



बृहन्मुंबई महानगरपालिका  
Municipal Corporation of Greater Mumbai



## Mithi River Water Quality Improvement Project

**Package 3:** Dry Weather Flow Interception at Tidal Outfalls (including Gate Pumps), Transfer Sewer, Training of River (Retaining wall and Service Road), Beautification including Promenades and Allied Works from Prem Nagar Outfall, Kurla to Mahim Causeway.

Design Build Operate Contract

**Volume 2E -Technical Specifications for Gate Pumps**

**Employer:**  
**Municipal Corporation of Greater Mumbai**  
Municipal Head Office Building, Mahapalika Marg,  
Fort, Mumbai - 400 001.



**MUNICIPAL CORPORATION OF GREATER MUMBAI**

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India

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## MITHI RIVER PACKAGE 3 - MECHANICAL PLANT & EQUIPMENT FOR PUMP GATE SYSTEM

### Preface:

As per consultant's report the pumping arrangement at different outfalls shall be as follows:

Sr No.	Ref.	Outfall Location	Type of Installation as per Consultants report	Storm Discharge estimated	Width of outfall (m)
				(m <sup>3</sup> /sec)*	
1	MR-101	Boran Nalla & Indian Oil	Gate Pump- Horizontal	15.66	12
2	MR-102	Double Barrel	Gate Pump- Horizontal	15.58	9.6
3	MR-103	Kala Nagar Outfall	Gate Pump- Horizontal	35.58	22.9
4	MR-104	Dadar Dharavi Nallah	Gate Pump- Horizontal	75.13	34
5	MR-105	Drive-in Theatre Nallah	Gate Pump- Horizontal	9.39	8
6	MR-106	MMRDA Outfall	Gate Pump- Horizontal	5.60	3.6
7	MR-107	ONGC Nallah	Gate Pump- Horizontal	3.27	4

### PUMP GATE SYSTEM EQUIPMENT

#### GENERAL

- A. This Section sets out the requirements of design, materials, manufacturing, erection, test & inspection and the technical requirements for all aspects necessary for safe, efficient and reliable operation of the proposed complete Pump Gate System at the respective stations as listed below:

Sr. No.	Pump-gate / Gate Station Sr. No. of P/S	Nalla Cross Section B(m) x H(m)	Gate Nominal Dimension & Q'ty	Pump Size, Nos of Pump, Pump Capacity, Nos of Pump Gate
1	Mithi River SWPS (MR-101)	12 x 4.3	5.4m(B) x 3.5m(H) x 2	1,350B x 2 / 960 m <sup>3</sup> /min - 1Gate/2Pumps x 2 ea
2	Mithi River SWPS (MR-102)	9.6 x 5.2	5.2m(B) x 5.0m(H) x 1	1,350B x 1 / 500 m <sup>3</sup> /min 1Gate/2Pumps x 1 ea
			3.2m(B) x 5.0m(H) x 1	1,200c x 1 / 190 m <sup>3</sup> /min - w/o Gate/1Pumps x 1 ea 1,350C x 1 / 250 m <sup>3</sup> /min 1Gate/1Pumps x 1 ea
3	Mithi River SWPS (MR-103)	22.9 x 4.6	6.3m(B) x 5.0m(H) x 2	1,500B x 2 / 1360m <sup>3</sup> /min - 1Gate/2Pumps x 2 ea
			6.3m(B) x 5.0m(H) x 1	1,200e x 1 / 400m <sup>3</sup> /min - w/o Gate/2Pumps x 1 ea 1,200E x 1 / 400m <sup>3</sup> /min - 1Gate/2Pumps x 1 ea

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4	Mithi River SWPS (MR-104)	34 x 5.3	5.3m(B) x 5.0m(H) x 5	1,350e x 5/ 4560 m <sup>3</sup> /min w/o Gate/2Pumps x 5 ea 1,350E x 5/ 4560 m <sup>3</sup> /min 1Gate/2Pumps x 5 ea
5	Mithi River SWPS (MR-105)	8 x 5.0	7.3m(B) x 3.5m(H) x 1	1,500B x 1 / 580 m <sup>3</sup> /min - 1Gate/2Pumps x 1 ea
6	Mithi River SWPS (MR-106)	3.6 x 4.2	3.6m(B) x 4.0m(H) x 1	900d x 1 / 114 m <sup>3</sup> /min - w/o Gate /1Pumps x 1 ea 900D x 1 / 228 m <sup>3</sup> /min - 1Gate/2Pumps x 1 ea
7	Mithi River SWPS (MR-107)	4 x 4.7	4.0m(B) x 2.5m(H) x 1	900B x 1 / 200 m <sup>3</sup> /min - 1Gate/2Pumps x 1 ea

Note: The Pump Gates are categorized 5 Types depending on the layout of pumps on one(1) gate leaf as given below:

Type	No of Gate Leaf	Nos of Pump Upper Layer	Designation	Nos of Pump Lower Layer	Designation
A	1	None		1	Pump D with A
B	1	None		2	Pump D with B
C	1	1	Pump D with c	1	Pump D with C
D	1	1	Pump D with d	2	Pump D with D
E	1	2	Pump D with e	2	Pump D with E

Type A: 1200A means that 1gate is equipped with (1200mm x 1) pump

Type B: 1200B means that 1gate is equipped with (1200mm x 2) pumps

Type C: Double layers Pump(s) 1200c (Upper) + 1200C (Lower) on 1gate

1200c means that (1200mm x 1) pump places on the upper layer

1200C means that (1200mm x 1) pump places on the lower layer

Type D: Double layers Pump(s) 1200c (Upper) + 1200C (Lower) on 1gate

1200d means that (1200mm x 1) pump places on the upper layer

1200D means that (1200mm x 2) pumps places on the lower layer

Type E: Double layers Pump(s) 1200c (Upper) + 1200C (Lower) on 1gate

1200d means that (1200mm x 2) pumps places on the upper layer

1200D means that (1200mm x 2) pumps places on the lower layer

- B. The Contractor shall submit Pump Gate System Manufacturer's warranties on machinery and equipment offered as regards to the quality and performance prior to the shipment. All factory testing shall be supported with certified documents to verify the guaranteed performance and standard applied for the testing.
- C. The Contractor shall submit drawings for any modification works to the existing reinforced concrete structure to accommodate the equipment offered, as regards to dimensions, configuration, foundations, mountings and openings, and shall ensure that the required modification works have been carried out prior to the installation works. The Contractor shall not be relieved of the responsibility for any negligence or omission of the works.
- D. The Contractor shall cause the Pump Gate System Manufacturer and its suppliers to coordinate design of the pump station equipment and controls such that all equipment are compatible and capable of achieving the performance and operational requirements.

**DEFINITION**

In this specification the words and expressions noted below shall have the following meaning unless the context dictates otherwise:

- A. "Company" means Municipal Corporation of Greater Mumbai for Mithi River Storm Water Pumping Station Project.

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- B. "Contractor" means the company which the Company has selected to perform the works for construction, pre-commissioning, commissioning and start-up under the contract to be executed between the relevant parties.
- C. "Mechanical Contractor" means the company to be selected and employed by the Contractor for performing Mechanical Works, such as Pump Gate System, rotary screen, stop log, sluice gate with flap gate and/or others as specified in Section 1.3 hereof.
- D. "Pump Gate System" means that it is consisted of roller type (pump) gate, guide frame for roller gate, one or two submersible pump(s) to be equipped on one gate leaf, flap valve(s) mounted on discharge of pump(s), gate lifting actuator, local main control panel (MOP), rotary screen along with belt conveyor and its local control panel (LCP). The floating type screen, sluice gate with flap gate and stop log are also included in this system.
- E. "Pumping Station" means the Company's pumping station in which the Pump Gate System are designed to control the upstream water toward downstream side of the gate and all related facilities to be newly constructed at Site, City or LBS area of Mithi River, Mumbai, India.
- F. "Project" means the Company's whole Pump Gate System Pumping Station including access road as well as the landscaping required for the Pumping Station to be newly constructed and/or modified at Site, City or LBS area of Mithi River, Mumbai, India.
- G. "Site" means the area where the Company intends to build a new Pumping Station and other adjoining or associated areas as applicable.

