MINISTRY OF URBAN DEVELOPMENT

CENTRE OF EXCELLENCE IN URBAN DEVELOPMENT

in the area

SOLID WASTE AND WASTE WATER MANAGEMENT

OPERATION AND MAINTENANCE MANUAL FOR SOLID WASTE PROCESSING PLANTS

CENTRE FOR ENVIRONMENT AND DEVELOPMENT

THIRUVANANTHAPURAM

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PREFACE

The Ministry of Urban Development (MoUD), Government of India, through its activities proposed under the Capacity Building Scheme for Urban Local Bodies (CBULB) established Centres of Excellence (CoE) in reputed institutions in the country to create the necessary knowledge base for improving municipal service delivery and management. The establishment of CoEs is an acknowledgement of the need for high quality Indian-context-specific research and creative interventions in the areas of governance, institution and capacity building, citizen-centric administration and resource and performance management. In establishing the CoEs, the MoUD expected that the CoEs would be able to find solutions to the many issues faced by Urban India. The basic objective of the CoEs is to foster cutting-edge and crosscutting research, capacity building and technical knowledge base in the area of urban development. The CoEs will address urban development issues at national, state and local levels and will provide support to state and local governments in:

The MoUD has approved a project to Centre for Environment and Development to set up a Centre of Excellence on ' Solid Waste and Waste Water Management '. The basic objective was to develop the capacity of the institution to support the Urban Local Bodies(ULB) in the country on solid waste and waste water management related activities.The CoEs will work with selected ULBs to develop strategies and framework to implement activities.

The CoE at CED which is concentrating on 'Solid Waste and Waste Water Management' has been focusing on three major aspects (i) Development of Strategy and Framework for Solid Waste and Waste Water Management in ULBs (ii) Capacity Building, Training and Awareness and (iii) Development of Knowledge Centre and Technical Support Unit on Solid Waste and Waste Water Management. CED is also working with Thiruvananthapuram City Corporation and Payyannur Municipality on these two sectors and trying to integrate the field experience to develop the strategy and framework.

The CoE team at CED has developed eight Resource Materials on SWM such as (1) Strategy and Framework for MSW Management (2) SWM Technology Manual (3) Operation and Maintenance Manual (4) Byelaw for ULBs on Solid Waste(Handling &Management) (5) Strategy and Framework for Wastewater Management,(6) Course Material on Solid Waste Management (7) Course Material on Wastewater Management and (8) Capacity Building and Training Manual. These documents had already submitted to MoUD and also to ASCI for Peer Review and their comments has also been incorporated in this final document.

This ***Operation and Maintenance Manual for Solid Waste Processing Plants*** describes the various operational and maintenance aspects of Windrow Compost Plants suited to Class-1 cities. This Manual has been prepared based on the experience of CED in operation and management of the SWM Plants of Thiruvananthapuram and Kochi Municipal Corporation each with capacities of 300 MTs of waste per day. Some quantities, measurements or specifications mentioned in the Manual may not be as such applicable in some of the other Plants working elsewhere. Hence this Manual may be used only as a model and not as the sole handbook with universal applicability.This will be a good reference manual for the Plant operational staff of the ULB or other agencies

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1.0 INTRODUCTION

Solid waste management is one of the essential obligatory functions of the Urban Local Bodies (ULB) in India, which is clearly mandated in Article 243W read with 12th Schedule of the Constitution of India. Municipal Solid Waste Management (MSWM) in broader terms encompasses organizational, administrative, financial and legal aspects. There are associated functional activities, viz., segregated storage, primary/secondary/bulk collection, transfer and transport, processing and disposal of wastes in an environmentally compatible manner. Any city may require a combination of different interventions to effectively manage its solid waste. An integrated approach for MSWM incorporating right strategies and collaborations/alliances coupled with location specific technology options will be the right answer for solid waste management in the urban local bodies. The commonly accepted and applied technology options constitute a variety of interventions starting from simple household composting units consuming the organic fraction of household waste amounting to less than one kilogram to large windrow composting plants capable of handling several hundreds of tons of solid waste every day. The quantity and characteristics of the waste are the main factors that determine the selection of technology option.

In India, 50-60% of municipal solid waste is organic waste. Considering the climatic conditions and other factors, composting of organic waste is excellently suited for India and Windrow composting is the best option to deal with the huge volume of bio-degradable waste. Windrow composting is the available best model for stabilization of the biodegradable portion of the MSW. In addition to a plant, a landfill site for non-biodegradables, leachate treatment plant and RDF to handle slow degrading but energy yielding substances are usually integrated in a windrow compost plant.

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2.0 WASTE PROCESSING

Processing of solid waste in a windrow compost plant involves number of activities. The waste collected from the city is brought to the plant in specially designed transportation vehicles, which are initially weighed in a weigh bridge located at the entrance of the plant. The waste is then dumped in the dumping yard at the outer periphery of the plant, where large items like wood, etc., are separated. The remaining waste is then heaped in windrows (large rows of approximately 3 metre width and 2 metre height and the length as allowable depending on the size of the plant). There will be seven rows, each row for each day of the week. These rows are turned every week for 5 weeks. As time passes, the size of the rows gets reduced due to decomposition of the waste and the resultant volume reduction. Hence the number of final rows will be less than the number of initial rows. This period, known as maturation period completes in 35 days, after which the waste undergoes mechanical

processing operation. The mechanical processing is sieving at three stages, where inorganic items not suited for composting are separated and the organic fraction converted as compost. Sieving at each stage is done employing differential sieves, reducing the mesh size at each stage, i.e. the first stage sieve employs 36mm mesh, the second stage applies 16 mm mesh and the final stage has a 4 mm mesh. The rejects separated at each stage of sieving are either reused or disposed of at the landfill.

A typical 250-350 TPD windrow composting plant requires the following facilities and each facility is described below:

Functional Facilities	Supportive Facilities

• Security cabin
• Weighbridge
• Pre-processing Area
• Storage Area for Reusable Items
• Composting plant
  - Composting area
  - Compost storage area
• Secured landfill for the disposal of rejects
• Site for RDF
• Leacheate treatment plant
• Store room
• Laboratory
• Office space
	• Parking area for vehicles
	• Vehicle washing area
	• Canteen
	• Quarters
	• Workshop for vehicles
	• Wash and change area

Security cabin: The plant should be protected by compound wall/fencing and entry to the plant will be restricted. There will be security staff to regulate entry of vehicles, staff and visitors. A suitable security cabin will be provided at the entrance, which will have the basic facilities.

Weighbridge: The entire quantity of waste brought to the plant in transportation vehicles is weighed in a weigh bridge to ascertain the quantity. The weighing capacity of the weigh bridge will depend on the quantity of the waste as well as the type of vehicles weighed. There are two types of weigh bridges-Analog and Digital. For weighing the waste, the low cost Analog weigh bridge will be sufficient. However, if there is possibility of commercial utilization of the weigh bridge, the ULB can think of installing a Digital one, having more accuracy.

There will be a Log Book kept at the weigh bridge to record the quantity of waste carried in each trip. This helps to identify the vehicle utilization and work load of transportation staff.

The pre-processing of the mixed MSW (removing large items like wood, plastic sheets/bags, thermocol, etc) is an essential step in the overall process. This stage facilitates to lower the production cost, to reduce the demand of inoculams, if used, to accelerate the process of composting and to get uniform good quality compost. This process also minimizes the landfill rejects, thereby increasing the life of landfill.

Storage Area for Reusable Items: The pre-processing will separate all recyclable/reusable items like plastics, metals, bottles, etc., which will be stored at a convenient place. These items could be appropriately reused in either of the following ways:

- Selling to external agencies
- Processing in ULB owned facilities (plants fully/partially owned by ULB)

Composting Plant: The plant will be housed in a roofed shed, circular or polygonal in shape for easy handling and stacking of the waste. The compost plant includes (i) processing area consisting of yard for windrow formation and turning, and the machinery in it (ii) compost maturity area and (iii) packing yard. The operations at the plant are described below:

(a) Windrow Formation:

After pre-processing, the first activity is windrow formation. By using excavator and backhoe loader, the biodegradable wastes are allowed to form a windrow, which has trapezoidal shape. (Windrow formation can be done manually using simple devices like spade, shovel, etc., if the quantity of waste is not too large).The size of a windrow will depend on the nature of the material being composted, and the reach of the turning machinery, or people available for making and turning it. The width of a windrow can vary from two to four metres at the base and tapering at the top and can have maximum of 2 metre height, and it can be as long as the site allows. Smaller

Fig.1: Windrow Formation

windrows are not advisable as they quickly lose heat (heat is essential for decomposition). As windrow diminishes in size as it degrades, two windrows can be combined as one and this is particularly useful in winter to retain heat, and it also provides more space for further operations.

At the outer periphery of the plant, seven windrows will be formed one for each day, i.e., one heap for Sunday, one for Monday and so on, so that seven waste heaps will be there at the periphery at the end of the week. After seven days the waste which came first is turned and placed in next position in the inner side in order to get space for fresh waste to heap in the outer periphery as described earlier. The same will be adopted for the remaining six days‟ waste. After 14 days the waste at second position is turned and placed at third position simultaneous with the waste at first position to second position to provide space for fresh waste as shown in the Fig. 1. This process is continued for 5 weeks (35 days).

(b) Mechanical sieving:

After 35 days, the degraded wastes are sent to the feeder conveyor for sieving and composting. The remaining composting activities will be at two levels:

Level 1:

At this level mechanical sieving is done with the help of Trommel and the main components of the plant used at this stage are:

- Feeder Conveyor (Feeding compartment that leads the waste to the Trommel)
- Primary Separation Unit (First Trommel)
    - First rejection belt
    - First product conveyor
- Refining Trommel (Second Trommel)
    - Second rejection belt •

  Second product conveyor
- Common rejection belt

- Hydraulic power packs

A line diagram depicting the level 1 process (mechanical sieving) is given below:

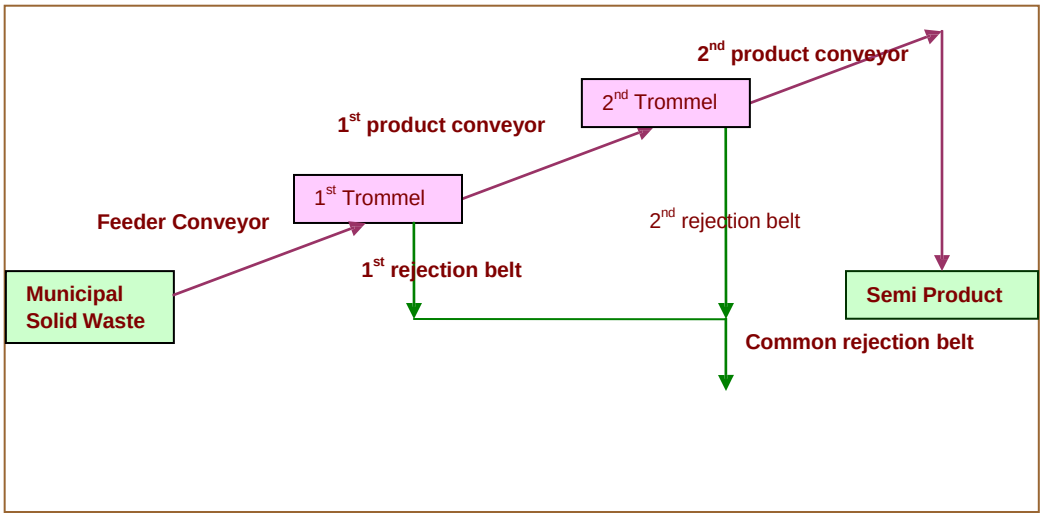


Fig.2 Line diagram of Mechanical Sieving (Level 1)

Feeder Conveyor or Feeding Compartment

The partially degraded waste is fed into the feeder conveyor, using backhoe loader. The feeder conveyor is 15 m long and 0.85 m wide. It is rectangular in shape and has an under carriage conveyor. The top of the feeder conveyor is open. The inner side has two metallic sheets which are fabricated in a fixed manner. The waste loading end is closed and other end is open to the primary separation unit (first Trommel).

