TEHKHAND WASTE TO ELECTRICITY PROJECT LTD.

DETAILED PROJECT REPORT

FOR

MUNICIPAL SOLID WASTE TO ENERGY

PROCESSING FACILITY FOR SDMC AT TEHKHAND

Project No. 1814

May 2018

KORUS ENGINEERING SOLUTIONS PVT. LTD.

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00 EXECUTIVE SUMMARY

00.01 Background & Objective of the Project

Population of Delhi has increased from 11 million (as per 2011 census) to about 19 million in 2017 and is expected to grow further. With growth of population, generation of Municipal Solid Waste (MSW) is also growing at alarming rate with current generation estimates of nearly 10,000 T/day. Generation is expected to be more than 17,000 T/day by year 2030 as per estimates by South Delhi Municipal Corporation (SDMC).

At present three Waste to Energy (WtE) projects are in operation. About 5500 T/day waste is processed in WtE plants and compost plants. Balance 4000 T/day is sent to landfills.

Present landfill sites for dumping of waste have outlived their life and are still being used in violation of prevailing rules for Solid Waste Management. Development of new landfill sites has also not been allowed by Delhi High Court. Capacity of Waste to Energy (WtE) plants is not adequate to handle total waste generated. National Green Tribunal as well as apex courts in Delhi have given directives to Delhi Government and Municipal bodies to make action plan for waste management as per SWM Rules 2016.

South Delhi Municipal Corporation (SDMC) has taken up installation of a new WtE plant to process MSW for generation of 25 MW power on PPP mode. Feasibility Report was prepared in 2017 by Development Environrgy Services Ltd. (DESL) and accordingly RFP was issued by SDMC to select developer for WtE project at Tehkhand, Okhla.

JITF Urban Infrastructure Limited (JUIL) participated in competitive bidding and have received Letter of Award No. D/EE (Engg Store)/2017-18/370 dated 01.03.2018 for MSW to Energy Processing Facility to be located in Tehkhand area in Okhla Phase-1, New Delhi.

JUIL, through its subsidiary is already successfully operation WtE plant in Okhla since 2011.

Following activities have been taken up for start of project :

1. SDMC have incorporated a SPV in the name of Tehkhand Waste to Electricity Project Ltd. (TWEPL)
2. SDMC have started process of getting clearances from statutory bodies for the project.
3. JUIL has taken over the SPV incorporated by SDMC on 9th April, 2018.
4. EIA has been submitted for the purpose of getting Environmental Clearance based on TOR issued by MOEF.
5. Concession Agreement with SDMC has also been signed.
6. Power Purchase agreement with State Power Distribution utility is in process.
7. Resource assessment and basic engineering of the project defining the configuration of the project has also been completed.
8. Techno Economic study covering Project cost estimates and financial viability has been completed.
9. Social and Environment Risk Analysis studies have been taken up as a part of EIA.

This Detailed Project Report has been prepared to enable TWEPL to 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 South Delhi Municipal Corporation at the doorstep of the facility.

The Project includes :

- Material Recovery Facility with handling capacity of 2400 TPD of MSW
- Power Plant of 25 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.

For the project, SDMC will allocate 15.0 acres as proposed by JUIL.

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 31st December, 2018 and plant commissioning by 30th September, 2020.

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 397.86 Crores as detailed in Chapter – 10.

00.07 Project Financials

The revenue for the project has been estimated based on sale of only power during operation of Plant for 25 years.

Assumptions made for calculations of financials are as per norms followed by lenders and assumptions derived from development, operation and maintenance of MSW based WtE projects of JUIL in the country.

The project IRR 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 18.7 % (Pre Tax) and 16.04% (Post tax)

The debt service coverage ratio (DSCR) of the project works out to 1.79.

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.

Waste management in Delhi has been in very in dismal state and several directives have been issued the concerned authorities by NGT, CPCB as well as Apex courts to take urgent actions for Solid Waste Management as per SWM Rules.

Delhi has 5 Municipal bodies and the solid wastes generated in Delhi can not be handled by existing facilities.

Existing Sanitary Land Fill Sites :

- Ghazipur (70 Acres), since 1984
- Okhla (56 Acres), since 1996
- Bhlasawa (40 Acres), since 1994

Landfill sites have outlived their life and are not designed as per latest rules. New landfill sites are not being permitted and operation of existing sites, which is not legal, is still continuing till alternative arrangement of disposal is not implemented.

Waste to Energy Projects :

- Okhla - 1950 TPD, 21 MW
- Ghazipur - 1300 TPD, 12 MW
- Narela/ Bawana - 3000 TPD, 24 MW

Okhla plant has inherent capacity to handle waste up to 1950 TPD with corresponding Power generation up to 21 MW. However, three operational WtE plants do not have adequate capacity to dispose off total waste generated.

In view of the above, there is an urgent need to create additional facilities for disposal of waste as per SWM Rules and directives of NGT and CPCB.

The Municipal bodies in Delhi have already taken initiatives in the direction of Municipal Solid Waste management MSWM Projects are being implemented at many new locations. These include improvement in collection, segregation, storage and transportation of waste, setting up of de-centralised as well as centralized compost and re-cycling facilities as well as additional capacity generation fro Waste to Energy Plants.

The South Delhi Municipal Corporation is responsible for providing municipal and civic services to the citizens of South and Western part of Delhi State, including collection, transportation and disposal of Municipal Solid Waste (MSW) generated within their jurisdiction. Feasibility study was prepared by DESL for SDMC for processing of MSW, which is presently being sent to landfill area. JUIL participated in competitive bidding and was successful in getting the Letter of Award for development, operation and maintenance of Waste to Energy (WtE) processing facility as per Solid Waste Management (SWM) Rules 2016, at Tehkhand Okhla, New Delhi through Public-Private Partnership (PPP) on Design, Build, Finance, Operate and Transfer (the "DBFOT") basis.

Implementation of this project will take the burden off from landfill sites and also add additional power to the grid.

SDMC have already incorporated a SPV in the name of Tehkhand Waste to Electricity Project Ltd. (TWEPL), which has been taken over by JUIL. TWEPL will be responsible for implementing the project and operate the same for 25 years as per Concession Agreement to be signed with SDMC and Power Purchase Agreement to be signed with DISCOMs in Delhi.

Objective of this Report is to investigate and project Technical Feasibility and Commercial viability of the project to enable TWEPL proceed with Financial Closure, obtain other statutory clearances and go ahead with further work for project implementation for Processing facility for 2400 TPD of MSW with 25 MW Power Plant.

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).

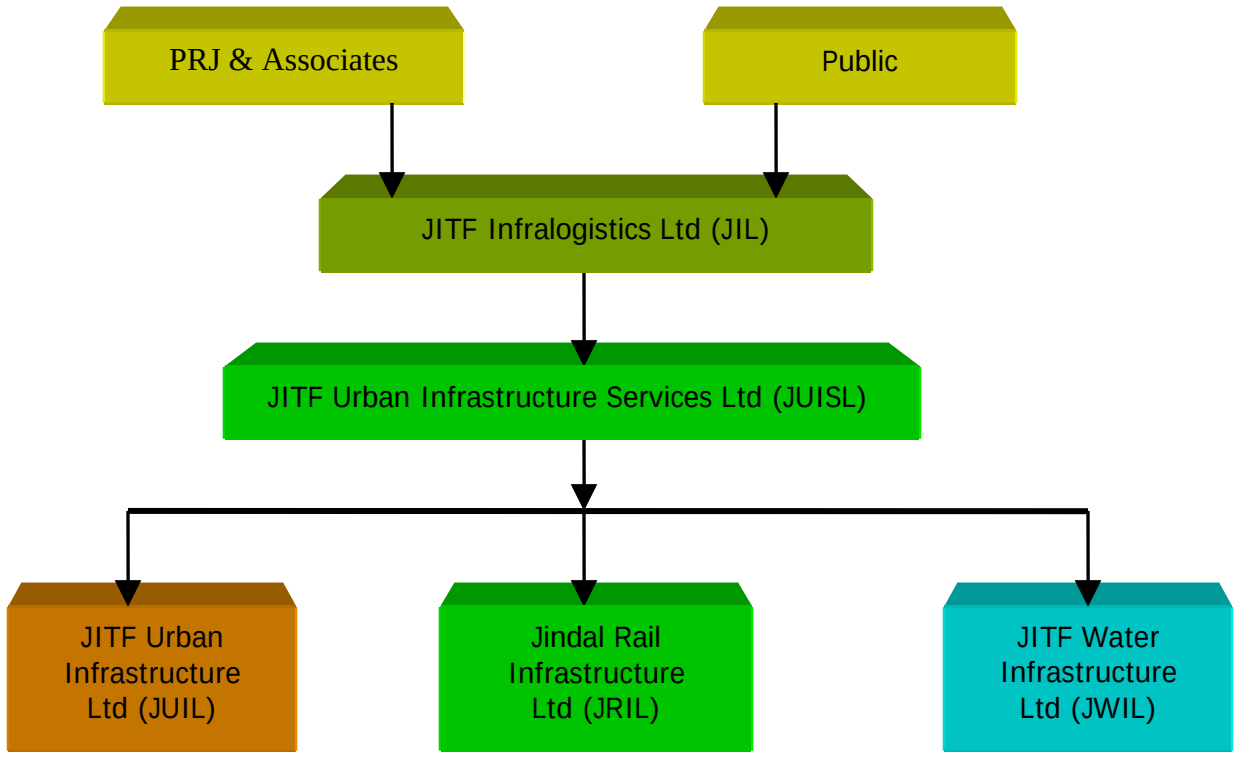
PR Jindal group's journey in infrastructure sector

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- 1: Structure of Infrastructure Business



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 1: 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 2

Table 2: 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 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 are under construction. One project in Gujarat and two in Rajasthan are in pipeline.

Table 3: 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 – 2 below :

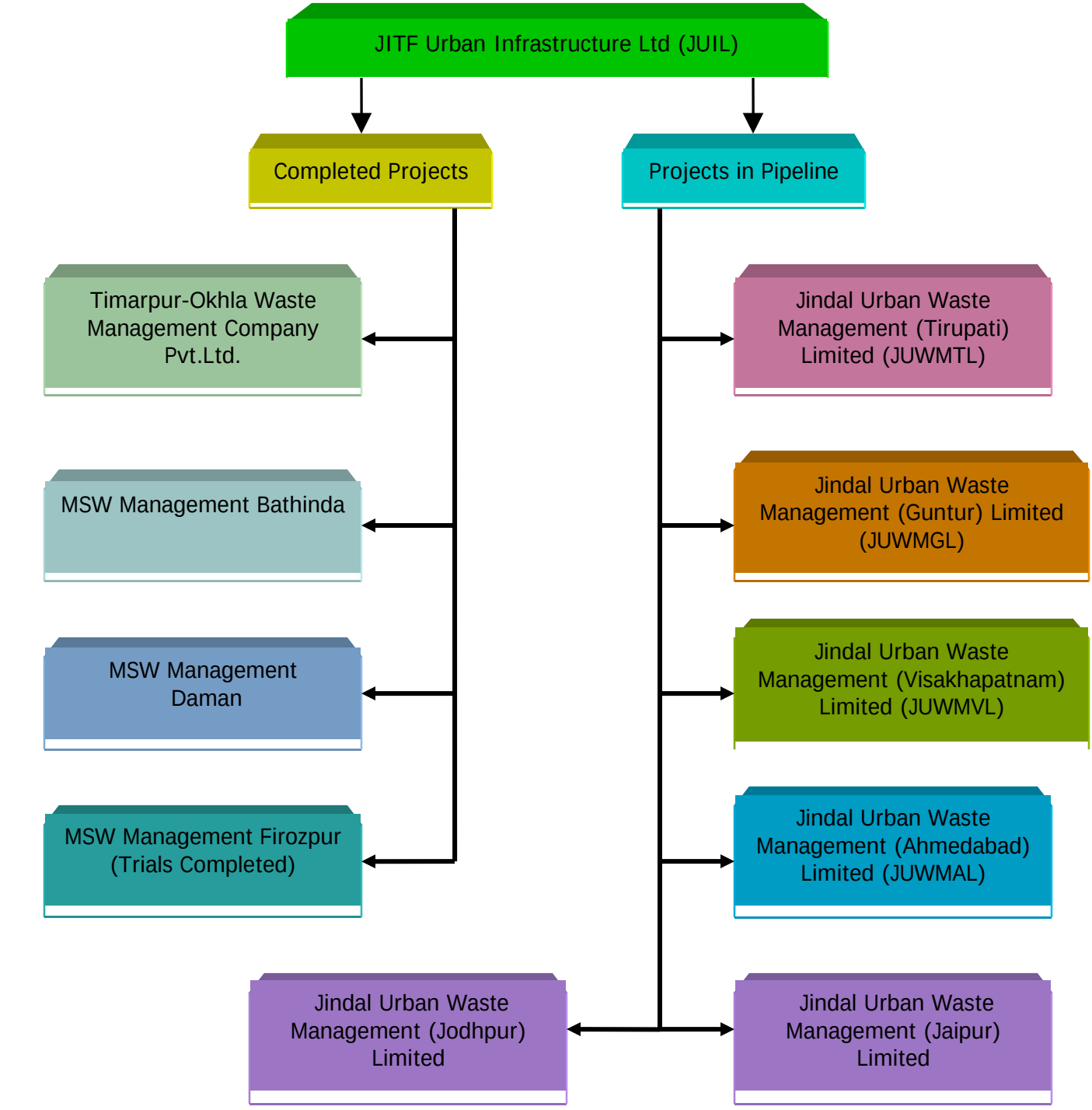


Figure- 2: Structure of JUIL

For execution of this project, SDMC have incorporated a Special Purpose Vehicle in the name of Tehkhand Waste to Electricity Project Ltd. The SPV has following Directors :

1. Mr. Dilip Ramani
2. Ms. Dilraj Kaur
3. Mr. Umesh Sachdeva

SPV has been taken over by JUIL and list of Directors are :

1. Mr. Umesh Chopra
2. Mr. Nilesh Gupta
3. Mr. Sandip Dutt

Tehkhand Waste to Electricity Project Ltd. will be under JITF Urban Infrastructure Ltd. (JUIL) similar to other SPVs for WtE Projects listed in Fig. - 2


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 a integrated facility for processing Municipal Solid Waste (MSW) delivered by South Delhi Municipal Corporation at the door of the facility. Process technology to be adopted shall conform to SWM Rules 2016 and order/directions of Hon'ble Court(s)/ NGT. As per RFP compliance to following aspects is to be ensured :

- The bio-degradable and recyclable content of the waste needs to be separated through a suitable Material Recovery Facility (the "MRF"),
- a suitable Processing Technology for processing of the bio-degradable content of the waste,
- a suitable Processing Technology for processing of combustible content of the Waste and conversion to Energy,
- a suitable technology for recovering and processing recyclable content of the waste,
- Generally not more than 20% of the waste received at the Project Facility should be disposed of in the Sanitary Landfill.

Basic configuration of the plant shall be as follows :

Plant Capacity :

MSW Handling Capacity	:	2400 TPD
Power Generation	:	25 MW

Plant Location :

- Area	:	Tehkhand, Okhla Phase -1
- District	:	South West - Delhi
Nearest Railway Station	:	Tughlakabad
Nearest Airport	:	Delhi

Nearest Access Road	:	Maa Anandamayee Marg on East, Mehrauli-Badarpur Road on North.
Nearest Highway	:	NH-2 Delhi – Mathura Road 2 km
Source of Water	:	Treated Waste Water from Okhla STP
Total Land Area of Existing Plot	:	15 Acres is available in area planned by SDMC for WtE Plant and SLF.
Power Connectivity	:	66 kV Grid Sub-station –Tuglakabad (Under Construction at 2km from site)

Figure- 3: Location Map of WtE Plant Site

Figure- 4: Google Earth Image of Tehkhand 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. Co-ordination 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. Engineering for three WtE plants in AP is in advanced stage and plant construction work is in progress. Work for WtE plant at Ahmedabad has also been started.

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 the new MSW based WtE project at Tehkhand, Okhla Phase-1, New Delhi.

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

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 (SBM) 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.

Delhi, being the Capital of India has been very proactive in implementing Solid Waste Management practices for collection, segregation, transportation and disposal of MSW. The city has also taken lead in converting Waste to Energy and three WtE plants are operational.

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 for Power Generation.
- Only inert material which cannot be recycled or converted into compost or RDF/ energy is to be sent to the landfills.

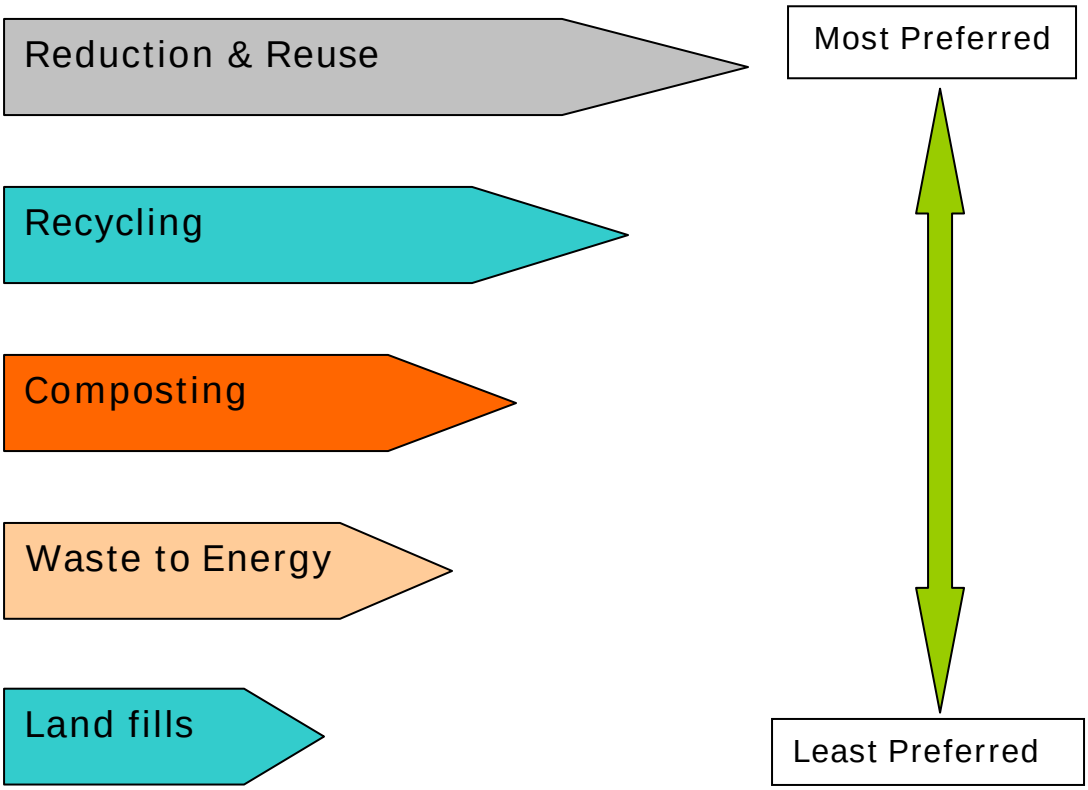
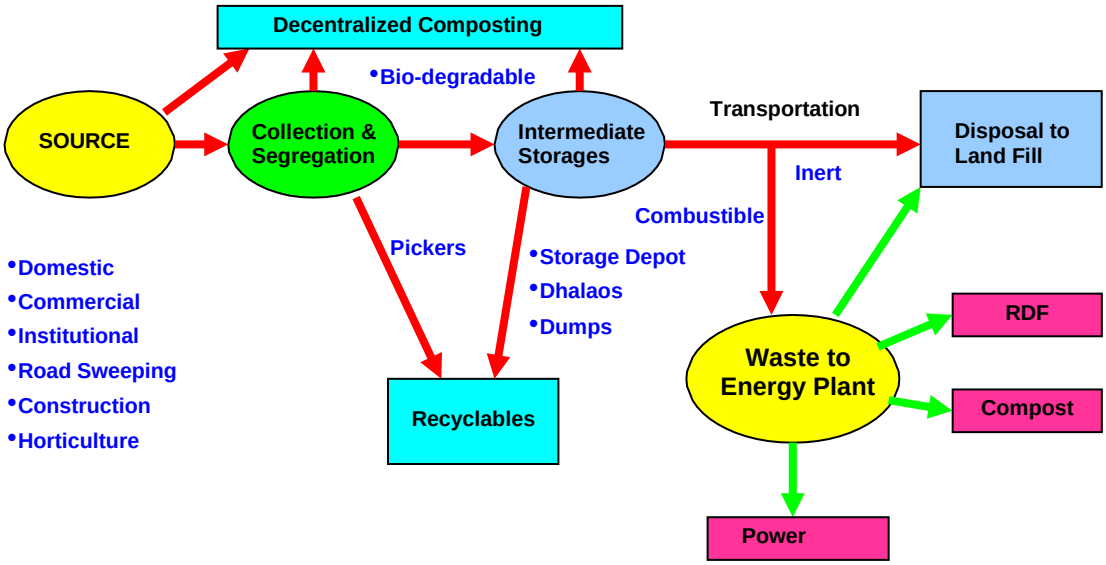


Figure- 5: Integrated Solid Waste Management Hierarchy

Fig - 5 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. This results in minimizing the quantity which is to be sent to landfills.

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- 6: 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 Delhi

Delhi is generating about 9,400 MT of municipal solid waste at the rate of 0.50 kg/capita/day. Out of this, nearly 3,500 MT of waste remains untreated and has to be dumped at one site or the other. The landfill/dumping sites have already exceeded the prescribed limit and height. The dumps have attained the height of over 40 metres as opposed to the permissible limit of 20 metres. NGT, CPCB as well as Apex courts have issued several directives to take urgent actions for Solid Waste Management as per SWM Rules.

South Delhi Municipal Corporation (SDMC) is the local body that is actively participating in Swachh Bharat Mission. SDMC was created in the year 2012 when the former Municipal Corporation of Delhi was divided into three ("trifurcation") different bodies, North Delhi Municipal Corporation (NMDC), South Delhi Municipal Corporation (SDMC) and East Delhi Municipal Corporation (EDMC). Both NDMC & SDMC contain 104 wards each whereas EDMC is smaller containing 64 wards. SDMC area has been divided into four zones, Najafgarh, South, Central & West for the purpose of collection of waste.

Waste collection has been increasing at a very fast rate over the years. Report prepared by SDMC has taken growth of MSW availability at an average rate of 4% (CAGR) in conservative basis. Surplus waste to be disposed is expected to increase to 2400 TPD by year 2026.

Delhi has taken a lead in developing WtE projects to take care of large quanitity of waste generated in city. Currently, three such projects are operating in Delhi (21 MW at Okhla, 12 MW at Ghazipur and 24 MW at Narela/Bawana). However, there is a need to establish more projects so that no waste is allowed to be dumped in landfills.

SDMC proposes to develop a new project at Tehkhand under the PPP model so that the entire quantity of waste generated in the area is processed scientifically with economic and environment benefits for the citizens of Delhi. Additionally, capacity of existing plant at Okhla is also proposed to be expanded to process total 2950 TPD of MSW at Okhla plant.

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 cannot be over emphasized. Waste to Energy Project at Tehkhand is part of efforts to achieve Zero Waste diversion to landfills.

Having identified the immense potential offered by Solid Waste Management, JITF 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 21 MW WtE project at Okhla in Delhi and 300 TPD RDF project at Bathinda, Punjab.

Development of WtE projects in the three largest clusters of Andhra Pradesh (Visakhapatnam, Guntur and Tirupati) has been awarded to JUIL and work on the projects has already been commenced. In state of Gujarat, WtE project at Ahmedabad city has also been taken up. Further, development of WtE projects in cities of Jaipur and Jodhpur in Rajasthan has also been awarded to JUIL and preliminary work on the projects has been started.

In response to the proposals invited by SDMC, JUIL has been successful in getting the Letter of Award for MSW processing facility to be located at Tehkhand, Okhla Phase-1, New Delhi.

Successful implementation of these projects would pave the way for JUIL to become the largest and most successful player in the field of waste management in India, developing a thriving WtE business for the group and at the same time contribute significantly in the success of Swachha Bharat Mission. The projects have positive effect on environment pollution in many ways i.e.

- Reduce green house gases emissions from landfills.
- Provide energy from renewable source.
- Eliminate ill effects created by waste dumps at landfill sites.

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 with latest amendments
2. Central Pollution Control Board Regulations
3. Delhi State Pollution Control Board
4. Municipal Solid Waste Management Manual of MoUD (Prepared by CPHEEO)
5. Concession Agreement with SDMC
6. Rules and guidelines of Central & Delhi State Electricity Regulatory Commissions.
7. Power Purchase Agreement with DICOMS of Delhi
8. Orders and Directive from Honorable Courts and NGT.

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.

Feasibility Report prepared by DESL for the project has already established the suitability of process involving segregation of MSW to make it suitable for incineration and producing electricity using steam produced in boilers attached to incinerators.

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.

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. For Delhi, CAGR of waste generation is taken as 4% to be on conservative side.

Over 9,400 t/d of MSW is generated in the Delhi State out of which SDMC area accounts for close to 35% of the total waste estimated at about 3,250 t/d. The historical trend of waste collection from the area is shown in the following table.

Waste collection from SDMC zones

Zone	Zone wise Waste Generation (t/y)						
	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016	2016-2017
Najafgarh	77,099	1,06,251	1,29,857	1,48,384	1,35,348	1,74,893	2,12,212
South	2,38,220	2,30,703	1,99,272	2,08,551	2,29,447	2,60,441	2,93,863
Central	2,33,035	2,45,253	2,25,551	2,14,290	2,26,637	2,56,388	3,13,899
West	2,34,754	2,51,421	2,54,290	2,37,824	2,77,477	3,43,360	3,60,508
Total (t/y)	7,83,108	8,33,630	8,08,970	8,09,049	8,68,910	10,35,082	11,80,481
Total (t/d)	2,145	2,284	2,216	2,217	2,381	2,836	3,234

** As per FR prepared by DESL for SDMC*

The average waste collection for the SDMC area has increased from 2,150 t/d in 2010-11 to about 3,250 t/d in the year 2016-17 showing a CAGR of about 7% for the last seven years and over 16% for the last two years. Various factors such as

increased rate of population growth, improved collection efficiency as a result of Swachh Bharat Mission (SBM) seem to have caused this sharp increase.

As per current collection, 1,700 t/d can be utilised in the proposed WtE project. This availability would further increase to about 2,000 t/d by 2021 and over 2,500 t/d by 2027 taking into consideration the projected CAGR of net availability at 4%.

Assured quantity of MSW that will be made available at door step of the facility by SDMC is specified at 2000 TPD plus minus 20 %. As per draft concession agreement this will be the minimum quantity that the ULB will supply.

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 2400 TPD considering the growth potential.

Waste Characteristics

Quality of the waste, i.e. its calorific value and other characteristics play important role for power generation projects. Both actual and reported GCV values can vary widely due to various reasons such as:

- Seasonal variation
- Zonal variation due to life style impact-more GCV due to presence of more combustibles in wastes from effluent colonies
- Mixing of sweepings, silts & C&D wastes
- Sampling and analysis error
- Absence of standardized methodology for preparation analysis of waste samples (as received, air dried, oven dried

Data on MSW from various cities shows that GCV of MSW as received can vary from 1100 to 1400 kcal/kg on as received basis. On dry basis the figures are still higher. Average GCV of MSW received at Okhla Plant is 1300 – 1350 kcal/kg.

As per reports of 20 samples collected by SDMC from various locations in April-May 2017. GCV varies from as low as 640 kcal/kg to 2810 kcal/kg. GCV of samples from street and landfill site is low. (Annexure-X of Feasibility Report by DESL). Weighted average calculated for these samples gives a GCV of 1225 kcal/kg for the year 2017.

Quality of waste is also changing over time due to better methods of collection and segregation of waste as well as life style changes. Various studies have indicated CAGR for increase in GCV of MSW is computed as 2.1% as per Chapter 3.2 of FR. Thus same increase in GCV is considered for the system.

For the purpose of calculations following assumptions have been made in the Report:

- Moisture level in mixed waste : 30 – 40 %
- Moisture reduction during processing of MSW : 18% (Leachate+Evaporation)
- Net weight of MSW 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 2017-18 – 1225 Kcal/Kg
- Improvement in GCV of waste 2.1% per year with a cap of 1500 Kcal/kg.
- 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 affect the GCV of feed to boilers.

03.03 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.

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. In view of this Tehkhand project qualifies for Power Production using MSW/ RDF.

As per the conditions of RFP, suitable technology conforming to SWM Rules and Pollution norms is to be adopted for WtE facility which shall ensure:

- The bio-degradable and recyclable content of the waste needs to be separated through a suitable Material Recovery Facility (the "MRF")
- a suitable Processing Technology for processing of the bio-degradable content of the waste
- a suitable Processing Technology for processing of combustible content of the Waste and conversion to Energy
- a suitable technology for recovering and processing recyclable content of the waste
- Generally not more than 20% of the waste received at the Project Facility should be disposed of in the Sanitary 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.
- 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 MSW processing process should also meet the requirements of the SWM Rules.

03.04 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 25 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. 1814-002 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^{o}C is reached within 2 days. After this, thermophilic bacteria is added due to which temperature rises to 65^{o}C, 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

03.05 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.

