JINDAL URBAN WASTE MANAGEMENT (GUNTUR) LTD.

DETAILED PROJECT REPORT

FOR

MUNICIPAL SOLID WASTE TO ENERGY FACILITY, GUNTUR, (A.P.)

Project No. 1639
30th November 2016

KORUS ENGINEERING SOLUTIONS PVT. LTD.

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00 EXECUTIVE SUMMARY

00.01 Background & Objective Of The Project

As a part of Swachh Bharat Mission, Government of Andhra Pradesh has adopted strategy for implementation of Solid Waste Management (SWM) Rules. Solid waste management plans have already been made for all the 110 local bodies in the state and the state government has plans to set up at least one model MSW-to-Energy (WtE) project in each district of the state.

New and Renewable Energy Development Corporation of Andhra Pradesh Limited (NREDCAP), on behalf of 53 Urban Local Bodies have already awarded Waste to Energy Projects for 10 clusters with total Power generation capacity of 63 MW.

JITF Urban Infrastructure Limited (JUIL), a subsidiary of Jindal Saw Limited (JSL) have received letters of award for three clusters-Guntur, Tirupati and Visakhapatnam through competitive bid process.

As per the conditions laid down in Letter of Award No. NREDCAP/BM/MSW/EOI/2015-16/1378 dated 03.12.2015, JUIL has promoted **Jindal Urban Waste Management (Guntur) Ltd.** for execution of the for 15 MW capacity WtE Project at Guntur.

Following activities have also been completed for start of project :

1. Concession Agreement with Urban Local Bodies comprising the cluster was signed on 6th February 2016.
2. Power Purchase agreement has been signed with AP Southern Power Distribution Company Ltd. (APSPDCL) on 6th Feb. 2016.

3. Resource assessment and basic engineering of the project defining the configuration of the project has also been completed.
4. Land Lease agreement has been signed on 21st July, 2016
5. Techno Economic study covering Project cost estimates and financial viability has been completed.
6. Social and Environment Risk Analysis studies have also been completed.

This Detailed Project Report has been prepared to enable Jindal Urban Waste (Guntur) Ltd proceed with Financial Closure, obtain other statutory clearances and go ahead with further work for project implementation.

00.02 Project Configuration

Waste to Energy Project will process Municipal Solid Waste (MSW) received from nine Urban Local Bodies (ULBs) in Guntur Cluster.

The Project includes :

- Material Recovery Facility with design capacity of 1650 TPD of MSW
- Power Plant of 15 MW capacity using combustion technology for steam production and Power generation using Steam Turbine – Generator.
- Balance of plant and other auxiliary facilities required for the project.

15.85 Acres of land is already allocated by Guntur Municipal Corporation near Naidupeta Dumping Yard. Approx. 4 Acres of additional land is proposed to be allocated by GMC.

Technological aspects and details of equipment and facilities are covered in Chapters 03 to 06 of this report.

00.03 Environmental & Social Aspects

Measures to be adopted for meeting the statutory requirements related to Environment Pollution have been studied in detail and covered in Chapter 07. Issues related to Health and safety of manpower engaged are also addressed in addition to social impact and management of related aspects.

00.04 Organisation Structure & Manpower

Requirement of manpower during project execution stage and for Operation & Maintenance have been assessed and organisation structure required for project planning and implementation has been presented in Chapter 08.

00.05 Implementation Schedule

Project implementation schedule in form of Bar Chart along with strategy for implementation and quality assurance are presented in Chapter 09. Financial closure is targeted by May 2017 and plant commissioning by October 2018.

00.06 Project Cost

The Capital Cost Estimates for the project are presented under different expenditure heads and are based on :

- Cost for major equipment such as RDF preparation, boiler, air pollution control and turbo generator are taken from historical estimates and validated on conservative basis by interaction with vendors

- Cost of balance of plant equipment, buildings, development & civil works, etc. are taken as per basic engineering and consultant data base

The Capital Cost of the Plant is estimated at Rs 21884 Lakhs as detailed in Chapter – 10.

00.07 Project Financials

The revenue for the project has been estimated based on sale of power, compost, recyclables and surplus RDF during operation of Plant for 25 years.

Assumptions made for calculations of financials are as per norms followed by lenders.

The project IRR (pre tax) has been computed taking into account the capital cost and revenue generated during tenure of the concession period of 25 years.

Computed figure for IRR is 17.10% (Pre Tax) and 15.37% (Post Tax)

The debt service coverage ratio (DSCR) of the project works out to 1.99.

Details are presented in Chapters 11 and 12.

Considering the analysis of IRR, the project is considered technically feasible and commercially viable.

01 INTRODUCTION TO THE PROJECT

01.01 Background & Objective Of The Project

Municipal Solid Waste (Management & Handling) Rules were framed by Govt. of India in year 2000. The Rules provided guidelines for collection, storage, transportation, sorting and segregation, processing and disposal of solid waste. After launching of Swachh Bharat Mission in 2014, these rules have now been updated and replaced by Solid Waste Management (SWM) Rules 2016. As per Rules, States have the responsibility of framing Waste Management Policy & Strategy and conforming to the State Policy, Urban Local Bodies (ULB) are responsible for making waste management plan for implementing SWM Rules.

Andhra Pradesh Govt. has been very proactive and Strategy on Andhra Pradesh Integrated Municipal Solid Waste was formulated in 2014 which provided framework for ULBs to implement SWM Rules. The Andhra Pradesh government has been aggressively promoting generation of power from MSW. The state government has plans to set up at least one model MSW-to-Energy (WtE) project in each district of the state. The state of Andhra Pradesh has 110 urban local bodies (ULBs), including 13 municipal corporations and 17 municipal councils.

Andhra Pradesh Urban Finance and Infrastructure Development corporation (APUFIDC) engaged agencies for preparation of Detailed Project Reports (DPRs) for Municipal Solid Waste management in areas covered by various ULBs in the state. For ULBs included in Guntur – Vijaywada cluster DPRs have been prepared by Tata Consulting Engineers Limited (TCE).

Note on Swachh Bharat Mission

Urban India is facing an ever increasing challenge of providing for the incrementa l infrastructural needs of a growing urban population. With increasing population, municipal solid waste management (MSWM) in the country has emerged as a challenge not only because of the environmental and aesthetic concerns, but also because of the huge quantities of municipal solid waste (MSW) generated every day.

Municipal Solid Waste (Management & Handling) Rules were formulated in 2000 which required all urban local bodies (ULBs) to establish a proper waste management system including a timeline for installation of waste processing and disposal facilities by the end of 2003, not only for metro cities and class I cities but also for all ULBs in the country. However, despite encouraging pilots and achievements, most ULBs continue to face challenges not only in the areas of appropriate and advanced collection and transportation systems, technology selection, and disposal methods, but also in sustainable financial management of MSWM. The non-compliance issue is still true after 16 years of the notification of the MSW (M&H) Rules, 2000.

In order to give a push to the municipal solid waste management in cities, the ministry o f Urban Development launched the Swachh Bharat Mission (SBM) in 2014.

SBM seeks to promote cities as engines of economic growth through improvement in the quality of urban infrastructure, with assured service levels and efficient governance. SBM aims to address the challenges in management of municipal solid waste and to support cities in developing modern and appropriate systems.

(Complied from MSW Management Manual by CPHEEO)

New and Renewable Energy Development Corporation of Andhra Pradesh Limited (NREDCAP), on behalf of Urban Local Bodies started process for selection and appointment of concessionaires for development of WtE projects. Some of the projects have already been awarded. **Swachha Andhra Corporation,** which was incorporated on 1st May 2015 with a goal to achieve the campaign "Swachh Bharat Mission" has been given the responsibility of monitoring of all WtE projects in Andhra Pradesh.

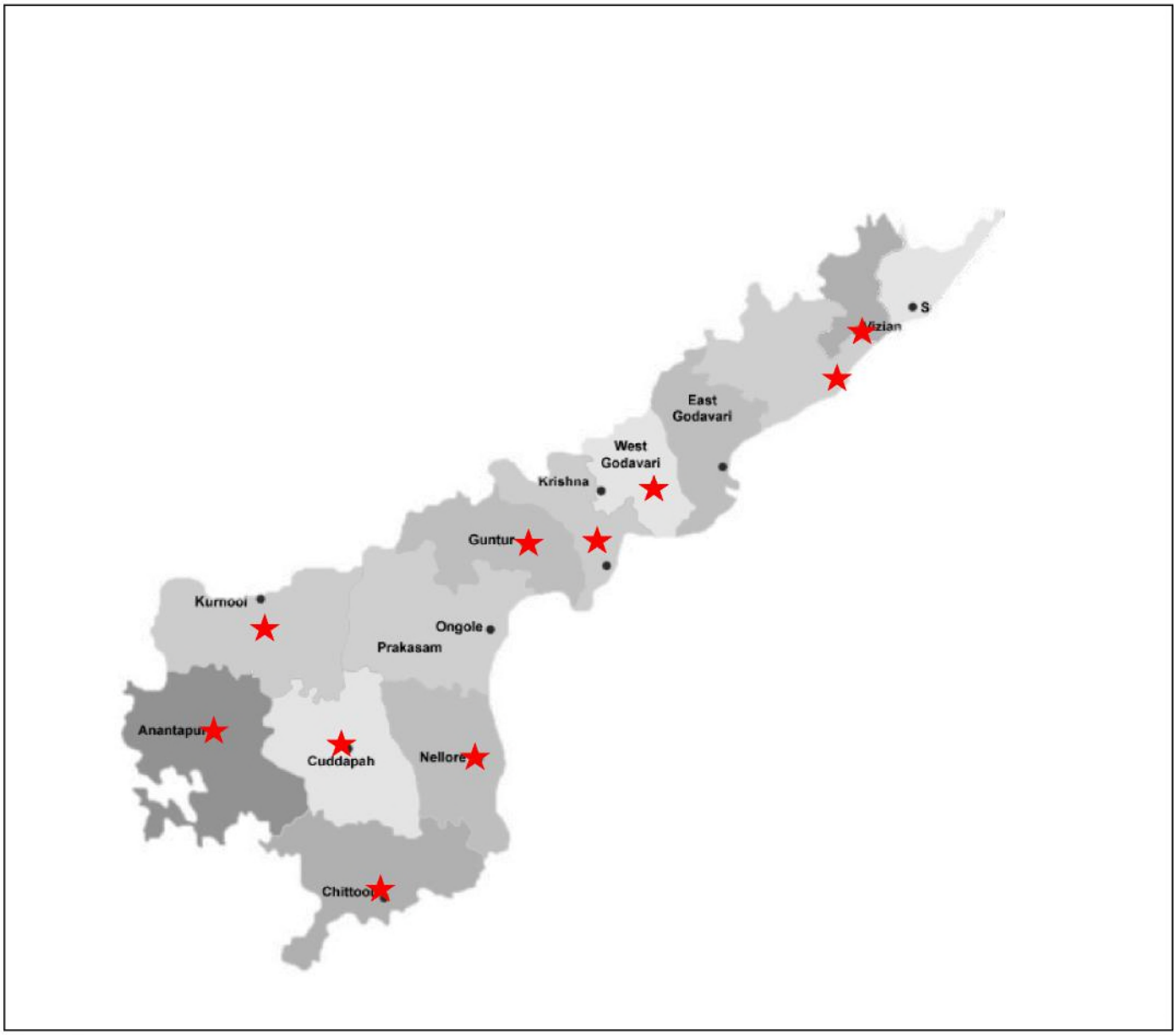
For 53 ULBs generating ~4471 Tonnes/day of Municipal Solid Waste as of 2015-16, Waste to Energy Projects have been awarded with total Power generation capacity of 63 MW in addition to other useful products like RDF and Compost.

Table 1: Waste to Energy Projects in Andhra Pradesh

Cluster Name	MSW Capacity TPD (as of 2015-16)	Capacity (MW)	Name of Developer
Visakhapatnam	952	15	JITF Urban Infra. Ltd.
Guntur	1202	15	
Tirupati	374	6	
Ananthapur	283	4	Essel Infra Projects.
Tadepalligudem	342	5	
Kadapa	317	5	
Machilipatnam	196	4	
Vizianagaram	208	4	
Kurnool	316	1	Nexus Novas
Nellore	296	4	Envikare LLP

(Details as per Letters of Award circulate by Swachh Andhra Corporation Dt. 31.03.2016)

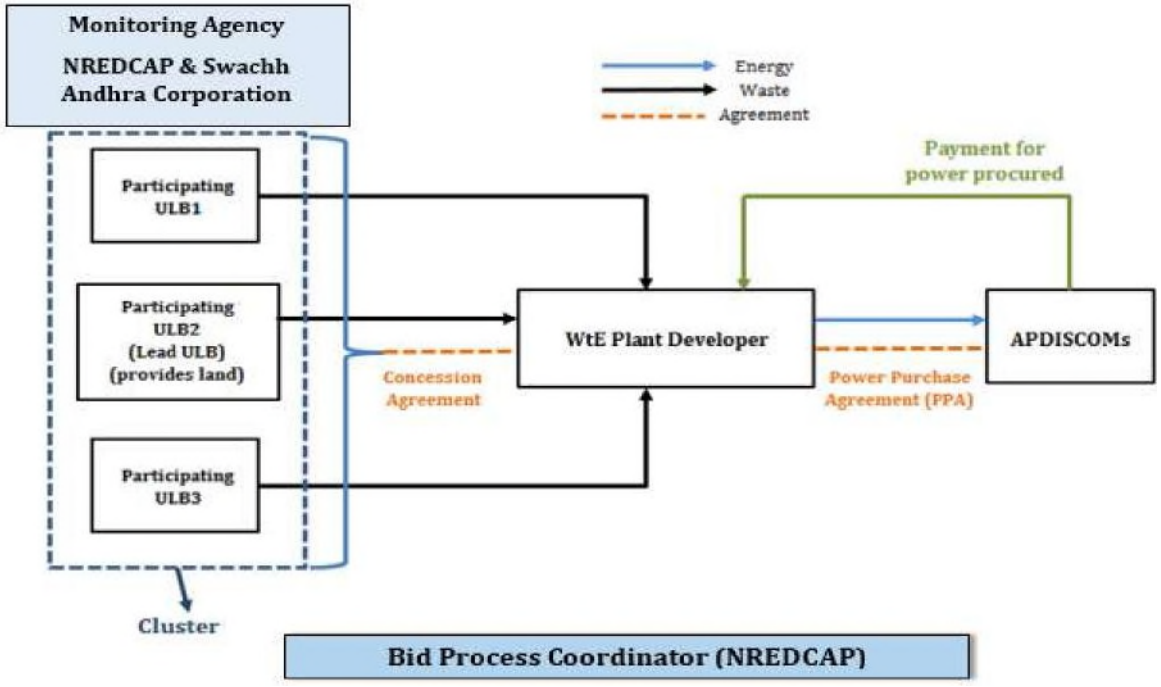
Figure- 1: Location of Waste to Energy Projects in Andhra Pradesh



Jindal Group, through its wholly owned subsidiary JITF Urban Infrastructure Limited (JUIL), participated in the competitive bidding process carried out by NREDCAP and succeeded in winning the bid for three clusters-Guntur, Tirupati and Visakhapatnam.

Projects are to be executed on Design, Build, Finance, Operate and Transfer (DBFOT) basis for converting waste to energy. Letter of Award No NREDCAP/ BM/ MSW/ EOI/2015-16/ 1378 was issued by NREDCAP to JUIL on 3rd Dec., 2015 for setting up of Waste to Energy Project of 15 MW capacity at Guntur covering total 9 ULBs comprising Vijayawada and Guntur Municipal Corporations and other seven municipalities in the cluster.

Figure- 2: Operating Structure of WtE Projects



In pursuance to the letter of award, JUIL has constituted separate companies for developing the three projects, JUIL being the holding company. **For executing Guntur WtE Project, Jindal Urban Waste Management (Guntur) Ltd. has been formed**.

Objective of this Report is to investigate and project Technical Feasibility and Commercial viability of the project to enable Jindal Urban Waste (Guntur) Ltd. proceed with Financial Closure, obtain other statutory clearances and go ahead with further work for project implementation for 15 MW WtE Facility.

The Detailed Project Report has been prepared for 15 MW capacity Waste to Energy Project by processing MSW received from Guntur Cluster covering the area under nine ULBs including Guntur and Vijaywada Municipal Corporations.

01.02 Group Corporate Profile

O.P.Jindal group was Founded in 1952 by Shri O. P. Jindal, a first-generation entrepreneur, the group today is a leading steel producer with interests spanning across the spectrum from mining iron ore to manufacturing value-added steel products. Group has grown to US$ 18 billion global business conglomerate.

PR Jindal Group was created post demerger of assets of OP Jindal Group. Mr. P.R. Jindal is Chairman of PR Jindal Group of companies.

PR Jindal Group has diverse business interests viz., manufacturing of steel pipes, pellets, infrastructure development and mining. The group recorded turnover of Rs.7971 Crores during FY 2015-16 and net worth of Rs.5116 Crores as on March 31st, 2016. Jindal SAW Limited (Jindal SAW), founded in 1984, is the group flagship company and is leading global manufacturer and supplier of Iron & Steel pipe products, fittings and accessories with manufacturing facilities in India, USA, Europe and UAE (MENA).

PR Jindal group's journey in infrastructure sector

PR Jindal Group forayed into infrastructure sector in 2007 and incorporated Jindal ITF Limited (JITF) as a subsidiary of Jindal SAW. Activities of JITF span across infrastructure, transport and fabrication solutions addressing the varied needs of the industry. JITF is engaged through its subsidiaries in various infrastructure businesses namely waste to energy, rail wagon fabrication, ship building, coastal and inland water transportation business, water infrastructure EPC business.

PR Jindal Group has identified municipal solid waste processing and power generation, water infrastructure, rail manufacturing as high potential businesses. In order to achieve faster growth and unlock shareholder value it was decided to demerge these high potential business into a separate infra vertical. This infra vertical is housed in Group's entity namely JITF Infralogistics Limited (JIL).

Municipal Waste Management and Waste to Energy Projects are looked after by JITF Urban Infrastructure Ltd. (JUIL).

Figure- 3 : Structure of Infrastructure Business before Restructuring

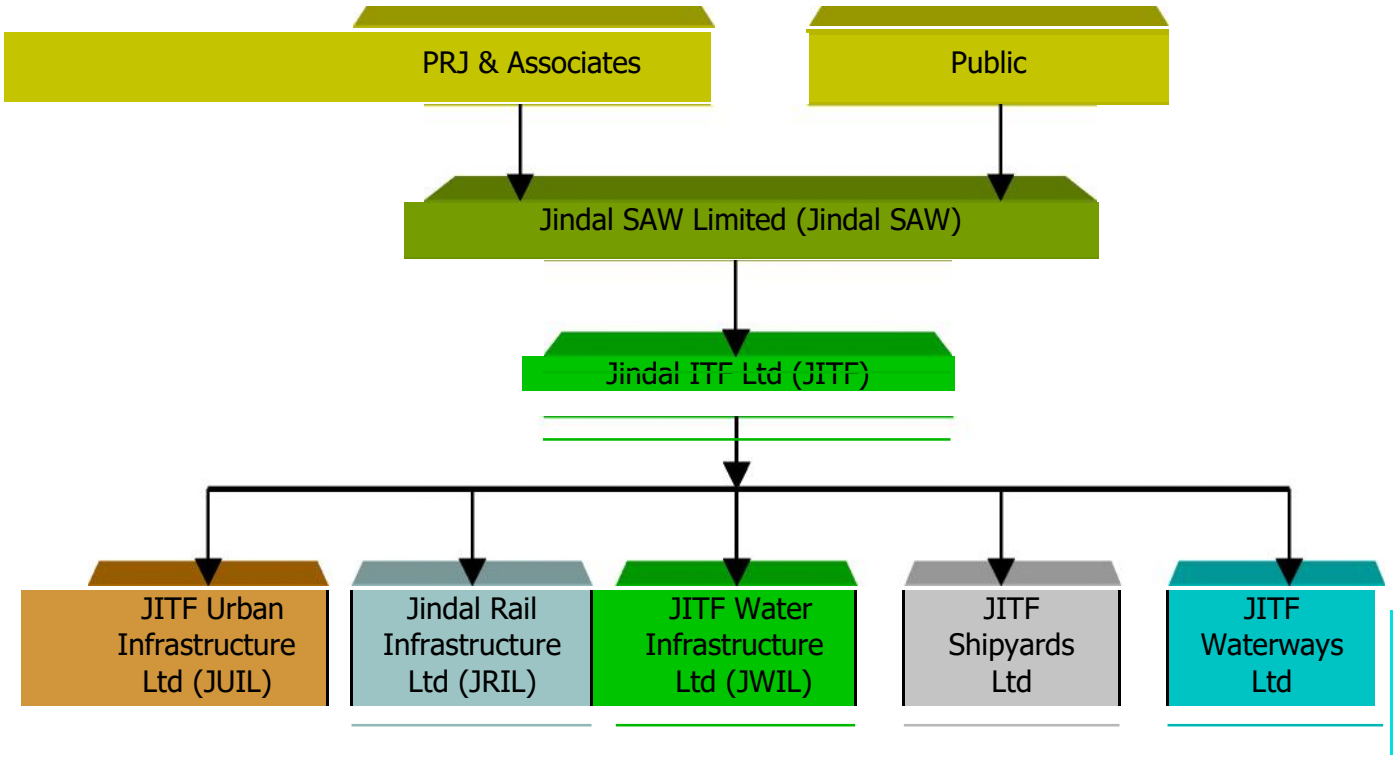
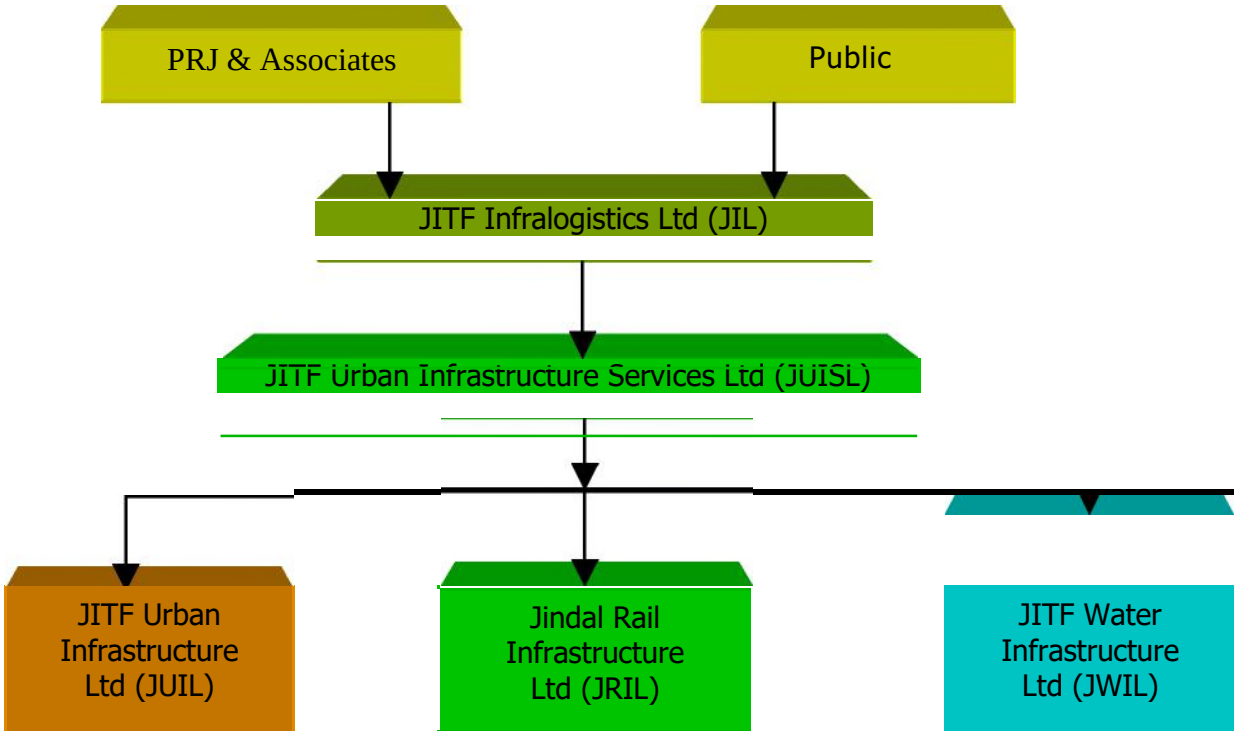


Figure- 4: Structure of Infrastructure Business after Restructuring



Group Flagship Company

Jindal SAW Limited (Jindal SAW), incorporated in 1984, is the flagship company of PR Jindal Group and is the largest steel pipe producer in India. In addition to pipes, pellets and value added products like pipe coatings, bends and connector castings, Jindal SAW also owns low grade iron ore mines in Rajasthan. The Company operates manufacturing facilities in India, the United States, Europe and United Arab Emirates. Its products find applications in energy, petrochemicals, oil and gas exploration, engineering, water transportation, and sanitation and sewage transportation. Jindal SAW is one of the largest steel pipe exporters from India with exports contributing around 35%-40% of the company's total revenues. Jindal SAW recorded turnover of Rs.6384 Crores during FY 2015-16 and had Net worth of Rs.5302 Crores as on March 31st, 2016.

Table 2: Particulars of Flagship Company

Company	Jindal SAW Limited (Jindal SAW)
Promoter	PR Jindal group
Registered Office Address	A-1, UPSIDC Industrial Area, Nandgaon Road, Kosi Kalan, Mathura, Uttar Pradesh – 281403
Date of Incorporation	October 31st, 1984
CIN Number	L27104UP1984PLC023979

Details of Key Management personnel is given in Table 3

Table 3: Profile of Key Personnel

Name	Designation	Qualification	Experience
Mr.Prithviraj Jindal	Chairman	Bachelors of Arts	Mr. Jindal pioneered the production of SAW pipes three decades ago. He has been at the helm of affairs of Jindal SAW and was associated in the setting up of SAW Pipes Limited (Jindal SAW, now) in 1984. Mr. Jindal Guides Company's global ambitions.
Ms. Sminu Jindal	Managing Director	MBA	Ms. Sminu Jindal has experience in the Steel, Oil and Gas sectors in India and is currently appointed as the Managing Director of Jindal SAW.
Mr. Neeraj Kumar	Group CEO	Masters in Physics and Masters in Business Management	Mr. Neeraj Kumar has wide experience with large Indian business houses, top multinationals and financial institutions across infrastructure, commodity, service and financial sectors. Mr. Kumar also worked as Director (Finance) & CFO of Jindal SAW.
Mr.Narendra Mantri	CFO	F.C.A.	Mr. Narendra Mantri is the CFO of Jindal SAW. He was earlier associated with Dalmia Bharat Sugar & Industries Ltd as CFO. He has close to 30 years of Work Experience.
Mr. Sunil Kumar Jain	Company Secretary	B.Com & CS	Mr. Sunil Jain has more than 30 years of experience in Corporate Secretarial and Legal field. He has handled varied matters in court cases and arbitration including matters related to forming of JV, cross border merger, domestic amalgamation/ demerger, issue of securities in international market both GDRs & FCCBs and their listing on London, Luxembourg and Singapore Stock Exchanges.

