AMENDMENT NO. 1, DATED 08-12-2016

To

NIT NO : DoP/PNPM/CPIIUC/CETP/Alathur-E001, Dated 28-11-2016

FOR

INSTALLATION OF 2 x 170 KL PER DAY = 340 KL PER DAY COMMON EFFLUENT TREATMENT FACILITY

ON LSTK BASIS

AT

ALATHUR, KANCHEEPURAM DISTRICT TAMILNADU

पी डी आई एल
PDIL

PROJECTS & DEVELOPMENT INDIA LTD.
(A Govt. of India Enterprise)
PDIL BHAWAN, A-14, Sector-1,
NOIDA U.P. (India)

And

CPIIUC

CHENNAI PHARMA INDUSTRIAL INFRASTRUCTURAL UPGRADATION COMPANY
B-24, SIDCO Pharmaceuticals Complex Alathur
Kanchipuram District, Tamilnadu,
PIN 603110

LDKSaigal
08/12/2016

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FOR

INSTALLATION OF 2 x 170 KL PER DAY = 340 KL PER DAY COMMON EFFLUENT TREATMENT PLANT (CETP) FACILITY

The following points are amended/clarified:-

(1) **The capacity/sizes/numbers of various equipments/facilities/systems mentioned in the NIT/BOQ/BOM are indicative. Bidders to consider these as required for fullfilling the Project requirement as the Bids are invited on LSTK basis.**

After award of job, the LSTK contractor shall have to carry out the detailed design as per releavant codes and standards to ensure a successful and intact system (in all respect) for the above mentioned CETP of 2 X 170 KL Per Day capacity, and shall submit the design documents/drawings for review by PMC.

No extra cost shall be entertained after award of Contract, if the capacity/sizes/numbers of various equipments/facilities/systems will increase on detailed design.

(2) **The LSTK Contractor shall have to submit:-**
- (i) **Four copies of all the drawings, documents and design calculations for review by PMC.**
- (ii) **Six copies of all the Final (Good for Construction) drawings & documents for execution of job, duly signed and stamped.**
- (iii) **Six copies of all the as-built drawings for records purpose, after Commissioning, duly signed and stamped.**
- (iv) **Four Copies (sets) of Soft files/Editable files (Autocad, Word, Excel, etc.) of all the drawings and documents (i.e. Project Deliverables) after Commissioning, in CDs.**

(3) **Some pages of Process Part and Instrumentation Part in the NIT uploaded on PDIL and DoP websites on 28-11-2016 are un-readable, hence the correct documents for Process Part (75 Sheets) and Instrumentation Part (29 Sheets) are attcahed with this amendment. The same to be referred/ considered as part of NIT.**

(4) **The LSTK Contractor shall have to carry out Soil Investigation & Topographical Survey of CETP Plot as well as entire Pipeline Route.**

(5) **Refer Sl. No. 3.1.1 on Page No. 10/52 of the TS for Static and Rotating Equipment Part of NIT uploaded on 28-11-2016. The type of resin to be used shall be DERAKANE type 411 & 470 or an equivalent resin.**

DFSarkar
08/12/2016

(6) Refer Sl. No. 3.6.1 on Page No. 47/50 of the TS for Piping Part of NIT uploaded on 28-11-2016. The Sl. No. shall be 2.2.6 in place of 3.6.1.

(7) Refer Page No. 1/50 of the TS for Piping Part of NIT uploaded on 28-11-2016. The Process Piping for Low Pressure Lines shall be Industrial PVC (Rigid) of approved ISI make – Finolex/Astral or equivalent.

****

Bidders are advised to visit following websites from time to time for updation about this Tender:-
PDIL website : pdilin.com and DoP website : pharmaceuticals.gov.in

For clarifications Bidders may write to :-
Sh. P.K. Singh, GM,Civil, PDIL : pksingh@pdilin.com ; Sh. D.K. Sant, DGM (Projects), PDIL : dksant@pdilin.com & Sh. B. Sethuraman : sethuraman_abilash@yahoo.com

DK Sant
08/12/2016

INTRODUCTION AND PROCESS DESCRIPTION

COMMON EFFLUENT TREATMENT PLANT FOR C.P.I.I.U.C AT SIDCO PHARMACEUTICAL COMPLEX, ALATHUR, KANCHIPURAM DISTRICT

TECHNICAL SPECIFICATIONS OF THE PROJECT

Introduction

- The Project has the following major aspects:

    1. Waste Water & Sewage Generation & Conveyance Management
    2. Combined Waste Water Treatment Process
    3. Treated Water (High Purity) storage and re-distribution

- The sources are from various Users within SIDCO PHARMA COMPLEX, ALATHUR, THIRUPORUR, Tamilnadu

- Treatment Philosophy and Technology shall be evolved after detailed study of the waste water characteristics, quantification analysis and its treatability. Care shall be taken to select the correct approach, the best technology and high quality components confirming to Good Engineering Practices and Good Management Practices.

Design Philosophy:

CONVEYANCE MANAGEMENT

A: Effluent Conveyance

There shall be an Electro Magnetic Flow Meter installed in every unit listed above. This EMFM will note, record and report quantity of waste water generated from each unit. Each unit has an existing tank for collecting their effluent. From this tank, each unit shall be install / use existing pump to transfer to the main conveyance header. This EMFM shall be located in this pipe line

There shall be a CENTRAL HEADER which shall convey the waste water from various units to the treatment location.

There shall be one point (opposite to M/s Clarion and as indicated in the Conveyance Routing) where the effluent line will be broken and a sump will be constructed. From there, a pumping system shall be in place to convey the effluent to the treatment process area. These details are provided in the routing map.

B: Sewage Conveyance

TREATMENT MANAGEMENT

TO TREAT THE WASTE WATER AND THEN PROCESS IT THROUGH R.O. PLANT TO RECOVER HIGH PURITY WATER FOR RE-USE.

A: Effluent Treatment – Conceptualization

The effluent from various industrial units are not easily bio degradable. The reports indicate high TDS and high COD and also high BOD.

The characteristics of effluent also will vary from one generator to the other. Even with one industrial source, at various times, one can expect varying quality of effluent generation.

Conventional approach to high TSS, high TDS & high COD effluent involves Primary Treatment using massive quantities of chemicals and generating massive volumes of hazardous sludge.

After this, the effluent is normally taken through a Secondary Biological Treatment and followed by high end filtration systems

In this case, it has been decided to adopt Electrolytic Degradation process for removing excess BOD, TSS & COD from the primary effluent. The detailed description, principles, design basis is provided in this report. Actual trials have been undertaken with the original effluent to determine the efficacy of the treatment and the design has been based on this actual trials done.

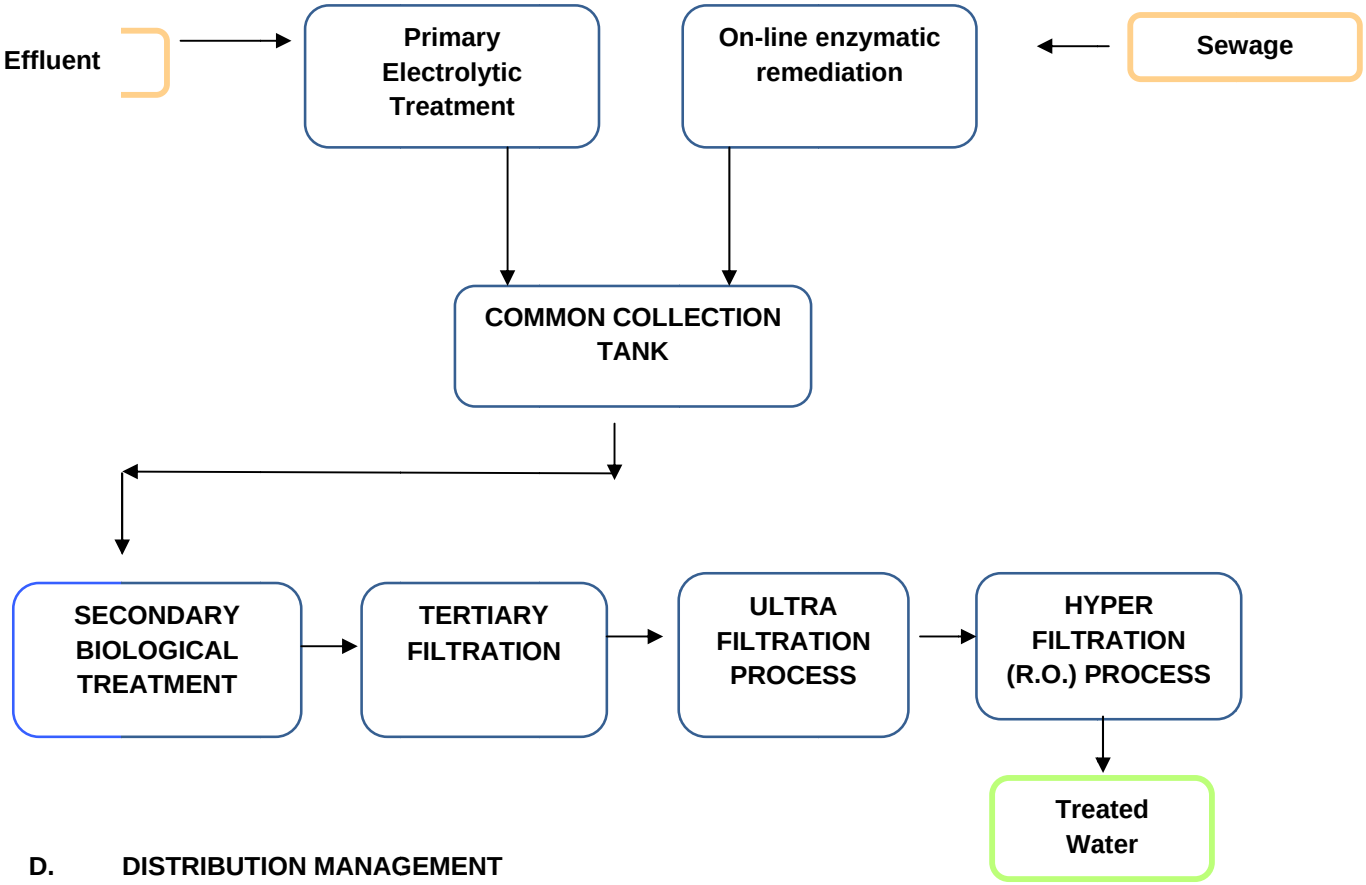
After Primary treatment, the effluent will be MIXED with the sewage and then processed through Biological Treatment. Sewage provides the fundamental balance of carbon, nitrogen and phosphorus along with the colony of bacteria required to break down the organics.

B: Sewage Treatment – Conceptualization

Sewage is easily bio degradable when compared with effluents. A specialized Enzymatic Remediation Program is included in the process. This ERP will start with the addition of special bio culture enzymes in the generating unit itself.

These powerful enzymes proliferate in the conveyance system and effectively reduce the deposition of organics in the pipe line. In addition, they bring about a significant level of bio activity in the sewage so that, when the effluent is mixed with the sewage and processed through biological treatment, the process is enhanced significantly , resulting in a stable output.

C: MACRO LEVEL PROCESS FLOW CHART



D. DISTRIBUTION MANAGEMENT

The treated water i.e. permeate of the R.O. Plant is collected in a Treated Water Tank.

From here, it is proposed to supply to all the Units through a suitable hydro pneumatic system . Hydro Pnuematic systems are highly evolved and technically superior processes that are adopted very widely, to replace conventional gravity mode supply. Through this system, supply and monitoring is integrated into one unit and at all points of time, water will be available at all locations in the entire distribution network.

Each receiving Unit shall have an electro magnetic flow meter that will provide the recording and the details of the treated water supplied on a daily basis.

PART A: TREATMENT SYSTEM IN THE PROJECT

Design Basis – Inlet Quality & Desired Outlet Quality

The indicative inlet waste water quality and Outlet at RO Permate is given below. The performance of the treatment plant will be based on this inlet quality. The treatment process and specifications should be able to cater to a variation of 20% upwards for each or all of these parameters.

parameter	effluent	sewage	Combined waste water	R.O. permeate (outlet)
pH	7.88	7	6.5 – 7.5	6.5 to 8.0
BOD (ppm)	1900	250	450	< 5
COD (ppm)	7000	600	1200	< 10
Oil & Grease (ppm)	26	20	< 30	< 1
TDS (ppm)	10000	1000	< 5200	< 500
TSS (ppm)	1200	400	< 450	<1
Nitrates (ppm)	43	20	5.7	<1
Phosphates (ppm)	8	10	1.5	< 5
Turbidity (NTU)	< 200	< 75	< 75	< 1

DESIGN BASIS - Quantity

Total effluent generated by all Industries at maximum load	:	87,700 lpd
Total sewage generated by all Industries at maximum load	:	56,250 lpd
Design basis for sizing - Effluent	:	1,00,000 lpd
Design basis for sizing - Sewage	:	70,000 lpd
Total waste water for treatment	:	1,70,000 lpd

Keeping in the mind the future projections on expansion and additions and also to provide flexibility of treatment options and sustainability of treatment even in case of emergencies, 100% redundancy is to be inbuilt in the process design, sizing of tanks and of planning the machinery for treatment.

This is reproduced in the table below:

Source	Maximum KLD	Additional KLD	Total Design KLD
Effluent	100	100	200
Sewage	70	70	140
Total	170	170	340

The process design has to be done in such a way to facilitate smooth operations and sustained output, even in case of break downs / problems.

Thus, each unit operation has an “alternative” route through which the waste water can be processed. This ensures maximum utilization and productivity of the effluent management program.

Redundancy has to be provided without affecting economics through integrated engineering designs.

A: TREATMENT PLANT AREA

Detailed Description of Process Selected

A EFFLUENT TREATMENT – Primary Electrolytic Process

Effluent from various industries are conveyed through piping network and reach the Effluent Collection Tank

From here, it is pumped through Primary Treatment done through Electrolytic Process. The description of Electrolytic Process and how it provides cost effective and technically superior alternative to conventional physic – chemical separation is given herein.

Electrolytic treatment is fast emerging as the alternative to biological treatment due to its ability to operate as a batch process, reduced power consumption, tremendous savings in space and civil works and its ability to give sustained treated water for variations in inlet impurity content.

The heart of the treatment is the ELECTRO CELL. Simplistically, the electro cell containing the four elements viz.. ANODE, CATHODE, ELECTROLYTE & CURRENT bring about the destruction of organics through the process of electrolysis followed by Electro coagulation, floatation and removal of suspended impurity.

Every non bio stable compound exhibits bond energy. When the force applied is greater than the bond energy, there is break down of the compound. When the force is in the form of “passage of electrons” i.e. Electricity, this break down results in the formation of carbon ash + hydrogen gas..

So, in Electrolysis, the DISSOLVED impurity is broken down and converted to SUSPENDED impurity. Once broken down, this suspended impurity is removed from the system by coagulation, floatation and subsequent precipitation.

The process is a combination of three unit operations occurring in a single reactor in one time zone – Electrolysis + Electro Floatation + Electro coagulation

Destruction of organics takes place through bond depolarization. The resultant is carbon in ash form and hydrogen gas. The hydrogen gas is generated in the cathode and this aids the electro floatation process. Aluminum is used as anode and this diffuses in the water providing electro coagulation.

Electro cell does the function of electro destabilization and electro de-emulsification to begin with followed by electro coagulation and agglomeration and electro floatation with the choice of electrodes specially designed to do this job.

Reaction at the anode :

- Me(s) – (3e-) = Me3+(aq)
- Me3+(aq) + 3H2O = Me(OH)3 + 3H+

Reaction at the cathode :

- 2H2O + 2e- > H2 + 2OH-

Key design factors :

1. Type of electrodes &spacing
2. Area of electrodes and charge density
3. Reactor design
4. Charge and Bond Energy
5. Approach velocity

Components in Electrolytic Process:

Effluent is collected in an equalization tank.

From here, it is pumped to the Electro Cell Unit. The Unit has Electro Coagulation Electrodes and skimmer unit. The Electrolytic process releases carbon ash from destruction of organics, which is Electro Floated to the top. The skimmer collects the “froth” and takes it for solid waste management process.

The outlet water is then passed through a tube settler unit for settling the remaining solids. The overflow from the tube settler goes to Common Collection Tank, where it gets mixed with the sewage and taken for further treatment.

Alum dosing is provided at the inlet of the system to accelerate the process of Electro Coagulation. Caustic Dosing is provided in the Equalization Tank to set the Alkalinity Level in the waste water which will significantly improve the Electro Coagulation Process

B COMBINED EFFLUENT TREATMENT – Secondary Biological Process

Biological treatment has been provided to control BOD, COD & TSS

The sewage from all Units shall be pumped into a common collection tank. The overflow from the tube settler of the Primary Electrolytic Process mixes with the sewage in this tank.

From here, it is pumped to the Biological Process.

In Biological Process, air is supplied to the bacteria. Using the oxygen in the air, the bacteria "breaks down" the organics in the waste water. The representative equation is given below:

Air + Bacteria + Organics ……> CO2 + H2O + Sludge

Thus, for a proper biological system, we need both AIR & FOOD to be supplied to the bacteria. We also need a proper BALANCE between the active bacterial culture present in the tank to the food (i.e. waste organics) that is presented to it, for consumption.

A proper biological system also needs a proper nutrient balance i.e. carbon, nitrogen and phosphorus balance to be maintained in the aeration system to ensure assimilation of the organics.

A host of technologies are available today for biological treatment. Extended Aeration Activated Sludge process has been chosen. The process design decision has been taken on the following basis:

Extended aeration is one of the oldest and most trusted processes for bio degradation.

The inlet quality is bound to vary due to the mixing of various sources of waste waters. In such cases, extended aeration process has the capacity to withstand load variations

The inlet is expected to contain more BODn than that will be present in just normal sewage. This nitrogen based BOD destruction is most effectively addressed in extended aeration.

The bio sludge that comes out of the process is nicely digested and easy to de water.

SUBMERSIBLE ASPIRATING AERATION SYSTEMS has been selected instead of BLOWER + DIFFUSER arrangement. The air supply system that has been selected will have significant savings in power, easy to maintain, easy to dismantle and re-assemble, not prone to clogging, will provide uniform oxygenation throughout the tank and will also give a very very fine bubble i.e. 10 micron oxygen bubble which will ensure high Dissolved Oxygen at all points within the system.

For many decades, the conventional systems have been using surface aerators, where the surface water is agitated and thrown in air in an umbrella shape to trap and dissolve oxygen in atmospheric air. Over the years, it has been realized that pumping of air in water is more economical than the surface aerator

actions. Conventional coarse bubble diffused aeration systems have evolved starting from use of slotted / perforated pipes.

As is known, the progressive reduction in size of air bubbles released below the surface, increases the surface area available for oxygen transfer, which results in higher oxygen transfer efficiency. This has resulted in developing fine bubble diffused aeration systems using diffusers, membranes etc. However, the constraints of pore size limit the achievable bubble size reduction in conventional diffusers,.

The aspirator type submersible aerators overcome this constraint through mechanical means. Aspirating aerators, widely used in India over past more than a decade provide high efficiency aeration in form of diffused micro bubbles.

Aspirators are essentially high speed agitators, which cause suction of atmospheric air, which on getting released in the turbulent zone near their propellers, becomes fragmented / micronised. The bubble size reduction is thus achieved through mechanical means and is an improvement over the porous membranes.

Many aspirator designs with terrestrial motors are available. However, the effectiveness / efficiency is limited due to inadequate suction or inadequate reach of the air currents. In many industrial effluent treatment plants (ETPs), the effluent nature can lead to foaming. This also causes difficulty in use of the aspirators with terrestrial motors.

The aspirator type submersible aerators overcome both these constraints. The micronisation of air bubbles is achieved through mechanical means; the very high speed motors cause adequate suction and significant zone of influence while the submersible motors are not affected by water. The oxygen transfer efficiency of the units is hence the highest.

The very high oxygen transfer efficiency i.e. the increased oxygen transfer per unit air volume pumped in, results in lowering air requirement for same treatment parameters. This results in reducing the power consumption of the system.

Through number of installations, it is established that *aspirating aeration* consumes atleast 50% less power than other aeration systems.

Some of the Salient Features of such Submersible Aerators are

- ✓ Design ensures effective aeration & mixing at much lower power consumption.
- ✓ No orifices, nozzles or pores in the system. Hence no clogging and recurrent requirement of clean up as in case of bottom grids.
- ✓ Installation of multiple independent units offers more flexibility in operation.
- ✓ No pre installation requirement like civil work. Units can be installed in an existing operation tank without emptying it.
- ✓ An important aspect of the aeration systems is the mode of oxygen transfer. In surface aeration, the oxygen first dissolves in water and this dissolved oxygen is drawn by bacteria from water. Thus the final oxygen transfer to bacteria is from water and this makes it necessary to have higher dissolved

oxygen (DO) level in the system. In case of submersible aeration, the oxygen transfer takes place across the air bubble and both water and bacteria are simultaneously competing and drawing the oxygen from the air. Thus in these systems, the DO level is not as relevant and is generally found to be lower. As the bubble size decreases, this observation is more marked.

- ✓ easy to maintain, easy to dismantle and re-assemble,
- ✓ will also give a very very fine bubble i.e. 10 micron oxygen bubble which will ensure high Dissolved Oxygen at all points within the system.

A typical aspirating aerator has a submersible motor and it has a propeller which rotates at 2800 rpm imparting large velocities to the liquid around it. The high velocities cause vortex where atmospheric air is sucked through air intake pipes open to atmosphere. The unit is positioned with help of floats and secured with use of ropes. The atmospheric air released in the highly turbulent zone is broken in form of microbubbles (of 10 micron size) and this formation of microbubbles contributes towards the very high efficiency of oxygen transfer.

Hence under normal ETP conditions, the oxygen requirement being fixed, less volume of air needs to be pumped in to achieve the desired oxygenation. This results in tremendous energy savings. Compared to surface aerator there is 50-55% power saving while the power consumed is about 40% less than diffuser systems. The total unit is in SS / marine bronze & high grade plastic construction.

Secondary clarification to settle the bio sludge is provided with sludge recirculation. Typical re-circulation will be between 0.6 to 0.9 Q (Q being the feed flow rate), in order to maintain proper MLSS .SVI will be monitored properly to ensure quality of effluent overflow in terms of clarity.

