturer for the engineer's approval along with report of surge analysis.

7.7 Design Conditions and Performance Characteristics

The surge protection system shall be designed and sized for the- following design criteria:

- a. maximum design conditions for pumps and piping
- b. worst flow supply scenario
- c. Positive (over) pressure - Positive surge pressures shall not exceed the design pressure of the pipeline
- d. Negative (under) pressure - Negative surge pressures shall not exceed 5m (shouldn't this be 5mm Hg) of vacuum (-5m)
- e. Contamination during negative pressure cases and leakage during excessive pressures.
- f. Recommendation from piping manufacturers.
- g. Water supply system stoppage during maintenance of piping
- h. Pump cavitation and piping lining damage

7.8 Materials

- a. Surge Towers. If these are constructed in concrete, then Specification shall apply. If in the same material as the pipeline, then the specifications applying to the pipeline shall apply.
- b. Surge vessels. These shall be constructed from steel in accordance with BS 5500.
- c. Coatings. Surge vessels shall be coated internally with an epoxy paint system of minimum thickness 300 microns. The system shall be proven in use in this application. The external coating system shall be in accordance with Specification.

7.9 Fabrication

(1) Surge vessel:

1) Design Considerations:

- Surge vessels shall be designed, fabricated, tested and inspected in accordance with ASME
- Code stamping is not required for the surge vessel.

- Corrosion allowance of 3mm shall be considered for the vessel.
- Steel plates shall be in compliance ASTM A516 Gr. 70. The nozzle pipes shall be ASTM A106 Gr. B and flanges shall be to ASTM A105. Fittings shall be to ASME A234 Gr. WPB.
- The capacity of the surge vessel shall be based on the worst scenario.
- The sizing of the surge vessel shall be based on the findings of the surge analysis study.
- The surge analysis shall utilize an approved computer software package. The results shall also show the location of the air valves and vacuum breaking valves along the pipeline route.
- Saddle supports for horizontal mounting, or legs for vertical mounting, complete with anchor bolts

2) Description and material of construction:

- Safety pressure relief valve nozzle rated for not less than 150 % working.
- Water delivery pipe to pumping main with isolating valve with interlock facility to prevent pump starting if the valve is not fully open.
- Suitably sized manhole with davit arm or hinges.
- Lifting lugs.
- Level indicator with level switch.
- Compressed air supply pipe with isolating valve and solenoid valve.
- Pressure gauge and pressure transmitter.
- Level transmitter.
- Access ladder and platform.
- Non return valve
- The drain valves and pressure relief valves shall be piped to discharge into a site drainage manhole.
- Surge vessel on the pumping stations sites shall be provided with complete automatic air charging systems with manual control capability as specified.
- In the event of the low-level alarm being activated the solenoid air vent valve shall operate until the level rises above the alarm and then for a

further predetermined time.

(2) Air compressors:

- a. Two Electric motor driven air compressors and motors complete with air filter, after cooler, air intake silencer, water separator, pressure regulator and any other necessary accessories where all are to be installed on the same skid. Compressors shall be tested in accordance with BS 1571. The compressors maximum pressure and capacity, air receiver minimum pressure and capacity shall be all sized based on results of surge analysis report and each unit capacity shall be able to supply all required amount of air to the surge vessels.
- b. Compressor operation shall be controlled also by pressure switch installed on air receiver where compressor is supposed to start at low pressure and stop at high pressure. Air compressors should be operated one unit. But one unit will be used within the range of upper and lowest limit at the normal level, and if the water level rises suddenly, two air compressors will be synchronize with operating
- c. Cylindrical air receiver vessel to BS 5500 of suitable capacity and made of hot dip galvanized steel complete with pressure gauge, water separator, condensate drain, alarm, control pressure switch for automatic control of compressor, safety relive valves etc.. The air receiver volume shall be at least six times the total volume of the air compressed in 1 minute, at duty pressure.
- d. Air supply lines installed all the way from air receiver and up to surge vessels shall be of the galvanized heavy gauge steel tubing type, to BS 1387. All isolating valves, safety and non-return valves filters, bends, tees, unions and other fittings shall be of galvanized steel BS 143 and shall be of the correct size and type for the steel tubing in use. Screwed or flanged joints may be incorporated. Pipes shall be flanged to BS 4504, PN 16 where required to make connections with plant items, and shall be designed for a pressure of not less than 3 x relief valve pressure blow point. Air main velocity shall not exceed 6 m/s. Pipework shall be
- e. installed horizontally and vertically but shall fall in the direction of air flow to facilitate draining of condensate. Automatic drains shall be fitted to prevent the accumulation of condensate at low points in the system. The nominal fall of the pipework shall be 1-in-80.
- f. Pressure relief valves and condensate drain valves shall be provided as required by the operating system. Isolating valves shall be full bore diaphragm

or ball pattern.

