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Schedules

Schedule B Special Conditions

1. Monitoring of Project Facility

The Committee shall undertake following activities related to the operations and maintenance of the Project Facility.

(i) Collect information on a daily basis on the quantum of waste brought to the Project Facility from the Weighment Facility.
(ii) Conduct calibration test of the Weighment Facility at least once in a period of six months.
(iii) Conduct sampling, as detailed in Schedule, on the Waste at such intervals on a daily basis to ensure that only Bio-degradable Waste is brought to the Project Facility.
(iv) Conduct such tests as laid down in Schedule for measurement of Performance Standards at an interval of not more than 15 days corresponding to the billing cycle and compile the results in the format prescribed to determine the penalty be recovered from the Contractor for non-performance.
(v) Conduct such tests to ensure conformance of the operations of the Project Facilities with the standards prescribed in prevalent Law/ Rules/ Statutes.
(vi) Ensure that the end product that is generated is disposed by the Contractor in an environmentally safe manner whereas the rejects are transported to the designated disposal facility in a timely manner.
(vii) Carry out/ assist the Committee for such activities that the Committee may so direct from time to time
(viii) Review the O&M Plan submitted by the Contractor from time to time and bring to the attention of the Committee deviations, if any from the same.
(ix) Obtain and maintain records with regards to the operation of the Project Facilities namely the composition (physical as well as chemical) of the End Product, weight of rejects, weight of end product, composition of rejects (approximate weighment basis or volumetric basis), resources deployed by the Contractor on a daily basis and any other records as required by the Municipal Body
(x) In case of any dispute/ disagreement between the designated transporting agency and the Contractor related to the Waste, then the Committee shall immediately inform the Municipal Body of the same and take steps as deemed necessary to resolve the dispute amicably without affecting the Project Facilities. However, if the resolution involves any financial burden on the part of the Municipal Body then the same shall be approved by the Municipal Body.

2. Contractors Obligations

(i) Acceptance of Municipal Waste

The Municipal Body shall endeavour to supply segregated Biodegradable waste to the Contractor in quantities as indicated in

Schedule herein. The Contractor shall be responsible at all times to accept the daily quantities of Waste.

In the event of inability of the Municipal Body to supply Waste, due to reasons attributable to the generators of Waste or due to reasons attributable to the transporting agency, the Municipal Body shall be obliged to supply Waste by collecting Waste from alternative sources or by engaging the services of any alternative transporter respectively.

Failure of Municipal Body to supply Waste continuously for a period of five consecutive days shall entitle the Contractor to engage the services of any third party transporter to collect Waste from the generators of Waste and claim 120% of the cost involved in collection, transporting and segregation from the Municipal Body.

In the event the Contractor is unable to hire the services of any third party transporter due to reasons attributable to the transporting industry per se, then the Municipal Body shall be obliged to pay to the Contractor an amount that is equivalent to the manpower costs, operational costs other than interest payment and principal repayment for the period for which the Municipal Body has failed to supply the Waste ("Idling Charge")

The Contractor shall be penalised for any non- acceptance of the Waste, other than for events in this Clause (i) herein above or due to Planned Maintenance for a period not more than 2 consecutive days, calculated as follows:

$P_{NA} = 0.6 * Q_{AVG} * R_T$

Where: -

$P_{NA:}$ Penalty for Non acceptance

R_T: Rate per Tonne quoted by the Contractor for the purpose of Treatment of the Waste

Q_{AVG}: Average Quantity of Waste supplied by the Municipal Body over the immediately preceding week

The Municipal Body shall have a liberty of recovering the penalty due from the Contractor' subsequent billing or by invoking the Performance Guarantee to the extents of the amounts due. In the event that the Performance Guarantee is invoked, the Contractor shall within 15 days of such an event, replenish the Performance Guarantee to the stipulated amount. Failure on account of the Contractor to do so shall be construed as an Event of Default on the part of the Contractor.

(ii) Segregation/ Screening of Accepted Municipal Waste

The Contractor shall provide for a screening/ segregation facility at the Project Facility.