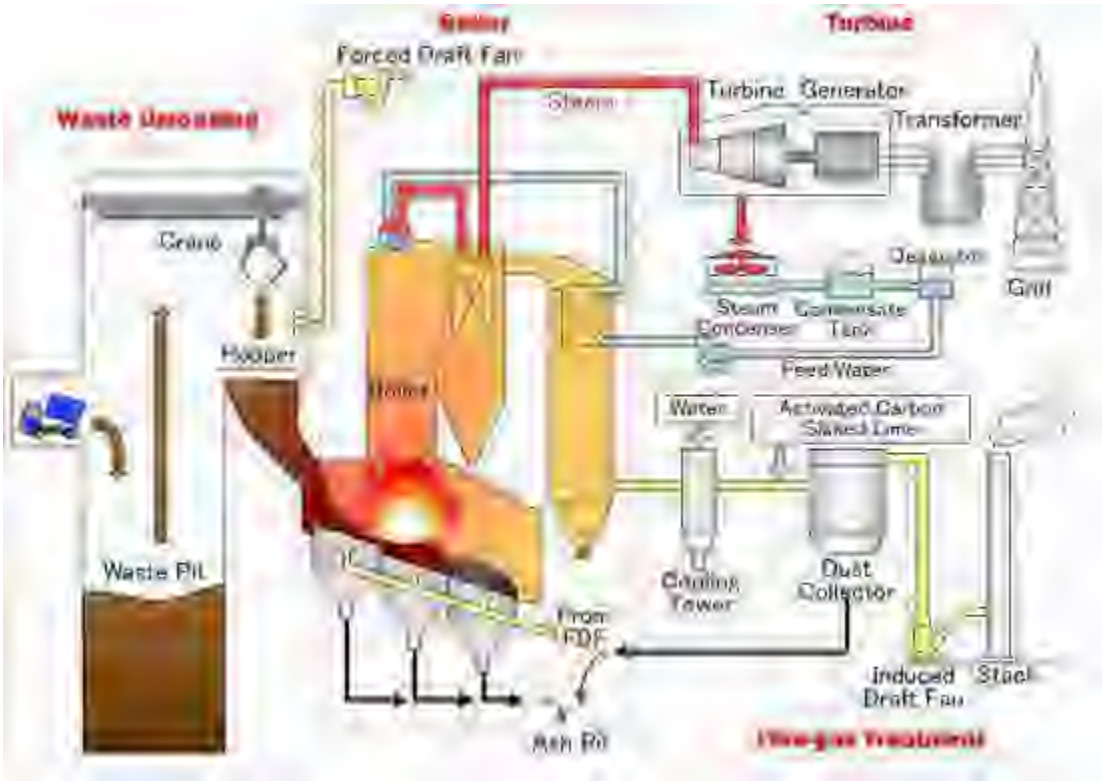


Figure- 7: Schematic –Combustion& air pollution control

Reverse Reciprocating with forward feed inclined grate has performed most successfully in WtE projects under different fuel conditions all over the world. MSW 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 MSW moves through the furnace. Primary combustion air is Preheated to dry the fuel and then allow complete combustion. 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.

03.06 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 modification.

Flow Diagram for Combustion boiler and Flue Gas Treatment is shown in Drg. No. 1814-002 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 fresh slaked lime powder 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.

03.07 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.

03.08 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.

03.09 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.

Part quantity of leachate collected is recycled for compost curing process. Balance is treated and only treated water is used as service water. Recovered slurry is fed back to the incinerator along with MSW fuel.

03.10 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 and consequently the pressure at around 42 kgf/cm^{2}(a).

JUIL has successfully implemented WtE project at Okhla based on reciprocating forward feed grate and Rankine technology at their Okhla plant. The project has been operating at desired PLF level of more than 80% since commissioning.

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

As RFP minimum power generation should be 25 MW. Considering internal requirement, provision will be kept in Turbine capacity to take care of power generation potential in future when quality and quantity of waste improves in future.

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

- MSW / Boiler feed storage Pit
- 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

04.02 Material Receipt

04.02.1 Weigh Bridges

Three weigh bridges of minimum 60 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 4: Technical requirements Weigh-bridge

Weigh-bridge type	:	Electronic type with load cells
Material handled	:	MSW trucks, compactors and other vehicles
Weigh-bridge capacity	:	60 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 SDMC. 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

As per LOA issued by SDMC for WtE project at Tehkhand, minimum handling capacity should be 2000 TPD of MSW. Considering 4% CAGR in MSW availability is likely to increase. Considering a cap on MSW supply at 120%, the fuel preparatory system has been designed to handle 2400 TPD MSW at present with additional margin of 20% for future needs. 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. 1814-002 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.

Three EOT (Electric Overhead Travel) cranes, two being installed presently and third one in future, with orange peel grab will be provided for handling of material. Main functions of cranes will be :

- Transfer of received MSW to storage heaps.
- Feeding hoppers of MRF facility
- Making heaps of segregated MSW for boiler feed.
- Feeding of boiler hoppers.

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.

For design of system, following parameters have been assumed

- Inert Material : ~15%
- Metals & recyclables : ~ 1 %
- Fine fractions : ~ 5%
- Moisture removal : 18% (15% as leachate & 3% evaporation)

Table 5: Capacity of Material Recovery Facility

Handling capacity of MRF	TPD	2400
Number of parallel streams	No.	2(Working)+1(Future)
Handling capacity of each stream	TPH	60
Operating Hours for each stream	Per day	~20
Capacity of common conveyor for Boiler Feed	TPH	120

Table 6: List of equipment for Material Recovery Facility

Equipment	Quantity
Feeding Hoppers	3
Ram Feeders complete with hydraulic arrangement.	4 nos. (Working in tandem)
Magnetic Separator	3
Ferrous Material Bin	1 for manual sorting belt at discharge of magnetic separator.
Ballistic Separator	3
Shredder	3
Belt Conveyors	3 Sets
Structure	1 Lot (Open gantries with both side walkway, trestles and transfer tower for belt conveyor.)
Chutes	All interconnecting chutes

Table 7: List of Belt Conveyors for Material Recovery Facility

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

Broad specifications of equipments for Material Recovery Facility

The broad specification of the material recovery facility equipments is summarized in the Table 8 below.

Table 8: 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. Two number boilers having steam generation capacity of 2x65 TPH and with RDF throughput equivalent of 600 TPD each have 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 from 1,100 to 2,500 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.

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 9: Specification of the boilers

Particulars	Unit	Value / Description
Number of boilers	No.	2
Boiler grate		Reciprocating forward feed-air cooled
Boiler type		Vertical
Boiler steam capacity (MCR)	t/h	65
Superheated steam pressure	kgf/cm^2 (a)	53
Superheated steam temperature	^{0}C	400
Feed water temperature economizer inlet	^{0}C	130
Fuel density	kg/m^3	500-600
RDF GCV limit-operational stability & safety	kcal/kg	1100-2500
Excess air	%	30% - 70%
Primary air temperature	^{0}C	220 - 240
Secondary air temperature	^{0}C	150
Efficiency	%	78 - 80
Exit flue gas temperature economizer	^{0}C	170 -190
Peak capacity	%	110 MCR
Steam Quality at MSSV outlet		
Conductivity measured at 25 °C	µS/cm	< 0.2
Silica as SiO_2	ppm	< 0.02
Hardness as $CaCO_3$	ppm	Nil
Bottom ash (Grate ash, Bank, Economizer)		Water cooled
Fly ash		Dense Phase Pneumatic Conveyor

Table 10: Boiler Auxiliaries

Particulars	Description
De-aerator	1 Common for two boilers
Boiler feed water pump	2W+1S, for two boilers with VFD control
PA fan	1W for each boiler with VFD control
SA fan	1W for each boiler with VFD control
ID fan	1W for each boiler with VFD control
FGCS	Two sets, 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 (NO_X) 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 (NO_X), 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 by Flue Gas Treatment

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 950 ^{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 to occasional operational instability.

The dry Flue Gas Treatment (FGT) system is the most attractive option wherein reactant is injected in as dry powder in a circulating fluidized type reactor allowing contact between gases and reactant. To get an optimum temperature for reaction to take place, conditioning of flue gas is done by spray of controlled quantity of atomized water.

Activated carbon is also injected to adsorb toxic components from the gases. Layer of reactants formed on the surface of filter bags also helps in trapping the pollutants. Advanced material selection for filter bags can result in particulate emission levels below the present CPCB norms.

'Advanced' SNCR systems can achieve NO_x emission guarantees of around 100 mg /Nm³. 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/Nm³ 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.

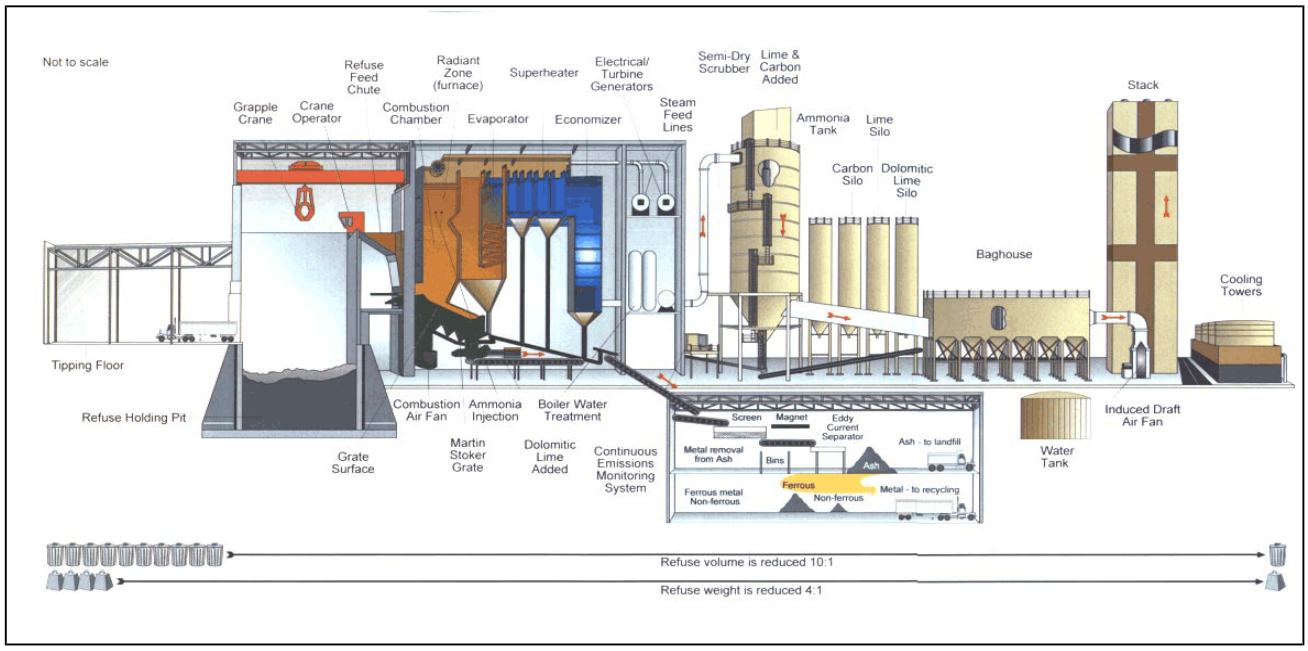


Figure- 8: General Process for Emission Control System

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)

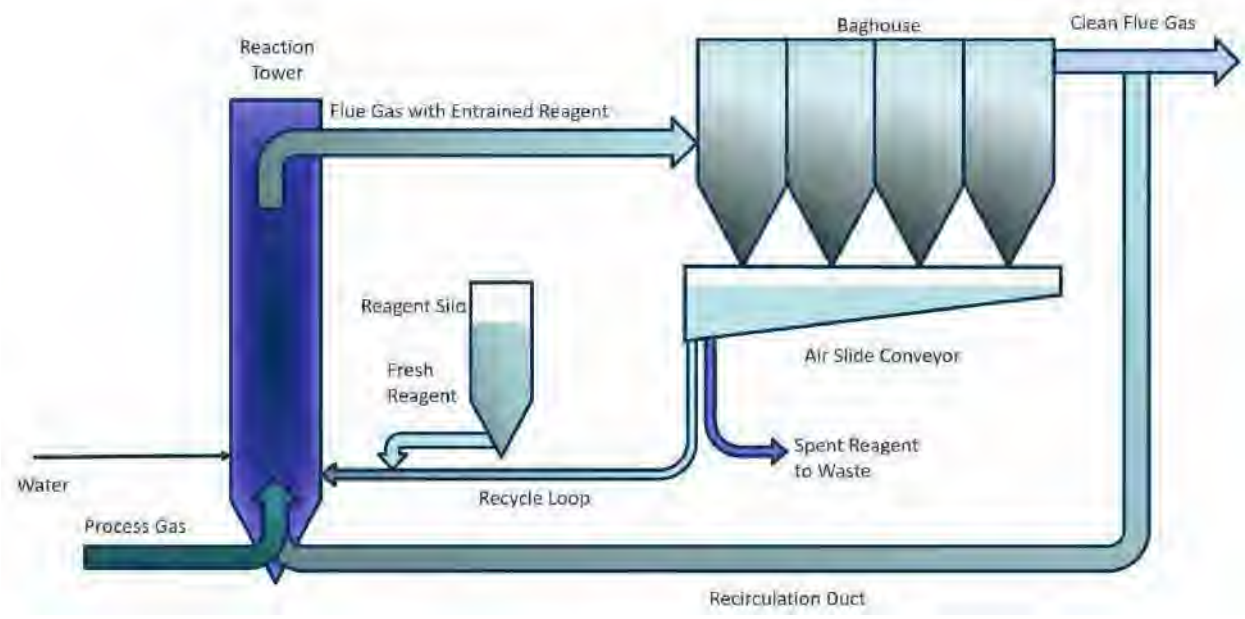


Figure- 9: Flue Gas Treatment Process Flow

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.

As per RFP stringent norms as per European Directive 2000/76/EC have been adopted in addition to CPCB norms. The standards to be adopted are indicated in table below :

The incinerators shall meet the following operating and emission standards mentioned in SWM Rules, 2016 and EU Standards.

Operating Standards

- Plant shall be operated (combustion chambers) with such temperature, retention time and turbulence, as to achieve total Organic Carbon (TOC) content in the slag and bottom ashes less than 3%, or their loss on ignition is less than 5% of the dry weight.
- The CO_2 concentration in tail gas shall not be less than 7% and CO should not be more than 100 mg/Nm^3.
- If the concentration of toxic metals in incineration ash exceeds the limits specified in the hazardous & other wastes Rules 2016, as amended from time to time, the ash shall be sent to hazardous waste treatment, storage and disposal facility.
- Suitably designed pollution control devices shall be installed or retrofitted with the incinerator to achieve the emission limits, if necessary.
- Wastes to be incinerated shall not be chemically treated with any chlorinated disinfectants.
- Chlorinated plastics shall not be incinerated.

Emission Standards

The stack emission should be in certain limits as tabulated below, the design emission control system shall meet stringent European norms (EUROPEAN DIRECTIVE 2000/76/EC) and MoEF norms as given in Table below.

Table 11: Emission norms

Parameter	Type of measurement	Daily averages (where continuous measurement used) in mg/m3	Half hour averages (where continuous measurement used) in mg/m3
	C: continuous N: non-continuous	Limits in 2000/76/EC	Limits in 2000/76/ EC
Particulate Matter	C	10 at STP	20 at STP
HCl	C	10 at STP	50 at NTP**
HF	C/N	1 at STP	4 at STP
SO2	C	50 at STP	200 at STP
NOX	C	200 at STP	400 at STP
VOC (as TOC)	C	10 at STP	20 at STP
CO	C	50 at STP	100 at STP
Hg and its components **	C/N	0.05 at NTP (Standard refers to sampling time anywhere between 30 minutes and 8 hours.)	n/a
Cd +Th + their components **	N	0.05 at NTP (Standard refers to sampling time anywhere between 30 minutes and 8 hours)	n/a
Sb + As + Pb + Cr + Co + Cu + Mn + Ni + V + their compounds**	N	0.5 at NTP (Standard refers to sampling time anywhere between 30 minutes and 8 hours.)	n/a
Total dioxins and furans**	N	0.1 at NTP*** (Standard refers to 6 -8 hours sampling. Please refer guidelines for 17 concerned)	n/a

Remarks:

- Emissions referring to dry gas at 11% O_2
- Minimum stack height shall be 60 metres above ground
- Volatile organic compounds in ash shall not be more than 0.01%.

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 12: Ash generation

Particular	Unit	Value
Fuel	t/d	2400
Ash	%	14
Ash	t/d	336
Bottom ash	t/d	252
Fly ash	t/d	84

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 13: Ash handling capacity

Particulars	Unit	Value
Ash extractor	t/d	350
Bed ash temperature	^{0}C	800
Temperature of discharge	^{0}C	35
Water required	t/h	5.25
Factor of margin	%	20
Water required	t/h	6.3
Vibrating conveyor	t/d	350

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.

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).

04.04.4 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 the turbine has been accordingly configured so that both the operational requirement of the SCAPH and overall performance requirement are optimally met.

Capacity of Steam Turbine Generator will have a margin to take care of improvements in fuel availability as well as quality of MSW in future.

Table 14: Specifications of turbine

Parameters	Unit	Value/ Description
STG		1 x 25 MW
Type		Impulse + reaction
Steam pressure	kgf/cm^2	52.38
Steam temperature inlet	^0C	395
Steam flow inlet	t/h	125
Exhaust steam pressure	kgf/cm^2	0.18

Exhaust steam flow	t/h	99
Mechanical efficiency	%	>95%

(Part of steam is extracted as bleed for SCAPH and deaerator heating)

Table 15: Specifications of Alternator

Parameters	Unit	Value
Codes and standard		IS/IEC
Design ambient temperature	°C	50
Design relative humidity	%	60
Frequency	Hz	50 (-5% to+3%)
Generating voltage	kV	11±10%
Quantity	No.	1
Rating	MVA	31.25
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 16: Specifications of Gear box

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

04.04.5 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 favorable 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. The amount of blow down is governed by the concentration of the dissolved salts in the make-up water. Water cooled condensers are preferred when quality of input water is good with low TDS.

It is proposed to use the treated sewage water for the power generation. Water from STP contains high TDS as well as residual BOD and COD content. This water is required to be treated to make it suitable for make-up for cooling towers. In case of water cooled condensers, size of water treatment plant is large and effluent generation in form of rejects from treatment plant is also high.

Air Cooled Condensers can be used for condensing the steam by forced circulation of atmospheric air across finned tubes.

Comparison of Water and Air Cooled Condensers is given in Table below :

Table 17: Comparison between ACC & WCC

Particulars	ACC	WCC
Cooling media	Air	Water
Vacuum at STG exhaust	>0.18	>0.10
System efficiency	Lower	Higher
Application	Scarcity of water	Abundant water
	High treatment cost of water	Water quality good
Investment	High	Low
Operating cost	Low	High
Auxiliary power	Low	High

Table 18: Water requirement

Parameters	ACC	WCC
Cooling tower water make up (t/d)	300	4000
Effluent (t/d)	~100	1200

Major requirement of water in WCC option is for make-up to cooling towers. In case of ACC no water is used in condensers. Water requirement is only for auxiliary and process needs.

In case of ACC, total effluent generated can be utilised in the plant for various service requirements including ash quenching, horticulture, dust suppression, etc. It will not be possible to achieve zero discharge from plant without treatment for recycling of the high TDS effluent generated with WCC option.

In case of Tehkhand project site, Sewage Treatment Plant (STP) is located far away from the WtE Plant site and cost of transportation and treatment will be high. Therefore, ACC option is adopted for the project.

The auxiliary power required for MRF processing facility and the power plant have been estimated at about 1875 kW and 2500 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. With a view to determine the exportable power the overall auxiliary consumption has been computed as follows.

Table 19: Requirement of Auxiliary power

Particulars	Unit	Value
Power generation	MW	25
Only power plant operation	H	8
Process operation	H	16
Only power plant auxiliary load	%	10.00
Power plant auxiliary load only	MW	2.5
Energy required for only power plant operation	MWh/d	20
Auxiliary load when process is in operation	%	17.50
Power required during hours when process is in operation	MW	4.375
Energy required during process operation	MWh/d	70
Energy required	MWh/d	90
Auxiliary average during 24 hours	%	15%

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. 1814-002 Sh.5

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 20: Water properties

Particulars details	Unit	Raw Water Quality
(Treated Water from STP)		
Total Suspended solid (TSS)	mg/l	763
Total Dissolved Solids (TDS)	mg/l	810
Hardness as CaCO3	mg/i	276
Chloride (as Cl)	mg/l	158
Chemical Oxygen demand (COD)	mg/l	32
Biochemical Oxygen Demand (BOD)	mg/l	7
Dissolved Oxygen	mg/l	3.4
pH		7.5 – 7.8

(Treated Sewage water data from 30 MGD STP of DJB as per Sample at existing STP in 2017

STP treated water will be available for the plant from Okhla STP of Delhi Jal Board. SDMC will make available water at project site by laying pipeline for a distance of nearly 8km.

Water Requirement

For the purpose of this report treated water available from STP is taken as input. Total requirement of treated STP water for the project is estimated as 900 m^3/day as per water balance. To minimize the water consumption, part of effluent has been considered for re-cycling back to the treatment plant and part which can not be re cycled will be use in areas like ash quenching, green belt, dust suppression, etc. Plant design will be based on concept of Zero discharge of effluent.

Estimated raw water consumption after considering re-circulation is as follows :

• Cooling Tower Evaporation	:	160 KLD
• Process requirement of Flue Gas Cleaning (Gas cooling, SNCR and lime hydration)	:	460 KLD
• Effluents used for ash quenching (Blow downs & rejects from treatment Plant)	:	100 KLD
• Service water	:	225 KLD
• Green Belt & other misc.	:	65 KLD
• Sludge fed to incinerator	:	50 KLD
• Losses	:	20 KLD
TOTAL	:	1080 KLD
• Recovered Water from LTP	:	180 KLD
NET WATER REQUIREMENT	:	900 KLD

Water balance is enclosed as Drawing No. 1814-002 Sh05

Source of Water

Water requirement for the project will be met from treated water available from Sewage Treatment Plant of Delhi Jal Board. Water from source will be supplied to WtE Plant by underground pipeline and stored in a Raw Water Reservoir.

Water Treatment

The proposed scheme for treatment of available water from STP and water balance is shown in the enclosed drawing no. 1814-002 Sh05. The scheme is described below in brief:

Treated water from STP of Delhi Jal Board located at Okhla will be transported to project site by long distance pipeline. Water from SPP will be stored in a Raw Water Reservoir.

Estimated consumption of the plant including reject water shall be 900 KLD. However, raw water treatment capacity shall be taken as 40 m^3/h. The water from Raw Water Reservoir shall be pumped to pre treatment unit where BOD, COD and TSS, odor and part TDS shall be removed by suitable process. Sludge recirculation system with sludge treatment including filter press shall be provided. The pre treated water shall be stored in a tank for feeding to further treatment. One part of this water shall be used as service water and other part of the water shall be fed to suitable UF, RO-1 & RO-2 systems to reduce Hardness and TDS. From this outlet one part shall be used for cooling tower as make up water and remaining shall be used as feed to DM plant.

The DM Plant shall consist of Mixed Bed Exchanger. The DM water shall be stored in a tank after pH correction for Boiler feed. The capacity of DM plant shall be 15 m^3/hr In addition to supply of make up water for boiler feed, DM water plant will also meet the requirement for urea solution plant of SNCR.

Regeneration arrangement for Exchanger shall be suitably provided by the supplier. All reject from filters, UF & water from filter press etc shall be Recycled and back to equalization tank. Rejects from RO and MB shall be collected in a drain sump/tank for ash quenching, dust suppression etc. Part of the pretreated water shall also be used as service water for general purpose, cleaning and washing etc.

Equipment for Water Treatment Plant

The systems shall be complete in all respects to provide required quality of water. Plant shall be designed for continuous operation and standby equipment/ steams shall be included to take care of maintenance.

Pre Treatment Unit

Suitable process to reduce the TSS, BOD and COD of incoming water is to be adopted. It is envisaged to have pre treated water of TSS less than 5 PPM and BOD, COD less than 5 and 30 PPM respectively. Process shall include system for partial reduction of TDS so that output water can be used as cooling tower make up after softening.

Biological process in combination with treatment and filtration equipment may be provided as per process design selected by Vendor. Suitable Air Blowers for Aeration tank and for sludge holding tank shall be used.

Arrangement for back washing and cleaning of filter media with the help of Air and water shall be provided. Suitable dosing shall also be provided for recovery cleaning.

UF and RO systems

After Pretreatment water will go to Ultra filtration Unit. In this unit silica will reduce to a suitable quantity.

RO-1 will consist of 2 stage , Reject of stage 1 will go stage 2 . Permeate from stage 1 and stage 2 will be collected in RO-1 permeate tank. Water from RO-1 permeate

Tank and UF permeate tank will go to Cooling water make up. Other part of RO-1 permeate will go to RO-2 & RO-2 permeate will go to RO-2 permeate tank. Reject of RO-2 is of good quality so it shall be gone to RO-1 inlet.

DM Plant

DM plant of 15m3/hr capacity shall be designed to deliver make up water for boiler feed. Part of the water from outlet shall be fed into inlet of DM Plant.

Table 21: Parameters of Cooling tower

Particulars	Unit	Value/ Remarks
Flow	m^3/h	300
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	^0C	42
Temperature of cold water outlet of cooling tower	^0C	32
Dew Point	^0C	23
Wet bulb	^0C	28
Range	^0C	10
Approach	^0C	4

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 22: Compressed air requirement (Nm3/h)

Applications	Instrument air	Service air
Boilers	300	600
Flue gas cleaning system	300	1500
STG set	30	-
Air cooled condenser	30	-
Ash handling system	20	300
Others BOPs and actuators	20	100
Sum Total	700	2500
Design with margin	800	3000

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

Table 23: Quality requirement for Compressed air

Particulars	Unit	Service air	Instrument air
Moisture content	Dryness [^{0}C]	+3	-40.0
Oil content	ppm	<2	< 0.0003
Minimum pressure	kgf/cm^2	6.5	8.5

It is proposed to install separate set of compressors to supply instrument and service air.

For Service air, oil lubricated screw compressors will be installed (3W + 1S) followed by Refrigerant type dryers.

For supply of Instrument air, non lubricated compressors will be installed followed by heatless type desiccant driers.

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 Compressed Air is shown in Drawing No. 1814-002 Sh06

04.05.3 HVAC System

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

Table 24: 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.

Maximum ambient temperature considered for design will be 55 deg C considering the summer conditions in the region. The design basis for HVAC system is as shown in table below:

Table 25: 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	500	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	320	Vapour-compression and absorption chillers	1 x 100 TR (screw compressor)
Ventilation with lower heat load	Closed RCC Hall	Electrical panel, PCC & MCC area	300	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	MSW Pit area	-	To be covered by the PA suction	-
Ventilation with lower heat load	Shed	Local Control Room (2 No.)	15 (each)	Ceiling fans	2
Sub cooling with electronics heat load	Closed RCC	Local Grab Control Room for MSW pit	15	Split air conditioner	1 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 26: Fire Fighting System

Description	Unit	Values
Main fire pump electrical driven		
No of Pumps	No.	1
Size	m^3/h	273
Diesel engine driven fire pump		
No of Pumps	No.	1
Size	m^3/h	273
Jockey pump		
No of Pumps	No.	1
Size	m^3/h	16.8

Pump House configuration is shown in Drawing No. 1814-002 Sh. 07

04.05.5 Effluent Treatment

Effluent is generated from three main sources:

1. Blow down from cooling tower and Boiler
2. Reject & back wash from water treatment section
3. Leachate from the MSW Storage

Reject from the back wash of the equipment's in water treatment section is re cycled in treatment plant itself. This will optimize the requirement of water from STP.

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).

Rejects from RO systems of WTP as well as blow downs will have high TDS and this will be used for bottom ash cooling and floor washing.

Leachate from MSW storage will be collected, treated and used in the Boiler.

Effluent generation is shown in Water Flow Diagram Drg. No.1814-002 Sh 05.

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.

Treatment Process

Estimated generation of leachate will be in the range of 100 KLD to 300 KLD depending on season. However, leachate treatment capacity shall be taken as 20 m^3/h.

Raw leachate from the collection pit in MSW handling area shall be pumped to the inlet of Leachate Treatment facility.

Primary treatment unit will be provided to reduce the suspended solids and part BOD, COD by suitable process. Process may include biological treatment, pH correction, coagulation, settling, filtration. Sludge recirculation system with sludge treatment including filter press shall be provided. Sludge recovered is proposed to be mixed with boiler fuel.

The pre treated water shall be stored in a tank for feeding to further treatment. Secondary Treatment will be designed to convert the leachate to slurry. Multi effect evaporation system is proposed for this stage. It is expected that slurry will have concentrated organic matter which can be injected in to boiler furnace for heat recovery. Recovered condensed water shall be utilized for ash quenching and other process requirements.

The system shall be designed for continuous operation under variable flow rates and input quality.

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 27: 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 28: Design Parameters for Electrical System

		Power Evacuation System	Power Generation system	Distribution System
Nominal System Voltage	:	66 kV	11 kV	415 V
Highest System Voltage	:	72.5 kV	12 kV	433 V
Frequency	:	50 Hz		
Voltage variation	:	±10%		
Frequency variation	:	±5%		
Combined variation	:	±10%		
Impulse Voltage withstand level.	:	325 kV $_{Peak}$	75 kV $_{Peak}$	
One min. Power Frequency withstand voltage	:	140 kV $_{rms}$	28 kV $_{rms}$	
Rated Short time Thermal current	:	TBS*	40 kA	65 kA / 50 kA
System Grounding	:	Solidly Grounded	Through NGR	Solidly Grounded

* To be specified as per system parameter of DISCOM

Proposed Power Distribution Scheme is as shown in Drg No. 1814-403 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 25 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 66/11 kV, 35/40 MVA Transformer, for power evacuation to the Grid by laying 66 kV transmission line up to grid sub station coming up at Tuglakabad at a distance of about 2 km from project site. The grid substation will also have adequate land available for installation of the 66 kV bay link for the project.

Table 29: Brief Specification Switchyard

Service Type	:	Outdoor
No. of Pole	:	Three (3)
Nominal System Voltage	:	66 kV
Highest System Voltage	:	72.5 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

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. 1814-403 Sh01

Table 30: Brief Specification of Power Transformer

Service Type	:	Outdoor, Oil filled
Numbers	:	1
Rating	:	35/40 MVA
Rated Voltage	:	66/11 kV ±10%
Frequency	:	50 Hz ±5%
Design Ambient temp.	:	50^0C
Vector group	:	Ynd1
% Impedance	:	10%
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)	:	140 kV
LV Winding (kV rms)	:	28 kV
Full wave lightning impulse withstand voltage		
HV Winding (kV_p)		325 kV
LV Winding (kV_p)		75 kV

Tariff Metering

Export/Import energy meters of 0.2s accuracy class as stipulated by DISCOM will be provided at the 66 kV evacuation sub-station. As per proposed 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 31: Brief Specification of DG set

Duty	:	Continuous
Quantity	:	One (1)
Continuous rating	:	900 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 66 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 110 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 32: Brief Specification of Distribution Transformer

Service Type	:	Outdoor, oil filled
Numbers	:	3
Rating	:	2.5 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 33: 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 34: Brief Specification of Motors

Type	:	Induction motor, Energy efficient IE-3
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. 1814-412 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 04.05.7 above.

