DETAILED PROJECT REPORT

FOR

200 KLPD GRAIN BASED ETHANOL PROJECT

AT

M/s. SLB ETHANOL PVT LTD.,

DECEMBER - 2021

AVANT-GARDE
SYSTEMS AND CONTROLS (P) LTD

AN ISO 9001:2015 AND ISO 17020:2012 ACCREDITED ORGANISATION)

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PROJECT AT A GLANCE		
Sl. No.	**Description**	**Value**
1	**Distillery Capacity (Total Spirits) in KLPD**	218
2	**Feed Stock**	Broken Rice
3	**No. Of days of operation**	335
4	**Starch content in Broken Rice (%)**	68
5	**AA production per MT of feed stock (Yield) (Lites / MT)**	450
6	**Broken Rice requirement per day (MT / Day)**	444.44
7	**Annual requirement of Broken Rice (MT)**	1,48,889
8	**Distillery Products**	Absolute Alcohol (AA)
9	**AA Produciton (KLPD)**	200
10	**AA Production/Annum, Lakh Lites**	670.00
11	**Distillery by products**	DDGS, Carbon-di-oxide,Technical Alcohol, Fusel oil
12	**DDGS produced per day (MT)**	88.89
13	**DDGS produced per annum (MT)**	29778
14	**CO2 produced per day (TPD)**	165.43
15	**CO_2 recoverable per day (TPD)**	115.80
16	**CO_2 recoverable per Annum (MT)**	38793.34
17	**Technical Alcohol produced per day (LPD)**	6540
18	**Technical Alcohol produced per annum, (Lakh Litres)**	14.26
19	**Fusel oil produced per day (LPD)**	200
20	**Fusel oil produced per annum, (Lakh Litres)**	0.67
21	**Process steam requirement for Distillery plant (TPH)**	34.52

22	**Boiler design MCR capacity**	45
23	**Boiler steam outlet parameters**	67 Kg/Sq.cm(g) & 485 Deg.C
24	**TG capacity (KW)**	5000
25	**Type of TG Selected**	Back Pressure with exhaust pressure of 4.5 Kg/Sq.cm(g)
26	**Steam generation from New Boiler (TPH)**	37.57
27	**Steam flow at the inlet of TG (TPH)**	31.05
28	**Power Generation from TG (kW)**	4085
29	**Power consumed for for Disitllery plant & Power plant**	4085
30	**Fuel Envisaged in the Boiler**	Coal
31	**Rice Husk / Coal Consumption in the Boiler (TPH)**	6.88
32	**Total water requirement (Cu.M / day)**	1700
33	**Actual Fresh water requirement considering recyling of water (Cu.M / day)**	800
34	**Project Commissioning Schedule**	1st April 2023
35	**Total Works cost Including GST (in Rs.Lakhs)**	22390
36	**Installed project cost considering IDC, Contingency, Pre-operative expenses etc., (Rs. in Lakhs)**	27020.07
37	**Equity (Rs. in Lakhs)**	1351
38	**Term Loan (Rs. Lakhs)**	25669.07
39	**Average DSCR**	1.54
40	**IRR - Post tax (%)**	19.68
41	**ROE (%)**	251
42	**Pay back period (years)**	3.5

EXECUTIVE SUMMARY

1.0 SLB Ethanol Private Limited (SLBEPL) is a newly registered company by the Popular news channel and Daily news paper agency M/s. Dinamalar.

2.0 The Alcohol is the generic term used for Ethyl Alcohol (C_2H_5OH) which is a hydrocarbon manufactured either from petroleum or by the fermentation of a monosaccharide like glucose or fructose. The Extra Neutral Alcohol (ENA) which is a purified form of alcohol, devoid of most of the commonly found impurities in the fermented alcohol, is fit for human consumption and its consumption worldwide is increasing annually. Apart from that, Alcohol in its anhydrous from is touted to be the future fuel as the world's petroleum reserves are exhaustible. In fact automotive engines are now being designed to accept hydrous alcohol with about 4 to 5% of moisture which will eliminate the need for dehydrating the hydrous alcohol for blending with gasoline.

3.0 Alcohol manufactured from Grains, by virtue of its renewable nature is an eco-friendly fuel which will be a worthy substitute for gasoline to prevent global warming. Many countries have taken up aggressive usage of absolute alcohol, also commercially called as Ethanol, to reduce the dependence on petroleum. Presently, ethanol is blended with gasoline in varying proportions to get the motor spirit. Brazil has done pioneering work in this direction, followed by many countries. United States has launched an aggressive ethanol manufacturing program and European Union is also showing keen interest in ethanol. India already has a policy to achieve the mandatory blending of 20% by 2025. Alcohol, after limited purification, finds wide usage in industrial applications and also in blending alcoholic drinks.