Typically, F/M values of 0.1 to 0.2, MLVSS of 2500 ppm, SVI < 150, VSS to SS ratio of 0.7 and MLVSS to MLSS ratio of 0.63, sludge age (Cell residence time) of about 22 days, Yield coefficient of 0.5 to 0.61, Endogenous decay coefficient of 0.05 to 0.07, substrate removal coefficient of 0.038 shall be taken as design basis for Complete Mix Activated Sludge Process, to achieve about 90 to 95% substrate removal efficiency.

Secondary clarifier is designed to accommodate a overflow rate not greater than 16 m3/d/m2 and solids loading not exceeding 150 kgs/day / m2. Depth to diameter is carefully designed to prevent pin flocs, floating matter due to dislodged sludge (created due to denitrification inside secondary clarifier and subsequent release of nitrogen) and froth formation.

The components of biological treatment shall be the following:

1. Aeration tank with aspirating aeration
2. Secondary clarifier
3. Return sludge pumps

C Tertiary Filtration & Ultra Filtration Process

Sand and carbon filtration systems shall be provided to bring down the turbidity, TSS and to be able to reduce the organics to some extent of fine polishing through activated carbon adsorption.

Typically, filtration rates shall be taken as 12 to 13 m3/hr/m2 for sand filter and 15 to 17 m3/hr/m2 for carbon filter.

Sand media would consist of gravel, pebble, coarse and fine sand

Activated carbon shall be chosen carefully to have high Iodine Number (>999) and we have opted for high quality carbon which is thermally extracted.

Important Note: MS tanks are not acceptable for sand and carbon filters. The site is near to coastal area and whatever coating one may give, corrosion would be inevitable. Thus, FRP tanks are provided for the same. Though costlier, the durability, ability to withstand corrosive atmosphere is very high with FRP.

Ultra Filtration using hollow fine fibre membranes have been employed to control SDI, to reduce COD to the extent of high molecular weight compounds that are semi / non bio degradable (this will prevent organic fouling of the RO process)

Ultra filtration is more of a “roughing” or “protecting” filter that will enable ionic level removal to proceed without much of a problem in the downstream hyper filtration process (R.O. membranes)

REJECT based UF system has been selected (not dead end filter) as one would expect high molecular weight loading (due to the nature of the waste water). Typically, operating flux will be between 30 to 45 GFD and the UF will have a MWCO of about 120 KD.

The UF will come with proper PLC system for operation of normal flow, rinse, backwash, rinse and normal flow cycles interposed with fast flush of the UF membranes.

To protect the UF membranes, micron / bag filter is provided upstream. PP spun cartridge in SS housing has been selected with about 25 micron rating in case of micron filter and PP bags with 25 micron rating enclosed in SS housing for bag filter.

Separate back wash pumps are provided for backwashing & rinsing the UF modules. CIP system has also been provided (operated through manual valves) to clean the membranes as and when required.

The UF modules will be mounted on MS Epoxy skid.

The components of Tertiary Filtration Process will be:

- Filter feed pump
- Sand filter
- Carbon filter

- UF feed tank
- UF feed pump
- UF feed filter
- UF module in MS epoxy skid
- PLC for UF operations
- UF backwash pumps
- UF C.I.P. system consisting of CIP tank, CIP micron filter and CIP pump
- Chemical dosing in feed to UF system

D Reverse Osmosis Process

R.O. process has been employed to generate high purity water from the waste water through membrane separation process.

The design basis of the R.O. plant shall be given as below:

- The treatment process has been designed for 100% redundancy in Stage 1. The Stage 1 has TWO SEPARATE PARALLEL STREAMS.
- Each stream is capable of taking 170 KLD.
- In practice, ONLY ONE STREAM will be operational for the total 100% load of the entire plant.
- The reject shall be generated only from ONE STREAM in practice.

Stage 1 Feed Flow Rate (m3/hour)	= 170 / 20 = 8.5 m3/hr
Recovery in Stage 1 considered (%)	65
Hence, reject generated in Stage 1 (m3/hr)	= 8.5 x 35% = 2.975 m3/hr Rounded off to : 3 m3/hr
This reject will now be processed through Stage 2. This is the reject for 170 KLD i.e. 100% of load contribution of the Plant. Stage 1 has ONE MORE PARALLEL STREAM. So, even if one stream has some problem, or undergoing cleaning etc.., we can operate the second stream. But, it is to be noted that, at any point of time, ONLY ONE STREAM will be operational.	
For Stage 2, we have assumed that BOTH STREAMS ARE OPERATIONAL CONTINUOUSLY (due to any emergency scenario)	
Reject from Stage 1 which will feed Stage 2 (m3/hr)	3 m/hr for 100% load x assumed that BOTH streams are working at tandem (emergency scenario) = 6 m3/hr

Hence, total maximum feed to Stage 2 (m3/hr)	6 m3/hr
Recovery in Stage 2 (%)	50%
Hence, the MAXIMUM reject generated (m3/hr)	= 6 x 50% = 3 m3/hr
Hours of operation (hours)	20
Hence, the maximum reject quantity (KLD)	=3 x 20 = 60 KLD

- First stage Membranes are spiral wound, polyamide thin film composite brackish water membranes with active surface area of < 375 sq.ft and mill space > 31 mill.
- Second stage Membranes are spiral wound, polyamide thin film composite sea water membranes with active surface area of < 300 sq.ft and mill space > 31 mill.
- Both stages are designed for low flux to prevent fouling. Typically, with UF as pre treatment, one can design RO system for about 17 GFD as flux. But, due to the nature of the effluent, we have considered a far lesser value as the design flux. Typically the flux is < 15 GFD.

Reverse Osmosis shall be a HYPER FILTRATION process. The product is received perpendicular to the feed flow and reject is carried forward to the next membrane / stage in series.

The core design of the R.O. plant is based on the following dynamics:

1. Feed Impurity
2. Recovery desired

Feed impurity:

The purpose of the hyper filtration process if to remove ionic impurities of even sparingly soluble salts. Thus, any other component in the water becomes an “impurity” w.r.t. the R.O. operation.

The impurity in feed can be broadly classified into the following core segments:

- ✕ Physical Impurity measured as T.S.S. & Turbidity
- ✕ Chemical Dissolved Impurity generally measured as T.D.S, Total Hardness
- ✕ Presence of dissolved metals
- ✕ Presence of high silica
- ✕ The buffering capacity of the water measured as pH, Alkalinity, Hardness and TDS and represented through L.S.I – Langlier Saturation Index or S.D.I. – Stiff Davis Index which provides the “scaling / corrosive tendency information” about the feed water
- ✕ Presence of dissolved organics
- ✕ Presence of organic fouling components in the feed water
- ✕ Presence of oxidative compounds in the water

The recovery of the R.O. plant is determined on the basis of FLUX and BETA FACTOR

Flux is the amount of permeate flow through unit area of membrane per unit time. The surface area of the membrane is fixed. The feed flow rate is fixed. Thus, flux becomes the operating condition.

More flux means more flow / unit area. This will save the NUMBER of membranes and pressure vessels and would bring down the Cap Ex. However, high flux means more pressure on the membrane and more concentration per unit length of the travel of 40" (being the length of one membrane).

This means the tendency to scale and deposit is significantly enhanced. This would mean blocks, higher pressure differential, reduced permeate output and / or more cleaning required. This may also result in physical stress damage to the membrane matrix.

Thus, flux is the core of R.O. design. We have designed the plant based on an extremely conservative flux and have used brackish water membranes in stage 1 and sea water membranes in stage 2.
This would mean more membranes and slightly increased Capital Investment. But the sustainability of the process is significantly enhanced.

In real time, we may get more recovery during the initial period of operations as the membrane surface would be relatively clean… But, irrespective of cleaning and permeate flushing, one may expect the membrane productivity to reduce over time or result in same productivity at higher pressure profiles.

Beta Factor is the concentration polarization standard. The factor is a empirical measure of the extent of fouling and scaling in the R.O. process. The standard is to maintain BF < 1.2 in the last membrane of the stage. In our design, this is easily achieved.

Our R.O. design for this plant shall be robust and capable of handling high impurity input as the flux is taken very conservatively and the staging is done based on our experience to ensure sustainable outlet quality and quantity.

How flux has been considered in this Plant:

Manufacturers' recommendation on flux for UF treated feed water : 15 GFD (gallons per sq.ft per day)

Stage 1 flux of this Plant:

No. of membranes provided	:	12
Active surface area of the membrane	:	375 sq.ft
Total permeate flow rate in stage 1	:	5,500 liters / hour
Hence, permeate flow / membrane	:	458 liters / hour only.
At this flow rate, the operating flux is	:	8 GFD

Stage 2 flux of this Plant:

No. of membranes provided	:	8
Active surface area of the membrane	:	350 sq.ft
Total permeate flow rate in stage 2	:	3,000 liters / hour

Hence, permeate flow / membrane : 375 liters / hour only.
At this flow rate, the operating flux is : 7 GFD

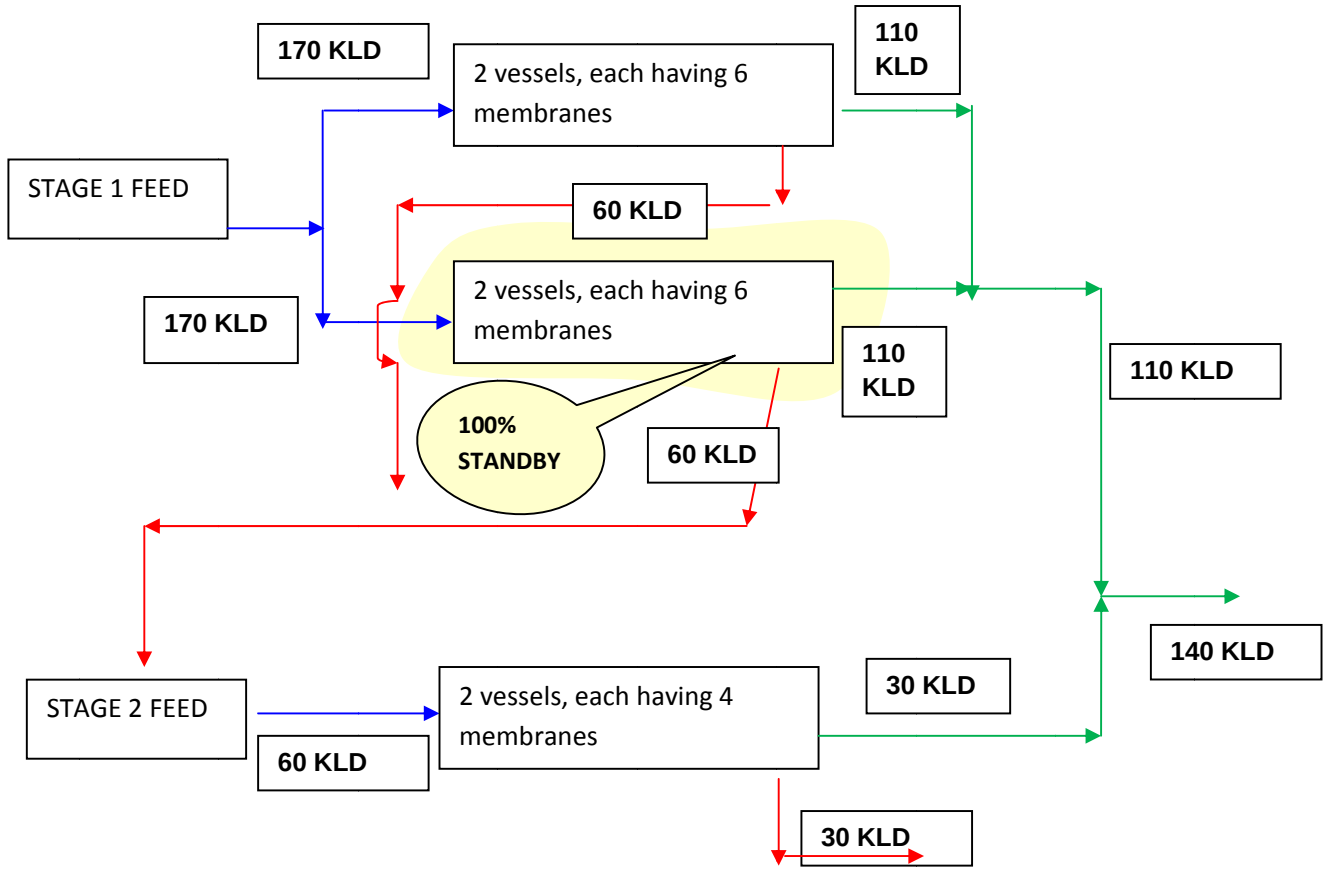
Thus, the design is EXTREMELY CONSERVATIVE and will definitely provide sustainable outlet quality, quantity, reduced fouling, consistent pressure profile and reduced cleaning frequency, thus enhancing the life of the membrane

Beta factor (concentration polarization) shall be kept below 1.18 in both the stages.

To protect the RO membranes, the following shall be considered:

- Micron filtration for silt control.
- Chemical dosing to prevent organic fouling and scaling inside the membrane
- CIP system for permeate flushing and chemical cleaning of the membrane
- To protect the high pressure pump, low and high pressure switches have been provided.
- Permeate and reject flow meters have been provided to monitor flow and recovery

The schematic representation of the R.O. process is given below:



E Solid Waste Management Process

Solid Waste Generation and Management process shall be as follows:

Solids from Bar Screening	Will be collected in specific bins kept near the chamber
Electrolytic Process – Froth from the Electro Reactor and solids from the Underflow of the Tube Settler	This will go to the Solids Holding Tank
Biological Process	Solids will go to the solids holding tank
Backwash Wastes	All backwash wastes will be collected in one tank. From here, it will be pumped to the Tube Settler. The underflow of the tube settler will go to the Solids Holding Tank.

So, all the wastes are collected in one tank. From here, it is pumped through Filter Press. The Filtrate of the filter press goes back to the Common Effluent Collection Tank and the cake is taken for disposal.

DESIGN & SIZING OF PROCESS UNITS:

The basic details of the design of each major equipment is given below. These are indicative and may change during detailed engineering. The Bidder to evaluate the design and sizing given below and accordingly place his Price Bid Offer.

This document is to be read in conjunction to the P&I diagram, Layout and other relevant drawings which form part of this tender document

BASIC DESIGN SHEETS - ALL PROCESS PUMPS

E Process Feed Pump	**P 101 A/B**	
design criteria	flow processed + head required	
The pump takes the effluent from effluent collection tank and pumps it to the Electro Cell Reactor. Discharge to atmospheric pressure only.		
effluent generated by the Units	m3/d	78.7
design capacity taken	m3/d	100
hours of operation	hrs/d	20
feed flow rate of pump provided	m3/hr	5
maximum vertical length of the feed pipeline (suction + discharge)	mts	5.5
number of valves on operation in the feeder line	nos	4
approx number of bends / tees in feeder line	nos	5
total operating head loss	mwc	7.9
actual head of pump provided	mwc	15
quantity	nos	2 - 1 w + 1 sb
type of pump	horizontal centrifugal	
liquid handled	effluent with solids at ambient Temp.	
impeller type	non clog open impeller	
Langlier Index of liquid handled	near Zero. Near Neutral with slightly acidic nature	
wetted parts	MOC	C.I.
indicative power consumption	hp	2
Raw sewage transfer pump	**P 102 A/B**	
design criteria	liquid accumulation for 24 hours in tank T 100 will be pumped in 12 hours	
The pump takes the sewage accumulated in raw sewage collection tank and pumps it to combined waste water collection tank. Discharge to atmospheric pressure only.		
sewage generated by the Units	m3/d	56.25
design capacity taken	m3/d	70
hours of operation	hrs/d	12

pumping capacity provided	m3/hr	5.8
maximum vertical length of the feed pipeline (suction + discharge)	mts	8.2
number of valves on operation in the feeder line	nos	3
approx number of bends / tees in feeder line	nos	6
total operating head loss	mwc	11.2
actual head of pump provided	mwc	20
quantity	nos	2 - 1 w + 1 sb
pump type	horizontal centrifugal	
liquid handled	sewage with solids at ambient Temp.	
impeller type	non clog open impeller	
Langlier Index of liquid handled	Mildly positive LSI. Near neutral pH with slightly alkaline nature	
wetted parts	MOC	C.I.
indicative power consumption	hp	2
aeration tank feed pumps	**P 103 A/B**	
design criteria	feed flow rate and head	
The pump feeds the combined waste water to the aeration system. Feed discharged to atmospheric pressure only.		
combined waste water (effluent + sewage) for design	m3/d	134.95
design capacity taken	m3/d	170
hours of operation	hrs/d	20
pumping capacity provided	m3/hr	8.5
maximum vertical length of the feed pipeline (suction + discharge)	mts	5
number of valves on operation in the feeder line	nos	5
approx number of bends / tees in feeder line	nos	6

total operating head loss	mwc	8.2
actual head of pump provided	mwc	20
quantity	nos	2 - 1 w + 1 sb
pump type	horizontal centrifugal	
liquid handled	combined waste water with solids (TSS @ 500 ppm)at ambient Temp.	
impeller type	non clog open impeller	
Langlier Index of liquid handled	Mildly positive LSI. Near neutral pH with slightly alkaline nature	
wetted parts	MOC	C.I.
indicative power consumption	hp	2
return sludge pumps	**P 104 A/B**	
design criteria	recirculation rate	
Note: return sludge pumps will be kept by the side of the Secondary Clarifier (T104). Please see layout of Plant and Machinery.		
This will take the bottom settled liquid from the Secondary Clarifier and pump it back to the aeration tank. The pump will be FLOODED SUCTION and the total height of the secondary clarifier above the suction pipe of the pump will be about 3 mts with water and this positive load will be acting on the suction side.		
This pump will have two discharge headers. One will go to the Solids Holding Tank (T 114) and the other will go to the Aeration Tanks (T 103 A & B). Discharge to atmospheric pressure only.		
aeration process flow rate	m3/hr	8.5
re-circulation ratio	Q / Q'	0.7
re-circulation rate	m3/hr	5.95
pump capacity provided	m3/hr	6
maximum vertical length of the feed pipeline - only discharge side (flooded suction)	mts	5
number of valves on operation in the feeder line	nos	7
approx number of bends / tees in feeder line	nos	9
total operating head loss (including negation of head loss due to positive load on suction of about 3 mts)	mwc	9.6

actual head of pump provided	mwc	15
quantity	nos	2
type of pump	horizontal centrifugal	
liquid handled	water with solids (1.2% w/v)	
impeller type	non clog open impeller	
Langlier Index of liquid handled	Mildly positive LSI. Alkaline pH at around 7.5 to 7.7	
wetted parts	MOC	C.I.
indicative power consumption	hp	2
filter feed pumps	**P 105 A/B**	
design criteria	feed flow rate and pressure	
From the filter feed tanks, the water will be pumped to the sand filter and carbon filter, which are in series. The outlet of the carbon filter will be discharged into the UF feed tank,		
Both sand filter as well as carbon filter are pressure vessels and the system typically operates at a feed pressure of about 2 bar with an allowed total pressure drop of about 0.5 bar. Once this pressure drop is reached, the system is taken up for backwash.		
total water to be treated through filtration	m3 /day	170
hours of operation	hrs /d	20
feed flow rate for design	m3/hr	8.5
maximum vertical length of the feed pipeline	mts	5.5
number of valves on operation in the feeder line	nos	4 + 2 nos of multi port valves.
approx number of bends / tees in feeder line	nos	10
media height in each vessel	approx mts	1.4
total operating head loss	mwc	19.5
actual head of pump provided	mwc	30

Quantity		nos	2 - 1 op + 1 sb
type of pump		horizontal centrifugal	
Langlier Index of liquid handled		Mildly positive LSI. Alkaline pH	
wetted parts		MOC	C.I.
liquid handled		clear water	
impeller type		clear water pump, closed impeller	
indicative power consumption		hp	2
filter backwash pumps		**P 106 A/B**	
design criteria	2 times normal flow rate . Adequacy check through desired backwashing rate (m/hr)		
maximum area for backwashing for sand filter		m2	0.68
backwash rate		m3/hr / m2	28
Hence minimum capacity needed		m3 / h	19.04
design criteria on 2 times normal flow		m3 /h	17
chosen higher capacity of the two values above.			
capacity of pump provided		m3 /h	20
maximum vertical length of the feed pipeline		mts	6
number of valves on operation in the feeder line	nos	8 + 2 nos of multi port valves.	
approx number of bends / tees in feeder line		nos	8
media height in each vessel		approx mts	1.4
total operating head loss		mwc	14.5
actual head of pump provided		mwc	25
quantity		nos	2 - 1 op + 1 sb
type of pump		horizontal centrifugal	
Langlier Index of liquid handled		Mildly positive LSI. Alkaline pH	
wetted parts		MOC	C.I.
liquid handled		clear water	
impeller type		clear water pump, closed impeller	
indicative power consumption		hp	2

U.F. feed pumps	**P 107 A/B**	
design criteria	feed flow rate and pressure	
After sand and carbon filtration and disinfection, the water is pumped to the Ultra Filtration Units, through a bag filter.		
The UF system is a "low pressure membrane separation" system. Typical feed pressure is around 2 bar and allowed reject pressure is about 1.5 bar.		
Pressure drop across bag filter is about 0.5 bar. Hence, total pressure drop of the system is 1 bar		
Two parallel UF systems are provided, each capable of handling 100% load i.e. 170 KLD. Two pumps are provided with common header so that any pump can operate any stream.		
total water to be treated through filtration	m3 /day	170
hours of operation	hrs /d	20
feed flow rate for design	m3/hr	8.5
maximum vertical length of the feed pipeline	mts	5.4
total operating head loss - bag filter + ultra filter + valves + bends + tees etc..	mwc	18.5
actual head of pump provided	mwc	25
quantity	nos	2 - 1 op + 1 sb
type of pump	horizontal centrifugal	
Langlier Index of liquid handled	Mildly positive LSI. Alkaline pH	
wetted parts	MOC	C.I.
liquid handled	clear water	
impeller type	clear water pump, closed impeller	
indicative power consumption	hp	2