01.03 Promoter Company Profile

JITF Urban Infrastructure Limited (JUIL) is the holding company for all the Urban Infra Projects of the PR Jindal Group. JUIL has promoted various SPVs for implementing Waste management and Waste to Energy projects.

JUIL has completed the following projects and these are in operation:

1. Waste to Energy Project – 16 MW at Okhla, New Delhi
2. MSW Management with RDF Plant at Bathinda, Punjab : 300TPD
3. MSW Management Project in Daman : 100 TPD
4. MSW Management Project at Firozpur, Punjab : 300 TPD (Commissioning trials are completed, Commercial operation is yet to begin.)

Three Projects in Andhra Pradesh, one in Gujarat and two in Rajasthan are in pipeline.

Table 4: Particulars of Promoter Company

Company	JITF Urban Infrastructure Limited (JUIL)
Promoter	JITF Urban Infrastructure Services Limited (JUISL)
Registered Office Address	A- 1-, UPSIDC Industrial Area, Nandgaon Road, Kosi Kalan, Distt, Mathura (U.P.) -281403
Date of Incorporation	March 28th, 2007
CIN Number	U70102UP2007PLC069540

Structure of JITF Urban Infrastructure Limited (JUIL) is shown in Fig – 5 below :

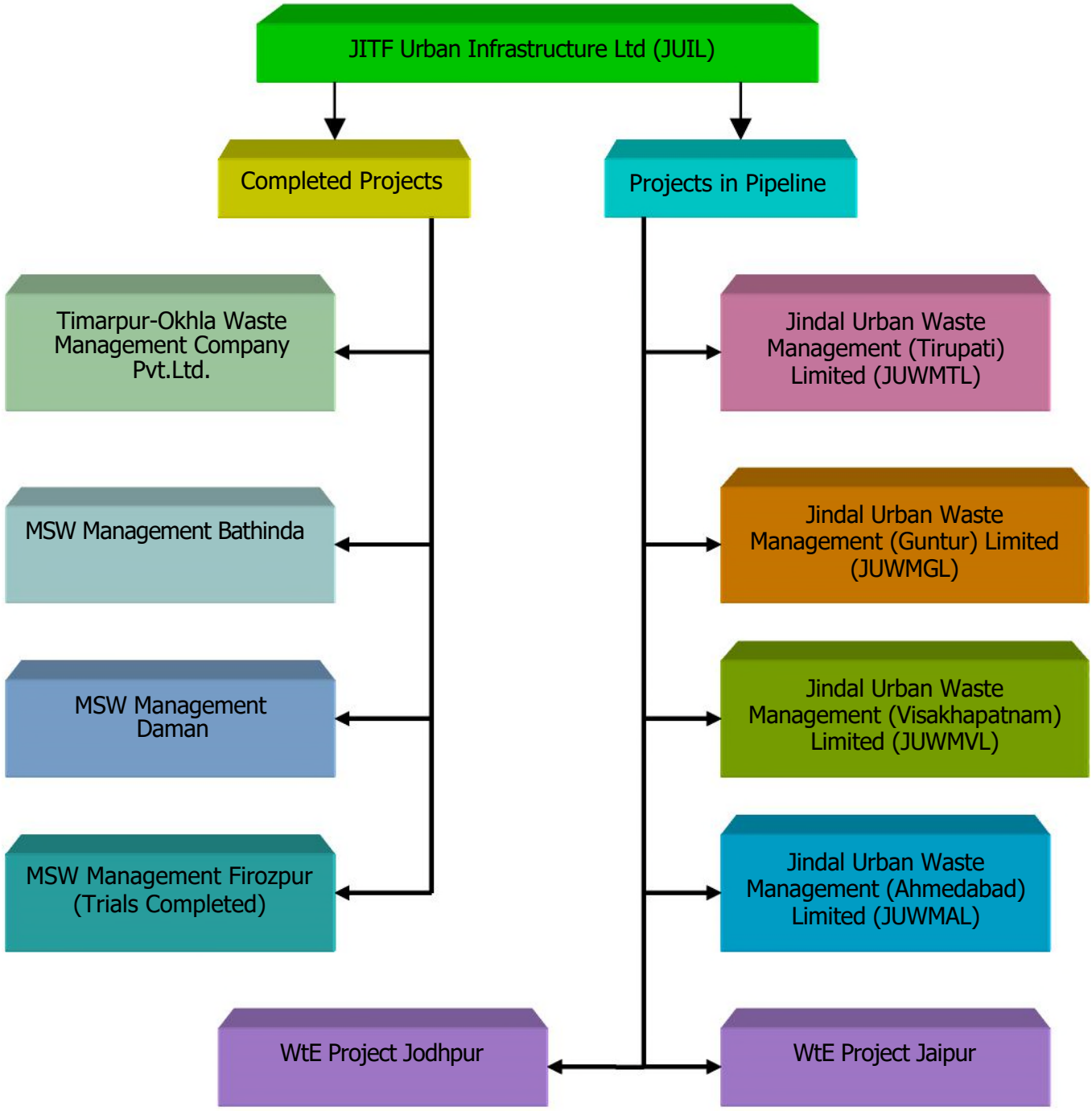


Figure- 5: Structure of JUIL

Snapshots of some completed Projects

WtE PROJECT AT OKHLA – NEW DELHI

MSW PROCESSING FACILITY AT BATHINDA

COMPOST AND RDF PRODUCED AT BATHINDA

01.04 The Project

The Waste to Energy Project will be an integrated facility for processing Municipal Solid Waste (MSW) delivered by Vijayawada and Guntur Municipal Corporation as well as other seven Municipalities in the cluster at the door of the facility. Material Recovery Facility will be designed for segregation of MSW into RDF, Compost, Recyclable material and Inerts. RDF will be used in a Power Plant to produce 15 MW of Power.

Plant Location :

- Village	: Kondaveedu
- Mandal	: Yadlapadu
- District	: Guntur (Andhra Pradesh)
Nearest Railway Station	: Guntur -14.4km
Nearest Airport	: Vijaywada – 67 km
Nearest Access Road	: NH- 16, 2km
Nearest Highway	: Chennai – Kolkata National Highway (NH-16) – 2km
Source of Water	: Treated STP Water
Total Land Area of Existing Plot	: 15.85 Acres (Survey No. 933 & 938)
Power Connectivity	: Grid Sub-station of APSPDCL, Vengalayapalem, 3 km

Plant Capacity :

MSW Handling Capacity	: 165 0 TPD
Power Generation	: 15 MW
Expected Compost Production	: ~ 76 TPD

Figure-6: Location Map of Site

DPR for WtE Project at Guntur

Annexure-5.1

Jindal Urban Waste Management (Guntur) Ltd.
Location Map for 15 MW WtE Plant

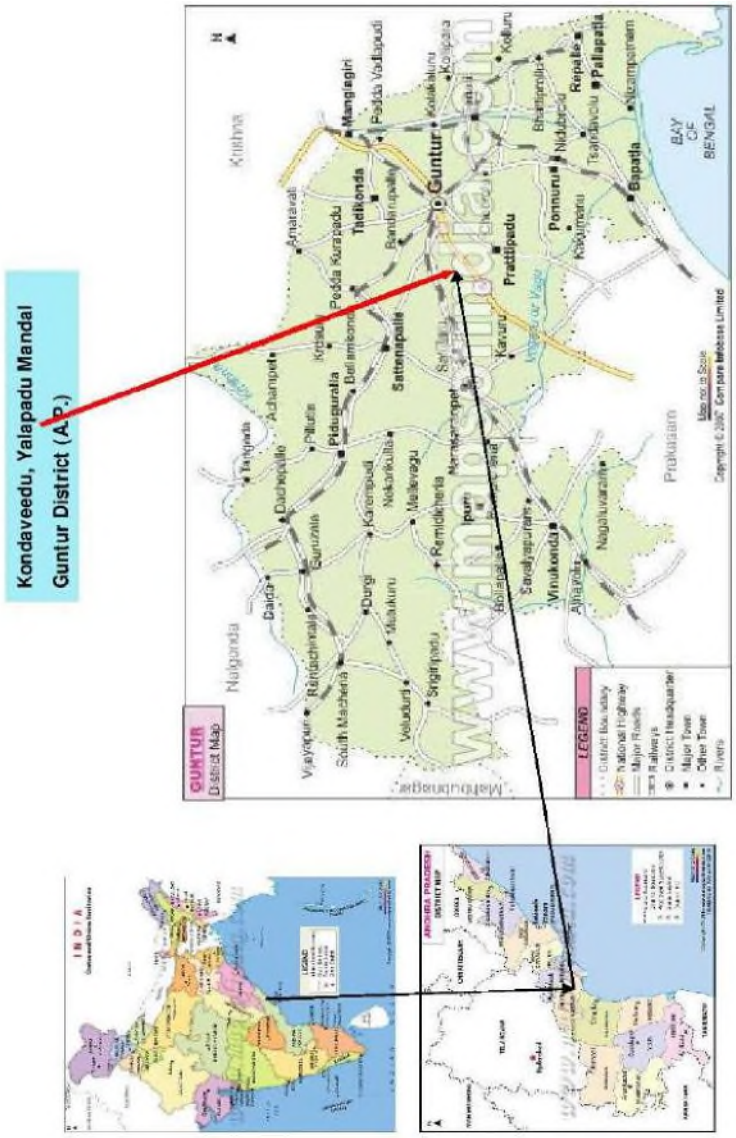


Figure- 7: Google Earth Image of Guntur WtE Site

01.05 Consultants And Assignment

01.05.1 Consultants Profile

KORUS – a multidisciplinary consultancy organization was established in 2005 by a group comprising experts of highest professional caliber and repute with a mission to provide world class professional services at local cost for the steel industry from project conceptualization to commissioning.

KORUS has assembled a team of more than 150 highly qualified and experienced professionals in all the relevant Technical and Engineering Disciplines in a short span and the organization is growing at a rapid pace.

KORUS team has the added advantage that its leading members have acquired hands-on shop floor experience in reputed public and private sector steel plants during the early years of their careers and then spent over three decades in providing Technical Consultancy and Project Design & Engineering Services.

The KORUS Approach

KORUS works closely with its clients to develop concepts and deliver design solutions with maximum impact on functionality, efficiency and life cycle cost of the plant. Because of this approach KORUS engineers have a reputation for being innovative. The well-knit team working under one-roof ensures that proposed solutions not only meet diverse requirements of the client but are also delivered on time and within budget.

Commitment to Quality

KORUS recognizes the importance of achieving global quality standards. It has developed a quality culture, which permeates every aspect of its activities. Quality improvement is a CONTINUOUS PROCESS and KORUS keeps it updated with worldwide best practices.

Key Personnel

The Key Personnel who are the brain trust of KORUS have acquired extensive experience, first by working on shop floor in reputed public and private sector steel plants in India and abroad during early stages of their careers and then by providing Technical Consultancy and project engineering services for over three decades in India, Indonesia, Kuwait, Malaysia, Nepal, Nigeria, Pakistan, Sri Lanka, Thailand, UAE and USA.

Range of Services

KORUS renders comprehensive services including requirement analysis and project conception to implementation. The services include:

Project identification and conceptualization.

- Field surveys / investigation / assessment of production potential and market VALUE of old plant and equipment; requirement of additional equipment, geotechnical considerations etc
- Preparation of Bankable Techno-Economic Feasibility Reports & Detailed Project Reports
- Preparation of preliminary designs and project engineering drawings for field activities.
- Preparation of Technical Specifications & Tender documents for procurement of production and Auxiliary Equipment and civil & structural construction works.
- Assistance in procurement of equipment.
- Preparation of detailed design and field execution drawings for utilities & services such as power, water, compressed air, fuel oil, gasses, maintenance workshops, testing laboratories, pollution control equipment, sheds, buildings, foundations, roads and

drainage and other infrastructure facilities.

- Project management services, monitoring and scheduling.
- Construction supervision and Quality Control / Assurance.
- Inspection, erection and commissioning of production and auxiliary equipment.
- Technology support for Sintering, Pelletizing, Iron making, Steelmaking, Rolling technology, Waste to Energy and Power Projects

Strengths of KORUS

With all the engineering disciplines under one roof, KORUS is able to provide end to end services for project implementation from concept to commissioning. Detailed engineering of Civil, Structural, Utility systems & piping, material handling and other services is carried out in house which ensures quality as well as timely delivery. Coordination between site team and design office team also takes care of modifications as required due to actual site conditions in a shortest possible time.

Key strength lies in integrating the complete plant by proper co-ordination of engineering activities carried out by different package suppliers. Responsibility of Interface management and filling the gaps is taken by KORUS for smooth completion of the project in totality.

Waste to Energy

Having associated with Iron & Steel industry, KORUS has gained vast experience in Energy systems and Power Plants based on Waste/ surplus energy available from technological processes. Captive Power Plants are integral to all Iron & Steel Plants with Power generation capacity from 4 MW to few hundred MW. KORUS has been associated with Jindal Group Companies since its inception and have successfully executed projects in wide range of technological fields.

Having gained expertise in Captive Power plants based on waste energy, KORUS has been associated by Jindal Group in its Endeavour to produce Energy (Fuel & Power) from Municipal Solid Waste. Korus is also providing Process & Technology upgradation and optimization for current expansion of Okhla WtE Plant. Pit extension and expansion is being done for better segregation and processing of MSW / RDF generation. To further strengthen the WtE group, KORUS has taken on board experts in the field of MSW processing and WtE projects.

01.05.2 The Assignment

JITF Urban Infrastructure Ltd. have assigned to KORUS Detailed Engineering, Consultancy and Project Management Services from concept to commissioning for their upcoming MSW/ RDF process plants for projects in Andhra Pradesh, Gujarat and Rajasthan.

01.06 Structure of the Report

Detailed Project Report (DPR) has been prepared with a view to present the total plant configuration along with Techno Economic Evaluation for the purpose of getting approvals from various statutory bodies as well as for financial closure with lenders. The Report is covered in various chapters as listed below :

1. Background and Introduction to the Project
2. Rationale for Project
3. Selection of Technology and sizing of main plant units
4. Selection of Plant & Equipment
5. Plant Location and Layout
6. Requirement of Land, Sheds, Buildings and other Civil Works
7. Environment, Health, Safety & Social Management

8. Organisational Structure Manpower Requirement
9. Project Implementation & Construction Schedule
10. Project Cost estimates & Means of Finance
11. Operating Costs, revenue generation & working results
12. Financial Projections and Project Appraisal

Executive summary is presented at the beginning of the Report.

02 RATIONALE FOR THE PROJECT

02.01 Municipal Solid Waste Scenario

Solid Waste Management Rules, 2016 have laid down Framework for Solid Waste Management. Duties & Responsibilities of all stake holders are covered in these Rules. All Urban Local Bodies (ULBs) are required to put in place complete Solid Waste management systems within a time frame. In Andhra Pradesh, Integrated Solid Waste Management Strategy is already in place since 2014 and most of ULBs have also prepared Solid Waste Management Plans. DPR for Solid Waste Management for Guntur Cluster has been prepared by M/s Tata Consulting Engineers Ltd. (TCE)

As per SWM Rules 2016, following provisions have been made:

- It has been made mandatory to segregate the waste at source with Processing of Waste into usable products to the extent possible.
- De-centralized facilities for composting of bio- degradable waste are to be created.
- Non bio-degradable and non recyclable waste with CV more that 1500 Kcal/kg is essentially to be sent to processing plant.
- Only inert material which cannot be recycled or converted into compost or RDF/ energy is to be sent to the landfills.

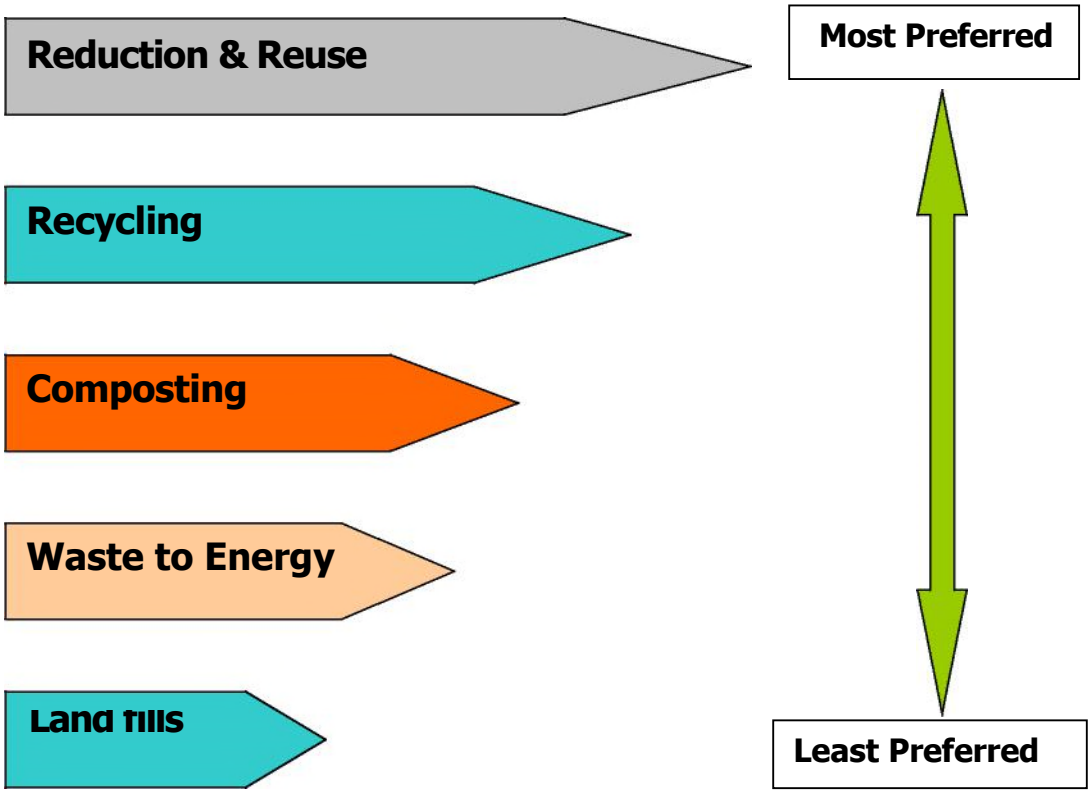
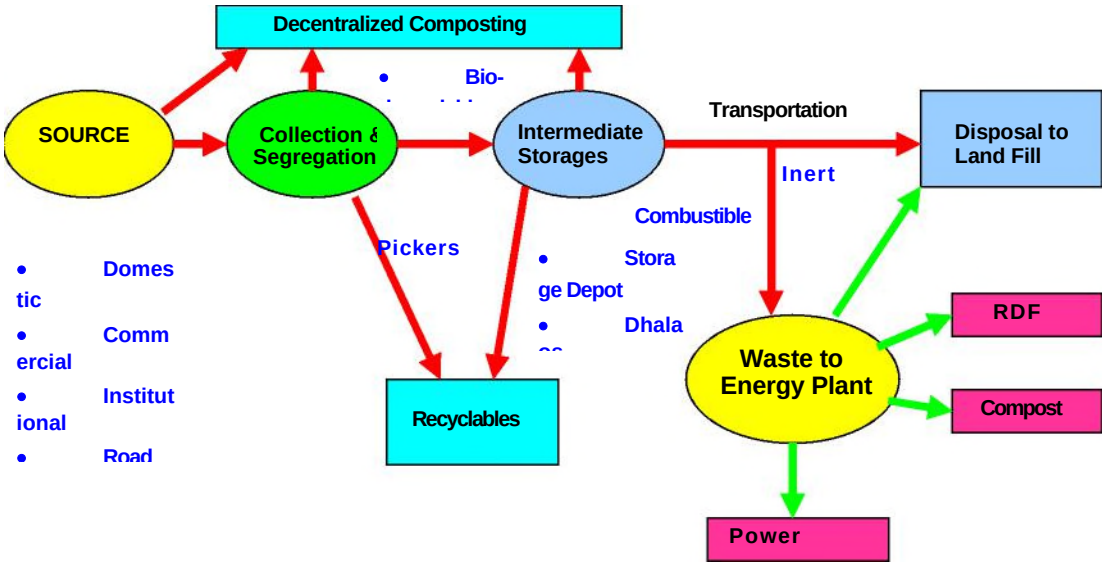


Figure- 8: Integrated Solid Waste Management Hierarchy

Fig- 8 shows the Integrated Solid Waste Management Hierarchy which is the guideline for the plans.

Waste to Energy Plants, therefore, have become essential part of SWM Plans. However, quality of feedstock directly impacts the performance, production rate as well as availability of steam generator for Power generation. At present MSW received at WtE facilities is without any segregation except recyclables collected by informal pickers. Moisture content ranges from 30 to 60%.

Figure- 9: Integrated Solid Waste Management System



Over the years, there has been steady growth in quantum of waste generation in towns/ cities. Composition of waste has also undergone change. Adoption of MSW management plans by all stake holders as per SWM Rules 2016 is likely to bring major changes in the quality of waste received at processing facility over a period of time. Facilities being planned should be suitable for present quality and also perform with expected quality in future. Moreover, part of investment made now should not become redundant in near future.

Once segregation at source or intermediate storage and de centralized composting is adopted, only part of the waste containing non compostable combustibles having minimum CV of 1500 kcal/kg is to be supplied by ULBs (Urban Local Bodies) to the WtE facility. This may result in reduction in percentage of MSW available for WtE plants, however, overall growth in MSW generation in ULB clusters will compensate the net availability. Quality and GCV of waste is also expected to improve thereby

Power Generation capacity will not have any adverse impact. On the other hand performance of Material Recovery Facility and incinerators will improve.

02.02 MSW Scenario for Guntur Cluster

Guntur would have total 9 Urban Local Bodies (ULBs), including Guntur and Vijayawada Municipal Corporations. The lead ULB for this cluster is Guntur, where WtE plant would be located. Waste from each of ULB will be transported to central WtE. Detail for this cluster and estimated waste generation is given in Table 5 below:

Table 5: ULBs Included in Guntur Cluster

Sl No.	Name of the ULB	Distance from Guntur in Km	Estimates by TCE,(TPD) (2015)	As per LOA by NRDECAP, (TPD)
1.	Guntur	0	350	320
2.	Vijayawada	37	550	525
3.	Tenali	28	50	68
4.	Chilakuripeta	40	68	62
5.	Sattenapalle	37	40	45
6.	Mangalagiri	25	40	52
7.	Narasaraopeta	46	51	65
8.	Ponnuru	31	35	35
9.	Tadepalli	32	25	30
Total			**1209 TPD**	**1202 TPD**

Guntur is located 64km to the north of the Bay of Bengal. It is the administrative capital of Guntur district which falls under the Andhra Pradesh Capital Region. The region around the city up to Visakhapatnam, is identified as a major industrial corridor in India.

The area of Guntur is about 159 sq. km and is divided into 62 numbers of wards. It is the third most populous city in the state with a population of 651,382 as per 2011 census. In the year 2012, the city limits were expanded by merging ten surrounding villages into the municipal corporation and the regional urban population is 7, 43,354. The total waste generated in the city is 320 MT per day in year 2015. The proposed new capital city in the vicinity of Guntur may result in exponential population growth in another 5- 10 years. This growth of population would be more than 20% over and above the natural growth of the city. The SWM in the city is governed by Guntur Municipal Corporation (GMC). GMC is also playing lead role for WtE project which will receive waste from other eight ULBs also.

The city has certain segment, where door to door collection and source segregation is followed. In general, the mixed waste is put in secondary collection bins of 3.5 and 4.5 cum bins. These bins are serviced by Dumper Placer (DP) vehicles.

The segregation of waste is mostly in informal sector, where rag pickers and kabariwalas take out recyclable waste and send that to recyclers.

The mixed waste (wet and dry) after collection is transported to Transfer Station (TS) at Etikuru through dumpers trucks (mini lorries and big lorries), auto tippers, hook loaders, tractors etc. The waste collected at TS is sent to Dumping yard by large trucks of 10 cum.

Transfer Station **Secondary Transport to Dump Yard**

Vijayawada is located on the banks of the Krishna River. It is located east of proposed Andhra Pradesh Capital City and is the second largest city in the state after Visakhapatnam in AP. The area of Vijayawada is 61.88 sq. km divided into 3 circles and 45 wards with a population of 10,48,240 as per 2011 census. The total waste

generated in the city is about 550 MT in year 2015. The proposed new capital city Amravati is in the vicinity of Vijayawada may result in exponential population growth in another 5- 10 years. SWM in the city is governed by Vijayawada Municipal Corporation (VMC).

Like in Guntur, Vijayawada city also has certain segments where door to door collection and source segregation is followed. In general, the mixed waste is put in secondary collection bins of 3.5 and 4.5 cum bins. These bins are serviced by Dumper Place (DP) vehicles. The segregation of waste is mostly in informal sector, where rag pickers and kabariwalas take out high value recyclable waste and send that to recyclers. Low value recyclables like thin plastic (<40 micron), rags, rubber, multilayered papers etc. are not taken by Kabdaiwalas and such waste are thrown in waste stream.

There are two transfer stations in the city, one at Ajitsingh Nagar and other newly proposed at Auto Nagar. The waste collected at Transfer Stations (TSs) is being sent to Dumping yard by large trucks of 10cum

Other seven ULBs forming part of the cluster are smaller towns with Municipal Committees. Waste generation is in range of 25 to 70 TPD. Part of each town are covered by door to door collection and waste is dumped in designated dump yards. The segregation of waste is mostly by rag pickers who take out material which can be sold.

Waste from all dump yards is to be transported to central WtE facility at Guntur and transportation up to the door of the facility is the responsibility of local ULBs. Transportation is proposed to be carried out using large refuse trucks of 10-12 T capacity.