Fig: 3 Feeding MSW

The conveyor is attached to a chain and the chain is operated by hydraulic power pack, hydro motor and reduction gear. When power pack is operated, the conveyor of the feeding compartment is directed towards the opening of the first Trommel, where sieving starts.

Primary Separation Unit (First Trommel)

A Trommel (Dutch word for „drum") is a mesh-type cylinder used to separate materials by size. The first Trommel is 6m long, 2m dia, 36mm mesh size, 8mm thick wire-meshed barrel. It has two pull rings at both ends.

Fig: 4 Mechanical sieving in Level 1

The configuration of the barrel is:

- 90mm Mild Steel of "C" class, extruding pipes or seamless pipes (6 nos.)
- 80 x 40 x 3mm rectangular pipes (6 nos.)
- 65 x 65 x 6 mm M.S angle (6 nos.)

- 100 x 8mm flange over the barrel (3 nos.)

It is placed over 4 nos. of press on tyre, 2 nos. each at both pull rings at two ends of the barrel. The barrel is placed at an inclination of 4º. This inclination is for the movement of garbage to the other end of the barrel while rotating. Barrel is supported by two Trommel stoppers at both ends. The sieving of the degraded MSW is done by rotating the barrel and the materials that is passed through the mesh are collected in an under carriage conveyor and carries the material to the 2nd Trommel. The materials that are retained in the Trommel are directed to another conveyor belt, i.e. first rejection belt. The screening efficiency of the sieve is mainly dependent on the moisture content of the material. Dry material can be sieved efficiently through finer or lesser mesh size.

Second Trommel (Refining Trommel)

This Trommel is similar to the first Trommel but for its 16mm mesh size. The Trommel is fabricated using:

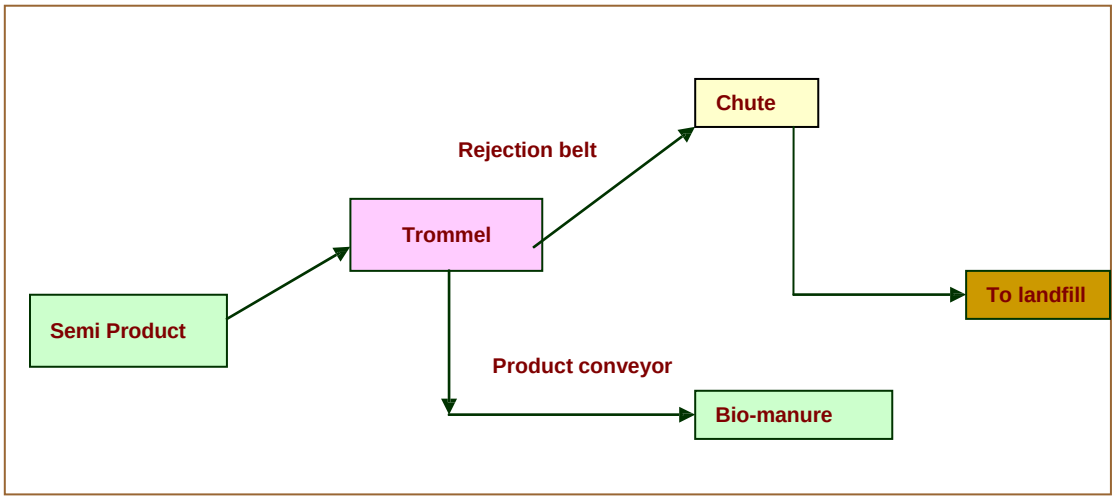
- 65mm M.S, “C” class extruding pipes or seamless pipes (6 nos).
- 65 x 65 x 6mm angle (6 nos).
- 100mm x 8 MS flange over the barrel (3 nos).
- 80 x 40 x 3 mm rectangular pipe (6 nos)

(c) Maturation of Semi Product:

The product obtained from the second Trommel (known as semi product) is dumped at a specified area for achieving maximum decomposition, for a period of 3-4 weeks (depending on the climatic variations). This is the end of level 1 activity. When the maturation is over, level 2 activity starts with final sieving that converts it as the final product.

(d) Final Sieving for Conversion of semi product as final product

This is the second level activity. At this level the matured semi product is fed through a hopper to the final Trommel of S.S 304.3mm having 4 mm mesh size, which removes any metal/glass particles or other unsuitable items that may get mixed with the raw wastes. The products from the Trommel is conveyed to the manure yard, where it undergoes maturation and then to the packing yard, where final product is stored before packing



. Fig.5: Line diagram of Mechanical sieving

(e) Sale of Manure

Based on the requirement, manure is packed by manual or automatic packing machine in convenient packs like 1kg, 2 kg, 5kg and 50kg bags. Use environment friendly packing materials. There should be facility for storing at least 3 months compost should be arranged.

Fig. 6 : Final Product – „MANURE"

Fig..7 : Ready to Sell: Manure in 50kg bags

(f) Disposal of Rejects:

The rejects coming out of first, second and third trommels are carried to the final rejection point through a rejection belt. These rejects are either put to reuse (recycling/ production of RDF etc) or disposed of at the secured landfill.

Machine Capacity

The number of first and second trommels will depend on the quantity of waste brought to the plant whereas the requirement of third trammel is determined by the quantity of semi product coming out of level 1. (The Thiruvananthapuram plant employs one first and second trommel and three Trommels of 4mm mesh size).

Power pack

It is a metallic tank with two compartments of size 1mx1m. One compartment has hydraulic oil (system 68) of 330 litres capacity and the other compartment is filled with water, for cooling. On the top of this tank, there is a motor of 20 HP with one duplex duty oil pump and a pressure control valve. The motor (20 HP) is coupled with oil pump. When the motor starts working, oil is pumped hydraulically to the hydromotor through the pressure control valve. Pressure control valves are used to pressurize the oil upto 50 kg/cm^2. This pressurized oil rotates the hydromotor which will drive the Trommel.

Secured Landfill: All rejects are disposed of at the secured landfill. The landfill shall comply with the following conditions:

- The minimum bottom liner specifications shall be a composite barrier having 1.5 mm HDPE geomembrane overlying 900 mm of soil (clay/amended soil) having permeability coefficient not greater than 1 x 10^{-7} cm/sec. The surface below amended soil layer should be well compacted
- Waste shall be compacted adequately and provided with daily cover of minimum 10cm of soil inert debris

- Prior to commencement of monsoon, intermediate cover of thickness of about 45 cm has to be provided with proper compaction and grading to prevent infiltration during monsoon. Proper drainage berms shall be provided to divert runoff from the active cell of the landfill.
- The final cover shall have a barrier layer comprising of 60 cm of clay/amended soil with permeability coefficient not greater than 1 x 10^{-7} cm/sec. On the top of the barrier soil layer there shall be a composite barrier having 1.5 mm HDPE sheet. Over that there shall be a drainage layer of 15 cm and on the top of drainage layer there shall be a vegetative layer of 45 cm thick.
- In order to prevent the pollution problems storm water diversion drains, leachate collection and treatment system and preventive measures for runoff from landfill area entering any stream, lake, river or pond shall be provided.
- Buffer zone around the landfill site and a vegetative cover over the completed site shall be provided.

Site for Refuse Derived Fuel (RDF): Many of the items in the MSW, like wood, coconut husk and shell, etc., are energy recoverable. These are transported in separate vehicles to the plant and a small portion will be obtained during pre-processing also. These are converted into value added RDF products that can be used for domestic/industrial purposes. The added advantage of RDF is reduction in the load of landfill.

Leachate treatment plant: Compost plant and landfill areas are the locations from where leachate is produced. Leachate can pollute both groundwater and surface water and hence adequate treatment system has to be provided. For designing of leachate treatment plant (LTP) the seasonal variations in quantity and quality of leachate have to be considered.

Store room: The plant should have storage facility adequate enough to store machinery spare parts, tools and implements, oil and grease, etc

Laboratory: A laboratory is essential for testing leachate, preparation of inoculums (if needed), testing water quality to ascertain pollution level etc. Facility for quality test of manure is optional.

Office space: For administrative purposes, an office has to be set up. The facilities will include (i) sufficient space to accommodate the staff (ii) conference hall (iii) toilet etc.

Other facilities: The plant will have other facilities like parking area for vehicles, vehicle washing area, workshop for vehicles, wash and change area, canteen and staff quarters.

Precautions while operating machineries

The plant and machinery used in the windrow composting is simple in operation and handling. There is very limited chance for a mechanical catastrophe. However, in the larger interest of the safety and welfare of the workers the following precautionary measures should be taken:

- Machinery and equipment must be protected against improper, careless and abusive operation. • New recruits should be given thorough training before they are put to operate the plant/machinery. • Operators should be conversant with the technical manuals of the machinery.
- Do not leave the machinery unattended when it is plugged in and switched on.
- The plugs and switches of electrical equipments should be in perfect order.
- The connections of extension cord, if used, should not be loose.
- Rules of operation should be clearly observed

- All safety devices should be properly working.
- Report unsafe conditions and give warning to others whenever noticed.

2.1 Process Parameters

Generally, a homogenous type of organic waste does not contain all the required characteristics for efficient composting, that is why it is necessary to mix different feedstock materials in order to obtain optimal moisture content, porosity and nutrient ratio. The major process parameters are:

Moisture content: The moisture of the waste is one of the critical factors to consider. The moisture tends to occupy the free air space between the particles. Hence, when the moisture content is very high, anaerobic conditions set in. However, the composting mass should have certain minimum moisture content in it for the organisms to survive. The optimum moisture content is known to be between 50 to 60 %. Higher moisture content may be required while composting straw and strong fibrous material which soften the fibre and fills the large pore spaces. Moisture content in MSW varies widely depending upon seasons, collection site, etc. It may be dry, partially wet or completely wet. Mixing water into dry material and raising moisture content to 50 - 55% is an essential step. Similarly, MSW with more than 70% moisture is to be mixed with dry material appropriately.

Compost Temperature: Temperature is one of the key indicators in composting. If the compost heats up to 50^{o} C, one can deduce that the ingredients contain adequate nitrogen and moisture for rapid microbial growth. To take the temperature readings, use a probe that reaches deep into the compost. Leave the probe in place for sufficient time for the reading to stabilize, then move it to a new location. Take readings in several locations, at various depths from the top and sides. Compost may have hot and cold pockets depending on the moisture content and chemical composition of ingredients.

Nutrient Carbon/Nitrogen (C/N) Ratio: The carbon to nitrogen ratio (C : N ratio) is the relative percentage of carbon to that of nitrogen in various organic materials. Decomposing microbes are most active and efficient when the C:N ratio is 30:1. The more carbon in the pile relative to nitrogen, the longer the decomposition process. Excess nitrogen causes the pile to lose nitrogen to the atmosphere as ammonia gas. The C/N ratio considers the available carbon as well as the available nitrogen while the available carbon and nitrogen in the MSW may vary from sample to sample. Whenever the C/N ratio is less than the optimum, carbon source such as straw, sawdust, paper, etc., are added whereas if the ratio is too high, the sewage sludge, slaughter house waste, blood, etc., are added as a source of nitrogen.

pH: The pH of MSW is also an important parameter. Most of the studies reported pH between 6.5 to 7.8 which is most suitable for composting process.