- g. Control panel equipped with all necessary monitoring and control instruments for compressors

(3) Local control panel:

- a. It should be STS304 and of a stand-alone dual door type and have Space Heater with a thermostat inside it.
- b. As a system which can control the air chamber, software which manipulates auxiliary facilities including air compressor valves, water level and pressure sensors (auto/manual selection, operate/stop, open/close, etc.) and function to control and monitor readings of meters should be furnished.
- c. The secondary electrical work, that is, the power supply and control cable work from the control panel to operate and control air compressors and auxiliary devices is within the scope of this work.
- d. To facilitate operation and maintenance, up-grade of programmable logic controller (PLC) to be used.
- e. Control Panel should have the following elements:
 - Manual/auto (on-site/remote) selection switch
 - Operate, stop, fault indicator and switch (air compressor)
 - Water level indicator (indicated in %)
 - Pressure indicator (indicated in bar.g)
 - Max. and min. water level lamp and warning system (available for random setup)
 - Voltmeter and current meter
 - Level and pressure signals (analog) and signals such as stop of air compressors, low and high level, and alarm (dry contact) can be transmitted to the control center for monitoring so that the control center can monitor them. (A terminal should be furnished to send signals to the control center)
 - It should be easy to store and manage data like compressor operating frequency, operating time, the occurrence of water hammer (high and low pressure and high and low water level) for the operator to manage the devices.

- Space Heater including thermostat, etc
- The secondary piping wiring shall be included in the accessories which will be installed by the contractor

7.10 Factory Inspection and Testing

- a. The surge vessel shall be hydro tested to a pressure 1.5times the design pressure.
- b. Visual inspection.
- c. Thickness test by electronic device.
- d. Coating thickness check.
- e. The below mentioned requirements shall apply to the ITP (Inspection Test Plan).
- f. Non-destructive testing.
- g. Welding procedure specifications together with procedure qualification records.
- h. Welder qualification records.
- i. Each major component of the equipment shall be subjected to a complete shop test as specified herein, witnessed by the Engineer and employer. All costs for the shop tests shall be borne by the Contractor

7.11 Spare Parts and Tools

The Contractor should include all necessary and required spare parts for surge protection equipment operation and provide relating special of standard tools and accessories.

Spare parts shall suitably be packed and labeled as to the related apparatus for long storage under the climate conditions prevailing in Indonesia.

The spare parts should be sufficient for two (2) years operation of surge equipment and the Contractor should provide the complete list of spare parts and relating unit prices.

All tools should be of high quality and housed in a suitable, portable, and lockable metal box.

The Contractor shall provide from the specialist manufacturers of the surge equipment all the spares and tools required during the commissioning periods as specified. Special tools, if required for normal operation/or maintenance of any component of

the surge control system, shall be supplied with the equipment.

7.12 Installation

- a. All equipment shall be installed and commissioned in accordance with the manufacturer's recommendations and under the supervision of the surge control system supplier's factory trained personnel.
- b. Surge protection system performance shall be verified by field tests at pumping rates specified for each pressure main and for power failure at the maximum pumping rate. The surge control system supplier shall provide a chart recorder and pressure transducer system to develop a permanent record for each pressure main test.

8 Flow Meter

8.1 Scope of Work

This part specifies the particular requirement for Contractors to design, manufacture, construct, install, test and commissioning of flow meters installed to operate water supply facilities, as specified herein.

8.2 Design requirement

The components of the flow meter are composed of a complete system, and each unit of the flow meter includes necessary accessories such as basic sensors and transducers.