### SCOPE OF WORK

- A. Mithi River Storm Water Pumping Station (MR-101 ~ MR-107) (CITY Area)

Item Description	Requirements	Remarks
1. Gate Leaf (SS400)	For individual Sr No of Pump Station, Please refer to Table 1A of Annex	M1~M7-101
2. Guide Frame (STS316L/SS400)		
3. Submersible Pump (type, outlet)		M1~M7-102
3.1. Pump Flow Rate (m <sup>3</sup> /min)		
3.2. Total Head (m)		
3.3. Rated Power (kW)		
3.4. Revolution (rpm) of motor		
3.5. Electrical Power Supply (V)		
4. Type/Capacity of Actuator		M1~M7 -103
5. Flap Valve (STS304L)		M1~M7 -104
6. Local main control panel (MOP)		M1~M7 -105
7. Coarse Rotary Screen (STS316L)		M1~M7 -106
7.1 Belt Conveyor (Horizontal)	M1~M7 -107	
7.2 Floating Screen	M1~M7 -108	
8. Stop Log	M1~M7 -109	
9. Flap Gate (STS316L) w/ Sluice Gate	M1~M7 -110/112	
10. Sludge Pump	M1~M7 -111	
11. EL. of Upstream Bottom (m)		
12. EL. of Gate Bottom (SILL) (m)		

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13. LWL of Upstream (m)		
14. HWL of Upstream (m)		
15. HWL of Downstream (m)		
16. Number of Gate / Pump		

#### INTERFERENCE WITH OTHERS

- A. The following interference work and service for submersible pump 150kW and above shall be coordinated among the relevant parties concerned as follows:

Description	Supply	Erection	Electrical Termination	Supervision	Technical Support	Remarks
Pump with Motor	M/M	M/C	M/C	M/M	M/M	From MOP to Motor
Junction Box	E/C	E/C	E/C	M/M	M/M	From MSB/MCC to Pump Junction Box
MOP	M/M	M/C	M/C	M/M	M/M	From MOP to Pump & Actuator
Monitoring Unit	M/M	M/M	M/M	M/M	M/M	Integral of MOP
Primary Power Line	E/C	E/C	E/C	E/C	E/C	From MSB/MCC to Pump Junction Box & LCP
Secondary Power Line	M/M	M/C.	M/C	M/M	M/M	From MOP to Actuator LCP to Rotary Screen
Soft Starter	E/C	E/C	E/C	E/C	E/C	In MSB/MCC
Water Level	E/C	E/C	E/C	E/C	E/C	From WL to MOP
Gate Structure	G/C	G/C	-	M/M	G/C	Concrete Work
Anchors for Guide Frame	M/M	M/C	-	M/M	M/M	

Note: G/C= General Contractor (Civil), E/C= Electrical Contractor, M/C= Mechanical Contractor, M/M= Mechanical Manufacturer, MOP= Pump gate Local Main Control Panel, LCP= LCP for Rotary Screen.

- B. The following interference work and service for submersible pump 149kW and lower shall be coordinated among the relevant parties concerned as follows:

Description	Supply	Erection	Electrical Termination	Supervision	Technical Support	Remarks
Pump with Motor	M/M	M/C	E/C	M/M	M/M	From MOP to Motor
MOP	M/M	M/C	E/C	M/M	M/M	From MSB/MCC to MOP
Monitoring Unit	M/M	M/M	M/M	M/M	M/M	Integral of MOP
Primary Power Line	E/C	E/C	E/C	E/C	E/C	From MSB/MCC to MOP & LCP
Secondary Power Line	M/M	M/C.	M/C	M/M	M/M	From MOP to Pump & Actuator LCP to Rotary Screen
Soft Starter	E/C	E/C	E/C	E/C	E/C	In MSB/MCC
Water Level	E/C	E/C	E/C	E/C	E/C	From WL to MOP
Gate Structure	G/C	G/C	-	M/M	G/C	Concrete Work
Anchors for Guide Frame	M/M	M/C	-	M/M	M/M	

Note: G/C= General Contractor (Civil), E/C= Electrical Contractor, M/C= Mechanical Contractor, M/M= Mechanical Manufacturer, MOP= Pump gate Local Main Control Panel, LCP= LCP for Rotary Screen.



**SUBMISSION OF DOCUMENTS OR APPROVAL**

The following documents require a written approval from the Client prior to commencement of manufacture:

- A. Technical Specification
- B. Pumping Station Plot Plan
- C. General Arrangement Drawing (Plan & Section)
- D. Shop Drawing for Pump Gate System
- E. Design Data for Pump Gate System
- F. Design Calculation for Pump, Roller Type (Pump) Gate, Actuator, Sluice Gate, Flap Gate, Stop Log, Floating Screen and Rotary Screen
- G. Inspection and Test Plan (ITP)
- H. Operating & Maintenance Manual

## MITHI RIVER PACKAGE 3 - MECHANICAL PLANT & EQUIPMENT FOR PUMP GATE SYSTEM

### DESIGN BASIS

#### 1) Mithi River Storm Water Pumping Station (MR-100 ~ MR-107) (CITY Area)

##### A) Roller Type (Pump) Gate (M1-101 ~ M7-101)

Item Description	Mithi River Storm Water P/S	Remarks
1. Type	For individual Pump Gate of Pump Station, please refer to Table 2A of Annex	Roller Type Pump Gate
2. Size and water depth		
3. Material Gate/Guide		Coating Condition S
4. Seals Type/Material		
5. Allowable Deflection		
6. Pressure Direction & Seal		
7. Skin Plate Thickness		Manufacturer to submit Calculation Sheet
8. Nos of Main Roller		
9. Nos of Side Roller		
10. Nos of Gate leaf		

##### B) Submersible Pump (M1-102 ~ M7-102)

Item Description	Mithi River Storm Water P/S	Remarks
1. Type, direction of shaft	For individual Submersible Pump of Pump Station, please refer to Table 3A of Annex	Axial Flow Horizontal
2. Outlet size, mm		
3. Material motor frame, impeller, main shaft		
4. Total Head, m		
5. Flow rate, cmm		
6. Pump Efficiency %		
7. Revolution, rpm		Manufacturer's standard
8. Motor power, kW		
9. Insulation		
10. Nos of pole		Manufacturer's standard
11. Starting method		
11. Power source		
12. Start-up frequency		
13. Cooling method		
14. Nos of pump		

##### C) Gate Lifting Actuator (M1-103 ~ M7-103)

Item Description	Mithi River Storm Water P/S	Remarks
1. Type	For individual Gate Lifting Actuator of Pump Station, please refer to Table 4A of Annex	Spindle Type Actuator
2. Lifting capacity, ton		
3. Material: gear, spindle, gear box, spindle cover		
4. Spindle (diameter x height)		
5. Motor, kW		
6. Speed, m/min		
7. Required electrical power		

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8. Number of Actuator, ea		
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**D) Flap Valve (M1-104 ~ M7-104)**

Item Description	Mithi River Storm Water P/S	Remarks
1. Type	For individual Flap Valve of Pump Station, please refer to Table 5A of Annex	Centre Hinged F/V
2. Size of Valve		
3. Material & No of Disc		
4. Seals Material		
5. Installation Angle		
6. Flange Specification		
7. Hole Dimension		
8. Nos of Flap Valve		

**E) Local Master Control Panel (MOP) (M1-105 ~ M7-105)**

Item Description	Mithi River Storm Water P/S	Remarks
1. Type	For individual Local Master Control Panel of Pump Station, please refer to Table 6A of Annex	Outdoor Stand Alone
2. Size		
3. Material		
4. Operation		
5. Monitoring & Control		
6. Gate Opening Status		
7. Nos of Control Panel		

**F) Coarse Rotary Screen (M1-106 ~ M7-106)**

Item Description	Mithi River Storm Water P/S	Remarks
1. Type	For individual Coarse Rotary Screen of Pump Station, please refer to Table 7A of Annex	Removable Type
2. Size		
3. Screen (Bar pitch)		
4. Bar Size		
5. Screen erection angle		
6. Rake speed, m/min		
7. Nos of rake		
8. Open/Close Actuator		Manufacturer's standard
9. Motor power kW/V/Hz		
10. Nos of rotary screen		

**G) Belt Conveyor (M1-107 ~ M7-107)**

Item Description	Mithi River Storm Water P/S	Remarks
1. Type	For individual Belt Conveyor of Pump Station, please refer to Table 8A of Annex	Trough Type Rubber Belt
2. Size & No of Conveyor Horizontal		
3. Motor power kW/V/Hz		

**H) Floating Screen (M1-108 ~ M7-108)**

Item Description	Mithi River Storm Water P/S	Remarks
1. Type	For Floating Screen of	Floating Screen

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2. Size	Pump Station, please refer to Table 9A of Annex	
3. Screen (STS316L)		
4. Bar Size		
5. Screen erection angle		
6. Operation Method		
7. Nos of Screen		

**I) Stop Log (M1-109 ~ M7-109)**

Item Description	Mithi River Storm Water P/S	Remarks
1. Type	For individual Stop Log of Pump Station, please refer to Table 10A of Annex	
2. Size of Stop Log		
3. Size of Guide Frame		
4. Material Gate/Guide		Coating Condition A
5. Seals & Seal Direction		

**J) Flap Gate (M1-110 ~ M7-110)**

Item Description	Mithi River Storm Water P/S	Remarks
1. Type of Gate	For individual Flap Gate of Pump Station, please refer to Table 11A of Annex	Centre Hinged Flap Gate
2. Gate Size (B x H)		
3. Materials (Gate/guide)		(STS316L)
4. Design Water Level, m		
5. Downstream W. EL, m		
6. Sill EL, m		
7. Gate Control		By Water Level

**K) Sludge Pump (M1-111 ~ M7-111)**

Item Description	Mithi River Storm Water P/S	Remarks
1. Type	For individual Sludge Pump of Pump Station, please refer to Table 12A of Annex	Submersible Non-Clog Pump w/ Quick Disconnection Coupling
2. Outlet size, mm		
3. Material motor frame, impeller, main shaft		
4. Total Head, m		
5. Flow rate, cmm		
6. Pump Efficiency %		
7. Revolution, rpm		Manufacturer's standard
8. Motor power, kW		
9. Insulation		
10. Nos of pole		Manufacturer's standard
11. Starting method		
11. Power source		
12. Start-up frequency		
13. Cooling method		
14. Nos of pump		