3.0 MAINTENANCE ASPECTS

3.1 Different types of maintenances

Maintenance is the action necessary for retaining or restoring a machine or equipment to a specified operational condition to achieve its maximum efficiency and maximum useful life, i.e., keeping the machine in good working condition throughout its life period. Maintenance includes tasks such as lubricating, checking alignment, adjusting, repairing and replacing different parts of the machine. It includes corrective maintenance and preventive maintenance.

There are mainly four types of maintenance:

a. Breakdown Maintenance

b. Daily Check up

c. Weekly Maintenance

d. Annual Maintenance

a. Breakdown Maintenance

Breakdown maintenance is needed when and where the machine is under breakdown. It implies that repairs are made after the equipment/machine is out of order and it cannot perform its normal function any longer. e.g., an electric motor of a machine or tool not working; a belt is broken, etc.

b. Daily Check up

Daily check up includes applying oil and grease to the machines, whenever required. Before starting the machine everyday, conveyor belts, reduction gear motors, oil level in power pack, water level in power pack, etc., should be checked. Trommels should be thoroughly cleaned daily and the meshes of the Trommels are cleaned depending upon the clogging condition.

c. Weekly Maintenance

It is mainly preventive maintenance. The machines are stopped on a particular day of the week for weekly maintenance which can be normally from 6am to 6pm preferably on Sundays. Thorough cleaning, checking, oiling and greasing of all parts of the machines and equipments are done. If any damaged parts like sprocket, chain, bearings, conveyor, etc., are found it should be replaced or repaired.

d. Annual Maintenance

Annual maintenance is also a preventive maintenance. Normally 10 to 14 days are taken for annual maintenance. Trommels are checked for their alignment. Replacement of damaged nets, pipes, rectangular pipes, bearings, sprockets, chain, conveyers and conveyor rollers and return rollers, etc., will be carried out during annual maintenance. Replacement of the oil in the reduction gears, repair of motors, painting of machines, etc will also be carried out.

The components and parts of the machine and the maintenance required at each level for a 300 TPD plant is described below:

3.2 Maintenance of machineries

The different machineries used in the plant have already been described earlier. The maintenance schedule is given below:

3.2.1 Feeding Compartment

The preliminary step in the mechanical sieving is feeding of partially degraded waste into the feeder conveyor. The conveyor of the feeding compartment is directed towards the opening of the first Trommel, where sieving starts. The different parts of the feeding compartment are:

1. MMG gear box (reduction gear of ratio 5:1), hydraulic drive (1 no.)
2. Hydro motor coupled to reduction gear (1 no)
3. Feeder conveyor with chain of 2” pitch, 32 m long (2 nos.)
4. Rail for running of chain
5. Conveyor belt of 800 mm width, 4 ply, 10mm thick, nylon threaded- 35 m long
6. Teflon beading fixed at the centre of conveyor supported with 50 mm angle

7. Sprocket
8. Bearing

1. MMG Reduction gear box

This needs daily check up and if any damage is noticed in the gear box, it has to be replaced with a new one. So it is better to keep a spare reduction gear in the factory itself.

2. Hydro motor

Hydro motor also needs daily check up. If any damage is found, it has to be replaced with a new one. Hence a spare motor is to be kept in the plant.

Sprocket & chain:

Sprocket -19 teeth duplex 1" Pitch - 1 no.
Sprocket – 38 teeth duplex 1" Pitch - 1 no.
Chain 3 m long duplex 1" Pitch - 1 no.

Daily greasing should be done for coupling sprocket and chain for conveyor belt.

3. Feeder conveyor with chain

The length of chain is 32 m (2 nos) and pitch of the chain is 2". Links are coupled with TVS bolts of half threaded M12 x 65, 800 nos. This should be replaced every 6 months. This chain can be fabricated in the factory itself. Rollers of chain are 50mm diameter, 20mm thick with 12 mm bolt hole. The connecting links with both chains is by 40 x 25 x 3mm rectangular pipes of length 800mm (115 nos.)

4. Rail for running of chain

Running rail of chain is 65 x 12 mm, M.S flat (4 nos.), 7.5 m length

5. Conveyor belt – 800 mm width 35 m long, 4 ply nylon threaded, 10mm thick. Conveyor is running through the chain and is bolted over rectangular pipes i.e. in the bottom side of the conveyor. The top of the conveyor is 50 x 50 x 6 mm angles with 500mm length fitted for carrying the waste.

6. Teflon beading

Teflon beading is provided to minimize the friction between chain and the rail. The size of beading is 25 x 12 mm with 30 m length.

7. Sprocket

Different sprockets needed are:

2" pitch, 13 teeth, 16mm thick sprocket of 4 nos.

Intermediate sprocket of 2 nos.

Spindle (Shaft) of sprocket is 65 mm thick M.S shaft of length 1.2m. It is replaced only at the time of damage. The drive sprocket at both ends and intermediate sprocket are to be replaced once in every year.

8. Bearings

A bearing is a device to allow forced relative motion between two or more parts, typically rotation or linear movement. Bearings needed here is as follows

Table.1: Feeding compartment bearing configuration

Category	Unit (no.)	Period of life (months)
UCP211	4	6
UCF211	2	6

Bearings should be changed twice in a year

Feeding conveyor chain

Link bolt	-	Replace in every 6 months
Rectangular pipe	-	Replace in every 2 years
Teflon beading	-	Replace in every year
50 x 50x 6mm Angle	-	Replace in every 3 years

Body and Structure

Side cover and structure needs only repairing.

Painting

All steel surfaces exposed to weather should be cleaned to remove rust and scale and then two coats of anticorrosive zinc chromate have to be applied. Red Oxide each 20 micron layer and then two coat of Industrial grade, enamel paint of reputed make shall be done once in a year.

Table. 2: Abstract of spares for feeding compartment

Sl. No	Name of the item	Specification	Quantity	Repairable	Replacement	Period of life	Total quantity required	Remarks
1	Reduction gear	MMG,Sl No. N004,ratio (5:1)	1 no.	No	Yes	NA	1	Total 2 nos. (1 working + 1 standby)
2	Hydro Motor (Orbit motor)	Sl No. 315C/2679	1 no.	No	Yes	NA	1	Total 3 nos. (2 working + 1 standby)
3	Metal Coupling	E 48, 50 teeth	2 sets of 2 nos.	No	Yes	6 months	8 nos.	
4	Nylon Coupling	E 48, 50 teeth	1 set	No	Yes	3 months	8 nos.	
5	Sprocket	1"pitch, 19teeth, duplex	1 no.	No	Yes	6 months	2 nos.	
6	Chain	1"pitch,duplex, 3 m long	1 no.	No	Yes	6 months	2 nos.	
7	Sprocket	1" pitch, 38 teeth, duplex	1 no.	No	Yes	6 months	2 nos.	
8	Feeding Conveyor Chain	2" pitch, simplex, 32 m	2 nos.	No	Yes	2 yr	2 nos. once in 2 yrs	Can be fabricated in the factory
9	TVS Bolt & nut	12mm x 65mm half thread	800 nos.	No	Yes	6 months	1600	

10	Chain rollers	EN 8, 50mm dia., 20mm thick, 12mm bolt hole	800 nos.	No	Yes	2 yr	800	Part of chain
11	Rectangular pipe	40 x 25 x 3mm, length 800mm	120 nos.	No	Yes	1 yr	96 m	
12	Rail for chain	65 X12mm M.S flat 7.5 m length	4 nos.	No	Yes	1 yr	30 m	
13	Conveyor belt	Width 800 mm, 100mm thick 4 ply Nylon threaded	1 no.	No	Yes	3 yr	20 m	Once in 3 years.
14	M.S angle	50 x 50x 6mm, 600mm length	60 nos.	No	Yes	3 yr	36 m	Once in 3 Years
15	M.S Flat	40 x 6 mm, 600mm length	60 nos.	No	Yes	3 yr	36 m	Once in 3 Years
16	Teflon beading	25x12 mm, 15 m long	2 nos.	No	Yes	1 yr	30 m	
17	Sprocket	2” pitch, 13 teeth, 16mm thick	6 nos.	No	Yes	1 yr	6 nos.	
18	Shaft for sprocket	1.2 m long, 65mm dia	3 nos.	Yes	No			
19	Bearing	UCP 211	4 nos.	No	Yes	1/2 yr	8 nos.	
20	Bearing	UCF 211	4 nos.	No	Yes	1/2 yr	8 nos.	
21	M.S bolt & nut with double washer	3/8” x 2 ½””	350 nos.	No	Yes	1 yr	350 nos.	

3.3.2 First Trommel

This segregation Trommel forms the heart of the preliminary compost refining system. The sieving of the degraded MSW is done by rotating the barrel and the materials that is passed through the mesh are collected in an under carriage conveyor which carries the material to the second Trommel. The materials that are retained in the Trommel are directed to first rejection belt. The major parts of first Trommel are:

1. Front end ring (product ring): diameter 1.2m, length 600mm, 4mm thick M.S sheet welded to the main ring of the barrel.
2. Back end ring (rejection ring) same as product ring.
3. Front & back pull rings(drive rings)
4. Trommel tyre- 4nos. with 5 Ton capacity
    a) Hub and shaft of Trommel tyre
    b) Bearing and lock -2 sets
    c) Bearing No 22215 JW/33 - 8 set
    d) Sprocket 38 teeth duplex 1" pitch – 2 nos.
    e) Press on tyre of size 16 ¼" x 11¼" x 6 – 4 nos.
5. Trommel stopper – 2 nos.
    a) Body and shaft- permanent
    b) Bearing 2 nos. in one stopper of NJ 308
    c) Stopper disc of EN8, 10" diameter, 1" thick
6. Hydro motor - 1 no.
   Replace only at the time of damage, so that we need 1 spare in stock
7. Sprocket and chain
   Trommel is in direct drive with hydro motor.
   Sprocket 19 teeth 1" pitch duplex - nos.
   Chain duplex – 3 m, 1" Pitch - 2 nos.
   Drive shaft is a permanent one and is repairable.
   Bearing for shaft UCP 210 - 4 nos.
   Product carrying conveyor:
    a) Conveyor drive reduction gear and hydro motor
    b) MMG reduction gear (hydraulic drive) 1 no.- only replaceable
    c) Hydro motor – 1 no. –only replaceable.
    d) Sprocket -25 teeth duplex – 1" pitch 2 nos.
    e) Chain- 1" pitch duplex, 3m long, 1 no.
    f) Metal coupling and nylon coupling

   Conveyor Size -700mm with 10mm thick 4 ply nylon threaded, 30m
   Conveyor roller; 100mm diameter, 230 mm length, 39 nos.
   Return rollers -800 mm, 7 nos.
8. Conveyor drive drum, L-700mm, dia 228mm – 3 nos.

Bearings	-	UCP-210	-	6 nos.
Bearings	-	UCF-210	-	2 nos.
Bearings	-	1209 K	-	2 nos.

9. First Rejection conveyor
    a) Conveyor belt of size -700 mm 10mm thick, 4 ply nylon threaded of length 20m

b) Motor 3 HP – 1 no.
c) Reduction gear, oil SP 320 3 lit, repairable, 40:1 ratio , U - 400
d) Sprocket 25 teeth duplex 2 nos.
e) Chain 1” pitches 3m length duplex
f) Drive drums – dia. 228mm, length- 700mm, shaft-65 mm dia 2 nos., repairable.
g) Bearings UCP 210 -2 nos.
h) Bearing UCF 210 – 2 nos.
i) Return rollers -7 nos., size 700mm length 90mm dia.
j) Net of size 36 x 36 mm net with 8mm thick wire 2.7 x 2 m size- 6 nos.
k) Bolt and nut with double washer 3/8” x 4” – 96 nos.
l) Pin bush coupling 6” -2 nos.