4.0 The Broken Rice with around 68% starch content is diluted with water and fermented. As the fermentation is an exothermic process, the wash is required to be cooled by constant recycling through

coolers. As the yeast cannot survive at high temperature approximately above 34 Deg.C, this continuous cooling of the wash is required. Once the fermentation is complete, the wash is taken in to the distillation section where the alcohol is stripped from the wash in distillation columns using low pressure process steam. Also, electrical power is required for driving the various pumps and other rotating equipment in the distillery. The alcohol production in a distillery is an energy intensive process, which utilizes both thermal energy from low pressure steam as well as electrical energy. The raw alcohol thus obtained is called the "Rectified Spirit (RS)". RS contains about 94% to 95% ethyl alcohol by volume and it also contains impurities such as Acetic acid, Acetaldehyde, Ethyl acetate etc.

5.0 This RS is further purified by removing most of the impurities, through a few more fractionating columns, to get ENA (Extra neutral Spirit) which is used for blending potable liquor. ENA contains about 96% ethyl alcohol. The RS could also be used for the production of absolute alcohol, (Anhydrous Alcohol), by dehydrating RS to reduce the moisture content to less than 0.5%. While ENA can contain some percentage of water, the water content in ethanol should be almost nil, and that is the reason this ethanol is referred as anhydrous alcohol. This water removal is carried out using molecular sieve dehydration process. This anhydrous form of ethanol contains a minimum of 99.5% ethyl alcohol.

6.0 Need for the Study:

In order to promote Ethanol manufacturing in the country, the Central Government (Ministry of Consumer Affairs, Food & Public Distribution) notifies modified scheme namely – "Scheme for extending financial assistance to project proponents for enhancement of their ethanol distillation capacity or to set up distilleries for producing 1st Generation (1G) ethanol from feed stocks such as cereals (rice, wheat, barley, corn & sorghum), sugarcane, sugar beet, etc"

Hence, SLBEPL proposes to install a 218 Kilo Litres Per Day (KLPD) capacity distillery plant in a newly procured land at Thervoy Kandigai Industrial Estate in the district of Tiruvallur near Chennai. This proposed distillery plant will be capable of producing 200 KLPD of Anhydrous Alcohol. Latest technologies for ethanol will be adopted in this project, which will ensure high efficiency, optimum operating costs & environmental sustainability for the proposed project.

7.0 The Distillery plant is designed to operate for 335 days in a year with grains such as Broken rice and Maize and Millets as feed stock. For the purpose of this DPR, 100% Broken rice for 335 days of operation is considered as feed stock. The expected starch content in Broken rice will be around 68%. During operation with grain, the Distillery plant will produce Absolute Alcohol (AA).

8.0 The proposed 200 KLPD Ethanol plant will have installation of the plant and equipment for the following process areas / sections. As discussed elsewhere in this report, the distillery will be capable of producing Absolute Alcohol(AA) only. The proposed distillery can also produce RS. However, as the plant is under Government of India EBP, Rectified Spirit is not allowed and hence storage tanks for RS is not envisaged. The following will be the major equipment in the distillery.

- Grain storage Silos
- Grain handling and milling section
- Fermentation section
- Wash to AA Distillation section
- Condensate and Spent Lees polishing section
- DDGS & Dryer section

- Decantation section
- Alcohol daily receiver and bulk storage
- Laboratory instrument and glassware
- Water treatment plant
- Cooling towers and cooling water system
- Boiler & Auxiliaries
- 5.0 MW Back Pressure turbo generator and auxiliaries
- Plant electrical system
- DCS based instrumentation for the process plant and the co-generation plant

9.0 This Detailed Project Report presents the details of the proposed scheme for the Distillery, Decantation and Dryer system, Boiler and co-generation power plant of the distillery, site facilities, availability of fuel and water, features of the main plant equipment including the co-generation power plant, cooling water system, electrical systems, environmental aspects, estimate of the capital cost and the schedule for the project implementation.