## MITHI RIVER PACKAGE 3 - MECHANICAL PLANT & EQUIPMENT FOR PUMP GATE SYSTEM

### L) Sluice Gate (M1-112 ~ M7-112)

Item Description	Mithi River Storm Water P/S	Remarks
1. Type of Gate	For individual Flap Gate of Pump Station, please refer to Table 11A of Annex	Sluice Gate integrate with Flap Gate
2. Gate Size (B x H)		
3. Materials (Gate/guide)		(STS316L)
4. Design Water Level, m		
5. Downstream W. EL, m		
6. Sill EL, m		
7. Gate Control		By Manual

### DESIGN REQUIREMENTS OF PUMP GATE SYSTEM

- A. All parts of the Pumping Station shall be designed:
- to operate in the specified environment with reasonable water-tightness;
  - so that the gate lifting actuator can be easily maintained and the maintenance is the minimum;
  - to operate in any weather conditions;
  - to secure operational reliability of the system; and
  - to select the suitable materials or corrosive resistant coating with the compatible ones which shall have the physical properties or zinc anode for Cathodic protection as specified in Section 3.2 Painting and Coating.
- B. The design loads for roller type (pump) gate shall include the followings:
- upstream and downstream design static head;
  - dead weight generated from gate leaf, submersible pump, flap valve, spindle, cable and all attachments to the gate leaf;
  - operating dynamic forces generated from lifter and submersible pump;
  - seismic load;
  - buoyancy;
  - wind force; and
  - thermal load.
- C. The design condition of submersible pump shall include the followings:
- The specific gravity of upstream water is 1,000 Kgf/m<sup>3</sup>
  - To avoid cavitation, NPSH available / NPSH required shall be greater than 1.3.
- D. The Pumping Station as a whole shall be designed: -
- to have the maximum possible reliability, especially during operation of submersible

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- pump, gate leaf, gate lifter and, sluice gate, flap gate, floating screen and rotary screen;
2. to enable to operate with the designed differential water levels;
  3. so that the submersible pump can be operated without vortex, cavitation and undue vibration at any operating water levels;
  4. so that the gate leaf can be partially opened without any undue vibration at any water levels;
  5. so that in the event of power failure, the gates can be closed by self-weight of the gate leaf;
  6. so that rotary screen can be operated without overflowing of trashes between main screen and front screen; and
  7. so that all pump gate system can be endurable for the period of 15 years under the designed environment.

(Intentionally left blank)

**ROLLER TYPE PUMP GATE, SLUICE GATE, FLAP GATE & STOP LOG**

A. The allowable stress for the roller type (pump) gate, sluice gate, flap gate & stop log, and their gate guide frame are as show in table 13.1:

[Table 13.1]

(STEEL MATERIALS)	SS400 & SM400B THK(t) ≤ 40mm	SM490B THK(t) ≤ 40mm
1) Axial Tensile Stress, $\sigma_t$ , Per Net Sectional Area	1,200	1,600
2) Axial Compressive Stress, $\sigma_c$ , Per Gross Sectional Area Compressive Members  l: Buckling Length of Compression, Members (Cm) r: Minimum Radius of Gyration of Sectional Area of Compressive Members (Cm) Compressive Attachments	1) $l/r \leq 20$ : 1,200  2) $21 < l/r \leq 93$ : 1,200-7.5 (l/r-20)  3) $94 < l/r$ : $\frac{10,000,000}{6,700+(l/r)^2}$	1) $l/r \leq 15$ : 1,600  2) $16 < l/r \leq 80$ : 1,600-11.2 (l/r-15)  3) $81 < l/r$ : $\frac{10,000,000}{5,000+(l/r)^2}$
3) Bending Stress, $\sigma_b$ ,  Bending Tensile Stress Per Net Sectional Area Bending Compressive Stress Per Gross Sectional Area Aw: Sectional Area of Web Plate (cm <sup>2</sup> ) Ac: Sectional Area of Compression, Flange (cm <sup>2</sup> )  l: Supporting Length of Compression, Flange (cm <sup>2</sup> ) b: Width of Compressive Flange (cm) (In case of Compressive Flange is directly welded on the Skin Plate)	1,200  1) $l/b \leq 9/K$ : 1,200  2) $9/K < l/b \leq 30$ : 1,200-11(K(l/b)-9)  If $Aw/Ac < 2$ , K=2  If $Aw/Ac > 2$ , $K = 3+Aw/2Ac)^{1/2}$	1,600  1) $l/b \leq 8/K$ : 1,600  2) $8/K < l/b \leq 80$ : 1,600-16(K(l/b)-8)  If $Aw/Ac < 2$ , K=2  If $Aw/Ac < 2$ , $K = 3+Aw/2Ac)^{1/2}$
4) Shearing Stress, $\tau$ per Gross Sectional Area	700	900
5) Remarks (1) $t > 40$ mm  (2) Stainless Steel STS304, STS316 Tensile/Compressive Stress Shearing Stress	$\sigma_a \times 0.92$  1,050 600	$\sigma_a \times 0.94$   
6) Combined Stress	1.5 $\sigma_a$	1.5 $\sigma_a$

B. The allowable stress for the roller type (pump) gate, sluice gate, flap gate & stop log, and their gate guide frame are as show in table 13.2:

[Table 13.2]

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Materials	Tensile	Comp	Shear	Remarks
General Structural Steel (SS, SM)	5	5	8.7	
Forged Carbon Steel (SF)	5	5	8.7	
Carbon Steel for Machine (S-C)	5	5	8.7	
Cast Steel (SC)	5	5	8.7	
Stainless Steel (STS)	5	5	8.7	
Cast Iron (GC)	10	3.5	10	
Graphite Cast Iron (GC)	7	2.5	12	
Bronze (BC)	8	8	10	
Wire Rope	8			Operating Static Load
Link Chain	6.5			Operating Static Load

- C. The allowable surface pressure for rotating members for the roller type (pump) gate, flap gate, stop log, and gate guide frame are as shown in table 13.3:

[Table 13.3]

Materials	Allowable Surface Pressure (Kgf/cm <sup>2</sup> )					Remarks
	Journal		Rotating			
	Contact	Stop	Roller, Hinge	Lift Bearing	Stop	
Bronze Cast	60	180	140	60	280	
Ph Bronze	60	180	140	60	280	
Bronze Cast	60	180	140	60	280	
Brass Alloy (HB210 above)	230	450	450	230	450	

- D. The gate leaf for pump gate shall have an opening(s) perforated through front and rear surfaces of the gate leaf; a fair of rollers arranged along both lateral sides of the gate leaf and adapted to be seated in guide paths defined in guides of the guide frame when the gate leaf is lowered to keep the gate in a closed state, so as to prevent vibrations of the gate leaf and leakage during operation.
- E. The arrangement of constituent members of the gate leaf for pump gate and the positions of connecting spindles of the actuator unit connected to the gate leaf are set to allow the centers of gravity of the gate leaf equipped with pump(s) to keep a strictly balance at the connecting spindles of the actuator.
- F. The gate leaf for pump gate and the arrangement of constituent load bearing members shall be arranged in order to prevent the resonance vibration, which may occur when the natural frequency of gate is placed within 80% ~ 120% of submersible pump's frequency, during the operation of the submersible pump selected under this specification.
- G. The skin plate on opposite side of water flow direction shall be supported and reinforced with the upper and lower horizontal beams, vertical reinforcing beams and both sides end beams. The shape of the above beams shall have reinforcing ribs in order to sufficiently sustain the applied design loads to the gate leaf and to keep horizontal deflection of horizontal and vertical beams within 1/800 or 1/1000 as stated in Table 2A and 2B.



- H. The thickness of load bearing members for roller type (pump) gate, sluice gate with flap gate and stop log shall include of 1mm for carbon steel and none for stainless steel corrosion allowance thickness per each water interface in addition to the calculated minimum thickness of members.
- I. The pump gate shall be designed to be integrally equipped with one or two horizontal shaft submersible pump(s) on the bottom layer and if pre-required one or two submersible pump(s) on the upper layer of the pump gate.
- J. The pump gate shall be designed not so as to extrude over the designed width of Nalla outfalls.
- K. The roller type (pump) gate, sluice gate with flap gate and stop log shall also have perimeter sealing rubber forming a rectangle at one side of gate leaf facing the downstream side of which shape will be "P type" or "Y type" and shall be provided with seals such that the sealing surfaces are reasonable watertight all around.
- L. The gate leaf for pump gate shall be designed that when the upstream water is forcibly discharged by operation of the pump(s) in a closed state of the gate, it shall be designed to prevent vibrations and noises caused by a rotating of the pump by resulting from tight engagement of the main roller on gate leaf and the wedge on guide frame.