Discharge line of Booster Pump 1 set

8.3 Reference

AWWA C715-18" Water meter designation for ultrasonic and electromagnetic meters

AWWA C751-19 Magnetic Inductive Flowmeters

Korea Waterworks Association (KWWA)

8.4 Equipment

Requirements not specified below shall follow the Guidelines for installation and maintenance of flow meters of Ministry of Environment of Korea and can be modified with the manufacturer's standard equipment according to the requirements and needs of each section.

(1) Electromagnetic Flowmeter

- a. Measurement range : 0.05 m/s15 m/s
- b. Measurement Field : Conductive Liquids
- c. Body Material : ST37 Black Steel + Corrosion Resistant Paint
- d. Sensor Material : SS316L Ops: SS304, HastelloyC, HastelloyB, Titanium, Tantalum, Platinum
- e. Inner Coating : Teflon (PTFE) or Hard Rubber (Rubber)
- f. Precision : 0.5% or 0.25%
- g. Temperature : -10°C...+ 60°C Rubber / -20°C+ 150°C Rubber
- h. Nominal Pressure : 1600 kPa (4000 kPa up to DN 50)
- i. Moisture : %5 - %95
- j. Measurable min. conductivity: 20μ/cm Water 5 μ/cm other liquids
- k. Connection : Flange Connection, Ops: clamb connection
- l. Pressure : 4Mpa, 1.6 Mpa, 1.0 Mpa
- m. Feed : 85-265 VAC 50 Hz or 24VDC, Battery operated
- n. Indicator : 3 x 16 Backlit LCD displaying instant or

total flow

- o. Alarms : Empty pipe, sensor error, over limit
- p. Reporting : Daily, Weekly, monthly and annual total flow
- q. Ground : Grounding electrode included
- r. All other auxiliary equipment shall be supplied.

8.5 Installation

Requirements not specified below shall follow the Guidelines for installation and maintenance of flow meters of Ministry of Environment of Korea and can be modified with the manufacturer's standard equipment according to the requirements and needs of each section.

(1) General

- a. To prevent noise in the transmitter, the wiring shall be separated from noise sources such as power sources, large-capacity transformers, and power lines.
- b. The terminal box shall have a waterproof structure, and during construction, measures must be taken to prevent rainwater intrusion by using conduits, etc. in the electrical wiring port to prevent rainwater from entering through the electrical wiring port.
- c. In the case of a built-in lightning arrester, grounding work must be done close to the transmitter.
- d. It shall be installed to facilitate installation and repair work.
- e. When installed outdoors, it should be installed to avoid direct sunlight.
- f. Sufficient space shall be secured for maintenance and comparative measurements, and facilities must be equipped to prepare for flooding.

8.6 Calibration

- 1. The contractor shall verify that all devices supplied in accordance with this specification meet the function and tolerance limits by calibrating them according to the procedures recommended by the manufacturer.
- 2. Calibration point: Each instrument is calibrated with an input simulator at 25, 50, 75, and 100% of span using a test instrument.
- 3. Bench calibration: Instruments that have undergone standard calibration must be tested on site to determine whether to adjust the calibration value, and

calibration adjustments shall be performed after consultation with the Consultants or Employer.

4. Field calibration: Instruments calibrated in the field without standard calibration shall be checked to see if they operate properly according to the loop diagram or specification data.
5. Analyzer calibration: After installation, the manufacturer or the manufacturer's representative shall calibrate and test each analyzer system. All samples required for calibration must be supplied by the manufacturer.
6. Calibration sheet: The following information shall be entered in the calibration sheet of each instrument.
 - a. Project name
 - b. Circuit number (loop no)
 - c. TAG number (tag no)
 - d. Manufacturer
 - e. Model number (model no)
 - f. Serial number (serial no)
 - g. Calibration range
 - h. Calibration data: Error at 10, 50, 90% of input/output and span
 - i. Test equipment used and serial number

9 Pressure Gauge

9.1 Scope of Work

This part specifies the particular requirement for Contractors to design, manufacture, construct, test and commission pressure gauge/meters installed to operate water supply facilities, as specified herein.

9.2 Design requirements

The components of a pressure gauge consist of a complete system, and each unit of the pressure gauge includes necessary accessories such as basic sensors and transducers.