The screening/ segregation facility should be a mechanised facility with an ability to handle all types of Waste both dry as well as wet waste. The Contractor can deploy partial mechanised segregation of the waste upon a written approval from the Municipal Body. The Waste other than the Bio-degradable Waste so segregated shall have to be separately stored in a separately demarcated area from where the same has to be transported to the Disposal Facility.

The Municipal Body undertakes to supply Waste in compliance of the Acceptability Criterion as detailed below:

Acceptability Criterion:

Random sampling shall be undertaken of the Waste that is being supplied by Municipal Body to ascertain the composition of the Waste supplied by Municipal Body. The

sampling procedure, detailed herein *Schedule* is to be conducted for at least two Waste loads on a daily basis by a Committee representative and the observations of the same are to be recorded and produced before the Committee upon demand.

Acceptability Criterion= the ratio of biodegradable waste to total waste shall not be less than 90%

If the Waste supplied by the Municipal Body to the Contractor is found to be in deviation of the Acceptability Criterion, then the Contractor shall deploy labour to segregate the same. The cost of deploying additional labour shall be separately recorded and initialled by the Committee representatives comprising the Contractor representative as well as the Municipal Body representative. The Contractor shall recover 120% of the amounts so spend by the Contractor in segregating the Waste and transporting the rejects to the designated disposal agency by submitting a bill in this regard.

(iii) Treatment of Municipal Waste

The Contractor shall operate and maintain the Project Facility as per *Schedule* .

The Contractor shall ensure that the Treatment of the Waste shall at all times comply with the Statutory Regulations including MSW Rules and other environmental laws/ regulations, emission norms, etc.

The Contractor shall be responsible for the sale/ disposal after Treatment of the End Product so generated as a result of the Treatment process. The Contractor shall ensure that the composition of the compost is in compliance with the MSW Rules and that the same is transported/ stored / packed in line with the regulatory stipulations at all times during the Contract Period.

(iv) Transportation of Rejected Waste

The Contractor shall consolidate/ collect all the rejects of the Waste during the Treatment process and stockpile the same at the designated location as mentioned in sub-clause (v) above.

The Contractor shall, towards the end of each day but under any case not more than 48 hours from the time of separation/ identification of such waste, at its own cost, shall collect, load and transport the rejects to the Disposal Facility as designated by the Municipal Body from time to time. The Contractor shall ensure that till the time the rejected Waste is handed over to the designated Disposal Facility, the rejects are safely stored and care would be taken to ensure that the same is in no way adversely affecting the surrounding environment.

The Contractor shall be responsible for maintaining records of the rejected waste so handed over to the designated Disposal Facility.

The Contractor shall use its own resources including manpower, machinery, etc to handle the rejected waste including storage, intermediate treatment, loading/ unloading, etc.

3. Payments to the Contractor

(A) Payment Terms

(i) The Municipal Body hereby undertakes to pay the Contractor an amount as calculated herein below in lieu of services rendered towards the operation and maintenance of the Project Facility for the acceptance of the Waste supplied by the Municipal Body;

$A = R_T * Q_{Act} * (100-P)$

Where;
A: Amount payable as per the terms of the Agreement
R_T: Rate per Tonne of Waste (as agreed between the Contractor and the Municipal Body subsequent to the bidding process)
$Q_{Act.}$ Quantity of waste accepted by the Contractor as per provisions of the Agreement
P: Performance Parameter as determined by the procedure laid down in Schedule

(ii) The Municipal Body shall make available the requisite funds to the credit of the Contractor as per the Payment Mechanism detailed in Clause 7.1

Schedule C Work Specifications- O&M Requirements

(This has been designed for Bio-methanation technology; if some other technology has to be deployed then the same shall be elaborated as per the structure given below)

1. Introduction

Nisargruna Biogas plant developed by BARC for processing of solid biodegradable waste is based on dual phase digestion process. The first phase is aerobis whereas the second phase is anaerobic.
The various components of the plant are:

(i) A mixer/ pulper (5 HP motor) for crushing the solid waste
(ii) Premix tanks (3)
(iii) Pre-digester tank
(iv) Air Compressor
(v) Solar heater for water heating
(vi) Main digestion tank (35 m^3)
(vii) Gas delivery system
(viii) Covered Manure pits (4)
(ix) Tank for recycling of water and water pump
(x) Gas utilisation system

The waste generated in kitchens in the form of vegetable refuge, stale cooked and uncooked food, extracted tea powder, waste milk and milk products can all be processed in this plant. The waste to be introduced in the pre-digester plant has to be shredded and mixed with water to make fine slurry. The waste is converted into slurry by mixing it with water in a 1:1 ratio. Usually this is the failure point as solid waste is difficult to digest and can easily clog the system by scum formation. Degradation of the waste is ensured with the help of thermophilic microbes. The growth of thermophiles in the pre-digester tank is assured by mixing the waste with hot water and maintaining the temperature in the range of 55-60^oC

After the pre-digester tank the slurry enters the main tank where it undergoes mainly anaerobic degradation by a consortium of archaebacteria belonging to *Methanococcus* group. These bacteria are naturally present in the alimentary canal of ruminant animals (cattle). They produce mainly methane from the cellulosic materials in the slurry. The undigested lignocellulosic and hemicellulosic materials are then passed on to the settling tank. After about a month, high quality manure can be dug out from the settling tanks. There is no odour to the manure at all. The organic contents are high and this can improve the quality of humus in soil, which in turn is responsible for the fertility.
Methane gas is generated in the main tank from where it is transported through Galvanised Iron pipes to the utilisation site. Drains for condensed water vapour are provided on the pipeline. This gas burns with a blue flame and can be used for cooking as well. The manure generated, as a by-product is high quality and could be used for supplementing organic farming requirements.

It must be stressed that the success of this biogas plant depends a great deal on proper segregation of the kitchen waste. The materials that can pose problems to the efficient running of the plant are coconut shells and coir, eggshells, bones and plastic pieces. Steel utensils like dishes, spoons etc. are likely to appear in the waste bags from hotels and household kitchens. While bones, shells and utensils can spoil the mixer physically; coir and plastic can have detrimental effects on microbial consortium in the pre-digester and main digestion tanks, which could be disastrous for the plant. Hence it is necessary that following precautions may be taken while collecting the kitchen waste. There should be a separate container for coconut shells, coir, eggshells, and bones. These will not be processed in the biogas plant. There should be separate containers of small volumes (5 L capacity) to collect the wet waste (spoilt or stale cooked food, waste milk products etc.). The vegetable refuse like peels of various vegetables, rotten potatoes, and tomatoes, coriander leaves etc. may be collected in garbage bags of 5-kilo capacity. *It must be noted that such segregation is of utmost importance for smooth running of the biogas plant.*

Thus the efficient disposal of kitchen waste can be eco-friendly as well as cost effective. While calculating the cost effectiveness of such waste disposal one has to consider more than monetary aspects. The dumping of uncooked food in unmanned areas may not be very civilized. It can also lead to growth in the population of nuisance animals. It is undoubtedly unhygienic and can pose a threat to the habitat. These factors will add to the value of such plants. Using the natural friends in the form of thermophiles, methanogenic micro organisms and their consortia we can certainly handle the kitchen waste and a variety of other biodegradable wastes.

The ULB has to mention details of the land housing the plant viz. area, location. Area requirements are 300-600-1000 meter square for 1 Tonne - 5 Tonne and 10 Tonne plant respectively. The ULB has to ensure that the transportation of the waste has to be minimal and so also the transportation of the gas generated, hence the location of the plant should be close to the generators as well as end users to the extent possible.

2. Review of Project Facility

(i) Undertake an assessment of the present Facility, jointly with the Independent Engineer, deployed by the Municipal Body towards treatment of the Waste.
(ii) Prepare a status report on the assessment of the treatment Facility and identify and list the items that would be required for the effective and efficient treatment of the Waste.
(iii) Submit the status report and the list of items along with the estimate of the cost that would be required to procure the items listed, to the Independent Engineer for review / comments.
(iv) Incorporate the comments of the Independent Engineer in the report and submit the same to the Municipal Body.