### **GUIDE FRAME FOR ROLLER TYPE (PUMP) GATE, SLUICE GATE, FLAP GATE AND STOP LOG**

- A. The guide frame for gate leaf shall be designed to withstand the design loads as well as transfer the dead load and the dynamic load generated while operation of the system.
- B. The guide frame for gate leaf shall provide the tight sealing device so as not to allow the leakage as stated in Section 1.12 hereof.
- C. The shape and dimension of guide frame shall be suitable for easy operation, water tight of the respective gate leaf.
- D. The guide frame shall be designed in consideration of constructability and operation and maintenance of the respective gate leaf.
- E. The material of guide frame on which sealing rubbers meet shall be of stainless steel STS316L and the supporting structural steel which will be embedded into the concrete shall be of structural steel SS400, BS 4360 - 86.
- F. As the guide frame being an integral part of the gate structure, the guide frame shall be designed and erected to prevent movement and deflection from concrete work.

### **ROLLERS FOR GATE**

- A. The material of main roller shall be forged steel or approved material of equivalent or more. The bearing to be used for roller shall be of lubrication free Oilless bearing.
- B. Bearing load of main roller should not exceed 0.8 times the rated bearing allowable load.
- C. The journal surface of the shaft of main roller should be eccentric with respect to the shaft end so that the track of all the rollers can be adjusted. The trajectory of the change should be adjusted so that all the wheels make uniform contact with the track frame.

- D. The diameter and width of the main roller shall be of sufficient strength taking into consideration of the contact between the roller and guide frame. The contact stress between main roller surface and the guide frame shall be within the allowable value.
- E. The diameter of main roller shall be planned to withstand the designed load conditions thereof.
- F. In considering the hardness of the contact surface, the material should be forged steel, roller rail should be harder than roller, and shaft should be harder than bearing.

### VIBRATION TOLERANCE RANGE

- A. The permissible vibration range of the integrated submersible pump is G2.5 (balance level) in accordance with ISO 1940-1.
- B. In order to prevent resonance, the stiffness of the roller type gate should be given in design thereof. The manufacturer should submit the satisfactory results on this during approval stage of design documents.
- C. The main rollers are formed on the upper and lower sides of both sides of the gate leaf, and the main rollers are seated on the guide frame when the gate leaf is closed, so that guide grooves are formed to prevent vibration generated when operating the pump(s). It should be made so that it absorbs vibration between gate leaf and guide frame.
- D. As the guide frame is integrated with the gate structure, and the permissible residual unbalance (vibration) from the pump(s) should be transmitted to the structure evenly through the guide frame.

### GATE SEALS

- A. Gates shall be provided with seals at the downstream of gate such that openings are watertight against downstream direction for all water levels and the leakage at the maximum differential head shall not exceed 0.1 litres per hour per gate leaf.
- B. The seal shall have sufficient strength to withstand any shearing effect during the lifting operations. Test certificate for the rubber seals on its properties and strength shall be made available in the final report.
- C. The rubber seals for the sides and top of the gate shall be the solid "P" type. The seal for the bottom of the gate shall be the flat rubber type for smooth operation of the gate. Seal mounting shall be done under the utmost care to prevent damage to the rubber under all conditions of operation. The side seals shall be adjusted for light contact against the sealing surface on the side rail assembly with no water load on the gate. A sufficient support shall be provided for the seal to eliminate possibility of water pressure bending it open.
- D. The seal shall be moulded from the rubber containing not less than one percent by weight of copper inhibitor or equivalent, and shall have the following physical properties in accordance with ISO 7619-1: -
  - 1. Material: Neoprene
  - 2. Shore A Durometer hardness: 40 ~ 80 (degree)
  - 3. Minimum elongation: 450 percents
  - 4. Minimum tensile strength: 14.5 Mpa
  - 5. Maximum water absorb: 5% (by weight)
  - 6. Specific weight: 1.1 ~ 1.4.

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- E. Transitions from side seals to bottom seal, if used, shall be made with moulded corner pieces spliced to the main seal pieces at about 300 mm from the corner.
- F. Gate seal fastenings and backing plates shall be stainless steel meeting applicable requirements of recognized standards.
- G. The base seal may be combined with a buffer or bearing strip adequate to arrest the travel of the gate when it is being lowered and to carry the weight of the gate and allow for the deformation of the gate when it is subsequently subjected to hydraulic loading in either direction.
- H. Gate seals and their fixings shall be designed in such a way that seals are easily replaceable and adjustable.
- I. Side seals shall be arranged so that water pressure increases the sealing effect.
- J. Seals shall be manufactured from synthetic rubber having suitable physical and chemical properties and having good resistance to abrasion, temperature changes and alternate wetting and drying, by the water, strong sunlight, ultraviolet rays, oxidation and ozonisation.

#### **SUBMERSIBLE PUMP**

- A. The pump shall be of submersible axial flow type consisted of suction, body and discharge part. The pump will be mounted on the flange of the roller type gate leaf and a flap valve having one or two discs and the top side of flap valve will be perpendicularly mounted on the discharge of each pump.
- B. The pump shall include the submersible pump, motor, monitoring & control unit, cable and accessories.
- C. Each pump shall be designed to have a stable head vs flow characteristic over the entire range of pumping operation and shall not deliver large changes in the discharge quantities with small changes in the differential head.
- D. The impeller shall be made so as to discharge water properly in terms of hydro-dynamics and to withstand corrosion caused by the pumping water and erosion caused by the flow of fluid. The impeller shall enable to discharge the water without clogging by debris contained in the water of sizes are of around 1/15 of submersible pump outlet diameters respectively.
- E. The allowable vibration limit of pump shall be in accordance with ISO 1940 -1 G2.5 (balance grade).
- F. The casing of pump shall be made of IS 210 Grade 250 (GC 250) to withstand the internal pressure, physical strength against vibration, corrosion and erosion, etc.
- G. The casing shall withstand 1.5 times of static head and 2 times of rated head. The casing shall also be easily assembled and disassembled.
- H. The pump and motor shall be mounted on the same shaft of which material is stainless steel STS Grade 410 (STS 410). The shaft shall withstand the maximum torque caused by the rated power, revolution, start up and stop mode of the pump.
- I. The bearing of pump shall withstand the radial directional loads and thrust directional loads generated by weight of rotor. The bearing life shall be of minimum 100,000 hours. The upper bearing will be Cylindrical Roller Bearing and lower one will be Angular Contact Ball Bearing.

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- J. The pump shall include double mechanical seal which will be located inside of bearing housing. The exterior of intermediate mechanical seal shall be made of silicon carbide which will prevent water from leak into the motor.
- K. The rotating part of pump will be sealed by spring and inserted O-ring.
- L. The wear ring shall be provided inside of pump casing which shall be of easily assembled and disassembled.
- M. The terminal board shall be provided in order not to induce water into the motor through cable. The terminal board shall be easily assembled and disassembled from the motor as well as sealed firmly.
- N. The mounting flange of pump shall be provided in accordance with ISO 7005-12(5K or 10K).
- O. The sealing between the metal-to-metal contacts shall be made by precise machining thereof as well as inserting rubber O-ring. In this event, it is not allowed to insert additional gasket, plate O-ring, grease alike, etc.
- P. The pump shaft shall be sealed by mechanical seal of which material shall be of silicon carbide and acid resistant exterior surface.
- Q. The power and control cables shall be provided suitable one in application for submersible pump.
- R. The pump shall be protected by monitoring and control unit as stipulated in Section 1.14 hereof. In the event the monitoring and control unit detects abnormal condition thereof, the monitoring and control unit will activate to switch off the electrical power to the pump.
- S. Each pump shall be provided with vortex shedding plate (STS 304) on the top of pump suction to prevent vortex formation.**
- T. Each motor for pump shall provide a margin of 10% over the maximum possible load at site under any operating condition; and insulation Class F, NEMA design B, service factor 1.15.
- U. The submersible pump shall be conducted performance test in accordance with the ISO 9906-2012 including its technical corrigendum.
  - 1. Flow Rate  
The flow rate test shall be carried out in accordance with ISO 9906-2012.
  - 2. Total Head  
The total head test shall be carried out in accordance with ISO 9906-2012.
  - 3. Efficiency  
The efficiency of pump test shall be carried out in accordance with ISO 9906-2012.
  - 4. Brake Horse Power  
The brake horse power test shall be carried out in accordance with ISO 9906-2012
  - 5. Balance of Rotor  
The allowable balance of rotor test shall be carried out in accordance with ISO 1940-1(G2.5).
  - 6. Field Test  
Operation inspection shall be made when upstream water condition and electrical power are ready.

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In the event Client's Inspector is unable to participate in the witness activity, the relevant item may be inspected by the third-party inspection (Public Authorized Inspector) or manufacturer's In-House inspection.