Table. 3 : Abstract of spares for 1st Trommel

Sl. No	Name of the item	Specification	Quantity	Repairable	Replacement	Period of life (years)	Total quantities required	Remarks
1	M.S pipe	90 mm,"c" class extruding pipe	36 m	No	Yes	2	36 m	
2	M.S rectangular pipe	80x40x3 mm	36 m	No	Yes	2	36 m	
3	M.S angle	65x65x6mm	36 m	No	Yes	3	36 m	
4	M.S Sheet	8mm	3.5 m^2	No	Yes	3	3.5 m^2 for flange	
5	Front & Back end ring	M.S, 4mm sheet	7 m^2	No	Yes	1	7 m^2	
6	Front & Back Pull ring	Permanent part of the Machine		No	Yes			
7	Trommel tyre (Press on tyre)	16 ¼" X 11¼"X 6"	4 nos.	No	Yes	2	4 nos.	
8	Hub & Shaft of Trommel tyre	Permanent part of the machine		No	Yes			
9	Bearing with lock for Trommel hub	33/JW 22215	8 sets	No	Yes	1	8 sets	
10	Sprocket	1" Pitch. 38 teeth duplex	2 nos.	No	Yes	1	2 nos.	
11	Chain	1" Pitch, duplex 3m long	2 nos.	No	Yes	½	4 nos.	
12	Trommel stopper	Body &shaft permanent		No	Yes			
13	Trommel stopper bearing	NJ 308, 6208	2+2 nos.	No	Yes	1	16 nos.	For 4 nos. of tyres

14	Trommel stopper disc	EN 8 Disc, 10" dia, 1" thick	2 nos.	Repairable yearly	No			
15	Hydro motor (Orbit motor)	H39043 AXJ 5085984	1 nos.	No	Yes		1 no.	1 working +1standby
16	Sprocket	1" pitch, 19 teeth, duplex	2 nos.	No	Yes	½	4 nos.	
17	Bearing	UCP 210	8 nos.	No	Yes	1	8 nos.	
18	Conveyor belt	width 700mm, thick 100mm , 4ply nylon threaded	50 m	No	Yes	3		
19	Conveyor rollers	length 230mm, dia. 100mm	39 nos.	No	Yes	2	2/ year	
20	Conveyor return rollers	length 800mm, dia. 90mm	7 nos.	No	Yes	2	2/year	
21	Bearings	UCP 210	8 nos.	No		1	8 nos.	
22	Bearings	UCF 210	4 nos.	No	Yes	1	4 nos.	
23	Bearings	1209K	2 nos.	No	Yes	1	2 nos.	
24	Reduction gear	MMG SL No N004 Ratio (5:1)	1 nos.	No	Yes			1 working +1standby
25	Drive drums		3 nos.	Yes	No			
26	Hydro motor	Sl.No 315 C/2679	1 nos.	No	Yes			1 working +1standby
27	Sprocket	1" pitch 25 teeth, duplex	2 nos.	No	Yes	½	4 nos.	
28	Metal coupling	E48, 50 teeth	4 nos.	No	Yes	1	4 nos.	
29	Nylon coupling	E48, 50 teeth	4 nos.	No	Yes	½	8 nos.	
30	Electric motor	3 HP	1 no.	Yes	No			
31	Reduction gear	U 400, ratio (40:1)	1 no.	Yes	No			

32	Sprocket	25 teeth, 1" pitch duplex	2 nos.	No	No	½	4 nos.	
33	Drive drum	Length 700mm, dia 228 mm	3 nos.	Yes	No			
34	Shaft	1 m length, 65mm dia	3 nos.	Yes	No			
35	Net (wire mesh)	36mm opening with 8mm thick wire 2.7x2 m size	6 nos.	Yes	No	2	6 nos.	
36	Pin bush coupling	6"	2 nos.	No	Yes	2	2 nos.	
37	M.S channel	200mm	6 m	No	Yes	common/year	6 m	Required for repairing of body & structure of the machine
38	M.S channel	150mm	12 m	No	Yes	common/year	12 m	
39	M.S channel	100mm	30 m	No	Yes	common/year	30 m	
40	M.S channel	75mm	18 m	No	Yes	common/year	18 m	
41	Angle	65 x65x 6mm	18 m	No	Yes	common/year	18 m	
42	Angle	50 x50x6 mm	60 m	No	Yes	common/year	60 m	
43	Angle	40 x40x6 mm	60 m	No	Yes	common/year	60 m	
44	Angle	25 x25x 6mm	60 m	No	Yes	common/year	60 m	
45	Angle	25x25x3 mm	60 m	No	Yes	common/year	60 m	
46	M.S Flat	40 x 6mm	150 m	No	Yes	common/year	150 m	
47	M.S Flat	25 x 6 mm	100 m	No	Yes	common/year	100 m	
48	M.S Flat	20 x 6 mm	100 m	No	Yes	common/year	100 m	
49	M.S Sheet	3mm	10 m	No	Yes	common/year	10 nos.	
50	M.S Sheet	4mm	6 m	No	Yes	common/year	6 nos.	
51	Checked plate	8mm	4 m	No	Yes	common/year	4 nos.	
52	M.S Plate	16mm	1 no.	No	Yes	common/Year	1 no.	

3.3.3 Second Trommel

This Trommel is similar to the first Trommel. The product obtained from the second Trommel is dumped at a specified area for achieving maximum decomposition and the rejects obtained are carried to the final rejection point through a rejection belt which receives rejects from the first Trommel. The different parts of the second Trommel are:

1. Front end ring (product ring)
2. Back end ring (rejection ring)
3. Front and back pull rings(drive rings)
4. Trommel tyre (press on tyre 4 nos.)
5. Trommel stopper - 2 nos.
6. Hydro motor -1 no.
7. Sprocket & chain
8. Drive shaft with coupling
9. E 48 metals & nylon coupling
10. Product carrying conveyor
11. Conveyor drive drums - 3 nos.
12. Rejection conveyor
13. Drive drums of rejection conveyor- 2 nos.
14. Conveyor guide return
15. Bolt & nut for net fixing
16. Conveyor roller
17. Conveyor return roller

1. Front end ring (product ring)
   Size - 1.2 m dia. length 600mm, width 4mm thick M.S sheet welded to the main ring of the barrel
2. Back end ring (rejection ring) same as front end ring
3. Front and back pull rings
4. Trommel tyre (press tyre) - 5 Ton capacity
   a) Hub and shaft of Trommel tyre
   b) Bearing and lock - 2 sets for 1 type
   c) Bearing No 22215 JW/33 i.e. 8 set
   d) Sprocket 38 teeth duplex 1” pitch – 2 nos.
   e) Press on tyre of size 16 ¼” x 11 ¼” x 6 – 4 nos.
5. Trommel stopper – 2 nos.
   a) Body and shaft- permanent
   b) Bearings 2 nos. in one stopper of NJ 308 and 4 nos. 620 F
   c) Stopper disc of EN8 life 1 year 10” dia. 1” thick- yearly repair is required
6. Hydro motor- 1 no.
   Replace only at the time of damage. Need 1spare in stock
7. Sprocket and chain
   Trommel is in direct drive with hydro motor. Sprocket 19 teeth 1” pitch duplex 2 nos. chain duplex – 3 m 1” Pitch 2 nos. with life of 6 months.
8. Drive shaft is a permanent one; bearing for shaft UCP 210- 4 nos.- life 1 year
9. Product carrying conveyor

a) size -700mm with 10mm thick 4 ply nylon threaded, 50 m
b) Conveyor rollers 4” dia. and length 250, 57 nos.
c) Return roller 800 mm-90mm, life - 1 year, 9 nos.
d) Conveyor drive drums- length- 700,dia. 9”, 3nos., spindle (shaft) 65mm, 1m

10. Conveyor drive reduction gear and motor

a)	Reduction gear U 400	
b)	40:1	1 no
c)	3 HP motor	1 no
d)	Sprocket	25 teeth 1” pitch, 2 nos.
e)	Chain 1” pitch 3 m	1 no:
f)	Pin brush coupling 6”	2 nos.

11. Rejection conveyor.

a)	size 700, 10mm, 4 ply nylon threaded of length 20 m	
b)	drive drums	3 nos
c)	UCP 210	4 nos.
d)	UCF 210	2 nos.
e)	conveyor rollers	18 nos., length 200mm dia 100 mm
f)	return rollers 3 nos., size	1000mm, 90 mm dia
g)	conveyor guard roller	4 nos, size 6”
	Hydro Motor – SL.No 315C/2679	1 no
	Reduction gear - (AB2/10 1989 DS MD MSKW 600/ 300.)	1 no.

Table. 4 : Abstract of spares for second Trommel

Sl.No		Specification	Quantity	Repairable	Non Repairable	Period of life (years)	Total quantities required	Remarks
1	M.S pipe	M.S "C" class extruding pipe of 65 mm	36 m	No	Yes	2	36 m	
2	M.S Angle	65 x 65 x6 mm	36 m	No	Yes	3	36 m	
3	M.S Rectangular pipe	80 x 40 x 3 mm	36 m	No	Yes	2	36 m	
4	M.S Sheet	8mm	3.5 m^2	No	Yes	3	3.5 m^2	
5	Front & Back end rings	M.S, 4mm sheet	7 m^2	No	Yes	1	7 m^2	
6	Front & Back Pull ring	Permanent part of the machine		No	Yes			
7	Trommel tyre (Press on tyre)	16 ¼" x 11 ¼" x 6", 5 Ton	4 nos.	No	Yes	2	4nos.	
8	Hub and Shaft of Trommel tyre	Permanent part of the machine		No	Yes			
9	Bearing with lock for Trommel tyre	33/JW 22215	8 sets	No	Yes	1	8 sets	
10	Sprocket	1" Pitch. 38 teeth	2 nos.	No	Yes	½	2 nos.	
11	Chain	1" Pitch, duplex , 3m long	3 nos.	No	Yes	½	3 nos.	

12	Trommel stopper		2 nos.	Yes	No		2 nos.	
13	Stopper disc	10” dia, 1” thick EN8	2 nos.	Yes	No		2 nos.	
14	Trommel bearing	NJ 308	2 nos.	No	Yes	1	2 nos.	
15	Trommel bearing	6208	2 nos.	No	Yes	1	2 nos.	
16	Hydro motor	H39043 AXJ 5085084	1 no.	No	Yes		1 nos.	Keep in hand 1 spare
17	Sprocket	1” pitch, 19 teeth, duplex	2 nos.	No	Yes	½	4 nos.	
18	Bearing	UCP 210	16 nos.	No	Yes	1	16 nos.	
19	Conveyor belt	Width 700mm, thick 10mm , 4ply nylon threaded	70 m	No	Yes	3		
20	Conveyor rollers	Length 250mm, dia 100mm	75 nos.	No	Yes	2	75 nos.	
21	Conveyor return rollers	Length 800mm, dia 90mm	12 nos.	No	Yes	2	9 nos.	
22	Bearings	UCF 210	4 nos.	No	Yes	1	8 nos.	
23	Sprocket	1” Pitch, 25 teeth, duplex	2nos.	No	Yes	½	4 nos.	