MSW Projections for Guntur Cluster

Tata Consulting Engineers Ltd. have projected the growth of population in the USBs the cluster. Accordingly, based on population growth, estimated generation of MSW is also projected in the DPR prepared for Solid Waste Management for the cluster. Population and Waste generation projections are given in Table 6 and 7 respectively.

Table 6: Population Projection for ULBs in Guntur Cluster

Sr. No.	ULBs	Population Projection					
		2015	2020	2025	2030	2035	2040
1.	Guntur	818445	920645	1035606	1164922	1310386	1474015
2.	Vijayawada	1163012	1335306	1533124	1760247	2021018	2320421
3.	Tenali	172225	181790	191885	202542	213790	225662
4.	Chilakuripeta	105613	110009	113435	115892	117380	117899
5.	Sattenapalle	58886	60791	61806	61930	61163	59505
6.	Mangalagiri	77238	81480	85568	89503	93284	96913
7.	Narasaraopeta	124089	132064	139846	147434	154827	162026
8.	Ponnuru	60941	62012	62846	63442	63801	63921
9.	Tadepalli	78721	90844	104913	120928	138888	158795

Table 7: Waste Generation in ULBs till 2040 for Guntur Cluster

Sr. No.	ULBs	Projected Waste Generation TPD					
		2015	**2020**	**2025**	**2030**	**2035**	**2040**
1	Guntur	372	460.2	569.5	704.7	872	1079
2	Vijayawada	528.6	667.6	843.1	1064.8	1344.9	1698.5
3	Tenali	69	81	94	109	126	147
4	Chilakaluripeta	43.2	51	59.7	70	81.7	95.2
5	Sattenpalli	21	24.7	28.8	33.5	38.7	44.6
6	Mangalagiri	31.3	36.8	43	50.1	58.5	68
7	Narasaraopeta	51	61.7	74.6	90	108.8	131.4
8	Ponnuru	21.5	24.3	27.3	30.7	34.4	38.6
9	Tadepali	31.8	40.3	51	64.6	81.6	103
	Total	**1169.4**	**1447.6**	**1791**	**2217.4**	**2746.6**	**3405.3**

02.03 Project Rationale

With the ever increasing volume of Municipal Solid Waste being generated all over India and the problems associated with its disposal, importance of Solid Waste Management can not be over emphasized. Waste to Energy Project at Guntur is a part of Integrated Solid Waste Management Plant conceived under Swachh Andhra Mission. Plant is to be set up at Centralized Waste Treatment Facility for Cluster of ULBs in Guntur - Vijayawada area being developed near Naidupeta Dump Yard in Guntur.

Having identified the immense potential offered by Solid Waste Management, JUIL has ventured into the SWM business with focus on creation of a sustainable ecosystem for future generations. It is inline with this strategy of the group that JUIL has been increasingly playing a defining role and proving that the WtE can be a good and sustainable business too. JUIL has successfully developed and been operating the most successful 16 MW WtE project in Delhi and 300 t/d RDF project in Bathinda.

Based on its technical and financial strengths and tariff bid, JUIL has succeeded in winning the bid for development of WtE projects in the three largest clusters (Visakhapatnam, Guntur and Tirupati) amongst the ten clusters awarded in AP. Letter of Award No. NREDCAP/BM/MSW/EOI/2015-16/1378 dated 03.12.2015 was issued by NREDCAP for setting up WtE facility of capacity 15 MW at Guntur with availability of 1202 TPD of mixed MSW from cluster of 9 ULBs. Accordingly Concession Agreement has been signed between Guntur Municipal Corporation alongwith other participating ULBs and Jindal Urban Waste Management (Guntur) Ltd on 6th Feb, 2016. Project is to be set up on Design, Build, Finance, Operate and Transfer (DBFOT) basis.

03 SELECTION OF TECHNOLOGY AND SIZING OF MAIN PLANT

UNITS 03.01 General

Several technologies and process route options are available for processing of MSW and recovery of useful energy from the same. However, Waste to Energy Plant to be established as a part of overall Solid Waste Management Plan must adhere to the Rule, Guidelines and Policies of Govt. of India, State Govt. and ULBs. Technology to be adopted should comply with:

1. SWM Rules 2016
2. Central Pollution Control Board Regulations
3. Andhra Pradesh Pollution Control Board
4. Municipal Solid Waste Management Manual of MoUD (Prepared by CPHEEO)
5. Concession Agreement with ULBs
6. Rules and guidelines of Central & Andhra Pradesh Electricity Regulatory Commissions.

In addition to compliance with statutory provisions, Reliability and Techno-economic viability are also key guiding factors.

Quantity and characteristics of Solid waste are expected to vary over a wide range on daily as well as seasonal basis. WtE processing facility is to be designed to take care of mixed waste under variable conditions.

03.02 Availability Of Waste

Quantity and quality of waste generated in any urban area changes over time due to change in demographic profile, economic growth and lifestyle changes. As per various studies conducted MoUD Manual on MSW Management have concluded that per capita waste generated ranges from 200-300 grams for smaller town to close to 600 grams for larger cities. For area under ULBs included in Guntur Cluster, present level of waste reaching the dump site is estimated as 400 - 450g/capita per day. Projected total availability at collection levels is estimated as about 1100-1200 T/day as per DPR prepared by TCE.

As per assessment made in MoUD Manual, per capita waste generation is increasing by about 1.3% per year. With an urban growth rate of 3.0%–3.5% per year, the annual increase in waste quantities may be considered at 5% per year. Impacts of increasing ULB jurisdiction should also be considered while assessing future waste generation rates. TCE have made projections for each of the ULBs based on population growth and growth in per capita generation. Figures have been presented in Table 6 and 7 in previous chapter.

With LOA figure of 1202 TPD for 2015, for the year 2018 when plant will be operative, availability is expected to be about 1320 TPD. Maximum availability for WtE plant during lifecycle is considered as 125% of initial quantity.

As per the terms of concession agreement, provision can be made to process MSW quantity in excess of the obligated quantity based on growth potential of MSW availability. Processing plant capacity is therefore selected as 1650 TPD considering the growth potential.

03.03 Waste Characteristics

Tata Consulting Engineers (TCE) have conducted elaborate sample analysis of wastes generated in Guntur cluster as a part of preparation of DPRs for overall Solid Waste Management in ULBs. DPRs updated in October 2016 are available on the website of Swachh Andhra Corporation. For Guntur and Vijaywada samples were analysed in May-June 2015 and exercise was repeated in November- December 2015.

Following are the highlights of the results complied by TCE :

1. Moisture level in waste from different areas:
    - Waste collected from commercial area has 18 – 20 % moisture.
    - Waste from markets (Vegetable & Fish) contains moisture from 47 to 58 %
    - Waste from residential areas is around 30%

2. Average Moisture level in mixed waste at Dump yards:
    - Ajit Singh Nagar – Vijaywada : 30.1%
    - Jakampudi – Vijaywada : 31.4%
    - Etikuru Transfer Station – Guntur : 30.1%
    - Naidupeta Dump Yard – Guntur : 31.4%

3. Calorific Value of MSW :

    - For Vijaywada the calorific value of the waste is in the range of 1024 – 1892 Kcal/ kg. The average calorific value is 1400 Kcal/ Kg. Highest calorific value was in commercial area, whereas, lowest in vegetable and mutton market waste. Calorific value at dumping sites was in the range of 1400 Kcal/Kg.
    - For Guntur the calorific value of the waste is in the range of 946 – 1620 Kcal/ kg. The average calorific vale is 1304 Kcal/ Kg. Highest calorific value was in

commercial area, whereas, lowest in vegetable and mutton market waste. Calorific value at dumping sites was in the range of 1272 Kcal/Kg.

TCE have estimated that after source segregation of waste is implemented GCV above 2000 Kcal/Kg can be achieved at both places.

In view of the above, for the purpose of calculations following assumptions have been made in the Report :

- Moisture level in mixed waste : 30 – 40 %
- Moisture reduction during processing to RDF : 18% (Leachate + Evaporation)
- Net weight of RDF available for boilers is taken after removal of moisture, inerts and recyclables as presented in Annexure 10.1 of financial chapters.
- GCV of MSW in 2015 – 1325 Kcal/Kg
- Improvement in GCV of waste 1% per year.
- Cap on the value of GCV of RDF feed to boiler : 2100 Kcal/Kg to be on conservative side.
- Sensitivity analysis is also carried out assuming no increase in GCV over years.

Seasonal variations are possible wherein moisture in waste is higher than average in rainy season. Excess moisture will get removed during processing as leachate. This will not effect the GCV of RDF feed to boilers.

Extracts from Report by TCE are presented below.

TATA CONSULTING ENGINEERS LIMITED

TATA

Table 13: Chemical Analysis of MSW – Vijayawada Municipal Corporation

S.No	TEST PARAMETERS	TEST METHOD	UNITS	Commercial & Institutional Area		Dumpsites		Household Waste						Vegetables, Fish & Mutton Market	
				Commercial waste - 1	Commercial waste - 2	Jakampudi	Ajit Singh Nagar	HIG-01	HIG-02	MIG-01	MIG-02	LIG-01	LIG-02	Vegtable Market Waste	Fish Market Waste
1	Moisture	ASTM D5231	%	19.2	18	31.4	30.1	26.8	28.2	27.1	29.8	30.6	28.2	58.2	48.9
2	Ash Content	ASTM D5231	%	33	27	28	29.3	30	25	24	25	22	28	24	29
3	Total Volatile Content (LOI)	ASTM D5231	%	32	33	31.2	31.8	34	33	32	31	38	33	34	27
4	Total Organic Carbon (TOC)	ASTM D5231	%	17	22	19.8	22.9	22	26	22	25	24	22	23	22
5	Phosphorus	ASTM D5231	%	0.8	1.2	1	0.9	0.8	1	0.9	0.1	0.4	0.5	0.8	0.6
6	Sulphur	ASTM D5231	%	0.7	1	0.9	1	0.7	0.8	1.1	1.2	0.8	1	1	1.2
7	Chloride	ASTM D5231	%	0.07	0.07	0.08	0.08	0.12	0.11	0.09	0.09	0.07	0.08	0.18	0.1
8	Calorific Value	ASTM D5231	K. cal/kg	1720	1892	1432	1396	1564	1368	1474	1390	1344	1256	1024	1102
9	Iron (Fe)	ASTM D5231	mg/kg	1.56	1.66	1.22	1.86	1.34	1.52	1.99	1.88	1.08	1.09	1.04	0.42
10	Arsenic (As)	ASTM D5231	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
11	Sellenium (Se)	ASTM D5231	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
12	Nickel (Ni)	ASTM D5231	mg/kg	2	2	1	1	6	3	8	10	34	38	3	1
13	Zinc (Zn)	ASTM D5231	mg/kg	18	21	31	28	53	24	46	37	26	29	34	21
14	Cadmium (Cd)	ASTM D5231	mg/kg	4.3	4.6	4.9	4.1	2.4	2.1	1.8	2.2	2.1	1.9	1.1	0.2
15	Copper (Cu)	ASTM D5231	mg/kg	8	10	15	12	14	11	10	13	11	12	11	15
16	Chromium (Cr)	ASTM D5231	mg/kg	4	5	2	2	9	5	9	10	6	5	4	6
17	Lead (Pb)	ASTM D5231	mg/kg	6.6	5.8	9.8	7.6	3.7	4.6	4.1	3.9	3.5	2.8	0.7	0.8
18	Mercury (Hg)	ASTM D5231	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1

Table 3-8: Chemical Analysis of MSW – Guntur Municipal Corporation

S.No	TEST PARAMETERS	TEST METHOD	UNITS	Commercial & Institutional Area		Dumpsites		Household Waste						Vegetables, Fish & Mutton Market	
				Commercial waste - 1	Commercial waste - 2	Naidupeta	Etikuru TS	HIG-01	HIG-02	MIG-01	MIG-02	LIG-01	LIG-02	Vegtable Market Waste	Fish Market Waste
1	Moisture	ASTM D5231	%	19.2	18	31.4	30.1	26.8	28.2	27.1	29.8	30.6	28.2	56.6	47.3
2	Ash Content	ASTM D5231	%	33	27	28	29.3	30	25	24	25	22	28	24	29
3	Total Volatile Content (LOI)	ASTM D5231	%	32	33	31.2	31.8	34	33	32	31	38	33	34	27
4	Total Organic Carbon (TOC)	ASTM D5231	%	17	22	19.8	22.9	22	26	22	25	24	22	23	22
5	Phosphorus	ASTM D5231	%	0.8	1.2	1	0.9	0.8	1	0.9	0.1	0.4	0.5	0.8	0.6
6	Sulphur	ASTM D5231	%	0.7	1	0.9	1	0.7	0.8	1.1	1.2	0.8	1	1	1.2
7	Chloride	ASTM D5231	%	0.07	0.07	0.08	0.08	0.12	0.11	0.09	0.09	0.07	0.08	0.18	0.1
8	Calorific Value	ASTM D5231	K. cal/kg	1502	1620	1256	1288	1424	1398	1380	1421	1329	1248	1080	946
9	Iron (Fe)	ASTM D5231	mg/kg	1.56	1.66	1.22	1.86	1.34	1.52	1.99	1.88	1.08	1.09	1.04	0.42
10	Arsenic (As)	ASTM D5231	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
11	Sellenium (Se)	ASTM D5231	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
12	Nickel (Ni)	ASTM D5231	mg/kg	2	2	1	1	6	3	8	10	34	38	3	1
13	Zinc (Zn)	ASTM D5231	mg/kg	18	21	31	28	53	24	46	37	26	29	34	21
14	Cadmium (Cd)	ASTM D5231	mg/kg	3.6	3.8	5.4	4.9	2.1	2.6	2.4	2.7	3	2.6	1.3	1.1
15	Copper (Cu)	ASTM D5231	mg/kg	8	10	15	12	14	11	10	13	11	12	11	15
16	Chromium (Cr)	ASTM D5231	mg/kg	4	5	2	2	9	5	9	10	6	5	4	6
17	Lead (Pb)	ASTM D5231	mg/kg	5.2	5.4	6.8	5.9	4.6	4.2	4.7	4.1	3.9	4.2	0.6	0.9
18	Mercury (Hg)	ASTM D5231	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1

03.04 Technological Options For Waste To Energy Projects

Rule No. 21.1 of SWM Rules 2016 defines the Criteria for waste to energy process as:

"*Non recyclable waste having calorific value of 1500 Kcal/kg or more shall not be disposed of on landfills and shall only be utilised for generating energy either or through refuse derived fuel or by giving away as feed stock for preparing refuse derived fuel. "*

Chapter 3.3 of MSW Management Manual states:

Waste to energy (WtE) refers to the process of generating energy in the form of heat or electricity from MSW. Energy from MSW can be achieved through:

1. *thermal processes like incineration or combustion of refuse derived fuel(RDF); and*
2. *biological processes like bio methanation and further conversion into electrical power or automotive fuel (compressed biogas).*

In addition to the above, Gasification and Plasma technologies for recovery of energy from waste are also available. However, these are not fully mature and are also capital intensive.

All WtE facilities require some degree of pre-processing of MSW leading to what is commonly known as refuse derived fuel (RDF). The quality requirement of RDF for different WtE technologies is illustrated in the following Table 8.

Table 8: Quality Parameters of RDF for WtE Processes

Parameters	Requirement			
	Bio-methanation	**Combustion**	**Gasification**	**Plasma**
Moisture	>50%	<30%	<20%	<10%
Volatile/ organic	>40%	>40%	>40%	>40%
Fixed carbon	<15%	NA	<15%	<15%
Total inert	<5%	<20%	<10%	<10%
GCV (kcal/kg)	NA	>1,200	>2,000	>2,000
C/N ratio	25-30	NA	NA	NA

As seen from the characteristics of the waste available, Bio-methanation is not recommended due to low C/N ratio. Waste is suitable for conversion to RDF and further disposal or combustion for production of electrical energy.

As per the criteria laid down in MSW Management Manual Power Production by incineration of waste is suitable when supply of waste is stable and amount to be processed is at least 500 TPD. Minimum LCV of 1450 kcal/kg and minimum yearly average LCV of 1700 kcal/kg is recommended. In view of this Guntur project qualifies for Power Production using MSW after processing to produce RDF which will have higher LCV than mixed MSW.

Participating ULBs in Guntur-Vijaywada cluster have a goal that the MSW management system shall be a 'model system' for the country, which would scientifically collect, transport, process and dispose of MSW, have maximum recycling and recovery, and create public awareness.

As per scope defined in Concession Agreement the technology adopted for WtE facility which shall ensure:

- the Non- biodegradable and recyclable content of the MSW are separated through a suitable Material Recovery Facility (the "MRF");
- a suitable technology is used for Processing of the bio-degradable content of the MSW;
- a suitable technology is used for Processing of combustible content of the MSW
- a suitable technology is used for, recovering and processing recyclable content of the MSW,
- not more than 25% of the MSW received at the Processing Facility is disposed off in the Scientific Landfill.
- not less than 2% of waste measured at Processing Output Weighbridge shall be disposed off in the Scientific Landfill

To meet the requirements of SWM Rules and MSW Management Manual, and Concession Agreement following technological consideration are made:

- Processing of mixed MSW in Material Recovery Facility using suitable technology for separation of recyclables and inerts for disposal and making MSW suitable for incineration.
- Selection of furnace which ensures stable and continuous operation and complete burnout of waste and flue gases using MSW as fuel.
- Flue gas emissions must meet the CPCB norms and standard referred in Schedule – II of SWM Rules-2016
- Leachate disposal and standards for compost produced incidental to the RDF production process should also meet the requirements of the SWM Rules.

03.05 Material Recovery Facility

Mixed MSW received at WtE facility has high level of moisture content and composition is also heterogeneous in terms of content and size. Raw waste also contains metals and inerts in various sizes in addition to finer organic matter. The processing of MSW involves segregation of material into following components:

- Inert material for disposal to landfills;
- Recyclable including metals for disposal by sale;
- Fine compostable material converted into stable compost for sale; and
- Processed MSW for use in Boilers of Power Plant.

Mechanical Segregation process is suitable only when moisture level is reduced and material is no longer sticky. Most of the equipments used in RDF manufacturing plants have relatively long performance track records in different types of industrial applications. Even then, these equipments including the ones imported from highly developed countries seem to have failed to perform in an integrated manner in the various RDF facilities installed in the country.

The DST TIFAC technology follows more or less similar process. This involves the conversion of MSW into RDF through homogenization, size reduction, drying and segregation. Hot air dryers, conveyors, feeders, rotary screens, etc are used in the process. Process is in use at some of the installations in the country. However, several operational and maintenance constraints are faced due to high level of moisture. Hot air generators used for drying also are to be designed for RDF fuel. Most of plants using this process are facing operation and maintenace problems due to high level of moisture and hetrogenous waste material.

JUIL has been successfully operating WtE plant at Okhla by partially drying the MSW using bio-drying process followed by mechanical segregation to the extent required.

Boilers selected are having combusion system suitable for wide variations in fuel cheracteristics. Threfore production of dry RDF as input to boilers is not essential.

The proposed project has been designed based on bio-drying followed by pre-processing required to make MSW suitable as feed to the combustion based power generation plant having 15 MW Power Generation Capacity with a margin of 20% to take cate of future availability and quality of waste.

Process Flow Diagram for the Material Recovery Facility proposed is shown in Drawing No. 1636-002 Sh 01 enclosed with Report.

Processing of MSW :

Municipal Solid Waste (MSW) arriving at the facility in trucks will be weighed in weigh bridge and unloaded into MSW storage pits near the Tipping floor. Tipping floor will be elevated up for effective unloading of waste. Tipping floor will have four gates to enable dump trucks to unload material in to storage pit.

EOT crane with orange peel type grab will move the received material to storage heaps after addition on inoculums to accelerate bio digestion of organic material. Periodic shuffling of material will allow moisture to settle down and get removed from pit bottom as leachate.

Initially mesophilic bacteria is added which oxidizes carbon to CO_2, which liberates large amount of heat. Temperature up to 50^oC is reached within 2 days. After this, thermophilic bacteria is added due to which temperature rises to 65^oC, thus releasing CO_2, moisture etc. Moisture reduction leads to free flowability of waste and loosening of material for easy separation and shredding.

Partially dried material can be fed to hopper for mechanical segregation for removal of inerts and fines. Unacceptable material can also be separated manually from conveyor system.

Mechanical Segregation:

After manual sorting, conveyors feed the material to Mechanical separator. Magnetic separator is installed to remove the ferrous scrap before feeding.

Ballistic separator performs screening action as well as gravity separation segregates the waste into following fractions:

- Fines below 10mm size : these contain digested organic matter and are sent to compost section for further curing and completion of composting process.
- Material above 80-100 mm size is retained on top screen and is sent to shredder for size reduction.
- Middle fraction (10 to 100mm) is feed for the boiler which is transported to Boiler Feed storage. EOT crane with grab will make separate heap ang also feed the stored material in to feed hoppers of boilers.
- Heavy inert material is separated by gravity/ inertia separation and is fed to inert material conveyor for disposal.

Output from shredder and coconut crusher is also mixed with boiler feed.

Ballistic Separator & Shredder Commissioned at Okhla

03.06 Combustion & Steam Generation

Mass Incineration of unprocessed waste has been the most commonly used technology for WtE projects globally. More than 500 such projects are operating in USA, Europe, China and many other countries. However, this is suitable where MSW is pre segregated at source itself.

Different types of combustion technologies such as travelling grate, reciprocating grate, reciprocating forward feed grate and circulating fluidised bed have been used globally including in India. Travelling grate is the lowest cost option and simple to operate. However, it requires fuel to be of consistent quality having low level of moisture and inert and relatively higher GCV. This technology was used in some projects in India but has not been able to perform resulting in closure of those projects as has been reported in the planning commission report. Few projects have been set up recently in India on circulating fluidised bed technology. This technology is fairly versatile and can accept low grade fuel with varying consistencies. However, feeding low bulk density fuel such as RDF in a pressurised furnace has remained a major challenge resulting in unstable operation of these projects.

The figure below illustrates a typical configuration of a well-designed and environment friendly power project based on MSW fuel.

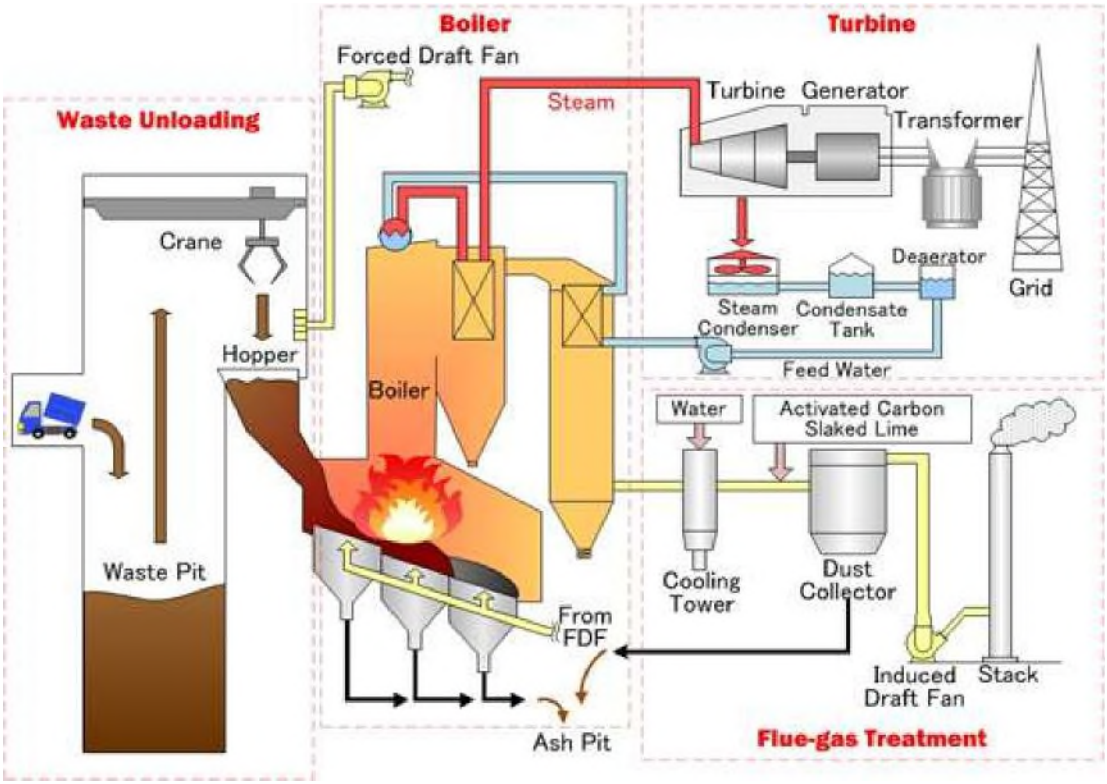


Figure- 10: Schematic –Combustion & air pollution control

Reciprocating forward feed grate has performed most successfully in WtE projects under different fuel conditions all over the world. RDF is slowly propelled through the combustion chamber (furnace) by a hydro- mechanically actuated grate. Fuel continuously enters one end of the furnace and ash is continuously discharged at the other after going through several to and fro movement within the chamber. The plant is configured to enable complete combustion as RDF moves through the furnace. Process conditions are controlled to optimize the feed moisture by steam heated air pre-heaters and control the residence time of the fuel in the furnace for complete combustion. Boilers are provided with sophisticated instrument, control and monitoring system to ensure stable operation of the furnace all the time. These include cameras for flame monitoring and temperature gauges for the various sections in the boiler.

The cost of this technology is high. But until other cheaper alternatives are technically proven under Indian operating conditions, this remains the best option for sustainable performance of WtE projects.

03.07 Flue Gas Treatment

Pollution from WtE projects remain a area of high concern both for the regulators and society at large. There is high level of dissatisfaction with the current status of waste management in India. At the same time, there are also apprehensions about likely environmental fall out from the better alternative of WtE projects. Combustion based projects are considered one of the most environment friendly technology provided due care is taken for control of air pollution. Air pollution control technology has been developed to take care of all concerns through elaborate arrangement of multi stage treatment and control and monitoring system.

Provisions are made in the design of the combustion system of boilers to minimize the level of pollutants present in the flue gas coming out of the boiler. Further treatment is required to bring the levels below the prescribed values as per SWM Rules and CPCB norms. Since norms become stringent over a period of time, care is to be taken to select treatment section so that future requirements are also met without much modifications.