V. Recommended materials for the submersible pump are as follows;

Item Description	Materials	Remarks
1. Motor Frame	IS 210 Grade 250	(GC 250)
2. Bracket Cover & Stuffing Box	IS 210 Grade 250	(GC 250)
3. Suction Cover	IS 210 Grade 250	(GC 250)
4. Impeller	BS 1631 Grade A, (SSC 13)	(SSC 13)
5. Main Shaft	BS 970 Grade 410	(STS 410)
6. Guide Casing	IS 210 Grade 250	Coating Condition S
7. Mechanical Seal	Silicon Carbide	
8. Wear Ring	BS 1631 Grade A, (SSC 13)	(SSC 13)
9. Bolt/Nuts	STS Grade 316	(STS 316)

### MONITORING & CONTROL UNIT FOR SUBMERSIBLE PUMP

- A. The Monitoring and Control Unit (MACU) shall provide individual inputs, and alarm indication, for the thermal switches/sensors, leakage sensor(s), bearing & winding temperature sensor(s), direction of motor rotation and speed of motor rotation. The MACU shall provide data input, sensor, and analog data conversion to digital, data processing, receiver, display, and communication. The sensor unit is embedded in the submersible motor pump and the data input, analogue data conversion to digital, data processing, receiver, display, and communication units are in the pump monitoring and control unit.
- B. When the submersible motor pump has a fault and the monitoring and control unit operates, immediately turn off the MCC or the MOP, check the cause of the fault, and reset it by pressing the reset button of the fault monitor and then restart the pump.
- C. The monitoring & control unit shall be consisted of PLC type so that it can be input the design parameters thereto at site and when comparison results therefrom occur abnormality, it will be judged either to stop the motor or to continue operation.
- D. Every abnormality shall be shown in the monitor display the alarm and communicate the data with local main control panel.
  1. Stator coil temperature
  2. Upper bearing temperature
  3. Lower bearing temperature
  4. Water leak sensor (Inside motor / Oil chamber / Stuffing box)

### LOCAL MAIN CONTROL PANEL (MOP)

- A. The location of local main control panel (MOP) for submersible pump(s) and gate lifting actuator shall be shown in the equipment layout plan to ensure that the equipment can be operated at the most optimal conditions.
  1. The MOP shall be supplied by the pump gate manufacturer.

- B. The MOP shall enable to operate automatically and manually, and the volt meter, amp meter, PLCs, magnetic switches, overload protectors, monitoring and control unit and other control lamps in items shown in sub-section 1.15 G hereinbelow should be provided.
- C. During automatic operation, it should be operated by the pre-input data.
- D. In manual operation, each device operation can be operated only by ON/OFF switch on the site MOP panel.
- E. The type of MOP panel shall be in outdoor self-supporting
- F. Each MOP panel should have either a front or rear door. The enclosure of the At-site MOP panel shall be made of stainless (STS) steel plate with a minimum thickness of 2.0mm or more, and the support shall be a STS steel pipe, which is strong enough to withstand external loads. The MOP panel should be equipped with a handle with a lock and an internal hinge, and the inner plate should be manufactured with a door type. When designing the MOP panel, the base plate should be over 300 × 300 × 6t and the post pipe should be 75mmΦ standard.
- G. The following instruments are to be installed in the MOP panel and all indicators, such as instruments and lamps, must be visible from the outside without opening doors or windows with locks.
  - 1. Voltage meter
  - 2. Power ON/OFF switch
  - 3. Ampere meter
  - 4. Pump ON/OFF switch
  - 5. Pump Emergency stop button
  - 6. Pump Monitoring & Control Unit (integrated)
  - 7. Water level indicator
  - 8. Pump Gate Full Open lamp
  - 9. Pump Gate Full Closed lamp
  - 10. Pump Gate Opening lamp
  - 11. Pump Gate Closing lamp
  - 12. Pump Gate Opening Ratio (digital)
  - 13. Local/Auto Selector switch
  - 14. Circuit breaker for motor and circuit
  - 15. Space heater
  - 16. Alarm lamp

### **GATE LIFTING ACTUATOR**

- A. The actuator provided at an upper end of the gate and an actuator driver to generate a force required to raise or lower the gate leaf includes geared or screwed spindles connected with the gate leaf; a gate position indicator (GPI) provided with a limit switch to sense the opening/closing state of the gate leaf; a manual operating member provided at one side of the actuator driver.
- B. The capacity of actuator shall include the dead weight of gate leaf, pump, flap valve, cable, spindles, rollers and all attachments to the gate leaf and friction force generated during operation of the gate.
- C. The actuator for roller type (pump) gate shall be enabling to lower by the self-weight of the gate leaf, pump, flap valve, spindle and cables during failure of power or emergency lowering of gate.

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- D. The actuator shall be consisted of the main reducer, subsequent reducer, worm shape gear and spindle.
- E. The roller type (pump) gate shall be smoothly raised/lowered by gearing of gear or screw and vertical spindle. After complete lowering of gate, spindle shall be kept on holding the gate in order to prevent vertical vibration generated during operation of pump and dynamic forces generated fluid dynamics.
- F. The actuator shall provide more than one brake system in order to stop operation thereof. The capacity of brake is 150% of required brake force.
- G. The actuator shall be designed to limit the vertical direction movement (vibration) of the gate leaf during operation of the pump.
- H. The actuator is required to provide a gate position indicator (GPI) which includes the upper and lower limit switch as well as adjustable by manual in situ.
- I. The gate shall provide a local main control panel which will systematically control the actuator and the pump, so as to automatically or manually control the rapid lowering of the connecting spindles and the forcible discharge of the upstream water toward the downstream water at a remote place, on the basis of water level signals indicative of a pump operating water level, pump stop water level, gate closing water level, and a gate opening water level transmitted from the water level sensor of the gate located toward the water channel, gate opening/closing state information from an information processor thereof, and signals sensed by a power source controller thereof.
- J. The actuator shall enable to operate by manual while electrical power is failure.

### **GATE LIFTER SPINDLE & SPINDLE COUPLINGS**

- A. The spindle shall be suitably sized to withstand the normal operating loads of the gate without buckling and permanent distortion. Spindle shall be machined from BS 970 Grade 060A47 (SM45C) solid bars with electro zinc coated.
- B. Gear or screw of the spindle shall be machined cut so as to smooth gearing during operation of actuator.
- C. Sufficient length of the spindle shall be provided to suit the site conditions; spindle shall be suitably supported to prevent buckling under compression.
- D. Rising spindle shall be provided with adjustable limit nuts or stop collars above and below the pedestal lift nut to prevent over-travel of the gate in either direction.
- E. The spindle shall be protected with spindle cover which is made of BS 4360 Grade 86 (SS 400) with hot-dipped galvanized.

### **FLAP VALVE**

- A. The flap valve is consisted of valve body, one or two discs, and rotational links which are located centered side of discs in order to minimize the friction loss through the valve during operation and to be easily operated when small water level different between both sides of valve and to be closed firmly when it is not operated in order to prevent from downstream water leak into the upstream side.
- B. The flap valve shall have single disc up to diameter of valve  $\Phi 900\text{mm}$  and double discs those for  $\Phi 1,000\text{mm}$  diameter and larger.

- C. The seal material for valve shall be of Neoprene or equivalent.
- D. The hinges for rotational links shall be sufficiently withstood the dynamic forces generated from the operating of submersible pumps.
- E. The disc(s) of flap valve must strong enough to withstand the shock when opening and closing and have a reinforcement structure, if necessary, to form a rotational link that guides the disc(s) when opening and closing.
- F. Dimensional tolerance of valve flange is to comply with ISO 7005-2 (Dimensional tolerance of pipe flange).
- G. Dimensional tolerance of bolts holes diameter is to comply with ISO 6708 (Nominal diameter and holes diameter of valve).
- H. The angle of installation of flap valve is perpendicular so as to minimize the friction loss through the flap valve and protrusion distance of valve to gate leaf.

### COARSE ROTARY SCREEN

- A. Rotary screen, as a trash removal equipment, is composed of main screen, front screen, frame, driving device, rake, chain, shaft, sprocket wheel, opening/closing facility of rotary screen, platform, local control panel (LCP), etc.
- B. The screen bar shall consist of flat plate, spacers, assembly bolts and nuts, and supports, which shall be made of stainless steel, with an effective spacing of around 1/15 of the diameter of respective pump(s).
- C. Rotary screen is being connected with the rakes connected to both side chains to clean the trashes. The rakes will be circulated continuously by the driving of the rakes between the flat bars so that during travelling of rakes remove the trashes on surface of the main screen
- D. The rakes are to lift the trashes from bottom of the screen to the horizontal conveyor, in order to free fall thereon.
- E. Frame is divided into upper and lower frames, and lower frame should be attached with rake link chain and guide rail.
- F. The front screen shall enable to rotate when pass the rakes in order to prevent entrance of trashes through gaps between the main screen and front screen.
- G. Wood, grass, vinyl, household waste and other trashes that likely interfere with the operation of the pump should be removed by the rotary screen continuously. Safety devices should be provided in the reducer to make the motor stop and alarm when overloaded.
- H. The rake chains should be installed to prevent out of track from the guide rail by using a flanged roller chain. The rake chain is designed to be smoothly rotated at the U-turn when therake chains are rotated. A take-up device is to be provided for adjustment, and a safe structure capable of withstanding water pressure.
- I. All parts of the device are to be constructed to withstand the additional load during operation or any load during installation.
- J. All parts except stainless should be coated with epoxy based material which does not affect the water quality after pretreatment of rust and other substances with sand blast and the coating thickness should be over 150  $\mu\text{m}$ .