24	Pin bush coupling	6”	2 nos.	No	Yes	3	2 nos.	
25	Conveyor guide roller	6” x 2 1/2”	4 nos.	No	Yes	2		
26	Hydro motor	SL.No 315 C/2679	1 no.	No	Yes			
27	Reduction gear	AB 2/10 1989 DSMD MSKW 600/300	1 no.	No	Yes			Keeping in hand 1 nos.
28	Metal coupling	E48, 50 teeth	2 nos.	No	Yes	1	2 nos.	
29	Nylon coupling	E48, 50 teeth	4 nos.	No	Yes	½	4 nos.	

3.3.4 DC conveyor for first rejection

The rejects from the first Trommel to the first rejection conveyor is changed at an angle of 90^{o} towards the rejection belt, so that the rejects from the first Trommel is collected in the common rejection belt and collected in the designated area for rejects. Different parts are:

1. Conveyor belt
2. Drive motor & reduction gear
3. Drive drums etc.

Table.5 : Abstract of first rejection conveyor

Sl. No	Name of the item	Specification	Quantity	Repairable	Replacement	Period of life (years)	Total	Remarks
1	Conveyor belt	1 m width 10mm thick 4 ply nylon threaded	36	No	Yes	3	36	
2	Drive	5 HP motor		Yes	No			
3	Reduction gear	U 600 Sl.No 160201 ratio (60:1)	1 no.	Yes	No			
4	Pin bush coupling	8”	2 nos.	No	Yes	2	2 nos.	
5	Pin bush coupling	10”	2 nos.	No	Yes	2	2 nos.	
6	Bearings	Plummer block 1213	2 nos.	No	Yes	1	2 nos.	
7	Bearing	Plummer block 1215	2 nos.	No	Yes	1	2 nos.	
8	Conveyor roller	length 280mm, dia 100mm	33 nos.	No	Yes	2	33 nos.	
9	Return roller	length 950mm, dia 90mm	8 nos.	No	Yes	2	8 nos.	

3.3.5 Common rejection conveyor

The rejects from first and the second Trommels are collected in the common rejection conveyor and dumped in the designated area of rejects. The different parts are as follows

1. Conveyor belt
2. Drive motor
3. Reduction gear
4. Pin bush coupling
5. Drive drum
6. Spindle
7. Bearing
8. Conveyor rollers
9. Return rollers
10. Conveyor guide rollers

Table.6 : Abstract of common rejection conveyor

Sl. No	Name of the item	Specification	Quantity	Repairable	Replacement	Period of life (years)	Total	Remarks
1	Conveyor belt	Width 1m, 10mm thick 4ply nylon threaded	50m	No	Yes	3	50 m	
2	Drive motor	7.5 HP		Yes	No			
3	Reduction gear	U600 Sl.No 160201 ratio 60:1	1 no.	Yes	No			
4	Pin bush coupling	8”	2 nos.	No	Yes	2 Years	2 nos.	
5	Pin bush coupling	10”	2 nos.	No	Yes	2 Years	2 nos.	
6	Bearings	Plummer block 1213	2 nos.	No	Yes	1 Year		
7	Bearings	Plummer block 1215	2 nos.	No	Yes	1 Year		
8	Conveyor roller	Length 280 mm dia 100mm	33 nos.	No	Yes	2 Years	33 nos.	
9	Return roller	Length 950mm dia 90mm	8 nos.	No	Yes	2 Years	8 nos.	

3.3.6 Third Trommel

The semi products are stored in the yard for another three to four weeks for further decomposition. Three Trommels are arranged in parallel, and the products from all the Trommels are conveyed to the manure yard and then to the packing yard, where final product is stored before packing. Meanwhile, the rejects passes through the rejection belt and then through a chute and finally get deposited in landfill.

The parts of Trommels 1, 2 and 3 are same for all the three Trommels which are described below:

1. front and back end rings
2. front and back pull rings
3. Trommel tyre -4 nos each, total 12 nos.
4. Trommel stopper-2 each, total 6 nos.
5. Hydro motor-1 each, total 2 nos.
6. Sprocket and chain
7. Drive shaft
8. Product carrying conveyor 1 each- 1 no.
9. Common product carrying conveyor-1 no.
10. Common rejection carrying conveyor-1 no.
11. Drive system of conveyors
12. Drive system and conveyors for product to manure house
13. Feeding chute each- 3 nos.
14. Vibrator in the chute- 3 nos.
15. Power pack for two Trommels-1 no.
16. Drive for third Trommel
17. Control panel
18. Conveyor rollers
19. Return roller
20. Conveyor guide roller
21. Net
22. Weld mesh
23. V- Belt
24. Sprocket and chain of third Trommel

Table.7: Abstract of spares for level 2

Sl. No	Name of the item	Specification	Quantity	Repairable	Period of life(years)	Total
1	M.S pipe	65mm, “c” class extruding pipe	108 m	No	3	108 m
2	M.S Rectangular pipe	80 x40 x 3	108 m	No	3	108 m
3	M.S angle	65 x 65 x 6mm	180 m	No	3	108 m
4	M.S Sheet	8mm sheet	5 m^2	No	3	5 m^2
5	Wire mesh	4 mm opening,	6 nos., 96 m^2	No	1	96m^2

		1.5mm thick S.S 304, size 15.3 x1.6 m				
6	Weld mesh M.S	25 x25 x2.5 mm	96 m^2	No	1	96m^2
7	Front and Back end rings	4mm M.S sheet	16 m^2	No	2	16m^2
8	Front and Back pull rings	Permanent part of the machine		No		
9	Bolt and nuts with double washer	3/8 ” x 2 ½ ”		No		
10	Trommel tyre	16 ¼ ”x11 ¼ ” x 6”	12 nos.	No	2	12 nos.
11	Hub and shaft of Trommel tyre	Permanent part of the machine		No		
12	Sprocket	19 teeth 1” pitch duplex 3 m	6 nos.	No	1	6 nos.
13	Bearing with lock	33/JW/22215	24 sets	No	2	
14	Hydro motor		2 nos.	No		
15	Chain	1” pitch, duplex 3 m	6 nos.	No		
16	Trommel stopper body and shaft	Permanent		No		
17	Stopper bearing	NJ 308	6 nos.	No	1	6 nos.
18	Stopper disc	6208	6 nos.	Yes	1	
19	Drive drum and shaft	Permanent		Yes		4 nos.
20	Conveyor belt product carrying	500mm width,10mm thick 4 ply nylon threaded	36 m	No	3	36 m
21	Conveyor rollers	length 230mm, dia. 100mm	75 nos.	No	2	75 nos.
22	Conveyor rollers	length 250mm dia. 100mm	46nos.	No	2	46 nos.
23	Conveyor return rollers	length 550mm dia. 90mm	20 nos.	No	2	20 nos.

24	Motor	3 HP	8 nos.	Yes		8 nos.
25	Reduction gear	4SN ratio (20:1)	3 nos.	Yes		3 nos.
26	Pin bush coupling	6”	10 nos.	No	3	10 nos.
27	Bearings	Plummer block (1213)	4 nos.	No	2	4 nos.
28	Bearing	Plummer block (1215)	18 nos.	No	2	18 nos.
29	Bearing	UCP 210	2 nos.	No	2	2nos.
30	Sprocket	19 teeth, 1” pitch duplex	4 nos.	No	1	4 nos.
31	Sprocket	25 teeth, 1” pitch duplex	1 no.	No	1	1 nos.
32	Chain	1” pitch 3 m long duplex	2nos.	No	1	2 nos.
33	Sprocket	19 teeth, 1” pitch duplex	1 no.	No	1	1 no.
34	Sprocket	25 teeth, 1” pitch duplex	3 nos.	No	1	3 nos.
35	Chain	1” pitch 3 m duplex	2 nos.	No	1	2 nos.
36	Sprocket	1” 38 teeth 3 m, duplex	1 no.	No	1	1 no.
37	Common product carrying conveyor	600mm width, 10mm thick 4 ply nylon threaded	80 m	No	3	80 m
38	Conveyor return roller	length 700mm dia. 90mm	8 nos.	No	2	8 nos.
39	Reduction gear	4SNU ratio 30:1	2 nos.	Yes	2	2 nos.
40	Conveyor return rollers	length 650mm dia. 90mm	18 nos.	No		
41	Feeding chute	Permanent	3 nos.	Yes		3 nos.
42	Vibrator	Permanent	3 nos.	No		3 nos.
43	V Belt	B62	9 nos.	No	¼	36 nos.
44	Motor	20 HP	2 nos.	Yes		2 nos.
45	Reduction gear	U600	1 no.	Yes		1 no.
46	Sprocket	45 teeth 1 ½ “ pitch	1 no.	No	2	
47	Sprocket	15 teeth 1 ½ ” pitch	1 no.	No	2	

48	Chain	1 ½ ” pitch 5m	1no.	No	2	
49	V Belt	C 90	3 nos.	No		6 nos.
50	SS 304 wire mesh	4mm x 4mm,1.5mm thick	96 m^2	No	1	96m^2
51	Weld mesh M.S	25 x25mm, 2.5mm thick wire	96 m^2	No	1	96m^2
52	Bolt & Nut with double washer	3/8 x 2 ½ ”	72 nos.	No	1	72 nos.

3.3.7 Power pack

It is a metallic tank with two compartments of size 1mx1m. One compartment has hydraulic oil (system 68) of 330 litres capacity and the other compartment is filled with water, for cooling. On the top of this tank, there is a motor of 20 HP, one duplex duty oil pump and a pressure control valve.

Table.8: Main components of Power Pack

Name of the item	Specification	Quantity	Repairable	Period of life (years)	Total quantity required
Oil pump			No		
Cooling coil	permanent		No		
Oil	Hydraulic system 68	400 lit	No	6	
Magnet set	built in (permanent)		No		
Oil filter	metallic built in (permanent)		No		
Secondary oil filter		1 no.	No	½	1 no.
Control valve with solenoid		1 no.	Yes		1 no.
Pressure gauge	2” dia 0-2000 PSI ¼”back fitting	2 nos.	No		2 nos.
Radiator for cooling		1 no.	Yes		1 no.
Cooling fan		1 no.	Yes		1 no.