10.0 With 68% Starch content in Broken Rice, one Metric Tonne of Grain could result in the production of 450 Litres of Absolute alcohol production. During operation with Broken rice as feed stock, in addition to the 200,000 Litres per day of AA, The distillery plant will produce by products such as Technical Alcohol and Fusel Oil. By including quantity of these by products, the total production capacity of Distillery plant will be 218,000 Litres per day. For the production of 200,000 Litres of alcohol per day, the distillery needs 444.44 Metric Tonne per day of Broken Rice.

11.0 The distillation process is the separation of ethyl alcohol from impurities like the acetaldehydes, acetones, esters and amyl alcohols etc. Operating for 335 days in AA mode, with the plant capacity utilization of 100% from Second year onwards, the plant could produce 670 Lakh Litres of AA. Apart from the above, the plant will also produce 6540 Litres of Technical Alcohol and 200 Litres of Fusel Oil per day. The fermentation process will produces carbon-Di-Oxide as a by product and it proposed to sell this gas as raw CO_2. There are companies which put up CO_2 purification plants adjacent to the distillery taking the raw CO_2 from the distillery. It is estimated that about 115.8 TPD of purified CO_2 is recoverable from the distillery which could find usage in beverage industry, welding process, pharmaceutical and other chemical processing industries. Liquid CO_2 is a good refrigerant and it finds wide usage in food industry for warehouse storage and for storage during transportation.

12.0 For the production of AA from fermented wash during grain operation, the expected steam requirement is 34.52 TPH. In addition to the above the Boiler is provided with a deaerator which requires steam for deaeration purposes. Considering all the above, the Boiler is sized for this project to have a MCR output of 45 TPH at 67 Kg/Sq.cm(g) & 485^0C. The steam produced in the boiler will be fed to a 5.0 MW nominal capacity turbo alternator for power generation. The exhaust steam of turbine shall be slightly superheated and shall have a pressure of about 5.5 ata i.e 4.5 Kg/Sq.cm(g), The power generation in the turbogenerator will be 4085 kW at the MCR operation.

13.0 The total power requirement (at 415V, 3 PH, 50 Hz level) for the complex during operation with Broken rice as feed stock is given below:

- Distillery Process requirement : 3340 KW
- Boiler and other utilities : 745 KW
- Total (operating reqt.) : 4085 KW

The Boiler should generate 37.57 TPH of steam to supply steam required for Distillery process and Deaerator. If this 37.57 TPH of steam is let in to the Turbine. The expected power generation from the TG will be 4800 kW leaving 615 kW excess. As it may be difficult to make a tie up with State Government for export of such marginal power, only steam required to generate 4085 kW will be let into the Turbine and the balance steam will be routed to process through PRDS. Thus, the expected Power generation in the new TG will be 4085 kW and there will be no surplus power.

14.0 The water requirements of the distillery plant are proposed to be met by the water drawn from Bore wells. The water drawn from the bore wells will be stored in a water reservoir for meeting the various uses of the distillery. The water is required for the distillery process in the fermentation section, cooling tower make up for the Fermentation cooling tower. Air cooled technology is being envisaged for cooling purposes in Distillation, Evaporation and power plant. Thus, the total raw water requirement for the plant will be 1700 Cu.m/day. This quantity is the fresh raw water without considering any recycling. However with the usable water recovered from the condensate and spent lees polishing plant, the raw water required will be reduced to 800 cu.m/day. The DM water requirement for the distillery and for the boiler is

approximately 400 cu.m per day. The DM water requirement will be met from a new Membrane based water treatment plant to be installed in the distillery.

15.0 The implementation of the new distillery project is expected to be completed within Eighteen (18) months, from the date of ordering of the main plant and equipment i.e the distillery process section and Boiler. It is presumed that the ordering of these items could be done by 1st of January 2022.

16.0 The size of the distillery project with the Cogeneration plant, calls for proper project management and control procedures to ensure implementation within the scheduled program. Adequate qualified and trained manpower shall be recruited to take care of the operation and maintenance of the new Distillery plant with cogeneration plant.

17.0 The total works cost, i.e., civil, mechanical and electrical for the complete distillery complex, including the miscellaneous fixed assets is estimated to be **Rs.22,390 Lakhs.** The total installed project cost, including the pre-operative expenses, interest during the construction, the margin money for the working capital and the contingency provision works out to be **Rs.27,020.07 Lakhs.** The total project cost will be funded with equity of **Rs.1351.00 Lakhs**, term loan of **Rs. 25669.07 Lakhs**, assuming a debt to equity ratio of 19.0. It is assumed that the Term Loan for the project will be repaid in 10 years in 40 quarterly instalments with one and half (1.5) years moratorium period from the date of loan disbursement. It is also assumed that the interest rate for term loan will be 8.0%. As the processing of the term loan may take some time, SLBEPL will arrange for some bridge loan to tide over the project funding requirements.