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- K. Rotary screen shall be opening and closing by wire drum type actuator provided on the top side rotating shaft in order to open the screen body when rotary screen is out of season or out of order.
- L. Recommended materials for the coarse rotary screen are as follows;

Item Description	Materials	Remarks
1. Screen	BS 970 Grade 316L	(STS 316L)
2. Upper Frame	BS 4360 Grade 86	(SS400 Hot dip galvanized)
3. Lower Frame	BS 970 Grade 316L	(STS 316L)
4. Plate	BS 970 Grade 316L	(STS 316L)
5. Rake	BS 970 Grade 316L	(STS 316) L
6. Rake chain	BS 970 Grade 304	(STS 304)
7. Sprocket	BS 970 Grade 060A47	(SM45C)
8. Guide Rail	BS 970 Grade 316	(STS 316)
9. Walk Way	BS 4360 Grade 86	(SS400 Hot dip galvanized)
10. Bolt/Nuts	BS 970 Grade 316	(STS 316)

#### LOCAL CONTROL PANEL FOR ROTARY SCREEN

- A. Local control panel (LCP) shall be equipped with such device as start-up and stop switch for drive motor, electronic overload relay, torque limit switch, automatic operation device operated by timer or level sensor, electric contact to send trip signal, self- trip & alarm unit, lamp etc.
- B. Local control panel shall be of water-proof outdoor type and be made of STS304 steel plate in 2.0 mm thickness and shaped steel.
- C. It shall perform automatic and manual operation. Automatic operation shall be performed by setting the operation time or time span between operations.
- D. The inside unit and electric wiring work of local control panel shall be in accordance with the requirement and relevant code.
- E. It shall contain the function to control such related unit as conveyor.
- F. Screen shall be operated automatically when water level difference between front and back of screen exceeds 100 mm.
- G. Screen shall be operated automatically in line with the operation of pump.
- H. It shall be equipped with the following unit.
1. switch for automatic / manual, selector switch for local/remote operation
  2. switch for normal / reverse rotation, switch for stop
  3. signal lamp for on/off/ abnormal
  4. emergency stop switch
- I. Electric wiring & conduit piping work from the local control panel to the relating unit shall be contained in this work.
- J. Terminals shall be provided for all the signals to be delivered to local main control panel (MOP).

#### FLOATING SCREEN

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- A. Floating Screen is consisted of floating chamber of which internal filled with very light material, travelling rollers, bar shape front screen, surrounding safety guide on floating chamber, gate guide frame and manual rake.
- B. The bar of the front screen is made of tubular pipe shall be placed in front the floating chamber. The floating chamber is also made of beam which generates the buoyancy so that the chamber shall be floated (raise or lower) in accordance with the water level. The chamber will be raised and lowered by the travelling rollers attached to the both side of floating chamber.
- C. The trash to be accumulated in front of screen will be removed by rake by manual on the top of the platform of floating chamber of which working space shall be provided with safety guide.
- D. Tubular shape front screen is to be installed in front of the chamber having effective clearance must be 150mm.
- E. The tubular shape pipe should be horizontally and vertically accurate, and the buoyancy beam should be fully welded to prevent leakage and filled with light weight material such as Styrofoam to maintain the buoyancy in case of breakage.
- F. All parts of the screen are to be manufactured to withstand all loads during operation or any load during installation.
- G. All parts except stainless should be painted after sandblasting and the coating in accordance with Section 3.2 hereof.

#### **BELT CONVEYOR (HORIZONTAL)**

- A. The conveyor for conveying trashes consists of frame, drive pulley, tail pulley, rubber belt, skirt roller, support, drive and controls.
- B. The supporting load and power of the conveyor belt shall be designed considering the specific gravity of the conveying material, the conveying speed, and the width of the belt, and the driving method by the pulley.
- C. The head pulley should have no slip in transmitting power, and the carrier roller, the conveying roller, and the side roller should be rubber-lined in the structural steel pipe and have rolling bearings.
- D. Carrier rollers should be installed at intervals of 1m and 2m, respectively.
- E. Belt should be made of rubber material with strong strength against oil and sewage, and tensile strength of belt should be made with sufficient strength.
- F. Take-up device for adjusting belt tension should have effective stroke of 300mm or more, and prevent excessive deflection of belt, and frame support should enable to withstand anticipated static load and dynamic load.
- G. Conveyor belts should be fitted with overload breakers and rope type emergency stop devices, including actuators and field operation panels.
- H. Skirt device is installed on the upper surface of the belt to prevent the debris from each damper from falling on the belt.

#### **FLAP GATE**

- A. Flap Gate is consisted of flap, buoyancy beams, hanging hinges, side links and gate guide frame. The flap gate shall be integrated inside of sluice gate so that it is easily accessible after lift up thereof during maintenance of flap or convert flap gate to stop log.

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- B. The shape of gate leaf is made of square and the material of skin plate and reinforcement should be of BS 970 Grade 316L (STS316L) or equivalent material.
- C. The gate leaf must withstand the highest water pressure and automatically open and close.
- D. The vertical and horizontal buoyancy beams should be constructed to be able to withstand water pressure and to secure watertight space, and each weld should be carried out to ensure air tightness of the members. Hinge shall be arranged so as for flap to be smoothly operated at small upstream and downstream water level different.
- E. Flap Gate shall be converted to stop log by toggle type clamps which are placed on both sides of guide frame. The toggle type clamps shall be completely off during normal phase.
- F. All other requirements for sluice gate and flap gate refer to Section 1.8 and 1.9 hereof.

### STOP LOG

- A. During normal operation stop logs shown in the drawing shall be stored near to the floating screen and when stop logs are required for isolating the pumping station during non-monsoon period to facilitate maintenance of the screens and pumping facility, the floating screen will be removed and instate stop log in the same guide frame.
- B. Provision for installing one set of stop logs each, covering the entire width at the upstream. Each log shall have two equally spaced stainless steel lifting lugs.
- C. Downstream side of pump station flap gate will be acted as stop log (Section 1.23E).
- D. All other requirements are in Section 1.8 and 1.9 hereof.

### SLUDGE PUMP

- A. The sludge pump shall be a free-standing portable type submersible non clog drainage pump set (1 working + 1 standby) shall be supplied for draining storm water of individual pump bay.
- B. Mechanical seal made of silicon / silicon-ceramic / carbon or equivalent materials shall be installed so that the suction liquid is not flow into the through part of the motor.
- C. Impellers are open type in principle and are of good wear resistance and easy to replace.
- D. In addition to the radial load, the bearings must be able to sufficiently support the mass of the rotating parts of the motor and the thrust load generated from the pump, and should be able to run for at least 30,000 hours.
- E. The automatic coupling/decoupling device shall be provided so that the flow does not leak from the discharge, and it can be coupled automatically with the discharge flange of the pump.
- F. The cable shall be suitable for underwater use, drawn out from the motor cover, and the lead part is to be waterproof.
- G. The pump should be operated in any posture within 90° to the vertical, and no significant change in its performance or service life.
- H. The pump is to be fitted with earth terminals at appropriate locations.
- I. Pump is to be provided with hanging hook.

**SLUICE GATE**

- A. The sluice gate is consisted of gate leaf, gate guide frame and lifting hoist. The flap gate in Section 1.23 shall be integrated inside of sluice gate.
- B. The gate leaf and gate guide frame shall be designed to fulfil the requirements of Section 1.8 and 1.9 hereof.
- C. The type of lifting hoist will be rack bar type one.
- D. The lifting hoist shall be consisted of the main reducer, subsequent reducer and rack bars spindle.
- E. The lifting hoist shall be smoothly raised/lowered by gearing of rack gear and vertical rack. After complete lowering of gate, rack shall be kept on holding the gate in order to prevent vertical vibration generated during operation of flap gate.
- F. The lifting hoist shall provide more than one brake system in order to stop operation thereof. The capacity of brake is 150% of required brake force.
- G. The lifting hoist is required to provide a gate position indicator (GPI) which includes the upper and lower limit switch as well as adjustable by manual in situ.

- The end of this Section 1

**FABRICATION OF GATE LEAF AND GUIDE FRAME**

A. General

1. The fabrication of roller type (pump) gate, roller gate, and stop log shall be made in accordance with the requirements given in the technical specification, relevant codes and standards, drawings, instructions, procedure and manual, etc.
2. The parts of gate leaves shall be pre-fabricated by computer aid machining as much as possible in order to keep precise control of dimension.
3. All bending work required on the plate shall be made by bending machine, no hot bending work by torch is allowed.
4. All welding work on the gate leaf shall be done by the qualified welders.

B. Gate Leaf

1. In Gate rollers shall be forged steel or better. Main rollers shall be designed to carry the radial loads, resulting from the most adverse combination of loading, in combination with an axial load applied at the roller rim due to thermal expansion or contraction of the gate. For the purpose of calculating this axial load the coefficient of friction between roller and roller path shall be taken as not less than 0.1.
2. The main roller assembly shall a heavy-duty stainless steel, self- lubricated bearing, a shaft (axle) and mounting collars. Other components of the main roller assembly shall be made of stainless-steel casting and STS304L materials. Castings shall be in accordance with recognized standards. The main roller assemblies shall be spaced along the sides of the roller type (pump) gate to carry equal portions of the hydraulic forces. The bearings shall be self-lubricated journal type. The main roller shaft shall be of STS304 or better and be of adequate diameter to take the thrust developed when the full head of water is in contact with the gate leaf. The main roller shafts shall meet the applicable requirements of recognized Standards.
3. The components of the main roller assembly shall have a Brinell hardness of not less than 180. Main roller links and pins shall be of annealed one.
4. The Gate side rollers shall be manufactured from STS304 materials.