3.3.8 Other components of Power Pack

1. Control panel with PID control (temperature indication of oil)
2. Pressure gauge – 2 nos.
3. Oil filter – 1 no.
4. Metallic oil filter 1 no. (inside the tank)
5. Oil system 68 – 6 years.
6. Power packs are of two nos., i.e. for each Trommels. They have separate control panels and has another joint control panel for both the Trommels.
7. Oil pump: Duty make duplex
8. Metallic coupling E 48, 50 teeth 4 nos.
9. Nylon coupling.
10. Pressure control valve with solenoid
11. Drive Motor (20 HP)- 2 nos.
12. Capacitors-2 nos.
13. ½ HP mono block pump-1 no.
14. Radiator-1 no.
15. Cooling fan-1 no.
16. Cooling Coil- 1 no

Table.9: Other components of Power Pack

Sl no	Name of the item	Specification	Quantity (nos)	Repairable	Period of life	Total (nos.)	Remarks
1	Control Panel	permanent	2	No		2	Permanent
2	Pressure gauge	2” dia , glycerine filled, pressure 0 – 2000 PSI ¼” back fillings	4	No		4	
3	Oil filter	metallic filter built inside tank	2	No		2	Permanent
4	Secondary oil filter	length 10”, dia 1 ½ ”	2	No	6 months	4	
5.	Oil	hydraulic oil system 68	800 lit	No	6 yrs	800 lit	
6	Oil pump	Duty make, duplex $\frac{51115285}{3090/3090}$	2	No			One in stock
7	Metallic	E 48, 50 teeth	4	No	1 yr	4	

	coupling						
8	Nylon coupling	E 48, 50 teeth	2	No	3 months	8	
9	Cotrol valve	Pressure control valve for hydraulic oil	2	Yes			One in hand
10	Drive motor	20 HP motor	2	Yes		2	
11	Capacitor		2	No			
12	Water pump	½ HP Mono block	2,	Yes			1 no. in stock
13	Radiator		2	Yes			
14	Cooling coil	permanent		No			
15	Magnet set	permanent		No			
16	Cooling fan			Yes			

Table. 10: Control Panel specification

Sl. No	Name of the item	Specification	Quantity (nos.)	Repairable	Period of life	Total (nos.)
1	Electronic timer	Star delta, 250/415 V, range 30,60,90,120 sec. Pour time -60, 90,120,150 m/sec	1	No		1
2	Switch gear	FN 200	1	No		1
3	HRC fuse	HNO 10 KA	3	No		3
4	HRC fuse unit	32 A	4	No		4
5	Contacts	MNX 25 L & T	3	No		3
6	Contacts	MNX 16	10	No		10
7	Contacts	MNX 45	1	No		1
8	Contacts	MNX 32	3	No		3
9	Contacts	MNX 12	5	No		5
10	Aux. Contacts	2 NO, 2 NC	20	No		20
11	Over load relay	4.5 to 7.5	9	No		9
12	Over load relay	6 to 10	5	No		5
13	Over load relay	14 to 23	4	No		4
14	Timer with coil	Coil volt – 250	1	No		1
15	Elmex connector	63 A	4	No		4

16	Elmex connector	16 A	16	No		16
17	Elmex connector	10 A	153	No		153
18	Elmex connector	32 A	120.	No		120
19	HRC fuse unit	32 A – 415 V	3.	No		3
20	PID Control		1	No		1
21	OEN relay with base	8 Pin , coil volt 240	2	No		2
22	OEN relay		2	No		2
23	3 pole insulator	16 A	5	No		5
24	3 pole insulator	63 A	5	No		5
25	3 pole insulator	6 A	3.	No		3
26	3 pole insulator	20 A	1	No		1
27	Single pole MCB	6A	4	No		4
28	Emergency switch		2.	No		2
29	Pressure cut off switch	250 V	1	No		1
30	Current transformer	250 V 10 A type M	5	No		5
31	Electronic timer	Star delta, 250/415 V, range 30,60,90,120 sec. Pour time -60, 90,120,150 m/sec	1	No		1
32	Switch gear	FN 200	1	No		1
33	HRC fuse	HNO 10 KA	3	No		3
34	HRC fuse unit	32 A	4	No		4

Table.11: Utility Equipments

Sl. No	Name of the item	Specification	Quantity (nos.)	Repairable
1.	Air Compressor	10 HP, Compressor 10 kg/cm^2 working pressure double stage air cool	1	No
2.	Air Compressor	1 HP, Compressor 10 kg/cm^2 working pressure double stage air cool	1	No
3.	Water Pump	10 HP, 10 Stage Vertical	2	No
4.	Water Pump	Mono block, 1 HP self priming pump	2	No
5.	Water Pump	½ HP Mono block	4	No
6.	Water Pump	Jet Pump 1 HP	1	No
7.	Diesel Generator	125 KVA	2	No

Table. 12 : Abstract of Repairable items

Sl. No	Name of the item	Specification	Total Quantity (nos.)	Remarks
1.	Electric Motor	20 HP/15KW valves	4	1 no. as spare
2.	Electric Motor	10 HP/15KW valves	3	
3.	Electric Motor	7.5 HP/15KW Valves	2	
4.	Electric Motor	5 HP/15KW valves	1	
5.	Electric Motor	3 HP/15KW valves	10	

Table.13 : Requirement of Mechanical Reduction gear

Sl. No	Name of the item	Specification	Total Quantity (nos.)	Remarks
1.	Reduction gear	U 400, graves make Ratio 40 :1	2	It is repairable, but takes more time. Keep one spare
2.	Reduction gear	U 600, graves make SL.No 160201 Ratio 60:1	4	
3.	Reduction gear	4 SNU, Elecon make Ratio 20:1	3	
4.	Reduction gear	4 SNU, Elecon make Ratio 30:1	2	

Table.14 : Maintenance required for different components

Sl. No	Name of the item	Specification	Total Quantity	Minimum requirement (annually/ once in two years and above)
1.	Conveyor belt	1 m width, 10mm thick 4 ply, Nylon threaded	86 m	Once in 3 Years
2.	Conveyor belt	80 mm width, 10 mm thick 4 ply, Nylon threaded	20 m	Once in 3 Years
3.	Conveyor belt	750 mm width, 10 mm thick 4 ply, Nylon threaded	80 m	Once in 3 Years
4.	Conveyor belt	700 mm width, 10 mm thick 4 ply, Nylon threaded	120 m	Once in 3 Years
5.	Conveyor belt	600 mm width, 10 mm thick 4 ply, Nylon threaded	80m	Once in 3 Years
6.	Conveyor belt	500 mm width, 10 mm thick 4 ply, Nylon threaded	36 m	Once in 3 Years
7.	Conveyor roller with spindle	length 230mm, dia 100mm, “C” class M.S Pipe	147 nos	Once in 2 Years

8.	Conveyor roller with spindle	length 250mm, dia 100mm, “C” class M.S Pipe	124 nos.	Once in 2 Years
9.	Conveyor roller with spindle	length 280mm, dia 100mm, “C” class M.S Pipe	33 nos.	Once in 2 Years
10.	Conveyor return roller with spindle	length 950 mm, 90mm dia, “C” class M.S pipe	16 nos.	Once in 2 Years
11.	Conveyor return roller with spindle	length 800 mm, 90mm dia, “C” class M.S pipe	19 nos.	Once in 2 Years
12.	Conveyor return roller with spindle	length 700 mm, 90mm dia, “C” class M.S pipe	26 nos.	Once in 2 Years
13.	Conveyor return roller with spindle	length 550 mm, 90mm dia, “C” class M.S pipe	20 nos.	Once in 2 Years
14.	Conveyor guide roller with spindle	150 mm long, 65mm dia	30 nos.	Once in 2 Years
15.	Wire Mesh M.S	36 x 36 mm, 8mm thick wire size 2.7x 2m	6 nos.	Once in 2 Years
16.	Wire Mesh M.S	16 x 16 mm, 6mm thick wire size 2.7 x2m	12 nos.	Once in Yearly
17.	Wire Mesh M.S S.S 304	4x 4 mm, 1.5 mm thick wire size 15.3 m x 1.6 m	6 nos.	Once in Yearly
18.	Conveyor chain rollers	EN 8 metal 50mm dia, 20mm thick, 12mm bolt hole	800 nos.	Once in 2 Years
19.	Teflon beading	12mm x25 mm	30 n	Yearly
20.	Trommel stopper disc	EN 8 Metal dia 100mm, thick 25mm	10 nos.	Yearly
21.	“V” Belt	B 62	9 nos.	Yearly
22.	“V” Belt	C 90	3 nos.	Yearly
23.	“V” Belt	B 78	2 nos.	Yearly
24.	TVS Bolt & Nut	12mm x 65 mm half threaded	800 nos.	Yearly
25.	M.S Pipe	90 mm “C” class M.S extruding pipe	36 m	Once in 2 years
26.	M.S. Pipe	65mm “C” class M.S extruding pipe	144 m	Once in 2 Years
27.	M.S rectangular pipe	80 x 40 x 3 mm	180 m	Once in 2 Years
28.	M.S rectangular pipe	40 x 25 x 3 mm	96 m	Once in 2 Years
29.	M.S Angle	65 x 65 x 6mm	180 m	Once in 3 Years
30.	M.S. Sheet	8mm thick	12 m^2	Once in 3 Years
31.	M.S. Sheet	4mm thick	30 m^2	Once in 3 Years
32.	M.S Flat	65 x 12mm	50 m	Once in 3 Years
33.	M.S. Flat	40 x 6mm	36 m	Once in 3 Years
34.	Pressure gauge	2” dia dial size, 0-2000	6 nos.	When damaged

		PSI, pressure range		
35.	Secondary Oil filter	10" long 2 ½ " dia	3 nos.	When damaged
36.		Douty make duplex 51115285 3090/3090	1 nos.	When damaged
37.	Hydraulic oil pump	Douty make duplex 7077976 3090/3070	2 nos.	When damaged
38.	Oil Pressure Control valve	Hydraulic oil Pressure control Valve	3 nos.	When damaged
39.	Radiator	For cooling fan	3 nos.	When damaged
40.	Copper cooling coil	For power pack	3 nos.	When damaged
41.	Cooling fan	For power pack	3 nos.	When damaged
42.	Power pack		3 nos.	When damaged
43.	Control panel		3 nos.	When damaged

Table. 15 : Annual requirement of consumables

Sl. No	Name of the item	Specification	Total Quantities.	Minimum requirement Annually/ once in two years and above.
1.	Sprocket	1" Pitch 19 teeth duplex	30 nos.	Yearly
2.	Sprocket	1" Pitch, 38 teeth duplex	16 nos.	Yearly
3.	Sprocket	1" pitch, 25 teeth duplex	16 nos.	Yearly
4.	Sprocket	2" pitch, 13 teeth 16mm thick single 16 m	6 nos.	Yearly
5.	Sprocket	1 ½ " pitch 45 teeth single	1 no.	2 Years
6.	Sprocket	1 ½ " Pitch 15 teeth single	1 no.	2Years
7.	Chain	1 ½ " pitch single	1 no.	2 Years
8.	Chain	1" pitch duplex 3 m	24 no.	Yearly
9.	Bearings	UCP 211	8 nos.	Yearly
10.	Bearings	UCF 211	8 nos.	Yearly
11.	Bearings	UCP 210	18 nos.	Yearly
12.	Bearings	UCF 210	6 nos.	Yearly
13.	Bearings	Plummer block taper 1213	4 nos.	Yearly
14.	Bearings	Plummer block taper 1215	12 nos.	Yearly

15.	Bearing with lock	33/JW 22215	20 Sets	Yearly
16.	Bearing with lock	NJ 308	10 nos.	Yearly
17.	Bearing with lock	6208	10 nos.	Yearly
18.	Trommel tyre	16 ¼ " X 11 ¼ " X 6"	6 nos.	Yearly
19.	Pin bush coupling	Set of 2 nos. 6"	3 Sets	Yearly
20.	Pin bush coupling	Set of 2 nos. 8"	1 Set	Yearly
21.	Pin bush coupling	Set of 2 nos. 10"	1 Set	Yearly
22.	Conveyor rollers with spindle	Length 230mm, dia 100mm, "C" class pipe	50 nos.	Yearly
23.	Conveyor rollers with spindle	Length 250mm, dia 100mm, "C" class pipe	40 nos.	Yearly
24.	Conveyor roller with spindle	280mm length. 100mm dia, "C"class M.S Pipe	15 nos.	Yearly
25.	Conveyor rollers with spindle	370 mm length, 90mm dia, "C" class M.S pipe	30 nos.	Yearly
26.	Conveyor return rollers with spindle	950mm length, 90mm dia, "C" class M.S pipe	16 nos.	Yearly
27.	Conveyor return rollers with spindle	800mm length, 90mm dia, "C" class M.S pipe	19 nos.	Yearly
28.	Conveyor return rollers with spindle	700mm length, 90mm dia, "C" class M.S pipe	26 nos.	Yearly
29.	Conveyor return rollers with spindle	550mm length, 90mm dia, "C" class M.S pipe	20 nos.	Yearly
30.	Conveyor guide rollers with spindle	150mm length, 65 mm dia	30 nos.	Yearly
31.	"V" Bolt	B 62	27 nos.	Yearly
32.	"V" Bolt	C 90	6 nos.	Yearly
33.	"V" Bolt	B 78	6 nos.	Yearly
34.	Teflon beading	12mm x 25mm	30 m	Yearly
35.	Metallic coupling	E48,50 teeth	22 nos.	Yearly