U.F. backwash pumps		**P 108 A/B**	
design criteria	manufacturer recommendation on backwash flow rate at 1.5 bar pressure		
UF system is backwashed once in about 45 minutes for about 45 seconds. The sequence of backwash followed by rinse is controlled through a P.L.C. system.			
The backwash system is chosen in such a way that 100% of load is backwashed in one sequence. Thus, one stream gets backwashed at a time. It is to be noted that, at 100% load, only one stream will be operational and the other will be a 100% standby.			
backwash rate for design		m3/hr	16.5
pump head recommended for backwash		mwc	20
actual head of pump provided		mwc	25
quantity		nos	2 - 1 op + 1 sb
type of pump		horizontal centrifugal	
Langlier Index of liquid handled		Mildly positive LSI. Alkaline pH	
wetted parts		MOC	C.I.
liquid handled		clear water	
impeller type		clear water pump, closed impeller	
indicative power consumption		hp	2
U.F. CIP pumps		**P 109 A/B**	
design criteria	manufacturer recommendation on CIP system flow rate at 1.5 bar pressure		
CIP system is provided for daily flushing of the UF membrane with permeate water to "wash away" any settled impurity. CIP wash is treated as a "rinse" wash and hence low flow rates are recommended for the same, to prevent "bulking" of membranes. CIP is also provided for cleaning the membrane in case of any problems / fouling			
CIP flushrate for design		m3/hr	5
actual head of pump provided		mwc	25
quantity		nos	2 - 1 op + 1 sb
type of pump		horizontal centrifugal	
Langlier Index of liquid handled	varying LSI. pH will range from 2.0 to 12.0 for cleaning chemicals		
wetted parts		MOC	S.S

liquid handled	clear water	
impeller type	clear water pump, closed impeller	
indicative power consumption	hp	1
R.O Stage 1 feed booster pumps	**P 110 A/B**	
design criteria	feed flow rate and pressure	
From the U.F. treated water tank, the water is to be pumped to the R.O. membrane through the high pressure pump. The HPP needs positive suction pressure to enable pressure buildup in the discharge. In addition, the feed water has to pass through Micron Filter which acts as a protection to the R.O. membrane.		
Hence, this pump is provided to take water from the UF treated water tank, pump it through the micron filter and deliver the water to the suction head of the high pressure pump		
total water to be treated	m3 /day	170
hours of operation	hrs /d	20
feed flow rate for design	m3/hr	8.5
maximum vertical length of the feed pipeline	mts	5
number of valves on operation in the feeder line	nos	6
head loss across micron filter	mwc	7
total operating head loss	mwc	14.5
actual head of pump provided	mwc	20
quantity	nos	2 - 1 op + 1 sb
type of pump	horizontal centrifugal	
Langlier Index of liquid handled	Mildly positive LSI. Alkaline pH	
wetted parts	MOC	C.I.
liquid handled	clear water	
impeller type	clear water pump, closed impeller	
indicative power consumption	hp	1.5

R.O. stage 1 high pressure pumps	**P 111 A/B**	
design criteria	feed flow rate and pressure	
The pressure of the high pressure pump is determined by the osmotic pressure of the feed water and the operating flux of the system. Higher the TDS, higher the pressure and higher the flux, higher the pressure.		
The TDS of the feed water is around 6200 ppm and the operating flux is kept way below the manufacturer's recommended maximum. The flux is around 12 GFD whearas the manufacturer' s recommended maximum is around 15 GFD.		
This safe design results in lesser pressure requirements and subsequently smoother operation of the R.O. process. The design pressure is based on this factor.		
process water capacity	m3 /day	170
hours of operation	hrs /d	20
feed flow rate for design	m3/hr	8.5
recommended pressure at maximum drop	bar	11.75
actual head of pump provided	bar	15
quantity	nos	2 - 1 op + 1 sb
type of pump	vertical centrifugal	
Langlier Index of liquid handled	acidic pH around 6.5 to 7.0	
wetted parts	MOC	S.S.
liquid handled	clear water	
indicative power consumption	hp	7.5
R.O Stage 2 feed booster pumps	**P 112 A/B**	
design criteria	feed flow rate and pressure	
The stage 1 rejects (from both streams i.e. 2 x 170 KLD streams are collected in a tank. From here, it is pumped to stage 2 membranes through a high pressure pump. Before this, the water passes through micron filter to protect the membrane.		
Hence, this pump is provided to take water from the R.O. stage 1 reject tank, pump it through the micron filter and deliver the water to the suction head of the high pressure pump		

total water as feed (assuming that both streams of stage 1 i.e. 170 KLD x 2 streams, are operational at the same time…)	m3 /day	120
hours of operation	hrs /d	20
feed flow rate for design	m3/hr	6
maximum vertical length of the feed pipeline	mts	5
number of valves on operation in the feeder line	nos	6
head loss across micron filter	mwc	7
total operating head loss	mwc	14.5
actual head of pump provided	mwc	20
quantity	nos	2 - 1 op + 1 sb
type of pump	horizontal centrifugal	
Langlier Index of liquid handled	mildly acidic. LSI around zero to mildly negative.	
wetted parts	MOC	C.I.
liquid handled	clear water	
impeller type	clear water pump, closed impeller	
indicative power consumption	hp	1.5
R.O. stage 2 high pressure pumps	**P 113 A/B**	
design criteria	feed flow rate and pressure	
The pressure of the high pressure pump is determined by the osmotic pressure of the feed water and the operating flux of the system. Higher the TDS, higher the pressure and higher the flux, higher the pressure.		
The TDS of the feed water is around 1400 ppm and the operating flux is kept way below the manufacturer's recommended maximum. The flux is around 10 GFD whearas the manufacturer' srecommended maximum is around 13 GFD.		
This safe design results in lesser pressure requirements and subsequently smoother operation of the R.O. process. The design pressure is based on this factor.		
process water capacity	m3 /day	120
hours of operation	hrs /d	20
feed flow rate for design	m3/hr	6

recommended pressure at maximum drop	bar	21.25
actual head of pump provided	bar	25
quantity	nos	2 - 1 op + 1 sb
type of pump	vertical centrifugal	
Langlier Index of liquid handled	acidic pH around 6.5 to 7.0	
wetted parts	MOC	S.S.
liquid handled	clear water	
indicative power consumption	hp	10
R.O. CIP pumps	**P 114 A/B**	
design criteria	no. of pressure vessels cleaned in sequence. Flow / pressure vessel	
CIP pump is used for periodic flushing of the membrane with permeate on a daily basis. In addition, preventive chemical cleaning also gets done through this pump. When under problems due to fouling, scaling, deposits etc.., the membranes are cleaned using this pump. Pressure is not a design criteria as flow, as the cleanign solution will be under re-circulation most of the times, in a closed loop system.		
No. of vessels cleaned in one sequence	nos	1.0
Flow / pressure vessel for cleaning	gpm	25.0
	m3/hr	5.7
minimum CIP pump flow rate required	m3/hr	6.0
actual CIP pump capacity provided	m3/hr	8.0
head	mwc	25.0
quantity	nos	2 -1 w + sb
type of pump	horizontal centrifugal	
Langlier Index of liquid handled	highly varying, from 2 pH to 12 pH	
wetted parts	MOC	S.S.
liquid handled	clear water	
indicative power consumption	hp	1.5

B/wash waste tube settler feed pumps		**P 115 A/B**	
design criteria	total accumulation of waste water in backwash waste tank and flow to tube settler.		
The backwash waste is processed through the tube settler. For this, the collected backwash waste is pumped to the tube settler through this pump.			
total backwash waste generated by the process		m3/day	28.0
volume of the hold up sump		m3	33.0
process flow rate to tube settler		lph	2000.0
feed flow rate for design		m3/hr	2.0
head		mwc	20.0
quantity		nos	2 - 1 w + 1 sb
liquid handled		water with solids.	
type of pump		horizontal centrifugal, open impeller	
wetted parts		MOC	C.I.
indicative power consumption		hp	1.0
filter press feed pumps		**P 116 A/B**	
design criteria	total solids to be processed for dewatering		
The capacity of the pump depends on the total quantity to be processed, total number of parallel units of filter press, down time considered for filter press cake removal and pressure of the process system.			
total quantity to be processed for dewatering (for 1 plant operation at 170 KLD)		m3/day	29.4
hours of operation of filter press		hrs /day	16.0
feed flow rate through filter press		m3 /hr	1.8
capacity of the pump provided		m3/hr	2.0
working pressure		bar	5.0
quantity		nos	2 - 1 op + 1 sb
liquid handled		water with 1.5% solids	
type of pump		screw pumps / reciprocating plunger	
wetted parts		MOC	S.S
indicative power consumption		hp	3.0

pH correction dosing tank	**DT 101**	
design basis	dosage (ppm)	
The feed pH of the raw effluent is bound to be mildly acidic. To improve the pH, the alkali dosing system is provided herein. The pH will be stablized around 7.0 ppm before introducing the waste water to Primary Treatment.		
total effluent to be treated	KLD	100
dosage	ppm	15
quantity	kgs/d	1.5
dosage strength	% w / v	10
specific gravity of solution	index	1.05
approx quantity of dosage / day	lpd	14.29
dosing tank volume provided	liters	100
quantity	nos	1
dosing tank material	MOC	LLDPE / PP
pH correction dosing pump	**DP 101**	
total dosing volume	lpd	14.29
dosing flow rate needed min…	lph	0.714
capacity provided	lph	0 - 6
type of pump	electronic metering	
discharge point	Into effluent collection tank, at atmospheric pressure	
operating pressure	KSC	1.5 to 2.0
quantity	nos	1
alum dosing tank	**DT 102**	
design basis	dosage (ppm)	
alum is dosed to initiate the process of electrolytic degradation of the complex organics through the primary bond depolarization. Alum does the preliminary depolarization through negative charge destabilization thus significantly loosening up the complex organic structure for subsequent destruction through electrolysis.		
total effluent to be treated	KLD	100
dosage	ppm	40
quantity	kgs/d	4
dosage strength	% w / v	10
specific gravity of solution	index	1.02

approx quantity of dosage / day		lpd	39.22
dosing tank volume provided		liters	100
quantity		nos	1
dosing tank material		MOC	LLDPE / PP
alum dosing pump		**DP 102**	
total dosing volume		lpd	100
dosing pump flow rate minimum		lph	1.961
capacity provided		lph	0 - 6
type of pump		electronic metering	
discharge point	on line in the feeder to ER 101 A/B - Electro Reactors.		
process line pressure		KSC	1.2 to 1.5
pump operating pressure		KSC	2
quantity		nos	1
hypo dosing tank		**DT 103**	
design basis		dosage (ppm)	
The water after secondary biological treatment is collected in a tank and disinfection is done through addition of hypochlorite solution.			
Sodium Hypo Chlorite produces hypochlorous acid (HOCL) which is the active disinfectant. This is an oxidizing biocide which kills micro organisms through cell wall destruction mode. Before that, the reducing compounds in the waste water consumes the oxidation compound, thus creating a "chlorine demand". Break Point Chlorination (BPC) is achieved on further addition - meaning which the usage of the oxidation potential has been exhausted and any dosage beyond BPC will result in FRC.			
The key pointer is the maintenance of F.R.C. (free residual chlorine) of 0.1 to 0.2 ppm in the water after chlorination.			
NaOCl is available in solution form which provides about 8 to 15 % of active oxidation potential. Typically, for the waste water after electrolytic treatment and the combined water after biological treatment, this BPC is reached at around 7 to 9.5 ppm. To compensate for available oxidation potential, a higher dosage of the solution is provided.			
total effluent to be treated		KLD	170
dosage		ppm	50
quantity		kgs/d	8.5
dosage strength		% w / v	10
specific gravity of solution		index	1.02
approx quantity of dosage / day		lpd	83.3
dosing tank volume provided		liters	200
quantity		nos	1

dosing tank material	MOC	LLDPE / PP
hypo dosing pump	**DP 103**	
total dosing volume	lpd	83.3
dosing flow rate needed min…	lph	4.2
capacity provided	lph	0 - 10
type of pump	electronic metering	
discharge point	Into tank, at atmospheric pressure	
operating pressure	KSC	1.5 to 2.0
UF alum dosing tank	**DT 104**	
design basis	dosage (ppm)	
The filtered water is to be processed through ultra filtration system. On line, polishing alum dosing is done to facilitate better entrapment of silt and fines in the surface of the membrane.		
The UF module is of P.E./P.E.S/PVDF fibre which is highly compatable with orthokinetic pin flocs formed on coagulation of silt and fines with alum dosage. It has been found in practice, that, employing small quantities of alum on line, significantly improves the performance of the UF membrane and more importantly, in easier removal of the settled material from the membrane fibre at the time of backwashing.		
total effluent to be treated	KLD	170
dosage	ppm	10
quantity	kgs/d	1.7
dosage strength	% w / v	10
specific gravity of solution	index	1.02
approx quantity of dosage / day	lpd	16.7
dosing tank volume provided	liters	100
quantity	nos	1
dosing tank material	MOC	LLDPE / PP
UF alum dosing pump	**DP 104**	
total dosing volume	lpd	16.7
dosing flow rate needed min…	lph	0.8
capacity provided	lph	0 - 6
type of pump	electronic metering	

discharge point	on line, in the feeder to UF before bag filter. Line pressure at around 1.5 to 2.0 bar.		
operating pressure		KSC	2.5 to 3.0
Stage 1 R.O. SMBS dosing tank		**DT 105**	
design basis		dosage (ppm)	
SMBS is employed after carbon filter. Sodium Meta Bi Sulphite is primarily a reducing agent that has the potential to capture oxidation compound in the water. We are dosing chlorine before UF. Some of the residual chlorine may pass through and there is a minor possibility that some of the same may reach the R.O. membrane. The R.O membrane needs to be protected against oxidation compounds.			
The activated carbon filter acts as a first level protection followed by bag filter, UF etc.. However, to ensure and safe guard the membrane, SMBS dosing is provided. The dosage is calculated based on the stoichoimetric equivalent of one mole of sulphite required to convert itself to sulphate through capture of oxidation potential. Additional dosage is added to convert the equation to practical limitations including purity, reaction time, dosage concentration, other competing dynamics etc..			
total effluent to be treated		KLD	170
dosage		ppm	35
quantity		kgs/d	5.95
dosage strength		% w / v	10
specific gravity of solution		index	1.05
approx quantity of dosage / day		lpd	56.7
dosing tank volume provided		liters	100
quantity		nos	1
dosing tank material		MOC	LLDPE / PP
Stage 1 R.O. SMBS dosing pump		**DP 105**	
total dosing volume		lpd	56.7
dosing flow rate needed min…		lph	2.8
capacity provided		lph	0 - 10
type of pump		electronic metering	
discharge point	on line, in the feeder to Micron Filter before R.O. Line pressure around 1.5 KSC		
operating pressure		KSC	2.5 to 3.0

Stage 1 antiscalant dosing tank	**DT 106**	
design basis	dosage (ppm)	
Anti scalant is dosed in the R.O. feed to counter the scaling potential of the feed water contaminants inside the R.O. membrane. As the permeate is generated in transverse direction to feed, there always exists a possibility that scaling of sparingly soluble salts may occur on the surface of the R.O. membrane. Scaling will affect the efficiency and the effectiveness of the entire process and may result in membrane damage.		
Scale control is achieved in the process through a multi step approach. The primary approach is designing the R.O. with low flux to shift the Concentration Potential or the Beta Factor of the water to the left of 1.2 Secondary step is in ensuring that pH does not become too alkaline (i.e. > 7.2). The protection mode is the anti scalant dosage.		
total effluent to be treated	KLD	170
dosage	ppm	3
quantity	kgs/d	0.51
dosage strength	% w / v	10
specific gravity of solution	index	1.05
approx quantity of dosage / day	lpd	4.9
dosing tank volume provided	liters	100
quantity	nos	1
dosing tank material	MOC	LLDPE / PP
Stage 1 antiscalant dosing pump	**DP 106**	
total dosing volume	lpd	4.9
dosing flow rate needed min…	lph	0.2
capacity provided	lph	0 - 3
type of pump	electronic metering	
discharge point	on line, in the feeder to Micron Filter before R.O. Line pressure around 1.5 KSC	
operating pressure	KSC	2.5 to 3.0
Stage 2 pH booster dosing tank	**DT 107**	
design basis	dosage (ppm)	

The reject from stage1 is the feed to stage 2. In R.O. process, pH destablization will occur to a certain extent. Normally, the permeate will carry the low pH and the dissolved carbon di oxide constituent. The reject normally reports at neutral. However, the concentration of other impurity would have significantly increased. Thus, the scaling potential of the second stage is much more than the first stage.		
Anti scalant dosing is also given as one line from the stage 1 dosing system. But, pH control is important to shift the Langlier Index to negative. pH control will ensure that the scaling potential of the water is significantly reduced. The effluent, in spite of all treatment, would contain some complex compounds for which no anti scalant may work. In such situations, pH control is the key to ensure scale free R.O. process in stage 2. Dilute Hydro Chloric Acid is used for pH control . HCL is easily miscible and has the potential to vary the hydrogen ion concentration instantaneously, thus reducing pH immediately. Sulphuric acid is not used as the potential for gypsum scale will be created on excess sulphate concentrations.		
total reject (at both stages operation)	KLD	120
acid dosage for pH correction	ppm	10
quantity	kgs/d	1.2
dosage strength	% w / v	5
specific gravity of solution	index	1.01
approx quantity of dosage / day	lpd	23.8
dosing tank volume provided	liters	100
quantity	nos	1
dosing tank material	MOC	LLDPE / PP
Stage 2 pH booster dosing pump	**DP 107**	
total dosing volume	lpd	23.8
dosing flow rate needed min…	lph	1.2
capacity provided	lph	0 - 6
type of pump	electronic metering	
discharge point	on line, in the feeder to Micron Filter before R.O. Line pressure around 1.5 KSC	
operating pressure	KSC	2.5 to 3.0
R.O. permeate dosing tank	**DT 108**	
design basis	dosage (ppm)	

The R.O. permeate is bound to have a low pH due to the process. This needs to be made into neutral pH in the range 6.5 to 7.5 so that re-use is possible. To achieve this, dosing has to be given in the permeate tank		
Caustic dosing is provided in the permeate tank to regulate the pH. The water is bound to be aggressive (due to its low TDS and low alkalinity values) and hence a minor dosage would be enough to correct it to neutral. It is to be noted that the pH is not to go beyond 7.5 and hence the regulation dosage is calculated at the above range only.		
total permeate from all stages, all phases	KLD	170.0
acid dosage for pH correction	ppm	12
quantity	kgs/d	2.04
dosage strength	% w / v	10
specific gravity of solution	index	1.01
approx quantity of dosage / day	lpd	20.2
dosing tank volume provided	liters	100
quantity	nos	1
dosing tank material	MOC	LLDPE / PP
R.O. permeate dosing pump	**DP 108**	
total dosing volume	lpd	20.2
dosing flow rate needed min…	lph	1.0
capacity provided	lph	0 - 6
type of pump	electronic metering	
discharge point	dosing to tank at atmospheric pressure	
operating pressure	KSC	1.5 to 2.0

ELECTRO CELL REACTOR ER 101 A/B

Detailed description of the process is given in the process description section of the DPR.

Design capacity	170 KLD
No of plants in parallel	2 nos
Total capacity of plant to treat waste water	340 KLD
Design feed flow rate / stream	8.5 m3/hr
Overall size of the electro cell reactor	Width : 3m Length : 8m Height: 0.75 m
Anode specifications	Material : aluminum Size of one electrode : 0.4 m x 0.4m Thickness of one electrode : 5 mm
cathode specifications	Material : aluminum
Applied Driving Force	Electric current
Typical operating amperage	60 to 120 amps
Typical operating voltage	10 to 30 v
Skimmer	Reduction gear assembly with vertical MS shaft
Skimming ends	Neoprene / FRP flaps

AERATION PROCESS - Basic Design Data Sheets:

Extended Aeration Process is employed for BOD degradation. The values of BOD removal are as given below:	
BOD value effluent before primary treatment (ppm)	1900
BOD removed in primary treatment (ppm)	1235
BOD to Biological Process contributed by Effluent (ppm)	665
total effluent inlet to plant (m3 / day)	100
BOD load to Biological Process Contributed by Effluent (kgs /day)	66.5
BOD value of raw sewage (ppm)	225
BOD removed by enzymatic remediation in collection tank (ppm)	25
BOD to biological process contributed by sewage (ppm)	200
total sewage inlet to the plant (m3/day)	70
BOD load to Biological Process Contributed by Sewage (kgs/day)	14
Total BOD inlet to the Aeration Process (kgs / day) effluent + sewage	80.5
total waste water for treatment (m3 / day)	170
hence Design Inlet BOD for biological treatment (ppm)	473.5
Design BOD inlet for aeration process (ppm)	500.0
Typical design parameters for extended aeration:	
Food to Micro Organisms ratio	0.15 to 0.25
hydraulic retention time (minimum) hours	16 - 20
MLVSS in the tank (ppm)	2500 - 3000
endogenous decay coefficient (kd value day inverse)	0.06
cell residence time desired (days)	> 20
Yield co-efficient (Y)	0.5

Calculation of Volume:	
volume based on this F/M ratio (m3)= [{Q *So} / {X * F/m}]	189.4
hydraulic retention time for this volume (hrs)	22.3
Thus, HRT criteria is satisfied…	
Volume based on Theta C (Cell Residence Time)	152
({ Theta C * Q * Y * [So - S] } / { X * [1 + Kd*Theta C] })	
Thus, Cell Residence Time criteria is satisfied…	
actual size of the tank provided in the design: 10.0 m x 7.3 m x 3.0m SWD + 0.5m FB	
actual volume of liquid hold up provided in the design (m3)	219.0
Calculation of Oxygen Requirement:	
Kgs of Oxygen required / Kg of BOD destroyed / day	1.5
value considered for design: (kgs Oxygen demand / kg BOD / day)	2
actual BOD destroyed in the Process (Kgs / day)	80.5
Hence oxygen demand for the system (kgs / day)	161
Aspirating Aeration is provided for the system.	
oxygen disbursement / 5 HP aspirating aerator (kgs / day)	200
Number of aeration system required	1
Provided; One (1) number 5 Hp aspirating aeration STORMIX / equivalent system is sufficient	