Figure- 10: Typical Stack Monitoring Device

05 PLANT LOCATION AND LAYOUT

05.01 Plant Location

New SDMC Waste to Energy Plant is proposed to be located at Tehkhand, Okhla Phase-1. Salient features of the plant site are as follows:

- Area	:	Tehkhand, Okhla Phase -1
- District	:	South West - Delhi
Nearest Railway Station	:	Tughlakabad
Nearest Airport	:	Delhi
Nearest Access Road	:	Maa Anandamayee Marg, Mehrauli-Badarpur Road
Nearest Highway	:	NH-2 Delhi – Mathura Road
Source of Water	:	Treated Waste Water from Okhla STP
Total Land Area of Existing Plot	:	15 Acres
Latitude	:	N 28° 30′
Longitude	:	E 77°47′
Site Elevation	:	190 m above MSL

Location Map is shown in Fig – 11

Land is allocated by DDA to South Delhi Municipal Corporation (SDMC) in Tehkhand near exiting land fill site in Okhla Phase-I. Site is connected to NH-2 by Maa Anandmayi Marg and Mehrauli – Badarpur road. Plan of the site allocated for the project is shown in Fig – 12.

Figure- 11: Location Map

Figure- 12: Plot Location

SITE FOR WtE PLANT AT TEHKHAND

05.02 Land-Use – WtE Plant

SDMC has earmarked 15 acres land for the project and the plot will be carved out of land taken over by SDMC for developing WtE project as well as SLF. As per layout, about 15 acres of land will be used for the project. 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 4 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. SDMC has also planned a green area between plant boundary and main road.

05.03 Proposed General Plant Layout

Layout of proposed MSW Processing Facility with Power Plant is shown in Drg No. 1814-001 Sh 01. 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) MSW & RDF pits are located in a closed shed with convenient transfer of received MSW from dump pits to the drying pits using grab cranes.

iv) Manual and mechanical segregation facilities are connected by belt conveyors with MSW & RDF storage pits.

v) 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. Cooling Tower 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) Separate area is allocated for compost curing, screening and storage, Fly ash brick making and bottom ash processing.

x) 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.

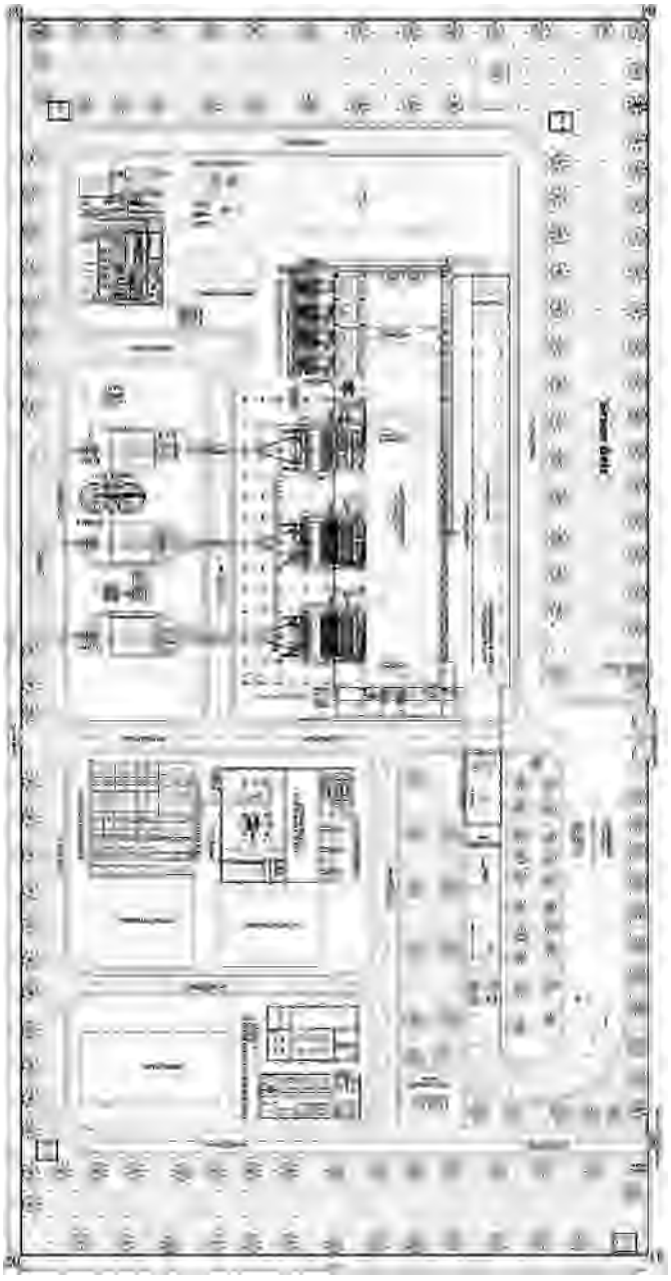


Figure- 13: Plant Layout - Tehkhand

05.04 Site Analysis

Project is located within the Area earmarked by SDMC for setting up of Waste to Electricity Plant and Sanitary Land Fill as per overall Waste Management Plan.

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

The site is easily approachable from NH-2 and arterial roads, therefore, well connected with municipal areas of South and west Delhi.

For disposal of non-combustible inert, sanitary landfill to be developed by SDMC is also located nearby.

Site is surrounded by dense growth on south side and forest area of Tuglakabad on west side.

06 REQUIREMENT OF LAND, SHEDS & BUILDINGS AND CIVIL WORKS

06.01 Requirement Of Land & Land Development

15.0 acres of land is required within which various facilities envisaged for the project are to be accommodated. Land lease agreement with SDMC for the plot is yet to be signed.

Land is uneven with boulders and weathered rocks. Site grading work will be carried out to the extent required. In low lying area, pits and reservoirs will be located.
Some existing sheds and foundations of previous construction are present which need to be demolished as per site requirement. Some trees and shrubs in the area need to be cut to make area available for development.

The dedicated land for power plant is developed as per the land profile assessed during visit to site. 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. Space is available around the periphery for developing additional buffer green belt.

06.02 Sheds & Buildings

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

Material Recovery Facility:

- Operator cabin for Weigh Bridges
- Shed for Manual & Mechanical segregation facility
- Compost processing shed

Boiler Island:

- Tipping Floor for receipt & unloading of MSW
- MSW Storage pit shed with EOT Grab Cranes
- Electrical Room for Flue Gas Cleaning System
- 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
- Boiler foundation, Flue Gas Cleaning system pedestals & 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

During construction period, the site shall be managed by the construction/ erection Contractors who shall be responsible and accountable for all activities on site.

Contractors shall have designated person for liasoning with site engineers 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.

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.

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 LeachateTreatment Plant.

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 20 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 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

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. Bottom ash will be used for making construction aggregate and fly ash will be used for making bricks.

Only residual inerts, which can not be converted to useful products 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

MSW/ RDF Storage

The proposed facility will have seven to ten days storage for boiler. 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.

Leachate Collection Pit & Circulation System -A leachate collection pit with suitable having capacity has been provided to collect the leachate generated from MSW storage. The leachate generated is collected in sump and pumped to the treatment plant for re-use.

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.

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- 14.

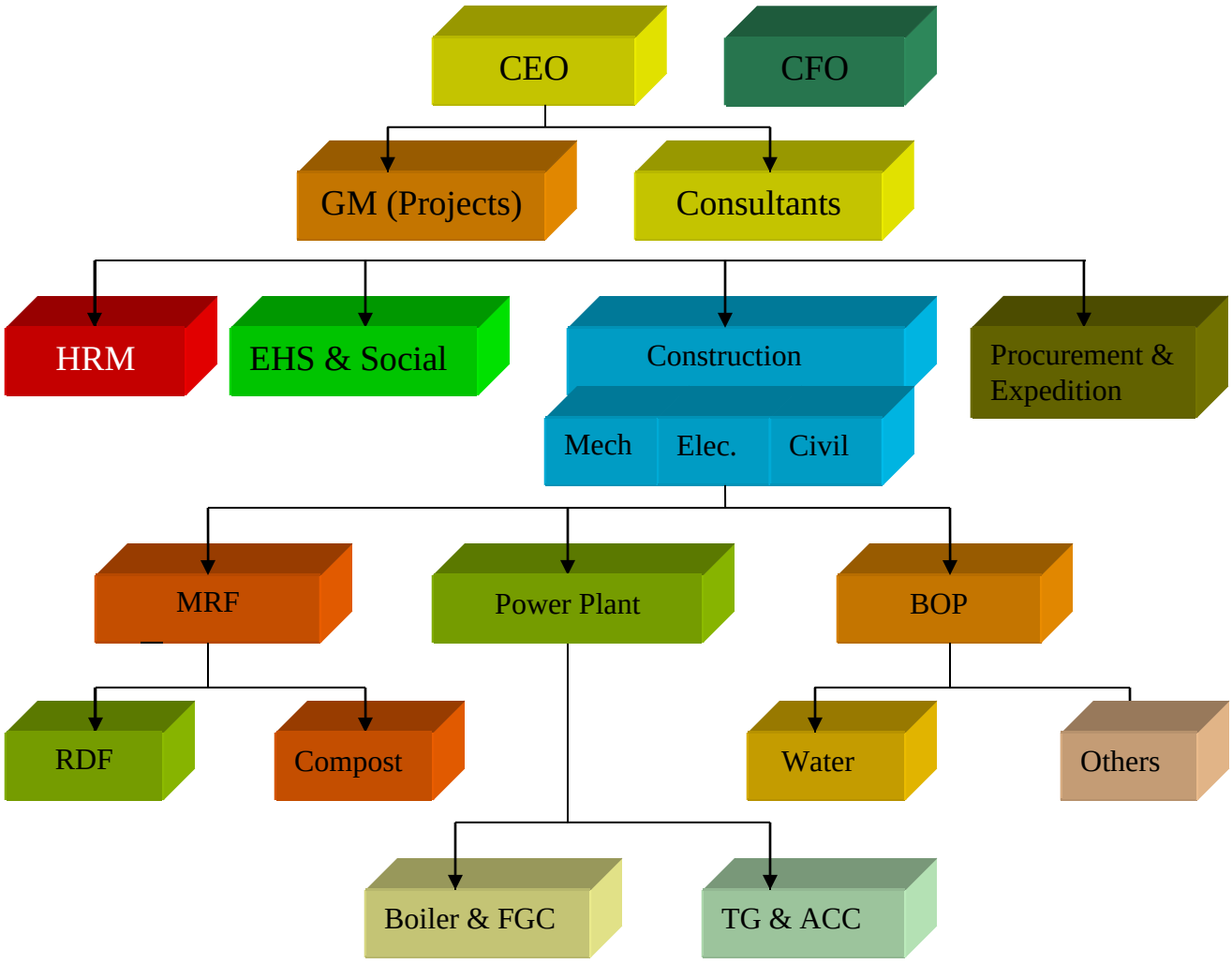


Figure- 14: Organization for Project Implementation

Table 35: 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 Operation of the WtE plant post construction Environment management for the WtE plant	WtE/Power/Captive power projects 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
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.

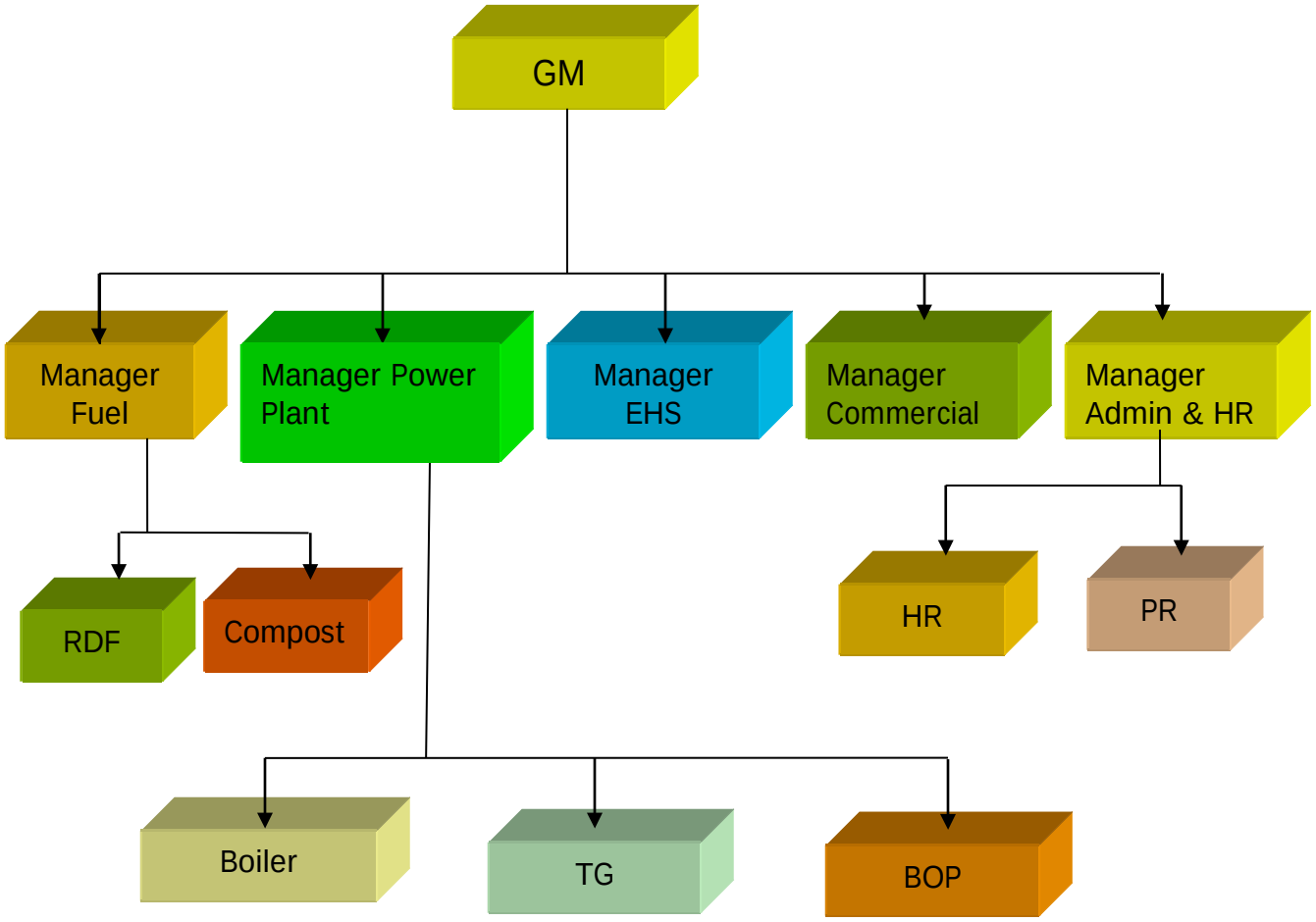


Figure- 15: Organization Operation & Maintenance

Table 36: 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			2
	Grab Operator	Grab operation	2	2	2	2	8
	Helper	To look/poke hoppers	2	2	2	2	8
	Supervisor	Manual Sorting Activities	1	1	1	2	5
	Helper/Pickers	Manual Sorting at lines	3	3	3	5	14
	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
	Separator Operator	Operation of Power pack	1	1	1	2	5
	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	5

Sl. No.	Designation	Task	Shifts				Total
			A	B	C	G+R*	
	Electrician	R&M	2	2		1	5
	Electrical Engineer (Shift)	R&M	1	1			2
	Turner	Lathe Operation				1	1
	Welder	Welding Work				2	2
	Helper	Helper in Workshop				2	2
	LTP Operator	LTP Operation				2	2
	Chemist for Lab	Testing				2	1
	TOTAL		28	28	15	38	108

Sl. No.	Designation	Task	Shifts				Total
			A	B	C	G+R*	
Power Plant							
	Shift In charge	Power plant Operation & Maintenance	1	1	1	1	4
	Boiler Attendant	Boiler & FGCS Operation	1	1	1	1	4
	Asst. Boiler Attendant	Boiler & FGCS Operation	3	3	3	3	12
	Fireman / Helper	Boiler & FGCS Operation	3	3	3	5	14
	TG Operator	Operation of TG & ACC	1	1	1	1	4
	Power House assistants	Operation of TG & ACC	2	2	2	2	8
	Operators	BFP & Deaerator	1	1	1	1	4
	Supervisor	Primary Water Treatment Plant	1	1	1		3
	Operator	Primary Water Treatment Plant	1	1	1	1	4
	Operator	RO Plant & Cooling Tower Operation	1	1	1	1	4

Sl. No.	Designation	Task	Shifts				Total
			A	B	C	G+R*	
	Helper	RO Plant & Cooling Tower Operation	1	1	1	1	4
	Chemist	Sample collection & checking	1	1	1	1	4
	Fitter	Maintenance of Power Plant	1	1	1	2	5
	Asst Fitter	Maintenance of Power Plant	1	1	1	2	5
	Welder	Maintenance of Power Plant	1	1	1	1	4
	Helper	Maintenance of Power Plant	1	1	1	1	4
	Operator	Operation of Turbine & ACC	1	1	1	1	4
	Helper	Operation of Turbine & ACC	2	2	2	1	7
	Shift In-charge	Electrical Operation & Maintenance	1	1	1	1	4
	Electrician	Responsible for Electrical Operation & Maintenance	1	1	1	1	4
	Helper	Electrical Operation & Maintenance	1	1	1	1	4
	Shift In-charge	Instrumentation & Automation	1	1	1	1	4
	Technician	Instrumentation & Automation	1	1	1	1	4
	TOTAL		29	29	29	31	118

** G + R represents General Shift and relievers.*

09 PROJECT IMPLEMENTATION SCHEDULE

09.01 Implementation Schedule

The Project Implementation Schedule shown in the form of a Bar Chart in Annexure-9.1 has been developed on the basis of the estimated duration of activities from date of LOA to commissioning. Construction phase is based on quantum of Civil and Structural Works to be executed at site, expected delivery schedule of the various equipment proposed to be installed and expected time period for the erection, testing and commissioning of equipment. As per LOA, project is to be completed within 27 months from signing of Concession Agreement. Concession agreement is expected to be finalized by July 2018 and financial closure is expected by Aug, 2018.

Activities up to preparation of DPR, which have been completed are also shown in the chart.

Detailed engineering and procurement process for major equipment has also started concurrently and ordering can be done soon after financial closure.

It is estimated that the procurement of equipment, engineering, construction of sheds, buildings and equipment foundations, erection of equipment, piping and cabling work shall be completed in a period of 14-15 months from order placement of major equipment. Another 2 months will be required for conducting the commissioning and Trial run of all systems and integrated facility. There after the commercial production shall commence. Commercial operation is expected to start by September 2020.

09.02 Project Implementation Strategy

There are some unique features of these WtE projects that would require an innovative implementation strategy for conformance with the bid conditions as articulated in the concession agreement as well as project performance objectives.

The project implementation strategy has been developed with a view to ensure that the cost of the project is managed within the budget and the cost as well as the implementation schedule does not get adversely impacted as a result of IE intervention.

09.02.1 Contracting Methodology

It is often believed that the best way to manage the project cost is by award of EPC contract to reputed contractors as opposed to EPCM strategy adopted by developers of smaller projects.

In a traditional EPC contract the owner contracts a company (EPC Contractor) to provide engineering, procurement and construction services for the entire project. The project is therefore largely managed by the contractor who also bears the associated risks. The EPC Contractor has direct contracts with several sub-contractors. The features of these contracts include:

- Better control on project cost and no adverse impact due to cost overrun.
- Lesser man-power requirement for project organization (to owner)
- Lesser transaction cost (to owner)
- High degree of risk for contractor
- Higher cost of the project due to owner (10-20%)

In EPCM (Engineering, Procurement and Construction Management) mode a company is contracted by the owner to provide engineering, procurement and construction

management services. Alternatively, consulting Company is engaged for providing all engineering and technical services with full responsibility of Project Integration. Project is split in to various supply and service/ construction packages. Procurement services, Project Management as well as Site services are controlled directly by Owner Company. This mode of implementation scores over the EPC on the following:

- Lesser overall project cost
- Better control on specifications and quality
- Flexibility in technology decision making
- Easy to implement changes, if required
- Better control on project cash flow

However, it becomes critically important to develop a robust project implementation organization for managing the project in the package route.

In this particular case, EPC option may not produce the desired result due to the following reasons:

- Very few WtE projects have so far been implemented in India and as already stated their track record is quite unsatisfactory.
- EPC contractors in the power sector are not very familiar with the technology for MSW handling and processing as well as cost of such projects.
- It would be necessary to carry out cost optimization exercise at every stage of the project development for ensuring financial viability of such projects. It would be very difficult to enforce such a review system on EPC contractors.
- During the stage of detailed engineering, it may become necessary to change specifications of some of the equipments/systems as a result of feedback from monitoring agency. EPC contractor may not either agree for such changes or ask for disproportionate cost escalation.

On the other hand, JUIL has already successfully implemented both MRF and WtE projects on non EPC mode and developed the required engineering insights for cost optimisation. JUIL along with it parent Company JSL have robust organisation with experience in handling large projects on non EPC mode. It is therefore, proposed to carry out the execution of the project under non EPC mode.

The owner will have on board an owner's engineer, while the project management will be handled by the owner's team. The roles and responsibilities of various key players under such a contracting model are described below:

Role of owners

- Arranging all permits and clearances
- Place orders for all equipment and services as per package specifications developed by Consultant.
- Liaison with all supply and service contractors for timely delivery.
- Developing organization for pre-construction, construction and O&M
- Managing cash flow

09.02.2 Role of Consultant

Consultant would be appointed by the Owner's for performing the following tasks on behalf of the Owner.

- Pre-bid services
    - Setting up overall performance parameters for the plant and preparing a management plan on action in individual areas for achievement of the overall performance
    - Basic engineering and preparation of bid documents

- Post-bid services
    - Review of bids and preparation of technical evaluation, comparative statement and recommendation report on bid selection
    - Preparation of draft contract documents for individual equipment
    - Assistance in finalization of equipment suppliers/vendors
- Project implementation phase
    - Managing all interfaces between various vendors and contractors.
    - Review of design of equipment and drawings prepared by equipment suppliers and providing comments for modifications or improvement.
    - Prepare execution drawings for civil, structural and other engineering as required for the project.
    - Integration of all sub-units of the plant and prepare execution drawings for interconnecting services.
    - Close monitoring of the implementation of the management plan and providing timely feed back to the Owner on intervention need
    - Preparing a master plan for the project implementation and assist in organization development work for implementation of the same.
    - Providing operation and maintenance related inputs to the Owner and review the design to ensure performance
    - Preparing the organization chart and process chart and assistance in recruitment & training of personnel
    - Monitoring quality assurance system followed by equipment suppliers and other contractors
    - Operating a project management system to ensure timely execution
    - Witnessing the pre-commissioning testing & commissioning of plant
    - Analysis of post commissioning troubles, if any and providing engineering inputs for solving the same
    - Witnessing the final performance test

09.02.3 Role of vendors

- Engineering Services
  - Detailed Engineering - for complete plant within the defined boundary limits of individual packages.
  - Training – As and where required.
  - Facilitating project execution as per agreed technical standards
  - Submission of Drawing and documents for review/ approval and take action taken on comments from Owner's engineers as per agreed plan.
  - Quality Assurance Plan & Inspection and testing procedure for all equipments shall be provided action taken on comments from Owner's engineers as per agreed plan.
  - Assistance for Statutory Clearances and approvals viz IBR for Boiler, Electoral Inspectorate, Transmission utility for grid interface equipments etc.
- Supply of Equipment
  - Supply of all equipments and systems within the boundary limits under the scope of equipment supplier
- Erection, Testing & Commissioning Services
  - Civil construction of power plant building, all equipment foundations, auxiliary plant buildings, foundations and all other civil work associated with plant within power plant boundary.
  - Erection of all Equipment as indicated under supply of equipment including all Erection Materials.
  - Testing, Commissioning of all the Equipment and Systems

09.02.4 Role of Monitoring agency

- The Monitoring Agency during operation period shall inspect the Project Facilities and processes at least twice in a month and carry out

tests as might be deemed necessary and furnish the observations of the inspection to the Concessionaire and to SDMC within 7 days of such Inspection

- The Monitoring Agency during operation period is authorized to conduct surprise checks on the Project Facilities and processes to ensure that they comply with the Project specifications
- The Monitoring Agency during operation period shall report the results of surprise checks to SDMC within 7 days of such checks
- The Monitoring Agency during operation period is authorized to require the Concessionaire to carry out such tests/ arrange to carry out such tests as it deems necessary and present the result and inferences of the same to SDMC
- In case any deficiency or maintenance requirement is observed by the Monitoring Agency during operation period during the inspection or tests, it shall report the same to SDMC along with the possible impact on the Project Facilities and the cost of rectification of the same
- The Monitoring Agency during operation period shall inspect the Project Facilities once the Concessionaire rectifies the defect and report the results of such inspection to SDMC.
- The Monitoring Agency during operation period shall audit and certify the weighbridges located at the Processing Facility at least once a month and submit the results of such review to SDMC and the Concessionaire
- The Monitoring Agency during operation period shall audit the MSW quantity supply data recorded at Processing Facility and Landfill site to ensure that the data reported by the Concessionaire is accurate and that the provisions of this agreement are conformed with. The Monitoring Agency during operation period is authorized to conduct surprise checks and tests for this purpose

09.03 Cost control

A two step methodology has been developed within the framework of overall management of the project consisting of:

1. At the design stage-The entire project would consist of various individual procurement & construction packages. Micro detailing would be carried during design and detailed engineering with a view to identify cost reduction opportunities in each package, particularly the high cost packages such as Material Recovery Facility, Boilers and Air Pollution Control System and STG Island. Brainstorming exercise would be carried out with the participation from the project as well as current operation and maintenance team for identification and execution of cost reduction measures. Cost budget would be prepared and approval obtained from the higher management.

2. Procurement & construction stage-One member each would be made responsible for budget and cost control for individual package. A control system would be developed and followed for capturing all cost at the initiation stage (procurement & construction) so that total cost remains within the approved budget.

09.04 Quality Assurance

A quality assurance plan (QAP) would be prepared consisting of:

- A detailed protocol including codes and standards that would be followed for design, drawings, construction, testing and commissioning
- Schedule of documents and drawings and 'Hold points' for IE clearances
- Transaction processes-electronic and physical for approval and release of drawings, documents for follow on action
- Monthly report on QAP and periodic review meetings, if required, for resolution of issues

09.05 Managing Project Schedule

The critical procurement and construction activities have been identified based on the prior experience of JUIL in execution of 16 MW Okhla and 400 t/d material recovery facilities at Bathinda. The detailed schedule has been prepared for the entire project. Linkages of various activities to the critical path have been established. JUIL has been following a very robust project management system for implementation of its various infrastructure projects including SWM projects.

Project management protocol has been prepared taking into account:

- Identified critical path for the MRF and WtE project
- JUIL system of management of infrastructure project
- Requirement of interface with Monitoring Agency
- Requirement of interface with SDMC

10 PROJECT COST ESTIMATES AND MEANS OF FINANCE

10.01 General

The Project Cost Estimates for the project are presented under different expenditure heads and are based on the offers received for the equipment and facilities envisaged to be installed for the plant as described in the preceding chapters.

10.02 Project Cost Details Of Plant

The Project Cost of the Plant is estimated at Rs 39860 Lakhs as Summarized in Annexure-10.2. It includes the cost of;

a) Land, Site Development, Buildings & Foundations, External Services

b) Plant Machinery & Equipment including Misc. Fixed Assets, Spares, Foundation & Installation for Waste to Energy(WtE) Plant

c) Mandatory Spares for 2 Years.

d) Engineering Consulting - Design and Supervision

e) Indirect Expanses

f) Contingencies

g) Margin Money for Working Capital

h) Interest during Construction (IDC)

1. Land, Site Development & Buildings - Rs 5850 Lakhs

The cost of Site Development covers the expenses towards cost of Leveling, Construction of boundary wall, internal roads, drainage etc. Land cost is not considered as the land is on lease and is considered in tariff calculations.

The cost of Buildings covers Civil & Structural Works relating to sheds, buildings, Equipment Foundations, overhead water tank, water reservoirs, shop offices, stores, flooring & Services etc.

The estimated cost of Land, Site Development and Buildings as per details given in Annexure-10.3.

2. Plant Machinery & Equipment, Including Installation for WtE Plant - Rs 25621 Lakhs

The cost of various items of Plant and Machinery envisaged for the unit are along with various duties as listed in Annexure-10.3, the figure also includes freight, Erection charges, GST etc.

3. Mandatory Spares For 2 Years - Rs 200 Lakhs

This is taken at Rs 200 Lakhs including freight, GST & Insurance.

4. Engineering Consulting – Design and Supervision — Rs 159 Lakhs

This includes the fee to be paid to the Consultants who shall be carrying out the detailed engineering of the project comprising the following tasks:

- Developing Plant & Shop Layouts.
- Design & supply of construction drawings for factory buildings, roads, drains and other Civil & Structural Works.
- Design and supply of construction drawings for equipment foundation of Plant & Machinery, Utility & Auxiliary Services etc.
- Preparing tender specifications for procurement of equipment, analysis of bids and assistance in finalizing the orders.
- Preparing tender specifications for installation of equipment, piping & cabling.
- Preparation of engineering drawings for electricals & utility services, including piping, cabling, earthing & lighting.
- Assistance in designer's supervision of work at site for Civil & Structure, installation and commissioning of equipment.

5. Indirect Expenses - Rs 998 Lakhs

Establishment expenses which include Salary & Wages of staff during construction period, administrative & travel expenses including those for foreign technicians and consultant's staff, expenses for hot & cold trials have been estimated under this head. Fees for Liasoning, Third Party Inspection, Independent Engineers, etc. are alson included. Details are covered in Annexure – 10.3

6. Contingencies - Rs 1592 Lakhs

Provision of Contingencies has been kept @5.0% for Land, Site Development, Foundations, Plant & Machinery, Independent Engineer's Cost During Construction etc.