3. Clearances, Permits and Approvals

(i) Assess the permits, approvals and clearances that would be required for the operations and maintenance of the Project Facility.
(ii) Determine the approvals, permits and clearances that are currently in place and highlight the list of balance permits, approvals and clearances, if any.
(iii) Submit a report to the Municipal Body and the time frame for obtention of the same along with the support that might be required from the Municipal Body in obtention of the same.

4. Operation and Maintenance of Treatment Facility

As stated above, the plant is based on microbial activities. The initial microbial culture development is therefore becomes extremely important for successful commissioning of the plant. There are two digesters. The microbial culture in the pre-digester builds up naturally. It will start building up only after biodegradable waste is processed. Before this happens, it is necessary to build up inoculum in the main digester. This is achieved by seeding with cattle dung. Usually 15-20% by volume seed is required. Fresh cattle dung is preferred. It is to be mixed with 1:1 water and proper slurry is made. The floating straw has to be removed. It is recommended that 80% of this slurry is put directly into the main digester while remaining 20% is passed through primary digester. This is required to provide some base material before waste is actually processed. It takes about 10-12 days for establishment of culture in the main digester. In hot summer this may be 5-6 days, in winter it would tale more than 20 days. The rising of dome would be an indication of establishment of culture. The first filling of dome contains very less quantity of methane. Hence when dome fully rises, it is recommended to open the valve fully and drive out all the gas contents. After this evacuation, methane will start filling in larger quantities and can be effectively used. Still it would take few more weeks to reach the expected purity of methane.

The capacity build up is very tricky in the operation of plant. It must be remembered that the whole operation depends upon microorganisms. The various cultures have to develop and coexist in tandem for successful processing of a variety of biodegradable wastes. The conditions required for their optimum activities have to be carefully monitored.

Following instructions should be strictly adhered to while making the plant operational:

(a) The first waste feeding of the plant will begin after 15 days of gobar seeding.
(b) The feeding should be as per the schedule given in the table given below. This schedule is given for 5 tonne plant. It would be different for different capacity plants.
(c) There is a need to monitor the type of waste being processed. Generally the pH of the raw slurry entering the pre-digester should be around 7-8. If this pH is too acidic, then materials responsible for acidity (mainly lemon and citrus skins, pickles, soured foods) may be segregated and processed in smaller aliquots by mixing with larger volumes of non-acidic materials.
(d) Floating materials in the raw slurry may be collected and reprocessed in the mixer. This is to ensure uniform homogenisation of the waste material. It would also help in reducing the scum formation. Providing a strainer at the pre-digester entry point can ensure this.
(e) The addition of hot water is an important step. Everyday two additions of 500L hot water (85-90^{o}C) each are recommended for a five tonne plant. If the solar heater is not efficient due to weather conditions, it is recommended that part of methane generated in the plant may be used for provision of hot water. The heating system may be provided and included in the initial design.
(f) The microorganisms in pre-digester are mainly aerobic. Hence it is necessary to maintain aeration intermittently using compressed air. Generally aeration at 2-3 intervals of 1-hour duration during a day through a 1 HP compressor would serve this purpose.
(g) The pH of the slurry entering the main digester is about 5-5.5. If it is in the range of 4-4.5, it is recommended that the pH of raw slurry may be checked. If the raw slurry were maintained at pH 7-8, there would not be any problem of pH maintenance. However careful monitoring of pH at these two levels is absolutely important for efficient running of the plant.
(h) The pH of manure slurry flowing into manure pits must be more than 7. If it is acidic, it means the problem in digestion process. Intervention at right time would ensure smooth running of the plant. The intervention may be either controlling the pH of raw slurry or addition of gobar (usually 5% of digester volume). The latter alternative may be tried immediately after noticing the indigestion in main digester. This would be evident by sour and foul smell of the manure slurry. The insect larvae in manure pits are another indication of improper digestion.