SAND FILTRATION AND CARBON FILTRATION – Basic Design Data Sheets

Sand Filter	**SF 101 A / B**	
design basis	filtration rate.	
Sand Filter is a surface filtration process. Hence, filtration rate is the criteria for sizing the unit. Depending on the nature of the feed water, the rate is bound to vary. Operating at lesser filtration rate would mean bigger vessel and more cost, but in turn, will increase the efficiency of the filtration process as the surface area for filtration for a given feed flow rate will be enhanced.		
Two sand filters are provided in parallel. Each Filter is capable of taking maximum feed load i.e. 170 KLD. This redudancy helps in running parallel operations even if one filter is found to have problems and hence needs maintenance down time.		
three to four media types are provided inside the pressure vessel. Gravel from the bottom, pebble on top of it, coarse sand on top of the pebble layer and fine sand at the very top. Flow is processed from TOP to BOTTOM. Being surface filtration, only the top layer acts as a filter and the remaining media is only "supporting structure"		
another design factor is the "dirt holding capacity" of the filter. The quantity of contaminant a filter element can trap and hold before the maximum allowable back pressure or delta P level is reached. This varies from 3 to 6 kgs of TSS load / sq.m. of the filtration area. In this design, as the filtration rate is taken very low, the DHC of the filter bed will be extremely good i.e. the clogging of filters will be extremely rare.		
design plant capacity / filter	m3/d	170
feed flow rate for design	m3/hr	8.5
filtration rate considered	m3/h/ m2	12.5
area required for filtration	m2	0.68
internal diameter requried	in mts	0.931
	in inches	36.6
vessel type	FRP pressure vessel	
Model of filter provided	model	4072
diameter of the vessel provided	in inches	40
height of the vessel provided	in inches	72
	in mts	1.8288
approx media heights:		
bottom : gravel	mm	200 - 250
next : pebble	mm	225 - 250
next : coarse sand	mm	150 - 230
top layer : fine sand	mm	150 - 250
total media height	mm	725 - 825
inlet arrangement	type	header with lateral distributor

outlet arrangement	type	collectors with box outlet
process control valve	type	multiport valve
dirt holding capacity	kgs SS / m2	3 to 6
T.S.S. load to the filter @ 100 ppm inlet TSS after biological treatment	Kgs /day	17
hence minimum area required	m2	0.18
Actual area provided is much more than this… Hence, dirt holding capacity criteria is satisfied.		
NOTE: The parameters of sand (uniformity coefficient and other factors)will be as per GEP and as per guidelines prescribed by CPHEEO manual on water treatment		
Carbon Filter	**CF 101 A / B**	
design basis	filtration rate.	
carbon filter is an adsoption process for trapping the trace organics, color, trace gases in the filtered water by passing it through the bed of activated carbon.		
Two carbon filters are provided in parallel. Each Filter is capable of taking maximum feed load i.e. 170 KLD. This redudancy helps in running parallel operations even if one filter is found to have problems and hence needs maintenance down time.		
carbon filters are operated at slightly higher surface filtration rates than sand filter. However, the design has been done with conserative values to ensure maximum effectiveness of the filter operations.		
design plant capacity / filter	m3/d	170
feed flow rate for design	m3/hr	8.5
filtration rate considered	m3/h/ m2	15
area required for filtration	m2	0.567
internal diameter requried	in mts	0.850
	in inches	33.4
vessel type	FRP pressure vessel	
Model of filter provided	model	3672
diameter of the vessel provided	in inches	36
height of the vessel provided	in inches	72
	in mts	1.8288
media	activated carbon with I.V. > 900	
valve type	multiport valve	
NOTE: The parameters of carbon will be as per GEP and as per guidelines prescribed by CPHEEO manual on water treatment		

BAG FILTER AND ULTRA FILTRATION SYSTEM – Basic Design Sheets

Bag Filter	**BF 101 A/B**	
design basis	flow / bag	
Bag filter is a surface filtration. Each unit area of the bag acts as a filter. Bag filters have the capability to process large volumes of liquid per unit area as compared with the micron filters. Bag filters are normally used before "protecting systems" i.e. typically before Ultra Filter and before Nano Filters.		
In this system, two bag filters are provided in parallel, each having a capacity to treat 8.5 m3/hr i.e. 170 KLD of feed flow rate. Each can be operated independently and jointly also (if so desired)		
feed flow rate for design	m3/hr	8.5
flow per 33" x 7" bag size	m3/hr	15.0
hence no. of bags required	nos	1.0
micron rating of bag	nominal	20.0
bag material	MOC	P.P.
housing	moc	SS
number of bag filters	nos	2.0

Ultra Filter	**UF 101 A/B**
design basis	flux
Ultra Filtration operates on molecular weight cut off (MWCO). The MWCO of the chosen UF modules is between 100 to 120 KD. The primary purpose of the UF system is to protect the R.O. membranes against turbidity and silt build up and also to remove large size micro biological contaminants and organic molecules, thus providing protection to the R.O. membranes against possible organic fouling	
Flux plays an important role in the efficiency of the process. Flux is the (flow / unit area of membrane / unit time).. Flux is always determined on permeate flow for membrane separation systems such as UF, NF & HF(hyper filtration, commonly referred as R.O. process). Higher flux for a given flow rate would mean lesser area requirement and thus lesser membranes and lesser capital investment. But, this will increase the fouling potential of the membrane and increae the cleaning frequency and the usage of cleaning chemicals...	

There are two parallel plants in this system, each having a capacity to treat 170 KLD @ 8.5 m3/hr. The main process of Inlet, Outlet, Backwash Inlet, B/w outlet and rinse is controlled through P.L.C. The flux is designed on a very conservative basis to ensure maximum effectiveness of removal of contaminants with significantly reduced fouling potential.		
feed flow rate for design / stream	m3/hr	8.5
UF module rating	MWCO	100 - 120 KD
UF module type	hollow fine fibre	
UF process type	Cross Flow , vertical mounted	
UF membrane material	PES / PE / PVDF	
UF module material	PE / PP	
design operating flux	GFD	40.0
expected recovery	%	90.0
typical membrane surface area of UF module	sq.ft	643.2
product recovery per membrane	liters / hour	4057.5
	m3/hr	4.1
actual number of membranes needed	nos	1.9
number of membranes provided	nos	3.0
UF permeate	m3/hr	7.7
UF reject	m3/hr	0.9
total number of UF modules for parallel streams	nos	6.0

MICRON FILTERS – Basic Design Sheets

MICRON FILTERS:	MF 101, 102, 103 & 104
design basis	flow / 10" cartridge length
Micron Filter is depth filtration. The cartridges are SPUN type with central core. Feed enters from outside, proceeds across the thickness of the cartridges and collects in the central product pipe and is sent out. The design criteria is the amount of water processed through one 10" cartridge length. The cartridges come in standard sizes of 10, 20, 30 & 40 inches length and are housed in SS housing fitted with pressure gauge.	
Too high a flow rate would mean much faster choking and more replacement frequency, but will reduce the initial installation cost. This design has adopted the manufacturer's recommendation on the minimum flow rate that can be taken through a 10" cartridge for a feed water which has been treated through sand and carbon filtration.	

In this plant, micron filters are placed in the following locations: (a) In the Ultra Filter Plant, the Micron Filter is kept at the discharge of the C.I.P. system pump. The chemicals used in the CIP system may carry some impurity and this is trapped through the micron filter. (b) In the R.O. plant, the Micron Filter is kept before the high pressure pump to protect the R.O. membrane (c) In the same R.O. plant, in stage 2 this is kept before stage 2 high pressure pump and (d) micron filter is kept in the CIP system of the R.O. plant for the same reason as it is kept for the UF CIP system.

UF CIP Micron Filter	**MF 101**	
feed flow rate for design	m3/hr	5.0
flow / 10" cartridge recommended	m3/hr	1.0
flow / 10" cartridge considered	m3/hr	0.8
hence number of 10" cartridges needed	nos	6.7
total length needed for micron filtration	inches	66.7
cartridge length provided	inches	40.0
number of cartridges provided	nos	2.0
actual cartridge length provided	inches	80.0
micron rating	nominal	25.0
cartridge material	MOC	P.P.
housing	moc	SS
R.O Stage 1 Micron Filter	**MF 102**	
one micron filter to feed both streams i.e. designed for total flow of 8.5 m3/hr x 2 = 17 m3/hr		
feed flow rate for design	m3/hr	17.0
flow / 10" cartridge recommended	m3/hr	1.15
flow / 10" cartridge considered	m3/hr	1.1
hence number of 10" cartridges needed	nos	15.5
total length needed for micron filtration	inches	154.5
cartridge length provided	inches	40.0
number of cartridges provided	nos	4.0
actual cartridge length provided	inches	160.0
micron rating	nominal	10.0
cartridge material	MOC	P.P.
housing	moc	SS
cartridge material	MOC	P.P.
housing	moc	SS

R.O Stage 2 Micron Filter	**MF 103**	
feed flow rate for design	m3/hr	6.0
flow / 10" cartridge recommended	m3/hr	1.15
flow / 10" cartridge considered	m3/hr	1.0
hence number of 10" cartridges needed	nos	6.0
total length needed for micron filtration	inches	60.0
cartridge length provided	inches	30.0
number of cartridges provided	nos	2.0
actual cartridge length provided	inches	60.0
micron rating	nominal	10.0
cartridge material	MOC	P.P.
housing	moc	SS
R.O CIP Micron Filter	**MF 104**	
CIP system feed flow rate	m3/hr	8.0
flow / 10" cartridge recommended	m3/hr	1.00
flow / 10" cartridge considered	m3/hr	0.9
hence number of 10" cartridges needed	nos	8.9
total length needed for micron filtration	inches	88.9
cartridge length provided	inches	30.0
number of cartridges provided	nos	3.0
actual cartridge length provided	inches	90.0
micron rating	nominal	25.0
cartridge material	MOC	P.P.
housing	moc	SS

R.O. PROCESS – Basic Design Sheets

Process will have TWO STAGES. The reject from first stage will be the feed to the next stage.
Stage 1 will have TWO PARALLEL PLANTS, each of 8.5 m3/hr (170 KLD) feed water flow rate.
Stage 2 will have ONE PLANT of 6 m3/hr (120 KLD) feed water flow rate, to receive the reject from BOTH the parallel streams.

Stage 1		
R.O. feed flow rate for design	m3/hr	8.5
	m3 /day	170.0
recovery of stage 1	%	65.0
permeate from stage 1	m3/hr	5.5
	m3 /day	110.5
reject from stage 1	m3/hr	3.0
	m3 /day	59.5

Now, Stage 2 is designed for reject of 3 m3/hr x 2 stream = 6 m3/hr (i.e. assuming that both the streams in stage 1 are under operation at a time… If only one stream of stage 1 is under operation, then this stage 2 will be run for only 10 hours instead of the design of 20 hours.

Stage 2		
feed flow rate	m3/hr	6.0
recovery of stage 2	%	50.0
permeate from stage 2	m3/hr	3.0
reject from stage 2	m3/hr	3.0

TOTAL QUANTITY OF PRODUCT (in KLD) FOR ONE STREAM OF 170 KLD	140.25
TOTAL REJECT (in KLD) FOR ONE STREAM OF 170 KLD BEING OPERATIONAL	29.75

DESIGN OF MEMBRANES		
stage 1 (2 parallel plants, each of 8.5 m3/hr feed capacity)		
design basis	flux	

There are several factors that needs to be considered when designing a R.O. system. TDS of the feed water, required recovery, the Langlier Index of the feed water, fouling potential, beta factor etc.. However, the core factor is the FLUX i.e. how much product that we are going to recovery / area / time from one membrane.

It is to be noted that the water quality and pressure and the recovery are all interlinked. The common thread running through all these is the FLUX. Higher the flux means more recovery per membrane. This means that we will have lesser membranes and hence lesser capital investment. But, higher flux would increase the scaling potential of the water as it passes through the membrane pressure vessel and will significantly increase the beta factor i.e. the possibility of concentration polarization of sparingly soluble salts on the membrane surface.

In this design, FLUX is considered as more of a technical factor rather than a commercial factor. The manufacturer's recommendation on general conditions of pre treatment and raw water characteristics has been taken into account. But the actual flux has been worked out at a lesser value than this. This plant deals with effluent. It means that, there is a significant possibility of finding complex compounds in the waste water. Under normal conditions, these would not affect the treatment in any way. But, when concentrated through two stages, their behaviour is bound to change and affect the performance. Hence, suitable allowance is provided for the same.

recommended maximum flux for UF pre treated R.O. feed water	GFD	15
Design Flux in stage 1 (after U.F.)	GFD	12.0
active surface area of one 8"dia x 40" long brackish water membrane as given by the manufacturer	sq.ft.	375 - 400
surface area considered for design	sq.ft.	375
permeate flow / membrane for above flux and surface area	liters / hour	709.7
	m3 /hour	0.7
total permeate flow of stage 1 @ 8.5 m3/hr feed flow	m3 /hour	5.5
Hence, number of membranes needed as per design	nos	7.8
Actual number of membranes provided	nos	12.0

Note: In addition to taking a lower flux and taking a lower permeate flow / membrane, the system has incorporated additional membranes i.e. from 8 nos, the system has been loaded by 50% more. While this may increase the initial cost, the performance and the effectiveness of the system will be sustained for a far longer period, cleaning frequency will reduce significantly and most importantly, the permeate TDS will remain stabilized at low operating pressures.

design configuration of stage 1	
Stage 1 vessel 1	6 nos of 8" x 40"
Stage 1 vessel 2	6 nos of 8" x 40"
membrane size	8" dia x 40" long
membrane manufactured configuration	spiral wound polyamide
membrane type	Brackish Water

stage 2

Stage 2 receives the reject of stage 1. Hence, more salinity and impurity concentration will be fed through the membranes in stage 2. Here, the flux is still LESSER than that of Stage 1, as the possibility of high beta factor is more significant. The membrane provided is also sea water membrane having capability of withstanding high pressures and of TDS up to 40,000 mg / l in the feed... Recovery of the system has also been kept much lesser - at only 50% to sustain the production and to prevent membrane loss.

recommended maximum flux for stage 2 process	GFD	12
Design Flux in stage 1 (after U.F.)	GFD	10.0
active surface area of one 8"dia x 40" long brackish water membrane as given by the manufacturer	sq.ft.	330 - 375
surface area considered for design	sq.ft.	350
permeate flow / membrane for above flux and surface area	liters / hour	552.0
	m3 /hour	0.55
total permeate flow of stage 2 @ 6 m3/hr feed flow	m3 /hour	3.0
Hence, number of membranes needed as per design	nos	5.4
Actual number of membranes provided	nos	8.0

design configuration of stage 2	
Stage 2 vessel 1	4 nos of 8" x 40"
Stage2 vessel 2	4 nos of 8" x 40"
membrane size	8" dia x 40" long
membrane type	spiral wound polyamide

membrane working feed water quality	Sea Water	
R.O. PRESSURE VESSELS:		
R.O. Stage 1 pressure vessels		
number of membranes in the system	nos	12.0
no. of membranes in each pressure vessel	nos	6.0
number of pressure vessels	nos	2.0
specification of each vessel	8" dia , 6 element long	
design working pressure	psi	400.0
	bar	28.2
actual working pressure - maximum	bar	15.0
material of pressure vessel	moc	FRP
port type	end port / side port	
coupling type	victaulic	
R.O. Stage 2 pressure vessels		
number of membranes in the system	nos	10.0
no. of membranes in each pressure vessel	nos	5.0
number of pressure vessels	nos	2.0
specification of each vessel	8" dia , 6 element long	
design working pressure	psi	600.0
	bar	42.3
actual working pressure - maximum	bar	25.0
material of pressure vessel	moc	FRP
port type	end port / side port	
coupling type	victaulic	

U.F. CIP Tank	**T 107**	
capacity of tank	m3	2.0
type of tank	moc	HDPE
quantity	nos	1.0
R.O. CIP Tank	**T 112**	
capacity of tank	m3	2.5
type of tank	moc	HDPE
quantity	nos	1.0

SOLIDS MANAGEMENT – Tube Settlers & filter press – Basic Design Sheets

E process Tube Settler	**TS 101**	
design basis	surface overflow rate.	
The tube settler provides tubes held at 45 to 60 degrees inclination to the direction of flow, kept inside a FRP tank. This results in suspended solids removal by entrapment and subsequent settling. Compared with conventional clarification, tube settlers are more effective as they provide more surface area to unit volume because of the media.. However, they are not offered in this design for secondary clarification (i.e. solids from bio process). The bio process solids are hygroscopic and may form film layers on the tube, thus hindering the process of settling.		
The tube settler in this system is designed for 2 x 100% load i.e. for 2 x 100 KLD = 200 KLD of effluent coming in at a time. Even if lesser quantity comes, then the process of settling is only enhanced and not reduced.		
capacity for design	KLD	200
quantity	nos	1
feed flow rate for design / module	m3/hr	10
design surface overflow rate	m3/hr / m2	1.5
area of settling required	m2	6.67
typical width	m	2
length required	m	3.33
retention desired	hrs	1.7
volume required for this retention	m3	17
hence minimum depth required	m	2.55
size of the tube settler	3.3m x 1.7m x 2.6 m LD	

B/w waste Tube Settler	**TS 102**	
design basis	surface overflow rate.	
The backwash from the sand and carbon filters as well as from the Ultra Filtration system is bound to contain suspended solids in high volume of liquid. This is processed through a tube settler, thus concentrating the solids. The under flow of the tube settler goes to the Solids Holding Tank from wherein the solids are taken for de watering.		
feed flow rate	m3/hr	2.0
design surface overflow rate	m3/hr / m2	1.5
area of settling required	m2	1.3

typical width	m	2.0
length required	m	0.7
retention desired	hrs	1.5
volume required for this retention	m3	3.0
hence minimum depth required	m	2.3
size of the tube settler	2.0m x 1.0m x 2.6m depth	

Filter Press:	**FP 101**	
quantity (nos)	nos	2.0
design feed flow rate	m3 /hr	2.0
design inlet consistency	% w/v	1.5
desired outlet consistency of cake	% w/v	30.0
process time / batch	hrs/batch	4.0
number of batches / day	nos	2.0
total processing hours / filter press / day	hrs/press/day	8.0
type of closing	type	manual
size of plates	mm xmm	355 x 355
type of filter press	type	recessed
operational mode	mode	manual
operating pressure	bar	4.0
Typical number of plates	nos	7.0
typical no of chambers	nos	6.0
area / unit	m2	0.9
Volume / liter of water equivalent	litrs	12.6
typical thickness of cake	mm	30 - 32

TECHNICAL SPECIFICATIONS

PART B: CONVEYANCE SYSTEM IN THE PROJECT

The information provided herein is indicative and is intended to serve as a guideline for the Bidder in his preparation of the tender. The Bill of Quantity and size of equipment provided also is indicative and is subject to change during detailed engineering. Bidder can evaluate the system and may accordingly price the same in his Price Bid.

CONVEYANCE SYSTEM:-

How Effluents from various units are collected and conveyed to the treatment plant area:

The process of conveyance shall be divided into the following segments:

Segment 1:

From INSIDE each unit to the terminating flange outside the boundary of the Unit (Units' scope) and from this flange, the interconnection to the conveyance main header which is in CETP Scope Segment

Segment 2:

Main Header to the treatment plant area (CETP scope)

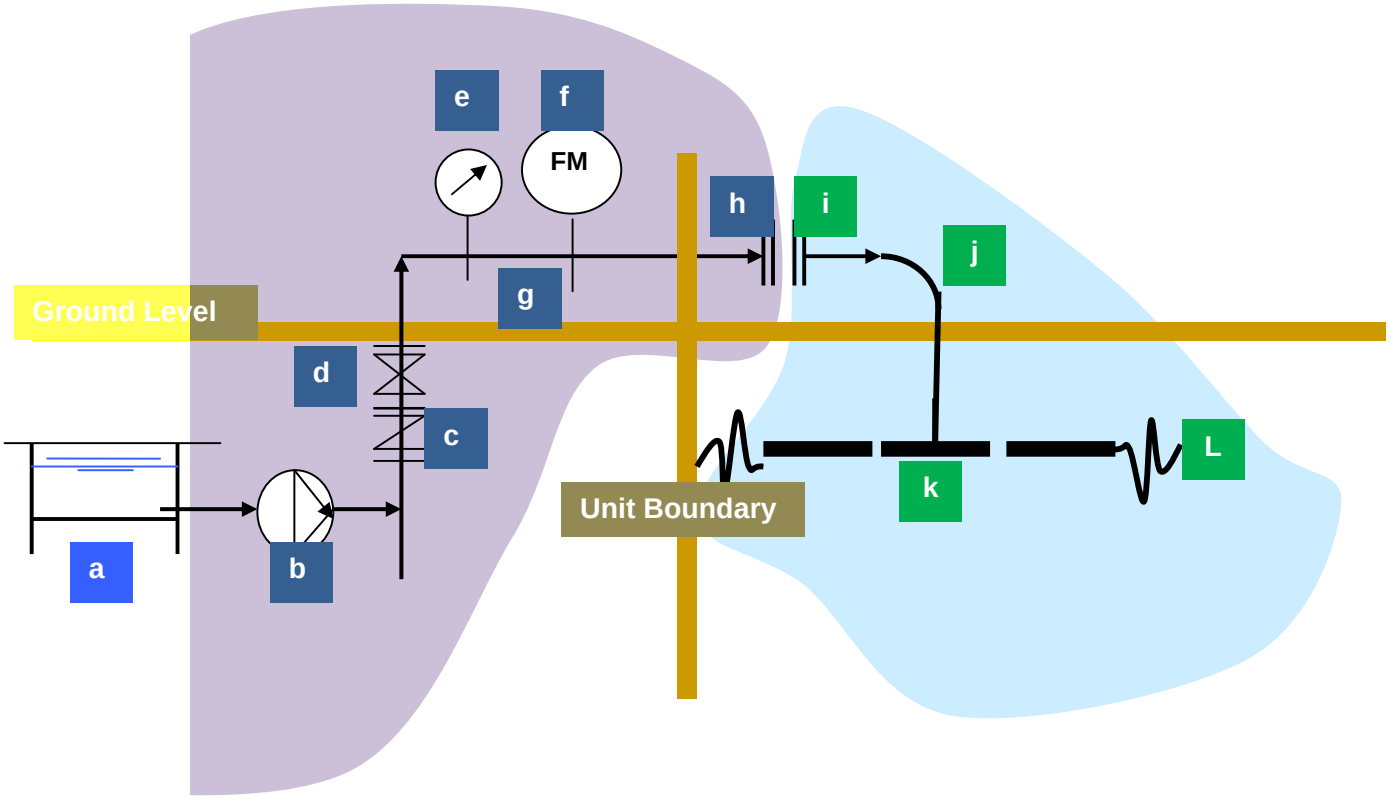
Segment 1

(how effluent is collected in each unit and brought to the outside battery limit and then linked with the CETP conveyance system)

- Currently, effluent is collected in a tank in each of the factory. Most of them have a pumping system for current methods of discharge / treatment.This pumping system shall be either retained or new pump shall be provided by the Unit, in line with the conveyance system requirements. The capacity recommended for each unit shall be given in the table in this section.
- The Unit shall be use the existing pumping system / new pump, to pump their effluent from their existing tank to their compound wall.This pipeline shall be terminate outside the compound wall at a height of about 1.2 mts from the ground level with a connecting flange.
- For the pipe line coming from each unit, one **ELECTRO MAGNETIC FLOW METER shall** be provided. This EMFM shall be record the total effluent given by the respective unit for treatment.
- Each unit shall be provided with a non-return valve to prevent back flow from the main header in to the effluent discharge pipeline of the unit.