7. Margin Money For Working Capital - Rs 241Lakhs

Margin money for working capital has been estimated at Rs 158 Lakhs as detailed in Annexure 12.3.

8. Financial Services Charges - Rs 820 Lakhs

It is calculated as 3% on the Debt being availed from the Financial Institutions.

9. Interest During Construction - Rs 2910 Lakhs

It is worked out in Annexure 10.4.

10. Means Of Finance

The total cost of the project is proposed to be financed as under:

Viability Gap Funding(VGF)	:	Rs 10500 Lakhs
Institutional Loan @ 70%	:	Rs 20286 Lakhs
Equity @ 30%	:	Rs 8786 Lakhs

11 REVENUE GENERATION & WORKING RESULTS

11.01 Revenue Generation

The revenue for the project has been estimated based on Sale of power, Compost & Recyclables only.

Product Mix & Heat & Mass Balance of the Plant for 25 years has been shown in Annexure 10.1.

1. Sale of Power

The revenue for power sales has been taken based on variable Tariff as per Letter of Award. The tariff is based on CERC guidelines for Waste to Energy Projects. The rate is determined at the time of bidding.

2. Sale of Compost

Bio Degradable portion of the waste collected during segregation shall be cured to produce compost which shall be sold in the market at a later stage.

3. Sale of RDF

Combustible portion of the waste collected during segregation shall be used to produce Refuse Derived Fuel which in turn shall be burnt to produce Power. The surplus RDF after meeting the internal requirements of 25 MW Power plant shall be sold in the market at a later stage.

4. Sale of Recyclables

Materials like metal Scrap, glass, paper, plastic etc shall be sold to the scrap dealers.

11.02 Cost Of Inputs

The costs of various inputs and their basis have been indicated in Annexure 10.0.

11.03 Process Costs

The Costs for the process include the followings:

- Lease Rentals
- Operating Costs
- Insurance Premiums
- PBG Charges

11.04 Sale Price Consideration

Sale prices for various items like RDF, Compost, and Recyclables have been indicated in Annexure 10.0 along with expected annual increase.

11.05 Income Statement

Annual costs & revenue generated from the process for 25 years have been presented in Annexure 11.1.

12 FINANCIAL PROJECTIONS AND PROJECT APPRAISAL

12.01 Computation of Financial Projections

Computation of Interest on the debt and its repayment schedule is attached as Annexure 12.1.

Depreciation schedule using SLM method considering 3.80% depreciation for Site Development, Sheds & buildings and Plant & Equipment is attached in Annexure 12.2. The WDV considering 10% yearly depreciation on civil works, and 15% yearly on Plant Equipment is also detailed therein.

Calculations of the requirement for the working capital and Margin Money have been worked out and are attached as Annexure 12.3.

Income Tax calculations for 25 years have been done and attached at Annexure 12.4.

Projected Balance Sheet for 25 years has been worked and attached at Annexure 12.5 and Projected Cash Flow Statement for 25 years has been worked and attached at Annexure 12.6.

12.02 Financial Appraisal

Financial Appraisal is carried out on the basis of the generally acceptable following criteria's;

1 Debt Service Coverage Ratio (DSCR)
2 Internal Rate of Return (IRR)
3 Pay Back Period
4 Sensitivity Analysis

1. Debt Service Coverage Ratio (DSCR) (Annexure 12.7)

The debt service coverage ratio for the project has been calculated for the period of Sixteen Years and average DSCR for is 1.79. Minimum DSCR over these years is 1.53.

2. Internal Rate of Return (IRR) (Annexure 12.8)

Internal rate of return is used to evaluate the desirability of investments on projects. The higher a project's internal rate of return, the more desirable it is to undertake the project. As calculated and detailed in Annexure 12.8 an Project IRR (Pre Tax) over 25 years of 8.70 %, IRR(Post Tax) is 16.04 % and Equity IRR of 19.42 % shows that the project is quite justifiable.

3. Pay Back Period (Annexure 12.9)

The payback period has been calculated on total inflow for a period of 25 years is 7 years 3 months.

12.03 Sensitivity Analysis (Annexure 12.10)

The Sensitivity Analysis for the Project is as follows:

S.No.	Case Basis	Project IRR (Post Tax) 25 Years	Equity IRR (Post Tax) 25 Years	Avg. DSCR	Min. DSCR	Pay Back Period (Years)
	Base Case (with Power, Compost & Recyclables sale only)	1.79	1.53	18.70%	16.04%	19.42%
1	Interest Rate increased to 13%	1.71	1.44	0.19	16.18%	17.83%
2	Increase in Hard Cost by 5%	1.66	1.43	0.18	15.73%	16.13%
3	Power is the only Source of Revenue	1.80	1.54	0.19	16.04%	19.37%
4	Decrease in waste quantity by 25%	1.63	1.44	0.17	14.34%	15.59%
5	Increase in O&M cost by 15%.	1.79	1.53	0.19	15.89%	19.04%
6	No increase in waste quality (i.e. GCV)	3.52	2.06	0.30	25.68%	37.29%
7	Decrease in base waste quality (i.e. GCV) by 10%	1.79	1.53	18.70%	16.04%	19.42%
8	Base case along with sale of RDF	1.71	1.44	0.19	16.18%	17.83%

12.04 Conclusion

As the Project critical ratios are quite favorable hence project is viable.

ABBREVIATIONS

~	Approximate value
<	Less then
>	Greater then
5-R	Reduce, Reuse, Recover, Recycle and Remanufacture
A+M	Automatic + Manual
AC	Alternating Current
ACC	Air Cooled Condenser
ACSR	Aluminum Conductor Steel Reinforced
ADS	Air density separator
AGMA	American Gear Manufacturers Association
Al	Aluminum
AOP	Auxiliary Oil Pump
AP	Andhra Pradesh
APC	Air Pollution Control
API	American Petroleum Institute
Approx	Approximate
As	Arsenic
AVR	Automatic Voltage Regulator
B	Boron
BOD	Bio-Chemical Oxygen Demand
BOP	Balance of Plant
C	Carbon
C&I	Control and Instrumentation
C&T	Collection and Transportation
C/N	Carbon to Nitrogen Ratio
Ca	Calcium
CA	Concession Agreement
$CaCO_3$	Calcium Carbonate
CACW	Closed Air Circuit Water Cooled
CAGR	Compounded Annual Growth Rate
Cd	Cadmium
CDM	Clean development mechanism
CEMS	Continuous Emission Monitoring System
CEO	Chief Executive Officer
CER	Renewable certificates

CERC	Central Electricity Regulatory Commission
CFO	Chief Financial Officer
CH_4	Methane
Cl	Chlorine
Co	Cobalt
CO	Carbon Mono Oxide
CO_2	Carbon Di Oxide
cod	Chemical Oxygen Demand
COD	Commercial Operation Date
CPCB	Central Pollution Control Board
CPHEEO	Central Public Health and Environmental Engineering Organization
CPP	Captive Power Plant
CSR	Corporate Social Responsibility
CST	Central Sales Tax
Cu	Copper
DBFOT	Design, Build, Finance, Operate and Transfer
DC	Direct Current
DCS	Distributed Control System
DER	Debt Equity Ratio
DERC	Delhi Electricity Regulatory Commission
DG	Diesel Generator
DI	Ductile Iron
Dia	Diameter
DISCOM	Distribution Company
DJB	Delhi Jal Board
DM	De-Mineralized
DoI	Directorate of Industries
DPR	Detailed Project Report
DSCR	Debt Service Coverage Ratio
DST	Department of Science &Technology
Dyn	Delta Star Neutral
EBITDA	Earnings Before Interest, Tax, Depreciation And Amortization
EDMC	East Delhi Municipal Corporation
EHS	Environmental Health & Safety
EIA	Environmental Impact Assessment
EMP	Environment Management Plant
EOP	Extraction Oil Pump

EOT	Electric Overhead Travel
EPA	Energy Purchase Agreement
EPC	Engineering Procurement and Construction
EPCM	Engineering Procurement and Construction Management
F	Fluorides
Fe	Iron
FGCS	Flue Gas Cleaning System
FGT	Flue Gas Treatment
FY	Financial Year
GCV	Gross Calorific Value
GHG	Green House Gases
GI	Galvanized Iron
GM	General Manager
GoI	Government of India
H	Hydrogen
HBD	Heat Balance Diagram
HCl	Hydrogen Chloride
HDPE	High Density Polyethylene
HF	Hydrogen Fluoride
Hg	Mercury
HOC	Halogenated Organic Compound
HP	High Pressure
HPSV	High Pressure Sodium Vapour Lamps
HR	Human Resource
HRM	Human Resource Management
HSAW	Helical Submerged arc Welding
HT	High Tension
HVAC	Heat Ventilation and Air Conditioning
I&C	Instrumentation & Control
I/O	Input/output
IBR	Indian Boiler Regulation
ID Fan	Induced Draft Fan
IDC	Interest During Construction
IE	Independent Engineer
IEC	International Electro-technical Commission
IED	Industrial Emissions Directive
IEEE	Institute of Electrical &Electronics Engineers

IP	Ingress Protection
IPP	Independent Power Producer
IRR	Internal Rate of Return
IS	Indian Standards
ISHRAE	Indian Society of Heating Refrigerating and Air Conditioning Engineers
ISO	International Organization for Standardization
JIL	JITF Infralogistics Limited
JITF	Jindal Infrastructure Transport Fabrication
JRIL	Jindal Rail Infrastructures Limited
JSL	Jindal Saw Limited
JUIL	JITF Urban Infrastructure Limited
JUISL	JITF Urban Infrastructure Services Limited
JV	Joint Venture
JWIL	JITF Water Infrastructure Limited
JWL	Jindal Waterways Limited
LASC&PT	Lightning Arrestor Surge Capacitor & Potential Transformer
LED	Light Emitting Diode
LHV	Low Heating Value
LoI	Letter of Intent
LOTO	Lockout/Tagout
LP	Low Pressure
LPBS	Local Push Button Station
LSAW	Longitudinal Submerged Arc Welded
LTP	Leachate Treatment Plant
LV	Low Voltage
MBF	Moving Bed Feeders
MCC	Motor Control Center
MCR	Maximum Continuous Rating
Mg	Magnesium
Mn	Manganese
MNRE	Ministry of New and Renewable Energy
MOC	Material of Construction
MOEF	Ministry of Environment & Forest
MoLE	Ministry of Labour & Employment
MRF	Material Recovery Facility
MS	Mild Steel
MSDS	Material Safety Data Sheet

MSL	Mean Sea Level
MSW	Municipal Solid Waste
N	Nitrite
NA	Not available
NDMC	North Delhi Municipal Corporation
NEERI	National Environmental Engineering Research Institute
NFB	Non Fund Based
NGO	Non-Governmental Organization
NGR	Neutral Grounding Resistor
NH	National Highway
NH_3	Ammonia
Ni	Nickel
NO	Nitrogen Oxide
NO_2	Nitrous Oxide
NOC	No Objection Certificate
No.	Numbers
NO_x	Nitrogen Oxides
NPV	Net Present Value
O or O_2	Oxygen
O&M	Operation and Maintenance
O_3	Ozone
ONAF	Oil Natural Air Forced
PA	Primary Air Fan
PAH	Polycyclic Aromatic Hydrocarbons
PAT	Profit After Tax
PCC	Power Control Centre
PFD	Process Flow Diagram
PLC	Programmable Logic Controller
PLF	Plant Load Factor
PPA	Power Purchase Agreement
PPP	Public Private Partnership
PVC	Polyvinyl Chloride
QAP	Quality Assurance Plan
R&M	Repair and Maintenance
RCC	Reinforced Cement Concrete
RDF	Refuse Derived Fuel
RFP	Request for Proposal

RH	Relative Humidity
RO	Reverse Osmosis
SA	Secondary Air
SBM	Swachh Bharat Mission
SCAPH	Steam Coil Air Pre Heater
SCR	Selective Catalytic Reduction
SDMC	South Delhi Municipal Corporation
SLF	Scientific Land Filling
SMF	Sealed Maintenance Free
SNCR	Selective Non-Catalytic Reduction
SO_2	Sulphur Di Oxide
SO_3	Sulphur Tri Oxide
SO_x	Sulphur Oxides
SPM	Solid Particulate Matter
SPV	Special Purpose Vehicle
SS	Stainless steel
STG	Steam Turbine Generator
STP	Sewage Treatment Plant
SWG	Standard wire gauge
SWM	Solid Waste Management
T&C	Testing & Commissioning
TAC	Tariff advisory committee
TDS	Total Dissolved Solids
TEFC	Totally Enclosed Fan Cooled
Th	Thorium
TIFAC	Technology Information, Forecasting & Assessment Council
TNW	Total Net worth
TOC	Total Organic Carbon
TOL	Total Outside Liability
TOWMCL	Timarpur Okhla Waste Management Company Pvt. Ltd
TPN	Three Pole Neutral
TRANSCO	Transmission Company
TSS	Total Suspended Solids
TWEPL	Tehkhand Waste to Electricity Project Limited
UCC	User Collection Charges
UNFCCC	United Nations Framework Convention on Climate Change
UPS	Uninterrupted Power Supply

V	Volt
VFD	Variable Frequency Drive
VGF	Viability Gap Funding
W+S	Working + Standby
WACC	Weighted Average Cost of Capital
WCC	Water Cooled Condenser
WPI	Wholesale Price Index
WtE	Waste to Energy
WTP	Water Treatment Plant
XLPE	Cross Linked Polyethylene
Ynd1	Star Neutral Delta
YoY	Year on year

UNITS AND MEASURES

+	Plus
-	Minus
±	Plus or Minus
~	Approximate
%	Percentage
µS	Micro Siemens
O	Degree
^{0}C	Degree Celsius
(a)	Absolute
A	Ampere
CFM	Cubic Feet per Minute
cm	Centimeters
cm^2	Centimeter Square
cum	Cubic Meter
D	Day
dB	Decibel
DBT	Dry Bulb Temperature
G	Grams
GWh	Giga Watt Hour
GWh/y	Giga Watt Hour Per Year
H	Hours
Hz	Hertz
kA	Kilo Ampere
kcal	Kilo Calorie
kcal/kg	Kilo Calorie Per Kilogram
kg	Kilogram
kg/d	Kilogram Per Day
kgf/cm^2	Kilogram force per square centimeter
kV	Kilo Volt
kV-rms	Kilo Volt Root Mean Square
kW	Kilo Watt
kWh	Kilo Watt Hour
L	Liter
M	Meter
m^2	Square Meter
m^3	Meter Cube

m^3/h	Meter cube per Hour
Mcal	Mega Calorie
Mcal/h	Mega Calorie per Hour
mg	Milligram
mg/l	Milligram per litre
mg/Nm^3	Milligram per Normal Meter Cube
min	Minutes
mm	Millimeter
MT	Metric Tons
MT/y	Metric Tons per Year
MVA	Mega Volt Ampere
MW	Mega Watt
MWh	Mega Watt Hour
MWh/d	Mega Watt Hour per Day
m/min	Meter per minute
$ngTEQ/Nm^3$	Nano gram Toxicity Equivalent per Normal Meter Cube
Nm^3	Normal Meter Cube
Nm^3/h	Normal Meter Cube per Cube
p.a.	per Annum
ppm	Part per Million
psi	Pounds per Square Inch
rpm	Revolution per Minutes
Rs/acre	Rupees per acre
Rs/kWh	Rupees per Kilo Watt Hour
Rs/MT	Rupees Per Metric Ton
T	Tons
t/d	Tons per Day
t/h	Tons per Hour
TR	Tons of Refrigerant
V AC	Voltage Alternating Current
V DC	Voltage Direct Current
y	Year

CURRENCIES

USD	United States Dollar
Rupees	Rs.

TEHKHAND WASTE TO ELECTRICITY PROJECT LIMITED

INDEX SHEET

WASTE TO ENERGY PLANT

2-Aug-2018

TEHKHAND WASTE TO ELECTRICITY PROJECT LIMITED

Key Assumptions

S.No.	Description	Unit	Value	Basis
A	TECHNICAL CONFIGURATIONS			
	Plant Design Capacity for Power generation	MW	25.00	As per Bid.
	Auxiliary	%	15.0%	As per CERC Guidelines
	Life of Project	Y	25.00	As per RFP
	CAGR - MSW	%	4.0%	As per FR Clause 3.1
	Availability of MSW in FY 2018-19	t/d	1839	As per FR Clause 3.1 Table 3
	Minimum Assured Quantity	t/d	1600	As per CA Clause 1.1.45
	Maximum Obligated Quantity	t/d	2400	As per CA Clause 1.1.44
	% Capacity Capping	%	120%	As per RFP
	MRF Capacity Capping	t/d	2400	To be at maximum obligated quantity
	% of inserts removed in pre-processing	%	15.0%	As per DPR
	% of Recyclables	%	1.0%	As per DPR
	% of moisture reduction as leachate & evaporation	%	18.0%	As per DPR
	% Fines for Compost production	%	5.00%	As per DPR
	GCV of MSW in FY 2017-18	kcal/kg	1225.00	As per FR Clause 3.2
	CAGR in GCV of fuel	%	2.1%	As per FR Clause 3.2
	MSW GCV upper limit capping	kcal/kg	1500.00	As per FR Clause 3.2
	Normative waste availability	%	100.0%	As per CA Clause 1.1.45
	Efficiency of Boiler	%	80.0%	As per DPR
	Heat Required per kWh Power	kcal/kWh	4150	Calculated as per Annexure 10.1 (should be less than 4500 as per RFP)
	Power Plant PLF min (first year)	%	65.0%	As per RFP
	Power Plant PLF min (second year)	%	75.0%	As per RFP
	Heat lost in composting	kcal/kg	500	Assumed as per group companies data
	Heat lost during storage	%	2.0%	Assumed as per group companies data
	Max GCV of boiler feed	Kcal/kg	2100	Assumed as per group companies data
	Max reject permissible	t/d	20.0%	As per RFP
	Max PLF capping	%	95.0%	As per DPR
B	SELLING PRICE			
	Selling rate of compost in FY 2017-18	Rs./ MT	2000.00	As per FR Clause 6.2
	Increase in selling price of Compost	%p.a.	5.0%	Assumption
	Selling price of RDF in FY 2017-18	Rs./MT	1800.00	CERC Guidelines
	Increase in price of RDF	%	5.0%	As per CERC guidelines Clause Clause 83
	Selling price of recyclables in FY 2017-18	Rs./ MT	4000.00	As per FR Clause 3.2
	Increase in selling price of recyclables	%p.a.	4.3%	CERC Guidelines
	Assumptions for tariff Calculation			
	Tariffs	Rs/kWh		As per Annexure 10.5
C	FINANCIAL ASSUMPTIONS			
	Inflation Rate	%	4.28%	CPI March 2018; http://mospi.nic.in/sites/default/files/press_release/CPI_PR_12apr18th.pdf
	Corporate tax rate (30% Tax, 12% Surcharge & 3% Cess)	%	34.608%	http://www.incometaxindia.gov.in/booklets%20%20pamphlets/12.pdf
	MAT (Minimum Alternate Tax) (18.5% Tax, 12% Surcharge & 3% Cess)	%	21.342%	http://www.incometaxindia.gov.in/booklets%20%20pamphlets/12.pdf
	Viability Gap Funding (VGF)	Rs Lakhs	10500.0	As per CR clause 14.1.1
	Debt	%	70.00%	As Per Current Funding Arrangements
	Equity	%	30.00%	As Per Current Funding Arrangements
	Upfront Equity	%	50.00%	As Per Current Funding Arrangements
	Upfront Equity	Rs Lakhs	4392.85	
	Loan Disbursement Period	Y	1.75	
	Moratorium	Y	0.75	As per Korus DPR
	Loan Repayment Period	Y	15.01	
	Loan Tenure (Loan Disbursement, Moratorium & Repayment)	Y	17.5	
	Long Term Interest Rate before COD	%	11.35%	As per Prevelling Rates
	Long Term Interest Rate after COD	%	10.85%	As per Prevelling Rates
	Working Capital Interest Rate	%	12.00%	As per Prevelling Rates
	Margin Money of Working Capital	%	25.00%	As per Prevelling Rates
	Depreciation Rate as per Company's Act	%	4.00%	As per Companies Law Act 2013
	Depreciation Rate as per IT Act (Plant & Machinery)	%	15.00%	Source:http://www.incometaxindia.gov.in/charts%20%20tables/depreciation%20rates.htm
	Depreciation Rate as per IT Act (Civil)	%	10.00%	Source:http://www.incometaxindia.gov.in/charts%20%20tables/depreciation%20rates.htm
	MAT credit available	Years	15.0	As per Prevailing Rates
	DSRA quarters	Quarter	2.0	As per Prevailing Requirement
	Bank Guarantee charges on Grant	%	1.50%	As per Prevailing Requirement
	Bank Guarantee applicable till		30-Sep-2022	As per CA, 2 years post COD
	Days to be considered for full depreciation in WDV	days	180.0	
	Financial services charges as % of Debt	%		As discussed with client
	USD to INR Rate	Rs	68.00	As per prevailing rates
D	O&M COST			
	MSW cost (fuel)	Rs. Lakhs	0.00	As per CA
	O&M costs	%	7.00%	As per group projects' data
	Insurance premium	of project costs	0.10%	As per DPR
	Reject Handling Charges (1-12 Years)	Rs/MT	300.00	As per CA clause 10.2.1
	Reject Handling Charges (13-25 Years)	Rs/MT	400.00	As per CA clause 10.2.1
	In house reject handling charges	Rs/MT	200.00	As per DPR
	Transportation Charges	Rs/MT	50.00	As per DPR
	Lease rentals			Commencing from COD as per Land Lease agreement
	Land Area of Project	Acres	15.00	As per CA clause 4.1
	Lease Rate Project @ Rs 25 lakhs/Acres/Annum for first 12 years	Rs. Lakhs/acres	25.00	As per CA clause 10.2.3
	Lease Rate Project @ Rs 30 lakhs/Acres/Annum from 13th year to 25 th year.	Rs. Lakhs/acres	30.00	As per CA clause 10.2.3
	Escalation in O&M cost	%	4.28%	Inflation rate
	Year of Escalation in lease rent cost	year	2031	As per Amendment 1 to RFP
	Year of Escalation in lease reject handling charges	year	2031	As per Amendment 1 to RFP
E	WORKING CAPITAL			
	Fuel costs	0	0.00	To be supplied by SDMC till tipping point
	Account receivable	Month	2.00	As per DPR
	O&M cost	Month	2.00	As per DPR
	Months an year	Month	12.00	
	Maintenance Spares	of O&M Expenses	15.00%	As per DPR
	Months a quarter		3.00	
F	CONSULTANCY COST			
	Consultant fee & Site Supervision -Project	Rs. Lakhs	135.00	DPR Prepration:10L, Detail Engineering: 80L, Site Visits-30 Mandays:10L, Site Supervision-8 Man months:5L, PIM 30L
	Independent engineer (IE) fee - Project for Year 1	Rs. Lakhs/a	0.00	As per FR Clause 6.1 SDMC will have own IE
	Independent engineer (IE) fee - During construction	Rs. Lakhs/a	0.00	As per FR Clause 6.1 SDMC will have own IE
G	MILESTONE DATES			
	Bid Submission Date		30-Sep-2017	As per RFP
	Financial Closure Date		31-Dec-2018	as per CA (6 months from effective date)
	Effective Date		30-Jun-2018	
	Construction Period		27.00	As per CA (27 months from effective date)
	COD		30-Sep-2020	As per CA (27 months from effective date)
	COD year		2020	
	Operation Year-1 end date		31-Mar-2021	
	Expiry date of concession agreement		30-Sep-2045	As per CA (25 years from Scheduled COD)
	First Construction quarter		31-Dec-2018	
	Financial year last month		3.00	
	Land Lease agreement signing date		30-Jun-2018	As per signed CA
	Principal moratorium from COD		30-Jun-2021	
	CA signing Date		10-May-2018	
	First Repayment Month		1-Jul-2021	
	Last Repayment Month		30-Jun-2036	
H	PROJECT COST ASSUMPTIONS			
	Financial services charges	as % of Debt	############	As per client, incl. BG charges for grant pre-COD
	Margin Money for Working Capital	of WC	############	As per DPR
	Contigency costs	as % of Hard Costs	############	As per DPR
	Project Life	years	##########	
I	REPAYMENTS			As discussed with client
	Year		Repayment	
	2021-22		3.00%	1-Jul-2021
	2022-23		7.00%	
	2023-24		7.00%	
	2024-25		8.00%	
	2025-26		8.00%	
	2026-27		8.00%	
	2027-28		8.00%	
	2028-29		8.00%	
	2029-30		9.00%	
	2030-31		9.50%	
	2031-32		6.00%	
	2032-33		6.00%	
	2033-34		4.00%	
	2034-35		4.00%	
	2035-36		4.00%	
	2036-37		0.50%	30-Jun-2036
	Total		**100.00%**	

TEHKHAND WASTE TO ELECTRICITY PROJECT LIMITED

Technical Assumptions and Plant Heat & Mass Balance

Particulars	UOM	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046
FY		2019-20	2020-21	2021-22	2022-23	2023-24	2024-25	2025-26	2026-27	2027-28	2028-29	2029-30	2030-31	2031-32	2032-33	2033-34	2034-35	2035-36	2036-37	2037-38	2038-39	2039-40	2040-41	2041-42	2042-43	2043-44	2044-45	2045-46
Mass of MSW @ 100% normative availability (Capped at 2400 t/d)	t/d	1989	2069	2151	2237	2327	2400	2400	2400	2400	2400	2400	2400	2400	2400	2400	2400	2400	2400	2400	2400	2400	2400	2400	2400	2400	2400	2400
% of inerts removed in pre-processing	%	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%
Mass of inerts removed	t/d	298.4	310.3	322.7	335.6	349.0	360.0	360.0	360.0	360.0	360.0	360.0	360.0	360.0	360.0	360.0	360.0	360.0	360.0	360.0	360.0	360.0	360.0	360.0	360.0	360.0	360.0	360.0
% of recyclables	%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%
Mass of Recyclables	t/d	19.9	20.7	21.5	22.4	23.3	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0
Mass of Recyclables	t/a	7260.1	7550.5	7852.5	8166.6	8493.3	8760.0	8760.0	8760.0	8760.0	8760.0	8760.0	8760.0	8760.0	8760.0	8760.0	8760.0	8760.0	8760.0	8760.0	8760.0	8760.0	8760.0	8760.0	8760.0	8760.0	8760.0	8760.0
% of moisture as Leachate	%	18.0%	18.0%	18.0%	18.0%	18.0%	18.0%	18.0%	18.0%	18.0%	18.0%	18.0%	18.0%	18.0%	18.0%	18.0%	18.0%	18.0%	18.0%	18.0%	18.0%	18.0%	18.0%	18.0%	18.0%	18.0%	18.0%	18.0%
Mass of moisture as Leachate	t/d	358.0	372.4	387.2	402.7	418.8	432.0	432.0	432.0	432.0	432.0	432.0	432.0	432.0	432.0	432.0	432.0	432.0	432.0	432.0	432.0	432.0	432.0	432.0	432.0	432.0	432.0	432.0
% Fines for Compost production	%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%
Mass of Compost	t/d	99.5	103.4	107.6	111.9	116.3	120.0	120.0	120.0	120.0	120.0	120.0	120.0	120.0	120.0	120.0	120.0	120.0	120.0	120.0	120.0	120.0	120.0	120.0	120.0	120.0	120.0	120.0
Mass of Compost	t/a	36300.4	37752.4	39262.5	40833.0	42466.3	43800.0	43800.0	43800.0	43800.0	43800.0	43800.0	43800.0	43800.0	43800.0	43800.0	43800.0	43800.0	43800.0	43800.0	43800.0	43800.0	43800.0	43800.0	43800.0	43800.0	43800.0	43800.0
GCV of MSW (Capped at 1500)	kcal/kg	1277.0	1303.8	1331.2	1359.1	1387.7	1416.8	1446.6	1477.0	1500.0	1500.0	1500.0	1500.0	1500.0	1500.0	1500.0	1500.0	1500.0	1500.0	1500.0	1500.0	1500.0	1500.0	1500.0	1500.0	1500.0	1500.0	1500.0
Calories in MSW	Gcal	2540.0	2697.1	2863.9	3041.0	3229.0	3400.4	3471.8	3544.7	3600.0	3600.0	3600.0	3600.0	3600.0	3600.0	3600.0	3600.0	3600.0	3600.0	3600.0	3600.0	3600.0	3600.0	3600.0	3600.0	3600.0	3600.0	3600.0
Mass of Processed MSW for Boiler Feed	t/d	1213.3	1261.9	1312.3	1364.8	1419.4	1464.0	1464.0	1464.0	1464.0	1464.0	1464.0	1464.0	1464.0	1464.0	1464.0	1464.0	1464.0	1464.0	1464.0	1464.0	1464.0	1464.0	1464.0	1464.0	1464.0	1464.0	1464.0
Other unaccounted loss for calories (Composting part)	Gcal	127	135	143	152	161	170	174	177	180	180	180	180	180	180	180	180	180	180	180	180	180	180	180	180	180	180	180
Heat lost during storage	%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%
Other unaccounted loss for calories (Composting part)	kcal/kg	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500
Heat of the composting (Organic)	Gcal/d	50	52	54	56	58	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
Calories in Processed MSW (RDF)	Gcal	2439.5	2591.4	2752.8	2924.2	3106.3	3272.4	3342.4	3413.8	3468.0	3468.0	3468.0	3468.0	3468.0	3468.0	3468.0	3468.0	3468.0	3468.0	3468.0	3468.0	3468.0	3468.0	3468.0	3468.0	3468.0	3468.0	3468.0
GCV of Processed MSW (RDF) for Boiler	kcal/kg	2010.6	2053.7	2097.6	2142.6	2188.4	2235.2	2283.0	2331.8	2368.9	2368.9	2368.9	2368.9	2368.9	2368.9	2368.9	2368.9	2368.9	2368.9	2368.9	2368.9	2368.9	2368.9	2368.9	2368.9	2368.9	2368.9	2368.9
Efficiency of Boiler	%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%	80.0%
Deaerator Temperature	°C	130.0	130.0	130.0	130.0	130.0	130.0	130.0	130.0	130.0	130.0	130.0	130.0	130.0	130.0	130.0	130.0	130.0	130.0	130.0	130.0	130.0	130.0	130.0	130.0	130.0	130.0	130.0
Economizer Inlet temperature	°C	130.0	130.0	130.0	130.0	130.0	130.0	130.0	130.0	130.0	130.0	130.0	130.0	130.0	130.0	130.0	130.0	130.0	130.0	130.0	130.0	130.0	130.0	130.0	130.0	130.0	130.0	130.0
Enthalpy of Steam	kcal/kg	768.2	768.2	768.2	768.2	768.2	768.2	768.2	768.2	768.2	768.2	768.2	768.2	768.2	768.2	768.2	768.2	768.2	768.2	768.2	768.2	768.2	768.2	768.2	768.2	768.2	768.2	768.2
Enthalpy of feed water	kcal/kg	130.0	130.0	130.0	130.0	130.0	130.0	130.0	130.0	130.0	130.0	130.0	130.0	130.0	130.0	130.0	130.0	130.0	130.0	130.0	130.0	130.0	130.0	130.0	130.0	130.0	130.0	130.0
Heat gain in boiler	kcal/kg	638.2	638.2	638.2	638.2	638.2	638.2	638.2	638.2	638.2	638.2	638.2	638.2	638.2	638.2	638.2	638.2	638.2	638.2	638.2	638.2	638.2	638.2	638.2	638.2	638.2	638.2	638.2
Heat required rebating efficiency	kcal/kg	797.8	797.8	797.8	797.8	797.8	797.8	797.8	797.8	797.8	797.8	797.8	797.8	797.8	797.8	797.8	797.8	797.8	797.8	797.8	797.8	797.8	797.8	797.8	797.8	797.8	797.8	797.8
Enthalpy of steam at turbine inlet	kcal/kg	765.13	765.13	765.13	765.13	765.13	765.13	765.13	765.13	765.13	765.13	765.13	765.13	765.13	765.13	765.13	765.13	765.13	765.13	765.13	765.13	765.13	765.13	765.13	765.13	765.13	765.13	765.13
Enthalpy of steam at turbine outlet (0.1 ata @46 degC)	kcal/kg	565.00	565.00	565.00	565.00	565.00	565.00	565.00	565.00	565.00	565.00	565.00	565.00	565.00	565.00	565.00	565.00	565.00	565.00	565.00	565.00	565.00	565.00	565.00	565.00	565.00	565.00	565.00
Theoretical Steam required	kg/kWh	4.30	4.30	4.30	4.30	4.30	4.30	4.30	4.30	4.30	4.30	4.30	4.30	4.30	4.30	4.30	4.30	4.30	4.30	4.30	4.30	4.30	4.30	4.30	4.30	4.30	4.30	4.30
Steam Required factoring turbine efficiency and auxiliary requirements	kg/kWh	5.20	5.20	5.20	5.20	5.20	5.20	5.20	5.20	5.20	5.20	5.20	5.20	5.20	5.20	5.20	5.20	5.20	5.20	5.20	5.20	5.20	5.20	5.20	5.20	5.20	5.20	5.20
Heat Required per kWh Power	kcal/kWh	4150	4150	4150	4150	4150	4150	4150	4150	4150	4150	4150	4150	4150	4150	4150	4150	4150	4150	4150	4150	4150	4150	4150	4150	4150	4150	4150
Mass of Processed MSW required per kWh	kg/kwh	2.06	2.02	1.98	1.94	1.90	1.86	1.82	1.78	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
Annual Requirement of RDF @ target PLF	t/a	429423	420410	411594	402966	394523	386259	378172	370257	364471	364471	364471	364471	364471	364471	364471	364471	364471	364471	364471	364471	364471	364471	364471	364471	364471	364471	364471
Annual availability of Processed MSW	t/a	420722	437550	455052	473254	492185	507642	507642	507642	507642	507642	507642	507642	507642	507642	507642	507642	507642	507642	507642	507642	507642	507642	507642	507642	507642	507642	507642
Surplus Processed MSW (RDF)	t/a	0	17141	43459	70289	97662	121383	129470	137385	143171	143171	143171	143171	143171	143171	143171	143171	143171	143171	143171	143171	143171	143171	143171	143171	143171	143171	143171
Annual Power Generation	GWh/a	203.8	208.1	208.1	208.1	208.1	208.1	208.1	208.1	208.1	208.1	208.1	208.1	208.1	208.1	208.1	208.1	208.1	208.1	208.1	208.1	208.1	208.1	208.1	208.1	208.1	208.1	208.1
Energy for Export	GWh/a	173.3	176.8	176.8	176.8	176.8	176.8	176.8	176.8	176.8	176.8	176.8	176.8	176.8	176.8	176.8	176.8	176.8	176.8	176.8	176.8	176.8	176.8	176.8	176.8	176.8	176.8	176.8
PLF achievable at 25 MW generation	%	93.1%	95.0%	95.0%	95.0%	95.0%	95.0%	95.0%	95.0%	95.0%	95.0%	95.0%	95.0%	95.0%	95.0%	95.0%	95.0%	95.0%	95.0%	95.0%	95.0%	95.0%	95.0%	95.0%	95.0%	95.0%	95.0%	95.0%