9.3 Reference standards

ASME B40.100-2022: Pressure Gauges and Gauge Attachments

Korea Waterworks Association (KWWA)

9.4 Equipment

Requirements not specified below shall follow the Guidelines for installation and maintenance of flow meters of Ministry of Environment of Korea and can be modified with the manufacturer's standard equipment according to the requirements and needs of each section.

(1) Diaphragm pressure gauge

- a. Type : Diaphragm type (STS 316)
- b. Measurement range : 0~1 MPa (0~10kg/cm²)
- c. Output signal : 4~20 mA DC
- d. Installation : Designated according to on-site installation situation
- e. Precision : $\pm 0.25\%$ F.S.
- f. Instruction : 4-Digit LCD Display
- g. Supply of all other pressure gauge auxiliary equipment and installation auxiliary equipment

(2) Differential pressure gauge

- a. Type : Diaphragm type (STS 316)

- b. Measurement range : 0~2 MPa (0~2kg/cm²)
- c. Output signal : 4~20 mA DC, 2-wire type
- d. Installation : Designated according to on-site installation situation
- e. Precision : ±0.25 % F.S.
- f. Instruction : 4-Digit LCD Display
- g. Supply of all other differential pressure gauge auxiliary equipment and installation auxiliary equipment

9.5 Installation

(1) General

Requirements not specified below shall follow the Guidelines for installation and maintenance of flow meters of Ministry of Environment of Korea and can be modified with the manufacturer's standard equipment according to the requirements and needs of each section.

(2) Pressure gauge

- a. The pressure outlet must be positioned within 45° below the horizontal and the socket shall be welded.
- b. In case of corrosive fluids, pipes made of corrosion-resistant material shall be used.
- c. The inside of the pressure supply piping shall be thoroughly cleaned before installation.
- d. If there is a risk of the liquid freezing, it shall be kept warm.

(3) Differential pressure gauge

- a. The pressure supply pipe must be inclined upward by more than 2/10, and the lower part shall be inclined upward by more than 1/10.
- b. The bending of the pressure supply pipe shall have a radius of 80 mm or more and be fixed at a suitable support.
- c. If there is a risk of the liquid freezing, it shall be kept warm.

9.6 Calibration

- a. The contractor shall verify that all devices supplied in accordance with this specification meet the function and tolerance limits by calibrating them

according to the procedures recommended by the manufacturer.

- b. Calibration point: Each instrument is calibrated with an input simulator at 25, 50, 75, and 100% of span using a test instrument.
- c. Bench calibration: Instruments that have undergone standard calibration must be tested on site to determine whether to adjust the calibration value, and calibration adjustments shall be performed after consultation with the Consultants or Employer.
- d. Field calibration: Instruments calibrated in the field without standard calibration shall be checked to see if they operate properly according to the loop diagram or specification data.
- e. Analyzer calibration: After installation, the manufacturer or the manufacturer's representative shall calibrate and test each analyzer system. All samples required for calibration must be supplied by the manufacturer.
- f. Calibration sheet: The following information shall be entered in the calibration sheet of each instrument.
 - Project name
 - Circuit number (loop no)
 - TAG number (tag no)
 - Manufacturer
 - Model number (model no)
 - Serial number (serial no)
 - Calibration range
 - Calibration data: Error at 10, 50, 90% of input/output and span
 - Test equipment used and serial number

10 Air Conditioner

10.1 Scope of Work

This section sets out specific requirements for the Contractor to install, test, and commission air condition.

10.2 Specification

a. Central Air Conditioning System

AC Type: Central (ceiling cassette)

Capacity: minimal 35.000 BTU/h

b. Wall Mounted Air Conditioning System

AC Type: Wall Mounted

Capacity:

AC ½ PK = ± 5.000 BTU/h

AC ¾ PK = ± 7.000 BTU/h

AC 1 PK = ± 9.000 BTU/h

AC 1½ PK = ± 12.000 BTU/h

AC 2 PK = ± 18.000 BTU/h

AC 2,5 PK = ± 24.000 BTU/h

10.3 Installation

Step 1: Preparation before Installation

Before starting the installation, make sure you have all the necessary equipment. Some of the tools and equipment you may need include:

1. Split AC Unit (Indoor-Outdoor).
2. AC bracket or stand.

3. Suitable power cable.
4. Tools such as screwdriver, drill, and pliers.
5. Refrigerant pipe and pipe insulation.
6. Clamps and bolts.