- This conveyance pipeline – from each unit to connect to the Main Header size is only between 1" to 2", as the individual capacities of each Unit is less.

TYPICAL FLOW SCHEMATIC:



A	Existing collection tank in each Unit	G	Line from the Unit coming outside the boundary wall of the Unit
B	Existing pump / New pump as per specifications given in the table below	H	This line will terminate with this flange end / thread end
C	Non Return Valve in line to ensure that back flow is not there	I	From CETP side, this is the connecting end flange connecting the unit pipe to the main header
D	Flow control ball valve	J	Bend

E	Pressure Gauge in discharge line	K	Tee
F	Electro Magnetic Flow Meter in discharge line	L	Main Header Line

Table showing the recommended pump capacity for each Unit to transfer their effluent from within their premises to the main header of the conveyance system of the CETP:

S.NO	**NAME**	**EFFLUENT (liters/day)**	**TANK (liters)**	**recommended pumping (liters / hour)**	**RECOMMENDED PIPE DIA &MOC**
1	EUROKEM LABORATORIES PVT LTD	800	2000	500	1"/ PVC
2	APEX LABORATORIES PVT LTD	42000	50000	400-500	2" / PVC
3	SPINCOTECH (P) LTD	900	1000	500	1"C/ PVC
4	STEDMAN	16000	5000	2000	1.5"C/ PVC
5	GLOBAL PHARMA HEALTH CARE PVT LTD	3000	3000	1000	1"/PVC
6	ORCHID PHARMACEUTICALS – FORMULATION DIV 1	3000	10000	2000	1.5"/PVC
7	UNILINK PHARMA PVT LTD	3000	10000	1000	1" / PVC
8	CARESS BEAUTY CARE PRODUCTS (P) LTD	6100	40000	1000-2000	1.5" /PVC
9	CLARION COSMETICS (FOOD DIVISION)	8200	40000	1000-2000	1.5" / PVC
10	TAMMAN TITOE PHARMA PVT LTD	4000	5000	1000	1" / PVC

Table showing the recommended interconnecting piping sizing for each Unit to transfer to the main header:

UNIT	PIPE DIA	VALVE	BEND/ELBOW	EMFM
EUROKEM LABORATORIES PVT LTD	1"	1" , NRV	1" , 90	1"
APEX LABORATORIES PVT LTD	2"	2", NRV	2", 90	2"
SPINCOTECH (P) LTD	1"	1", NRV	1", 90	1"
STEDMAN	1.5"	1.5", NRV	1.5", 90	1.5"
GLOBAL PHARMA HEALTH CARE PVT LTD	1"	1", NRV	1", 90	1"
ORCHID PHARMACEUTICALS – FORMULATION DIV 1	1.5"	1.5", NRV	1.5", 90	1.5"
UNILINK PHARMA PVT LTD	1"	1", NRV	1", 90	1"
CARESS BEAUTY CARE PRODUCTS (P) LTD	1.5"	1.5", NRV	1.5", 90	1.5"
CLARION COSMETICS (FOOD DIVISION)	1.5"	1.5", NRV	1.5", 90	1.5"
TAMMAN TITOE PHARMA PVT LTD	1"	1", NRV	1", 90	1"

Segment 2

(The main header that conveys the effluent collected from various units to the treatment plant site)

MAIN HEADER - Design Basis:

The main header conveys the effluent from various units to the treatment location.

All the Units, except M/s Tamman & TItoe are located in a cluster, in the same road. This is indicated in plot plan enclosed.

Hence it is proposed to construct one main header starting from M/s Regenix Laboratories till M/s Clarion (as indicated in the conveyance route plan)

There are TWO EXCEPTIONS:

1. M/s Euorkem neither have sewage nor effluent connection. Hence, two new pipes will be laid for the Unit. One will convey the sewage and link with the manhole outside M/s AR Labs and the other will convey the effluent and link it with the main header starting from M/s Regenix Lab.

2. M/s Tamman & TItoe is located right opposite to the proposed CETP location. Hence, two separate pipes will be laid for the Unit. One will convey the sewage and discharge to Tank # T 100 (Raw Sewage Collection Tank) in the CETP. The other will convey the effluent and link it with Tank # T 101 (Raw Effluent Collection Tank)

All the other units are located IN ONE SINGLE ROAD and hence they will all be connected to the main header.

The Main Header by itself shall be come in TWO PARTS.

Part 1 shall collect the effluent from all the units and bring it to one point outside M/s Clarion Compound Wall.

Here, the gravity flow is BROKEN and an intermediate sump of 20 KL is constructed.

Part 2 shall be start from this sump through PUMPING SYSTEM and convey the effluent directly to the treatment plant Tank # T 101

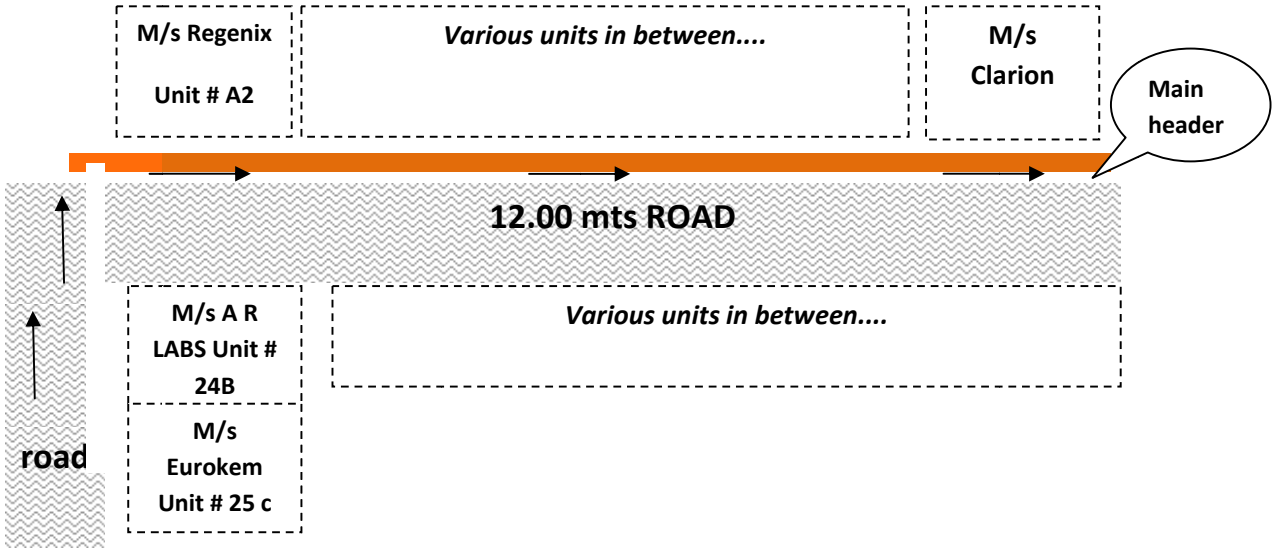
MAIN HEADER SIZE :-

- The total design effluent is 100 KLD. However, the CETP has capability and infrastructure to treat 200 KLD i.e 100 KLD * 2 streams for effluent.
- The maximum discharge through the main header shall be when all the units are discharging their effluent at a given point of time together.
- It is assumed that all the units utilize their 100% pumping capacity when discharging their effluent.
- In such a case, the total volume of effluent that shall be to conveyed in the above criteria will be 17,000 liters / hour [Calculating the maximum discharge from each unit].
- The main header shall be provided with a gentle slope to ensure that the waste water flows without any impediment.
- Flow of the pipe line shall be 17 m3/hour.
- Velocity assumed at 1.0 m/s on a very conservative side.

- The inner dia of the pipe required for these above conditions is maximum of 3.0” dia. Hence, the header shall be of 4” diameter.
- Material of Construction : PVC
- Pipe operating pressure : 1.0 to 1.5 bar
- Pipe design withstanding pressure under normal operations : 4.0 bar
- Total header length : 1.6 kms based on site conditions.

CONSTRUCTION OF THE MAIN HEADER:-

Part 1: collection of effluents from various units & conveyance by gravity till Intermediate Sump



Part 1:

- Part 1 carriers all the interconnections from various units except M/S TAMMAN & TITOE. 4" dia, PVC pipe for design pressure of 4.0 KSC minimum with bends, tees of equivalent material and specifications on pressure.
- Once all the units are covered, the flow is broken through the intermediate sump located outside Clarion.

Part 2: construction of intermediate sump + pumping system and conveyance of main header till the treatment plant area.

Item # 1 : Under Ground Sump of 20 KL capacity:

- The soil conditions in the proposed CETP area is very poor and building a underground structure is not recommended. If pumping system is not present , then the indicative invert level of the effluent conveyance pipeline will be about 9 feet below the 0.00 level of proposed CETP. In addition to this, during the recent rains , it was observed that the entire proposed area was flooded. Hence the main process tanks are all kept above ground. The plant and machinery shed is kept above the main process tank due to site situation. All these factors were studied for the techno-economic feasibility and based on the outcome, it has been decided to construct this intermediate tank and pump the effluent.
- The sump shall be of approximately 20,000 liters capacity.
- The location of the sump is indicated in the drawing. The sump is proposed to be located either near the last unit that is discharging their effluent i.e M/s CLARION or near the existing sump cum pump house for the sewage.

Item # 2 : Effluent Transfer Pumps

- From the sump, it is planned to install a pump to convey the effluent to the proposed CETP.
- The capacity of the pumps shall be about 20,000 liters / hour, keeping In mind (a) the maximum discharge from all units at a time is only 16-17 m^3 / hour and the capacity of the tank under maximum discharge is more than one hour.
- The pumps shall be provided with dry run protection. The pumping system shall be linked with the level of effluent in the sump.
- It is proposed to provide REED BASED proportionate height level controlling system. The control system shall be of five levels LOW LOW , LOW , MEDIUM, HIGH and HIGH HIGH with progressive height from the bottom level of liquid.

- Two pumps are provided. During normal operation, one will working and the other will be standby.
- The pumps are typically submersible centrifugal ,though, at a later date, based on case of maintenance, these may be replaced with horizontal centrifugal, non-clocg, open impeller pumps.

The pump operation w.r.t. level will be as follows:

LEVEL CONDITION	OPERATION
"LOW-LOW"	Both pumps shall be shutdown through dry run protection.
"LOW"	Typically, "LOW" level shall be 20% higher than "LOW-LOW" level. One pump shall start and if the level goes down again to "LOW-LOW" this shall be again cutoff.
"MEDIUM"	One pump operates smoothly. Typically, this is 50% of total liquid depth.
"HIGH"	This point is reached at about 70% of the liquid depth. At "HIGH POINT, the second pump will start operating and will stop once the level goes below HIGH".
"HIGH-HIGH"	This is an highly abnormal condition and is activated when the liquid depth reaches 90% of the total depth.Both pumps will operate at this point.

The operation of the pumps shall be through local auto control system. Provision for normal over ride shall also be provided. The auto control system integration will be done with 100% redundancy because of the importance of this infra structure.

Item # 3: Main Header from Pump Discharge to T 101 – Effluent Collection Sump in the treatment plant area:

- The main header now will continue from the discharge of the pump till it reaches the effluent collection tank (T101) in the proposed CETP.
- The main header is now designed for the maximum discharge capacity of the pump which is 20m3/ hour. At a pumping velocity of about 2.0 m /sec, the recommended pipe diameter works out to be 3” inches.

- The maximum vertical head will be about 4.23 meters based on the site Topo Survey results [Please see reference drawings]. Sump vertical depth will be about 3.0 meters. The maximum horizontal head loss, bend loss is calculated at about 3.67 meters.
- Though the total theoretical head loss is about 11 – 12 meters, it is proposed to have a pump of capacity 20m3/hour discharging at 25 MWC under normal working conditions.
- In reality, the flow through will be lesser which, in turn, would only increase the next available head for the pump, thus making the selection sustainable and safe.
- Please refer the routing map for conveyance system.

SEWAGE CONVEYANCE:-

- All the units, except M/s EUROKEM have existing connection and conveyance system to take their sewage to the existing wells near the oxidation pond (please see drawing).

- None of the discharges are currently been monitored. It is thus, first planned to install Electro Magnetic Flow meters (EMFM) in each of the units in the discharge line of the sewage before it connects with main header.

- The sewage now gets collected in the existing wells before being pumped to the existing oxidation pond, which is dysfunctional. Hence, before the sewage header enters the oxidation ponds, it will be re-routed from the last manhole, to join the effluent line and reach the CETP area. The pipe routing is given in the drawing.

- This re-routed sewage collects in a proposed underground sump (T100). From here, it will be pumped to common collection tank, to be further processed for treatment.

TREATED WATER DISTRIBUTION:-

- While environmental management and pollution abatement are the core reasons for the CETP, it is also important to recycle and re-use water. For this, the CETP has technically superior membrane separation system, which provides 80% of the inlet water processed and ready for re-use.

- As on date, all the units are purchasing lorry water at a cost, with no control on quality. This water is processed through individual treatment units and used for both process, utility as well as for toilets, washings ect…

- Now it is planned to supply the recycled water to the units. The water shall be as good, if not better than the current source of their raw water. However, this treated water shall be re-used only for tertiary applications involving toilet flushing, gardening, floor washing etc…This amount of water shall be saved.

- Treated water i.e. permeate from the R.O Plant is collected in a final treated water sump after PH correction.

- From this sump, the water is conveyed to each unit, through the same system for effluent conveyance, but done in reverse.

- First, the water pumped through Hydro Pneumatic System. Two options were evaluated for techno-commercial feasibility. One was to construct an over head tank and supply through gravity main to all the units. The second option was to have pressurized system supply.
- Construction of the over head tank was found to be economically unfeasible due to poor soil conditions in the proposed site. Also, using a hydro pneumatic system was found to be technically superior, due to the following aspects:

    1. Constant flow and pressure at all points in the system.
    2. Greater accuracy and consistency in monitoring the off take from each unit through Electromagnetic flow measurement.

- The Hydro Pnuematic system shall be installed in the plant area. From here, a supply main will go to the location of all the units, except M/s Tamman&Titoe. For the latter, a separate pipeline will be provided directly from the system/plant output line due to the proximity of the unit.
- The main header will be laid alongside the incoming effluent line (please see the pipe routing drawing). The header will terminate at starting point of the main effluent header.
- From this supply header, individual pipelines with non-return valve will be provided to each unit with a flanged end connection terminating before the compound wall of each unit.
- From this connection, the user has to convey the treated water in to his unit with his own pipeline system. In this user pipeline, an EMFM will be installed to monitor and record the usage of treated water by the user.
- Each pipeline shall be provided with a ball valve which the user can open and collect the treated water in his tank.
- The pipeline diameter, specifications will be same as that for effluent intake from each unit (which is provided earlier).

SUMMARY:-

A :EFFLUENT CONVEYANCE:-

- Conveyance of raw effluent from M/s Eurokem Laboratories to join the main header .
- Conveyance of raw sewage from M/s Eurokem Laboratories to join the sewage header near AR Labs.
- Main effluent conveyance header from individual units till the intermediate sump.
- Intermediate sump about 20KL capacity.
- Transfer pumps- submersible centrifugal /horizontal centrifugal non clog open impeller pumps of 20 m^3 /hr @ 20 MWC.

- Main header section || to the treatment plant area.
- Inflow piping from each unit, starting from the compound wall of each unit with termination in the manhole
- Termination of the raw effluent conveyance piping at T-101.
- One number of Electromagnetic flow meter of suitable range and for fitment in suitable pipe size, to be installed in the raw effluent intake line from each unit.
- Separate effluent line from M/s Tamman&Titoe (opposite to the proposed location), terminating at T-101, along with Electro magnetic flow meter.

B: SEWAGE CONVEYANCE:-

- Conveyance of raw sewage from M/s Eurokem Laboratories to join the sewage header near AR Labs.
- Existing sewage conveyance network to be retained. Necessary upgradation to be done to the existing pumping system.
- From the last manhole, before reaching the existing open wells, the raw sewage will be diverted to terminate at T-100 with the plant area.
- Providing EMFM for each unit to measure & monitor the amount of sewage discharge.

C: TREATED WATER DISTRIBUTION:-

- Provision of hydro pneumatic system 5m^3/ hr, with line pressure at user point, not less than 20 bar.
- Main header to supply to all units.
- Individual pipeline lateral from main header to supply to each unit, through same manhole used for effluent conveyance. Both the effluent pipe line and return water pipeline will run side by side.

CIVIL WORKS IN THE CONVEYANCE SYSTEM:

- Detailed civil works Bill of Quantity is given in the following pages. The conceptual approach for construction related activities is presented below:

Conveyance of sewage line from Eurokem to the man hole near AR Labs – earth work excavations

- Conveyance of effluent from Eurokem to main header earth work excavations and Main header line starting from Reginix up to Clarion, as shown in the drawing. The main header will be buried piping covered with compacted earth, between the end of existing road and the compound wall / boundary of the individual units.
- The excavations will be typically 2-3 feet wide. Starting depth of pipelines about 2-3 feet from FGL at pipe insertion point. The site has undulating gradient with an initial increase in gradient for about 2-4 feet followed by sloping level till the last unit i.e M/s Clarion. Based on site investigations and techno-economic feasibility studies, the typical excavation depth will be about 5 feet average with respect to finished ground level. Individual section calculations and design engineering will be provided during detailed engineering prior to execution.
- Civil works consists of earthwork excavations, preparation of support system for resting the main header till the intermediate sump.
- For every unit, the joining with the main header will be made through man hole. The details of the same are given in the Bill of Quantity for Civil Works.

Other civil works:

- Construction of underground intermediate sump of capacity 20 KL. All civil works related to this, including provision of cover slab ,rungs, manholes ect…

Excavations and preparation of pedestal and support systems for laying of the main header pipeline – pumped flow from UG sump.

Civil works related to road crossing at the following locations:

1. Effluent line from M/s Eurokem filling the main header.
2. Effluent line from M/s Apex Laboratories filling the main header.
3. Effluent line from M/s Spincotech joining the main header.
4. Effluent line from M/s Unilinx joining the main header.
5. Road crossing of the main header from M/s Clarion to the opposite side (please refer pipe routing drawing).
6. Road crossing to the opposite side of the proposed CETP.

Civil works will generally consist of earthwork, excavations, preparing of surface, laying of pipeline, suitable covering , re-preparation of top surface and road finishing to bring the same back original condition. Suitable identification working will be provided on the starting side as well as on the ending side of the road crossing.

Mechanical Works in the Conveyance System:

These consist of the following items. Details are given in the separate Bill of Quantity provided in the next section.

- Effluent line with valves as shown in the drawing earlier from various units connecting to the main header
- Main header line
- Intermediate pumps
- Sewage connection from existing last manhole to U.G. Sump T 100 in treatment plant area
- Effluent Main Header connection to T 101 Effluent Collection Sump in treatment plant area
- Sewage and Effluent Lines separately from M/s Tamman & Titoe to T100 and T101 respectively.
- Hydro Pneumatic System for distribution
- Distribution main header
- Individual return water supply lines from the distribution main header to the individual units with valves provision as given in the drawing.

Electrical & Instrumentation Works in the Plant Area:

The brief list is given below. BOQ is provided in the next section.