C. Gate Guide Frame

1. The guide frame shall be designed to withstand the applied design loads delivered from the main rollers while the gate is raised or lowered.
2. The guide frame shall provide the guide paths which prevent the horizontal movement when the gate leaf is fully closed so as to prevent vibrations caused by pump operation.
3. As the guide frame being an integral part of the gate structure, the guide frame shall be designed and erected to prevent movement and deflection from concrete work.
4. At each side of the gate leaf, an adequate number (minimum of two) of main rollers, to prevent distortion of the gate under any loading, and suitably positioned, shall be provided

for guidance in the upstream and downstream directions. Two side guide rollers shall be provided at the side (i.e., top and bottom) of the roller/vertical lift gate for guidance and constraint against side movements.

5. Clearances between main rollers and guides shall be adequate to allow gate operation correctly under the worst combination of thermal movement and structural deformation of the gate.
6. Main rollers and guides shall be designed to carry any additional loads which may result from thermal movement of the gate when it is subjected to the most severe combination of hydraulic loading. Operating temperature range shall from 10°C to 65°C.
7. Gate guides and main rollers shall be designed to transmit the most adverse combinations of loads from the gate leaf, for any particular position of the gate to the civil engineering structure without exceeding the permissible stresses.
8. The material of guide frame on which sealing rubbers run shall be of STS316L and the supporting structural steel which will be embedded into the concrete shall be of structural steel SS400. The minimum thickness of the guides shall not be less than 7 mm.

**D. Assembly at Shop**

1. The gate leaves shall be assembled at shop in accordance with the dimensions shown in the relevant shop fabrication drawings. During assembling thereof, if there is any incorrect alignment, it shall be rectified prior to application of painting or coating.

**E. Inspection for Fabricated Parts**

1. The inspection will be carried out for material inspection, welding inspection, assembling inspection at shop. Inspection shall be witnessed by the Client's inspector in accordance with the approved Inspection and Test Plan (ITP).
2. In the event Client's Inspector is unable to participate in the witness activity, the relevant item may be inspected by the third-party inspection (Public Authorized Inspector) or maker's In-House inspection.
3. The material inspection will be carried out by review of relevant mill certificates.
4. The welding inspection will be carried out by visual inspection.

**F. Allowable Misalignment**

During fabrication and assembly of steel members and parts, the following allowable misalignment formula will be applied.

$$E = E_0/2 (1 + L/10) \text{ (maximum } \pm 20\text{mm)}$$

Where,  $E_0$ : standard allowable misalignment per each 10m

L: Allowable misalignment for parts (m)

$E_0$  value are as follows;

- Width, Height, Others:  $\pm 8\text{mm}$
- Center to Center:  $\pm 6\text{mm}$
- Dimension related to sealing:  $\pm 4\text{mm}$

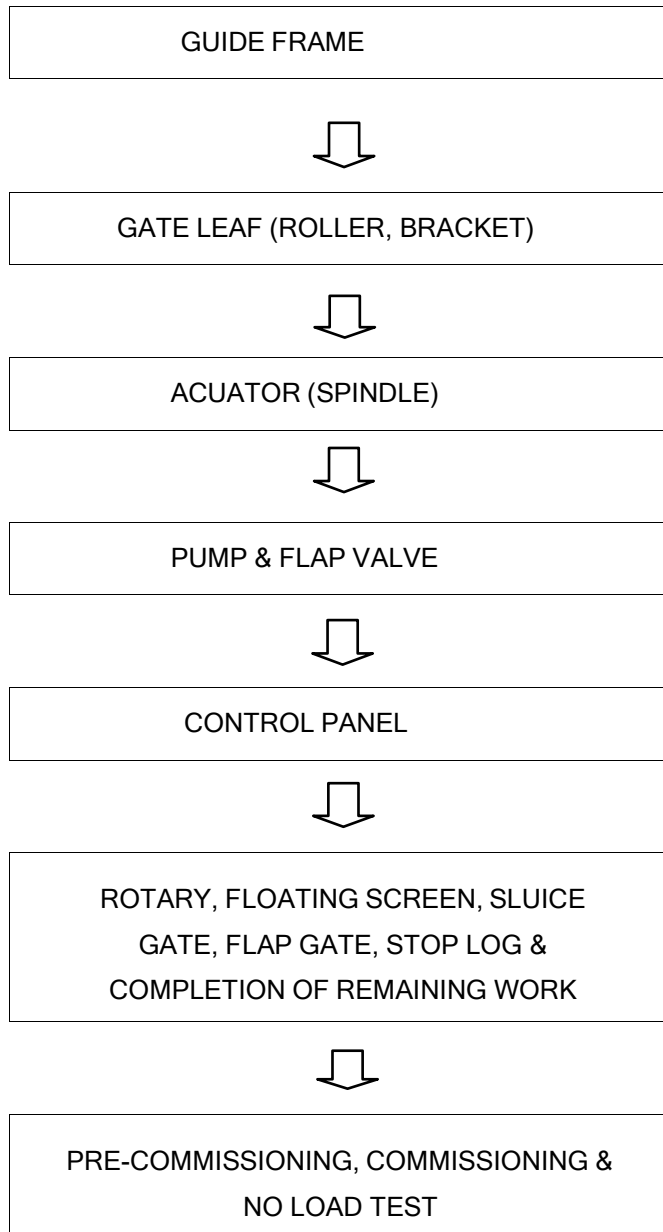
Seal surface on guide frame interfacing with Seal Rubbers

1. Supporting structure:  $\pm 3\text{mm}$  per every 10m
  2. Machined surface:  $\pm 11.5\text{mm}$  per every 10m
  3. Deflection for whole span
- Supporting structure: 1/1000
  - Machined surface: 1/2000

- The end of this Section 2

**PROCEDURE FOR PUMP GATE SYSTEM INSTALLATION**

The Pump Gate System will be installed in accordance with the following procedure:



**A. Guide Frame**

1. It shall be verified that the civil structures in related to the guide frame be constructed in accordance with the approved project drawings and anchor plates be correctly installed which are to be connected with guide frame prior to concrete powering by Civil works contractor.
2. As the seal beams of guide frame are to be maintained tight seal and withstood whole water pressure applying on guide frame through gate leaf, they shall be carefully handled in order not to be damaged nor distorted until completion of erection.
3. Contractor shall provide all temporary and safety for opening items required to complete installation of guide frame.



4. Guide frame shall be erected in the order of bottom, side and upper beam.
5. After completion of welding of guide frame, welded area on the surface of exposed beams shall be thoroughly grinded in order to prevent from damage of seal rubber.

**B. Gate Leaf**

1. Prior to installation of gate leaf, guide frame shall be verified as it is not distorted after erection thereof. If there are any defects, they shall be rectified.
2. After assembling of main and side rollers, if they are un-assembled at the shop, gate leaf shall be installed in the guide frame by proper crane. Minor alignment shall be done by chain block.
3. After installation of gate leaf, Contractor shall check the rollers and seal rubbers for their function.
4. The spindle will be assembled on the brackets on the top of gate leaf.

**C. Gate Lifting Actuator**

1. Prior to installation of actuator, Contractor shall verify the center to center of spindle, center of gate leaf, and the center of actuator.
2. During installation of actuator, the actuator shall be lowered keeping on a level from the beginning so that after installation, it shall be on a level. The Actuator on frame shall be installed on the both spindle in accordance with the approved project drawing.
3. The Actuator on frame shall be firmly fixed by anchor bolts.
4. The gate position indicator (GPI) shall be set by the upper and lower limits.
5. The power and control cables from and to the local control panel and actuator shall be installed, terminated, and tested.
6. The Actuator shall be pre-commissioned and commissioned with temporary power. During this stage, the seal rubber must avoid dry condition.

**D. Submersible Pump & Flap Valve**

1. Prior to installation of submersible pump, gate leaf and actuator must be checked and operable.
2. Submersible pump shall be installed on the mounting flange of gate leaf by proper crane.
3. Both power and control cable shall be installed carefully so as not to damage, terminated, and tested.
4. Both power and control cable shall be protected by flexible cable protector.
5. Flap valve shall be installed on the discharge flange of submergible pump.

**E. Local Main Control Panel / Local Panel**

1. Prior to installation of local control panel, Contractor shall discuss with Company for selection of appropriate location of panel.
2. All power and control cable shall be installed, terminated, and tested.
3. Pre-commissioning and loop test shall be carried out.
4. Dry test run shall be made with temporary power. During this stage, Company, electrical and instrument contractors shall be closely coordinated.
5. After trial operation, training of Company's operator will be performed at site.