Schedule for capacity build up in a five tonne Nisargruna plant

First seeding	0 day
No feeding	1-15 days
500 Kg waste/day	15-30 days
1 tonne waste/day	30-45 days
1.5 tonne/day	45-60 days
2 tonne/day	60-75 days
3 tonne/day	75-90 days
4 tonne/day	90-120 days
5 tonne/day	After 120 days

Utilization of methane gas

Methane generated during processing of biodegradable waste can be used in 3 different ways:

1. **Cooking:** Methane can be supplied using GI pipelines. The pressure in the dome may not be interfered with. The diffusion process can carry methane up to 1-2 Km. Water traps have to be provided to remove condensing water from the gas. Specially developed burners are needed to utilize the gas for cooking purpose. This is the best application of methane. Only limitation would be the end user must be available in the vicinity, otherwise pipeline may become very expensive. Industrial canteens, crematoria or boilers would be ideal users of such methane. This would give good returns (in the range of 15-16 Rs./Kg of methane). It must be remembered that every tonne of biodegradable waste can generate about 30-40 Kg of methane.

2. **Generation of electricity:** Methane can be converted into electricity using a diesel generator attached with biogas mixing unit. Such generators of 10, 25 and higher KVA capacity are available and can be locally obtained from Kirloskars. This may not be very beneficial proposition, but would be ideal at places where no end user of gas is available. Five tonne plant can generate about 200 units of electricity per day. However it would incur an additional expenditure for diesel supply and generator maintenance.

3. **Compression of methane:** Compression of methane in cylinders opens up a possibility of transporting and utilization of methane as vehicle fuel. Such usage is being done in European countries.

Utilization of manure

Manure generated in the plant can serve as an excellent soil conditioner. It can be supplied to farmers for use at farms, etc. Alternatively municipal gardens and local gardens can be assured of regular manure supply from the Nisargruna plants. Thus money would be saved in the budgets of these gardens for procurement of manure, and that would be indirect earning from the Nisargruna plant.

5. Replacement/ Replenishment of any or all parts of the Treatment Facility

(i) The Contractor shall, in the event requiring replacement/ replenishment of any or all parts of the Project Facility, submit an application in these regards to the Independent Engineer stating clearly the reasons for replacement/ replenishment and the specifications of such replacements/ replenishments.

(ii) The Independent Engineer shall forthwith conduct an assessment of the application and shall seek such details as required from the Contractor to ascertain the need of the replacement/ replenishment of the requisitioned Project Facility.

(iii) The Contractor shall however, if the need be, go ahead and procure the replacement/ replenishment of the requisitioned Project Facility pending the

approval from the Municipal Body. Subsequently, upon submission of the above-mentioned report by the Independent Engineer, depending on the Independent Engineer's opinion, Municipal Body shall decide on the reimbursement to be paid to the Contractor for such replacement/ replenishment of the Project Facility. If in the opinion of the Independent Engineer, it is decided by the Municipal Body that such replacement/ replenishment of the Project Facility is indeed required then the Municipal Body shall reimburse the Contractor upto such amounts expended by the Contractor for the purpose of such replacement/ replenishment.

6. Hand Back of Project Facility

(i) The Contractor shall hand back the Project Facility to the Municipal Body as per the procedure laid down in Article X.

(ii) The Contractor shall ensure that the Project Facility are in good operating condition and are in compliance with the applicable permits, laws, statutes and that the hand back to the Municipal Body shall be done in a smooth transitional manner without affecting the operations of the Facility.

Schedule D Correspondences that may form part of the Agreement

Schedule E Details of Project Site and Project Facility

To be filled in by the respective ULB with the details of the Project Site and the Project Facilties.