- Electrical Power Connection – typically On-Off PB station for the intermediate transfer pumps
- Electro Magnetic Flow Meter to be provided in the following locations
- Effluent line from each Unit discharging to the main header
- Sewage line discharging from each Unit
- Return Supply Line to each Unit
- Pressure Gauge at the outlet of the intermediate transfer pump
- Reed Based Level Control for intermediate transfer pump

TREATMENT PLANT AREA - EQUIPMENT – BASIC BILL OF QUANTITY

The brief specifications and the quantity of each of the mechanical equipment in the process area is provided herein. These are indicative and subject to change during Detailed Engineering. These are provided as a guideline for the Bidder to place his Price Bid Offer

HORIZONTAL CENTRIFUGAL PUMPS - Non Clog, Open Impeller pumps		
Cost for design, engineering, manufacture, packing, forwarding, freight to site, Supply, installation, testing, trial run and commissioning of horizontal centrifugal, non - clog, open impeller pumps for various process applications . The pumps to be fitted with TEFC, IP 55, Class F insulated SQI motor, suitable for 3 phase, 50 Hz, 415v AC power supply. Pumps will be mounted on suitable pump base with fasteners. All pumps will have negative suction process condition and hence are to be fitted with Non Return Check Foot Valves. All pumps to be provided with dry run protection. Impeller shall be of C.I. construction and should be capable of handling solids typically found in raw sewage transfer applications. Other parts material ie.. shaft, shaft sleeve etc as applicable will be developed for process fluid pH of around 6.5 to 7.5, maximum salinity of 10,000 mg / liter		
P102 Raw sewage transfer pumps, 5.8 m3/hr, 20 mwc	2 nos	
P103 aeration feed pumps, 8.5 m3/hr, 20 mwc	3 nos	
P104 return sludge pumps, 6 m3/hr, 15 mwc	3 nos	
P115 backwash waste tube settler feed pumps, 2 m3/hr, 20 mwcc	2 nos	

HORIZONTAL CENTRIFUGAL PUMPS - Clear Water Pumps		
Cost for desing, engineering, Manufacture, packing, forwarding, freight to site,Supply, installation, testing, trial run and commissioning of horizontal centrifugal, clear water pumps for various process applications. The pumps to be fitted with TEFC, IP 55, Class F insulated SQI motor, suitable for 3 phase, 50 Hz, 415v AC power supply. Pumps will be mounted on suitable pump base with fasteners. All pumps will have negative suction process condition and hence are to be fitted with Non Return Check Foot Valves. All pumps to be provided with dry run protection. Impeller shall be of C.I. construction and closed type. Other parts material ie.. shaft, shaft sleeve etc as applicable will be developed for process fluid pH of around 6.5 to 7.5, maximum salinity of 10,000 mg / liter		
P105 filter feed pump, 8.5 m3/hr, 30 mwc	3 nos	
P106 filter backwash pumps, 20 m3/hr, 25 mwc	3 nos	
P107 U.F.feed pumps, 8.5 m3/hr, 25 mwc	3 nos	
P108 U.F. backwash pumps, 17 m3/hr, 25 mwc	3 nos	
P110 R.O.Stage 1 feed booster pumps, 8.5 m3/hr, 20 mwc	3 nos	

HORIZONTAL CENTRIFUGAL PUMPS - C.I.P. Pumps		
Cost for desing, engineering, Manufacture, packing, forwarding, freight to site, Supply, installation, testing, trial run and commissioning of horizontal centrifugal, CLEANING IN PLACE pumps The pumps to be fitted with TEFC, IP 55, Class F insulated SQI motor, suitable for 3 phase, 50 Hz, 415v AC power supply. Pumps will be mounted on suitable pump base with fasteners. Pumps will be on FLOODED SUCTION. All pumps to be provided with dry run protection. Operation of pumps through Motor Control Centre Feeder Supply. Impeller shall be of S.S. construction and full pump to be in SS 304 material of construction to handle cleaning process chemicals. Pump to be suitable for high corrosive duty condition as: (a) pH between 2.0 to 13 (b) TDS around 5,000 to 20,000 ppm		
P109 U.F. C.I.P. pump, 5 m3/hr, 25mwc	2 nos	
P114 R.O. C.I.P. pumps, 6 m3/hr, 25 mwc	2 nos	

HORIZONTAL CENTRIFUGAL PUMPS - Non Clog Open Impeller in S.S. wetted parts		
Cost for design, engineering, Manufacture, packing, forwarding, freight to site, Supply, installation, testing, trial run and commissioning of horizontal centrifugal, non - clog, open impeller pumps fitted with TEFC, IP 55, Class F insulated SQI motor, suitable for 3 phase, 50 Hz, 415v AC power supply. Pumps will be mounted on suitable pump base with fasteners. All pumps will have negative suction process condition and hence are to be fitted with Non Return Check Foot Valves. All pumps to be provided with dry run protection. Operation of pumps through Motor Control Centre Feeder Supply. Impeller shall be of C.I. construction and should be capable of handling solids typically found in raw sewage transfer applications. Other parts material ie.. shaft, shaft sleeve etc as applicable will be developed for process fluid pH of around 6.5 to 7.5, maximum salinity of 10,000 mg / liter		
P101 E process feed. pump, 5 m3/hr, 15 mwc	3 nos	
P112 R.O.Stage 2 feed booster pumps, 6 m3/hr, 20 mwc	3 nos	

VERTICAL CENTRIFUGAL PUMPS -R.O. feed high pressure pumps		
Cost for desing, engineering, Manufacture, packing, forwarding, freight to site, Supply, installation, testing, trial run and commissioning of vertical centrifugal, high pressure vertical centrifugal multi stage pumps fitted with TEFC, IP 55, Class F insulated SQI motor, suitable for 3 phase, 50 Hz, 415v AC power supply. Pumps will be mounted on suitable pump base with fasteners. Pumps will have wetted parts in S.S and all other parts to be in S.S. also. C.I. is not acceptable as per this process specification. Operation of pumps through Motor Control Centre Feeder Supply. High Pressure Pumps to be provided with Low Pressure Switch and High Pressure Switch protection. LPS to cut off pump at pressure < 1.5 bar and HPS to cut off pump at pressure > 20% extra to the outlet pressure as per process conditions.		
P111 R.O. Stage 1 high pressure pump, 8.5 m3/hr, 15 bar (150 mwc)	3 nos	
P113 R.O. Stage 2 high pressure pump, 6 m3/hr, 25 bar (250 mwc)	2 nos	

DOSING TANKS		
Cost for desing, engineering, Manufacture, packing, forwarding, freight to site, Supply, installation and erection of LLDPE / FRP / PP chemical dosing tanks of various capacities as given below. The dosing tanks shall be free standing, to be kept on fixed concrete floor. Dosing tanks to be equipped with inlet line provision for chemical mixing water and drain provision. Dosing pumps to be mounted on top of the dosing tanks.		
DT 101 pH correction dosing tank of 100 liters capacity	1 nos	
DT 102 alum dosing tank of 100 liters capacity	1 nos	
DT 103 hypo dosing tank of 200 liters capacity	1 nos	
DT 104 UF alum dosing tank of 100 liters capacity	1 nos	
DT 105 R.O. stage 1 SMBS dosing tank of 100 liters capacity	1 nos	
DT 106 R.O. Antiscalant dosing tank of 100 liters capacity	1 nos	
DT 107 R.O. stage 2 feed pH booster tank of 100 liters capacity	1 nos	
DT 108 R.O. permeate pH dosing tank of 100 liters capacity	1 nos	

DOSING PUMPS		
Cost for desing, engineering, Manufacture, packing, forwarding, freight to site, Supply, installation, testing, trial run and commissioning of electronic metering pumps of various capacity and at various pressures listed below. The dosing pumps are to be mounted on top of the respective dosing tanks. The arrangement should be complete with feed check valve, flexible teflon / rigid PVC piping for suction line and rigid PVC for supply. The dosing pump should have stroke and frequency variable facility.		
DP 101 pH correction dosing pump , 0 - 6 lph range, 2.0 KSC pressure	1 nos	
DP 102 alum dosing pump , 0 - 6 lph range, 2.0 KSC pressure	1 nos	
DP 103 hypo dosing pump , 0 - 10 lph range, 2.0 KSC pressure	1 nos	
DP 104 UF alum dosing pump , 0 - 6 lph range, 2.5 KSC pressure	1 nos	
DP 105 R.O. stage 1 SMBS dosing pump , 0 - 6 lph range, 2.5 KSC pressure	1 nos	
DP 106 R.O. Antiscalant dosing pump , 0 - 3 lph range, 2.5 KSC pressure	1 nos	
DP 107 R.O. stage 2 feed pH booster dosing pump , 0 - 6 lph range, 2.5 KSC pressure	1 nos	
DP 108 R.O. permeate pump , 0 - 6 lph range, 2.5 KSC pressure	1 nos	
Spare Dosign Pumps , 0 - 6 lph range, 2.5 KSC pressure	2 nos	

E - Process Reactor		
Cost for design, engineering, Manufacture, packing, forwarding, freight to site,supply, installation, testing, trial run and commissioning of Eprocess Reactor suitable for typical inlet C.O.D. of about 7,000 ppm and B.O.D. of about 2,000 ppm and T.S.S. of about 1,200 ppm and T.D.S. of about 10,000 ppm. Reactor to be of F.R.P. construction of thickness not less than 4 mm and typical overall size of about 7.68m x 3.55m , with inlet distrubutor channels and pipes, overflow channels, skimmer mounted on top of the reactor with 0.25 hp reduction gear TEFC, IP 55, Class F motor, skimmer to be provided with MS rake arms with rubber squeegees/flaps at their end, typically rotating at 1 to 5 rpm. The E Process to be designed for an current factor amperage range of 20 to 100 amps at 10 to 30 volts, for the inlet water quality. The electro cell is to have anode in aluminum and cathode in aluminum / SS in plates form, with plate thickness not exceeding 3.9mm. Typical plate size to be about 0.4m x 0.4m and 10 sets of 60 electrodes are required for the process flow. Preference given to conductivity grade aluminum. Gap between anode and cathode not to exceed 11 mm.		
ER 101 E Process Reactor for flow rate of 5 m3/hr at feed	**2 nos**	

Tube settlers		
Cost for design, engineering, Manufacture, packing, forwarding, freight to site, supply, installation, testing, trial run and commissioning of tube settlers in FRP construction. Tube settler plates to be in PVC of preferred dimensions 0.6m x 1.2m and placed at an inclination angle of 45 to 60 deg, inside the FRP compartment. Tube settler to have inlet about 100mm from the bottom of the side water depth. Hopper bottom with sludge well to be provided for solids collection. Sludge well to be about 0.4m x 0.4m x 0.4m minimum and can be increased as per FRP design considerations. Outlet through launder falling into the next unit operation through gravity flow. Dimensions of the tube settlers as per drawing and design specifications		
TS 101 3.3m x 1.7m x 2.6m LD + 0.4m FB	1 no	
TS 102 2.0m x 1.0m x 2.6m LD + 0.4m FB	1 no	

Aspirating aerators		
Cost for design, engineering, manufacture, freight to site, supply, installation, testing, trial run and commissioning of aspirating aeration system in extended aeration process. Aspirating aerators to be of 5 hp rating and preferred model is STORMIX 5. System to be complete with inlet air pipe, aerator assembly to be fully submerged type with submerged motor, propeller system. Aspirating aeration to be designed for about 10 to 15 micron bubble diameter of air diffusion and capable of handling design BOD load of 90 kgs/day		
ASP 101 5 hp aspirating aerator + spare included	**3 nos**	

Secondary Clarifier Mechanism		
Cost for Design, engineering, manufacture, freight to site, supply, installation, testing, trial run and commissioning of Secondary Clarifier mechanism to suit tank of diameter 6.0mts and with 2.8m LD total including hopper bottom and sludge well depths. Mechanism to have central driven geared motor with central shaft in MS, rake arms in MS and neoprene squeegees. Access through Platform from peripheral to the central drive with hand rail protection. Weir loading and design calculations to be as per specifications given in CPHEEO manual on Sewage Treatment		
SC 101 secondary clarifier mechanism to suit 6.0m dia x 2.8m approx TD	**1 no.**	

Sand Filter - SF 101 A/B – Two (2) nos.
Cost for design, engineering, Manufacture, packing, forwarding, freight to site,Supply, installation, testing, trial run and commissioning of Pressure Sand Filter in F.R.P. vessel construction, model # 4072 with multi port valve and distributor system. Filter diameter to be 40" and HOS to be 72". Filter to have gravel, pebble and sand media as per specifications given in CPHEEO manual for Water Treatment and depth as per data sheets. Typical media depths not be less than 200mm for gravel, 150 mm for pebble and 200 to 250 mm for sand. Sand characteristics to be as per specifications of CPHEEO manual. Filter to have dirt loading capacity equivalent to inlet TSS of about 99 ppm and should be capable of giving outlet TSS < 10 ppm reckoned at the rate of 3 to 7 kgs of TSS / sq.m. of filtration area. DIrt loading capacity to be sufficient to initiate backwash once in 8 hours i.e. once / shift. Filter to have inlet and outlet piping, inlet and outlet for backwash and air vent.

Carbon Filter		
Cost for design, engineering, Manufacture, packing, forwarding, freight to site, Supply, installation, testing, trial run and commissioning of Activated Carbon Filter in F.R.P. vessel construction, model # 3672 with multi port valve and distributor system. Filter diameter to be 36" and HOS to be 72". Filter to have activated carbon media supported on gravel media as per specifications given in CPHEEO manual for Water Treatment. Activated Carbon to be preferably of coconut shell based, chemically extruded carbon with Iodine Value NOT LESS THAN 900. Typical Chlorine Halving Value of carbon should not be more than 12 cms. Optionally, peat extruded, thermally activated high purity granular carbon can also be provided with Iodine Value not less than 1100 and with Chlorine Halving Value of not more than 6.5 cms. Filter to have inlet and outlet piping, inlet and outlet for backwash and air vent. Filter to be mounted on HDPE / PP stand given by the manufacturer.		
CF 101 A/ B Carbon Filter model 3672 complete with all accessories	**2 nos**	

Bag Filter		
Cost for design, engineering, Manufacture, packing, forwarding, freight to site, Supply, installation, testing, trial run and commissioning of Bag Filter as pre-treatment to the UF module inlet water. Bag filter to have PP bag, 20 micron nominal rating, typically about 33" long x about 7" dia, fixed in a SS 304 housing, with inlet and outlet connections, pressure guage 0 - 7 bar, 1.5 inch dial, SS bourdon type, glycerine filled guage to be fitted in the filter housing. Filter housing to have drain connection for cleaning.		
Bag filter, 8.5 m3/hr, PP bag, SS housing, 20 microns rating	**2 nos**	

Micron Filters		
Cost for design, engineering, Manufacture, packing, forwarding, freight to site, Supply, installation, testing, trial run and commissioning of Micron Filters. PP spun cartridge type depth micron filter fixed in a SS 304 housing, with inlet and outlet connections, pressure guage 0 - 7 bar, 1.5 inch dial, SS bourdon type, glycerine filled guage to be fitted in the filter housing. Filter housing to have drain connection for cleaning. Rating and length of cartridges as per details given below		
MF 101 Ultra Filter C.I.P. system filter, 40" long x 2 nos, 25 micron rating	1 no	
MF 102 R.O. stage 1 micron filter, 40" long x 4 nos, 10 micron rating	1 no	
MF 103 R.O. stage 2 micron filter, 30" long x 2 nos, 10 micron rating	1 no	
MF 104 R.O. C.I.P. system filter, 30" long x 3 nos, 25 micron rating	1 no	

Ultra Filtration System
Cost for design, engineering, Manufacture, packing, forwarding, freight to site, Supply, installation, testing, trial run and commissioning of complete Ultra Filtration System. The system to be consisting of Ultra Filtration Modules with inlet and outlet connections for normal process, backwash and rinse, to be mounted on a MS Epoxy skid, including necessary support and fittings. Ultra Filtration Module to be CROSS FLOW hollow fine fibre filter, vertically mounted, around 100 to 120 KD M.W.C.O. and operated at around 40 to 50 GFD flux. Typical recovery is to be 90% to 94%. Membrane module to be in PES / PP / PVDF with housing integrated with the membrane module. Inlet to filter and Reject to drain to have victaulic coupling with S.S. piping. Product to be taken out from centre. Recommended to have TOP to DOWN flow in normal mode with reversibility built in, in the engineering design. Ultra Filtration System to be operated through local P.L.C. system with solenoid valves for inlet, outlet, backwash inlet, backwash outlet connections. Suitable solenoid valves (electrically operated) to be provided at the respective locations. UF system will have a dedicated backwash pump (as per specifications mentioned earlier) and the backwashing and rinsing operations will happen through PLC with manual over ride facility.

UF 101 A/B Ultra Filter System, 8.5 m3/hr x 2 streams, 90% recovery, 120 KD M.W.C.O., flux not greater than 50 GFD , on MS epoxy skid complete with all fittings and accessories	1 lot	

R.O. Pressure Vessels		
Cost for design, engineering, Manufacture, packing, forwarding, freight to site, Supply and installation of pressure vessels to house R.O. membranes. Pressure Vessels to be in F.R.P. construction. Preference given for SIDE PORT connections, but END port is also acceptable. Connections between end cap to pipe to be through victaulic coupling. Pressure vessels to be mounted on M S Epoxy skid with horse shoe clamping / alternative arrangement. Pressure vessels to be designed as per pressure rating given for individual stages.		
PV 101 8 inch dia x 6 element long @ 600 psi working pressure rating	2 nos	
PV 102 8 inch dia x 4 element long @ 900 psi working pressure rating	2 nos	

R.O. Membranes		
Cost for design, engineering, Manufacture, packing, forwarding, freight to site, Supply and installation of R.O. membranes. R.O. Membranes to be spiral wound, poly amide membranes of brackish water and sea water configurations as given below. Typically, for brackish water membrane, the active surface area should not be greater than 400 sq.ft and for sea water membrane, the active surface area should not be greater than 365 sq.ft. Typically, mill space below 32 mil is not acceptable as the process fluid is effluent and sewage mix. All membranes to be 8 inch dia x 40 inches long. Bigger diameter is not acceptable. Membrane to be supplied with a MINIMUM OF TWO NUMBER of interconnectors. Typical feed TDS will be around 6,000 to 7,000 ppm for first stage for brachish water and 15000 to 17000 ppm in second stage for sea water membranes		
Brackish water membranes	12 nos	
Sea Water membranes	10 nos	

R.O. SKID		
Cost for design, engineering, Manufacture, packing, forwarding, freight to site, Design, engineering, fabrication, supply, installation of MS epoxy skid to house the R.O. system. The skid is to have TWO portals for 6 element 8" dia vessels and TWO portals for 5 element 8" dia vessels. Skid is also to have facility of housing R.O. permeate flow meter and R.O. Reject Flow Meter. Memrane housings to be clamped to the skid through Steel semi circular clamp with Rubber bottom to prevent movement of the housings. Skid to have facility for two additional portals which can be used to load additional membrane housings at a later date		
R.O. skid in MS epoxy material complete with all accessories and fittings	**1 lot**	

C.I.P. Tanks		
Cost for design, engineering, Manufacture, packing, forwarding, freight to site, Supply, installation of HDPE tanks for Cleaning In Place System of both R.O. as well as U.F. systems. The tanks are to have two to three inlet facilities from the top and have three outlet at about 200 mm from the bottom. Drain arrangement also to be provided. Tanks are to be in HDPE from ISO certified organization only. Tanks will be mounted on a suitable civil platform. Tanks are to be provided with tubular type level indicator externally. Suction pipe to CIP pump to be supported properly to prevent vibration induced leakage to the tanks. Suction line to be minimum of 2.4 mts length between the tank and the suction head of the pump.		
T 107 U.F. CIP tank of 2,000 liters capacity	1 no	
T 112 R.O. CIP tank of 2,500 liters capacity	1 no	

Solids Dewatering System		
Cost of design, engineering, manufacture, procurement, freight to site, supply, installation, testing, trial run and commissioning of suitable filter press system. The system consists of screw / reciprocating plunger pump to feed to the filter press. Filter Press will be manual, recessed type press with MS fabricated structure pipe button surface and MS flat parallel bar, with PP cloth. Each batch will be of 4 hours duration and 2 batches are expected in a day. Filter operations to be manual. Water with 1.5% w/v inlet solids is expected and the outlet cake consistency should not be more than 36.8% moisture. six chamber and seven plates of size 355mm x 355mm and with active surface area not less than 0.78 m2 is to be provided. FRP drip tray with drain valve is also to be provided. Filter Press will have centre inlet and four corner outlet. Filter Press feed pump to have TEFC, IP 55, Class F insulated motor. The Filter PRess Unit will be mounted on a platform and all around drain system to be provided to prevent the filtrate water from contaminating the entire surroundings.		
P 116 Filter Press Feed Pump, 2.0 m3/hr, 5 bar operating pressure with all accessories and fittings	2 nos	
FP 101 Filter Press, 2,000 lph feed flow rate, 4 bar operating pressure with all accessories and fittings	2 nos	

Conveyance System – Equipment and Accessories – Bill of Quantity

Note: this is only indicative and may vary during detailed engineering. This information is provided to the Bidder to enable him evaluate the cost of the components

Machinery, Piping and Instrumentation Works		
Supply and fixing main header pipe for effluent conveyance, 4" O.D., PVC material, design pressure rating capability at 6 KSC, of approved ISI make - Finolex / Equivalent , laying and fixing will be as per conveyance route plan and final route map frozen during detailed engineering.		
Effluent Feeder Main Header	1700 mts	
Supply and fixing main header pipe for return supply (treated water) conveyance through hydro pneumatic system, 3" O.D., PVC material, design pressure rating capability at 9 KSC, of approved ISI make - Finolex / Equivalent , laying and fixing will be as per conveyance route plan and final route map frozen during detailed engineering.		
Return Supply Feeder Main Header	1700 mts	
Supply and fixing of NON RETURN VALVES to be provided for each Unit, of varying sizes as indicated below. M.O.C. of NRV to be suitable for handling pH range 2.0 to 12.0 and as per BIS standards.		
1" NRV	4 nos	
1.5" NRV	5 nos	
2" NRV	2 nos.	
Supply and fixing of P.V.C. Ball Valves as per BIS standards in the following sizes for effluent header		
1" PVC Ball Valve	4 nos	
1.5" PVC Ball Valve	5 nos	
2" PVC Ball Valve	2 nos.	

Supply and fixing of P.V.C. spool piece with flanged end for connecting the Unit line with the inlet to the CETP header line		
1" spool piece, 5 mts long	4 nos	
1.5" spool piece, 5 mts long	5 nos	
2" spool piece, 5 mts long	2 nos.	

Supply and fixing of P.V.C. spool piece with flanged end for connecting the inlet to the CETP to the main effluent conveyance header:		
1" spool piece, 3 mts long	4 nos	
1.5" spool piece, 3 mts long	5 nos	
2" spool piece, 3 mts long	2 nos.	

Supply and fixing of P.V.C. Bends & Tees in the Unit Line connecting to the effluent main header:		
1" bend	12 nos	
1.5" bend	15 nos	
2" bend	6 nos.	
1" tee	4 nos	
1.5" tee	4 nos	
2" tee	2 nos	
Supply and fixing of P.V.C. connecting tees		
4" x 1" tee	4 nos	
4" x 1.5" tee	5 nos	
4" x 2" tee	2 nos.	

Supply and fixing of P.V.C. pipe line, 4 KSC pressure rating, approved ISI make, to convey the effluent from the collection tank of the individual units to outside the compound wall of the individual units:		
1" dia PVC	8 lengths	
1.5" dia PVC	8 lengths	
2" dia PVC	4 lengths	

Supply and fixing of Electro Magnetic Flow Meters (EMFM) to measure the quantum of effluent discharged from each unit. The EMFM to be line mounted and will display, record and report the flow in the pipe line.		
EMFM for 1" dia line	4 nos	
EMFM for 1.5" dia line	5 nos	
EMFM for 2" dia line	2 nos	
Engineering, suply, fixing, installation, testing, trial run and commissioning of hydro pneumatic system for return supply line, including conveyance pump rated at **10 m3/hr @ 5.7 bar line pressure,** including pressure vessels, valves, fittings - all complete		
hydro pnuematic system 10 m3/hr, 5.7 bar line pressure	1 lot	
Supply and fixing of P.V.C. Ball Valves as per BIS standards in the following sizes for return line to various Units.		
1.5" Ball Valve	10 nos.	
Supply and fixing of P.V.C. spool piece with flanged end for connecting the Unit line with the return supply header		
1.5" spool piece, 5 mts long	20 nos.	
Supply and fixing of P.V.C. Bends in the Unit Line connecting to the return supply header		
1.5" bend	20 nos	
Supply and fixing of P.V.C. connecting tees		
3" x 1.5" tee	10 nos	

Supply and fixing of P.V.C. pipe line, 4 KSC pressure rating, approved ISI make, to convey the treated water to the compound wall of individual units:		
1.5" dia PVC	20 lengths	

COMMON EFFLUENT TREATMENT PLANT FOR C.P.I.I.U.C AT SIDCO PHARMACEUTICAL COMPLEX, ALATHUR, KANCHIPURAM DISTRICT

INSTRUMENTATION SCOPE

FOR

COMMON EFFLUENT TREATMENT SYSTEM

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ATTACHMENT NUMBER	DESCRIPTION	
PC94-CPIIUC-CETP-E1-IN-SP	SPARES LIST	
PC94-CPIIUC-CETP-E1-IN-IVL	INSTRUMENTS VENDOR LIST	
PC94-CPIIUC-CETP-E1-IN-IDD	INSTRUMENT DRAWINGS DOCUMENT	

1.0 GENERAL

This document defines the general requirement of instrumentation scope for Effluent Treatment System.