TEHKHAND WASTE TO ELECTRICITY PROJECT LIMITED

SUMMARY OF PROJECT COST ESTIMATES
Based on Waste to Energy Plant

in Rs Lakh

Sl. No.	Particulars		Total	Ref.
1.0	LAND, SITE DEVELOPMENT, BUILDINGS & FOUNDATIONS, EXTERNAL SERVICES		5850	Ann 10.3
2.0	PLANT MACHINERY & EQUIPMENT INCLUDING INSTALLATION FOR WASTE TO ENERGY PLANT (WtE)		25621	-do-
3.0	MANDATORY SPARES FOR 2 YEARS		200	-do-
4.0	ENGINEERING CONSULTING - DESIGN AND SUPERVISION		159	-do-
5.0	TOTAL OF ITEM 1.0 to 4.0 (Hard Cost)		31831	
6.0	INDIRECT EXPENSES		998	Ann 10.3
7.0	SUB-TOTAL 1.0 to 6.0 (Without Contingency) (Hard Cost including Indirect Expenses)		32829	
8.0	CONTINGENCY @5% of Item 5.0		1592	
9.0	FINANCIAL SERVICES CHARGES		820	
10.0	INTEREST DURING CONSTRUCTION (IDC)		2910	Ann. 10.4
11.0	PROJECT COST WITHOUT MARGIN MONEY & DSRA (Item 1 0 to 10 0)		38151	
12.0	MARGIN MONEY FOR WORKING CAPITAL		228	Ann. 12.3
13.0	DSRA		1407	2 Quarter Interest and Repayment
14.0	TOTAL ESTIMATED PROJECT COST (Item 11.0 to 13.0)		39786	
			Rs 397.86 Crores	
15.0	VIABILITY GAP FUNDING (VGF)		10500	
16.0	PROJECT COST LESS VGF		29286	
	MEANS OF FINANCE INCLUDING VGF			
	Tota VGF		10500	
	Total Debt		20500	70.00%
	Total Equity		8786	30.00%

TEHKHAND WASTE TO ELECTRICITY PROJECT LIMITED

PROJECT COST ESTIMATES (DUTIES WISE)

25 MW MSW(Municipal Solid Waste) based Power Plant

S. NO.	PLANT & EQUIPMENTS	Basic Cost/Assessable Value(AV) AV= CIF x 1.01	Freight	Design, Erection, commissioning, E&C Supervision, PG Test (% or Actutal)	Installed cost without taxes	Basic Custom Duty (BCD)	Insurance	GST on Basic Cost/AV/BCD	GST on Basic Cost @28%	GST on E & C, Services & Items @18%	GST on Freight	Total estimated costs
		Rs. Lakhs	2.50%	5.00%	Rs. Lakhs	5.00%	0.10%	5.00%	28.00%	18.00%	5.00%	Rs. Lakhs
	WASTE TO ENERGY (WtE) PLANT											
1.0	Land & Building (Ref. Annexure 10.3.1)											
1.1	Site development											
	Site contour survey, soil investigation, Water testing, Waste testing	15	-	-	15	-				2.7		17.7
	Site grading, fencing & boundary wall	180			180					32.4		212.4
	Approach Road & Drains	300			300					17.8		317.8
	Site office, store, gate post, etc.	125			125					7.4		132.4
	Sub Total 1.1											680.3
1.2	Civil & Structural Work											
	Cement	459			459				128.5			587.5
	Reinforcement Steel	1296			1296					233.3		1529.3
	Steel sections for building Structures	375			375					67.5		442.5
	Sheeting	83			83					14.9		97.4
	Chimney Stack	150			150					27.0		177.0
	Contract (Without Cement & steel)	1980			1980					356.4		2336.4
	Sub Total 1.2											5170.1
1.3	Land cost	-	-	-	-	-						
	Total of Item 1.0	4962.5										5850.4
2.0	Plant & Equipment (Ref. Annexure 10.3.1)											
2.1	MRF Area											
	Weigh bridges 60T	30	0.8	1.5	32.3	-	0.0	1.5		0.3	0.04	34.1
	Grab EOT Cranes & Grabs in MSW area & Boiler Feed area	520	13.0	26.0	559.0	-	0.5	26.0		4.7	0.65	590.9
	Material Handling System - Hoppers, Feeders, Conveyors etc.	300	7.5	15.0	322.5	-	0.3	15.0		2.7	0.38	340.9
	Ballistic Separator .	90	2.3	4.5	96.8	-	0.1	4.5		0.8	0.11	102.3
	Shredder	300	7.5	15.0	322.5	-	0.3	15.0		2.7	0.38	340.9
	Destoner for Compost + Cyclone separator	20	0.5	1.0	21.5	-	0.0	1.0		0.2	0.03	22.7
	Magnetic Separator	9	0.2	0.5	9.7	-	0.0	0.5		0.1	0.01	10.2
	Bobcat	30	0.8	1.5	32.3	-	0.0	1.5		0.3	0.04	34.1
	Compost Plant	5	0.1	0.3	5.4	-	0.0	0.3		0.0	0.01	5.7
	Leachate Treatment Plant + Laboratory	1000	25.0	50.0	1075.0	-	1.0	50.0		9.0	1.25	1136.3
	Sub Total 2.1											2617.9
2.2	Power Plant											
	Boiler (imported) (0.08% is Sea transport insurance of CFR)	9906	225.0	1830.0	11960.9	495.3	9.9	520.1		203.4	11.25	13102.8
	Boiler Auxillaries	1050	26.3	52.5	1128.8	-	1.1	52.5		9.5	1.31	1193.1
	Flue Gas Cleaning System	1600	0.0	180.0	1780.0	-	1.6	80.0		32.4	0.00	1894.0
	Steam Turbine with Alternator	1350	0.0	60.0	1410.0	-	1.4	67.5		10.8	0.00	1489.7
	Water cooled condenser	900	0.0	25.0	925.0	-	0.9	45.0		4.5	0.00	975.4
	Balance of Plant	1530	38.3	76.5	1644.8	-	1.5	76.5		13.8	1.91	1738.5
	Sub Total 2.2											20393.3
2.3	Laying of Water Pipeline from STP	0	0.0	0.0	0.0	-	0.0	0.0		0.0	0.00	0.0
2.4	Electrical	1215	30.4	160.0	1405.4	-	1.2	60.8		28.8	1.52	1497.7
2.5	Instrumentation	760	19.0	110.0	889.0	-	0.8	38.0		19.8	0.95	948.5
2.6	Misc Items/Services	100		50.0	150.0	-		5.0		9.0	0.00	164.0
	Total of Item 2.0	20714.9										25621.4
	Sub Total (Item 1.0 to 2.0)	25677.4										31471.8
3.0	Engineering Consulting - Design and Supervision (Ref. Annexure 10.0)	135.00	-	-	-	-	-			24.3	-	159
4.0	Mandatory spares for 2 years of operation		-	-	-	-	-		-	-	-	200
	Total (Item 1.0 to 4.0)											31831
5.0	Indirect Expenses											
5.1	Liasioning Fees											
	Statuory Compliances/Approval Fees	10.00	-	-	10	-	-				-	10
	Liasioning Charges	40.00	-	-	40	-	-				-	40
	EC (Plant)	50.00	-	-	50	-	-				-	50
	CDM		-	-	0	-	-				-	0
5.2	Pre-operative Expenses											
	Construction Power Connection	35.00	-	-	35	-	-			6.3	-	41
	Manpower	400.00	-	-	400	-	-			72.0	-	472
	Monthly recurring site expenses	250.00	-	-	250	-	-				-	250
	Insurance (Manpower+Plant)	30.00	-	-	30	-	-				-	30
	IT Expenses	15.00	-	-	15	-	-				-	15
	Setup of Local Office	25.00	-	-	25	-	-				-	25
	Registration Charges for Land Lease	65.00	-	-	65	-	-				-	65
	Sub Total (Item 5.0)	920.00										998
	Total (Item 1.0 to 5.0)											32829

TEHKHAND WASTE TO ELECTRICITY PROJECT LIMITED

PROJECT COST ESTIMATES (BASIC COSTS)

25 MW MSW(Municipal Solid Waste) based Power Plant

S. NO.	PLANT & EQUIPMENTS	UOM	Quantity	Rate	Total estimated costs	Remarks
				Rs/Unit	Rs. Lakhs	
	WASTE TO ENERGY (WtE) PLANT					
1.0	Land & Building			-	-	
1.1	Site Development					
	Site contour survey, soil investigation, Water testing, Waste testing	LS			15.0	Estimates by KORUS
	Site grading, fencing & boundary wall	LS			180.0	- do -
	Approach Road, Internal Roads & Drains	LS			300.0	- do -
	Site office, store, gate post, etc.	LS			125.0	- do -
	Sub Total 1.1				620.0	
1.2	Civil & Structural Work					
	Cement	ton	7650	6,000.0	459.0	Estimates by KORUS
	Reinforcement Steel	MT	2880	45,000.0	1,296.0	- do -
	Steel sections for building Structures	MT	500	75,000.0	375.0	- do -
	Sheeting	m^2	15000	550.0	82.5	- do -
	Chimney Stack (1 no. 60m high)	LS			150.0	- do -
	Contract (Without Cement & steel)	m^3	18000	11,000.0	1,980.0	Composite rate includes Earthwork, Backfilling, RCC, PCC, Masonary, Plastering & misc. finishing items
	Sub Total 1.2				4,342.5	
	Total Land Development, Civil & Structural Work (Item 1.0)				4,962.5	
2.0	Plant & Equipment					
2.1	MRF Area					
	Weigh bridges 60T	nos.	3	10.0	30.0	As per KORUS data bank
	Grab EOT Cranes in MSW area & Boiler Feed area	nos.	2	180.0	360.0	As per KORUS data bank
	Grabs for Cranes	nos.	4	40.0	160.0	
	Material Handling System - Hoppers, Feeders, Conveyors etc.		3 set		300.0	
	Ballistic Separator .		3		90.0	
	Shredder		3		300.0	
	Destoner for Compost + Cyclone separator		1		20.0	
	Magnetic Separator		3		9.0	
	Bobcat				30.0	
	Compost Plant	LS			5.0	Estimates by KORUS
	Leachate Treatment Plant + Laboratory	LS			1,000.0	
	Sub Total 2.1				2,304.0	
2.2	Power Plant					
2.2.1	Boiler					
	2 x 65 tph Boiler with Martin Reverse Reciprocating Grate System along with Auxilliaries (CFR Mundra) inclu. Structure	Set	1	9,800.0	9,800.0	Estmates by Korus
	2 x 65 tph Boiler (Design, Engineering & PGT)	LS	1	500.0	500.0	-do-
	2 x 65 tph Boiler (supervision of erection & Commissioning)	LS	1	200.0	200.0	-do-
	2 x 65 tph Boiler (Erection & Commissioning by Indian Contractor)	LS	1	1,100.0	1,100.0	-do-
	Sub Total 2.2.1				11,600.0	
2.2.2	Boiler Auxillaries					
	Boiler Feed Pump-3 No. (with Motors)	LS			80.0	As per Order
	Dearator-1 No.	LS			110.0	Estimates by KORUS
	IBR Piping incldg Feed water Piping (upto inlet of feed control station)	LS			90.0	-do-
	Boiler Fans (with motors)	LS			200.0	-do-
	Air Ducting for PA & SA Fan	LS			50.0	-do-
	Flue gas Ducting for FGCS inlet & outlet	LS			60.0	-do-
	Expansion jts & Dampers	LS			10.0	-do-
	Insulation & Cladding with application	LS			150.0	-do-
	Refractory with application	LS			270.0	-do-
	Misc Item	LS			30.0	-do-
	Sub Total 2.2.2				1,050.0	
2.2.3	Flue Gas Cleaning System					
	Flue Gas Cleaning System for 2 x 65 tph boiler on F.O.R. Delhi basis	Set	1	1,600.0	1,600.0	Estimates by Korus
	Flue Gas Cleaning System for 2 x 65 tph boiler (Compelete erection, Commissioning & PGT)	LS	1	180.0	180.0	-do-
	Sub Total 2.2.3				1,780.0	
2.2.4	Steam Turbine with Alternator					
	25 MW Steam Turbine with Alternator on F.O.R. Delhi Basis	Set	1	1,350.0	1,350.0	
	25 MW Steam Turbine with Alternator (Design & Engineering)	LS	1	20.0	20.0	-do-
	25 MW Steam Turbine with Alternator(Complete erection, Commissioning & PGT)	LS	1	40.0	40.0	-do-
	Sub Total 2.2.4				1,410.0	
2.2.5	Air Cooled Condenser					
	Air cooled condenser for 25 MW TG on F.O.R. Delhi Basis	Set	1	900.0	900.0	Consultant's Data Bank
	Air cooled condenser for 25 MW TG (Complete erection, Commissioning & PGT)	LS	1	25.0	25.0	-do-
	Sub Total 2.2.5				925.0	
2.2.6	Balance of Plant					
	Ash Handling System - Bed Ash & Fly Ash	Set			60.0	Estimates by KORUS
	Water Treatment Plant-Pre treatment, RO/UF/DM, Tank-250 (2 No.), Pumps	Set			250.0	- do -
	IBR Valves	Set			75.0	- do -
	Control Valve & Steam traps	Set			90.0	- do -

TEHKHAND WASTE TO ELECTRICITY PROJECT LIMITED

PROJECT COST ESTIMATES (BASIC COSTS)

25 MW MSW(Municipal Solid Waste) based Power Plant

S. NO.	PLANT & EQUIPMENTS	UOM	Quantity	Rate	Total estimated costs	Remarks
	Non IBR Piping-Raw Water, Cooling Water, Wrapping Coating	Set			180.0	- do -
	Non IBR Valves, bellows	Set			15.0	- do -
	Structural support for Piping, Spring supports	Set			20.0	- do -
	PRDS	Set			50.0	- do -
	Cooling Water System-Cooling Tower, Pumps, Motors	Set			30.0	- do -
	Compressed Air System	Set			90.0	- do -
	Fire Hydrant & Fire Alarm System	Set			200.0	
	Air Condotioning & Ventillation System	Set			150.0	
	Elevator 1 No.	Set			30.0	
	TG Crane 1 No.	Set			70.0	
	Fuel Oil System	Set			20.0	
	Brick Plant & Inert Processing Unit	Set			200.0	
	Sub Total 2.2.6				1,530.0	
	Sub Total 2.2				18,295.0	
2.3	Laying of Water Pipeline from STP	Set			-	
2.4	Electrical					
	Switchyard & Power Transformer	Set			350.0	
	HT Switchgears	Set			35.0	
	Distribution Transformers	Set			75.0	
	LT Switchgears	Set			35.0	
	MCCs for Plant units	Set			150.0	
	Plant Earthing Sysytem	Set			10.0	
	Erection material	Set			25.0	
	HT Cables	Set			25.0	
	LT & Control Cables	Set			35.0	
	Plant Lighting & Lightning Protection Sysytem	Set			20.0	
	VVFD Drives for Fans, pumps, etc.	Set			90.0	
	DG Set	Set			50.0	
	Battery charger with battery bank	Set			15.0	
	Transmission Line- 2.5 KM	Set			200.0	
	Cable Tray & Accessories	Set			100.0	
	Sub Total 2.4				1,215.0	
2.5	Instrumentation					
	DCS				120.0	
	UPS system with ACDB				30.0	
	Field Instruments				75.0	
	Cable & cable Tray hardware				150.0	
	SWAS				35.0	
	CEMS				250.0	
	Ambient Air Quality Monitoring				75.0	
	CCTV & communication				25.0	
	Sub Total 2.5				760.0	
	Total Plant & equipment (Item 2.0)				22574.0	
	Total Basic Cost of WtE Plant (Item 1.0 & 2.0)				27536.5	

TEHKHAND WASTE TO ELECTRICITY PROJECT LIMITED

PROJECT COST ESTIMATES
Interest during Construction Period

	Quarterly Project Construction Period		2018-19		2019-20				2020-21			Total
	Considerations	30-Sep-18	31-Dec-18	31-Mar-19	30-Jun-19	30-Sep-19	31-Dec-19	31-Mar-20	30-Jun-20	30-Sep-20	31-Dec-20	
	Interest % for Project finance (before COD)	11.35%										
	Interest % for Project finance (before COD)											
	Debt %	70.00%										
	Equity%	30.00%										
S.No.	Item of Cost	Total Cost (Rs Lakhs)	AMOUNT TO BE SPENT in Rs Lakh									
	PROJECT COST PHASING											
		Project Phasing Percentage	15%	20%	15%	15%	6%	7%	10%	12%	0%	100%
		Cumulative Phasing	15%	35%	50%	65%	71%	78%	88%	100%	100%	
		Grant Phasing Percentage	25%	0%	0%	0%	0%	0%	0%	0%	75%	100%
	Project Cost Heads											
1.0	Land & Building	5850	878	1170	878	878	351	410	585	702	0	5,850
2.0	Plant & Equipment	25621	3843	5124	3843	3843	1537	1793	2562	3075	0	25,621
3.0	Mandatory spares for 2 years of operation	200	30	40	30	30	12	14	20	24	0	200
4.0	Engineering Consulting - Design and Supervision	159	24	32	24	24	10	11	16	19	0	159
5.0	Preliminary and Pre-Operative Costs	998	150	200	150	150	60	70	100	120	0	998
6.0	IDC	2910	0	84	240	367	447	501	576	693	0	2,910
7.0	Contingency	1592	239	318	239	239	95	111	159	191	0	1,592
8.0	Financial services charges	820	820	0	0	0	0	0	0	0	0	820
	Total Project costs Excl DSRA & MMWC	38151	5983	6968	5404	5531	2512	2911	4018	4824	0	38,151
	DSRA	1407	0	0	0	0	0	0	0	1407		1,407
	MMWC	228	0	0	0	0	0	0	0	228		228
	Total Project Cost	39786	5983	6968	5404	5531	2512	2911	4018	6459		39,786
	DEBT:EQUITY PHASING											
	Quarter starting		31-Dec-2018	31-Mar-2019	30-Jun-2019	30-Sep-2019	31-Dec-2019	31-Mar-2020	30-Jun-2020	30-Sep-2020	31-Dec-2020	
	Sources of fund											
	Grant											
	Opening Grant		-	2,625	2,625	2,625	2,625	2,625	2,625	2,625	2,625	
	Upfront Grant		2,625								7,875	10500
	Residual Total Grant											
	Closing Grant		2,625	2,625	2,625	2,625	2,625	2,625	2,625	2,625	10,500	
	Fund Required After Grant		3,358	6,968	5,404	5,531	2,512	2,911	4,018	6,459	-7,875	29286
	Equity											
	Opening Equity		-	3,358	4,393	4,719	6,378	7,132	8,005	8,786	8,786	
	Upfront Equity		3,358	1,035	-	-	-	-	-	-	-	4393
	Residual Total Equity		-	-0	326	1,659	754	873	781	-	-	
	Closing Equity		3,358	4,393	4,719	6,378	7,132	8,005	8,786	8,786	8,786	
	Opening Residual Equity		-	-	-0	326	1,985	2,739	3,612	4,393	4,393	
	Addition			-0	326	1,659	754	873	781			4393
	Closing		-	-0	326	1,985	2,739	3,612	4,393	4,393	4,393	
	Equity required as per DER		1,007	3,098	4,719	6,378	7,132	8,005	9,211	11,148	8,786	
	Debt											
	Opening		-	-	5,934	11,011	14,882	16,641	18,679	20,500	20,500	
10,250	Addition Regular Debt		-	5,934	5,077	3,871	1,759	2,037	1,821			20500
	Addition Bridge Debt								1,416	6,459	-7,875	
	Closing		-	5,934	11,011	14,882	16,641	18,679	20,500	20,500	20,500	
	Cummulative for DER		-	-	-	-	-	-	-	-	-	
50%	Debt											
	Brdige loan phasing in lieu of grant		31-Dec-2018	31-Mar-2019	30-Jun-2019	30-Sep-2019	31-Dec-2019	31-Mar-2020	30-Jun-2020	30-Sep-2020	31-Dec-2020	
	Total Project Expenditure		5,983	6,968	5,404	5,531	2,512	2,911	4,018	6,459	-	39786
	Shortfall in grant disbursement		-	-	-	-	-	-	1,416	6,459	-7,875	
0%	Bridge loan equity		-	-	-	-	-	-	-	-	-	
100%	Bridge loan in lieu of Grant		-	-	-	-	-	-	1,416	6,459		
	IDC towards Bridge Loan		-	-	-	-	-	-	161	733	-	
	Grant to be adjusted in bridge loan & equity		-	-	-	-	-	-	-	-	-	
	IDC CALCULATION											
			31-Dec-2018	31-Mar-2019	30-Jun-2019	30-Sep-2019	31-Dec-2019	31-Mar-2020	30-Jun-2020	30-Sep-2020		
	Interest rate		11.35%	11.35%	11.35%	11.35%	11.35%	11.35%	11.35%	11.35%		
	Cummulative debt		0	5934	11011	14882	16641	18679	21916	26959		
	Period in days		92	90	91	92	92	91	91	92		
	Quarterly Interest		0	84	240	367	447	501	576	693		
	Total IDC		2910									
			31-Dec-2018	31-Mar-2019	30-Jun-2019	30-Sep-2019	31-Dec-2019	31-Mar-2020	30-Jun-2020	30-Sep-2020	31-Dec-2020	
	Project Capex		3358	6884	5163	5163	2065	2409	3442	4131	-7875	
	Equity Inflow		3358	1035	326	1659	754	873	781	0	0	
	Equity portion of IDC,DSRA, MMWC		0	25	72	110	134	150	173	699	0	
	Net equity funding for Capex		3358	1009	254	1549	620	723	608	-699	0	

TEHKHAND WASTE TO ELECTRICITY PROJECT LIMITED

POWER TARIFF CALCULATIONS

S.NO.	ITEM		YEAR OF OPERATION																						
		2019-20	2020-21	2021-22	2022-23	2023-24	2024-25	2025-26	2026-27	2027-28	2028-29	2029-30	2030-31	2031-32	2032-33	2033-34	2034-35	2035-36	2036-37	2037-38	2038-39	2039-40	2040-41	2041-42	2042-43	2043-44
	Discounting Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
1.0	Tariff to be Quoted & considered for Revenue calculations (Rs/kWh)	4.30	4.75	5.25	5.25	5.50	5.50	5.82	6.00	6.00	6.00	6.00	5.10	5.00	4.50	4.50	4.50	4.50	4.50	4.50	4.50	4.50	4.50	4.50	4.50	4.50
2.0	Discounting Factor	0.76	0.69	0.63	0.58	0.53	0.48	0.44	0.40	0.37	0.34	0.31	0.28	0.26	0.23	0.21	0.19	0.18	0.16	0.15	0.14	0.12	0.11	0.10	0.09	0.09
3.0	Discounted Total Tariff	3.26	3.29	3.32	3.03	2.90	2.65	2.56	2.41	2.20	2.01	1.84	1.43	1.28	1.05	0.96	0.87	0.80	0.73	0.67	0.61	0.56	0.51	0.46	0.42	0.39
4.0	Levellised Tariff (Rs/kWh)	5.13																								