18.0 SLBEPL proposes to use Broken rice for 335 days of operation for production of AA. The cost of Broken Rice is taken as Rs. 17000/MT. The cost of Rice Husk and coal is considered as Rs. 3000 / MT and Rs. 7627 / MT respectively. The cost of production will include cost of utilities, water, chemicals, consumables, repairs and maintenance expenses, salaries and wages for the plant operating personnel & for contract labour, plant insurance cost, administration expenses and selling expenses for the various products of the distillery.

19.0 The saleable products from the distillery are the AA, raw Carbon-di-oxide, Technical Alcohol and the Fusel oil. In addition, DDGS during grain operation also will be available for sale. Based on the existing price levels, the Selling price of AA produced from Broken rice is taken as Rs. 54.13 per Litre (including GST of 5 %). The sale price of Technical alcohol and Fusel oil is taken as Rs.23.60 per Litre (Including 18% GT). The raw Carbon-Di-Oxide will be sold at Rs.2.36 per kg (Including 18% GST). The Selling price of DDGS is considered as Rs. 28320 / MT (Including 18% GST) respectively.

20.0 5% Yearly Escalation is considered for cost of coal. Raw water, Technical alcohol, Fusel Oil, CO2, Repairs & maintenance, Utilities, Salaries & wages, Administrative expenses. 2.5% yearly Escalation is considered for cost of Broken rice and DDGS. For the selling price of AA, the price is taken as constant for first five (5) years and then an increase is 5% is considered for the next five years.

21.0 The depreciation computed is on straight line basis at 6.33% for plant and machinery and 3.34% for buildings and civil works. However, for income tax computation purposes, depreciation

rates of 10% for civil works, 15% for the plant and machinery are taken on the written down value of the assets.

22.0 Income tax at the rate of 30%, with a surcharge of 5% or 10% (depending on the net taxable income being less than Rs.1000 Lakhs or more) and a Cess of 3% is considered in the financial analysis of the project. Minimum Alternate Tax (MAT) as per Income-Tax Act is at the rate of 18.5% with surcharge of 5% or 10% (depending on the book profits being less than Rs.1000 Lakhs or more) and a Cess of 3% is also considered in the analysis.

23.0 A detailed financial analysis is made on the basis of the above given financial assumptions. The post tax Internal Rate of Return IRR for the proposed distillery project works out to **19.68%**. The simple payback period is **3.5** years.

24.0 The Return on Equity (ROE) works out to **251%**. The average debt service coverage ratio over the five year period is **1.54**.

25.0 Considering the present initiatives and recent new encouraging Selling price of Absolute alcohol produced from Grain, SLBEPL is in the process of installation of a Distillery plant in Thiruvallur District of Tamilnadu. The fuel blending has a great potential and the mandatory blending of 20% by 2025 is already in place. The project viability analysis indicates that the proposed distillery unit is immensely viable.

1.0 INTRODUCTION & ALCOHOL MARKET POTENTIAL

1.1 Ethyl Alcohol commonly known as Ethanol, with the molecular formula of C_2H_5OH, is an important organic compound which has wide use, in industrial applications, as fuel for internal combustion engines and as an intoxicating ingredient of alcoholic beverages. In the Industrial applications it is used as solvents and in the synthesis of varied organic chemicals like ethylene. Acetone, acetaldehyde, acetic acid, poly styrene, PVC etc. Eventhough the major consumption as of now is for alcoholic beverages, Ethyl alcohol has the potential to fuel the future relegating gasoline to a secondary place. Brazil has pioneered the blending of Ethyl alcohol with gasoline to be used as automotive fuel, followed by United States of America and many other countries. Many countries, including India, have implemented policies to ensure that the bio-fuels become important element of their transport fuel mix. Bio-ethanol, unlike petroleum, is a form of renewable energy that can be produced from agricultural feed stocks. Ethanol can be produced from several raw materials like sugarcane or sugar beet molasses, cassava, maize and other grains. Concerns about its production, from raw materials other than sugar cane molasses, relate to increased food prices, the large amount of arable land required for crops etc. However the latest developments with cellulosic ethanol production may allay some of these concerns relating to the food security.