Schedule F Indicative Waste Quantities

The Municipal Body shall endeavour to supply the following quantities of waste on an annual basis through out the tenure of the Contract Period:

Year	Waste Quantity (in tonnes)
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

Year 1 denotes the period beginning from COD until the corresponding end of the Financial Year i.e. 31st March

Year 2,3,4… denotes the Financial Year beginning 1st April and ending at 31st March unless for Year 10 which denotes the Financial Year beginning 1st April and ending at the Termination Date.

In case of early determination of this Agreement, the interpretation of this clause shall according be modified to read the last year as the year in which the Termination Date falls.

Schedule G Performance Evaluation Framework

Performance Measurement of MSW Treatment for the City of ***	
Time of Inspection From To	Date
Performance Measured By Name Designation Signature 1 2	

Section A: Daily Evaluation

Treatment of Bio-degradable MSW through bio-methanation

Performance Factors	**Yes / No**
1. Mixer is working without any hassle. Whether the slurry gets properly filtered and filters are not getting clogged?	
2. IS the drain from slurry tank to water recycling tank working properly?	
3. Incidents of rodents & flies?	
4. Breakdown/ Malfunctioning of plant?	
5. Removal of pre-process and post-process rejects from the site?	
Payment dedn. If any of the above criteria are not met	2.50%

Section B: Random checks with regards to Air Pollution

Ambient air quality measurement (at the boundary of the site on the down wind direction)

S.No.	**Parameters**	**Acceptable levels**	**Satisfactory: Yes / No**
(i)	Sulphur dioxide	120 μ g/m^3 (24 hours)	
(ii)	Suspended Particulate Matter	500 μ g/m^3 (24 hours)	
(iii)	Methane	Not to exceed 25 per cent of	

		the lower explosive limit (equivalent to 650 µg/m^3)	
(iv)	Ammonia daily average (Sample duration 24 hrs)	0.4 mg/m^3 (400 µ g/m^3)	
(v)	Carbon monoxide	1 hour average: 2 mg/m^3 8 hour average: 1 mg/m^3	
Payment deduction if Ambient air quality is not met: 2.50%			

Section C: Monthly

Compost quality measurement (only if intended to be used for food crops)

Parameters	Concentration not to exceed * (mg/kg dry basis, except pH value and C/N ratio)	Concentration measured	Satisfactory: Yes/No
Arsenic	10.00		
Cadmium	5.00		
Chromium	50.00		
Copper	300.00		
Lead	100.00		
Mercury	0.15		
Nickel	50.00		
Zinc	1000		
C/N ratio	10:1 – 15:1		
PH	7.5-8		

Process Checks (mandatory)

Parameters	Not to exceed/ Desired result	Measured level/ Observation	Satisfactory: Yes/No
pH of feed slurry	7 - 8		
pH of pre-digested slurry	4.5 – 6		
Colour of pre-digested slurry	Yellow		
pH of digested slurry	7 – 8		
Colour of digested slurry	Black		

Payment deduction if above criteria are not met for the Month: 2.50%

Section D: Random Check with regards to Leachate generation / disposal

Recycled water disposal standards

S. No	Parameter	Standards for the various modes of disposal of Leachate		
		Disposal standards	Measurement recorded	Does it violate the minimum / maximum standard: Yes / No
1.	Bio-chemical oxygen demand, ppm, max	100		
2.	Chemical oxygen demand ppm, max.	200		
3.	Methane composition %, min.	70		
Payment deduction if any one of the Leachate standards are not satisfied: 2.50 %				

Schedule H Schedule of Rates quoted by the Contractor during the bidding stage

Financial Year Beginning	Amount in Rs. per month

Schedule I Sampling Procedure

(i) The Waste is first unloaded on to a clean and impervious hard surface.

(ii) The Waste is then thoroughly mixed with the help of a spade and a cone is formed of the Waste.

(iii) The cone of Waste is then flattened and divided into four quarters.

(iv) Remove two opposite quarters and mix together the remaining two quarters.

(v) Repeat the process until a sample having approximately 20% of the original waste volume is obtained.

(vi) After such a representative sample is obtained, segregate the waste based on biodegradable, non-biodegradable waste.

(vii) Weigh the biodegradable waste and divide it by the total sample weight.