2.0 CODES & STANDARDS

IEC 13	Diagrams, Charts and Tables, Preparation of Logic Diagrams
IEC 534	Industrial - Process Control Valves
IEC 584	Thermocouples
IEC 605	Equipment Reliability Testing elements
IEC 611-12	Part 12Graphical Symbols for Diagrams. Binary Logic
IEC 654	Measurement and Control equipment
IEC 751	Industrial Platinum Resistance Thermometer Sensor
IEC 801	Electromagnetic Compatibility for Industrial Process measurement and Control Eqpt.
IEC 902	Industrial Measurement and Control Terms and Definitions
ISA S-5 .1	Instrumentation Symbols and Identification
ISA S-5.2	Binary Logic Diagrams for Process Operation
ISA S-5 3	Graphic Symbols for Distributed Control/Shared Display Instrumentation, Logic and Computer Symbols
ISA-S20	Instrumentation specification formats
ANSI/ISA S 5.1	Process Instrumentation Terminology
ANSI/ ISA S71.04	Environmental conditions
ANSI/ ISA S75.01	Control Valve Equations
ANSI/ ISA S75.02	Control Valve Procedure Capacity Test
ANSI/ ISA S75.03	Face-to-Face Dimensions for Flanged Globe Style Control Valve Bodies
ANSI/	Quality Control Standard for Control Valve Seat
FCI 70.02	Leakage
BS 6020	Instruments for the Detection of Combustible Gases
DIN 3582	Screwed Plugs, Tapped Holes, with Whitworth Part 2Pipe Threads: General Outlay of Types
DIN 43760	Measurement Standard for RTD.
DIN 19243	Measurement and Control Electrical Sensors, Electrical Position Sensors and Signal Converters used for Intrinsically safe two-wire DC System.
EN-50-014/020	Electrical Apparatus for Potentially Explosive Atmospheres
EN 54 Part I	Components of Automatic Fire Detection System Introduction.
EN 5,4 Part 5	Heat sensitive Detectors - Point Detectors containing a Static Element.

ISO 3511.1	Process Measurement Control Functions and Instrumentation Representation Part I: Basic requirements.
ISO 3511.2	Process Measurement Control Functions and Instrumentation Representation Part 2: Extension of Basic Requirements.
ISO 3511.4	Process Measurement Control Functions and Instrumentation Representation Part 4: Basic Symbol for Process Computer, Interface and shared Display/Control Systems.
ISO 4200	Plain End Steel Tubes, Welded and Seamless - General Table of Dimensions and Masses per Unit Length.
ISO 5167	Measurement of Fluid by Means of Orifice Plates, Nozzles and Venturi Tubes Inserted in Circular cross-section Conduits Running Full.
API RP 520	Sizing, selection and Installation of Pressure relieving devices in Refineries
API RP 521	Guide for Pressure Relieving and Depressuring System
API RP 2000	Venting Atmospheric and low pressure storage tanks
API- Chapter 5.4 :	Accessory equipment for liquid meters Manual of
Chapter 6.2	Loading rack and tank truck metering system
Chapter 6.6:	Pipeline Metering Systems Measurement
Chapter 12:	Calculation of Standards Petroleum Quantities
2.1 & 12.2	Part 1 and 2
API-RP-550	Manual on Installation of refinery Instruments Part I and Control System
ANSI - B 16.104	Control Valve seat leakage
ISA-S 75.01	Control Valve sizing
ISA S 18.1	Specifications and guides for the use of general Annunciators.
IEC 529	Environmental Protection of equipment
ANSI B 2.1	Pipe threads
ANSI B 16.5	Steel pipe flanges, flanged valves and fittings
IEC 79.11/	Intrinsic safety code and practice
IEC-79.14	International Boiler Regulation
IS 2148	Flameproof enclosure of electrical apparatus

3.0 UTILITIES

Utilities shall be provided at one point within battery limit. Further step down or distribution shall be in the scope of package bidder.

Refer utility data document attached elsewhere.

Bidder must mention requirement of the utilities in their bid.

4.0 AREA CLASSIFICATION

Non Hazardous

5.0 SCOPE OF WORK

Scope of work for instrumentation shall include but not limited to the following :

Design, engineering, procurement, fabrications, supply, inspection, testing, painting, transportation, storage & handling at site, calibration, erection and commissioning of complete instrumentation alongwith accessories as per the scope.

However this does not absolves bidders of their responsibility for guaranteed performance of the system as per the requirement of the package. Based on their experience, bidder may indicate additional instrumentation, which is required for orderly functioning of the package, in the bid.

Deviations/ proposed inclusions to the basic specifications shall be clearly listed out in the bid.

6.0 INSTRUMENT AND CONTROL PHILOSOPHY

Main monitoring and control shall be accomplished by principal's PLC CONTROL Panel. Bidder shall provide the Local control panel for process control, Interlocks and emergency shutdown for the safe operation and shutdown of the plant. The local control panel shall accommodate all the control and monitoring instruments for monitoring and control from the package unit local control panel and also with alarm annunciations, pushbuttons, switches, MCB, isolation, power distribution, wiring etc.
Bidder shall be fully responsible for supplying package unit complete with design, engineering, selection of materials, sizing and selection of instruments.

Package vendor shall be responsible for local instruments, controls, local panels, installation & wiring, trays & cable laying & termination to junction boxes within the battery limit. Bidder's scope shall cover termination of multi-core cable in the junction boxes within battery limit and identification of multi-core cable in Control Panel.

7.0 INSTRUMENTATION DESIGN CRITERIA

7.1 Environmental protection shall be IP65 (NEMA 4X) for electronic instruments and IP55 for temperature and pressure gauges. All field instruments shall be tropicalised, vermin proof and suitable for saline atmosphere. Special care shall be taken for corrosive services.

7.2 Transmitters shall be electronic 2 wire type, output 4- 20 mA dc wherever applicable

7.3 Pneumatic signal 20 to 100 kPa shall be considered wherever applicable

7.4 Field switches with hermetically sealed contacts shall be closed in normal operating condition (Open to Alarm).

8.0 FIELD CABLING JUNCTION BOXES AND GROUNDING

8.1 Separate junction boxes shall be used for 4-20 mA, contacts (field switches and solenoids), mV (Thermocouple), RTD and power cables wherever applicable.

8.2 Shields on all cables shall be terminated at control system I/O rack or panel. This will serve as single ground point.

8.4 Separate trays shall be used for signal cables, power cables and thermocouple cables. A minimum separation distance of 500mm shall be maintained.

8.5 Fibre optics cable shall be considered for long distance outdoor signals transmission.

8.6 Single pair (IS) instrument cables shall be of following specification

a) Conductor material : Electrolytic grade untinned stranded copper, cross sectional area 1.5 mm².
b) Insulation material : Low Density Polyethylene (LDPE > 0.925 gm/cm3 at 20°C), Thickness > 1 mm.

c) Shielding material : Aluminium Mylar, 0.05 mm thickness, overlapping 50%
e) Drain wire : Annealed fine copper material
f) Inner sheath material: PVC Type ST2 Thickness 0.5mm
g) Armouring : Galvanized steel wire 0.9 mm dia
h) Outer sheath material: Extruded PVC ST2 with FRLS (Fire Retardant Low Smoke) properties ,Thickness 1.4mm
j) Conductor Resistance: < 12.3 ohms/ KM
k) Mutual Capacitance : < 250 pico farad/ meter
l) Mutual inductance : < 1 mili Henry/ KM
m) L/R Ration : < 40 micro Henry/ ohm
n) Insulation Resistance: 5000 Mega ohm/ KM

8.7 Thermocouple mV signal shall be transmitted through extension cable and shall be individually shielded. RTD cables shall be copper conductor individually shielded triads.

8.8 Cable and conduits shall be numbered at both ends as per principal's numbering system.

8.9 Colour code for various instrument cables shall be as below

Type of Cable	Outer sheath colour	Pair/ Triad colour
Power	Black	Live : Black Neutral : White Ground : Green
Signal Discrete 24 VDC (Field switches/ Solenoid)	Dark Blue	(+) Black (-) White
RTD	Light Blue	(+)Black (-) White (C) Red
Thermocouple	Light Blue with Yellow Band at 500 MM Interval	(+) Yellow (-) Red

9.0 INSTRUMENTATION REQUIREMENT

9.1 Each instrument and Junction box shall be identified by unique tag no.

9.2 Pressure gauges shall be of industrial safety type with SS bourdon and solid front (pointer and shatter proof glass is separated from bourdon with solid disc). Dial size shall be 150mm with stainless steel casing. Process connection shall be ½" NPT M. Weather protection shall be

IP55. Pressure gauges for vibrating services like pump / compressor discharge shall be glycerin filled type or with pulsating dampener device.

9.3 Diaphragm seal type pressure gauges shall be considered for corrosive services (if applicable). Diaphragm material and internals parts/ movement shall be SS316.

9.4 Dial thermometers, in general, shall be every angle bimetallic type with 150mm dial size and stainless steel body parts. Weather protection shall be IP55.

9.5 Level gauge glass shall be reflex or magnetic type, in general. Level gauges shall be supplied with pair of offset shut off valves with ball check. Level gauges shall be provided with drain / vent valves. Use of tubular gauges shall not be acceptable. Special care shall be taken for gauges on corrosive services.

9.6 Pressure Transmitters and differential pressure transmitters shall be inherent motion-free type of the floating differential capacitance/ inductance or piezoelectric principle. Bodies shall normally be in stainless steel with pressure elements in AISI 316. For Pressure elements in austenitic stainless steel is a requirement in hydrogen service. Two-valve/ three-valve integral manifold of 316 SS material in general shall be used with pressure / dP transmitter. 'SMART' type transmitters compatible with DCS will be used. Overall accuracy for Smart Transmitter shall be ± 0.07 % or better. Process connection shall be 1/2" NPT.

9.7 Thermocouples shall be the sheathed type with high purity magnesium oxide insulation. The hot junction shall be isolated from ground. Sheath diameter shall normally be 6 mm (1/4") Inconel 600 sheath material shall be used for design temperature above 400 deg. C, whereas ordinary SS material can be used below 400 deg. C. The nominal wire diameter shall be approx. 0.19 x sheath OD. Type K thermocouples shall be used unless stated otherwise on drawings or specifications. All temperature elements shall be duplex type.

9.8 Thermo wells shall be fabricated out of SS316 bar stock in general. Immersion length of thermo wells shall be standardized to 200 mm in case of pipe and 400 mm in case of vessels.

9.9 Orifice plate shall be concentric square edged type. Material shall be SS316 unless special material is required for service. Calculations and dimensions of orifice shall be followed in accordance with ISO5167. Straight run requirement shall comply ASME MFC 3M or API chapter 14 using a beta (d/D) ratio between 0.2 to 0.7.

9.10 Bypass rotameters shall be provided for local flow measurement wherever applicable. The assembly shall be complete with orifice assembly, interconnecting tubing and float chamber. The chamber material shall be SS316. Scale of rotameter shall be linear.

9.11 Pressure/ Safety relief valves shall be designed in accordance with API RP 520.

9.12 Control valves shall be with pneumatic diaphragm or piston operated actuators. Pneumatic positioner and I/P converter shall be included. Seat leakage class shall be minimum IV in accordance with ANSI B 16.104. Pneumatic piping and fitting shall be of stainless steel material. Tube size shall be 6 mm or 12 mm depending on the actuator size. Cast iron or ductile iron bodies shall not be used for control valves, regulators and level instruments. Composite noise level shall be less than 85 dBA. Non standard sizes like 1-1/4",2-1/2",3-1/2",5" and ratings like 125#, 250# shall not be acceptable. For valves having pipe to body size ratio more than 2:1, principal's approval shall be required. Hand wheel shall be provided for manual operation.

9.13 Conductivity analysers shall be of intrinsic safe design suitable execution class specified. Probe installation shall be flow through type with online replacement facility. Automatic temperature compensation shall be available. Sensor body material shall be SS316. Integral 2 wire 4-20 mA output transmitters shall be provided. Mounting accessories shall be included. Accuracy shall be ± 1% or better.

9.14 For pH / ORP measurement, electro-chemical sensor with integral transmitter shall be provided. Installation shall be flow through type with online replacement facility. Automatic temperature compensation shall be available. Sensor body material shall be SS316. Integral transmitters shall be 2 wire 4-20 mA output type. Mounting accessories shall be included. Accuracy shall be ± 1% or better.

9.15 Fully immersible type turbidity sensor with integral transmitter shall be provided. Installation shall be flow through type with online replacement facility. Sensor body material shall be SS316. Integral transmitters shall be 2 wire 4-20 mA output type. Mounting accessories shall be included. Accuracy shall be ± 1% or better.

9.16 Solenoid valves shall be 24 V DC intrinsic safe with stainless steel body. Coil insulation class shall be H as per NEMA. Vents open to atmosphere shall be provided with insect screens. Manual override facility shall be provided for operation from the field.

9.17 Local Control Panel

Local control panel and accessories, if any, shall be in the scope of package supplier. The design of panel shall be self supported type and panel shall be fabricated out of cold rolled steel sheet of 4 mm thick for front and 3 mm thick for side and back and 2 mm for top. Panel shall be supplied integrally bolted 100 x 50 x 6 mm thick MS channel base. Ant vibration pads shall be provided. Cable entries shall be from bottom.

9.18 Identification and marking

Self adhesive tapes or signs are not permissible for permanent marking of any instrument. Nameplates shall be lamicoid with 6 mm minimum size black letters on white background and identified with their relevant loop. Each instrument shall be fitted with a SS tag plate and shall contain the following information as minimum.

Manufacturer's name, serial no. and model
Tag no.
Sizes,
Rating
Range
Certification

Other relevant information as per manufacturer's standard for proper identification of the instruments shall be provided.

10.0 ERECTION & COMMISSIONING

Erection and commissioning activities at site should be carried out strictly as per the Quality Assurance Plan (QAP) approved by Principal. Vendor shall be responsible for obtaining the approval of QAP prior to start of site activities.

Please refer APPENDIX-1 for instrument erection material and connection details.

10.1 ERECTION MATERIAL

10.1.1 All erection material required for installation and commissioning of the instruments within the battery limit shall be included in the scope of bidder. Package vendor shall arrange necessary tools and tackles required.

10.1.2 Junction boxes and cable glands

Vendor shall supply junction boxes wherever required. Configuration shall be 6/ 12 inlet (1/2" NPT) and one outlet (1"/1.5" NPT). Junction boxes shall be of fiberglass ultraviolet proof / stainless steel body and shall be weather proof to IP65 (NEMA 4X). Terminals shall be screwed type and certified for intrinsic safe application. Explosion proof junction boxes shall be used wherever required. Cable entries shall be from bottom. Telephone shoe shall be provided in junction boxes. 30% spare terminals and minimum 2 nos. spare entry shall be available in junction boxes. Cable glands shall be double compression type and material shall be SS. Instrument side cable gland size shall be preferably ½" NPT M.

10.1.3 Instrument Valves and Manifolds

Vendor shall supply instrument valves (miniature type) and valve manifolds wherever required. Body material and rating shall be as per piping class or SS whichever is better and shall be forged type. Valve trim material shall be SS316 as minimum or superior as required by process conditions.

For all DP transmitters impulse piping, 3-way integral manifolds shall be used. For pressure transmitters, 2 way integral manifold shall be used. Gauge cock with vent connection shall be used for pressure gauges.

10.1.4 Impulse Tubing

SS 316 tubes of size ½ "shall be used for impulse tubing.

10.1.5 Tube Fittings

SS 316 tube fittings of Swagelok / Hoke Gyrolok /Parker Hannifin make of suitable ratings shall be supplied.

10.1.6 Instrument Airlines fittings & Valves

All pipes and pipe fittings for airline shall be of SS304 material. Tubes for airlines shall be SS304 and size shall be 6 mm or 12 mm with thickness of 1 mm. Vendor shall supply Swagelok / Parker Hannifin type compression fittings of SS316 material. The ferrule hardness shall be greater than 90RC.

10.1.7 Cable trays.

Aluminium perforated cable trays of 3 mm thickness with aluminium cover shall be used. Suitable cable clamps made of aluminium shall be supplied for binding the cables at every 500mm. Nut and bolt material shall be of stainless steel.

10.1.8 Instrument support/structural steel

Vendor shall supply instrument stands, stanchions and other structural steel material required for supporting the cable trays, impulse lines and instruments.

10.2 INSTALLATION

10.2.1 All direct mounted instruments like thermocouple, thermo well, temperature gauges, pressure gauges; pressure switches etc. shall be installed in such a way that they have better readability and accessibility. Location of the instrument shall be selected in such a way that their axis is 1.4 Meter from the floor of the platform. Package vendor shall provide all the necessary platforms and ladders for maintenance of the instruments.

10.2.2 Local instruments that are not line mounted shall have instrument support securely anchored, of rigid construction and ¼" hole above the base plate. Plug and seal at the top of the pipe to prevent water entry. If possible, multiple instruments in a close proximity may be supported by a common support.

10.2.3 All capillary type instruments shall have proper capillary support to protect capillary against mechanical damages. All capillary type instruments shall have 3" flange of rating 300#RF.

10.2.4 All pressure, differential pressure instruments shall be provided with block and bleed, bypass, drain/vent valves etc as per the installation sketches approved by owner and shall have accessibility. 3 way manifold for flow transmitters shall be integral type.

10.2.5 All primary piping (impulse lines) shall have a slope of 1:10 on the horizontal run.

10.2.6 All welding shall be carried out as per the relevant code with proper electrodes. Any testing (non-destructive) like DP test on root weld and final weld shall be carried out as applicable. All consumables shall be part of vendor's scope of supply. Any pre or post weld treatment as required by the codes shall be carried out. High pressure lines shall be provided with minimum joints.

10.2.7 Welded areas, drilled holes and pipe thread on galvanised pipe stands shall be prepared and spread with cold galvanisation.

10.2.8 All threaded joints by Teflon tapes only.

10.2.9 All impulse lines shall be supported at regular intervals with 'U' clamps.

10.2.10 Instrument drain/vent connections shall be piped to safe area like OWS (oily water sewer) or above pipe racks to avoid accumulation of hazardous fluid in the plant atmosphere.

10.2.11 All level gauges/transmitters to be provided with drain connection at ground level. External standpipe shall not be used for level measurement of fluid services below – 40°C.

10.2.12 Steam tracing, wherever required, shall be carried out by 6mm OD 1mm thick SS tubes, and condensate traps shall be provided to collect all the condensate and shall be piped to the nearest pipe drain funnels.

10.2.13 All tubes/cables shall be properly laid on cable trays, which shall be supported at regular

intervals.

10.2.14 Separate routing or physical separation shall be maintained between signal cables and shut down/power cables.

10.2.15 Wherever intrinsically safe system cabling is employed the minimum separation of 200mm shall be adhered to between IS and Non-IS signal cables.

10.2.16 Instruments in steam, liquid or condensing services shall be located below the process connection. For gas and non-condensing vapours, instruments shall be located above process points.

10.3 TESTING AND CALIBRATION

10.3.1 All impulse lines shall be properly flushed after isolating both the instrument and the vessel/piping. Online instruments should be removed / isolated during flashing of lines.

10.3.2 All impulse line shall be tested hydraulically at 1.5 times the maximum operating pressure. Ensure that instrument and vessel/piping is isolated during this test.

10.3.3 In case of special conditions where hydro testing is not permitted due to service conditions, the impulse lines testing shall be carried out by using air or nitrogen.

10.3.4 All external cage type level instruments shall also be tested up to 1.5 times operating pressure.

10.3.5 After pressure testing, all these impulse lines shall be drained and dried with dry air to remove any moisture.

10.3.6 Instrument airline will be service tested only for any leak after pressurizing and isolating the main root valve, by soap solution.

10.3.7 All instrument cables shall be tested for continuity and insulation. While megger is used for insulation testing, ensure that instruments and zener barrier are isolated at both ends.

10.3.8 All instruments supplied by the vendor shall be calibrated using proper test equipment .

10.3.9 All instruments shall be calibrated for 0%, 25%, 50%, 75%, 100% and vice versa.

10.3.10 All temperature gauges shall be calibrated using temperature baths.

10.3.11 All thermocouples shall be calibrated as per instrument ranges.

10.3.12 All transmitters shall be calibrated as per instrument ranges.

10.3.13 All displacer type level transmitters shall be calibrated with water or suitable fluids and corrected for specific gravity.

10.3.14 All alarm and trip switches shall be calibrated over the entire range and finally set and checked for alarm trip/points and reset points as per the alarm/trip set point schedule. After setting these shall be sealed.

10.3.15 All control valves prior to stroke checking shall be externally cleaned thoroughly. The full stroke of valve shall be checked for opening and closing. Any adjustments required for obtaining full stroke and reducing hysterisis shall be carried out.

10.3.16 Bubble tight shut-off control valves and shut down valves shall be checked for seat leak test and gland leak test.

10.3.17 Solenoid valve shall be checked functionally for its operation.

10.3.18 Safety valves and relief valves shall be set/tested by using dry air/nitrogen, leakage, if any, shall be removed by proper lapping of seat and disc.

10.3.19 All field instrument shall be calibrated as per the manufacturer's instruction.

10.3.20 After performing the calibration of all instruments, the entire loop shall be checked for proper operation through principal's DCS system.

10.3.21 The entire shut down scheme shall be simulated from the process trip switches and the scheme shall be tested for its proper operation through principal's ESDS, prior to start up of the unit.

10.4 COMMISSIONING

10.4.1 This activity shall be carried out in a systematic manner so as to avoid any accident to plant and operating personnel as per the agreed procedure between vendor and owner.

10.4.2 During the plant start up all the instruments calibration, controller alignment, trip point settings shall be trimmed so as to meet the operation requirement.

11.0 SPARES

Spares shall be considered along with main supply for the instrumentation within battery limit. Bidder shall quote unit rates of spare in the bid. However actual quantity shall be decided by principal at the time of order.