1.2 Considering the present encouraging prices announced by Govt. Of India for Absolute Alcohol produced from Grains, SLBEPL would like to implement a Grain to ethanol distillery project at a newly identified land in Thiruvallur District of Tamilnadu. The Capacity of the Distillery plant will be to produce 200 KLPD AA

during grain mode of operation. The Grain based Distillery will operate for 335 days in an year.

1.3 The distillery will be designed as a Zero Effluent discharge plant. The high pressure steam generated in the boiler will enable adequate power generation in a turbogenerator for meeting the requirements of the distillery operations and will also provide the process steam required for the distillery operations. The distillery design will employ the multi pressure technology with the distillation columns operating under various pressures to economize on the energy consumption in the distillation process. This distillery project will also include a effluent treatment plant, based on anaerobic digestion, aeration, clarification and Reverse Osmosis, to treat the condensate generated in the spent wash concentration plant and the spent lees generated in the distillation process. The permeate from the RO system will be used as process water, thus reducing the dependence on external water and the concentrated RO reject will be mixed with the influent spent wash upstream of the concentration plant.

1.4 Alcohol Supply & Demand

1.4.1 Alcohol Supply

India's total installed ethyl alcohol production capacity is 5 billion litres per annum in about a total of 400 Distilleries. Out of this 100 distilleries use both grains and molasses or grain alone as the raw material for the production of alcohol. Rest of the distilleries use molasses as the feed stock for the production of alcohol. Even though the annual production capacity of the 400 odd distilleries is about 5.0 Billion Litres of alcohol, the actual total production realised is only about 70%,

resulting in an actual production of about 3.5 Billion Litres. The reasons for the 70% capacity utilization are (a) most of the distilleries operate with bio-composting as the means of disposal of the effluent and these distilleries cannot operate during the monsoon periods (b) molasses availability is also limited and most of the distilleries run out of feed stock. The production of 3.5 Billion litres of alcohol, assuming all the production if with molasses as the feed stock, needs about for more than 13.2 Million MT of molasses. With the grain based alcohol production at about 10% of the total extra neutral alcohol production the above assumption to arrive at the molasses requirement will not be very much off the mark. With the cane production at about 450 Million MT per annum and with only about 60% of the cane going to the white sugar manufacturing sector the annual molasses production will be about 12.5 Million MT. About 30% of the cane production goes to the Gur and khandasari sweetener production widely used in rural India and the production of Gur / Khandasari does not yield molasses. The very fact that the molasses price keeps increasing every year show that there is a demand for the molasses. The above discussion show that there is a shortage of the raw material for the production of alcohol and unless the cane production is increased or alcohol production from cane juice takes off in a big way the alcohol production cannot be greatly increased. With the food security under threat due to vagaries in monsoon and due to urban development, it is unlikely that the grain based alcohol production will increase and reduce the overall ethanol shortage.

1.4.2 Demand for Anhydrous Alcohol

Blending of ethyl alcohol with gasoline has many advantages. The resultant mixture called the gasohol has been used by many countries as the automobile fuel. Brazil has pioneered the blended fuel usage and go for the maximum blending, even more than 20% of ethyl alcohol with gasoline. In fact they have started using even 100% ethanol as the fuel in specially designed flexi automobile engines. Because of the higher octane number of ethanol (113) compared to the conventionally used octane booster, Methyl Tertiary Butyl Ether (MTBE) (109) there is possibility that the usage of MTBE could either be reduced or even eliminated. With the oxygen content of 35% in pure ethanol, the fuel combustion in the engine is more complete and the hydrocarbon and carbon monoxide emissions from engine exhausts gets reduced to a greater extent. So, the blending of ethanol to gasoline, apart from reducing the extent of dependence on gasoline will also help in a cleaner environment.

Government of India (GOI) made 5% ethanol blending to gasoline in 9 states and 5 union territories in January 2003. In September 2006 this mandate was extended to a few more states and Union territories. In September 2008, the GOI made blending mandatory across all the states and union territories. In 2008 a proposal to increase the blending to 10% was made and subsequently in 2009, a proposal to increase the blending to 20%, by the year 2017, was made. Now, the present target is to achieve 20% blending by 2025.