Make sure you understand the wall structure and the proper location for installation. Avoid places exposed to direct sunlight or near other heat sources.

Step 2: Selection of AC installation position

When installing a split air conditioner at home, pay attention to the correct installation location. The placement of indoor and outdoor air conditioners must be right so that the air conditioner can work optimally. Pay attention to the airflow of the AC fan. This will allow the blown cold air to be distributed evenly throughout the room. Here is the ideal distance for indoor AC installation. Make sure you understand the wall structure and the right location for the installation. Avoid places that are exposed to direct sunlight or near other heat sources.

Height to floor distance: about 2.1 - 2.5 meters

Distance from the wall: approximately 15-20 cm

Distance from the ceiling: 15-20 cm

Step 3: Installation of Bracket and Indoor Unit

1. Attach the bracket to the wall using a drill and bolts. Make sure the bracket is firmly attached and aligned.
2. Place the indoor unit on the bracket carefully. Make sure the unit is in a stable and secure position.

Step 4: Placement of the Outdoor Unit

1. Determine a suitable location for the outdoor unit. This location should have good air circulation and minimal exposure to dust or dirt.
2. Mount the outdoor unit on its stand, usually using a vibration-resistant rubber to reduce sound and vibration.

Step 5: Cable and Pipe Connections

1. Connect the electrical cable from the indoor unit to the outdoor unit according to the guidelines stated in the manual.
2. Install the refrigerant pipework carefully. Make sure the pipes are well insulated to prevent heat leakage.

Step 6: Refrigerant Charging

Refrigerant charging is a stage that is best done by a licensed professional. Refrigerants must be charged according to the manufacturer's specifications and applicable safety rules.

Step 7: Testing and Maintenance

Once the installation is complete, conduct a test to ensure that the air conditioner is functioning properly. Check that the air temperature output matches the desired setting. Also, make sure that all components are well connected and that there are no refrigerant leaks.

The installation of a split air conditioner, although it looks quite simply, still requires specialized knowledge and skills. If you are unsure or have no experience in AC installation, it is better to call a professional. Improper installation can result in performance, efficiency, and even safety issues. By following this guide or with the help of an expert, you can enjoy the comfortable cool air of a properly installed split AC.

11 Exhaust

11.1 Scope of Work

The scope of work for exhaust installation is in the kitchen and bathroom.

11.2 Specification

The material of the exhaust is aluminum with the dimensions of the Louver Grille 35x35cm Natural silver color and white coating.

11.3 Installation

1. Cutting the opening

The first step in louver installation is to measure the louver dimensions and mark the corresponding area. Carefully cut the opening and make sure that the edges are straight. Be sure to verify measurements before making any cuts.

2. Placing the louver

With the opening prepared, align the louver with the opening. It's important to ensure that it's perfectly level for optimal performance. If the louver is drainable, this becomes even more important as gravity aids in draining the louver.

3. Securing the louver

Secure the louver in place using screws or other fasteners. For metal and aluminum louvers, use appropriate screws that prevent corrosion.

4. Sealing and waterproofing

With the roof louver secured, it is time to seal it in place. Apply a weatherproof sealant around the edges of the louver. This step is crucial to prevent water leaks.

5. Testing

If the louver is adjustable, check the louver to ensure that it opens and closes properly.

12 Mechanical Equipment Testing

Before the test takes place, all equipment must be checked carefully to ensure that the equipment is ready to be tested. For pumps, the things that need to be tested are as follows:

- a. Discharge (m^3/hr)
- b. Head (m)
- c. Efficiency (%)
- d. Required power (Kw)
- e. Bearing vibration measured in the bearing housing at rated capacity
- f. Bearing temperature is measured at the saturation point of the temperature rise. The tests mentioned above are carried out at a minimum of 5 (five) pump operating points from the Q - H curve, with a minimum operating time of 5 (five) hours continuously. It is not permitted to stop the pump during the test period unless there is an urgent matter/disruption.

The flow test on the pump is carried out by an independent party after the pump is installed. If there is a disturbance before the testing period ends, the testing process must be repeated from the beginning.