**F. Rotary Screen, Floating Screen, Sluice Gate, Flap Gate, Stop Log, Sludge pump**

1. They shall be installed in accordance with the manufacturers instruction and Project final drawings

**FIELD INSTALLATION & TESTS**

- A. The General Contractor (Civil) shall be responsible for concrete pouring in exterior side gate guides to the civil structure. Mechanical Contractor shall be responsible for installation of the Pump-gate unit, the gate lifting actuator and the associated accessories as set out in Section 1.4 hereof. Pump-gate unit shall be handled, installed and lifted up at Site according to the Manufacturer's instruction. Method of statement on the installation of Pump-gate unit shall be submitted to the Site Operator beforehand.
- B. During pre-commissioning, commissioning and the trial run operation, the Contractor shall satisfy himself (a) the adequacy of the installation; (b) safe and efficient operation on the Pump-gate unit: (c) correct functioning of the controls and other devices.
- C. After the successful test run of the Pump-gate unit system, the Contractor shall arrange for the no-load test to demonstrate the compliance to the specifications.

**PAINTING / COATING**

- A. The Pump Gate System shall be coated or painted as follows;

1. General

Painting/Coating should be applied to the exterior of all exposed steels and components. However, the followings are excluded;

- (1) the surface of stainless steel.

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- (2) the surface of the plated steel.
- (3) the surface to be poured into concrete or the surface to be buried in concrete.
- (4) Component coated with grease or other materials.
- (5) Other mechanical friction surfaces or surfaces to be welded on site (within 1 inch from the weld).

### 2. Painting/Coating Condition

- (1) Condition S: The metal product is completely submerged or temporarily submerged in brine water or equivalent corrosive liquid.
- (2) Condition A: The metal product is completely submerged or temporarily submerged in swage water, sludge, rain water, or equivalent corrosive liquid.
- (3) Condition B: The metal product is not exposed to non-corrosive atmosphere.
- (4) Condition C: The metal product is exposed to corrosive atmosphere.

### 3. Coating or Painting

Unless otherwise specified, the following painting method shall be applied.

Condition	Surface Preparation	Paint/Coat
S	SP-10	Near White Blast Cleaning
	P	Tar Epoxy Resin
	IC	Tar Epoxy Resin
	FC	Tar Epoxy Resin with Zinc Anode Cathodic Protection
A	SP-10	Near White Blast Cleaning
	P	Tar Epoxy Resin
	IC	Tar Epoxy
	FC	Tar Epoxy Resin
B	SP-10	Near White Blast Cleaning
	P	Alkyd Resin
	IC	Alkyd Resin
	FC	Alkyd Resin
C	SP-10	Near White Blast Cleaning
	P	Inorganic Zinc
	IC	Polyamide Epoxy HB
	FC	Polyamide Epoxy HB

SP: Surface Preparation, P: Prime Coat, IC: Intermediate, FC: Top Coat

4. Zinc anodes will be placed on the visible surface of submersible pumps or gate.
5. Painting for Assembled Products

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All surfaces of assembled product shall be painted of prime and top coat in accordance with the approved color code.

If they completed top coat at shop, touch up paint shall be applied at field for the damaged area.

6. Painting at Field

The areas damaged during transportation and erection shall be painted by the means of original application.

7. Electrically Zinc Coated Product

The product coated by electrical zinc method shall be repaired by JASS 18 or equivalent method.

8. Motor & Panel Painting

The surface of motor and panel shall be coated or painted in accordance with the instruction given by the maker.

- The end of this Section 3

## **MAJOR EQUIPMENT OPERATION & PERFORMANCE REQUIREMENTS**

### A. Operation Requirements

1. Starting and stopping of the pumps shall be controlled by the pre-set water levels that will be adjusted at Site. However, this shall be taken into consideration of operation range of the respective pumps.
2. One of the pumps is set to operate initially at pre-set water level in the sump. If the water level continues to rise, second pump shall be ON, and so on until all the pumps operate. Pumps shall be assigned to operate in alternating sequence. Pumps that are faulty or inoperative will be bypassed. Pumps can be set to stop pumping at one common level or staggered to stop at different levels.
3. When downstream water level is lower than that of upstream, Pump gate will be opened so that gravity flow will discharge upstream water toward downstream.
4. When downstream water level goes higher than that of upstream water, Pump gate will be completely closed. During gate closed state, if upstream water level reaches to the pre-set water level, submersible pump and rotary screen will be automatically operated in order to forcibly discharge upstream water toward outside. When of the downstream water level drops lower than that of upstream water, the submersible pump and rotary screen will be stopped and Pump gate will be opened so that gravity flow will discharge upstreamwater toward outside.
5. The pumping station shall be kept on dry state during dry season in order to avoid odorous smell by operation of the roller gate and sludge pump.
6. The submersible pump shall be operated lower water level than LWL.
7. Details of local main control panel according to pump gate system operation are as follows.
  - Pump gate operation - manual operation at site
  - At-site (sequence by PLC) manual and automatic operation
    - Manual operation: Field control by manual
    - Auto operation: Automatic or remote operation by detected water levels

### B. Design Requirements

1. Pump unit shall be designed to operate at the required speed without cavitation or vibration.
2. The complete pump unit shall be designed to operate without overload on any component at any point along the pump's entire operating curve.

### C. Pump Suction Ability

1. Pumps offered shall enable to operate over the head ranges under extreme conditions of maximum and minimum water level in the pump sump, and with reference to the highest river water level and the pump discharge outlet level.

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D. Major Equipment Performance and Operation limits

The following operational limits of pump shall be submitted by the tenderers.

(A1) Submersible Pump Performance (CITY Area)

Pump Station	Note	Flow Rate Q(cmm)	Total Head H(m)	Efficiency $\eta$ (%)	BHP P(Shaft)	NPSH Nav/Nre
MR-101	Qbep	960(=240 x 4)	BTS	BTS	BTS	BTS
MR-102	Qbep	500(=250 x 2)	BTS	BTS	BTS	BTS
	Qbep	190(=190 x 1)	BTS	BTS	BTS	BTS
	Qbep	250(=250 x 1)	BTS	BTS	BTS	BTS
MR-103	Qbep	1360(=340 x 4)	BTS	BTS	BTS	BTS
	Qbep	400(=400 x 2)	BTS	BTS	BTS	BTS
	Qbep	400(=400 x 2)	BTS	BTS	BTS	BTS
MR-104	Qbep	2280(=228 x 10)	BTS	BTS	BTS	BTS
	Qbep	2280(=228 x 10)	BTS	BTS	BTS	BTS
MR-105	Qbep	580(=290 x 2)	BTS	BTS	BTS	BTS
MR-106	Qbep	114(=114 x 1)	BTS	BTS	BTS	BTS
	Qbep	228(=114 x 2)	BTS	BTS	BTS	BTS
MR-107	Qbep	200(=100 x 2)	BTS	BTS	BTS	BTS

Note: Q = flow rate(cmm), H = total head(m),  $\eta$  = pump efficiency, P = motor required power(kW), Qbep = Q@ best efficiency point(cmm), Nav = NPSH available, Nre = NPSH required, BTS = Bidder to specify

(B1) Maximum Required Electrical Power (CITY Area)

Pump Station	Submersible Pump	Gate Actuator	Coarse Rotary Screen	Rotary Screen Actuator	Belt Conveyors	Total
MR-101	BTS	BTS	BTS	BTS	BTS	BTS
MR-102	BTS	BTS	BTS	BTS	BTS	BTS
	BTS	BTS	BTS	BTS	BTS	BTS
	BTS	BTS	BTS	BTS	BTS	BTS
MR-103	BTS	BTS	BTS	BTS	BTS	BTS
	BTS	BTS	BTS	BTS	BTS	BTS
	BTS	BTS	BTS	BTS	BTS	BTS
MR-104	BTS	BTS	BTS	BTS	BTS	BTS
	BTS	BTS	BTS	BTS	BTS	BTS
MR-105	BTS	BTS	BTS	BTS	BTS	BTS
MR-106	BTS	BTS	BTS	BTS	BTS	BTS
	BTS	BTS	BTS	BTS	BTS	BTS
MR-107	BTS	BTS	BTS	BTS	BTS	BTS

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	BTS	BTS	BTS	BTS	BTS	BTS
MR-124	BTS	BTS	BTS	BTS	BTS	BTS
MR-125	BTS	BTS	BTS	BTS	BTS	BTS
	BTS	BTS	BTS	BTS	BTS	BTS

(C1) Performance of Gate Lifting Actuator (CITY Area)

Pump Station	Actuator Type	Lifting Capacity (T)	Lifting Velocity m/min	Function of Emergency Lowering	Diameter of Spindle, mm
MR-101	BTS	50	0.4 ± 10%	BTS	BTS
MR-102	BTS	50	0.4 ± 10%	BTS	BTS
	BTS	50	0.4 ± 10%	BTS	BTS
MR-103	BTS	80	0.4 ± 10%	BTS	BTS
	BTS	80	0.4 ± 10%	BTS	BTS
MR-104	BTS	80	0.4 ± 10%	BTS	BTS
MR-105	BTS	80	0.4 ± 10%	BTS	BTS
MR-106	BTS	30	0.4 ± 10%	BTS	BTS
MR-107	BTS	30	0.4 ± 10%	BTS	BTS

(D) Provision of Pump Monitoring & Control - All P/S

Description	Bearing Temp	Motor Temp.	Water Leak	Motor Moisture		
Monitoring	BTS	BTS	BTS	BTS		

- The end of TS