Even though the decision to go with 5% blending was mandated in 2008, the program has not been fully implemented due to one reason or other. The price of ethanol was a major issue for the

non implementation of this program. In 2010 an adhoc provisional procurement price of Rs.27 per litre was fixed. As this price was less than the ENA price, many of the distilleries did not show interest in supplying the anhydrous ethanol to the Oil Marketing Companies (OMC). Even though many of the distilleries have put up facility for the production of anhydrous alcohol, these facilities are in addition to the facilities put up by them for the production of RS and ENA. When the anhydrous alcohol price was not attractive many of them decided to continue with the ENA production. Subsequently when the OMCs offered a price of Rs.36 to 37 per Litre of ethanol, there was some response and OMCs could procure about 220 Million Litres in 2012. In 2013 when OMCs floated a global tender for the supply of ethanol, the international suppliers responded with a price range of Rs. 70 to 91 per Litre of ethanol. As this price was higher than the gasoline price the tender was scrapped.

For the new season (2020-2021)

- AA from damaged grain is Rs. 51.55 / Litre
- AA from FCI Rice is Rs. 56.87 / Litre

The installed production capacity, in the country, for anhydrous alcohol production is about 2 billion litres per annum. Many of the ethanol distillery plants have put up the facility for the production of anhydrous alcohol, but have not been using the facility because of the low off-take.

With the foregoing discussions it is clear that the actual production of ethanol is lower than that required to meet with the requirements of the potable alcohol industry and the requirements of OMCs' even 10% blending. This does not take

into account the alcohol required by the many chemical industries with ethyl alcohol as the raw material. Even though the crude price may be lower now, it is not going to remain at this level for long and even with lower crude prices the advantage of blending is that the country saves on the foreign exchange out flow. It is understood that the present Government wants to give a push to this blending program and hoping that many of the distilleries are putting up additional anhydrous alcohol production facilities. So, with the demand for ethyl alcohol set to increase, in the alcoholic beverages industry and in blending segment the future looks very promising for the Alcohol industry.

1.5 SLB Ethanol Private Limited (SLBEPL) is a newly registered company. The Promoters are none other than the Publishers of M/s Dinamalar, a leading Tamil Daily:

Sri. K. Ramasubbu, Director, is the Publisher of Dinamalar, Chennai edition and has rich industrial experience of nearly 42 years. He is a master degree holder in Journalism.

Dr. L. Ramasubbu, a Director has doctorate in Journalism and has industrial experience of nearly 40 years. He is the Publisher of Dinamalar, Madurai Edition.

Sri. L. Adimoolam, a Director has Engineering Degree from Regional Engineering College, Tiruchirapalli and has industrial experience of nearly 36 years. He has also rich experience in Solar Power generation and runs two Solar Power companies with 4 MWp production. He is the Publisher of Dinamalar, Coimbatore Edition as well.

Sri. K. Venkatraman, a Director has a Degree in Photography, and has industrial experience of nearly 32 years. He is the Publisher of Dinamalar, Puducherry Edition.

1.6 Having decided to implement the ethanol distillery project, SLBEPL has appointed M/s. Avant-Garde Systems & Controls (P) Ltd., Chennai-600116, a consultancy company with good experience in the sugar and ethanol Industries, as their consultants for the preparation of the Detailed Project Report.

1.7 The subsequent sections of this report furnishes the details of the proposed distillery process plant, the power plant, site facilities etc. The report also dwells on the environment aspects, estimate of the capital cost, financial analysis and the schedule for the implementation of the proposed multi product Distillery Project.

1A. MARKET OVERVIEW

1.0 Ethanol Sector Overview

India is the fourth largest producer of ethanol in the world after Brazil, USA and China. India ethanol market is projected to grow from $ 2.50 billion in 2018 to $ 7.38 billion by 2024, exhibiting a CAGR of 14.50% during 2019-2024, on the back of increasing ethanol use in applications such as fuel additives and beverages. Ethanol is a prominent alcoholic beverage, mainly found in beer, cider, wine, spirits and ale. Indian government is trying to reduce its dependence on imported crude oil and incentivizing Indian sugar manufacturers to produce ethanol for Oil Marketing Companies (OMCs). It is expected that ethanol production will increase by three to five folds in the future in order to meet the demand for its 20% Fuel Blending Program (FBP). Factors such as increasing alcohol consumption and changing lifestyle along with growing influence of the western culture are likely to drive the demand for ethanol in the country.

Industrial methylated spirits derived by adding methanol to ethanol is used as a solvent in chemical industries and in domestic burners for household chores such as heating and cooking. However, consumption of ethanol coupled with denatured alcohol is lethal and induces sleep. These properties are anticipated to hinder market growth and pose challenges to industry partakers.