Please refer attachment "Spare Guidelines For Instruments "document no. (PC94-PNIN-SP-01) for the details of spares requirements.

12.0 TESTING AND INSPECTION

All instruments and accessories shall be inspected & tested to ascertain that the supply is in accordance with approved specification. The inspections & tests shall not relieve the supplier/ manufacturer from his responsibilities for materials and the performance of the equipment supplied.

Within two weeks of receipt of the Letter Of Intent (LOI) /order, vendor must contact the Inspection Agency specified in the order and finalise with them the Quality Assurance Plan (QAP) for carrying out Inspection and test.

In absence of any Inspection Agency the vendor must submit the quality Assurance Plan

for principal's approval. All tests, in such cases, shall be conducted by original equipment manufacturer's quality department and the results of tests shall be forwarded alongwith the supply.

Procedure and extent of tests shall be governed by QAP mutually agreed between the package vendor and principal's inspection authority.

No assembly shall be shipped until all the required tests are successfully completed and certified "Cleared for despatch" by the inspection authority.

13.0 PACKAGING AND IDENTIFICATION

13.1 Instruments shall be packed in order to protect them from moisture, rain, rust, corrosion and vibration so as to withstand numerous handling during sea / air voyage and inland transportation and ensure their safe arrival and storage at plant site during full guarantee period without any risk of corrosion, rusting or corrosion due to humid and hot climate.

13.2 Items shall be packaged to prevent damage due to rough handling. Items in the same packaging shall be separated using wooden strips or suitable material to prevent the damage due to rubbing.

13.3 All items shall be free from dust and moisture or any foreign matter before packaging. All Items /components shall be sleeved in polyethylene and heat-sealed or packed in waterproof vapour-tight package. Ends shall be protected and openings shall be sealed to prevent ingress of moisture or foreign particles.

13.4 Items subject to damage by water or humidity shall be packed in waterproof vapour tight containers.

13.5 Spares shall be packed separately with proper marking as "SPARE".

13.6 Knocked down items shall be packaged and shipped together to the possible extent.

13.7 Electronic instruments shall be given additional protection against the dust and moisture and shall be wrapped in opaque airtight plastic cover secured with tape as applicable.

13.8 Anti corrosive material coating shall be applied wherever applicable to avoid rusting of the exposed parts and internal surfaces shall be protected by vapour inhibiters.

13.9 All crate, skids and palates shall be suitable for use with forklifts and shall be suitable for rail, truck, barrage or ship transport.

13.10 Shipping details indicating order reference shall be applied to the top and two opposite sides of the package.

13.11 Lifting instructions, caution signs, lifting locations shall be clearly marked on the shipment. Fragile areas shall be marked as "**DO NOT LIFT HERE**". Items with weight more than 9000 KG shall be marked with "**CENTRE OF GRAVITY**".

13.12 Pictorial signs like '**FRAGILE**", " **THIS SIDE UP**", "**KEEP DRY**", "**SLING HERE**", " **STORE IN AIR CONDITIONING ENVIRONMENT** " etc. shall be properly stencilled on the package as per the national language of country of origin and destination. Size of symbols shall be in proportion to the size of consignment.

14.0 INSTRUMENT SUB VENDOR

All instrumentation covered in the package vendor's scope, shall be supplied as per the instrument vendor list attached with this document. For items not indicated in the list, principal's approval shall be required.

15.0 DOCUMENTATION

Please refer documentation schedule attached elsewhere.

APPENDIX-1

INSTRUMENT ERECTION MATERIAL AND CONNECTION DETAILS

Inst Code	Inst Type	Connection Size		Inst conn.	Remarks
		On Pipe	On Vessel	Size	
PS	Pr.Switch	0.75" THD	1.50" FLG	0.5" THD	0.75" by piping
PD(T, I)	Diff. Pr. Trans.	0.75" THD	1.50" FLG	0.5" THD	0.75" by piping
PI	Pr. Gauge	0.75" THD	1.50" FLG	0.5" THD	0.75" by piping
PP	Pr. Point(Test)	0.75" THD	1.50" FLG	--	0.75" by piping
PT	Pr.Trans.	0.75" THD	1.50" FLG	0.5" THD	0.75" by piping
AE	Analyzer point	0.75" THD	1.50" FLG	0.5" THD	0.75" by piping
			4" FLG	4" FLG	Flue Gas Duct
LC	Level Control	--	1.50" FLG	1.50" FLG	
LG	Level Gauge	--	1.50" FLG	0.75" FLG	0.75" FLG by piping
LS	Level Switch	--	1.50" FLG	1.0" FLG	1.0" FLG by piping
LT	Level Trans	--	1.50" FLG	0.5" THD	0.75" by piping
LT(DISPL)	Level Gauge	--	1.50" FLG	0.75" FLG	0.75" FLG by piping
FT	Flow Trans	0.5" THD	--	0.5" THD	
TI	Temp. Gauge	1.50" FLG	1.50" FLG	1.50" FLG	
TE	Thermocouple	1.50" FLG	1.50" FLG	1.50" FLG	
Remote Seal	All Type	3"FLG	3" FLG	3"FLG	
Stand Pipe	Level Inst.		2" FLG		

Erection material

Connection between tapping point to instrument through SS 316 tubing and tube fittings of Swagelok / Hoke Gyrolok /Parker Hannifin make .

All nuts, bolts & gaskets under piping scope.,

DRAWING & DOCUMENTATION SCHEDULE

Sl.No	Description	With Bid (Y/N)	For Review/ Approval	For Information	Final/ Approved / As-built
1	Drawing & document schedule	Y	Y		Y
2	Instrument Index	N		Y	
3	Instrument sizing calculations (control vales, safety valves & flow elements)	N		Y	
4	Utility requirements	Y		Y	
5	Instrument specification/ data sheets for critical items	N	Y		Y
6	Level sketches	N		Y	
7	Material Requisition	N	Y		Y
8	Purchase Requisition	N		Y	
9	Vendor Drawings	N		Y	
10	Functional Schematic	N		Y	
11	Power supply distribution	N	Y		Y
12	Wiring diagram for panels	N		Y	
13	Junction box detail	N		Y	Y
14	Configuration diagram	N	Y		Y
15	I/O assignment	N	Y		Y
16	Instrument cable schedule	N		Y	
17	Instrument location plans	N		Y	
18	Instrument installation drawings	N		Y	

19	Bill of material for installation items	N		Y	
20	Spare part list for :	N			
21	a. Mandatory Spares			Y	
22	b. Start up & commissioning			Y	
23	Inspection & test procedures	N		Y	
24	Complete catalogues with part list for all vendor supplied instruments, control etc.	N		Y	
25	Installation, operation & maintenance manuals	N		Y	
26	As Built Drawings			Y	
27	System Architecure	Y		Y	
28	Hazardous Area Classification Drawing	N	Y	Y	Y
29	Guarantee Certificate	Y		Y	
30	Instrument test certificates and calibration reports	N		Y	Y

NOTE: Drawing/Documents which are applicable for this job, shall be submitted by the bidder as per above schedule.

SPARE GUIDELINES

FOR INSTRUMENTS

1. Vendor shall quote commissioning spares as well as maintenance and 2 years operation & maintenance spares. The list of spares for (whichever is applicable with package unit) instruments indicated here is a broad guideline, which will not limit the scope of supply. Vendor shall also include other spares for commissioning & 2 years normal operation maintenance.

2. Vendor shall quote all types of cards, subassemblies and general consumables, wherever applicable.

3. Electronic instrument spares must consist of power supply system and other component, fuses etc to the extent of 15%, if not otherwise specified.

4. Vendor shall quote unit price of the spares alongwith the main instrument in the offer. Spares and their quantity will be decided by principal prior to placement of order.

5. The vendor of package unit shall also include 30% spares of erection material such as fittings, isolation valve / drain valve, pipe, tubes, cable, clamps, Junction boxes, compression fittings, spare ferrules for compression fittings etc. in their scope. These spare erection materials shall be clearly indicated separately in the Bill of Materials.

6. In case of special cables such as cables between transducer and preamplifier (speed, vibration, pH etc.) 100% spare cables with end connection (if any) shall be provided by the vendor.

7. Instrument consumed during commissioning and guarantee period shall be replaced free of cost by package vendor.

SL NO	ITEM	2 YEARS OPERATION & MAINTAINACE	COMMISSIONING SPARES
1	Dial Thermometer	10%(min.1 each range/size)	1 of each range
2	Displacer type level transmitter for each model a) Relay assembly./Electronic Head b) Torque tube assembly c) Nozzle assembly d) Restriction orifice assembly e) 'O' rings/gaskets f) Other recommended spares g) Float & chain/link assembly	2 set 1 set 1 set 1 set 5 sets 1 set 1 set	1 set - - - 2 sets 1 set
3	Pr. & DP Transmitter 1.Complete Transmitter a) Sensor module b) Circuit board of each type c) Set of 'O' rings,gaskets & adjustable screws/pots d) Clamps e)Manifolds f)Loop calibrator	10%(min.1 each) 10%(min.1 each) 10%(min.2 each) 20%(min.5 sets) 5% (min.3) 5% (min.3) 2 nos.	10%(min.1 each) 10%(min.1 each) 20%(min.5 sets) 10%(min.5 each) 5%(min. 2) 2 nos.
4	I/P Converter Complete I/P converter	10%(min.1)	5% (min.1)
5	Level Gauge For each model a) Reflex glass with gasket b) Transparent glass with gasket c) Bulb for illuminator	20 % 20 % 20 %	5% 5% 5%
7	Level Switch Float assembly Contact assembly Unit spare	2 sets 4 sets 1 set each	- 2 sets -
8	Pressure Gauge	10%(min.1 each range)	1 of each range
9	DP Gauge	10%(min.1 each range)	1 of each range
10	Pressure Switch	10%(min.1each range/model)	1 of each model

11	Thermocouple assembly/RTD a) Element assembly for each type/immersion length b) Terminal Block Assembly c) Thermowell d) Thermowell of special material e) Element for high temperature/corrosive service	10% (min.2) 10% (min.1) 10% (min.1) 100% 100%	10% (min.1) 10% (min.1) - 10% (min.1) 10% (min.1)
12	Control Valve (Globe) ***If Applicable*** for each tag Gland packing Gaskets (body,bonnets etc) Piston/seal rings for balanced cage guided valve seat ring Complete trim include seating,plug and stem assembly Soft seating/Lining, if any COMMON SPARES Actuators Diaphragm of different sizes 'O' rings for piston actuator Positioners Complete positioner Recommended spares kit Solenoid valves Complete solenoid valves Solenoid valve coils Repair kit MISCELLANEOUS SPARES Accessories such as air lock,valves, volume boosters,limit switches, check valves, I/P converter, fittings, tubing for actuators. Any other spares recommended by Manufacturer.	4 sets 4 sets 2 sets 1 set 1 set 2 sets 10% (min.2) 10% (min.2) 10%(min.1 each) 10%(min.2 each) 10%(min.1 each) 10%(min.1 each) 10%(min.1 each) 10%(min.2each) 1 set	6 sets 4 sets 4 sets 1 set 1 set 5 sets 10% (min.2) 10% (min.2) 10%(min.1 each) 20%(min.5 each) 10%(min. 1 each) 20%(min.2 each) 20%(min.2 each) 10%(min.2each) 1 set

	b) 'O' ring c) Pressure seal d) Spiral pin e) Cage lock f) Plug with stem g) Plunger h) Cage i) Balancing cylinder	4 sets 4 sets 4 sets 1 set 4 sets 4 sets 1 set 1 set	2 sets 2 sets 2 sets 2 sets - - - -
13	Butterfly Valve for each tag Gasket Piston ring Packing Seat ring Trim Solenoid Valve (Complete unit) Limit switch (complete unit)	 2 sets 2 sets 2 sets 1 set 1 no. 10% 10%	 2 sets 2 sets 2 sets 1 set - 1 no. 1 no.
14	Orifice Assembly For each tag Gasket	 4 nos.	 1 no.
15	Rotameter For each type/ model Indicator assembly (pointer, cover & gasket)	 10 %	 -
16	Magnetic flowmeter Complete electronics Set of fuse	 1 set 1 box	 - 1 box
17	Ultrasonic flowmeter a) Sensor b) Amplifier / power card c) Set of 'O' rings & gaskets d) Other spare parts recommended by manufacturer e) Safety valve unit for critical equipment.	 1 no. 1 set 2 sets(tag wise) 1 set 1 set each	 - - 1 set(tag wise) 1sets 1 set each
18	PLC Hand held calibrator Bus interface unit Discrete Input module Discrete Output module Analog Input module Analog output module Power supply module Relays	 1 no. 1 no. 3 nos. 4 nos. 1 no. 1 no. 1 no. 5 nos.	 1 no. 1 no. 1 no. 1 no. 1 no. 1 no. - 1 no.

VENDOR LIST

(INSTRUMENTATION)

INSTRUMENTATION:

Sl.No	Vendor's Name	Country
1. pH, conductivity & ORP Analyser		
1	Endress+ Hauser (India) pvt. Ltd. (Liquid Analyser)	India
2	ABB India Limited	India
3	Yokogawa Electric Corporation	India/
4	Hach company	India/
2. Flow Element: Orifice/ Venturi/ Flow Nozzle		
1.	Baliga Lighting Equipments Limited	India
2.	General Instruments Consortium	India
3.	Micro Precision Products Private Ltd.	India
4.	Minco India Flow Elements Pvt Ltd	India
3. Magnetic Flow meter		
1.	Emerson Process Management (I) Pvt. Ltd.	India
2.	ABB India Ltd.	India
3.	Endress + Hauser (India) Pvt. Ltd.	India
4.	Krohne Marshall Pvt. Ltd.	India
5.	Siemens Ltd.	India
6	Yokogawa	India
4. Pressure Gauges		
1.	A N Instruments Pvt. Ltd.	India
2.	General Instruments Consortium,	India
3.	H.Guru Industries	India
4.	Precision Industries Ltd.	India
5.	Ashcroft India(P) Ltd.	India
5. Pressure & D/P Transmitters		
1.	Emerson Process Management (I) Pvt. Ltd.	India
2.	Honeywell Automation India Limited	India
3.	Yokogawa Limited	India
4.	Siemens Ltd.	India
5	Endress + Hauser (India) Pvt.Ltd.	India
6.	ABB	India
6. Vol. Seal Pr./Dp Transmitter including Urea Grade		
1.	Honeywell Automation India Limited	India
2.	Yokogawa Limited	India
3.	Siemens Ltd.	India
4.	ABB India Limited	India
5.	Emerson Process Management (I) Pvt. Ltd.	India
6.	Endress+ Hauser (India) Pvt. Ltd.	India
7. Transparent/ Reflex / Bicolor Mag.Level Gauges		
1.	Chemtrols Samil(India) Pvt Ltd.	India
2.	Pune TechtrolPvt.Ltd.	India
3.	Tecnomatic (India) Pvt. Ltd.	India
4.	Bliss Anand Private Ltd.	India
5.	CesareBonetti	India

Sl.No	Vendor's Name	Country
6.	Nihon Klingage Co. Ltd.	India
7.	Clark-Reliance Corp.	India
8. Displacer Type Level Transmitters		
1.	Chemtrols Industries Limited	India
2.	Dresser Valve India Pvt Ltd	India
9. Temperature Elements (Thermocouple, Rtd)		
1.	Altop Industries Ltd.	India
2.	Pyro Electric Instruments Goa Pvt. Ltd.	India
3.	Tempsens Instruments (I) Pvt. Ltd.	India
4..	Electrical & Electronics Ltd	India
5.	General Instruments Consortium	India
6..	Industrial Instrumentation,	India
7.	Endress + Hauser (India) Pvt. Ltd.	India
8.	Goa Instruments Industries Ltd	India
10. Dial Thermometer (Hg In Steel/Glass)		
1.	A N Instruments Pvt. Ltd.	India
2.	General Instruments Consortium,	India
3.	H.Guru Industries	India
4.	Waaree Instruments Ltd	India
5	Ashcroft India(P) Ltd.	India
6.	Goa Instruments Industries Ltd	
11. Temperature Transmitters		
1.	ABB India Limited	India
2.	Endress+ Hauser (India) Pvt. Ltd.	India
3.	Siemens Ltd.	India
5	Emerson Process Management (I) Pvt. Ltd.	India
6	Honeywell Automation India Limited	India
7	Yokogawa Limited	India
12. Globe / Angle Valves (Normal Type)		
1.	Dresser Valve India Pvt Ltd	India
2.	Emerson Process Management India Ltd	India
3.	Instrumentation Ltd. (Palakkad)	India
4.	Mil Controls Limited	India
5.	Samson Control Pvt Ltd	India
6	Flowserve india control pvt. Ltd.	India
7.	Koso fluids controls pvt. Ltd.	India
13. Butterfly Valves (Normal Type)		
1.	Tyco Valves & Controls (I) Ltd	India
2.	Virgo Engineers Ltd.	India
3.	Flowserve india control pvt. Ltd.	India
4.	Koso fluid controls (pvt.) ltd.	India
5	Bray Controls	India
14. Solenoid Valves		
1.	Asco (India) Limited	India
2.	Festo	India
3.	IMI Norgren-HerionFluidtronicGmbh&Co.	India

Sl.No	Vendor's Name	Country
15. Air Filter Regulator		
1.	Shavo Norgren(India) Pvt Ltd.	India
2.	Emerson	India
3.	As per control Valve manufacturer	
16. Limit/Proximity Switches		
1.	Pepperl + Fuch	India
2.	Honeywell Inc.	India
17. Safety Valves & Thermal Relief Valves (Normal Make)		
1.	Fainger Leser (P) Ltd..	India
2.	Tyco Sanmar Ltd.	India
3.	Bliss anand private limited	India
18. Rupture Discs		
1.	BS&B Safety Systems (India) Limited	India
2.	Fike Europe	India
19. Marshalling Panel / Control Panel of Control System		
1.	Rittal.	India
20. Other Panel		
1.	Rittal.	India
2.	Electronics Corporation Of India Ltd	India
3.	Industrial Control Appliances (P) Ltd.,	India
4.	Jaisun&Hutchisun Controls Ltd.,	India
5.	Pyrotech Electronics Pvt.Ltd.	India
6	United Electric Co. (Delhi) Pvt. Ltd. (Upto 10 Mtrs.)	India
7	Yokogawa Limited	India
8	Instromet International N.V	Holland
9.	Prima automation (India) PVT. LTD.	India
10.	TAN SWA technologies Inc	
21. Panel Access. (Relay,Switch,Lamp,Terminal,Push Button)		
1	Larsen & Toubro Ltd.(Control& Automation (Lamp, Push Button)	India
2	Rockwell Automation India Ltd. (Relays)	India
3.	Econix Hi-TECH Components Pvt. LTD. (For Terminal Blocks & accessories Only)	India
4.	Elmex contros pvt. Ltd.	India
5.	Paramount	India
6	Phoenix contact (india) pvt. Ltd. (for terminal blocks)	India
7	M/s Powercam Electricals Pvt Ltd (Pilot lamp, Push button)	
22. Programable Logic Controller - Package		
1.	Ge Fanuc Systems Prvitate Limited	India
2.	Honeywell Automation India Limited	India
3.	Rockwell Automation India Ltd.	India
4	Siemens Ltd.,	India
5.	ABB India Limited	India
6.	Emerson Process Management (I) Pvt. Ltd.	India
7.	Rockwell automation India Pvt. Ltd	India
8	Yokogawa	India

Sl.No	Vendor's Name	Country
23. I/P Converter		
1.	Emerson Process Management (I) Pvt. Ltd.	India
2.	Invensys (Foxboro)	India
3	Yokogawa Limited	India
24. Instrument Power & Control & Extension & Compensating Cables Cables		
1.	Associated Cables Ltd.	India
2.	Associated Flexibles & Wires Pvt. Ltd.	India
3.	Cords Cable Industries Ltd.	India
4.	Kei Industries Limited	India
5.	T C Communications Pvt Ltd	India
6.	Thermo Cables Limited	India
7.	Udey Pyro Cables Pvt Ltd	India
25. Cable Trays & Accessories (Al./Gi)		
1.	Globe Electrical Industries	India
2.	Indiana Engg Works Pvt Ltd	India
3.	Metalite Industries,	India
4.	Parekh Engineering Company	India
5.	Sadhana Engineering Corporation	India
6.	Steelite Engineering Limited	India
26. Junction Box & Cable Gland		
1.	Baliga Lighting Equipments Limited	India
2.	Ceag Flameproof Control Gears Pvt.Ltd.	India
3.	Flameproof EquipmentsPvt. Ltd.	India
4.	Flexpro Electicals Pvt. Ltd.	India
5.	Trinity Touch Pvt. Ltd. (	India
27. Pipes		
1.	As per piping list	
28. SS Tubes		
1.	Swagelok	India
2.	Parker	India
29. Pipe Fittings		
1.	As per piping list	India
30. Compression Fittings		
1.	Aura Inc	India
2.	Baldota Valve & Fitting Co.Pvt.Ltd.	India
3.	Excel Hydro-Pneumatics Pvt Ltd,	India
4.	Excelsior Engg Works	India
5.	Panam Engineers	India
6.	Precision Engineering Industries	India
7.	Reliance Engg. & Electrical Corpn.	India
8.	Arya Crafts & Engineering Pvt Ltd.	India
9.	Fluid Controls Pvt Ltd	India
10	Wesmec Engineers Pvt. Ltd.	India
31. Instrument Miniature Valves		
1.	Audco India Limited(L&T Valves Divn.)	India
2.	Aura Inc	India
4.	Chemtrol Industries Ltd	India

Sl.No	Vendor's Name	Country
5.	Excel Hydro-Pneumatics Pvt Ltd,	India
6.	Chemtrols Samil(India) Pvt Ltd	India
7.	Hyd- Air Engineering works Lonavla	India
8.	Excelsior Engg Works	India
9.	Ksb Pumps Limited (Valves Divn)	India
10.	Panam Engineers	India
11.	Tecnomatic (India) Pvt. Ltd.	India
32. Instrument contractor for inst. Construction /erection works		
1.	Instrucon engineers and controls (I) Pvt. Ltd (upto 0.5 crores)	India
2.	Jasubhai engineering pvt. Ltd.	India
3.	L&T	India
4.	Miraj instrumentation service (upto 0.5 crores)	India
5.	Pace process control pvt. Ltd.	India
6.	Petron engg. Construction ltd.	India
7	Technimont ICB ltd.	India
8.	M/s Godrej & Boyce mfg. co. ltd	India