TEHKHAND WASTE TO ELECTRICITY PROJECT LIMITED

INCOME STATEMENT

Amount Rs Lakhs

S.NO.	ITEM	CONSTRUCTION			YEAR OF OPERATION																								
	Financial Year	2019	2020	2021	2021	2022	2023	2024	2025	2026	2027	2028	2028	2029	2030	2031	2032	2033	2033	2034	2035	2035	2036	2037	2038	2038	2039	2040	2041	2042	2043	2044	2045	2046
		2018-19	2019-20	2020-21	2020-21	2021-22	2022-23	2023-24	2024-25	2025-26	2026-27	2027-28	2028-29	2029-30	2030-31	2031-32	2032-33	2033-34	2034-35	2035-36	2036-37	2037-38	2038-39	2039-40	2040-41	2041-42	2042-43	2043-44	2044-45	2045-46	
	Year Ending	31-Mar-19	31-Mar-20	31-Mar-21	31-Mar-21	31-Mar-22	31-Mar-23	31-Mar-24	31-Mar-25	31-Mar-26	31-Mar-27	31-Mar-28	31-Mar-29	31-Mar-30	31-Mar-31	31-Mar-32	31-Mar-33	31-Mar-34	31-Mar-35	31-Mar-36	31-Mar-37	31-Mar-38	31-Mar-39	31-Mar-40	31-Mar-41	31-Mar-42	31-Mar-43	31-Mar-44	31-Mar-45	31-Mar-46	
	Plant Construction/Operation Months	6.0	12.0	6.0	6.0	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	6
					1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24			
	Power for Exports (GWh/a)				86	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177
	Compost Production (t/a)				18100	37752	39263	40833	42466	43800	43800	43800	43800	43800	43800	43800	43800	43800	43800	43800	43800	43800	43800	43800	43800	43800	43800	43800	43800	43800	43800	43800
	Surplus RDF (t/a)				0	17141	43459	70289	97662	121383	129470	137385	143171	143171	143171	143171	143171	143171	143171	143171	143171	143171	143171	143171	143171	143171	143171	143171	143171	143171	143171	143171	143171
	Recyclables Production (t/a)				3620	7550	7853	8167	8493	8760	8760	8760	8760	8760	8760	8760	8760	8760	8760	8760	8760	8760	8760	8760	8760	8760	8760	8760	8760	8760	8760	8760	8760
	COSTS																																	
1.0	Total Fuel Cost (Annexure 10.0)				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.0	Lease Rentals (Annexure 10.0)				187	375	375	375	375	375	375	375	375	375	375	375	450	450	450	450	450	450	450	450	450	450	450	450	450	450	450	450	450	225
3.0	Operating & Maintenance (O&M)Costs (Annexure 10.0)				1332	2785	2904	3028	3158	3293	3434	3581	3734	3894	4061	4235	4416	4605	4802	5007	5222	5445	5678	5921	6175	6439	6715	7002	7302	7302	3807
4.0	Insurance Premium (Annexure 10.0)				20	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	20
5.0	Reject Handling Charges (Annexure 10.0)																																	
5.1	From Site to Dumping Site (Annexure 10 0)				113	227	227	227	227	227	227	227	227	227	227	227	302	302	302	302	302	302	302	302	302	302	302	302	302	302	302	302	302	151
5.2	Internal Reject Handling (Annexure 10 0)				75	151	151	151	151	151	151	151	151	151	151	151	151	151	151	151	151	151	151	151	151	151	151	151	151	151	151	151	151	76
5.3	Transportation Charges (Annexure 10.0)				19	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	19
	Sub-total 5.0				207	415	415	415	415	415	415	415	415	415	415	415	491	491	491	491	491	491	491	491	491	491	491	491	491	491	491	491	491	245
6.0	Total of Costs (Sub Total 1.0 to 5.0)				1746	3615	3734	3858	3988	4123	4264	4411	4564	4724	4891	5140	5396	5585	5782	5988	6202	6426	6659	6902	7155	7420	7695	7983	8282	8282	4297
	REVENUES																																	
7.0	Total Power Exports (Gwh/a) (Ann. 10.1)				88	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	88
7.1	Tariff (Rs/kWh) (Ann 10.0)				4	5	5	5	6	6	6	6	6	6	6	6	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
7.2	Revenue from Sale of Power				3792	8400	9284	9284	9726	9726	10292	10611	10611	10611	10611	9019	8842	7958	7958	7958	7958	7958	7958	7958	7958	7958	7958	7958	7958	7958	7958	7958	7958	3979
8.0	Compost Production (tpa) (Ann 10.1)				18100	37752	39263	40833	42466	43800	43800	43800	43800	43800	43800	43800	43800	43800	43800	43800	43800	43800	43800	43800	43800	43800	43800	43800	43800	43800	43800	43800	43800	21900
8.1	Selling Price of Compost (Rs/t) (Ann 10.0)	2000	2100	2205	2315	2431	2553	2680	2814	2955	3103	3258	3421	3592	3771	3960	4158	4366	4584	4813	5054	5307	5572	5851	6143	6450	6773	7111	7467	7840	7840
8.2	Revenue from Sale of Compost				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9.0	RDF Production (tpa) (Ann 10.1)				0	17141	43459	70289	97662	121383	129470	137385	143171	143171	143171	143171	143171	143171	143171	143171	143171	143171	143171	143171	143171	143171	143171	143171	143171	143171	143171	143171	143171	71586
9.1	Selling Price of RDF (Rs/t) (Ann 10.0)	1800	1890	1985	2084	2188	2297	2412	2533	2659	2792	2932	3079	3233	3394	3564	3742	3929	4126	4332	4549	4776	5015	5265	5529	5805	6095	6400	6720	7056	7056
9.2	Revenue from Sale of RDF				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10.0	Total Recyclables Production (tpa) (Ann 10.1)				3620	7550	7853	8167	8493	8760	8760	8760	8760	8760	8760	8760	8760	8760	8760	8760	8760	8760	8760	8760	8760	8760	8760	8760	8760	8760	8760	8760	8760	4380
10.1	Selling Price of Recyclables (Rs/t) (Ann 10.0)	4000	4171	4380	4567	4763	4967	5179	5401	5632	5873	6124	6386	6660	6945	7242	7552	7875	8212	8564	8930	9313	9711	10127	10560	11012	11483	11975	12488	13022	13022
10.2	Revenue from Sale of Recyclables				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11.0	Revenue from Grant Recognition				420	420	420	420	420	420	420	420	420	420	420	420	420	420	420	420	420	420	420	420	420	420	420	420	420	420	420	420	420	0
12.0	Total Revenue				4212	8820	9704	9704	10146	10146	10712	11031	11031	11031	11031	9439	9262	8378	8378	8378	8378	8378	8378	8378	8378	8378	8378	8378	8378	8378	8378	8378	8378	3979
13.0	Total Operating Expenses				1824	3772	3813	3858	3988	4123	4264	4411	4564	4724	4891	5140	5396	5585	5782	5988	6202	6426	6659	6902	7155	7420	7695	7983	8282	8282	4297
	Depreciation, Interest & Income Tax (EBIDTA) (12.0 - 6.0)				2466	5205	5970	5846	6158	6023	6448	6619	6466	6306	6140	4299	3866	2793	2595	2390	2176	1952	1719	1476	1223	958	683	395	96	-318	-318
13.2	EBIDTA%				1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14.0	Financial Expenses																																	
14.1	Interest on Term Loan (Annex. 12.1)				1112	2199	2080	1924	1757	1579	1401	1223	1045	856	651	478	345	234	145	56	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1
14.2	Interest on Bank Borrowings for working capital (Annx 12.3)				82	86	98	96	101	100	106	109	107	105	103	76	70	54	52	49	47	44	41	38	34	31	28	24	20	10	10	10	10	10	10
14.3	FBG Maintenance Charges				79	158	79	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Total of 14.0				1273	2443	2256	2020	1859	1679	1508	1333	1153	962	754	554	415	288	197	105	47	45	42	39	36	32	29	25	21	11	11	11	11	11	11
15.0	PBDT (13.1-14.2-14.3)				1272	2920	3793	3826	4300	4344	4941	5287	5314	5345	5386	3745	3451	2505	2399	2285	2129	1907	1677	1437	1187	926	654	370	74	-330	-330
16.0	Depreciation (Ann 12.2)				761	1526	1526	1526	1526	1526	1526	1526	1526	1526	1526	1526	1526	1526	1526	1526	1526	1526	1526	1526	1526	1526	1526	1526	1526	763	763	763	763	763	763
17.0	Operating Net Profit / Loss Before Tax (15.0-16.0)				511	1394	2266	2299	2774	2818	3415	3761	3788	3819	3860	2219	1925	978	873	759	603	381	151	-89	-339	-600	-872	-1156	-1452	-1093	-1093	-1093	-1093	-1093	-1093
18.0	Tax for the Year (Ann. 12.4)				109	297	484	491	592	601	729	1195	1294	1381	1461	949	896	609	608	599	572	517	457	391	318	240	157	68	0	0	0	0	0	0	0
19.0	Profit After Tax (17.0-18.0)				402	1096	1783	1809	2182	2217	2686	2565	2494	2438	2399	1269	1029	369	265	160	31	-136	-306	-480	-658	-841	-1029	-1224	-1452	-1093	-1093	-1093	-1093	-1093	-1093
20.0	Net Cash Accruals (16.0+19.0)				1163	2622	3309	3335	3708	3743	4212	4091	4020	3964	3925	2795	2555	1895	1791	1686	1557	1390	1220	1046	868	685	497	302	74	-330	-330	-330	-330	-330	-330

TEHKHAND WASTE TO ELECTRICITY PROJECT LIMITED

INTEREST ON TERM LOAN AND REPAYMENT SCHEDULE

In Rs Lakhs

Description	2018-19	2019-20	2020-21	2020-21	2021-22	2022-23	2023-24	2024-25	2025-26	2026-27	2027-28	2028-29	2029-30	2030-31	2031-32	2032-33	2033-34	2034-35	2035-36	2036-37
Year Ending				31-Mar-21	31-Mar-22	31-Mar-23	31-Mar-24	31-Mar-25	31-Mar-26	31-Mar-27	31-Mar-28	31-Mar-29	31-Mar-30	31-Mar-31	31-Mar-32	31-Mar-33	31-Mar-34	31-Mar-35	31-Mar-36	30-Jun-36
Plant Construction/Operation Months	6.0	12.0	6.0	6.0	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	6
		Construction										Operation								
1. Opening balance	-	5,934	18,679	20,500	20,500	19,885	18,450	17,015	15,375	13,735	12,095	10,455	8,815	6970	5022	3792	2562	1742	922	102
2. New borrowing (LT)	5,934	12,745	1,821	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3. IDC payable	84	1,556	1,269	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Percentage Repayment					3%	7%	7%	8%	8%	8%	8%	8%	9%	10%	6%	6%	4%	4%	4%	0.5%
4. Principal payable (LT)	-	-	-	-	615	1,435	1,435	1,640	1,640	1,640	1,640	1,640	1,845	1,947	1,230	1,230	820	820	820	102
5. Interest payable (LT)	-	-	-	1,112	2,199	2,080	1,924	1,757	1,579	1,401	1,223	1,045	856	651	478	345	234	145	56	1
6. Principal at end (LT)	5,934	18,679	20,500	20,500	19,885	18,450	17,015	15,375	13,735	12,095	10,455	8,815	6,970	5022	3792	2562	1742	922	102	0
7. VGF (10,500 used for repayment)																				
QUARTER - 1																				
1. Opening balance	-	5,934	18,679	20,500	20,500	19,885	18,450	17,015	15,375	13,735	12,095	10,455	8,815	6,970	5,022	3,792	2,562	1,742	922	102
2. New borrowing (LT)	-	5,077	1,821		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3. IDC payable	-	240	576																	
Percentage Repayment	-	-	-	-		1.75%	1.75%	2.00%	2.00%	2.00%	2.00%	2.00%	2.25%	2.38%	1.50%	1.50%	1.00%	1.00%	1.00%	0.50%
4. Principal payable (LT)	-	-	-	-	-	359	359	410	410	410	410	410	461	487	307	307	205	205	205	102
5. Interest payable (LT)					556	535	496	456	411	367	323	278	233	182	132	99	67	44	22	1
6. Principal at end (LT)	-	11,011	20,500	20,500	20,500	19,526	18,091	16,605	14,965	13,325	11,685	10,045	8,354	6,483	4,715	3,485	2,357	1,537	717	(0)
QUARTER - 2																				
1. Opening balance	-	11,011	20,500	20,500	20,500	19,526	18,091	16,605	14,965	13,325	11,685	10,045	8,354	6,483	4,715	3,485	2,357	1,537	717	(0)
2. New borrowing (LT)	-	3,871																		
3. IDC payable	-	367	693																	
Percentage Repayment	-	-	-	-	1.00%	1.75%	1.75%	2.00%	2.00%	2.00%	2.00%	2.00%	2.25%	2.38%	1.50%	1.50%	1.00%	1.00%	1.00%	
4. Principal payable (LT)	-	-	-	-	205	359	359	410	410	410	410	410	461	487	307	307	205	205	205	-
5. Interest payable (LT)				-	553	525	486	445	400	356	311	267	220	169	124	90	61	39	17	(0)
6. Principal at end (LT)	-	14,882	20,500	20,500	20,295	19,167	17,732	16,195	14,555	12,915	11,275	9,635	7,892	5996	4407	3177	2152	1332	512	0
QUARTER - 3																				
1. Opening balance	0	14882	20500	20500	20295	19167	17732	16195	14555	12915	11275	9635	7892	5996	4407	3177	2152	1332	512	0
2. New borrowing (LT)	0	1759																		
3. IDC payable	0	447																		
Percentage Repayment	-	-	-	-	1.00%	1.75%	1.75%	2.00%	2.00%	2.00%	2.00%	2.00%	2.25%	2.38%	1.50%	1.50%	1.00%	1.00%	1.00%	
4. Principal payable (LT)	-	-	-	-	205	359	359	410	410	410	410	410	461	487	307	307	205	205	205	-
5. Interest payable (LT)	-			556	548	515	476	434	389	345	300	256	208	156	115	82	56	33	11	0
6. Principal at end (LT)	0	16641	20500	20500	20090	18809	17374	15785	14145	12505	10865	9225	7431	5509	4100	2870	1947	1127	307	0
QUARTER - 4																				
1. Opening balance	0	16641	20500	20500	20090	18809	17374	15785	14145	12505	10865	9225	7431	5509	4100	2870	1947	1127	307	0
2. New borrowing (LT)	5934	2,037																		
3. IDC payable	84	501																		
Percentage Repayment	-	-	-	-	1.00%	1.75%	1.75%	2.00%	2.00%	2.00%	2.00%	2.00%	2.25%	2.38%	1.50%	1.50%	1.00%	1.00%	1.00%	
4. Principal payable (LT)	-	-	-	-	205	359	359	410	410	410	410	410	461	487	307	307	205	205	205	-
5. Interest payable (LT)				556	542	505	466	423	378	334	289	245	195	143	107	74	50	28	6	0
6. Principal at end (LT)	5934	18679	20500	20500	19885	18450	17015	15375	13735	12095	10455	8815	6970	5022	3792	2562	1742	922	102	0
DSRA Schedule																				
DSRA Requirement				556	1407	1757	1679	1699	1610	1521	1432	1343	1351	1299	854	787	527	482	438	52
Opening DSRA Balance				0	556	1407	1757	1679	1699	1610	1521	1432	1343	1351	1299	854	787	527	482	438
Addition to DSRA Balance				556	851	350	-78	19	-89	-89	-89	-89	8	-52	-445	-67	-261	-44	-44	-386
Closing DSRA				556	1407	1757	1679	1699	1610	1521	1432	1343	1351	1299	854	787	527	482	438	52
DSRA Deficit				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

TEHKHAND WASTE TO ELECTRICITY PROJECTLIMITED

CAPTILISATION AND DEPRECIATION SCHEDULES

ON SLM(Straight Line Method) AND WDV(Written Down Value) METHODS

SLM Method — In Rs. Lakhs

S No		Site Development and Shed & Buildings	Equipment & Other Misc Assets	Total
1	Total Depreciable Assets (Hard+Soft)			38151
2	Basic Value (Hard Cost)	5850	25621	31472
3	Apportioned Amount (Hard+Soft)	7092	31059	38151
4	Margin Money			228
5	DSRA			1407
6	Project Cost			39786
	SLM Depreciation Rate	4.00%	4.00%	-
	Yearly Depreciation	284	1242	1526

WDV Method — Rs Lakhs

	WDV Rates	10%	15%	
Year	Opening Balance	7092	31059	38151
2020-21	Dep 1	709	4659	5368
	WDV	6383	26400	
2021-22	Dep	638	3960	4598
	WDV	5744	22440	
2022-23	Dep	574	3366	3940
	WDV	5170	19074	
2023-24	Dep	517	2861	3378
	WDV	4653	16213	
2024-25	Dep	465	2432	2897
	WDV	4188	13781	
2025-26	Dep	419	2067	2486
	WDV	3769	11714	
2026-27	Dep	377	1757	2134
	WDV	3392	9957	
2027-28	Dep	339	1494	1833
	WDV	3053	8463	
2028-29	Dep	305	1269	1575
	WDV	2748	7194	

TEHKHAND WASTE TO ELECTRICITY PROJECTLIMITED

CAPTILISATION AND DEPRECIATION SCHEDULES

ON SLM(Straight Line Method) AND WDV(Written Down Value) METHODS

SLM Method

In Rs. Lakhs

S No		Site Development and Shed & Buildings	Equipment & Other Misc Assets	Total
2029-30	Dep	275	1079	1354
	WDV	2473	6115	
2030-31	Dep	247	917	1164
	WDV	2226	5197	
2031-32	Dep	223	780	1002
	WDV	2003	4418	
2032-33	Dep	200	663	863
	WDV	1803	3755	
2033-34	Dep	180	563	744
	WDV	1622	3192	
2034-35	Dep	162	479	641
	WDV	1460	2713	
2035-36	Dep	146	407	553
	WDV	1314	2306	
2036-37	Dep	131	346	477
	WDV	1183	1960	
2037-38	Dep	118	294	412
	WDV	1064	1666	
2038-39	Dep	106	250	356
	WDV	958	1416	
2039-40	Dep	96	212	308
	WDV	862	1204	
2040-41	Dep	86	181	267
	WDV	776	1023	
2041-42	Dep	78	153	231
	WDV	698	870	
2042-43	Dep	70	130	200
	WDV	629	739	
2043-44	Dep	63	111	174
	WDV	566	628	
2044-45	Dep	57	94	151
	WDV	509	534	
2045-46	Dep	51	80	131
	WDV	458	454	

TEHKHAND WASTE TO ELECTRICITY PROJECT LIMITED

WORKING CAPITAL & MARGIN MONEY

In Rs Lakhs

Financial Year	2018-19	2019-20	2020-21	2020-21	2021-22	2022-23	2023-24	2024-25	2025-26	2026-27	2027-28	2028-29	2029-30	2030-31	2031-32	2032-33	2033-34	2034-35	2035-36	2036-37	2037-38	2038-39	2039-40	2040-41	2041-42	2042-43	2043-44	2044-45	2045-46
Year Ending	31-Mar-19	31-Mar-20	31-Mar-21	31-Mar-21	31-Mar-22	31-Mar-23	31-Mar-24	31-Mar-25	31-Mar-26	31-Mar-27	31-Mar-28	31-Mar-29	31-Mar-30	31-Mar-31	31-Mar-32	31-Mar-33	31-Mar-34	31-Mar-35	31-Mar-36	31-Mar-37	31-Mar-38	31-Mar-39	31-Mar-40	31-Mar-41	31-Mar-42	31-Mar-43	31-Mar-44	31-Mar-45	31-Mar-46
No. of Months	6.0	12.0	6.0	6.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	6
Working Capital Calculations																													
Fuel costs (Annexure 10.0 & 11.1)				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Receivables (Annexure 10.0 & 11.1)				1,408	1,470	1,617	1,617	1,691	1,691	1,785	1,838	1,838	1,838	1,838	1,573	1,544	1,396	1,396	1,396	1,396	1,396	1,396	1,396	1,396	1,396	1,396	1,396	1,396	1,326
O&M (Annexure 10.0 & 11.1)				583	602	622	643	665	687	711	735	761	787	815	857	899	931	964	998	1,034	1,071	1,110	1,150	1,193	1,237	1,283	1,330	1,380	1,432
Maintenance spares (Annexure 10.0 & 11.1)				88	90	93	96	100	103	107	110	114	118	122	129	135	140	145	150	155	161	166	173	179	185	192	200	207	215
Total Working Capital Requirement	-			912	958	1,088	1,071	1,126	1,107	1,181	1,214	1,192	1,169	1,146	845	779	605	577	548	518	486	453	419	383	345	306	265	223	109
Short Term Borrowing (Ann 10.0)				684	718	816	803	845	830	886	910	894	877	859	634	584	454	433	411	388	364	340	314	287	259	230	199	167	82
Interest on Working Capital (Ann 10.0)				82	86	98	96	101	100	106	109	107	105	103	76	70	54	52	49	47	44	41	38	34	31	28	24	20	10
Margin Money for Working Capital (Ann 10.0)				228	239	272	268	282	277	295	303	298	292	286	211	195	151	144	137	129	121	113	105	96	86	77	66	56	27
Change in Net Current Assets				(912)	(46)	(130)	18	(55)	19	(74)	(32)	22	23	24	301	66	174	28	29	30	32	33	34	36	37	39	41	42	114
Change in Short term borrowing				684	35	98	(13)	41	(14)	56	24	(16)	(17)	(18)	(225)	(49)	(131)	(21)	(22)	(23)	(24)	(25)	(26)	(27)	(28)	(29)	(31)	(32)	(86)
Change in Margin Money Requirement				228	12	33	(4)	14	(5)	19	8	(5)	(6)	(6)	(75)	(16)	(44)	(7)	(7)	(8)	(8)	(8)	(9)	(9)	(9)	(10)	(10)	(11)	(29)
Term Loan installment due in a year				615	1,435	1,435	1,640	1,640	1,640	1,640	1,640	1,845	1,947	1,230	1,230	820	820	820	102			-	-	-	-	-	-	-	

TEHKHAND WASTE TO ELECTRICITY PROJECT LIMITED

INCOME TAX CALCULATION

Rs in Lakhs

Financial Year		2020-21	2021-22	2022-23	2023-24	2024-25	2025-26	2026-27	2027-28	2028-29	2029-30	2030-31	2031-32	2032-33	2033-34	2034-35	2035-36	2036-37	2037-38	2038-39	2039-40	2040-41	2041-42	2042-43	2043-44	2044-45	2045-46
Year Ending	31-Mar-21	31-Mar-21	31-Mar-22	31-Mar-23	31-Mar-24	31-Mar-25	31-Mar-26	31-Mar-27	31-Mar-28	31-Mar-29	31-Mar-30	31-Mar-31	31-Mar-32	31-Mar-33	31-Mar-34	31-Mar-35	31-Mar-36	31-Mar-37	31-Mar-38	31-Mar-39	31-Mar-40	31-Mar-41	31-Mar-42	31-Mar-43	31-Mar-44	31-Mar-45	31-Mar-46
Corporate Tax Rate	34.608%																										
Minimum Alternate Tax Rate (MAT)	21.3%																										
MAT Lapse Year	31-Mar-36																										
PBT (Income eligible for tax)		511	1394	2266	2299	2774	2818	3415	3761	3788	3819	3860	2219	1925	978	873	759	603	381	151	-89	-339	-600	-872	-1156	-1452	-1093
Add: Depreciation as per Co Act		761	1,526	1,526	1,526	1,526	1,526	1,526	1,526	1,526	1,526	1,526	1,526	1,526	1,526	1,526	1,526	1,526	1,526	1,526	1,526	1,526	1,526	1,526	1,526	1,526	763
Less: Depreciation as per IT Act		5,368	4,598	3,940	3,378	2,897	2,486	2,134	1,833	1,575	1,354	1164	1002	863	744	641	553	477	412	356	308	267	231	200	174	151	131
Adjusted PBT		(4,096)	(1,679)	(148)	447	1,403	1,858	2,807	3,454	3,739	3,991	4,222	2,742	2,588	1,761	1,758	1,732	1,652	1,495	1,321	1,129	920	695	453	196	(77)	(461)
Accumulated Adjusted PBT		(4,096)	(5,775)	(5,922)	(5,475)	(4,072)	(2,214)	593	4,047	7,786	11,777	15,998	18,740	21,328	23,089	24,847	26,579	28,231	29,726	31,046	32,175	33,095	33,790	34,243	34,439	34363	33902
Corporate Tax Liability		-	-	-	-	-	-	205	1,195	1,294	1,381	1,461	949	896	609	608	599	572	517	457	391	318	240	157	68	-	0
MAT Computations:																											
PBT (Books)		511	1,394	2,266	2,299	2,774	2,818	3,415	3,761	3,788	3,819	3,860	2,219	1,925	978	873	759	603	381	151	(89)	(339)	(600)	(872)	(1,156)	-1452	-1093
Minimum Alternate Tax (MAT) Liability		109	297	484	491	592	601	729	803	808	815	824	473	411	209	186	162	129	81	32	-	-	-	-	-	-	0
Tax Liability w/o MAT Credit		109	297	484	491	592	601	729	1,195	1,294	1,381	1,461	949	896	609	608	599	572	517	457	391	318	240	157	68	-	-
MAT Credit earned in this period		109	297	484	491	592	601	524	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cumulative MAT Credit Available		-	109	407	890	1,381	1,973	2,574	3,098	3,098	3,098	3,098	3,098	3,098	3,098	3,098	3,098	3,097	3,096	3,095	3,094	3,093	3,092	3,091	3,090	3,089	3,088
MAT Credit Utilized in this period		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MAT Credit due to lapse in this period		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	1	1	1	1	1	1	1	1
MAT Credit lapsed in this period		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	109	297	484	491	592	601	729	1,195	1,294	1,381	1,461
Actual tax payable		109	297	484	491	592	601	729	1,195	1,294	1,381	1,461	949	896	609	608	599	572	517	457	391	318	240	157	68	-	-

TEHKHAND WASTE TO ELECTRICITY PROJECT LIMITED

BALANCE SHEET

In Rs Lakhs

DESCRIPTION	CONSTRUCTION			YEAR OF OPERATION																								
Financial Year	2018-19	2019-20	2020-21	2020-21	2021-22	2022-23	2023-24	2024-25	2025-26	2026-27	2027-28	2028-29	2029-30	2030-31	2031-32	2032-33	2033-34	2034-35	2035-36	2036-37	2037-38	2038-39	2039-40	2040-41	2041-42	2042-43	2043-44	2044-45	2045-46
Year Ending	31-Mar-19	31-Mar-20	31-Mar-21	31-Mar-21	31-Mar-22	31-Mar-23	31-Mar-24	31-Mar-25	31-Mar-26	31-Mar-27	31-Mar-28	31-Mar-29	31-Mar-30	31-Mar-31	31-Mar-32	31-Mar-33	31-Mar-34	31-Mar-35	31-Mar-36	31-Mar-37	31-Mar-38	31-Mar-39	31-Mar-40	31-Mar-41	31-Mar-42	31-Mar-43	31-Mar-44	31-Mar-45	31-Mar-46
Number of Months	6	12	6	6	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	6
SOURCES OF FUNDS																													
Equity share capital/ Promoters contribution			8,786	8,786	8,786	8,786	8,786	8,786	8,786	8,786	8,786	8,786	8,786	8,786	8,786	8,786	8,786	8,786	8,786	8,786	8,786	8,786	8,786	8,786	8,786	8,786	8,786	8,786	8,786
Reserves & Surplus				402	1,498	3,281	5,090	7,272	9,488	12,174	14,740	17,233	19,671	22,070	23,339	24,369	24,738	25,002	25,162	25,193	25,057	24,751	24,271	23,613	22,773	21,743	20,520	19,068	17,975
Net Networth			8,786	9,188	10,284	12,067	13,875	16,057	18,274	20,960	23,525	26,019	28,457	30,856	32,125	33,154	33,523	33,788	33,947	33,979	33,842	33,536	33,057	32,399	31,558	30,529	29,305	27,853	26,761
Loan Funds																													
Grant(VGF)			#####	10,080	9,660	9,240	8,820	8,400	7,980	7,560	7,140	6,720	6,300	5,880	5,460	5,040	4,620	4,200	3,780	3,360	2,940	2,520	2,100	1,680	1,260	840	420	-	
Long Term Loans			#####	19885	18450	17015	15375	13735	12095	10455	8815	6970	5022	3792	2562	1742	922	102	0	0	0	0	0	0	0	0			
Total Source of Funds			39,786	39,153	38,394	38,322	38,070	38,192	38,349	38,975	39,480	39,709	39,779	40,528	40,148	39,937	39,066	38,090	37,727	37,339	36,782	36,056	35,157	34,079	32,818	31,369	29,725	27,853	26,761
USES OF FUNDS																													
Gross Block of Fixed Assets			38,151	38,151	38,151	38,151	38,151	38,151	38,151	38,151	38,151	38,151	38,151	38,151	38,151	38,151	38,151	38,151	38,151	38,151	38,151	38,151	38,151	38,151	38,151	38,151	38,151	38,151	38,151
Less Cummulative Depreciation				761	2,287	3,813	5,339	6,865	8,391	9,917	11,443	12,969	14,495	16,021	17,547	19,073	20,599	22,125	23,651	25,177	26,703	28,229	29,755	31,281	32,807	34,333	35,859	37,386	38,149
Net Block of Fixed Assets			38,151	37,390	35,864	34,338	32,812	31,286	29,760	28,234	26,708	25,181	23,655	22,129	20,603	19,077	17,551	16,025	14,499	12,973	11,447	9,921	8,395	6,869	5,343	3,817	2,291	765	2
Current Assets				*912*	*958*	*1,088*	*1,071*	*1,126*	*1,107*	*1,181*	*1,214*	*1,192*	*1,169*	*1,146*	*845*	*779*	*605*	*577*	*548*	*518*	*486*	*453*	*419*	*383*	*345*	*306*	*265*	*223*	*109*
Current liabilities				*1,299*	*2,153*	*2,251*	*2,443*	*2,485*	*2,470*	*2,526*	*2,550*	*2,739*	*2,824*	*2,089*	*1,864*	*1,404*	*1,274*	*1,253*	*514*	*388*	*364*	*340*	*314*	*287*	*259*	*230*	*199*	*167*	*82*
Net Current Assets			228	(387)	(1,196)	(1,163)	(1,372)	(1,358)	(1,363)	(1,345)	(1,337)	(1,547)	(1,655)	(944)	(1,019)	(625)	(669)	(676)	35	129	121	113	105	96	86	77	66	56	27
DSRA			1,407	1,407	1,407	1,757	1,679	1,699	1,610	1,521	1,432	1,343	1,351	1,299	854	787	527	482	438	52	-	-	-	-	-	-	-	-	-
Cash & Bank Balances			1,635	743	2,319	3,390	4,952	6,567	8,343	10,565	12,678	14,732	16,428	18,043	19,709	20,697	21,656	22,258	22,756	24,184	25,214	26,022	26,657	27,114	27,389	27,475	27,368	27,033	26,732
Total Use of Funds			39,786	39,153	38,394	38,322	38,070	38,192	38,349	38,975	39,480	39,709	39,779	40,528	40,148	39,937	39,066	38,090	37,727	37,339	36,782	36,056	35,157	34,079	32,818	31,369	29,725	27,853	26,761