In terms of source, India ethanol market has been categorized into sugar & molasses based ethanol, second generation (mixed grains) and grain-based ethanol. Based on

application, the market has been segmented into industry solvent, fuel & fuel additive, beverages, disinfectant, personal care, and flavoring & fragrance. Based on purity, the market has been segmented into denatured and undenatured. Government's emphasis on ethanol production from bio mass and solid waste is likely to become a major source of ethanol production in future.

According to OECD-FAO Agricultural Outlook 2018-2027, demand for biofuels is shifting towards emerging economies, which are rapidly putting in place policies that favor the domestic bio-fuels market.

Furthermore, the market projections suggest that 84% of the total additional demand for ethanol is expected from developing countries. Additionally, in many countries, compulsory blending rules impose a minimum share of ethanol and biodiesel to be utilized in transport fuel.

A report recently filed with the USDA Foreign Agricultural Service's Global Agricultural Information Network shows the average ethanol blend rate in India is expected to reach a record 5.8% this year, up from the record of 4.1% set last year.

India currently aims to achieve an E10 blend by 2020 and E20 by 2030. According to the report, India's Ethanol Blending Program stipulates procurement of ethanol produced directly from B- heavy molasses, sugarcane juice, and damaged food grains. A surplus sugar season coupled with financial incentives to convert excess sugar into ethanol is expected to help the country's oil marketing companies (OMCs) procure more than 2.4 billion liters (634.01 million gallons) of ethanol this year.

It is unlikely the country's E20 goals will be reached by 2030 due to the general inability of the cane industry to supply India's fuel demand, the fact that imports are managed in a way that minimizes the role they can play, and the expected timeframe for commercial-scale production of advanced biofuels.

India is expected to consume a record 3.8 billion liters of ethanol this year, up from a record 3.1 billion liters in 2018. It is estimated that 6.6% blend rate could be achievable if all the ethanol produced form molasses this year is blended with gasoline. Potential blending would be higher yet if imports were permitted and duties lowered. However, given demand from the potable and industrial sectors and limitations on imports, a national blend average of 5.8% in 2021 is expected.

Ethanol production in India is expected to reach a record 3 billion liters this year, up 11% from 2018. Last year, approximately 2.7 billion liters of ethanol was produced from molasses.

Regarding imports, the U.S. has remained the largest ethanol supplier to India for the past six years. Indian ethanol importers were down 14% last year, falling to 633 million liters. The U.S. accounted for 94% of 2018 imports.

India had 166 ethanol refineries in place last year, up from 161 in 2018. That number is expected to increase this year. Nameplate capacity was 2.3 billion liters in 2018 and is expected to increase to 2.6 billion liters this year. Capacity use was 117% in 2018 and is expected to fall go 115% in 2021.

2.0 Food Grain Diversions to Ethanol

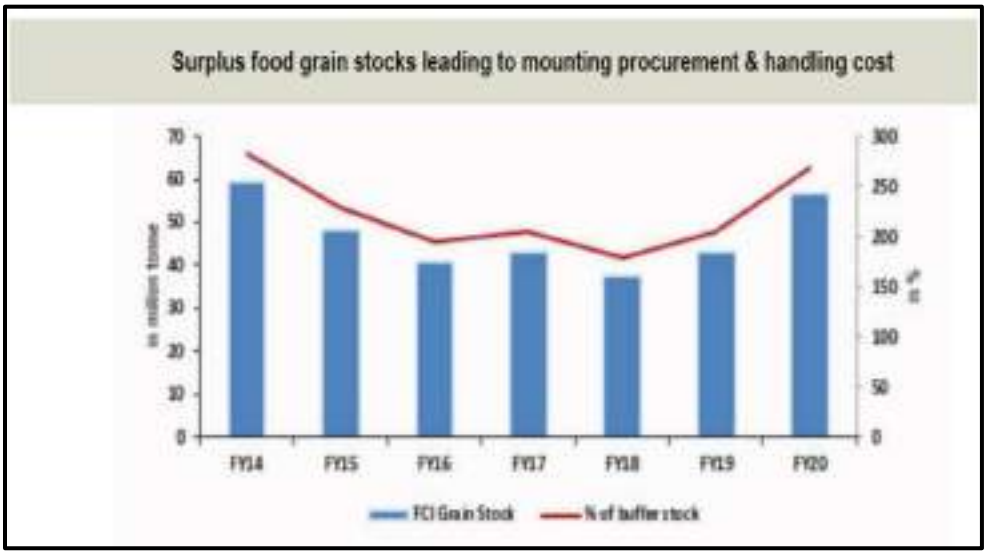
The food vs. fuel debate started a decade back when food prices started soaring with the increase in diversion of food crops towards manufacture of ethanol and biodiesel. Ethanol production, specifically in the US and Brazil, tripled from 18.4 billion litre to almost 59.6 billion litre between 2001 and 2007.