Flow Diagram for Combustion boiler and Flue Gas Treatment is shown in Drg. No. 1639-002 Sh02

The flue gas treatment system consisting of lime and activated carbon injection system, quenching chamber and reaction tower followed by bag filters ensure total compliance with the most stringent regulation anywhere in the world. Process control for the flue gas treatment facility consists of three loops, in which the first loop continuously controls the flow of re-circulated absorbent to the reactor by continuously monitoring the quantity of flue gas. The second loop is controlled by a

temperature measurement of the outlet gas, which ensures that the flue gas is cooled down by controlling the quantity of water sprayed. The third loop is used to control the adding quantity of lime milk through acid gases (HCl, SO2) of the outlet loop. Flue gas flowing out from the reactor then goes into the bag filter removal of micro particles including hazardous substances. The purified flue gas is discharged by ID fan and vented into the atmosphere. The number of components and their footprints and quite large, requiring large amount of land area. Both capital and operating costs are fairly high and have to be specifically factored for financial viability analysis of such projects.

03.08 Ash Handling

Combustion of RDF produces fly ash and bottom ash, just as is the case when coal is burnt. The total amount of ash produced by municipal solid waste combustion ranges from 4 to 10% by volume and 15–20% by weight of the original quantity of waste and the fly ash amounts to about 10–20% of the total ash. Volume reduction of MSW by upto 90% is possible with combustion plants, thereby almost eliminating the requirement of landfill.

03.09 Odor Pollution Control

Odor pollution can be a problem with old-style plants, but odors and dust are extremely well controlled in newer WtE plants. They receive and store the waste in an enclosed area with a negative pressure with the airflow being routed through the boiler which prevents unpleasant odors from escaping into the atmosphere. However, not all plants are implemented this way, resulting in inconveniences in the locality.

03.010 Effluent Treatment

Effluent is generated due to draining of leachate from the waste bins and waste water from air pollution control and cooling water system. Technology is available for minimising the water requirement in various processes and recycling the waste after treatment for applications such as floor washing, gardening and ash quenching.
Bulk quantity of leachate collected is recycled for compost curing process. Balance is treated and only treated water is used as service water.

03.011 Power Generation

Rankine Steam Cycle is used for power generation. Efficiency of the Rankine cycle depends upon the pressure and temperature of the superheated steam. With a view to contain the corrosion impact at higher temperatures, steam temperature for RDF power plants is maintained at around 400^{o}C.

JUIL has successfully implemented the 16 MW WtE project based on reciprocating forward feed grate and Rankine technology at their Okhla plant. The project has been operating at desired PLF level since then.

Proposed configuration for this project will ensure that the fuel (RDF) quality available for combustion in boilers using bio drying process will be better than the fuel used in existing Okhla plant resulting in efficient operation as well as better availability of plant for power generation.

More detailed description has been provided at Chapter 4 of the report including proposed flow diagrams for each process.

04 SELECTION OF PLANT & EQUIPMENT

04.01 General

The project consists of the following main units:

MSW Receipt

- Weigh bridge
- Tipping Floor

Material Recovery Facility

- Bio Drying Section
- Material Segregation

Power Plant

- Boiler including auxiliaries
- Air pollution control system
- Ash handling and Disposal
- Turbo generator
- Condensing plant

Balance of Plant

- Water system
- Compressed air system
- Electrical system
- Control & instrumentation system
- HVAC
- Fire fighting
- Effluent treatment
- Environment monitoring system
- Sanitary Landfill

04.02 Material Receipt

04.02.1 Weigh Bridges

Two weigh bridges (1-input & 1-output) of minimum 40 tons weighing capacity will be installed on approach road from main vehicle entry gate to the material recovery facility. Salient features of the weigh bridges proposed are:

- Recording facility for complete details of vehicles using close circuit cameras.
- Platform scales have the capability of accurately measuring tare and net weights of range of vehicles.
- Recording facility for tare, gross and net weight and volume of each consignment.
- Computerized system for billing and tracking vehicle movement.
- The weigh bridge will be a permanent structure furnished with appropriate space to maintain and operate the computerized weight recording system, store historical records and have sufficient room for two weigh bridge operators.
- Maintain an electronic database for each delivery with time stamp and provide a print out of the specifications and details for each consignment received at the Project Site with provision for on line monitoring and transmission of data.

Table 9: Technical requirements Weigh-bridge

Weigh-bridge type	: Electronic type with load cells
Material handled	: MSW trucks, compactors and other vehicles
Weigh-bridge capacity	: 40 MT
Accuracy	: + 5 kg
Weigh-bridge construction	: Pit less with approach ramps on both sides and non-skid type steel plates
Platform size	: 9m x 3m
No. of load cells for weighing	: Minimum four number
Nominal load	: 23 MT per load cell
Max. load without damage	: 150% of rated capacity
Destructive load	: 225% of rated capacity
Weighing console	: Microprocessor based with suitable memory device for storing data of 90day with 250 trucks per day transactions.
Area classification	: Safe
Corrosion Allowance for fabricated items	: 3mm
Material of Construction	: IS 2062, for fabricated structure / component
Control Console Room	: The console shall be provided on suitable table with the operator chair at a convenient location in the control room. The control room shall also be provided with window air- conditioner(s). UPS for 2 h. rating, required for the system shall be supplied.
Design Standard:	Indian Standard IS-1436 (1991): Weighbridges – Specification IS-9281 Part 1 of 4 (1979) : Specification for Electronic Weighing System

Weighbridges shall conform to the Indian Standards for Weights and Measures certified by statutory authorities.

04.02.2 Tipping floor

MSW shall be delivered at the plant premises by respective ULBs. Each truck carrying the municipal solid waste will be visually inspected before it goes to a weighbridge. If the MSW vehicle contains a high percentage of unwanted materials, then it shall not be accepted in the plant. After weighing , the trucks will proceed to the tipping floor, where the driver unloads the waste in the designated dumping pit . This tipping floor is elevated for effective unloading of waste in to the pit.

Sufficient quantity of decomposing microbial cultures (inoculums & sanitizer) will be inoculated at this point with sprayer to reduce odor and enhance digestion process.

04.03 Material Recovery Facility

It has been estimated that about 1,326 t/d waste would be available in 2018, the first year of operation of the proposed WtE project at Guntur. Considering the committed quantity at 125%, the fuel preparatory system has been designed for 1,650t/d. The details of the system and components are described as follows.

Material recovery facility consists of MSW unloading, manual / mechanical segregation and shredding. Processing of waste will be done in the 2 shifts (16 hours) and one shift will be for maintenance and cleaning of processing section. Equipment sizing will be done accordingly to handle the waste in this stipulated time. Proper redundancy will be designed for critical equipment's to reduce the breakdown time.

The detailed process flow and material balance diagram for MRF is included as Drawing No. 1636-002 Sh.04

04.03.1 MSW Pits

There will be a common pit for receipt and Storage of MSW. MSW will be stored in heaps for moisture removal. Hoppers will be provided to feed the material to MRF and segregated material will also return to same pit. Separate heaps will be made for storage of processed MSW for charging in to boiler feed hoppers.
Area including tipping floor and pit will be in a closed shed with adequate provision of natural lighting. Air from shed will be sucked by Primary air fans of the boilers to create a negative pressure in pit so that foul smell does not affect the surroundings.

Two EOT (Electric Overhead Travel) cranes with orange peel grab will be provided for handling of material.

04.03.2 Manual & Mechanical Segregation

Manual Segregation:

Dried material is fed by grab crane with 8 m^3 capacity grab into hopper (FH-1). Hydraulically operated Ram feeder feeds the wide horizontal conveyors (BC-1). Manual sorting will be done on conveyor platform. Large items and Inerts are manually sorted and loaded on to conveyor (BC-2) and discharged at one end of conveyor into a collecting open bin for subsequent disposal by pay-loaders and dumpers.

Mechanical Segregation:

After manual sorting, the material moves through the Magnetic separator installed above horizontal conveyors (BC-1) to remove the ferrous scrap before feeding into the Ballistic Separator.

The Ballistic Separator performs screening action as well as gravity separation and segregates the waste into following fractions:

- Material above 100 mm size is retained on top screen and is sent to shredder for size reduction.
- Heavy inert material and coconut shells are separated by gravity and fed to conveyor BC-3. Two chutes are attached at the end of BC-3 conveyor. The conveyor profile suggested is such that it separates inerts and coconut shells by virtue of its inertia. The heavier inerts fall into the first chute while coconut shells, which constitute a large fraction of waste, will be separated due to inertia gained by rolling action and discharged into a separate bin placed below the second chute. These will be fed manually to coconut crusher.
- Fines below 6 mm size contain digested organic matter and are discharged onto conveyor BC-4. This conveyor discharges the material at the delivery end into a heap.

- Middle fraction (6 to 100mm) is Processed MSW which is transported to storage pit for Boiler Feed via conveyor (BC-5), (BC-7) & (BC-8).

Each Ballistic separator has its own shredder. The shredder will shred +100 mm fraction. The output of the shredders will be fed onto the conveyor BC-6 and BC-6 will feed material to conveyor BC-7 which will feeds material to conveyor BC-8 which further discharges the material and make heap in the boiler feed storage pit.

04.03.3 Disposal of Rejected Material

All rejected materials are sent to landfill sites through vehicles. The weighbridge operator weighs the tare vehicle as well as loaded vehicle after the rejected material is loaded.

04.03.4 Overall Parameters of MRF

MSW received from Municipal Corporations is heterogeneous and its characteristics change with source of collection, season and other factors. MRF is to be designed to take care of wide variation in quality of waste.

Estimated physical characteristics of MSW to be considered for design are as follows:

- Inert Material : ~20%
- Metals : < 0.5 %
- Sand & fine soil : ~ 1 %
- Moisture : 20-40 %

Table 10: Capacity of Material Recovery Facility

Handling capacity of MRF	TPD	1650
Number of parallel streams	No.	1(Working)+1(Future)
Handling capacity of each stream	TPH	50
Operating Hours for each stream	Per day	~16
Capacity of common conveyor for Boiler Feed	TPH	100

Table 11: List of equipment for Material Recovery Facility

Equipment	Quantity
Feeding Hoppers	1
Ram Feeders complete with hydraulic arrangement.	2 nos. (Working in tandem)
Magnetic Separator	1
Ferrous Material Bin	1 for manual sorting belt at discharge of magnetic separator.

Equipment	Quantity
Ballistic Separator	1
Shredder	1
Belt Conveyors	8
Structure	1 Lot (Open gantries with both side walkway, trestles and transfer tower for belt conveyor.)
Chutes	All interconnecting chutes

Table 12: List of Belt Conveyors for Material Recovery Facility

Purpose	Quantity
Horizontal Feed Conveyor (BC-1)	1
Rejects Conveyor from manual sorting (BC-2)	1
Ballistic Separator discharge to Inert Conveyor (BC-3)	1
Ballistic Separator discharge to fines Conveyor (BC-4)	1
Ballistic Separator discharge to Boiler feed Conveyor	
1 (BC-5)	
Shredder discharge to Fuel Conveyor (BC-6)	1
Fuel Conveyor (BC-7)	1
Processed MSW Conveyor (BC-8) to Boiler Feed	
1 Storage Pit	

Broad specifications of equipments for Material Recovery Facility

The broad specification of the material recovery facility equipments is summarized in the Table 13 below.

Table 13: Broad specifications of equipments for MRF

Equipment	Specifications
Belt Conveyor	Belt: Suitable design width e.g. 1,500mm/1,200mm/1,000mm/800mm/600mm/500mm, 3 ply 8 mm thick, rubberized M-24 grade Covers: MS sheet 4 mm and 14 SWG Gear box: Reputed make Support: Steel fabricated Foundation: RCC block / structural steel support Drive: Electrical drive Input Material: MSW
Ballistic Separator	Separation into 3 fractions (-10mm, 10-100mm & +100mm) Input Material: MSW Capacity: 40t/h MOC : Fabricated from MS, heavy duty Angle adjustment : 10-25°
Magnetic Separator	Permanent Magnetic Inline Separators made with powerful Strontium Ferrite magnets Manufactured to suit conveyor width Working depth: up to 300mm Drive [kW]: 1.5
Shredder	Power [kW]: Vendor to Specify Hydraulic power [kW]: Vendor to Specify Dia Rotor [mm]: 1,000 Rotor speed [rpm]: 0 - 35 Throughput* [t/h]: ~ 30 Input Material: MSW

Equipment	Specifications
	MOC : Fabricated from MS, heavy duty
Hopper	MOC : Fabricated from MS plate with suitable supports
EOT Crane	Type : Double Girder box type Type of application : For lifting and carrying of MSW Class of duty: Class II (medium duty) Standards: The crane to be designed in accordance with the latest editions of IS 807 and IS 3177 and other relevant standards Location : indoor Height of lift : 30 m (approx) Span : 30m (approx) Bay length : 100 m Speeds: Hoisting/lowering : 40 m/min for Processed MSW storage Cross travel : 60 m/min (approx) Long Travel : 80 m/min (approx) Bridge Girder: Double Girder Box type fabricated out of MS in one piece plate as per IS – 2062
Grab bucket	Input Material: MSW Capacity:8 cum Type: Cactus type MOC : Fabricated from MS, heavy duty Class Of Duty: up to Class IV(M8), Extra Heavy Duty Design Standard: IS : 3177/IS : 807 Grab Working Cycle: Opening 8 to 10 seconds

04.04 Power Plant

04.04.1 Boilers including auxiliaries

Reciprocating forward feed type technology has been selected as this has been proven under Indian condition and versatility in terms of fuel quality. Steam requirement has been computed by developing heat and mass balance (HMBD, included as Drawing No. 1639-001 Sh 05). Two number boilers with RDF throughput equivalent of 600 t/d MSW each has been considered. This would help in reducing the project cost (standard module) and improving operational reliability taking into account the periodic stoppages required for cleaning of boilers operating on biomass fuels. The following three parameters have been taken onto account while carrying out basic engineering design of the boilers:

- Air temperature for combustion
- GCV of the fuel
- Exit flue gas temperature

Boiler combustion system would be designed to operate on RDF of GCV ranging of 1,100 to 2,000 kcal/kg. This would ensure operation sustainability even under uneven drying conditions, fire safety of the RDF plant and storage bin and safety of the reciprocating grate. The grate has three sections, first one for drying, followed by combustion & the last for conveyance of ash. Provision has been made for supply of pre-heated air to take care of flame stability under varying moisture content in the RDF fuel. This would ensure maintenance of appropriate furnace condition ensuring output, efficiency and environment performance all the time.

Heat & Mass Balance for steam system is given in Drawing No. 1639-002 Sh. 5

04.04.2 Auxiliary fuel and firing System:

There shall be a dedicated oil firing system for each boiler, these burner system comprises set of start-up and auxiliary burners. The main purposes of these burners are:

Start-up burner, it will support during refractory dry out for gradually heat up the furnace during start-up for drying and baking of the refractory lining. This system is also used to start the boiler from cold condition for preheating (if necessary) of the furnace during normal start up procedure of the furnace.

Auxiliary burner

- The auxiliary burners have been designed to maintain the required temperature and retention time.

- These burners are used during startup and shutdown condition to achieve certain combustion temperature in controlled way when there is no fuel so as to avoid any damage in installation due to sudden temperature variations.

There is limit of flue gas exit temperature (190^0 C) from the perspective of reaction in SNCR. This limits the waste heat recovery potential in the air pre-heater. Further, it is very difficult to control the temperature of pre-heated air in an air pre-heater. It has therefore, been considered necessary to install steam heated air pre-heater (SCAPH). Two-stage SCAPH-the 1^{st} one based on low pressure steam from bleed of STG and the 2^{nd} one from high pressure saturated steam from steam drum, with appropriate control system would be used. This would help in regulating the final temperature of air as per requirement of the boiler corresponding to the moisture level in the RDF and at the same time optimize the overall thermo-dynamic efficiency of the system along with sustainable environment performance.

Broad specification of the boiler is tabulated below:

Table 14: Specification of the boilers

Description	UOM	Parameters
No of Boiler	No's	2
MSW Handling capacity	TPD	1200 (2 X 600)
Maximum MSW Handling Capacity	TPD	1600
Rated Steam Generation Capacity	T/Hr	51.29
Design Pressure	Kg/Cm2	53
Rated Steam Temperature	Deg.C	400
Heating surface Area	M2	7124
Boiler Efficiency	%	83

Table 15: Boiler Auxiliaries

Particulars	Description
De-aerator	Common for both boilers
Boiler feed water pump	2W+1S, for two boilers with VFD control
PA fan	1W+1S, for each boiler with VFD control
SA fan	1W+1S, for each boiler with VFD control
ID fan	1W+1S, for each boiler with VFD control
FGCS	Two set, one each for each boiler
SCAPH	LP & HP SCAPH in cascade for each boiler

04.04.3 Flue gas pollution control

Sources of pollution & potential impact

In addition to particulates, certain harmful chemicals can get generated from solid waste during the process of combustion that requires treatment/removal to prevent their harmful impact on human health and environment in general.

Sulphur dioxide (SO_2), hydrogen chloride (HCl), hydrogen Fluoride (HF) and nitrogen oxides (NOx) are acid gases. Solutions of acid gases and water have a low pH-value, thus acidic, and can have negative impacts on vegetation. Acidic gases released into atmosphere are converted into sulphuric acid, hydrochloric acid and nitric acid as they dissolve in water droplets and precipitate onto soil and into water basins. Emission of acidic gases can result in acid rain impacting vast amounts of vegetation and areas of the natural habitat by acidification. The deposition of acid gases can also have corrosive effects on buildings.

Sulphur dioxide (SO_2) health concerns include effects on the respiratory system. People with asthma or bronchitis are most vulnerable to these adverse health effects. Combustion processes that lead to high concentrations of sulphur dioxide (SO_2) generally also lead to the formation of sulphur trioxide (SO_3). This in turn leads to the formation of fine sulphate aerosol particles in the atmosphere, imposing health risks, as they penetrate into the lungs and over time causing potential respiratory disease. Hydrogen chloride (HCl) is gaseous and forms hydrochloric acid when in contact with humidity or water droplets and deposit on to the ground. Flue gas treatment measures to reduce sulphur dioxide (SO_2) emissions also lead to a significant reduction in hydrogen chloride (HCl) emissions.

Exposure to highly concentrated hydrogen chloride (HCl) may affect human health; causing throat irritation and in extreme cases severe swelling of the throat. Inhalation of hydrogen chloride (HCl) can also lead to asthma. However, hydrogen chloride (HCl) at normal background levels is unlikely to have any adverse impacts on human wellbeing.

The components nitric oxide (NO) and nitrogen dioxide (NO_2) are together termed nitrogen oxides (NOx), because over time nitric oxide (NO) is transformed into nitrogen dioxide (NO_2).Nitrogen dioxide (NO_2) can contribute significantly to the formation of ozone near ground level and contribute to the formation of photochemical smog. Excess ozone (O_3) concentrations are believed to cause increased respiratory symptoms and asthma. Nitrogen dioxide (NO_2) is in itself toxic and reacts with ammonia, moisture, and other compounds to form small particles. The health effects of nitrogen dioxide (NO_2) are similar to that of sulphur oxides. Other oxides of nitrogen include nitrous oxide (N_2O). Nitrous oxide (N_2O) is not a direct hazard to health, but a greenhouse gas with a significant global warming potential.

Ammonia (NH_3) is a volatile gaseous component originating as excess from the injection of ammonia water or urea in the nitrogen oxide (NO_x) cleaning processes. Ammonia (NH_3) deposition to ground has effects on biological conditions through nitrification.

Heavy metals are metallic elements with a greater density than iron and are generally of environmental concern. These metals, with the exception of mercury (Hg), are released in their oxidized form during combustion. They are discharged from the plant with either boiler bottom ash, fly ash or the residual FGT products. Heavy metals from fly ash can leach into a watery phase and thereby enter the environment. Therefore, fly ash is sent to safe/hazardous landfills.

Mercury (Hg) is the most prominent heavy metal and a naturally occurring element that is found in air, water and soil. The tendency of mercury to stick to fly ash particles is low. Mercury (Hg) may have toxic effects on the nervous system and organs. Even at low concentrations mercury (Hg) can cause serious health problems and is a threat to the child development. Human activity is the main cause of mercury release. Once in the environment mercury (Hg) can be accumulated in the food chain. Mercury must be specially taken care of in the flue gas treatment plant, either by application of activated lignite coke as an adsorbent or by absorption in an acidic reactor.

Organic compounds, as a rule, are only generated when there is incomplete combustion e.g. lack of combustion air or insufficient combustion temperatures. Organic compounds are molecules that contain carbon (C) and typically hydrogen (H), oxygen (O) and other elements. Simple molecules like carbon dioxide (CO_2) are regarded as inorganic, whereas methane (CH_4) is classified as organic. Organic molecules can form long molecule chains, rings, and combinations hereof. A well-known class of such molecules are polycyclic aromatic hydrocarbons (PAH´s) which

can be toxic and can influence hormonal balance. Organic compounds and PAH´s are unlikely to form or survive under normal combustion conditions.

Dioxins and furans are highly toxic and relatively stable organic compounds with a polycyclic structure. The presence of chloride (Cl) is a precondition for the formulation of dioxins. During typical waste combustion processes dioxins and furans can get generated in the boiler in trace amounts under certain furnace conditions and mostly segregated and conveyed away with fly ash. In the FGT dioxins are further reduced by injection of activated carbon or lignite coke or alternatively by catalytic reduction. Dioxins entering the environment are persistent pollutants and can accumulate in the food chain, mainly in the fatty tissue of animals. Dioxins can cause reproductive and development problems, damage to the immune system, interfere with hormones and also cause cancer. Human exposure is mainly through food consumption, thus food supply is monitored by relevant agencies/organisations to detect concentrations and prevent human consumption.

Particulate matter and dust mainly originates as fly ash from the combustion process. The introduction of powdery reagents and reaction products in FGT plants also adds to particulate matter presence in the flue gas. Particulate filters limit particulate matter and dust emissions from incinerators. The absence of a particle filter at an incinerator would result in a dark exhaust plume from the stack.

There are various technologies for the reduction depending upon the type of the emissions level required & emissions available.

Pollution control

Prevention of generation of hazardous chemicals by maintaining proper and stable furnace operating conditions followed by installation of state of art emission control technology have been adopted for control of emission. Fuel processing section has been designed to maintain fairly consistent with GCV of fed fuel to the boiler. The reciprocating forward feed type technology with fully automatic combustion control system has been selected to maintain the furnace operating condition. This would ensure that minimum temperature of 850 ^{0}C is always maintained in the combustion chamber and with a gas residence time not less than 2 (two) seconds. Reciprocating movement of the burning fuel mass and supply of proper quantity of preheated air would ensure complete combustion maintaining total organic carbon (TOC) content in the slag and bottom ashes less than 3%, or their loss on ignition at less than 5% of the dry weight.

Various technologies have been developed for flue gas emission control taking into account the potential formation of such chemicals due occasional operational instability. A comparative assessment of these technologies is illustrated in the following table.

Table 16: Comparative evaluation-emission control technologies

Evaluation particulars	Dry	Bi-carbonate	Semi-dry	Combined (wet & dry)	Wet
Operational reliability					
Performance history of reliable operation	II I	III	III	II	II
Capability					
Ability to handle changes in raw gas composition	I	II	II	III	III
Flexibility					
Ability to meet more stringent future emission limit	I	I	II	III	III
Health and safety					
Reduced contact with hazardous material	II	III	II	II	II
Sensitivity to local conditions					
Limited plume visibility	II I	III	III	I	I
Discharge of treated waste water	N/A	N/A	N/A	N/A	I
Other environmental issues					
Low chemical consumption	I	III	II	III	III
Low electricity consumption	II I	III	III	II	II
Low residue production	I	III	II	III	III

The semi-dry FGT system is the most attractive option wherein reactant is sprayed in slurry form in place of dry powder. A wet flue gas treatment system can reduce some emission limits to lower levels. However, this system produces effluent requiring treatment at the plant and its discharge as wastewater.

However, it is recommended to go with semi-wet type of system.

'Advanced' SNCR systems can achieve NO_x emission guarantees of around 100 mg /Nm^3. This corresponds to 50% of the current daily average emission limit set in the IED. SCR systems can reduce NO_x emissions to 25 mg NO_x/Nm^3 or lower. Air quality modelling should consider the emission limits that can be achieved with SNCR 100 and SCR systems to facilitate an informed consultation and decision on the de-NO_x system choice. Furthermore, financial considerations should also form part of the decision making process.

The key components of the combined system, flue gas and material flows together with conditions such as typical flue gas temperatures at various stages of the plant are shown in the following figure.