TEHKHAND WASTE TO ELECTRICITY PROJECT LIMITED

CASH FLOW STATEMENT

In Rs Lakhs

DESCRIPTION	CONSTRUCTION			YEAR OF OPERATION																							
Financial Year	2018-19	2019-20	2020-21	2020-21	2021-22	2022-23	2023-24	2024-25	2025-26	2026-27	2027-28	2028-29	2029-30	2030-31	2031-32	2032-33	2033-34	2034-35	2035-36	2036-37	2037-38	2038-39	2039-40	2040-41	2041-42	2042-43	2043-44	2044-45	2045-46
Year Ending	31-Mar-19	31-Mar-20	31-Mar-21	31-Mar-21	31-Mar-22	31-Mar-23	31-Mar-24	31-Mar-25	31-Mar-26	31-Mar-27	31-Mar-28	31-Mar-29	31-Mar-30	31-Mar-31	31-Mar-32	31-Mar-33	31-Mar-34	31-Mar-35	31-Mar-36	31-Mar-37	31-Mar-38	31-Mar-39	31-Mar-40	31-Mar-41	31-Mar-42	31-Mar-43	31-Mar-44	31-Mar-45	31-Mar-46
Number of Months	6	12	6	6	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	6
PAT				402	1,096	1,783	1,809	2,182	2,217	2,686	2,565	2,494	2,438	2,399	1,269	1,029	369	265	160	31	-136	-306	-480	-658	-841	-1,029	-1,224	-1,452	-1,093
Depreciation				761	1,526	1,526	1,526	1,526	1,526	1,526	1,526	1,526	1,526	1,526	1,526	1,526	1,526	1,526	1,526	1,526	1,526	1,526	1,526	1,526	1,526	1,526	1,526	1,526	763
Operational Activities																													
Net Current Assets				-387	-1196	-1163	-1372	-1358	-1363	-1345	-1337	-1547	-1655	-944	-1019	-625	-669	-676	35	129	121	113	105	96	86	77	66	56	27
Change in Net Working Capital				-228	-12	-33	4	-14	5	-19	-8	5	6	6	75	16	44	7	7	8	8	8	9	9	9	10	10	11	29
Financing Activities																													
Term Loan change			20500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Grant change			10500	-420	-420	-420	-420	-420	-420	-420	-420	-420	-420	-420	-420	-420	-420	-420	-420	-420	-420	-420	-420	-420	-420	-420	-420	-420	0
Equity change			8786	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Loan Repayment				0	-615	-1435	-1435	-1640	-1640	-1640	-1640	-1640	-1845	-1947	-1230	-1230	-820	-820	-820	-102	0	0	0	0	0	0	0	0	0
Investing Activities																													
Fixed Assets			-38151	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Increase in DSRA				1407	0	350	-78	19	-89	-89	-89	-89	8	-52	-445	-67	-261	-44	-44	-386	-52	0	0	0	0	0	0	0	0
Opening Balance			0	1,635	743	2,319	3,390	4,952	6,567	8,343	10,565	12,678	14,732	16,428	18,043	19,709	20,697	21,656	22,258	22,756	24,184	25,214	26,022	26,657	27,114	27,389	27,475	27,368	27,033
Addition			1635	-892	1,576	1,071	1,562	1,615	1,777	2,222	2,112	2,054	1,696	1,615	1,666	988	959	602	497	1,428	1,030	808	635	457	275	87	-108	-335	-301
Closing Balance			1635	743	2,319	3,390	4,952	6,567	8,343	10,565	12,678	14,732	16,428	18,043	19,709	20,697	21,656	22,258	22,756	24,184	25,214	26,022	26,657	27,114	27,389	27,475	27,368	27,033	26,732

TEHKHAND WASTE TO ELECTRICITY PROJECT LIMITED

Calculation of Debt Service Coverage Ratio

In Rs Lakhs

Year of Operation	2020-21	2021-22	2022-23	2023-24	2024-25	2025-26	2026-27	2027-28	2028-29	2029-30	2030-31	2031-32	2032-33	2033-34	2034-35	2035-36	2036-37
Year Ending	31-Mar-21	31-Mar-22	31-Mar-23	31-Mar-24	31-Mar-25	31-Mar-26	31-Mar-27	31-Mar-28	31-Mar-29	31-Mar-30	31-Mar-31	31-Mar-32	31-Mar-33	31-Mar-34	31-Mar-35	31-Mar-36	30-Jun-36
INFLOW																	
Profit After Tax	402	1,096	1,783	1,809	2,182	2,217	2,686	2,565	2,494	2,438	2,399	1,269	1,029	369	265	160	31
Depreciation	761	1,526	1,526	1,526	1,526	1,526	1,526	1,526	1,526	1,526	1,526	1,526	1,526	1,526	1,526	1,526	1,526
Interest on Term Loan	1,112	2,199	2,080	1,924	1,757	1,579	1,401	1,223	1,045	856	651	478	345	234	145	56	0
Total Inflow	2,275	4,821	5,388	5,259	5,465	5,322	5,613	5,315	5,065	4,820	4,576	3,274	2,900	2,129	1,935	1,741	1,557
OUT FLOW																	
Interest on term loan	1,112	2,199	2,080	1,924	1,757	1,579	1,401	1,223	1,045	856	651	478	345	234	145	56	0
Principal repayment	0	615	1435	1435	1640	1640	1640	1640	1640	1845	1947	1230	1230	820	820	820	102
Total Outflow	1,112	2,814	3,515	3,359	3,397	3,219	3,041	2,863	2,685	2,701	2,598	1,708	1,575	1,054	965	876	102
DSCR	2.05	1.71	1.53	1.57	1.61	1.65	1.85	1.86	1.89	1.78	1.76	1.92	1.84	2.02	2.01	1.99	3.80
Average DSCR	1.79																
Min DSCR	1.53																

TEHKHAND WASTE TO ELECTRICITY PROJECT LIMITED

Calculation of Fixed Asset Coverage Ratio

In Rs Lakhs

Year of Operation	2020-21	2021-22	2022-23	2023-24	2024-25	2025-26	2026-27	2027-28	2028-29	2029-30	2030-31	2031-32	2032-33	2033-34	2034-35	2035-36	2036-37
Year Ending	31-Mar-21	31-Mar-22	31-Mar-23	31-Mar-24	31-Mar-25	31-Mar-26	31-Mar-27	31-Mar-28	31-Mar-29	31-Mar-30	31-Mar-31	31-Mar-32	31-Mar-33	31-Mar-34	31-Mar-35	31-Mar-36	30-Jun-36
Total Fixed Assets	37,390	35,864	34,338	32,812	31,286	29,760	28,234	26,708	25,181	23,655	22,129	20,603	19,077	17,551	16,025	14,499	12,973
Total Debt Outstanding	20,500	19,885	18,450	17,015	15,375	13,735	12,095	10,455	8,815	6,970	5,022	3,792	2,562	1,742	922	102	0
FACR	1.82	1.80	1.86	1.93	2.03	2.17	2.33	2.55	2.86	3.39	4.41	5.43	7.44	10.07	17.37	141.46	
Average FACR	2.64																
Min FACR	1.80																

TEHKHAND WASTE TO ELECTRICITY PROJECT LIMITED

CALCULATION OF INTERNAL RATE OF RETURN (IRR)

Rs in Lakhs

Particulars	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24	2024-25	2025-26	2026-27	2027-28	2028-29	2029-30	2030-31	2031-32	2032-33	2033-34	2034-35	2035-36	2036-37	2037-38	2038-39	2039-40	2040-41	2041-42	2042-43	2043-44	2044-45	2045-46
PROJECT IRR (Post Tax)																												
Net Income		0	402	1096	1783	1809	2182	2217	2686	2565	2494	2438	2399	1269	1029	369	265	160	31	-136	-306	-480	-658	-841	-1029	-1224	-1452	-1093
Add: Depreciation		0	761	1526	1526	1526	1526	1526	1526	1526	1526	1526	1526	1526	1526	1526	1526	1526	1526	1526	1526	1526	1526	1526	1526	1526	1526	763
Add: Interest Payment		0	1112	2199	2080	1924	1757	1579	1401	1223	1045	856	651	478	345	234	145	56	0	1	1	1	1	1	1	1	1	1
Sub: Change in wc	-	0	912	46	130	-18	55	-19	74	32	-22	-23	-24	-301	-66	-174	-28	-29	-30	-32	-33	-34	-36	-37	-39	-41	-42	-114
Sub: Project Capex	-	-25,043	302	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Add: Terminal Value			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Project Cash Flow		-25043	1666	4775	5258	5276	5410	5341	5539	5283	5087	4843	4599	3574	2966	2303	1963	1770	1588	1423	1254	1082	906	724	537	344	118	-214

Project IRR(Post tax)	IRR
- Project Life	16.04%
- Loan Term	15.77%

PROJECT IRR (Pre Tax)

Particulars	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24	2024-25	2025-26	2026-27	2027-28	2028-29	2029-30	2030-31	2031-32	2032-33	2033-34	2034-35	2035-36	2036-37	2037-38	2038-39	2039-40	2040-41	2041-42	2042-43	2043-44	2044-45	2045-46
Post Tax cashflow		-25043	1666	4775	5258	5276	5410	5341	5539	5283	5087	4843	4599	3574	2966	2303	1963	1770	1588	1423	1254	1082	906	724	537	344	118	-214
Tax Payout			109	297	484	491	592	601	729	1195	1294	1381	1461	949	896	609	608	599	572	517	457	391	318	240	157	68	0	0
Project Cash Flow Pre Tax		-25043	1775	5073	5742	5767	6002	5943	6267	6478	6381	6224	6060	4523	3861	2912	2571	2370	2159	1940	1711	1473	1224	965	694	412	118	-214

Project IRR (Pre tax)	IRR
- Project Life	18.70%
- Loan Term	18.47%

EQUITY IRR (Post Tax)

Particulars	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24	2024-25	2025-26	2026-27	2027-28	2028-29	2029-30	2030-31	2031-32	2032-33	2033-34	2034-35	2035-36	2036-37	2037-38	2038-39	2039-40	2040-41	2041-42	2042-43	2043-44	2044-45	2045-46
Net Income	0	0	402	1,096	1,783	1,809	2,182	2,217	2,686	2,565	2,494	2,438	2,399	1,269	1,029	369	265	160	31	-136	-306	-480	-658	-841	-1,029	-1,224	-1,452	-1093
Add: Depreciation		0	761	1,526	1,526	1,526	1,526	1,526	1,526	1,526	1,526	1,526	1,526	1,526	1,526	1,526	1,526	1,526	1,526	1,526	1,526	1,526	1,526	1,526	1,526	1,526	1,526	763
Sub:Change in NWC		0	-228	-12	-33	4	-14	5	-19	-8	5	6	6	75	16	44	7	7	8	8	8	9	9	9	10	10	11	29
Sub: Debt Repaid		0	0	-615	-1435	-1435	-1640	-1640	-1640	-1640	-1640	-1845	-1947	-1230	-1230	-820	-820	-820	-102	0	0	0	0	0	0	0	0	0
Sub: Project Capex	-4368	-3145	91	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Add: Terminal Value																												
Sub: Change in DSRA			1407	0	350	-78	19	-89	-89	-89	-89	8	-52	-445	-67	-261	-44	-44	-386	-52	0	0	0	0	0	0	0	0
Equity Cash Flow	-4368	-3145	74	2019	1556	1973	2063	2187	2679	2549	2463	2105	2023	1935	1376	1292	1008	903	1833	1434	1212	1038	859	676	487	292	64	-358

Equity IRR	IRR
- Project Life	19.42%
- Loan Term	19.04%

TEHKHAND WASTE TO ELECTRICITY PROJECT LIMITED

PAY BACK PERIOD

In Rs Lakhs

Year of Operation		2020-21	2021-22	2022-23	2023-24	2024-25	2025-26	2026-27	2027-28	2028-29	2029-30	2030-31	2031-32	2032-33	2033-34	2034-35	2035-36	2036-37	2037-38	2038-39	2039-40	2040-41	2041-42	2042-43	2043-44	2044-45
INFLOW																										
Operating Profit (EBIDTA)		2,466	5,205	5,970	5,846	6,158	6,023	6,448	6,619	6,466	6,306	6,140	4,299	3,866	2,793	2,595	2,390	2,176	1,952	1,719	1,476	1,223	958	683	395	96
Net inflow		2,466	5,205	5,970	5,846	6,158	6,023	6,448	6,619	6,466	6,306	6,140	4,299	3,866	2,793	2,595	2,390	2,176	1,952	1,719	1,476	1,223	958	683	395	96
Cumulative inflow		2,466	7,671	13,641	19,487	25,646	31,669	38,117	44,736	51,203	57,509	63,649	67,947	71,813	74,606	77,201	79,591	81,767	83,719	85,438	86,914	88,136	89,095	89,778	90,173	90,268
OUTFLOW																										
Total Project Cost Less Margin Money		39,558																								
TOTAL CUMULATIVE OUTFLOW	39,558	39,558	39,557.7	39,558	39,558	39,558	39,558	39,558	39,558	39,558	39,558	39,558	39,558	39,558	39,558	39,558	39,558	39,558	39,558	39,558	39,558	39,558	39,558	39,558	39,558	39,558
Cumulative Net Cash Inflow		(37,091.5)	-31,886	-25,916	-20,070	-13,912	-7,889	-1,441	5,179	11,645	17,951	24,091	28,390	32,256	35,048	37,643	40,033	42,209	44,161	45,880	47,356	48,579	49,537	50,220	50,615	50,711
Payback period		7.26	years																							

TEHKHAND WASTE TO ELECTRICITY PROJECT LIMITED

SENSITIVITY ANALYSIS

S No.	Case Basis	Avg. DSCR	Min. DSCR	Project IRR (Pre Tax) Project Life	Project IRR (Post Tax) Project Life	Equity IRR Project Life	Avg. FACR	Min. FACR	Pay Back Period (Years)
	Base Case (with Power sale only)	1.79	1.53	18.70%	16.04%	19.42%	2.64	1.80	7.26
1	Interest Rate increased to 1%	1.71	1.44	0.19	16.18%	17.83%	2.62	1.79	7.35
2	Increase in Hard Cost by 5%	1.66	1.43	0.18	15.73%	16.13%	2.60	1.78	7.72
3	Decrease in waste quantity by 10%	1.80	1.54	0.19	16.04%	19.37%	2.64	1.80	7.26
4	Increase in O&M cost by 15%.	1.63	1.44	0.17	14.34%	15.59%	2.64	1.80	7.80
5	Decrease in base waste qulaity (i.e. GCV) by 10%	1.79	1.53	0.19	15.89%	19.04%	2.64	1.80	7.31
6	Base case along with sale of Compost, RDF, Recyclables	3.52	2.06	0.30	25.68%	37.29%	2.63	1.80	5.19

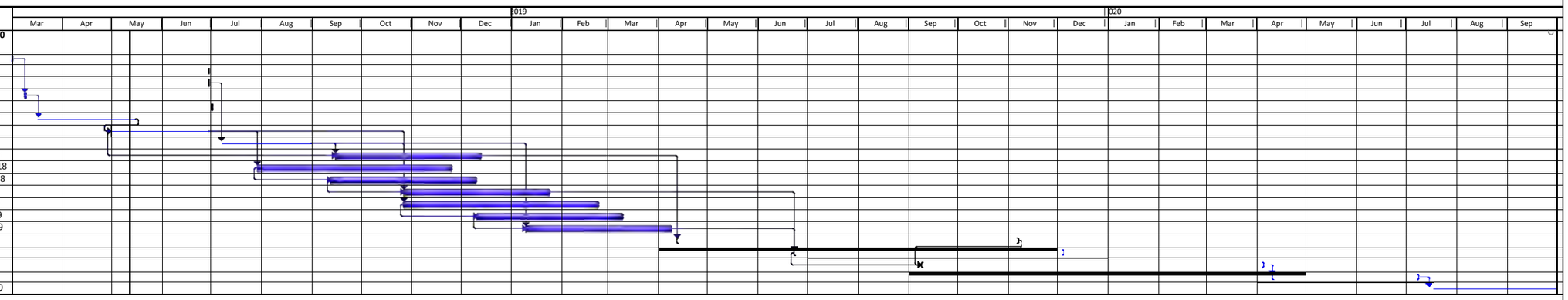
Annexure 9.1 Dated 12.05.2018

Korus Engineering Solutions Pvt. Ltd.

IMPLEMENTATION SCHEDULE FOR 25 MW WASTE TO ENERGY PROJECT AT TEHKHAND, OKHLA PHASE - I, NEW DELHI

Tehkhand Waste to Electricity Project Ltd.

ID	Task Name	Start	Finish
0	**PROJECT IMPLEMENTATION**	**Thu 3/1/18**	**Wed 9/30/20**
1	LOI Allotment	Thu 3/1/18	Thu 3/1/18
2	Signing of Concession Agreement	Sat 6/30/18	Sat 6/30/18
3	PPA Signing	Sat 6/30/18	Sat 6/30/18
4	Appointment of Consultant	Fri 3/9/18	Fri 3/9/18
5	Land Lease & Handover	Mon 7/2/18	Mon 7/2/18
6	DPR Finalization	Sat 3/17/18	Tue 5/15/18
7	Basic Engineering & Layout Finalization	Tue 5/1/18	Fri 6/29/18
8	Financial Closure	Sun 7/8/18	Fri 8/31/18
9	Land Development	Sun 9/16/18	Fri 12/14/18
10	Detailed Engineering - Major Equipmen	Mon 7/30/18	Mon 11/26/18
11	Enquiry Flotation & Offer Evaluation	Thu 9/13/18	Tue 12/11/18
12	Order Placement - Major Equipment	Sun 10/28/18	Fri 1/25/19
13	Detailed Engineering - Balance of Plant	Sun 10/28/18	Sun 2/24/19
14	Enquiry Flotation & Offer Evaluation	Wed 12/12/18	Mon 3/11/19
15	Order Placement - Balance of Plant	Fri 1/11/19	Wed 4/10/19
16	Civil Works	Sun 4/14/19	Sat 11/9/19
17	Material Supplies	Tue 6/25/19	Fri 12/6/19
18	Erection & Commissioning	Wed 9/11/19	Tue 4/7/20
19	Plant Commissioning & Trial Run	Mon 4/13/20	Sat 7/11/20
20	COD	Sat 7/18/20	Wed 9/30/20



Project: PROJECTIMPLEMENTATIO
Date: Sat 5/12/18

Task | Split | Milestone | Summary | Project Summary | External Tasks | External Milestone | Deadline | Progress

Date Format: MM/DD/YY

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Green Belt

GATE FOR TRUCK ENTRY

GATE FOR LIGHT VEHICLE ENTRY

GUARD ROOM

WAITING SHED

W.T. -1

W.T. -2

W.T. -3

W.T. -4

6m WIDE ROAD

4m WIDE ROAD

WEIGH BRIDGE 10m x 3m

WEIGH BRIDGE 10m x 3m

RAMP

STORE

OPEN STORAGE AREA

CAR PARKING AREA

SOTARGE AREA

COMPRESSOR & DRYER AT GROUND FLOOR

TIPPING FLOOR

MSW \ BOILER FEED STORAGE PIT

MATERIAL RECOVERY FACILITY

HOPPER-1 HOPPER-2 HOPPER-3 HOPPER-4

GRAB MAINTENANCE

BALLISTIC SEPARATOR

SAND RECOVARY UNIT

AUXILIARY COOLING TOWER

DM WATER STORAGE

BELOW RAW WATER STORAGE TANK

FLY ASH BRICK PLANT

WASTE SILO

ID FAN

ID FAN-1

ID FAN-2

CHIMNEY

AUX. TRANSFORMERS

BOILER FEED PUMP(G.L)

SECOND FLOOR MAIN CONTROL ROOM

FUTURE EXTENSION

TG BUILDING

AIR COOLED CONDENSER

1. CANTEEN
2. OFFICE
3. GUEST HOUSE / CONFRENCE ROOM

SWITCHYARD

FUTURE GATE

345000

175000

B1 B2 B3 B4

Boundary Coordinates

B1	28° 30' 35.37"N	77° 16' 50.61"E
B2	28° 30' 32.48"N	77° 16' 56.52"E
B3	28° 30' 23.07"N	77° 16' 50.39"E
B4	28° 30' 25.36"N	77° 16' 44.94"E

The Co-Ordinates Indicated Are Tentative and Will Be Confirmed After Detailed Survey.

No.	Date	Revision Description	Design	Drawn	Chkd.	Appd.
0	24.07.18	PRELIMINARY LAYOUT	KJ/PW	SD/PW	KJ/PW	KJ/PW

KORUS Engg. Solutions Pvt. Ltd.

TEHKHAND WASTE TO ELECTRICITY PROJECT LTD.

WASTE TO ENERGY PLANT

PLANT LAYOUT

SCALE: 1:320

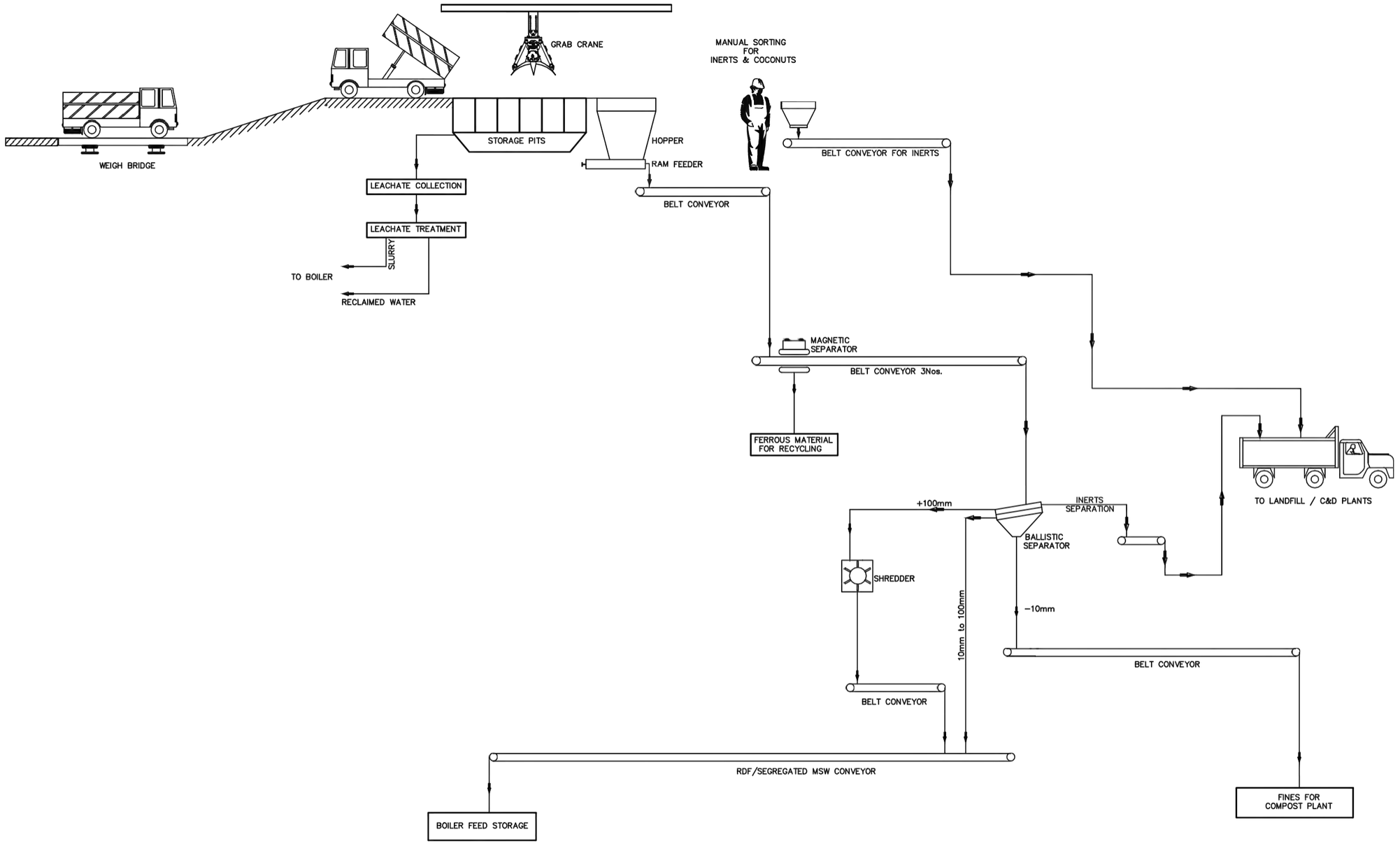
Designed: KJ/PW
Drawn: SD/PW
Chkd.: KJ/PW
Appd.: KJ/PW
Date: 24.07.18

Size: A1
Dr. No.: 1814-001
Rev.: 0

Rev. 0
Sheet -
Sr. No. 1
1814-001

Please Do Not Scale. If in Doubt, ASK.

Rev. 0 | 1814-002 | Sh. 1 Next 2



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CAD Ref. No.

Rev. No.	Date	Revision Description	Design	Drawn	Chkd.	Appd.
0	18.04.18	PRILIMINARY	N.GUPTA	NITISH	N.GUPTA	D.D.K

TEHKHAND WASTE TO ELECTRICITY PROJECT LTD.

WASTE TO ENERGY PLANT

FLOW DIAGRAM FOR MATERIAL RECOVERY FACILITY

KORUS Engg. Solutions Pvt. Ltd.

Scale	N.T.S	Design	N.GUPTA
		Drawn	NITISH
		Chkd.	N.GUPTA
		Appd.	D.D.K
		Date	18.04.18
Size	A1	1814-002	Rev. 0
Sh.	1	Next	2

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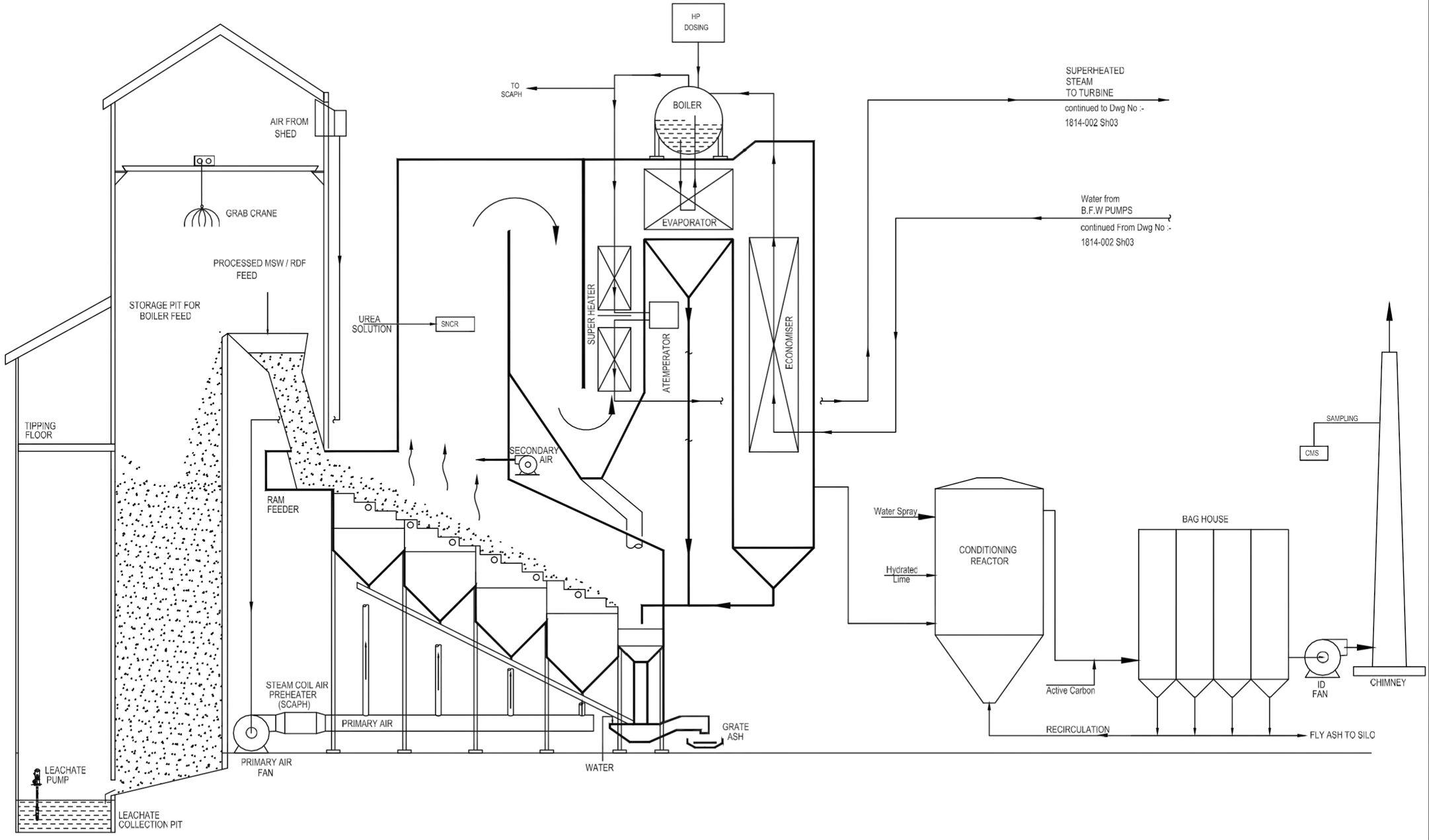
1814-002 | Rev. 0 | Sh. 2 | Next 3



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CAD Ref. No.

Rev. No.	Date	Revision Description	Design	Drawn	Chkd.	Appd.
0	19.03.18	PRELIMINARY	N.GUPTA	NITISH	N.GUPTA	D.D.K

TEHKHAND WASTE TO ELECTRICITY PROJECT LTD.

WASTE TO ENERGY PLANT

FLOW DIAGRAM FOR BOILER AND FLUE GAS CLEANING

Scale	Design	Drawn	Chkd.	Appd.	Date
N.T.S	N.GUPTA	NITISH	N.GUPTA	D.D.K	19.03.18

KORUS Engg. Solutions Pvt. Ltd.