36.	Nylon Coupling	E 48,50 teeth	36 nos.	Yearly
37.	Hydraulic hose	5/8" ID MEETS –DIN20022-1SN.WP 130 bar (EXEEDS 100RIAT) Flame Resistant, length 1.7m, Flare nut 1 ¼ inch BSP at both ends	10 nos.	4 /Years
38.	Conveyor joining clip	2 ½ "	200 nos.	Yearly
39.	Wire mesh	50mm x 50 mm^2, 8mm thick wire size 2.7 x 2 m	6 nos.	Yearly
40.	Wire mesh	20mm x 20 mm, 6mm thick wire size 2.7 x2 m	12 nos.	Yearly
41.	Wire mesh S.S 304 Wire mesh	4mm x 4 mm, 1.5 mm wire thickness size 15.3 x1.6 m	6 nos.	Yearly
42.	Wire mesh	25mm x 25 mm^2, 2.5mm thick wire	96 m^2	Yearly
43.	M.S. Channel	200mm	12 m	Yearly
44.	M.S. Channel	150 mm	18 m	Yearly
45.	M.S. Channel	100 mm	36 m	Yearly
46.	M.S. Channel	75 mm	18 m	Yearly
47.	M. S Angle	65 x 65 x 6 mm	60 m	Yearly
48.	M. S Angle	50 x 50 x 6 mm	60 m	Yearly
49.	M. S Angle	40 x 40 x 6 mm	60 m	Yearly
50.	M. S Angle	50 x 50 x 6 mm	60 m	Yearly
51.	M. S Angle	25 x 25 x 6 mm	60 m	Yearly
52.	M. S Angle	25 x 25 x 3mm	60 m	Yearly
53.	M.S. Flat	40 x 6mm	200 m	Yearly
54.	M.S. Flat	25 x 6mm	150 m	Yearly
55.	M.S. Flat	20 x 6mm	150 m	Yearly

Table. 16 : Specification and requirement of electrical items

Sl. No	Name of the item	Specification	Minimum requirement Quantity
1.	Electrical contact	MNX 25, Coil volt 240V 3 pole, L & T make	10 nos.
2.	Electrical contact	MNX 20, Coil volt 240V 3 pole, L & T make	5 nos.
3.	Electrical contact	MNX 16, Coil volt 240V 3 pole, L & T make	5 nos.

4.	Electrical contact	MNX 32, Coil volt 240V 3 pole, L & T make	10 nos.
5.	Electrical contact	MNX 45, Coil volt 240V 3 pole, L & T make	2 nos.
6.	Electrical contact	MNX 12, Coil volt 240V 3 pole, L & T make	4 nos.
7.	Aux: contact	1 No 1 NC	10 nos.
8.	Aux: contact	2 No 2 NC	10 nos.
9.	Over load relay	MNX Range 14-23	5 nos.
10.	Over load relay	MNX Range 4.5-7.5	10 nos.
11.	Over load relay	MNX Range 6-10	5 nos.
12.	Over load relay	MNX Range 20-33	3 nos.
13.	Timer	Thermal timer with coil volt 240, make L & T, GT, 200	2 nos.
14.	Timer	Electronic timer (Star delta) 240/415 V, range 30/60/90/120 sec Pulse 69/q90/120/150 sec Serial no L & T 780	1 no.
15.	MCCB	25 A 3pole	5 nos.
16.	MCCB	16 A3pole	5 nos.
17.	MCCB	6.0 A3pole	3 nos.
18.	MCCB	40 A3pole	5 nos.
19.	MCCB	63 A3pole	5 nos.
20.	Fuse	HRC- L&T make HN type, 63 A 415V,5.7W,100 KAGG	24 nos.
21.	Fuse	100A,415A,HN00,100KAGG	10 nos.
22.	Fuse	63A,415V,HF 14 X51	24 nos.
23	Fuse	160A,415V12.7W HN size 0-100 KAGG	10 nos.
24	Fuse Wire	200A	3 Kg

25	Kit cat fuse	300A	4 nos.
26	Cable Lug	120	6 nos.
27	Cable Lug	95	6 nos.
28	Cable Lug	75	10 nos.
29	Cable Lug	50	10 nos.
30	Cable Lug	35	10 nos.
31	Cable Lug	25	20 nos.
32	Cable Lug	16	20 nos.
33	Cable Lug	10	50 nos.
34	Cable Lug	2.5	100 nos.
35	Cable Lug	1.5	100 nos.
36	Cable Lug Banana type(plug)	16	50 nos.
37	Cable Lun Banana type	10	50 nos.
38	Cable Lun Banana type	6	50 nos.
39	Cable Lun Banana type	2.5	50 nos.
40	Cable Lun Banana type	1.5	50 nos.
41	Cable	1 Sq mm	5 Coil
42	Cable	2.5 Sq mm	5 Coil
43	Cable	4 Sq mm	2 Coil
44	Cable	6 Sq mm	2 Coil
45	Cable	3 Core (2.5 Sq mm)	1 Coil
46	Bulb	60 W	50 nos.
47	CFL	20 W or equivalent	100 nos.
48	Tube (Fluorescent)	40 W	100 nos.
49	Copper chock	40 W	30 nos.
50	Starter	for tube light	100 nos.

51	Sodium Vapour bulb	150 W	10 nos.
52	M/H	400 W	1 no.
53	M/H	70 W	2 nos.
54	Socket	5A 5 in one	24 nos.
55	Top	5.0A	24 nos.
56	Socket	16 A	10 nos.
57	Top	16 A	10 nos.
58	One way Switch	5A	30 nos.
59	Holder	Brass bulb holder	24 nos.
60	Relay	OEN relay with base 6 pin type coil volt 240	10 Nos.
61	Cable	3.5 4core 35 Sq mm	60 m
62	Cable	3.5 4core 50 Sq mm	50 m
63	Cable	4core 16 Sq mm	50 m
64	4 way distribution box		1 nos.
65	Insulator	4 pole 63 A	1 nos.
66	MH light	400 W & all fittings	1 nos.
67	PID control		2 nos.

Table. 17: Specification and requirement of consumables

Sl. No	Name of the item	Specification	Minimum requirement Quantity
1.	Bolt & Nuts with double Washer	3/8" x 4"	1000 nos.
2..	Bolt & Nuts with double Washer	3/8" x 21/2"	1000 nos.
3.	Bolt & Nuts with double Washer	3/8" x 11/2"	500 nos.
4.	Bolt & Nuts with double Washer	1/2" x 4"	500 nos.
5.	Bolt & Nuts with double Washer	5/8" x 21/2"	300 nos.
6.	Bolt & Nuts with double Washer	5/8" x 11/2"	300 nos.
7.	Bolt & Nuts with double Washer	3/4" x 6"	100 nos.
8.	Bolt & Nuts with double Washer	1/4" x 2"	100 nos.
9.	Bolt & Nuts with double Washer	1/4" x 4"	100 nos.

10.	Bolt & Nuts with doubleWasher	1/4" x 11/2"	100 nos.
11.	Bolt & Nuts without Washer	12 X 65 mm half threaded (TVS Bolt & nuts)	1000 nos.
12.	Teflon tape	3/4"	24 nos.
13.	Insulation tape	1/2"	100 nos.
14.	Hack Saw blade	1/2", 18 teeth HSS (18 TPI)	50 nos.
15.	Hack Saw blade	1/2", 24 teeth HSS (24 TPI)	50 nos.
16.	Hack Saw blade	1/2" ordinary	200 nos.
17.	Super glue	Tube	150 nos.
18.	Ana bond	666	24 nos.
19.	Omini	Puncher clearing of vehicle tube, heavy duty	50 Sheets
20.	Omini glue	Puncher clearing of vehicle tube, heavy duty	25 Tubes
21.	Valve Pin	Valve Pin for heavy duty vehicle tubes	200 nos.
22.	Welding rod	Advani make 4 mm rod	5 Pkts
23.	Welding rod	Advani make 3.15 mm rod	20 Pkts
24.	Welding rod	Advani make 2.15 mm rod	5 Pkts
25.	Welding rod	Local make 3.15 mm rod	30 Pkts
26.	Cutting rod	Arc cutting rod 4 of 5 mm	3 Pkts
27.	Emery Cloth	120	12 nos.
28.	Emery Cloth	100	12 nos.
29.	Nylon breaded hose	1" ID	60 m
30.	Nylon breaded hose	4/3" ID	60 m
31.	Nylon breaded hose	1/2" ID	100 m
32	M. Seal		3 kg
33.	Bush Bolt	5/8”	50 nos.
34.	Bush Bolt	6/8”	50 nos.
35.	Bush Bolt	3/8”	50 nos.
36.	Grinding Wheel	4”	30 nos.

Table. 18: Specification and requirement of plumbing accessories

Sl. No	Name of the item	Specification	Minimum requirement Quantity
1.	PVC Pipe	2"(ID) 6Kg pressure ISI pasted 20 nos.	100 m
2.	PVC Pipe	1 ½ "(ID) 6Kg pressure ISI pasted 5 nos.	25 m
3.	PVC Pipe	1 ¼ "(ID) 6Kg pressure ISI pasted 5 nos.	25 m
4.	PVC Pipe	1"(ID) 6Kg pressure ISI pasted 20 nos.	100 m
5.	PVC Pipe	¾ "(ID) 6Kg pressure ISI pasted 25 nos.	125 m
6.	PVC Elbow	2"(ID) 6Kg pressure ISI pasted 25 nos.	15 nos.

7.	PVC Elbow	1 ½ "(ID) 6Kg pressure ISI pasted 25 nos.	10 nos.
8.	PVC Elbow	1 ¼ "(ID) 6Kg pressure ISI pasted 25 nos.	10 nos.
9.	PVC Elbow	1"(ID) 6Kg pressure ISI pasted 25 nos.	50 nos.
10.	PVC Elbow	¾ "(ID) 6Kg pressure ISI pasted 25 nos.	50 Nos.
11.	PVC Bend	2"(ID) 6Kg pressure ISI pasted 25 nos.	15 nos.
12.	PVC Bend	1 ½ ""(ID) 6Kg pressure ISI pasted 25 nos.	10 nos.
13.	PVC Bend	1 ¼ "(ID) 6Kg pressure ISI pasted 25 nos.	10 nos.
14.	PVC Bend	1"(ID) 6Kg pressure ISI pasted 25 nos.	50 nos.
15.	PVC Bend	¾ "(ID) 6Kg pressure ISI pasted 25 nos.	50 nos.
16.	PVC Reducer bush	1"(ID) 6Kg pressure ISI pasted 25 nos.	25 nos.
17.	PVC End Cap	1"	10 nos.
18.	PVC End Cap	¾ "	10 nos.
19.	Gun metal tap (water tap)	Brass tap ½ "	10 nos.
20.	Gun metal tap (water tap)	Brass tap1"	10 nos.
21.	Valve	2", Gun metal Ball valve	2 nos.
22.	Valve	¾ " Gun metal ball valve	10 nos.
23.	Solvent Cement	Hybond, 250 X 12	3 ltrs
24.	Shellac	Shellac compound (50 Ml)	20 nos.
25.	Nobile putty	500 X 6 nos.	3 Kg
26.	Cotton thread		25 nos.
27.	PVC MTA	2"(ID) 6Kg pressure ISI pasted 25 nos.	10 nos.
28.	PVC MTA	1 ½ "(ID) 6Kg pressure ISI pasted 25 nos.	10 nos.
29.	PVC MTA	1 ¼ "(ID) 6Kg pressure ISI pasted 25 nos.	10 nos.
30.	PVC MTA	1"(ID) 6Kg pressure ISI pasted 25 nos.	20 nos.
31.	PVC MTA	¾ "(ID) 6Kg pressure ISI pasted 25 nos.	25 nos.
32.	PVC FTA	2"(ID) 6Kg pressure ISI pasted 25 nos.	5 nos.
33.	PVC FTA	1 ½ "(ID) 6Kg pressure ISI pasted 25 nos.	5 nos.
34.	PVC FTA	1 ¼ "(ID) 6Kg pressure ISI pasted 25 nos.	5 nos.