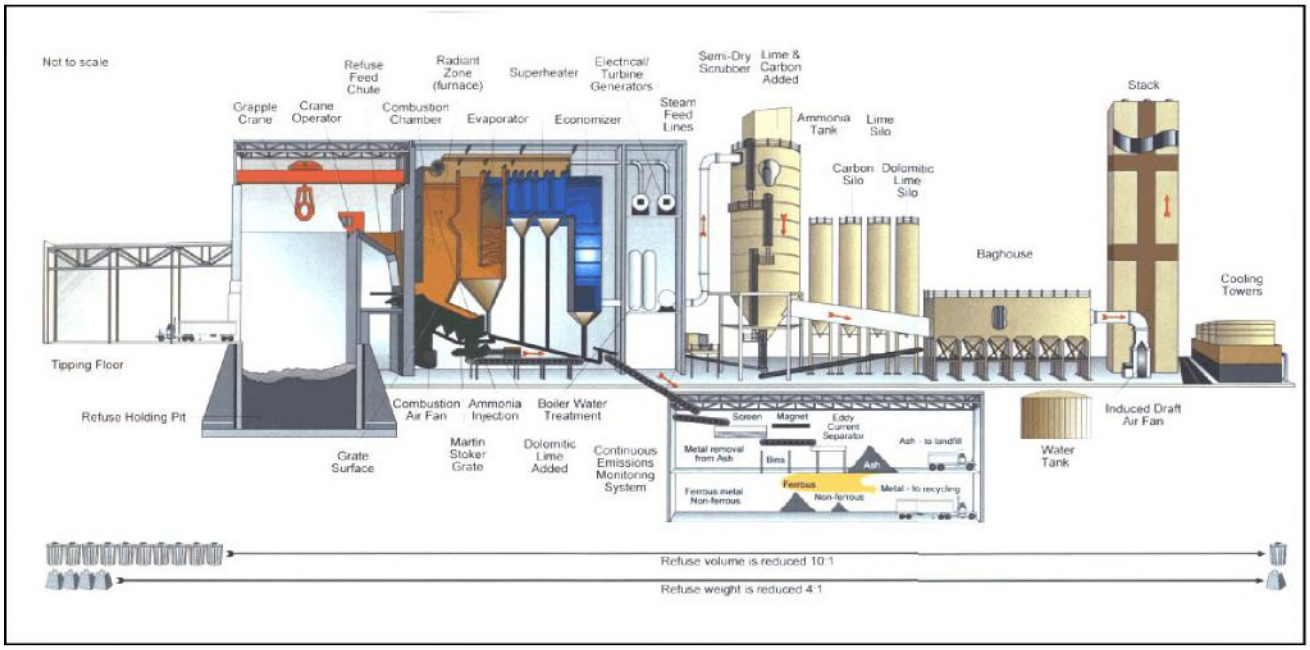


Figure- 11: General Process for Emission Control System

The system consists essentially of the following major components:

- Flue Gas System inlet Duct
- Reactor and Product Recirculation System
- Bag House Filter
- Sorbent Handling System
- End Product Handling System
- Process Water System
- Auxiliary Systems (Compressed Air System, Nitrogen Inerting System)

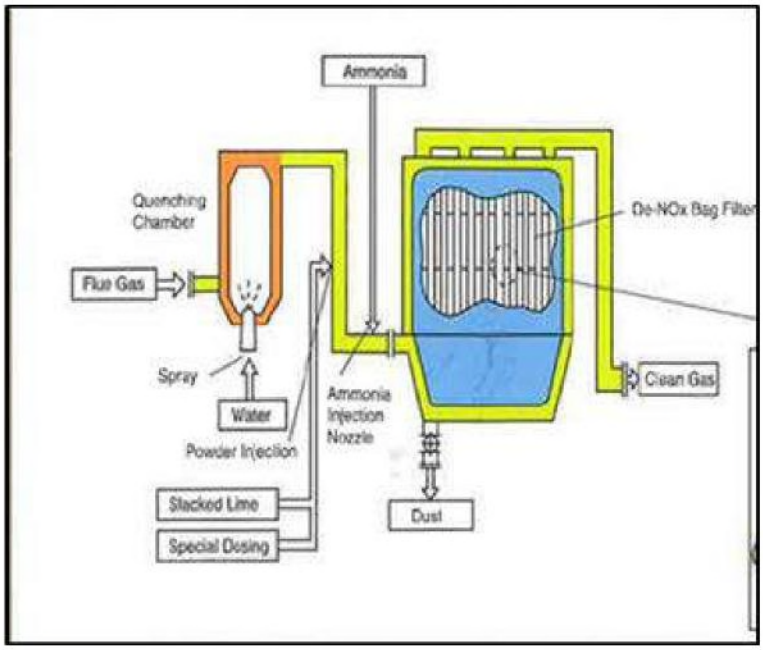


Figure- 12: Flue Gas Treatment Process Flow

Outlet emissions are monitored through sophisticated continuous emission measuring instruments. The system measures following parameters: CO_2, HCI, NO, NO_x, O_2, SO_x and SPM. Gas temperature and the pressure are also analysed continuously to regulate the dosing of sorbents. However, all other parameters would be monitored on weekly basis.

By means of the Reactor and the externally circulating fluidized bed it is possible to adjust extremely long solids retention times which enhance the pollutant collection efficiency and the utilization of the sorbent. Besides this fact the good effectiveness of the process is obtained by a high-turbulent flow of the solids in the Reactor and by the resulting maximum mass and heat transfer.

Dioxins/Furans and Mercury removal by adsorption

The control of the dioxins/furans and heavy metals – especially mercury – is performed by means of adsorption on pulverized activated carbon (HOC). The HOC is injected into the Reactor together with the slaked lime.

Due to the high specific surface of the adsorbents combined with an ideal pore size distribution the HOC-dust excellently removes the above mentioned pollutants. An adequate residence time for the adsorption of the pollutants is available due to the entrained flow phase within the Reactor and the filter cake on the filter bag surface and due to the external recirculation of the whole sorbent. As the flue gas penetrate this homogeneous layer at the filter bags from the outside to the inside, heavy metals, dioxins/furans and traces of the acid gas components are physically and chemically adsorbed and thus removed from the flue gas. The particulate pollutants are removed using the bag house filter.

The effectiveness of the selected pollution control technology has been very well established in the 16 MW WtE TOWMCL project as would be seen from the monitoring result compared against the norm below.

Table 17: Emission norms as per CPCB, MoEF

Parameters	Unit	Emission standard	TOWMCL Okhla Plant	Sampling Duration
Particulate matter	mg/Nm^3	50	30	30 min
HCl	mg/Nm^3	50	30	30 min
SO_2	mg/Nm^3	200	100	30 min
CO	mg/Nm^3	100 50	100	30 min Standard refers to daily average value
Total organic carbon	mg/Nm^3	20	20	30 min
HF	mg/Nm^3	4	4	30 min
NOx	mg/Nm^3	400	350	30 min
Total dioxins & furans	$ngTEQ/Nm^3$	0.1	0.1	6-8 hours sampling
Cd +Th + their compounds	mg/Nm^3	0.05	0.05	2 hours
Hg and its compounds	mg/Nm^3	0.05	0.05	2 hours
Sb + As + Pb + Cr + Co + Cu + Mn + Ni + V+ their compounds	mg/Nm^3	0.5	0.5	2 hours

04.04.4 Ash Handling & Disposal

Inerts are partially removed in the MRF processing plant. Balance amount of inert present in the RDF along with inherent ash in various combustible materials would constitute the total ash content in the fuel fed to the boilers. The generated ash in the boiler would be in two forms-bed ash and fly ash. Bed ash is discharged by the grate to the ash system designed for the purpose. Fly ash is formed by the fine inert and product of combustion carried away by the flue gas.

The fly ash content ranges from 20 to 25% of the total ash depending upon the separation efficiency of the ballistic separator in the processing plant. Accordingly, the estimates for the bottom and fly ashes are as shown below.

Table 18: Ash generation

Particular	Unit	Value
Fuel	t/d	1,100
Ash	%	19.25
Ash	t/d	212
Bottom ash	t/d	168
Fly ash	t/d	44

Bottom ash from grate & ash form the bank & economizer is hot & generally water quenched, whereas the ash form the flue gas handling is conveyed to the silo by dense phase pneumatic conveying system. Considering the fly ash from bank & economizer is assumed to 50%, same is used to compute the following capacities.

Table 19: Ash handling capacity

Particulars	Unit	Value
Ash extractor	t/d	200.00
Bed ash temperature	0c	800.00
Temperature of discharge	0c	35.00
Water required	t/h	2.93
Factor of margin	%	20.00
Water required	t/h	3.50
Vibrating conveyor	t/d	280.00

Water is required for the ash quenching. It is proposed to utilize treated effluent for the same with a view to achieve the set objective of zero discharge from the plant.

Table 20: Water requirement for ash quenching

Particulars	Unit	Value
Average temperature of ash	0c	800.00
Temperature of discharge	0c	35.00
Water required	t/h	2.93
Factor of margin	%	20.00
Water required	t/h	3.50
Available water from treated effluent	t/h	4.50

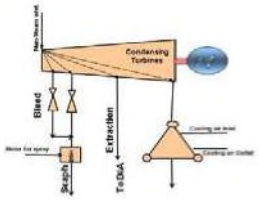
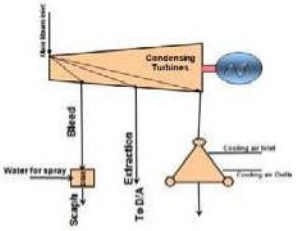
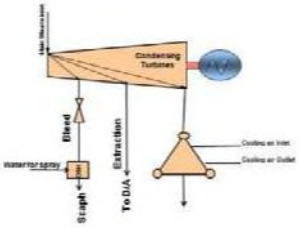
The entire requirement of ash quenching water will be met from effluent. The quenched ash would be discharged into vibratory conveyors for onward disposal. Fly ash is conveyed to the silo by a pneumatic system, which has been proven to be the best option. It is transported out from the silo for onward processing/disposal (landfill/ brick manufacture).

04.04.5 Turbo-generator

Turbo-generators convert the thermal energy of steam into mechanical work (Turbine) & then convert the mechanical energy to the electricity (Alternator). Depending upon the size of the machine and operating parameters, the alternator can be either directly coupled to the turbine or mechanically connected through a gear box in between, later is mostly the case in case of smaller capacity machines such as the ones for WtE projects.

High pressure steam is admitted into the chamber of the turbine and then expanded in fixed and moving nozzles depending upon the turbine configuration. During the process of expansion (adiabatic in ideal case), the nozzles/blades thermal energy is converted into mechanical work. Low pressure steam at the end of the expansion can be either extracted for processes and/or preheating of feed water for improving the overall thermodynamic efficiency of the plant or condensed directly at lowest possible pressure (related to the absolute atmospheric pressure) for generating maximum power from the available steam. Steam is required in the WtE plant for the SCAPH as well as feed water de-aerator. This steam can be extracted from the turbine under different modes, the relative merits and demerits are as shown in the following table.

Table 21: Comparative of bleed & extraction

Design consideration	Extraction (Wander bleed)	Controlled Extraction	Uncontrolled extraction
Most efficient load range	50-80%	80-100%	Design Set point
Generally preferred	Process is important. Power production is not so important.	Constant pressure at outlet at all loads range.	Where steam pressure & temperature at outlet is not so relevant to process.
Controlling	HP steam bleed taken into account at low load, where as the MP steam bleed is taken at full load	Pressure is constant but outlet temperature varies, as isentropic efficiency varies with load.	No controlling- as the outlet temperature & pressure is the function of the load.
Used	Mainly for process rather than power generation.	Where constant pressure & temperature is required.	Where the steam parameters can vary with load.
Overall STG efficiency	Moderate	High	Function of steam properties at design point.
Schematic Representation			

As stated above, maintaining outlet air temperature from the SCAPH is vital for stable operation of the boilers. Temperature of the steam from the bleed from the turbine would fluctuate with load making it difficult to control the air temperature. Maintaining de-aerator temperature on the other hand would be possible with bleed steam under all conditions. Wander bleed (extraction) provides the compromise solution. The turbine has been accordingly configured so that both the operational requirement of the SCAPH and overall performance requirement are optimally met.

Table 22: Specifications of turbine

Description	UOM	Parameters
Steam Handling Capacity	T/Hr	102.23
Design Pressure	Kg/Cm2	52.38
Temperature	Deg.C	395
Power Generation	MW	15
Turbine speed	rpm	6850
Exhaust Pressure	Kg/Cm2	0.185
Exhaust Flow	TPH	79.474

Table 23: Specifications of Alternator

Parameters	Unit	Value
Codes and standard		IS/IEC
Design ambient temperature	°C	50.00
Design relative humidity	%	60.00
Frequency	Hz	50 (-5% to+3%)
Generating voltage	kV	11±10%
Quantity	No.	1.00
Rating	MVA	18.75
Power factor		0.80 (lag)
No. of phases	No.	3
Speed	rpm	1500
No of Poles	No.	4
Short circuit ratio		> 0.50
Connection		Star
Insulation type		Class F for both rotor and stator
Temperature rise		Class B for both rotor and stator
Excitation type		Brush less excitation
Cooling method		CACW
Control Panel		AVR (2A +2M), Synchronizing panel , Generator Relay and Metering Panel, LASC&PT Panel, NGR Panel

Table 24: Specifications of Gear box

Parameters	UOM	Value/ Description
Standard		AGMA 2
Efficiency	%	>98%

04.04.6 Condensing Plant

High pressure steam is expanded in the turbine and condensed in the condenser at the lowest possible pressure for extracting maximum possible work from the thermal energy contained in the steam. Generally the water cooled condensers are most favourable for condensing steam. Hot water is cooled by the cooling tower & heat is rejected to atmosphere by evaporation of water. Thus over the time span the concentration of the salt level in the cooling water sump increases. This requires periodic blow down to maintain the concentration of total dissolved solids (TDS) within limit. Higher concentration of the TDS in circulating water will lead to the scaling on the surface of condenser thus decreasing the performance. TDS in the circulating water is normally not allowed to exceed the range of 2,500-3,000 ppm for circuiting water. The amount of blow down is governed by the concentration of the dissolved salts in the make-up water. It is proposed to use the sewage water/ bore well water for the power generation. As per experience of past projects that treatment cost of the water with high TDS levels for use in the cooling tower becomes techno-economically nonviable. The comparative evaluation of water system compared for air cooled condenser (ACC) and water cooled condenser (WCC) which is shown in the following table.

Table 25: Comparison between ACC & WCC

Particulars	ACC	WCC
Cooling media	Air	Water
Vacuum at STG exhaust	>0.17	>0.10
System efficiency	Lower	higher
Application	Scarcity of water	Abundant water
	High treatment cost of water (Sewage water/ Bore well with high TDS)	Water quality good
Investment	High	Low
Operating cost	Low	High
Auxiliary power	Low	High

Table 26: Water requirement

Parameters	ACC	WCC
Cooling tower water make up (t/d)	200	2,980
Effluent (t/d)	~100	833
Effluent TDS (ppm)	3,200	3,800

In past projects it has been studied that the life cycle costing for similar type of the water properties yields more attractive for air cooled condenser than water cooled condenser. It is therefore, proposed to deploy ACC for the project. The specification of the ACC has been developed as shown in the following table.

Table 27: Specifications of Air Cooled Condenser

Description	UOM	Parameters
No of Fan	No's	6
Fan Dia	mm	11085
Finned Area	M2	174574
Fan Motor Capacity	KW	130
Flow	TPH	80
Rated Pressure	Kg/Cm2	0.18
Design Ambient Temperature	Deg.C	42
Exhaust Steam Temperature	Deg.C	57.4
K Bundles	No's	40
D Bundle	No's	8

Different types of fins are available for ACC. The comparative analysis is tabulated below:

Table 28: Comparatives-ACC types

Criteria	KL Type	Extruded Type	G-Type
Corrosion	Tube Protected against corrosion	Tube protected against corrosion	Provides perfect fit between fin & tube
Vibration	Resistant against vibration	Fins have extra rigidity	Comparatively Lower
Thermal Performance	High thermal performance and stress resistance with atmospheric corrosion protection	Heat transfer remains constant	Varies have comparative less performance than other
Temperature Operation	KL can be replaced by any other type of fins (Can be used up to 320^{0}C)	Can be used up to 300^{0}C	Can be used up to 400^{0}C

As it can be seen from the table that the KL type of fins are more corrosion resistant, having high thermal performance & resistant against vibration. Considering all above points it KL option has been recommended.

The auxiliary power required for MRF processing facility and the power plant have been estimated at about 1100 kW and 1500 kW respectively constituting about 7.5% for MRF and 10%for power plant. The processing plant has been designed to operate only for 16 hour a day. Therefore the plant would consume about 17.5% as auxiliary for 16 hour and 10% for rest 8 hour. Accordingly peak power export would be at 13.5 MW. With a view to determine the exportable power the overall auxiliary consumption has been computed as follows.

Table 29: Requirement of Auxiliary power

Particulars	Unit	Value
Power generation	MW	15.00
Only power plant operation	H	8.00
Process operation	H	16.00
Only power plant auxiliary load	%	10.00
Power plant auxiliary load only	MW	1.50
Energy required for only power plant operation	MWh/d	12.00
Auxiliary load when process is in operation	%	17.50
Power required during hours when process is in operation	MW	2.63
Energy required during process operation	MWh/d	42.00
Auxiliary average during 24 hours	%	15.00
Auxiliary power average during 24 hours	MW	2.25
Energy required	MWh/d	54.00

04.05 Balance Of Plant

04.05.1 Water Systems

Water is required in a power plant for different applications; largest requirement is for cooling followed by other processes including boiler and smaller quantity for drinking and sanitation. Natural water can be used for cooling but it is preferable to use soft water for maintaining high cycle efficiency of the power plant. Demineralised water is required as make up for boiler feed whereas specifications of drinking water are as per the standard laid down for the same.

The detailed water balance diagram is included as Drawing No. 1639-002 Sh.7

The quantitative and treatment requirement are primarily governed by availability and quality of the raw water. Properties of the raw water at the project site as per test report are tabulated below:

Table 30: Water properties

Particulars details	Unit	Raw Water Quality
(Treated Water STP)		
Total Suspended solid (TSS)	mg/l	200.0
Total Dissolved Solids (TDS)	mg/l	1200.0
Calcium (as Ca)	mg/l	78.0
P.Alkalinity (as $CaCO_3$)	mg/l	21.2
Total Alkalinity (as $CaCO_3$)	mg/l	500.0
Nitrate (as NO_3)	mg/l	12.0
sulphate (as SO_4)	mg/l	124.0
Sodium as Na	mg/l	174.0
Iron (as Fe)	mg/l	1.76
Zinc (as Zn)	mg/l	< 1.0
Chloride (as Cl)	mg/l	250.0
Chemical Oxygen demand (COD)	mg/l	250.0

Particulars details	Unit	Raw Water Quality
Biochemical Oxygen Demand (BOD)	mg/l	50.0
Dissolved Oxygen	mg/l	5.9
Bore Well Water		
pH		7.03
Total Dissolved Solids at 105^0C	mg/l	2574
Chlorides	mg/l	1080
Total Hardness as CaC03	mg/l	1072
Nitrates as NO3	mg/l	Traces
Iron as Fe	mg/l	Nil

(Bore well data for Guntur is as per Sample at Naidupeta Dump Yard)

TDS concentration in Bore well water is high and yield of water from bore wells is also low. STP at Guntur is located about 25 km from the project site, however, Guntur Municipal Corporation has assured that water will be made available at a point near to the project location.

Water Requirement

For the purpose of this report treated water available from STP is taken as input. Total requirement of water for the project is estimated as 324 m3/day as per water balance.

It would be desirable to soften the water required for make up in the auxiliary cooling tower. The capacity of the auxiliary cooling tower has been computed at 350 m^3/h assuming 10% design margin. The specification for the same is as presented in the following table.

Table 31: Parameters of Cooling tower

Particulars	Unit	Value/ Remarks
Flow	m^3/h	350
Cells	No.	2
Type		Induced draft counter flow
Fills		PVC
Basin		RCC
Fans		With VFD & angle control
Temperature of hot water inlet to cooling tower	0_C	42
Temperature of cold water outlet of cooling tower	0_C	32
Dew Point	0_C	23
Wet bulb	0_C	28
Range	0_C	10
Approach	0_C	4

Accordingly the broad requirement of the clariflocculator, softening and DM water plant has been computed as shown in the following tables.

Table 32: Specifications of Clariflocculator plant

Particulars	Unit	Value
Capacity	t/d	324
Hardness inlet	PPM	200
TDS inlet	PPM	1200
TSS	PPM	200
BOD	PPM	250
COD	PPM	50
BOD outlet	PPM	< 10
COD outlet	PPM	<20
TSS	PPM	< 50

Table 33: Specification of Softening plant

Particulars	Unit	Value
Capacity	t/d	230
Hardness inlet	Ppm	200
Hardness outlet	Ppm	<10
TDS inlet	Ppm	1200

DM water system would consist of Primary sand filter-*Activated carbon filter -* Ultra-filtration-* reverse osmosis-* De-gases-* De-mineralized plant

Table 34: Parameters for DM Plant

Particulars	Unit	Value
Capacity	t/h	10.0
Hardness inlet	ppm	200
Hardness outlet	ppm	Nil
TDS inlet	ppm	1500
TDS outlet	ppm	<0.20
TSS	ppm	Nil

Flow Diagram for water treatment is shown in Drawing No. 1639-002 Sh06

04.05.2 Compressed Air System

Compressed air is required for services such as pneumatic ash handling system and for instrumentation. The requirement of compressed air has been calculated based on normative consumption and proposed configuration of the project.

Table 35: Compressed air requirement (Nm3/h

Applications	Instrument air	Service air
Boilers	205	378
Flue gas cleaning system	200	1100
STG set	15	-
Air cooled condenser	20	-
Ash handling system	15	150
Others BOPs and actuators	12	15
Sum Total	467	1534
Design at 15% margin	650	1725

The quality requirement for the service and instrument air is different as shown in the following table.

Table 36: Quality requirement for Compressed air

Particulars	Unit	Service air	Instrument air
Moisture content	Dryness [^{0}C]	Saturated	-40.0
Oil content	ppm	<2	< 0.0003
Minimum pressure	kgf/cm^2	6.5	8.5

It is proposed to install common compressors to supply both instrument and service air. The dryer and filters will be used only for the quantity of air required for Instruments application. For rest of the air, dryers and filters will be bypassed. This air will be used for meeting the requirement of conveying air and service air.

The total air required is 2,380 Nm^3/h considering the standard capacities; we propose to install 3 x 800 Nm^3/h screw type compressors (2W+1S) along with VFD. The compressed air system would include all the required ancillaries such as filters, coolers, dryers, receivers and electrical and instrument and control system.
Flow Diagram for water treatment is shown in Drawing No. 1639-002 Sh08

04.05.3 HVAC System

The temperature and RH to be maintained in various areas of the plant is as follows:

Table 37 : Design Temperature & RH for premises.

Area	DBT °C	RH
Control room and other rooms with electronic equipments	23 ± 1	50 ± 5
UPS &battery charger	24 ± 1	50 ± 5
Operational staff/ administrative rooms	24 ± 1	30 -70
Variable Frequency Drive (VFD) panel room	26 ± 1	30 -70
Switchgear room	25 ± 1	

The main plant control room housing the controls for the boiler and the turbo-generators shall be air conditioned with packaged air conditioners (using chilled water). The condenser plant and other buildings shall be provided with suitable exhaust fans of heavy duty, to ensure heat dissipation and effective ventilation for maintaining a dust free atmosphere. The offices, local control rooms in material sorting facility area and CEMS area will be facilitated with split air conditioner of suitable size. The WTP area will be covered using ceiling fans. The design basis for HVAC system is as shown Table 38:

Table 38: Design basis for HVAC system

Duty type	Type of Construction	Equipments / Systems	Area (m^2)	Recommended HVAC system	Approximate Quantity & Size
Ventilation with heat load	Closed RCC Hall	STG Hall	400	Venturi extractor	12 Nos x 500 m^3/h
Sub cooling with electronics heat load	Closed RCC Hall	Control Room, VFD Drive Room, DCS & PLC room	390	Vapour-compression and absorption chillers	1 x 90 TR (screw compressor)
Ventilation with lower heat load	Closed RCC Hall	Electrical panel, PCC & MCC area	200	Exhaust fans	07 No. x 1000 m^3/h
Ventilation with dust collection	Open Area	Ash Handling, Boiler House	-	Not required	-
Sub cooling	Closed RCC	Offices	40	Split air conditioner	4 No. x2 TR
Ventilation without heat load	Closed RCC	Material Recovery Facility	-	To be covered by the PA suction	-
Sub cooling with electronics heat load	Closed RCC	Local Grab Control Room (4 No.)	15 (each)	Split air conditioner	4 No. x 1.5 TR
Ventilation with lower heat load	Shed	Local Compost Control Room (2 No.)	15 (each)	Ceiling fans	2
Ventilation with lower heat load	Shed	Local MRF Control Room (2 No.)	15 (each)	Ceiling fans	2
Sub cooling with electronics heat load	Closed RCC	Local Grab Control Room for MRF pit (2 No.)	15 (each)	Split air conditioner	2 No. x 1.5 TR
Sub cooling with electronics heat load	Closed RCC	CEMS	6	Split air conditioner	1 No. x 1.5 TR
Ventilation with lower heat load	Shed Area	WTP Control Room	40	Ceiling fans	8

04.05.4 Fire-fighting System

The fire extinguishing system would consist of the following sub systems:

- Hydrant System
- Spray Water System
    - High Velocity water spray system
    - Medium velocity water spray system
- Hand Appliances System
- Sprinkler System

The hydrant system contains a header pipeline that covers the overall plant and also the hydrants categorized as Fire escape hydrants, single hydrants and water monitors.

The spray system would be deployed for the electrical equipments, specifically the high velocity water spray system for transformer and medium velocity water spray system for all the conveyors.

Number of hand operated portable devices would be housed all around the plant as per requirement of TAC.

Sprinkler System shall include the following:

1. Galvanized iron class C(heavy class) main sprinkler distribution piping complete with welded, forged steel fittings, supports, hangers all required accessories.
2. Installation control valves drain valve, test valve and all connecting pipes and fittings
3. Sprinkler head, nozzles and spare sprinklers.
4. Connection to riser, pumps and appliances.
5. Sprinklers, pump, motors, Control panels, Air vessels, cabling, instruments and accessories etc.

Operation of fire extinguishing system shall be semi-automatic. A common pressurized fire water header would be installed for the Hydrant system, Spray System and sprinkler system. The constant pressure is maintained in fire water header through Jockey pumps.

As per TAC rule no. 7.2.3, grass, hay, fodder, chaff, biomass fuel is coming in the category of High Hazard Occupancy Sub category "A". We have assumed RDF similar to above mentioned fuels therefore RDF area can be considered in High Hazard Occupancy Sub category "A". According to TAC 7.2.1 rest of the plant area can be considered in Light Hazard Occupancy. Accordingly, the broad capacity of the fire fighting system has been worked out as follows.

Table 39: Fire Fighting System

Description	Unit	Values
Main fire pump electrical driven		
No of Pumps	No.	1.0
Size	m^3/h	273.0
Diesel engine driven fire pump		
No of Pumps	No.	1.0
Size	m^3/h	273.0
Jockey pump		
No of Pumps	No.	1.0
Size	m^3/h	16.8

Pump House configuration is shown in Drawing No. 1639-002 Sh. 09

04.05.5 Effluent Treatment

Effluent is generated from three main sources:

1. Drain from cooling tower
2. Reject & back wash from water treatment section
3. Leachate from the windrow section

As the TDS of raw water is quite high thus it is recommend installing the air cooled condenser. There will be small cooling tower for auxiliaries.

Reject from the back wash of the equipment's in water treatment section & continuous reject from RO is collected in the tank, Blow down of the cooling tower is also collected in the same tank (Central monitoring basin).

There is net generation of the approximately 151 t/d of effluent from cooling tower & WTP section, with TDS level varying from 500 to as high as 8,400 ppm. Same is mixed in tank where the TDS is diluted to around 4045 ppm.