Dwg. No. 1814-002 | Rev. 0 | A1 | Sh. 2 | Next 3

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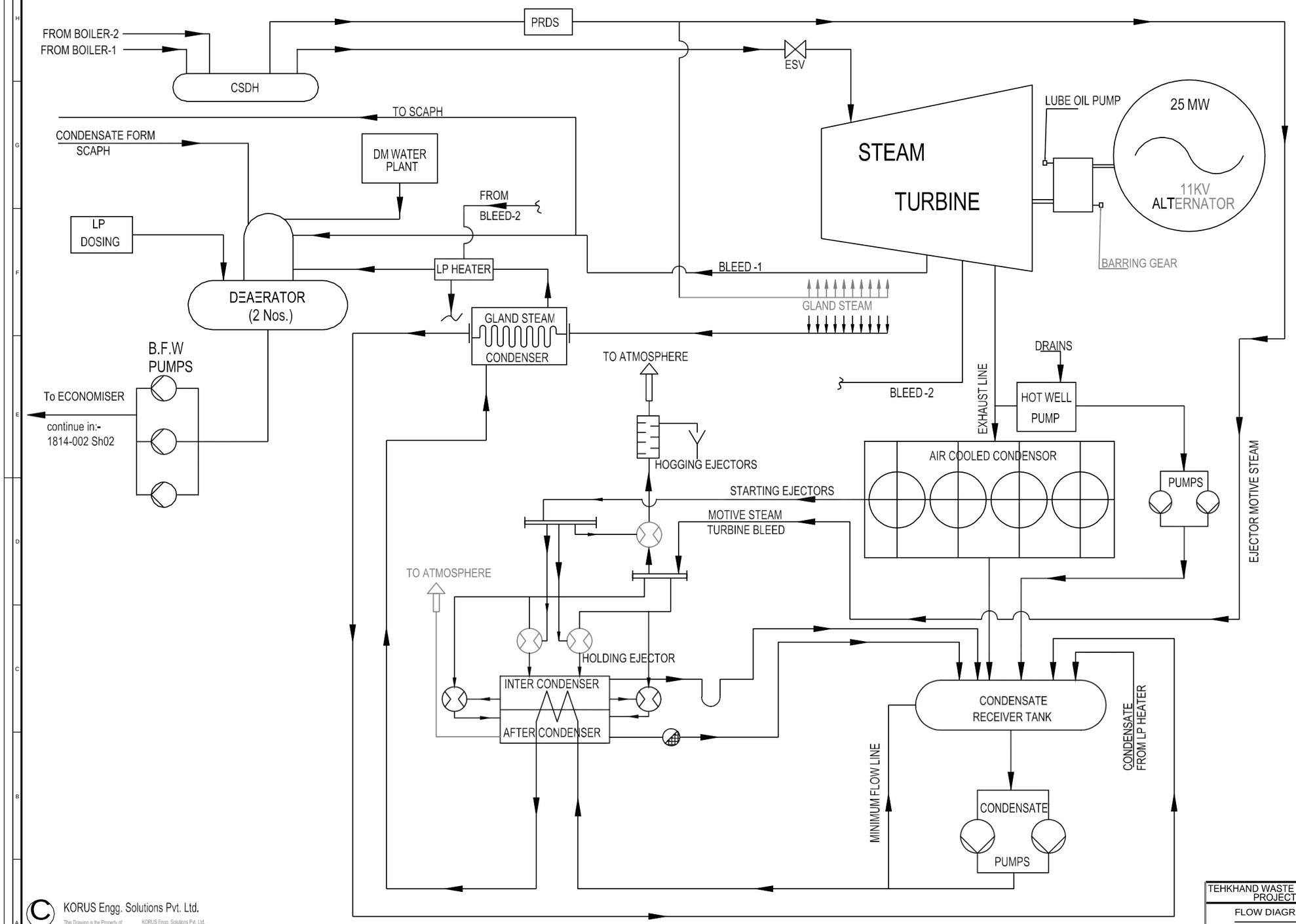

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CAD Ref. No.

Rev. No	Date	Revision Description	Design	Drawn	Chkd.	Appd.
0	18.04.18	PRELIMINARY	N.GUPTA	AVINASH	N.GUPTA	D.D.K

TEHKHAND WASTE TO ELECTRICITY PROJECT LTD.

WASTE TO ENERGY PLANT

FLOW DIAGRAM FOR POWER GENERATION

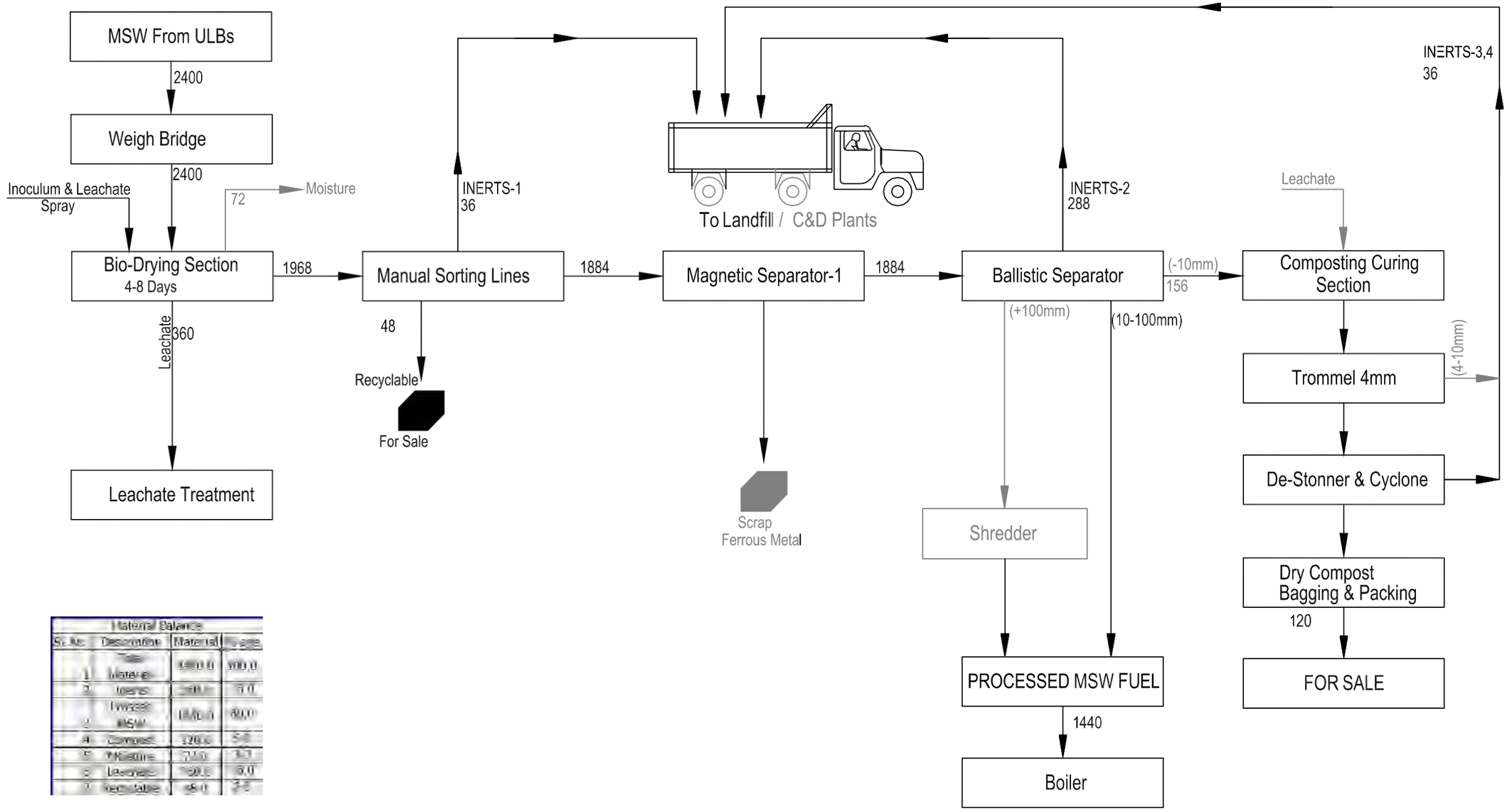
KORUS Engg. Solutions Pvt. Ltd.

Scale		Design	N.GUPTA
N.T.S		Drawn	AVINASH
		Chkd.	N.GUPTA
		Appd.	D.D.K
		Date	18.04.18

Dwg. No. 1814-002 Rev. 0

A2 Sh. 3 Next 4

Please Do Not Scale. If in Doubt, ASK.



Material Balance

Sr. No.	Description	Material	% age
1	Total Material	2400.0	100.0
2	Inerts	360.0	15.0
3	Process MSW	1440.0	60.0
4	Compost	120.0	5.0
5	Moisture	72.0	3.0
6	Leachate	120.0	5.0
7	Recyclable	48.0	2.0

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Rev. No.	Date	Revision Description	Design	Drawn	Chkd.	Appd.
0	12.05.2018	PRELIMINARY	N.GUPTA	NITISH	N.GUPTA	D.D.K

TEHKHAND WASTE TO ELECTRICITY PROJECT LTD.

WASTE TO ENERGY PLANT

MATERIAL BALANCE FOR RDF PRODUCTION

Scale		Design	N.GUPTA
N.T.S		Drawn	NITISH
		Chkd.	N.GUPTA
		Appd.	D.D.K
		Date	12.05.2018

KORUS Engg. Solutions Pvt. Ltd.

Size A1 | 1814-002 | Rev. 00 | Sh. 4 | Next 5

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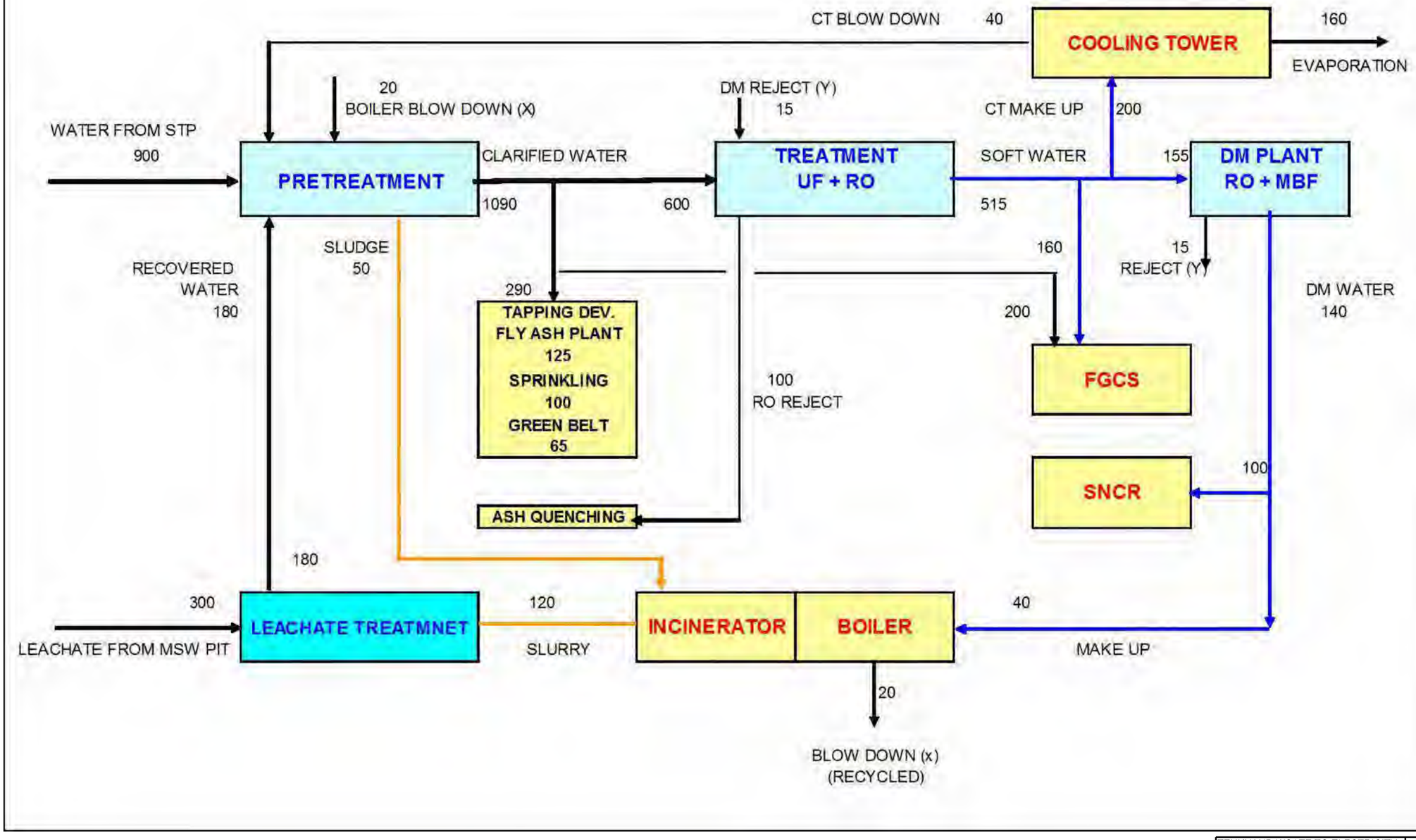
TEHKHAND : WATER BALANCE

UNITS : KLD



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Rev. No.	Date	Revision Description	Design	Drawn	Chkd.	Appd.
0	18.04.18	PRILIMINARY	N.GUPTA	NITISH	N.GUPTA	D.D.K

TEHKHAND WSATE TO ELECTRICITY PROJECT LTD.

WASTE TO ENERGY PLANT

WATER BALANCE DIAGRAM

KORUS Engg. Solutions Pvt. Ltd.

Scale	N.T.S	Design	N.GUPTA
		Drawn	NITISH
		Chkd.	N.GUPTA
		Appd.	D.D.K
		Date	18.04.18
Size	A3	1814-002	Rev. 0
Sh.	5	Next	6

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Rev. 0 | 1814-002 | Sh. 7 Next 8

SCREW AIR COMPRESSOR
Moisture Separator
Heat Exchangers
Air Cooled
Air Intake Filter
1 No. Screw Air Compressors
1000 Nm³/hr(working)

SCREW AIR COMPRESSOR
Moisture Separator
Heat Exchangers
Air Cooled
Air Intake Filter
1 No. Screw Air Compressors
1000 Nm³/hr(working)

SCREW AIR COMPRESSOR
Moisture Seperator
Heat Exchangers
Air Cooled
Air Intake Filter
1 Nos. Screw Air Compressors
1000 Nm³/hr(working)

SCREW AIR COMPRESSOR
Moisture Seperator
Heat Exchangers
Air Cooled
Air Intake Filter
1 Nos. Screw Air Compressors
1000 Nm³/hr(standby)

AIR RECEIVER
Pressure Gauge
Pressure Relief Valve
Air Receiver
Drain

BY-PASS

REFRIGERATED AIR DRYER
2 MICRON FILTER
Air Dryer

REFRIGERATED AIR DRYER
FILTER
Air Dryer

REFRIGERATED AIR DRYER
2 MICRON FILTER
102-CA-100-M1C
Air Dryer

PI PS
PT
PG

AIR RECEIVER
Pressure Gauge
Pressure Relief Valve
Air Receiver
Drain

FILTER

1500 Nm³/hr
FGCS BAG FILTER & SILOS
BULKER UNLOADING

400 Nm³/hr
BALANCE OF PLANT

600 Nm³/hr
START UP BURNER (ONLY IN STARTING)
AUXILIARY BURNER
SNCR
BOILER

TG

SCREW AIR COMPRESSOR
Moisture Separator
Heat Exchangers
Air Cooled
Air Intake Filter
1 Nos. Screw Air Compressors
800 Nm³/hr (working)

SCREW AIR COMPRESSOR
Moisture Seperator
Heat Exchangers
Air Cooled
Air Intake Filter
1 Nos. Screw Air Compressors
800 Nm³/hr(standby)

INSTRUMENT AIR RECEIVER
Pressure Gauge
Pressure Relief Valve
Air Receiver
Drain

DESICCANT DRYER
Instrument Air Dryer

DESICCANT DRYER
Instrument Air Dryer

PI PS
PT
PG

INSTRUMENT AIR RECEIVER
Pressure Gauge
Pressure Relief Valve
Air Receiver
Drain

40 Nm³/hr
BALANCE OF PLANT

300 Nm³/hr
BOILER

30 Nm³/hr
TG

30 Nm³/hr
ACC

300 Nm³/hr
FGCS

INSTRUMENT AIR LINE
COMPRESSED AIR LINE

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0	19.03.18	PRELIMINARY	N.GUPTA	NITISH	N.GUPTA	D.D.K

TEHKHAND WSATE TO ELECTRICITY PROJECT LTD.

WASTE TO ENERGY PLANT

FLOW DIAGRAM FOR COMPRESSED AIR

Scale	N.T.S	Design	N.GUPTA
		Drawn	NITISH
		Chkd.	N.GUPTA
		Appd.	D.D.K
		Date	19.03.18

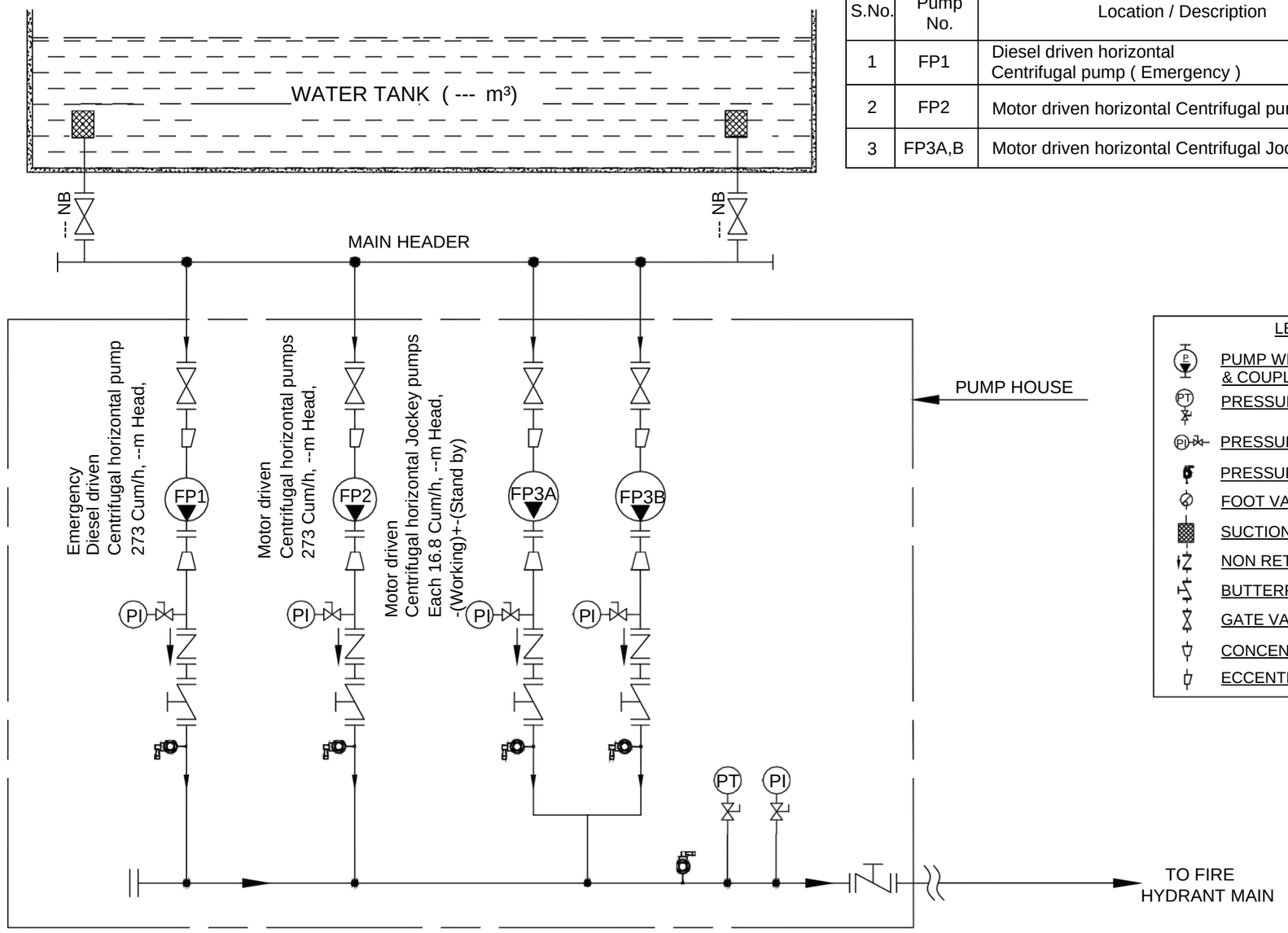
KORUS Engg. Solutions Pvt. Ltd.

Size A1 | 1814-002 | Rev. 0 | Sh. 6 | Next 7

Please Do Not Scale. If in Doubt, ASK.

Table - 1 Details of Pumps

S.No.	Pump No.	Location / Description	Qty.	Flow Rate m³/h (each)	Head (m)	Estimated Power
1	FP1	Diesel driven horizontal Centrifugal pump (Emergency)	-W	273	--	-- BHP
2	FP2	Motor driven horizontal Centrifugal pump	-W	273	--	-- KW
3	FP3A,B	Motor driven horizontal Centrifugal Jockey pumps	-W+-S	16.8	--	--- KW



LEGENDS

- PUMP WITH MOTOR & COUPLING
- PRESSURE TRANSMITTER
- PRESSURE INDICATOR
- PRESSURE SWITCH
- FOOT VALVE WITH STRAINER
- SUCTION STRAINER
- NON RETURN VALVE
- BUTTERFLY VALVE
- GATE VALVE
- CONCENTRIC REDUCER
- ECCENTRIC REDUCER

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CAD Ref. No.

Rev. No.	Date	Revision Description	Design	Drawn	Chkd.	Appd.
0	19.03.16	PRELIMINARY	N.GUPTA	ATUL Kr	N.GUPTA	D.D.K

TEHKHAND WASTE TO ELECTRICITY PROJECT LTD.

WASTE TO ENERGY PLANT

FLOW DIAGRAM FOR FIRE WATER

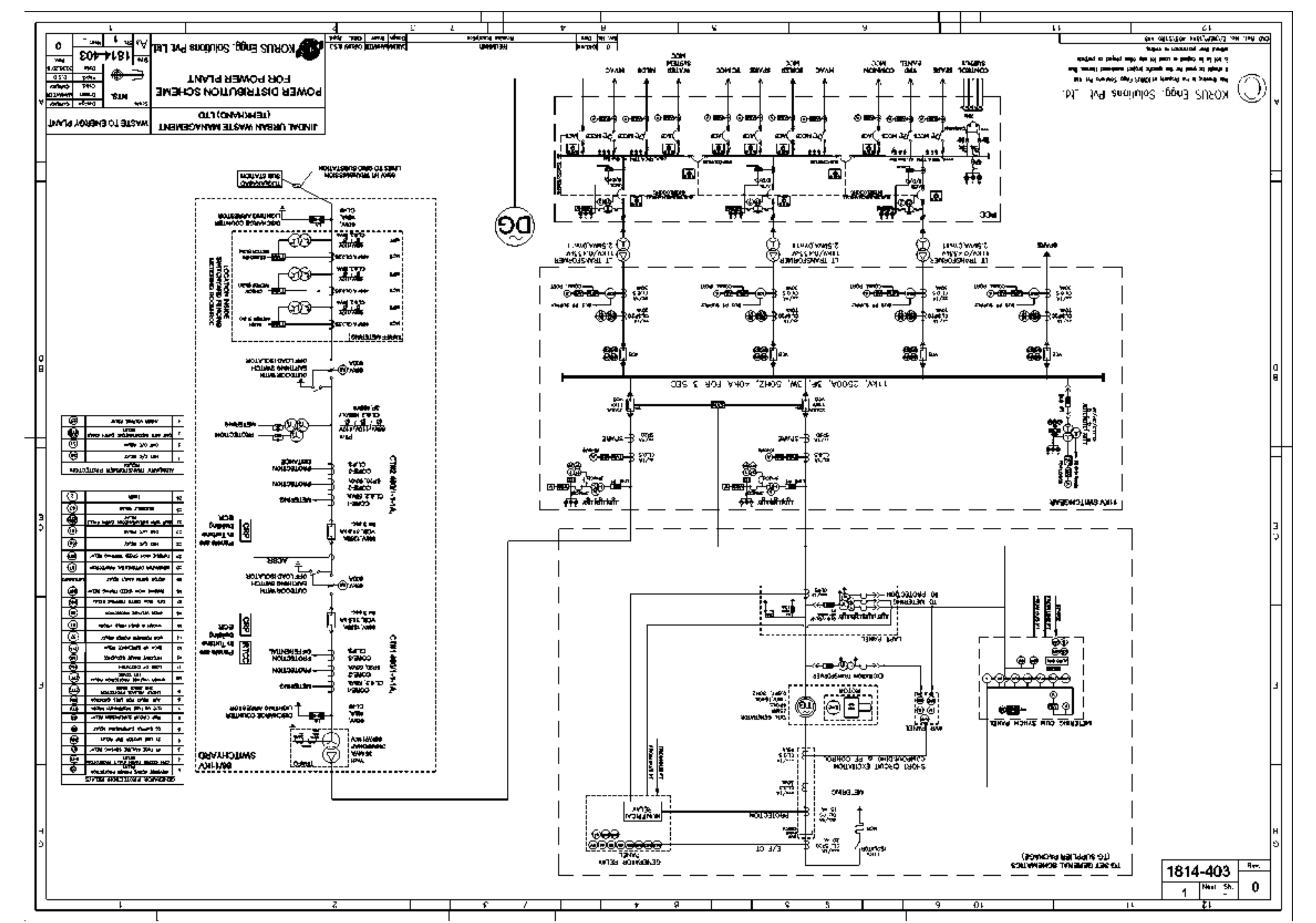
KORUS Engg. Solutions Pvt. Ltd.

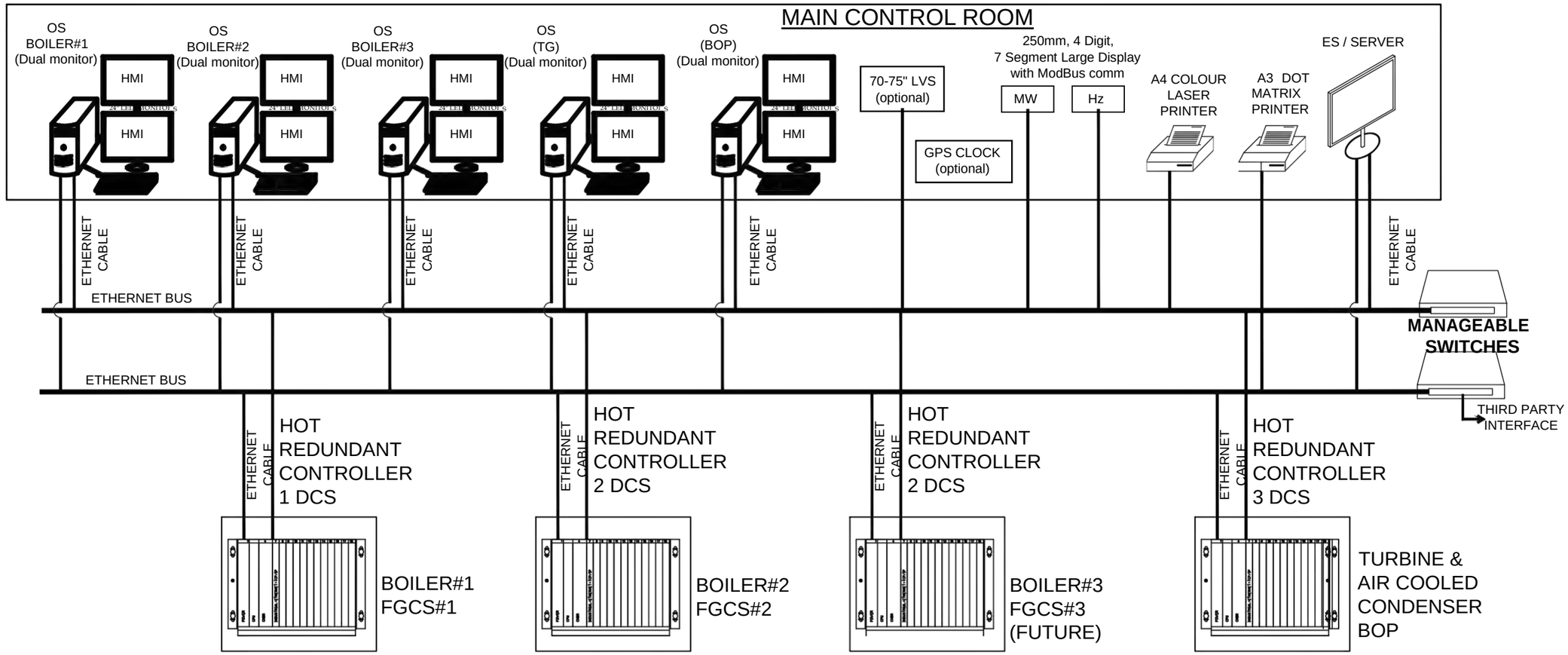
Scale		Design	N.GUPTA
N.T.S		Drawn	ATUL Kr
		Chkd.	N.GUPTA
		Appd.	D.D.K
		Date	24.11.16

Size A1 | 1814-002 | Rev. 0 | Sh. 7 | Next --

1814-002 Rev. 0 Sh. 8 Next --

JINDAL URBAN WASTE MANAGEMENT (TEHKHAND) LTD	WASTE TO ENERGY PLANT
POWER DISTRIBUTION SCHEME FOR POWER PLANT	
KORUS Engg. Solutions Pvt. Ltd.	1814-403 / Sh. 1 / Rev. 0





	MODBUS TCP/IP
	ETHERNET CABLE
	ETHERNET FIBER OPTIC
	PROFIBUS CABLE
	FIBEROPTICS
	HARD WIRE

NOTE :

1. All Communication Cables (ie Profibus / Ethernet) which ever is required with their connection accessories shall be in scope of Automation system supplier.
2. UPS (Uninterrupted Power Supply) for the above system of suitable rating & shall be consider by supplier.
3. All the cards shall be G3 coated.
4. All screen should be available on all OS. (unlimited Graphics)
5. Maintenance log required i.e. all device running hour and no. of start should be logged in an excel sheet.
6. Different Hooter for priority one and priority two alarm (one for high value & second for high-high value)
7. Provision of online monitoring of data (at least 30 Analog value) need to be monitored online, Facility to display Massage like "Plant is under Maintenance")

PROPOSED

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CAD Ref. No.–E:\WtE\1814–412\S1R0–Y18

Rev. No.	Date	Revision Description	Design	Drawn	Chkd.	Appd.
0	21.03.2018	FOR DPR ONLY	GARUAV	GARUAV	GARUAV	D.S.D

JITF URBAN WASTE MANAGEMENT (TEHKHAND) LIMITED

WASTE TO ENERGY PLANT

AUTOMATION CONFIGURATION DIAGRAM

KORUS Engg. Solutions Pvt. Ltd.

Scale	NTS.	Design	GARUAV
		Drawn	GARUAV
		Chkd.	GARUAV
		Appd.	D.S.D
		Date	21.03.2018
Size	A3	1814-412	Rev. 0
Sh.	1	Next –	