35.	PVC FTA	1"(ID) 6Kg pressure ISI pasted 25 nos.	20 nos.
36.	PVC FTA	¾ "(ID) 6Kg pressure ISI pasted 25 nos.	20 nos.
37.	PVC Coupling	2"(ID) 6Kg pressure ISI pasted 25 nos.	15 nos.
38.	PVC Coupling	1 ½ "(ID) 6Kg pressure ISI pasted 25 nos.	10 nos.
39.	PVC Coupling	1 ¼ "(ID) 6Kg pressure ISI pasted 25 nos.	10 nos.
40.	PVC Coupling	1"(ID) 6Kg pressure ISI pasted 25 nos.	20 nos.
41.	PVC Coupling	¾ "(ID) 6Kg pressure ISI pasted 25 nos.	25 nos.
42.	PVC Reducer bush	2"(ID) 6Kg pressure ISI pasted 25 nos.	5 nos.
43.	PVC Reducer bush	1 ½ "(ID) 6Kg pressure ISI pasted 25 nos.	5 nos.
44.	PVC Reducer bush	1 ¼ "(ID) 6Kg pressure ISI pasted 25 nos.	10 nos.

Table.19 : Average annual requirement of oil and grease

Sl. No	Name of the item	Specification	Minimum requirement (litres)
1.	Grease Oil	SP 320	210
2.	Engine Oil	15 W 40	630
3.	Engine Oil	20 W 40	420
4.	Lubricating Oil	Servo 40	210
5.	Hydraulic Oil	System 68	420
6.	Hydraulic Oil	System 32	630
7.	Grease	Multipurpose	1800 Kg

Table. 20 : Spare parts of vehicles

Sl. No	Name of the item	Specification	Minimum requirement
1.	Tyre JCB back Heavy duty	14:00:25	8 nos.
2.	Tyre bull back	16:9:28	12 nos.
3.	Tyre JCB Front	9:00:16	8 nos.
4.	Tyre Bull Front	7:50:16	5 nos.

5.	Tyre Tipper lorry	900:20	36 nos.
6.	Tube JCB	14:0025	8 nos.
7.	Tube Bull	16:9:28	12 nos.
8.	Tube	9:0016	8 nos.
9.	Tube	7:50:16	5 nos.
10.	Tube	9:00:20	36 nos.
11.	Flap	14:00:25	8 nos.
12.	Flap	7:50:16	5 nos.
13.	Flap	9:00:20	36 nos.

Table..21: Long term maintenance required components

Sl. No	Name of the item	Specification	Quantity	Two years and above
1.	Conveyor belt	1 m width, 10 mm thick, 4 ply Nylon threaded	86 m	3
2.	Conveyor belt	800 m width, 10 mm thick, 4 ply Nylon threaded	20 m	3
3.	Conveyor belt	750 m width, 10 mm thick, 4 ply Nylon threaded	50 m	3
4.	Conveyor belt	700 m width, 10 mm thick, 4 ply Nylon threaded	120 m	3
5.	Conveyor belt	600 m width, 10 mm thick, 4 ply Nylon threaded	80 m	3
6.	Conveyor belt	500 m width, 10 mm thick, 4 ply Nylon threaded	36 m	3
7.	Conveyor Chain roller	EN 8 metal 50mm dia 20mm thick, 12.5 mm bolt hole	1000 nos.	2
8.	M.S. Pipe	90mm M.S “C” class extruding pipe	36 m	2
9.	M.S Pipe	65 mm M.S “C” class extruding pipe	144 m	2
10.	M.S. Rectangular Pipe	80 x 40 x 3 mm	180 m	2
11.	M.S. Rectangular Pipe	40 x 25 x3mm	96 m	2
12.	M.S Angle	65 x 65 x6 mm	180 m	3
13.	M.S Sheet	3mm thick	12 m^2	3

Table. 22 : Abstract of non repairable items- Reduction Gear and Hydro Motor

Sl. No	Name of the item	Specification	Total Quantities	Remarks
1.	Reduction gear, hydraulic drive	MMG Sl.No N004 Ratio 5:1	2 nos.	Keep one in stock
2.	Reduction gear, hydraulic drive	AB 2/101989 DSMD MSKW 600/300	1 no.	
3.	Hydro Motor (Orbit motor)	Sl.No. 315C/2679	3 nos.	
4.	Hydro Motor (Orbit motor)	H39043 AXJ 5085084	4 nos.	
5.	Hydraulic hose	5/8" ID MEETS –DIN20022-1SN.WP 130 bar (EXEEDS 100RIAT) Flame Resistant, length 1.7m, Flare nut 1 ¼ inch BSP at both ends	10 nos.	Keep four in stock

Table. 23: Other miscellaneous components

Sl. No	Name of the item	Specification	Total Quantity	Remarks
1.	Metallic Coupling	E 48, 50 teeth	22 nos.	
2.	Nylon Coupling	E 48, 50 teeth	11 nos.	
3.	Sprocket	1" pitch, 19 teeth, duplex	20 nos.	
4.	Sprocket	1" pitch, 38 teeth, duplex	11 nos.	
5.	Sprocket	1"pitch, 25 teeth, duplex	9 nos.	
6.	Sprocket	2" pitch, 13 teeth, single 16mm thickness	6 nos.	
7.	Sprocket	1 ½" pitch, 45 teeth single	1 nos.	
8.	Sprocket	1 ½" pitch, 15 teeth single	1 nos.	
9.	Chain	1 ½" pitch, Single, 5 m long	1 nos.	
10.	Chain	1" Pitch, duplex 3 m long	19 nos.	
11.	Bearing Pillow block	UCP 211	4 nos.	8/ Year
12.	Bearing Pillow block	UCF 211	4 nos.	8/Year
13.	Bearing Pillow block	UCP 210	36 nos.	18/ Year
14.	Bearing Pillow block	UCF 210	10 nos.	6/ Year

15.	Bearing Pillow block	1209 K	2 nos.	2/Year
16.	Bearing Plummer block, Taper	1213	8 nos.	4/Year
17.	Bearing Plummer block, Taper	1215	24 nos.	12/Year
18.	Bearing with lock	33/JW 22215	40 Sets	20 set/Year
19.	Bearing	NJ 308	10 nos.	10/Year
20.	Chain	1" Pitch, duplex 3 m long	19 nos.	
21.	Trommel tyre (Press on tyre)	16 ¼" X 11 ¼ " X 6"	20 nos.	6/Year
22.	Pin bush Coupling	Cast iron, set of 2 nos., with bolt 6"	7 Sets	3 Sets/ Year
23.	Pin bush Coupling	Cast iron, set of 2 nos., with bolt 8"	3 Sets	1 Set/Year
24.	Pin bush Coupling	Cast iron, set of 2 nos., with bolt 10"	3 Sets	1 Set /Year
25.	Conveyor belt	1 m width, 10mm thick 4 ply, Nylon threaded	86 m	
26.	Trommel tyre (Press on tyre)	16 ¼" X 11 ¼ " X 6"	20 nos.	6/Year
27.	Pin bush Coupling	Cast iron, set of 2 nos., with bolt 6"	7 Sets	3 Sets/ Year
28.	Pin bush Coupling	Cast iron, set of 2 nos., with bolt 8"	3 Sets	1 Set/Year
29.	Pin bush Coupling	Cast iron, set of 2 nos., with bolt 10"	3 Sets	1 Set /Year

3.3 Major trouble shooting

1. ***Chain struck*:** Due to over load, sometimes chain may break

   Remedy: Overload is mainly due to the accumulation of garbage. Check sprocket, feeding chain and drive sprocket. Remove the waste and clean thoroughly. If the chain is broken, rejoin it.
2. ***Stoppage of first and second Trommel due to overload:*** This may cause breakage of main pipes of Trommel, tripping of motor and abnormal sound in the rotation of Trommel.

   Remedy: Remove the load inside the first and second Trommels. Check drive sprockets, chain drive drums and bearings corresponding to the bonds. If any problem is found in the above said points, remove the load or rectify the damaged parts.

3. Breaking of conveyor belts:

Remedy: Immediate remedy is to rejoin the conveyor by using conveyor joining clips and permanent solution is joining the belt by cold vulcanization.

4. Stoppage of Power Pack

Remedy: Check the control panel i.e. check all the corresponding contacts, timer, OEN relay etc.

4.0 MANPOWER REQUIREMENT

A solid waste management plant employs different categories of employees ranging from plant manager on top of the hierarchy to several unskilled workers at the bottom. The work force will also include professionals like engineers, skilled persons such as electricians, foreman, plumbers, welders, etc and many other categories. Though levels in the hierarchy will vary, each one will have his own definite share of roles and responsibilities that is essential for effective and efficient running of the plant. If the nature of activities in the plant determines the employee categories, the volume of activity decides the employee strength. The important aspects pertaining to manpower are hiring best employees for the right profile at the right time, capacity building and attractive service packages. Especially in areas like solid waste management where staff turnover is quite high, employee satisfaction is very important. It should be ensured that those possessing dedication and right attitude should be retained. Simply speaking, what distinguishes a successful firm from unsuccessful one is the quality of manpower.

As already stated, the manpower requirement mainly depends upon the capacity of the plant. Normally, large compost plants are managed in shifts. Shifts are assigned to each person at the beginning of every month. Regular training for the existing technical and non-technical staff and induction training for the new employees has to be properly planned and executed for the smooth operation of the plant. Refresher trainings help to sharpen the skills and acquire new knowledge.(details of capacity building and training programme for Plant operators are included in the Capacity Building Plan on SWM for ULBs prepared as part of CoE by CED)

Based on the staff pattern and our experience of the Thiruvananthapuram SWM plant, the approximate manpower requirement for a 300 TPD plant is given below:

Table. 24 : Manpower Requirement

Category	Number
Plant Manager	1
Assistant Plant Manager	1
Accountant cum Office Assistant	1
Office attendant	1
Lab Technician	1
Supervisors (3 shifts-1 for each shift)	3
Foreman	1
Store keeper	1
Plant operators (3 shifts-1 for each shift)	3
Electrician/ Plumber/Welder	1
Driver (Tipper-1, excavator-3, back hoe loader-3, sheep foot roller-1, Car/Jeep-1)	9
Cleaning staff	20
Security Staff	3
Weigh Bridge Operator	1
Leachate Treatment Plant Operator (3 shifts)	6
RDF Plant Operator (2 shifts)	4
Landfill Operation Workers	6
Canteen workers (Optional)	4

Conclusion

There are a variety of technologies practised in solid waste management out of which some are time tested but some others have yet to establish local applicability. In the Indian context where major share of the waste is organic, composting is the best management option for which windrow composting is the solution. The process, machineries used in the processing plant, maintenance of machineries and manpower requirements have been discussed in the Manual. Rather than a strict rulebook, this Manual is expected to be a guiding document for any ULBs to set up a new plant/carryout operation and maintenance of the Plant.