As TDS is quite high thus same cannot be discharged into water body, effluent can be used in the plant for the various applications like ash quenching, washing, service water, horticulture, etc, this will consume the effluent on the other hand will reduce the fresh water consumption, thus same is having dual advantage. Effluent generation and balance is shown in figure 13 below :

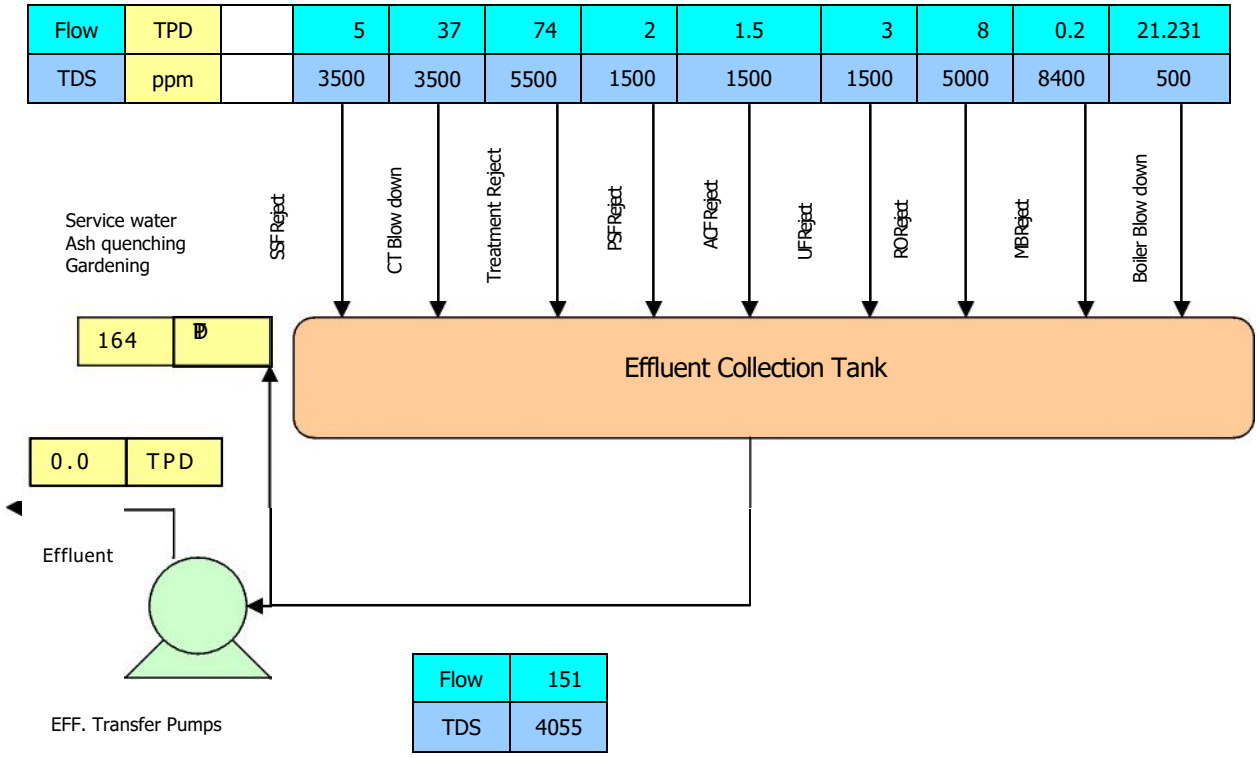


Figure- 13: Effluent Generation & Balance

Leachate is produced in the windrow section in (MRF Island); same is computed to vary in range of 3-5% on the mass of the fuel (MSW). Same is function of the climate also. Leachate collected can be pumped & sprinkled onto the composting section as same has the organic fraction in the water is also required for the composting. Thus this will be zero emission as we are completely utilizing the effluent & reducing the raw water.

04.05.6 Leachate Management

Leachate is the water-based complex liquid, comprising of innumerable organic and inorganic compounds, which percolates through landfills and accumulates at the bottom. The water from inherent moisture of the decomposing waste and also due to precipitation subsequently moves through the waste deposit collecting the leached chemicals thereby forming leachate. Leachate contains a host of chemicals that may be

toxic to both humans and environment. Also, the high Bio-chemical Oxygen Demand (BOD) of leachate makes its treatment inevitable.

Leachate when escapes to nearby environment poses an enormous threat to the groundwater and surface water contamination hence making the process of Leachate Management exceptionally critical.

While the characteristic of leachate depends considerably on the waste deposit, age of the landfill, temperature and moisture content, it is significantly concentrated in terms of toxic chemicals and thus the treatment of leachate becomes crucial in preventing the high-risk contamination.

Composting Leachate:

Composting of carbonaceous waste produces additional water along with a wide range of other gases including methane, carbon dioxide and a complex mixture of organic acids, aldehydes, alcohols and simple sugars, which dissolve in the leachate.

Although the chemicals present in leachate generated from open-air composting are not present in concentrations toxic to human, but the treatment is still necessary to avoid the contamination of water sources.

Composting leachate majorly consists of two contaminants- Ammonia and dissolved organic compounds, measured as Chemical Oxygen Demand (COD), both of which proves to be virulent to the aquatic organisms present in the water bodies by reducing the dissolved oxygen to levels inappreciable for their survival.

Table 40: Characteristics of leachate generated from composting waste

Sl.No.	Parameters	Unit	Value in Compost Leachate	Standards for discharge in a stream
1.	pH		6	6-9
2.	COD	(mg/l)	37,556	400
3.	BOD_5 at 20°C	(mg/l)	13,336	20
4.	Ammonium nitrate (NH^+_4-N)	(mg/l)	14,678	50
5.	Total Suspended Solids (TSS)	(mg/l)	5,634	50
6.	Oil & Grease	(mg/l)	77.9	5
7	Adsorbable Organic Halogens (AOX)			0.50
8	Poly Aromatic Hydrocarbons (PAH) each			0.059
9	Benzene			0.14
10	Toluene			0.08
11	Xylene (sum of o,m, p-xylene)			0.32

Leachate management follows the hierarchal procedure comprising of;

a) Leachate Avoidance: by keeping the compost as dry as possible.

b) Leachate Minimization: by re-circulating the leachate onto the composting heap.

c) Leachate Collection & Treatment: by incorporating proper drainage system to collect the leachate from the bottom and efficiently treating to comply with the standards before disposing the treated liquid waste into streams.

Leachate Treatment

a) Liners: The geo-membrane liners are preferably placed underneath the composting heap which prevents the escape of leachate to outer environment by offering low

permeability. Liners are also placed over the heap during monsoons to minimize infiltration of water due to precipitation.

b) Drainage System: The leachate drainage system is responsible for the collection and transport of the leachate collected inside the liner. Leachate collection systems are installed above the liner and usually consist of a piping system sloped to drain to a central collection point where a pump is located. The pipes and conduits must be captive of bearing the load they are subjected to, since they are placed beneath the composting heap.

c) Leachate Treatment Plant: Based upon the analyzed characteristics of the leachate collected, the treatment units are provided.

Treatment Process

a) Influent Leachate Storage Tank: For collecting and storing the leachate generated. Helps in flow equalization and allows controlled flow of leachate per treatment cycle.

b) Mesh Screens: Removes unwanted solid particles that may cause clogging of the drainage system and also leads to wear & tear of further treatment units.

c) Oil & Grease Trap: Efficient removal of oil & grease produced from decomposing organic matter.

d) Moving Bed Biofilm Reactor: The inoculums are added after studying the characteristic of leachate to be treated. The bacteria/activated sludge grow on the internal surface of the carriers. The bacteria break down the organic matter from the waste water. The aeration system keeps the carriers with activated sludge in motion. Only the extra amount of bacteria growth, the excess sludge

will come separate from the carriers and will flow with the treated water towards the final separator.

Blowers: aids biological growth and facilitate waste reduction.

e) Secondary Clarifier: Here, the supernatant treated water is collected and stored in the sump tank, while the settled sludge received in the hopper attached at the bottom of the clarifier is to the sludge drying beds.

f) Sump Tank: temporarily stores the water and provides further aeration via blower.

g) Carbon filter and Sand Filter: Provides proper filtration from any unwanted particles.

h) Sludge Disposal: Sludge containing the carriers is dried at the sludge drying beds and used as manure for gardening.

The treated water is re-circulated by spraying onto the composting heap in order to maintain its moisture content. Thus, the treatment plant becomes a Zero Discharge Unit.

04.05.7 Environment Monitoring System

The flue gas measurement and monitoring is required for meeting the pollution control board's requirement and also for operation / control of the plant. Central Pollution Control Board has formulated guidelines for flue gas emissions in various kinds of industries. The flue gas measurement and monitoring should meet the CPCB's guidelines and standards. As per CPCB guidelines, below table gives the frequency of monitoring for various parameters for Common Hazardous Waste Inclinator plant:-

Table 41: Flue gas monitoring parameters

Parameters	Location	Frequency
Temperature	Stack emission	Continuous
Carbon Monoxide	Stack emission	Continuous
Excess Oxygen	Economizer outlet, Stack emission	Continuous
Total Particulate Matter	Stack emission	Continuous
HCl emission	Stack emission	Continuous
SO_2	Stack emission	Continuous
NO_x	Stack emission	Continuous
HF emission	Stack emission	Quarterly
Mercury	Stack emission	Quarterly
Heavy metals	Stack emission	Quarterly
Dioxins and Furans	Stack emission	Quarterly

Note: - The above requirement is as per the CPCB's Guidelines for Common Hazardous Waste Incineration, Doc. No. HAZWAMS/---/2010-2011 (May 24, 2010).

The stack is equipped with a Continuous Emission Monitoring System (CEMS). The CEMS will be installed at a sufficiently high level in the stack to assure an even flue gas flow at the monitoring point.

Equipment for measuring gaseous components is installed in an analyser room near to the measurement platform (extractive measurements). Equipment for measuring the flow, dust, pressure, temperature, HCL, H_2O and NH_3 will be installed in situ in/on the flue.

Sampling platform shall be provided as per CPCB norms to collect stack samples from the chimney for monitoring the air pollutants, as and when required. Access shall be provided, online, to see the continuous monitoring data by the local regulatory Board/ Committee and annual environmental report giving complete details of operation &

compliance with regulatory requirements need to be published and made available to the public.

There is a laboratory service inside the plant boundary which follows ISO 9000 and other similar standards. The lab shall be well-equipped for monitoring and analysis of environmental parameters for air quality, meteorology, water, wastewater, noise, groundwater, MSW characterization study, GCV testing of MSW & RDF, sieve analysis of waste, compost quality check, ash etc. The dedicated weigh bridge which measures the MSW input to the plant and rejects coming out There will be online display inside the plant boundary which shows all above key parameters.

04.06 Electrical System

Plant Electrical System comprises:

- Power Generation
- Power Evacuation
- Power Distribution for Complete WtE facility

04.06.1 Design Criteria

The broad design parameters of electrical power evacuation, generation and distribution system are as follows:

Table 42: Design Parameters for Electrical System

		Power Evacuation System	Power Generation system	Distribution System
Nominal System Voltage	:	33 kV	11 kV	415 V
Highest System Voltage	:	36 kV	12 kV	433 V
Frequency	:	50 Hz		
Voltage variation	:	±10%		
Frequency variation	:	±5%		
Combined variation	:	±10%		
Impulse Voltage withstand level.	:	170 kV Peak	75 kV Peak	
One min. Power Frequency withstand voltage	:	70 kV rms	28 kV rms	
Rated Short time Thermal current	:	31.5 kA	40 kA	65 kA / 50 kA
System Grounding	:	Solidly Grounded	Through NGR	Solidly Grounded

Proposed Power Distribution Scheme is as shown in Drg No. 1638-403 Sh.01

Necessary control and protection system for parallel operation with grid and also protection of the Generator and the auxiliaries would be provided. It is proposed to provide electronic system for both the AVR and synchronization system. All protection system would be designed for the prevailing fault level at the Grid Sub-station

04.06.2 Power Generation

Power will be generated at 11 kV. The generator will be rated for 15 MW, 11 kV, 50 Hz, and 0.8 PF. The generator will be of air-cooled design and will be provided with brushless type excitation system.

04.06.3 Power Evacuation

Power generated from the Power Plant will be connected to 11 kV Switch Board through segregated phase bus. One of the Circuit Breaker (Synchronized) of this board is connected to LV side of 33/11 kV, 20 MVA Transformer, for power evacuation to the Grid by laying 33 kV transmission line from Grid Sub-station of APSPDCL, Vengalayapalem. The grid substation has also adequate land available for installation of the 33kV bay link for the project.

Table 43: Brief Specification Switchyard

Service Type	:	Outdoor
No. of Pole	:	Three (3)
Nominal System Voltage	:	33 kV
Highest System Voltage	:	36 kV
Rated Short time Breaking current	:	31.5 kA
Rated operating sequence (for Auto reclosing)	:	O-0.30 sec -CO-3 min-CO
SF_6/VCB	:	1250A
CT Ratio	:	
PT Ratio	:	
Gapless Lightening Arrestor	:	6 nos.
Isolator with earth switch	:	2 sets
Insulator and Conductor	:	ACSR Conductor (Panther/Zebra)

Metering Section:

Metering facility shall be installed at grid interconnection point. As per the PPA, three meters shall be installed i.e. main meter, check meter and standby meter. Specification of these meters shall be as per the DISCOM metering code. The bill amount generated shall be based upon the main meter.

Proposed Power Distribution Scheme is as shown in Drg No. 1639-403 SH01

Table 44: Brief Specification of Power Transformer

Service Type	:	Outdoor, Oil filled
Numbers	:	1
Rating	:	20 MVA
Rated Voltage	:	33/11 kV ±10%
Frequency	:	50 Hz ±5%
Design Ambient temp.	:	50^0C
Vector group	:	Ynd1
% Impedance	:	6%
Insulation Class	:	A
Temp. rise top oil	:	40^0C
Temp. rise winding	:	45^0C
Tapping range on HV side	:	OLTC & RTCC, 16 steps -10 to +10 @ 0.8%
Overload	:	As per IEC/IS
Separate source power frequency voltage withstand		
HV Winding (kV rms)	:	70 kV
LV Winding (kV rms)	:	28 kV
Full wave lightning impulse withstand voltage		
HV Winding (kV_p)		170 kV
LV Winding (kV_p)		75 kV

Tariff Metering

Export/Import energy meters of 0.2 accuracy class as stipulated by APSPDCL will be provided at the 33kV evacuation sub-station. As per PPA, three meters shall be installed i.e. Main meter, Check meter and Standby meter. Specification of these meters shall be as per DISCOM metering code. The bill amount generated shall be based upon the main meter.

04.06.4 Black Start of the Power Plant

It is the process of restoring an electric power station or a part of an electric grid to operation without relying on the external transmission network.

Normally, the electric power used within the plant is provided from the station's own generators. If all of the plant's main generators are shut down, station service power is provided by drawing power from the grid through the plant's transmission line.

To provide a black start, Power plants shall have diesel generators.

The power required for Black start can be taken from the DG set of required rating.

Table 45: Brief Specification of DG set

Duty	:	Continuous
Quantity	:	One (1)
Continuous rating	:	1500 kVA
Diesel engine	:	4 stroke, water cooled
No. of Phase	:	Three (3)
Voltage	:	415 V ±10%

Frequency	:	50 Hz ±5%
Design Ambient Temp	:	50^0C
Power Factor	:	0.8 (lag)
RPM	:	As per Manufacturer's standard
Class of Insulation	:	H
Starting	:	Auto/Remote
Type of Alternator	:	Self-starting (Electrical)
Cooling System	:	Radiator cooled

04.06.5 Power Distribution

Required number of distribution Transformers is provided to cater the Aux. load requirement of the power plant. These Transformers are fed from the 11 kV switchboards. PCC (Power Control Centre) are considered with the Transformers for further distribution of the loads.

415V PCC also have Incomers and Bus coupler configuration and required number of outgoing feeders.

The 415V Power Control Centre (PCC) will feed the 415V Motor Control Centres (MCCs) for group control of motors as well as Lighting Distribution Board (LDB) and Power Distribution Board (PDB).

Voltage Levels

The generation voltage will be 11 kV, 50 Hz while the power evacuation voltage to grid will be at 33 kV. Power Plant auxiliaries and plant loads will be fed from 415V.

For single phase consumers, 240 V will be used. Control power supply will be 230 V AC derived through dual control transformers for control of motors.

415V Substation for Auxiliary Power Distribution

LVSS of power plant comprises of Unit Auxiliary transformer (UAT), LT Power Control Center (PCC), Motor Control Center (MCC), LT Cables, Motors, earthing, lighting etc.

One (1) no. LVSS viz. for Boiler & TG auxiliaries, miscellaneous loads, for Water Cooled Condenser, Water system and Pneumatic Ash Conveying system will be considered. Actual number of MCCs required will be reviewed during engineering. Necessary provision for feeding emergency DG set power to TG MCC will be made through an incomer of adequate rating.

Table 46: Brief Specification of Distribution Transformer

Service Type	:	Outdoor, oil filled
Numbers	:	3
Rating	:	2.0 MVA
Rated Voltage	:	11/0.433 kV ±10%
Frequency	:	50 Hz ±5%
Design Ambient temp.	:	50^0C
Vector group	:	Dyn11
% Impedance	:	6%
Insulation Class	:	A
Temp. rise top oil	:	40^0C
Temp. rise winding	:	45^0C
Tapping range on HV side	:	Off load, +5% to -5% @ 2.5%
Overload	:	As per IEC/IS
Separate source power frequency voltage withstand		
HV Winding (kV rms)	:	28 kV
LV Winding (kV rms)	:	5 kV

Full wave lightning impulse withstand voltage		
HV Winding (kV_p)	:	75
LV Winding (kV_p)	:	NA

Table 47: Brief Specification of LV PCC

Service Type	:	Indoor
Numbers	:	3
Voltage	:	415 V ±10%
Frequency	:	50 Hz ±5%
Distribution	:	TPN
Busbar Rating	:	3200A Continuous
Busbar Material	:	AL
Current Density of Busbar	:	1A/1.5 Sq mm
Incomer Type	:	ACB, 4P
Configuration	:	Dual Incomer with Buscoupler
Short circuit rating	:	65 kA for 1 sec
Control Supply	:	230 VAC
Space Heater & LED	:	230 VAC
Ingress Protection	:	IP 42

Motors and Controls

All AC motors will be squirrel cage induction type energy efficient machines. The rating and speed of various motors will be suitably based on duty requirements of driven equipment. Motor control centres will have two (2) nos. incomers and one (1) no. bus coupler. DC motor for emergency oil pump and Jack oil pump of Turbo-Generator will be connected to 110 V DC supply from battery.

Table 48: Brief Specification of Motors

Type	:	Induction motor
Duty	:	Continuous
Cooling	:	TEFC
Winding	:	Copper
RPM	:	As per Process requirement
No. of Poles	:	As per Process requirement
Insulation class	:	F
Temp rise restricted Class	:	B
Rated Voltage	:	415 V ±10%
Rated Frequency	:	50 Hz ±5%

Power and Control Cables

11 kV cables (UE) will be of cross linked polyethylene insulated (XLPE), PVC sheathed, armoured type with aluminum conductor. Cable for 415 V system will be 1100 V grade, heavy duty, XLPE insulated, PVC sheathed armoured, aluminum conductors. 1100V grade multi core PVC insulated PVC sheathed cables with stranded copper conductors will be used for control application. Special cables will be used for signal / data transmissions as required.

04.06.6 Earthing and Lightning Protection

11 kV Generator will be earthed through NGR to limit the earth fault current. 415 V transformer neutrals will be solidly earthed. All non current carrying metallic parts of various electrical equipment will be properly earthed in accordance with Indian Standards, IE rules and other statutory requirements.

04.06.7 Plant Lighting System

Lighting for the plant will be designed as per current industrial standards. Power for lighting in the power plants and adjoining areas will be fed from emergency power through Lighting Distribution Board (LBD) and Miniature Circuit Breaker Distribution Boards (MCBDBs). Additionally portable chargeable battery type emergency lamps may be considered wherever required.

High efficiency sodium vapour lamps will be used for illuminating high /medium bay areas, pump houses and other plant buildings and outdoor areas / roads. LED lamps will be used for control room, HT & LT panel room, administration and miscellaneous buildings.

04.06.8 110 V DC Power supply system

110 V DC supply system comprising Battery , Battery chargers, DCDB will be provided for the complete requirement for control protection and interlocks, emergency DC drives of Turbo generator etc., for the Power Plant. The Battery Sizing will be done such that it would be possible to feed the Emergency lube oil pump.

04.07 Instrumentation & Controls

A well designed control and instrumentation system is very vital for sustainable performance of a WtE plant. It also helps in better management of the environmental and social concerns of the public at large through a transparent and open display of real time performance of the plant. A well designed C&I system helps in achieving the set performance goals in a project in respect of:

- Operational efficiency and resource conservation
- Productivity of men & machines
- Safety
- Environmental Integrity

The instrumentation and control system for WtE Plant shall be of Microprocessor based programmable instrumentation with hydraulic/ pneumatic final control Elements. The system shall be of latest state-of-the-art hardware and software based digital Control and information system based automation system. The system shall have capabilities to Supervise, control, operate & collect data from various field instruments located in Power Plant and auxiliaries through-out the network running inside the plant and control room.

The Distributed Control System (DCS) configuration is shown in the drawing No. **1639-412 SH01.** The system configuration shall be functionally/ geographically distributed. In general the configuration shall be as per the enclosed configuration drawing.

The overall I&C system for the project has been designed to have a judicial mix of local and remote control with adequate redundancy briefly summarised as follows.

Material recovery facility (MRF) area is provided with local control panels at many levels. These panels would communicate with the DCS primarily for the purpose of monitoring and historical trend analysis.

Critical controls of STG set are controlled through their dedicated panels. STG Panel shall house Electronic Governor and Vibration Monitoring Panel. These operations are independent of the DCS operations. However, indications are available in the DCS for monitoring. All other operations are through the DCS such as remote controls for all auxiliary motors of turbine (AOP, EOP and barring gear), condenser hot well level controls, and alarm annunciator for turbine faults, turbine, gearbox and generator bearing oil temperature monitoring, turbine safety interlocks and trip logic. Necessary direct reading field instruments like pressure gauge, temperature gauges, pressure transmitters and level gauges will be provided as per manufacturer's standard practice.

On-line Emission Monitoring System

Continuous emission monitoring systems are used as a tool to monitor air emission standards. Typical monitored emissions include: sulphur dioxide, nitrogen oxides, carbon monoxide, carbon dioxide, hydrogen chloride, airborne particulate matter, mercury, volatile organic compounds, and oxygen. CEM systems can also measure air flow, flue gas opacity and moisture.

Details of Stack Monitoring are covered in Para 4.6 above.

Figure- 14: Typical Stack Monitoring Device

04.08 Sanitary Landfill (Scientific Landfill)

There will be a dedicated engineered scientific landfill site which will handle the disposed waste from the MSW processing facility. Drainage system, leachate collection system and HDPE Liners have to be established. The facilities will also include weigh bridge, operator cabin, approach road etc.

Leachate Collection System:

The leachate collection system will be designed to maintain a leachate depth or head of 30 cm or less above the liner. The design leachate head is very important as flow of leachate through imperfections in the liner system increases with an increase in leachate head above the liner. Maintaining a low leachate level above the liner helps to improve the performance of the composite liner system. The main components of leachate collection system are leachate collection tank, feeder mains and header main.

Liner System Design:

The liner system for landfill site shall be designed for non-permeable lining system at the base and wall of waste disposal site area. For landfill receiving residues of waste processing facilities or mixed waste having contamination of hazardous material (such as aerosol, bleaches, polishes, batteries, waste oils, paint products and pesticides) minimum liner specification shall be a composite barrier having 1.5 mm High density Polyethylene (HDPE) geo-membrane or equivalent overlying 90cm of soil(clay/amended soil).

Final Cover System:

The final cover system consists of the following components,

1. Vegetative layer of 450 mm thick with good vegetation supporting soil
2. Drainage layer of 150 mm thick granular material
3. Barrier layer of 600 mm thick clay/amended soil
4. Gas venting layer of 200 mm thick granular material.

05 PLANT LOCATION AND LAYOUT

05.01 Plant Location

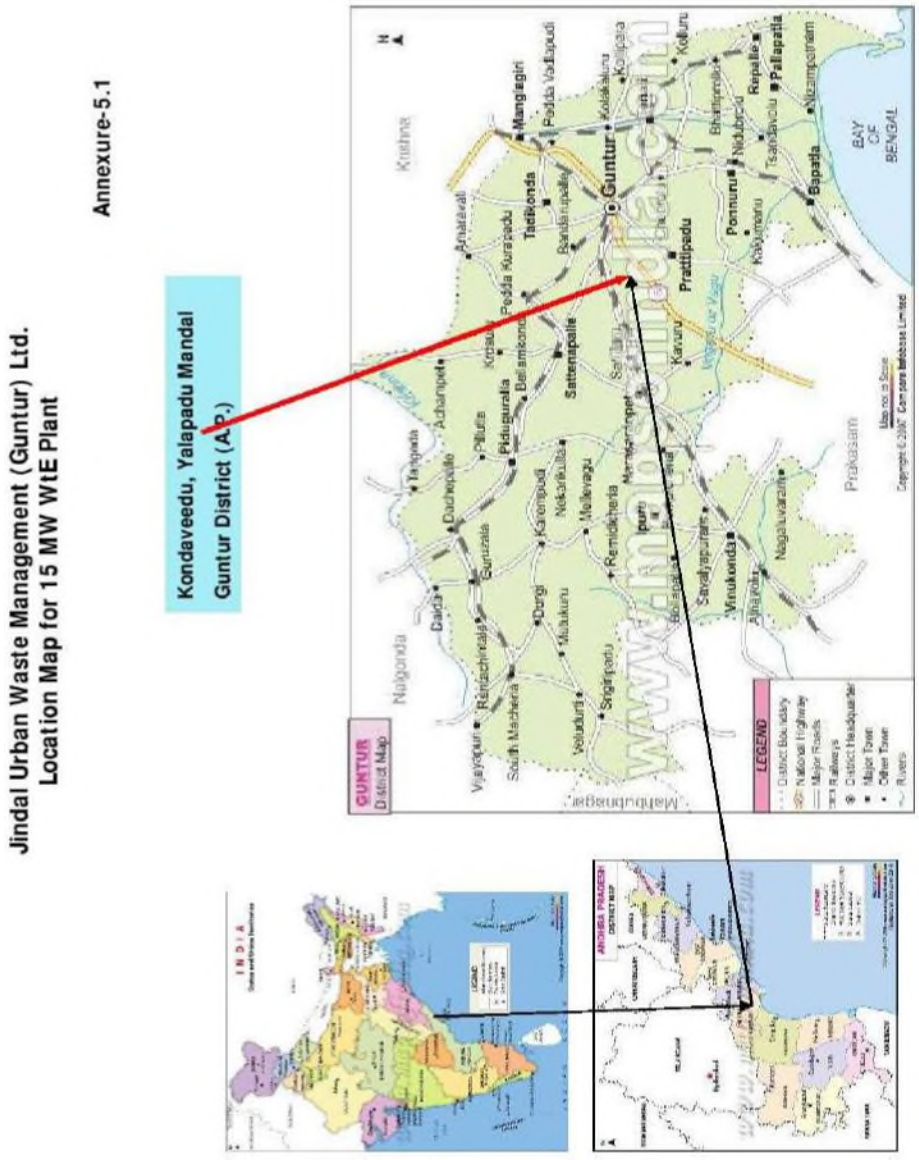
Guntur Waste to Energy Plant is proposed to be located in Kondaveedu Village, Yadlapadu Mandal in Guntur District. Salient features of the plant site are as follows:

Latitude	: 16^0 – 17′ N
Longitude	: 80^0 - 20′ E
Nearest Railway Station	: Guntur (14.4 km)
Nearest Airport	: Vijayawada (16.2 km)
Nearest Access Road	: NH-16 (2km)
Nearest Highway	: NH-16 Chennai – Kolkata National Highway (Previously NH-5)
Source of Water	: Treated STP Water
Total Land Area of Existing Plot	: 15.85 Acres allocated out of 20 acres.

Location Map is shown in **Fig – 15**

Land is allocated by Guntur Municipal Corporation (GMC) near Naidupeta dump yard as per the terms of Concession Agreement. Site is connected to NH-16 by approach road. Plan of the site allocated for the project is shown in **Fig – 16.**

Figure- 15: Location Map



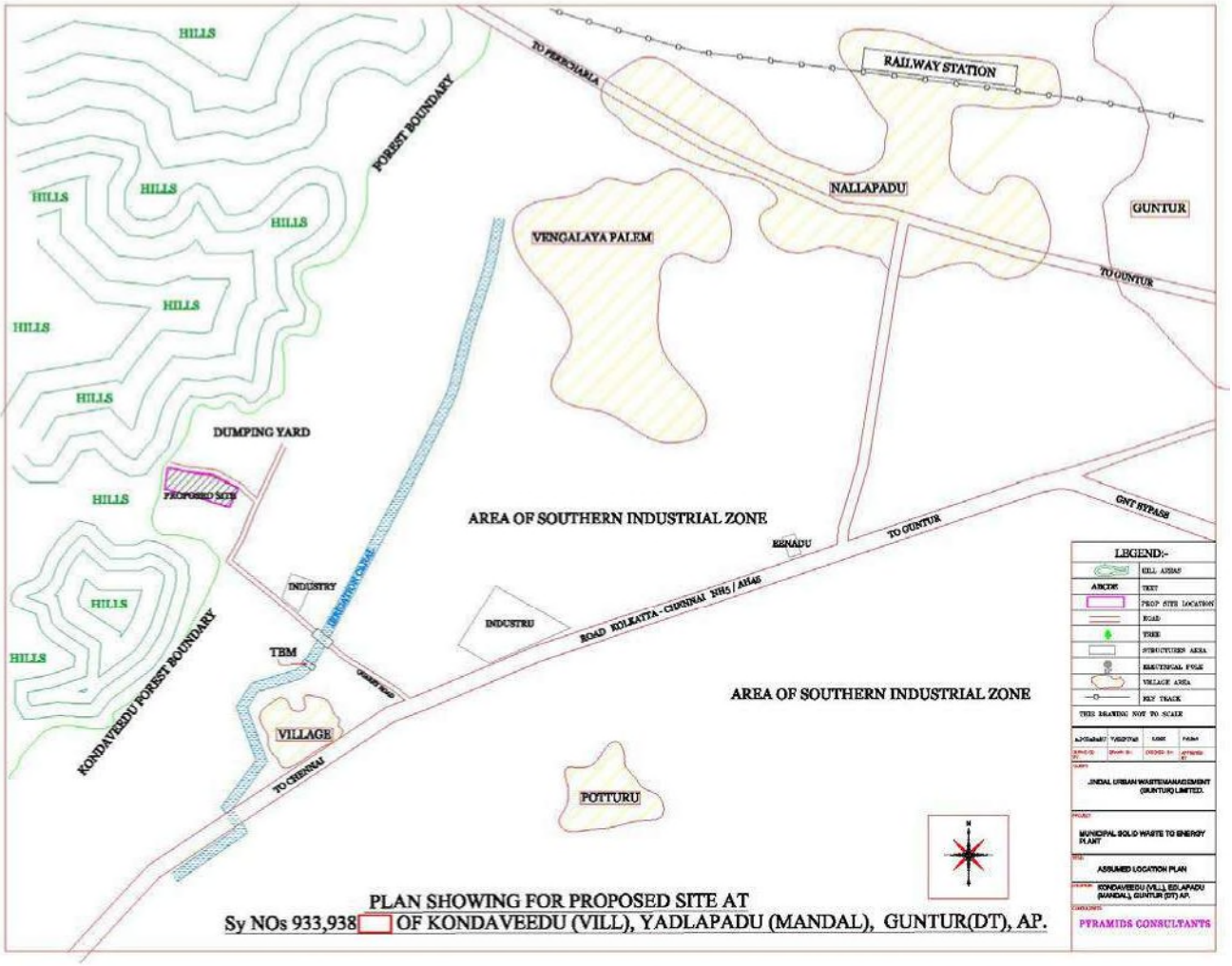


Figure- 16: Plot Location

SITE FOR WtE PLANT AT GUNTUR

NAIDUPETA DUMP YARD

05.02 Land-Use – WtE Plant

At present land allocated for the project is about 15.85 acres. As per bid documents, 20 acres (approx) of land has to be allocated by GMC to the Company. The company is in talks with GMC and balance land will be allocated soon. The area will be used for construction and development of Integrated MSW processing facility comprising Material Recovery facility and Power Plant with auxiliaries, Water treatment plant, Administrative and amenities Blocks and Common facilities etc. Apart from the above, internal roads and green belt will be developed as per the norms. About 6 Acres will be developed as greenbelt. This greenbelt will serve as a buffer between the peripheries and the industry, there by controlling the air emissions and noise levels.

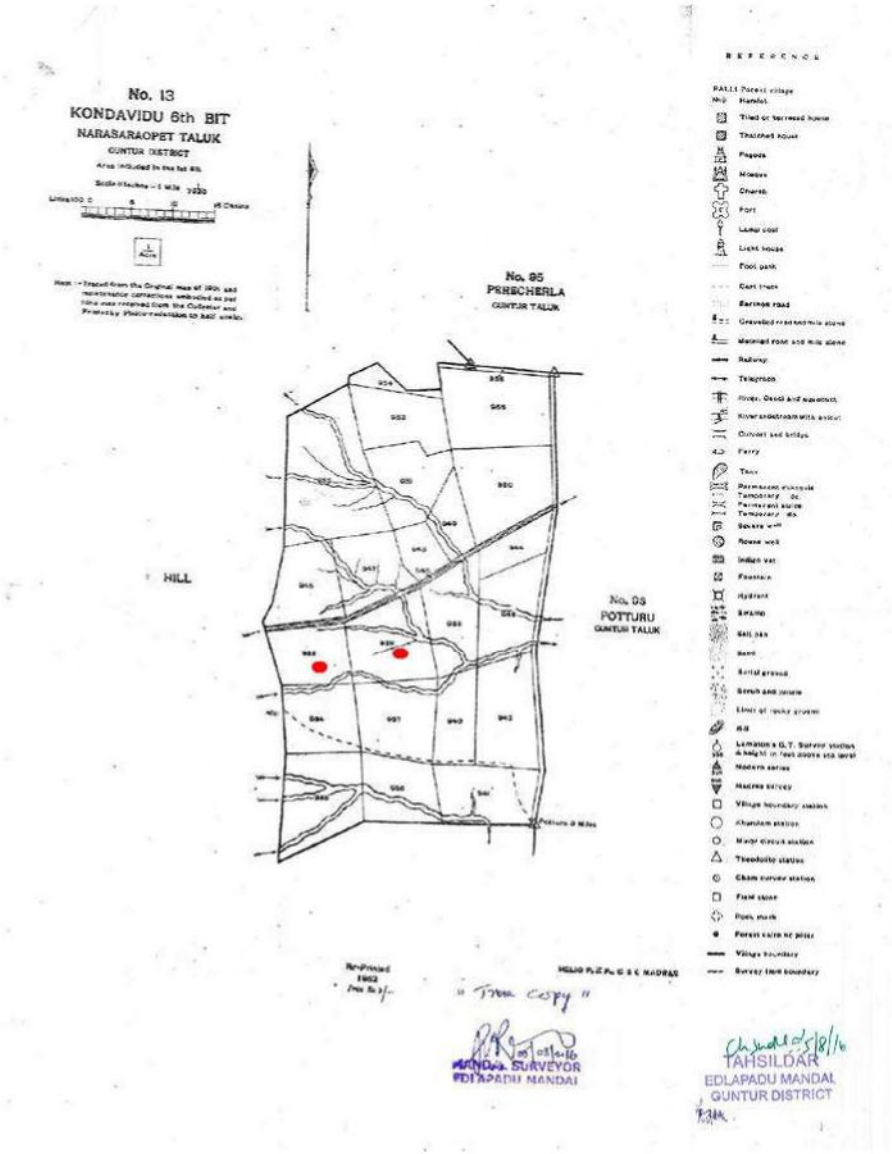


Figure- 17: Certified Map of Plot

05.03 Proposed General Plant Layout

Layout of proposed MSW Processing Facility with Power Plant is shown in **Drg No. 1639-001**. Following aspects have been considered in the layout shown in the drawing:

i) The proposed Integrated MSW processing facility as well as auxiliary units are located in a **compact configuration.**

ii) MSW Tipping and processing area is located with convenient approach for vehicles from main material gate. Weigh bridges are located near the entry point. Parking area for trucks is also envisaged near the entry gate.

iii) Bio drying pits are located in a closed shed with convenient transfer of received MSW from dump pits to the drying pits.

iv) Manual and mechanical segregation facilities are connected by belt conveyors,

v) Separate area is allocated for compost curing, screening and storage.

Boiler island with RDF storage, flue gas treatment and chimney are arranged in compact layout.

vi) Turbine-Generator building is located close to Boiler to minimize steam piping. Air Cooled condenser is adjacent to TG building

vii) Electrical & Control Room building is attached to the TG building shed. Switch yard will be outdoors close to plant boundary for power evacuation through overhead conductors.

viii) Space is provided for Water treatment plant with storage. Location will ensure that it does not come in path of predominant wind direction from flue gas treatment area.

ix) Environmental aspects, pollution control and safety measures are accorded due importance.

x) Utmost economy but at the same time maximum flexibility have been kept in view in locating various units for ease in material movement within the plant as well as in and out of the plant.

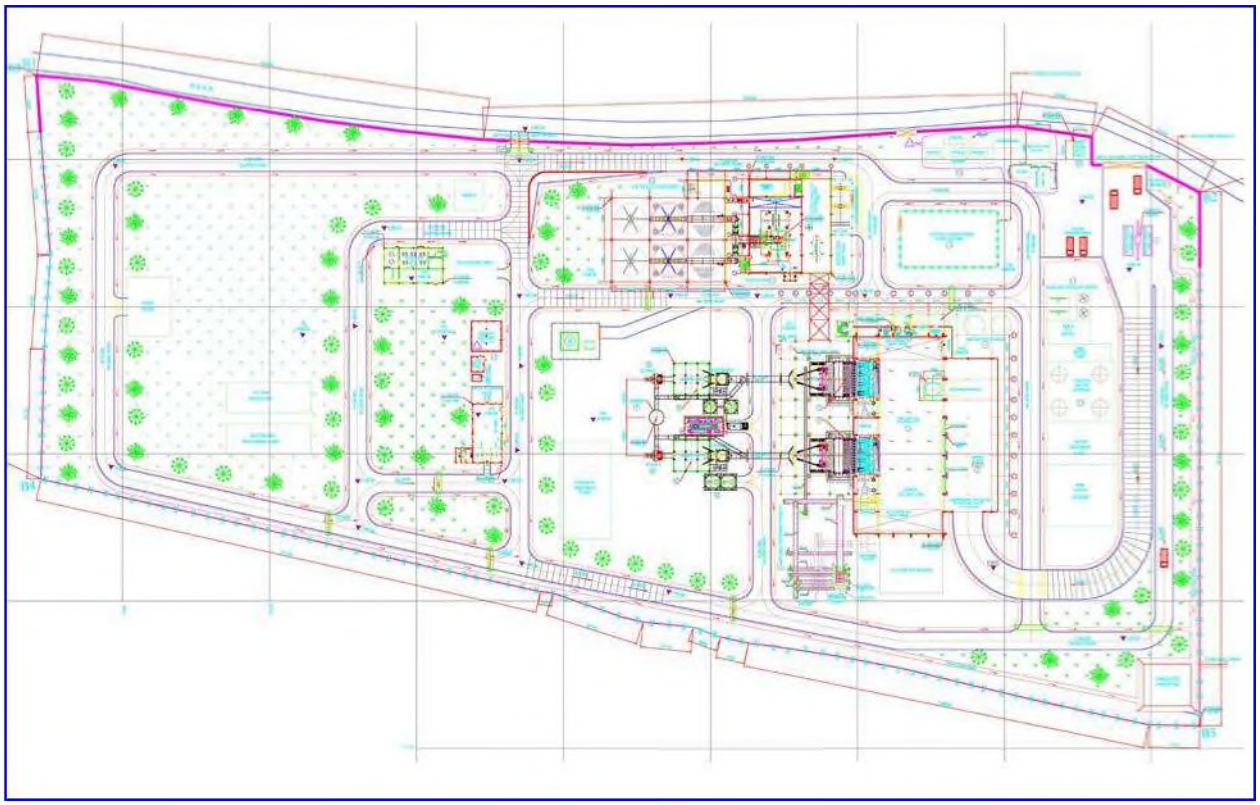


Figure- 18: Plant Layout – Guntur

05.04 Site Analysis

Project is located within the Area earmarked by GMC for disposal and processing of Municipal Solid Waste as per overall Waste Management Plan.

Vacant land has been handed over by GMC, therefore, there will be no requirement for Rehabilitation and Resettlement.

The site is easily approachable from NH-16, therefore, well connected with municipal areas of Guntur, Vijaywada and other towns in the cluster.

For disposal of non-combustible inert, sanitary land fill site is also located nearby.

06 REQUIREMENT OF LAND, SHEDS, BUILDINGS AND OTHER CIVIL WORKS

06.01 Requirement Of Land & Land Development

GMC have allocated 15.85 acres of land within which various facilities envisaged for the project are to be accommodated. Land lease agreement for the plot has been signed. The area is adequate for accommodating all plant facilities.

For developing landfill site additional area of about 65 Acres will be required. The site will be provided by GMC at suitable location in their own land.

Survey has been conducted for the plot and contour plan and soil investigation report for the area is also available.

The dedicated land for power plant is developed as per the results of topographic survey, excavation or back filling may require for land development. Dressing of surfaces including strutting, shoring & dewatering if required and filling and back filling in layers.

Landscaping will be done to enhance the visible features of an area of land which includes flora or fauna, gardening, art and craft of growing plants to create beautiful environment, nature elements such as landforms, terrain shape and elevation or bodies of water.

Approach road shall be designed to accommodate vehicles having a minimum 40 ton gross weight. The access road shall be at a minimum of 15m wide to handle two-way transfer trailer traffic from the scale house to the face of the landfill.

Interconnecting roads inside the plants will be developed keeping waste input and rejects outflow into consideration. The interconnection of different equipment placement

is properly addressed in layout and approach road thereof. The width of road is maintained as per standards.

General layout and construction details such as fencing/boundary wall, building sectional view, etc., plantation and greenbelt area with species details. The green cover requirements within the processing facility shall be minimum of 3 m wide along the site boundary. Garden/lawns shall be created wherever possible to improve the aesthetics. Part of green belt area required as per norms is proposed to be developed in additional area proposed to be allocated by GMC.

06.02 Sheds & Buildings

Following sheds and buildings are envisaged to be constructed to accommodate various facilities of the project:

Material Recovery Facility:

- Operator shed for Weigh Bridges
- Common Shed for tipping floor and Bio-drying Section having two bays with EOT Grab Cranes
- Shed for Manual & Mechanical segregation facility
- Compost Storage & Packing shed

Boiler Island:

- RDF Storage & feeding shed with EOT Grab Cranes
- Protection canopies for Fans & Pumps

TG Building:

- TG Building with RCC Columns & operating floors, masonry walls, side sheeting, EOT Crane and structural roof.
- Electrical and control room building having two floors plus cable basement.

Balance of Plant:

- Building for water treatment plant
- Pump rooms for Fire fighting and circulating pumps
- Compressor House & DG Station

Auxiliary Buildings:

- Administrative & Office Block
- Canteen & amenities building
- Laboratory
- Store
- Gate complexes with security rooms, etc.
- Toilets & Rest Rooms at various locations.
- Covered Parking & open parking

06.03 Foundations & Civil Works

Civil foundation work for equipment shall be executed as per the soil investigation report of that area. The structure & foundation work has to be done for following equipment & buildings:

- Ramp for MSW unloading
- MSW pit
- Shed column foundations
- Foundation for equipment of material recovery facility
- RDF fluff pit
- Boiler foundation & Chimney

- STG deck & its columns
- STG building
- Air cooled condenser deck & its columns
- Water treatment plant
- Auxiliary Cooling tower
- Raw water reservoir & fire fighting tank
- Miscellaneous tanks
- Foundations for other miscellaneous equipment like compressors, pumps, fans, DG, Skid mounted assemblies, etc.
- Pipe trestles, conveyor gallery & cable gantry supports
- Switchyard and Transformers.

07 ENVIRONMENT, HEALTH, SAFETY & SOCIAL MANAGEMENT

07.01 Health & Safety

The site shall be managed by the Principal Contractor who shall be responsible and accountable for all activities on site.

He shall delegate authority for the day-to-day running as deemed appropriate, but liaise with those with delegated authority on a daily basis to discuss and sort out Health and Safety issues that have been identified.

Staff is responsible for their own safety, for their actions that may affect the safety of those they are working with or persons who may be working nearby. In this respect they have the obligation to report unsafe actions and situations to the client/ Site Manager. It's everyone's duty to prevent unsafe situations and actions.

The health and safety of all those who work at the Plant shall be ensured, as far as is reasonably practicable by:

- Assessing the risk of all work activities, recording the significant findings and developing method statements as appropriate.
- Providing and maintaining safe plant and systems of work, together with appropriate personal protective equipment.
- Minimising risks associated with hazardous substances including waste to be processed, materials used and the by-products of waste treatment processes.
- Minimising risks associated with other occupational health risks including noise, vibration and manual handling.

- Maintaining the Plant in safe condition including as regards workplace transport and fire risks.
- Providing appropriate information, instruction, training and supervision to those working at the Plant or visiting the Plant, including information and training with regard to the emergency procedures.
- Implementing effective systems for active and reactive monitoring of compliance, including by inspections, audits and incident/ near miss investigation.

Staff has to follow plant's in-house rules and regulations as described further in this HSE plan..

In addition the following rules & regulations if any, are also imposed to each staff:

- The client's worksite safety rules and regulations.
- The general safety rules imposed by Indian / State Government legislation.

If a hazard arises or suspected to be present, they shall be reported immediately and, if necessary, all work stopped and persons withdrawn from the area.

07.01.1 Risk assessments and Work Procedures

Risk assessments are an important step in protecting the health and safety of people working in construction sites. The key aim is to identify hazards early on, so they can be eliminated or reduced before the work will be carried out. Therefore before any work can commence which is not part of a person's daily routine a Risk Assessment must be carried out of the activity being undertaken. As a result work procedures are made to

give specific instructions on how to safely perform a work related task or operate a piece of plant or equipment.

In most cases, the assessment results in permits to work and/ or Lockout/ Tagout (LOTO) procedures.

Activities listed below are some examples of work that will need a risk assessment and work procedures:

- Working at height
- Hot work
- Using lifting equipment
- Working with hazardous substances
- Entry into confined spaces
- Excavation work
- Use of cranes or hoists
- Erection of scaffolding or access towers
- Electrical testing

The above list of activities is not exhaustive and other activities may require a recorded method statement/ risk assessment.

For this project, risk assessments and method statements are made by the supplier of the specific equipment to be erected and/ or installed. Reviewing by the principal contractor.

07.01.2 Training

Site personnel will attend a site induction that will include a briefing on the site rules and regulations, including how to notify site management of any deficiencies. It will also include information on how to address training where training deficiencies have been identified. Site inductions shall be carried out by the Principal contractor for all personnel intending to work on site for any period of time.

Personnel who are to carry out work (inclusive advisory or supervision work) on the construction site shall hold a current SCC certificate – Safety for Operational Supervisors. Personnel can only undertake tasks or work on equipment where they have been authorised and trained for that task or equipment. Safety training will be undertaken as required by competency role profiles and risk assessment. Training will be provided based upon identified needs and will focus on job specific requirements and wider awareness. (e.g. confined space, Electrical testing, etc).Anyone who may be employed on a construction site must have taken a first aid course.

07.01.3 Drugs and Alcohol Policy

Alcohol and drug misuse affects performance, behaviour and relationships at work and at home. There is overwhelming evidence of links between alcohol misuse and social and psychological disturbances, medical problems, accidents and violence.

Alcohol consumption is prohibited to all employees and contractors within the site boundary including car parks.

- Furthermore, all personnel are forbidden to:
- Use prohibited drugs at any time
- Abuse prescribed or "over the counter" drugs at any time
- Attend for work under the influence of alcohol
- Have in their possession drugs of abuse during working hours including breaks
- Attend for work under the influence of prescribed medications or over the counter medications that will or may adversely affect their ability to perform their duties.

All project managers/ supervisors are required to bring this policy to the attention of contractors and report to their line manager if they see anyone consuming alcohol or misusing drugs, or who appear to be under the influence of either.

Any contravention of the drug or alcohol policy will be viewed as a serious disciplinary matter, any transgressor will be removed from site.

07.01.4 Working in site/ plant area

Prior to working in an area not previously discussed or approved during a pre-work review or where process-related hazards may be present, consult the Principal Contractor for the following information:

- Special instructions
- Restrictions
- Permits required
- Location of lockout
- Potential changes in work environment, including unexpected liquids or vapours
- Special training
- Location of emergency alarms, emergency equipment, evacuation routes and assembly points
- Type of emergency escape equipment available and how to use it.

All personnel attending site, shall be equipped with Long Sleeves work clothes, Safety Helmet, Safety Boots, Hi-Vis vest or jacket and Safety Glasses which shall be worn at all times whilst working in the construction area unless there is a specific requirement in the Method Statement or Risk Assessment agreed by the principal contractor/ Client that specifically removes this requirement. Open fronts, short sleeves and shorts are not allowed.

Other task specific Personnel Protective Equipment may be required during the project. The risk assessment shall identify the specific type/ grade of protective equipment to guard against the specific hazards identified in these risk assessments.

For certain operations other specialist equipment may be required, including fall arrest system, buoyancy equipment, gas detection, oxygen deficiency monitoring equipment and breathing apparatus. Details of the precise utilisation of such items shall be addressed in the specific method statement and risk assessment. Personnel provided with this special PPE shall have received appropriate training prior to use.

All PPE should be maintained on good condition. Holes in boots or overalls etc will not be tolerated and replacements shall be issued as soon as possible. Work clothes should be washed regularly as to prevent skin infections, irritations and other forms of skin diseases. Replace safety helmets immediately if it is cracked or distorted.

Hearing protectors shall be worn in areas where noise levels exceed 85 dB, and where areas with hearing protection warning sign is posted such as pump room, boiler house, turbo generator hall, air cool condenser, fans areas, etc.

When handling chemicals, please refer to the Material Safety Data Sheet (MSDS) for the appropriate glove to be used

Respirators shall be worn in contaminated atmospheres. When working in refuse bunker, fly ash handling areas or any dusty environment, suitable masks or respirators must be worn.

Employees with pre-existing conditions of heart disease, asthma, hypertension or breathing difficulties are not encouraged to wear respirators unless physically certified by a doctor.

07.01.5 Equipment safety rules

All necessary tools and equipment, including personal protective equipment, shall be properly maintained. Defective tools and equipment shall be repaired or replaced immediately.

- All equipment shall be used only by employees who have been properly trained and are otherwise competent to use the tools and equipment safely

- Only authorised personnel shall operate heavy-duty equipment/ equipment/ machinery in the Plant. Equipment can only be started when the following two conditions are fulfilled:

- Comply with the applicable Permit-To-Work System
- Local check has been carried out to confirm that the equipment is in working condition and that no one is near the equipment. For equipment with local on/ off switch, it should always be started locally. Unauthorised possession of equipment switching keys by any person is prohibited. No bypassing is allowed unless approval given by the authorised person

Safety guards and other safety features provided for all tools and equipment must not be removed for convenience.

The allowable safety load limit of a machine, a working tool, or piece of equipment may not be exceeded. Tools, equipment, and machinery shall not be altered in any manner that would reduce their original safety limit. Any and all changes to machines, equipment and/or materials must be approved by an official inspection unit.

Machines for manual use and all such similar apparatus must be adapted to the prevailing conditions. For example, for work to be carried out above shoulder height, the apparatus selected should be as light as possible, and easily manageable.

Equipment and machines are designed for a specific purpose. Do not abuse or misuse them.

Never wear loose sleeves, dangling neckties or finger rings while working around machinery.

Permits/ authorization

Permits will be issued at the work site when required for the works. Prior to start of the operations, it's necessary to become informed about the work permits that are applicable for the site.

When permits to work are in force, they are always required before commencement of work, in written and properly authorized.

Plant's personnel shall carefully read, understand, sign and explicitly comply with all conditions required by the permit.

The permit holder must be on the work spot for the duration of the works being carried out under the permit, if he is to leave the work spot whilst work is on-going, he must transfer the permit through the correct permit transfer system.

In commissioning or testing of equipment, the person responsible for the equipment must be present so that all necessary checks are made prior to the commencement of work.

Table 49: List of permits commonly required for work on site/ plant

Type of Permit	When Required
Work permit	A general permit for all activities
T&C Permit	For testing and commissioning
Hot Work	For works involving naked flame, sources of ignition or sparks
Confined Space	For work carrying out inside a confined space such as underground manholes, tanks, inlet channel, area where possible of asphyxiated from lack of oxygen, the risk of fire/ explosion and the presence of dangerous airborne substances

Work at height	For work activities carried out at a workplace exceeding the height of 2m
Excavation	For any excavating (including drilling) in earth, roads, parking lots, slabs, and slab floors
Lifting & Hoisting	For any lifting and hoisting activities involving lifting machines or lifting appliances
Radiation permit	For radiation works

Working on height

Not all work at height can be reasonably removed by the design process. Therefore, the hierarchy of managing and selecting work equipment for work at height shall be followed as set out by the Work at Height Regulations.

Working at height will be covered as part of the risk assessment for all work where there is a risk a person could be injured by falling.

Hot work

Some systems or equipment have a hot surface and consequently a thermal hazard.Where reasonably practicable insulation of the system or equipment is provided in design.Other thermal hazards occur in e.g. the SNCR system, bag filter, ID fan, boiler feed water pumps, steam circuit, fire fighting pump station. General arrangements for controlling are in most cases implementation of the Lockout/ isolation procedure combined with providing personal protection means.

- No hot works are allowed to be carried out in the following areas:
- Fully closed storage tanks, vessels or drum of any nature (pressure vessel)
- Pipes and vessels under internal pressures whether of steam, feed water, air or gases

- Pipes, tanks and spaces which have contained fuel and other flammable substances

Naked flames, hot works or element that produces sparks (including electric devices) must not be near vicinity of fuel storage areas, oil paint and bottled gas stores and locations where activities such as painting works are in progress.

Chemical hazards

All chemicals must be accompanied by a Material Safety Data Sheet (MSDS) to enable the user to prepare for the arrival, storage and use of the specific substance and to ensure that all safety and environmental implications can be taken into account before the work is started.

Plant's personnel should carefully read the MSDS and shall handle all chemicals in accordance with the instructions as stated. It should not be mistaken by appearance of chemicals (e.g. some chemicals look like water). Legal requirements and instructions for labelling, handling and care of waste must be followed. The removal of used products, which are contaminated after a spill, shall be carried out in line with the site waste procedure.

Noise

Exposure to excessive noise should be avoided.Excessive noise is avoided by providing noise enclosure where reasonably practicable (e.g. turbine/ generator and auxiliaries). Where the specific risk assessment for noise still shows that action is required, the principal contractor must ensure that the appropriate controls are introduced. For reference the action levels are as follows:

- Lower exposure Action Levels: Daily or weekly noise exposure of 80 dB(A) or a maximum noise (peak sound pressure) of 135dB(A) where appropriate hearing protection should be worn.

- Upper Exposure Action Levels: Daily or weekly noise exposure of 85 dB(A) or a maximum noise (peak sound pressure- of 137 dB(A) where appropriate hearing protection shall be worn.

- Exposure limits: Daily or weekly exposure of 87 dB(A) or peak sound pressure of 140 dB(A).

- Notwithstanding the above, common sense shall apply and ear protection shall be worn if the short term working noise level is found to be uncomfortable for the exposed person at levels below 80 dB(A). At levels higher than 80 dB(A) ear protection is obliged.

Moving/ rotating parts of machines

Hazards caused by moving or rotating parts of machines are covered with providing an electrical/ pneumatic lockout procedure.

Pressurised Equipment/ Compressed air

The term 'pressurised equipment' refers to equipment and units for which the maximum permitted pressure specified by the manufacturer is greater than 0.5 bar.Flanges, nozzles, coupling, bearing elements, lifting eyes and similar elements, which are connected to pressuring-bearing parts, are counted as part of the pressure-bearing device.

In the event of any work on pressurised equipment a lockout procedure and restricted access has to be implemented. Personnel has to be trained for this specific purpose.

Turbine and steam circuit are examples of pressurised equipment.

When using compressed air for cleaning purposes, it should be ensured that it does not exceed 30 psi. Compressed air should not be used to clean dust or debris off the body.Compressed air can cause injuries and great pain when it comes into contact with body. Thus, all compressed air must handle with care.

X-Ray Measurements

All necessary licenses/ permits for the materials or equipment should be obtained before use.Hazard warning signs should be used to identify restricted areas and equipment.

Electrical

Only authorised persons is allowed to carry out work to the site/ plant's electrical installation. Unauthorized personnel should not be permitted to enter any switch room.

- No equipment or extension cord should be used if the grounding prong has been removed. No two-wire extension cords are permitted.
- All electrically powered hand tools shall be inspected before use.

After work or in the case of power failure, all portable electrical tools should be switched off. Any equipment that is locked or tagged out into the switch receptacle should not be activated.

Conductor should not be handled with bare hands, but with rubber gloves or insulated appliances designed for the voltage applied. Rubber boots shouldalso be provided against the risk of electrical shocks, if necessary. All electrical appliances and conductors have to be clearly marked to indicate their purpose and voltage.

The nominal voltage of the extra low voltage supply is 24V AC 50 Hz single phase. This voltage is safe in conditions where simultaneously accessible parts (such as exposed electric cable) may be touched by a person whose skin is dry or moist, but not wet. It shall not be used in locations where a person is immersed in water or working in the rain or working in a confined conductive location such as inside tanks or boiler furnace etc.

07.02 Environmental Protection

Chemicals and wastes must be stored in appropriate locations and containers so as not to cause pollution to the environment. Staff should conserve energy by switching off office equipment, lights, etc. when not in use.No one should discharge chemical substances through open drains.

The purpose of the Environment Management Plant (EMP) is to mitigate potential emissions from various activities associated with the integrated facility. This includes understanding and incorporating mitigation measures to ensure that the emissions at site boundary are within the required pollution limits.

07.02.1 Air Pollution Management Plan

In addition to the robust and state of the art air pollution control system for the boiler flue gas, following mitigation measures are proposed to reduce the dust levels in the ambient air environment:

- Maintaining and/or re-establishment of a grass cover on area where there is no on-going activity
- Frequent watering of unsealed roads and stockpile area- cover material
- Blacktop of the roads as and when they are settled and ready for the same
- Repair, relaying of blacktop roads from the landfill area to the main road
- Using dust control sprays during loading and unloading of wastes
- Ceasing dust generating activities during high wind times
- Minimizing working distances for internal transport of wastes
- Periodical monitoring of ambient air quality for all relevant parameters as indicated in the monitoring plan
- Odour control by rapid stabilization and disposal of wastes at the earliest along with daily cover placement

The above mentioned measures will help in minimizing the fugitive emissions and dust.

07.02.2 Noise Pollution Management Plan

The sources of noise generation in the landfill will be from the generators, heavy earth machinery in addition to the vehicular movement. While all noise levels are well within the acceptable limits, the following strategies would be adopted to further minimize the noise levels:

- Maintaining the site machinery in good operating condition
- Regular maintenance of systems and installation of noise control equipment wherever required
- Development of green belt all around the site
- Periodical monitoring of noise levels

07.02.3 Water Pollution Management Plan

During the construction phase, a septic tank shall be provided to treat the domestic wastewater generated due to labour settlements. Temporary facility would have impermeable flooring and proper leachate collection arrangement. Leachate has to be treated before discharge. The small quantities of leachate generated will be collected in the sump and treated in Effluent Treatment Plant. Excessive leachate generation in monsoon season will be combated by covering the sub-cells of the facility during rain with HDPE sheets and ensure that no water comes in contact with the waste. This treated leachate will be used for maintaining moisture level of windrows in compost curing section..

07.02.4 Development of Green Belt

With the development of the proposed plant, green belt would be developed and other aesthetic changes would be made to the plant site, thereby creating overall positive impact on the aesthetics of the site. A properly landscaped entrance area with a green belt of 15 m containing tree plantation for good visual impact will be maintained in line

with the norms stipulated in Environment Clearance. The domestic wastewater generated along with washings/leachate from MSW pits will be treated and used in windrows along with green belt development.

A green belt is provided to mitigate various emissions. Green belts are wide strip of trees and shrubs planted in rows to reduce air velocity there by facilitating settling of the particles on the leaf surfaces and allowing absorption of the pollutant gases. It also serves to cool the atmosphere by transpiration from the leaf surface and also provide habitat for birds, reptiles and insects. The advantages of a green belt are given below:

- Greenbelts are important habitats for birds and animals, which add to the aesthetic value of the environment. Generally, birds prefer to make their habitat, nest, on trees. Further trees provide shade and hiding places to wild life
- It helps to restore the ecological balance
- It helps in prevention of soil erosion
- It helps to improve the aesthetics in the area
- It also diminishes noise pollution by absorbing high degree of noise due to their spongy foliar crown

Selection criteria of Plant species for Green belt development

The selection of plant species for the development depends on various factors such as climate, elevation and soil. The list of plant species that can be suitably planted and having significant importance are provided below. The plants should exhibit the following desirable characteristic in order to be selected for plantation. The species should be fast growing and providing optimum penetrability. The species should be wind-firm and deep-rooted.

The species would form a dense canopy. As far as possible, the species should be indigenous and locally available Species tolerance to air pollutants like SPM, SO_x and NO_x should be preferred.

- The species should be permeable to help create air turbulence and mixing within the belt.
- There should be no large gaps for the air to spill through.
- Trees with high foliage density, leaves with larger leaf area and hairy on both the surfaces.
- Ability to withstand conditions like inundation and drought.
- Soil improving plants (Nitrogen fixing, rapidly decomposable leaf litter).
- Attractive appearance with good flowering and fruit bearing.
- Bird and insect attracting tree species.
- Sustainable green cover with minimal maintenance

07.02.5 Specific Measures for EMP

MSW Handling & Processing

The unloading as well as processing of the waste would not generate dust and odour. Since these activities are carried out under covered areas.

Leachate

The municipal waste arriving at the site will be unloaded on a tipping floor, which is covered. The concrete platform shall be constructed to prevent ground water contamination due to leachate. Leachate generated shall be stored in an underground leachate tank and used for spraying on windrows to maintain moisture level of the windrows.

Material Recovery Facility

Solid rejects

The solid rejects (maximum of 20% of the total waste) from the processing would consist of stone, sand, earth, ceramic etc. that will be segregated and managed appropriately. The inert produced shall be disposed in an Engineered landfill.

Noise Pollution

There sources of noise pollution includes truck traffic, blowers, shredders. Where necessary, enclosures would be provided to ensure that noise levels do not exceed the prescribed standards

RDF Storage

The proposed facility will have seven days storage for RDF fluff. To mitigate potential fire problems, adequate measures such as water hydrants with adequate pressure or dry powder type will be provided.

Rotating & Moving Equipment

There are a large number of rotating & moving equipment in the RDF Plant and accidental occurrences can take place in few of the equipment, as mentioned below:

- Shredder: - During operation, the hammers may get broken and come out with high velocity. These can cause accidents. To avoid these, safety features will be built in the equipment design.

- Rotary Screens: All rotary screens are covered to ward off the dangerous occurrences.

- Conveyors: Although conveyors operate at low speed but can cause some accidents due to negligence of the operating personnel. For this suitable training will be imparted to all concerned.

Compost Plant

Leachate Drain System-Proper drain will be provided to collect leachate generated from compost pad.

Leachate Collection Pit & Circulation System -A leachate collection pit with suitable having capacity has been provided to collect the leachate generated from compost pad. The leachate generated from the compost pad is recycled to the windrows through HDPE pipe lines and pumps.

Other Measures

All the workers handling MSW / RDF will be provided with safety gears such as safety boots, gloves safety glasses and dust masks enc. The storage area is enclosed and barricaded to prevent entry of stray animals and unauthorized persons.

- Maintaining buffer zone and plantation around the facility
- Vehicles carrying solid waste shall be covered.
- Collection system should be properly supervised so that quick and regular removal of waste from the dustbin is practiced.
- The proper cleaning of tipping floor will be done periodically.

07.03 Community Engagement

Community engagement plays a very important role for sustainable operation of waste management system in general and WtE projects in particular. This is proposed to be achieved by undertaking various activities broadly in line with the following objectives:

(i) Training & capacity building activities for improving employability of the local population

(ii) Creating awareness about benefits of WtE projects for the local community through various promotional activities

(iii) Keeping the community informed about environmental performance of the project on an ongoing basis

07.03.1 Training and capacity building

Training centers would be constructed for providing skill development for employability as well as social development through general education and promotion of health and hygiene. Training courses would be developed in collaboration with the Government/Private technical institutes in the vicinity of the project site and NGOs active in the area of social development. Assistance would be sought from the ULBs and other Government departments to facilitate implementation of the training and extension program.

07.03.2 Awareness development-WtE projects

It is proposed to develop audio-visual education materials, which would be periodically shown to the public along with educational films on ecology and environmental sustainability in general and WtE projects in particular. It is also proposed to participate in community development activities for promoting better waste management practices at least around the project area.

07.03.3 Information Management

It is proposed to develop an electronic information management system, which can be linked to the mobile telephones for sharing information on project performance, accept public grievances and communicate redressed measures in a transparent manner.

08 ORGANISATION & MANPOWER REQUIREMENT

08.01 Project Implementation Stage

For implementation of the Project, efficient organisation is to be created with specified key result areas and substantial delegation at execution and operation level. The organization structure during project stage has been developed with clearly defined responsibility for execution and cost management and smooth transition from construction to operation. Recruitment for the project stage shall also be carried out in a phased manner coinciding with the construction schedule. Project stage structure and the tentative schedule for filling up the structure are shown in the following figure.

The Chief Executive Officer (CEO) for the business overall and the Chief Financial Officer (CFO) are part of the corporate management team and are managing the development of new and operation of the existing businesses and projects. The following table shows the roles and responsibilities at the individual positions to be filled up for the project, the qualification requirements and the schedule for filling up the positions.

Organisation structure for Project implementation is shown in Fig- 19.

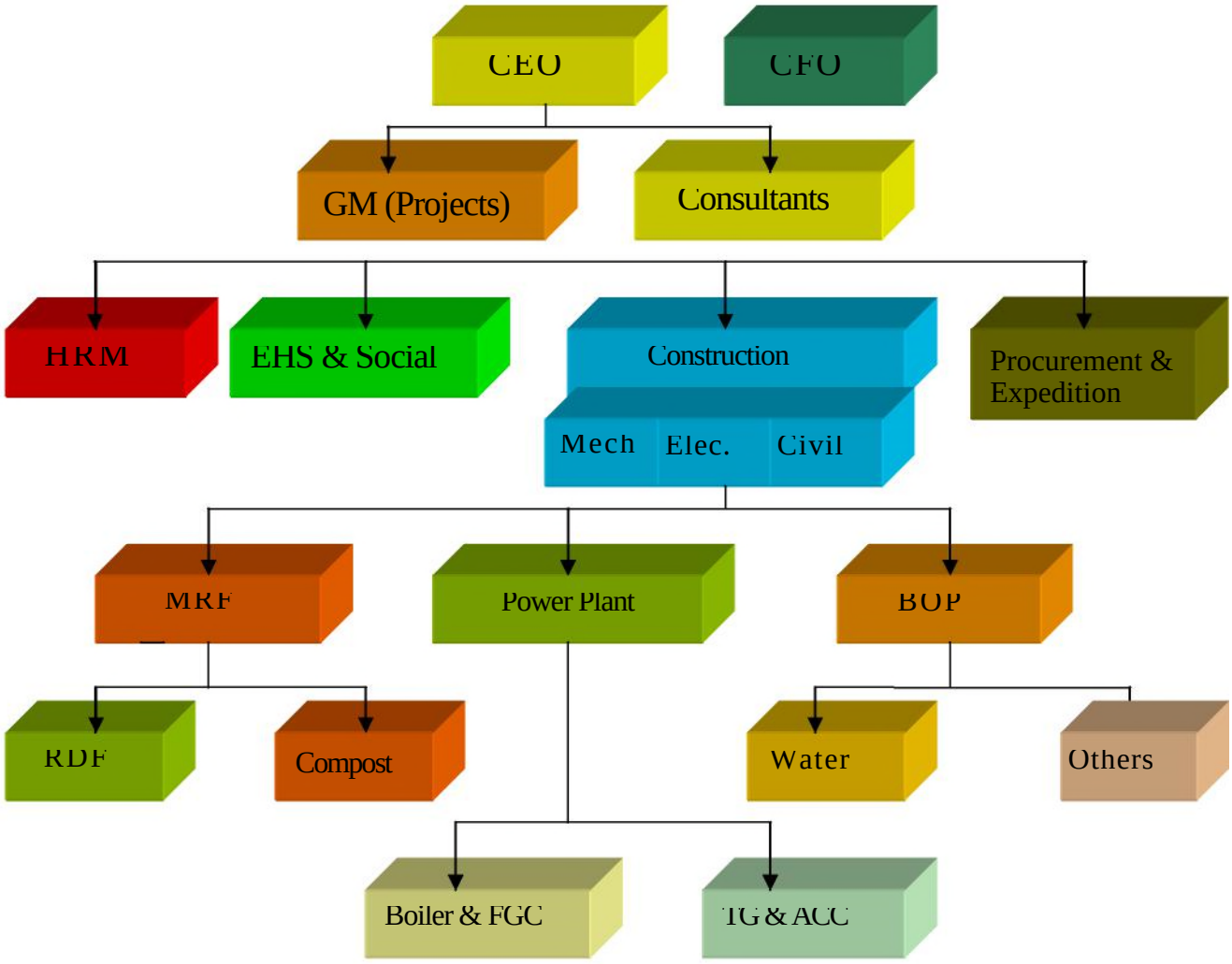


Figure- 19: Organization for Project Implementation

Table 50: Project Manpower

Position	Roles & responsibilities	Qualification requirement	Schedule for appointment
General Manager	Overall responsibility for project development and operation thereafter including technical, commercial, HRM, social and environment and compliances	Mechanical/Electrical Engineer with minimum 15 years experience in development and operation of WtE/Power/Captive power/Infrastructure projects	Immediate
Manager (HRM)	Planning and development of the organization structure, system and human resource development processes at the project and operation stages Training & capacity building activities	Post Graduate in HR/Social development with minimum 10 years experience in operating plants preferably in the semi urban areas Experience of working with NGOs involved in environment related activities preferred	Immediate
Manager (Material recovery facility)	Procurement & construction of the weigh bridges, MRF facility as per cost & time budget Operation of the facility meeting the fuel requirement for WtE plant and compost production as per plan Compliance with the relevant provisions of the concession agreement for the MRF area Environment management for the MRF area	Mechanical/Chemical/Civil Engineer with minimum 10 years experience in solid waste management system Persons with experience in development of SWM technologies would be preferred	Immediate
Manager (Power)	Procurement & construction of the boiler, APC system, fuel & ash handling system, STG set, Condensing	Mechanical/Electrical Engineer with minimum 10 years experience in development and operation of	Immediate

Position	Roles & responsibilities	Qualification requirement	Schedule for appointment
	plant as per cost & time budget	WtE/Power/Captive power projects	
	Operation of the WtE plant post construction Environment management for the WtE plant	Persons having experience of MSW/RDF fired boilers would be preferred	
Manager (EHS) & Social	Development of the overall environment, health, safety plan for the entire facility, provide technical inputs to Manager (MRF) & (Power) for implementation of the EHS plan and monitoring of the EHS system during construction and operation phase Operation of the EMP system including training and capacity building activities	Environmental engineer preferably with additional qualification on HR/Social development Prior experience of working with NGOs in the relevant areas and extension work in industrial projects in rural areas would be desirable	On financial closure
Manager (Balance of plant-Mechanical)	Procurement & construction of the balance of plant including water, compressed air, Effluent treatment, fire fighting& HVAC systems as per cost & time budget Operation & maintenance of the raw water, cooling water, treated water &effluent treatment plant post construction	Mechanical/Chemical engineer with minimum 10 years experience in water treatment related projects	On financial closure
Manager (Electrical)	Procurement & construction of the entire electrical and instrumentation and control systems as per	Electrical engineer with minimum 10 years of experience in IPP/export oriented Captive power plants. Experience in	Immediate

Position	Roles & responsibilities	Qualification requirement	Schedule for appointment
	cost & time budget Liaison with the Distribution Utility during construction and operation of the plant Electrical maintenance of the entire system post construction	development/operation of the integrated control system such DCS would be preferred	
Manager (Civil)	Construction of all infrastructure, structures & foundations as per cost & time budget	Graduate civil engineer with minimum experience of 5 years as Lead for execution of infrastructure/housing projects	Immediate
Engineer (RDF)	Operation and maintenance of the RDF facility including fuel quality &feeding system for the boilers	Chemical engineer/Environmental engineer/Post Graduate in Chemistry with minimum 5 years experience in operation of SWM/Composting plants	Six months prior to commissioning
Engineer (Composting)	Operation and maintenance of the composting plant including quality management and conformance to the requirement of CA	Post graduate with 5 years experience in operation and maintenance of composting plants	Six months prior to commissioning
Others Mechanical engineers-2 Electrical engineer-1 I&C engineer-1	Supporting project construction activities and in operation and maintenance work post commissioning	Graduate/Diploma engineer with 2 to 5 years experience infrastructure projects	Two months prior to start of the construction work
Consultants	Detailed engineering Procurement & construction documents Project management	-	Already engaged

08.02 Plant Operation & Maintenance

The management structure during the operational phase would change as shown for performing day to day jobs of operations and maintenance activities.

The Operation & Maintenance manpower has been estimated for the Material Recovery Facility & Power plant sections as shown in the following tables. The manpower has been determined on the basis that the Plant shall be operated for all the seven (7) days in a week round the clock on three shift per day basis.

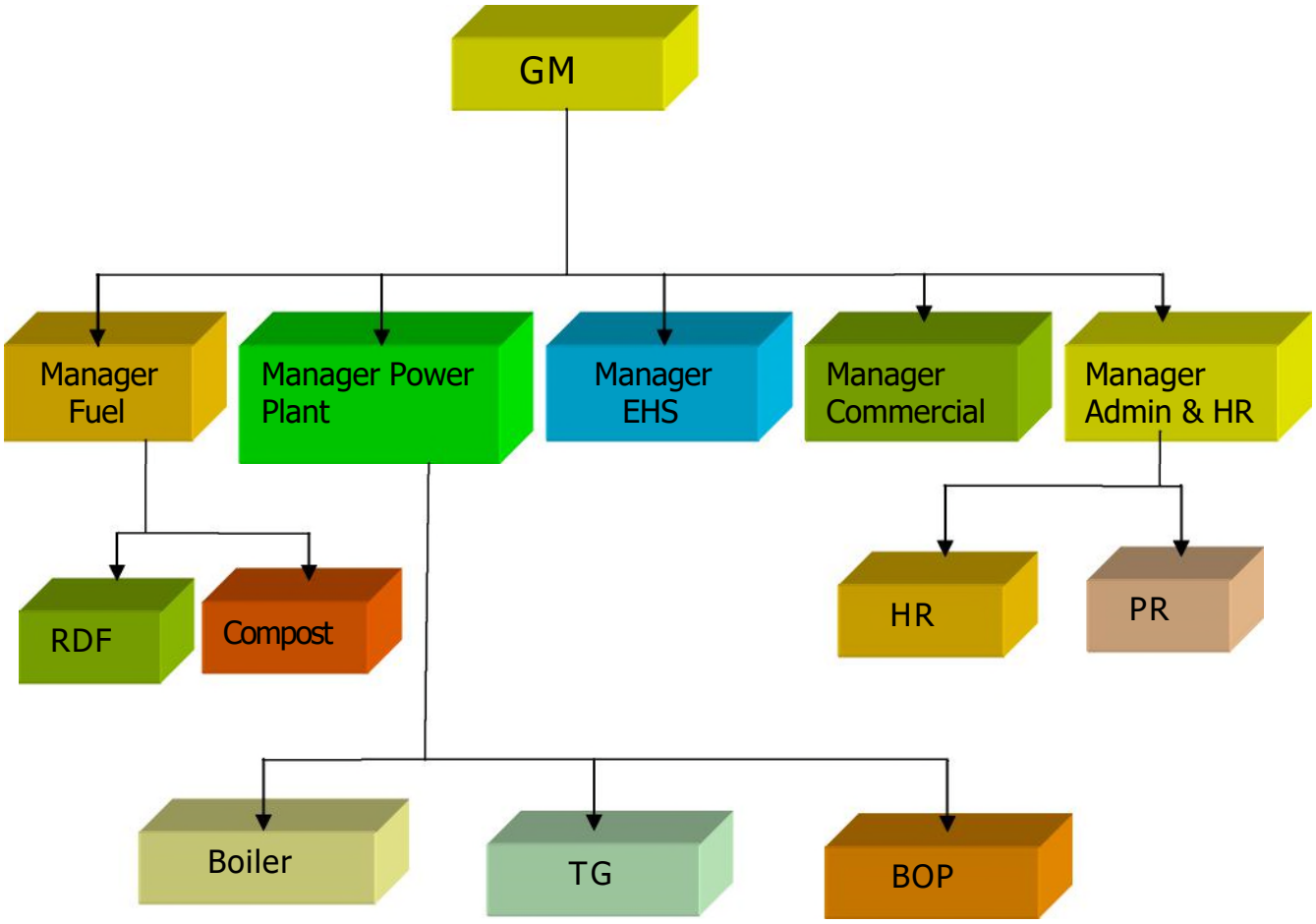


Figure- 20: Organization Operation & Maintenance

Table 51: Manpower Deployment for Operation & Management

Sl. No.	Designation	Task	Shifts				Total
			A	B	C	G+R*	
Material Recovery Facility							
	Supervisor	Inspection & Weighing of MSW	1	1			2
	Supervisor	Supervision & Control of Trucks	1	1			3
	Grab Operator	Grab operation	1	1	1	2	5
	Helper	To look/poke hoppers	1	1	1	2	5
	Supervisor	Manual Sorting Activities	1	1	1	2	5
	Helper/Pickers	Manual Sorting at lines	12	12	12	16	52
	Line Operator	Operation of conveyors/Trommel	1	1	1	2	5
	Shift In charge	Overall responsible for Shift	1	1			2
	Power Pack Operator	Power Pack Operation	1	1	1	2	5
	Helper/ House Keeping	Cleaning at floor	1	1	1	2	5
	Supervisor	Trolley Positioning & removal	1	1		1	3
	Shredder Operator	Operation of shredder	1	1	1	2	5
	Power Pack Operator	Operation of Power pack	1	1		1	3
	Helper/Pickers	Manual sorting & house keeping	2	2	2	3	9
	Mechanical engineer (shift)	Repair/ Maintenance (R&M)	1	1			2
	Fitter cum Welder	R&M	1	1		1	3
	Helper	R&M	2	2		1	5
	Hydraulic Mechanic	R&M	2	2		1	3