In December 2007, the United Nations Food and Agriculture Organization (FAO) calculated that world food prices rose 40% in 2007 while price hikes impacted all major biofuel feedstock, including sugarcane, corn, rapeseed oil, palm oil and soybeans. India was also impacted by increasing global food prices. There was a sharp increase in minimal support prices (MSP) between 2011 and 2014 when food inflation was persistent at 10%. In the next five years, things have been quite different with India facing the reverse problem of consistent excess food grain production. This first led to moderation of food inflation to 6% between 2014 and 2016 with a further decline to 1.5% in 2016-19. One of the biggest problems for Indian farmers in recent times has been excess production of major crops. The continuous increase in agriculture production has resulted in higher supply of rice, wheat, fruits & vegetables. The government largely procures not more than 20% of the produce. Moreover, paddy and wheat contribute more than 90% of this procurement.

Due to lack of export opportunities and limited food processing capacity, government agencies [Food Corporation of India (FCI), National Agricultural Cooperative Marketing Federation of India (Nafed) and other state procurement agencies], in turn, sell the stock in the open market through the Open Market Sales Scheme (OMSS). This mechanism only delays the supply of food

grains to the market and does not reduce it from the system, forcing farmers to sell the crop below MSP.

With the record production of wheat & rice in the last few years, supply of food grains has increased significantly. This makes the minimal support price, the maximum price farmers could get. The solution to this problem could be diversion of excess food crops for manufacture of fuel (ethanol & biodiesel) & shift from rice/wheat towards other cash crops.

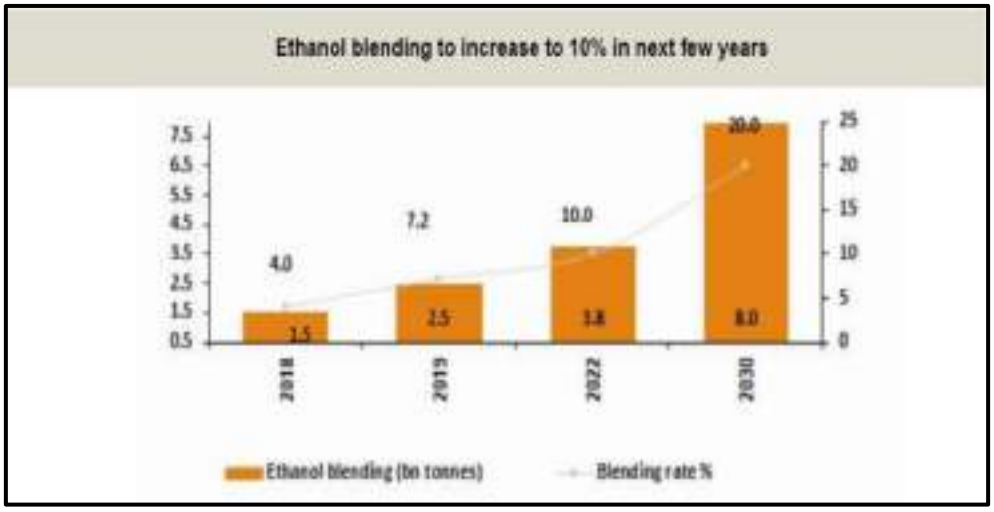


Source: Food Corporation of India, Ministry of Agriculture

Another problem with excess food grain production has been cost related to storage. FCI & other state agencies have procured 35.8 million tonnes (MT) of wheat in 2018-19, which is second highest ever procurement by them. Moreover, by the end of Kharif crop, rice procurement by agencies is expected to touch an all-time high at 45 MT by the end of October 2019. The buffer stock for wheat & rice is likely to be 47 MT and 27 MT in 2019 against the buffer stock norm of 27 MT and 13 MT, respectively. Though FCI & state agencies together have a sufficient storage capacity of 85

million tonnes for the excess food grain, costs related to this storage are enormous. The annual carrying cost of this stock is estimated to be Rs 13,710 crore. In 2012-14, the government used exports to reduce the excess wheat from the system. However, currently global wheat prices are trading 30-40% below fob cost of Indian wheat, which makes export of Indian wheat unviable. Hence, diverting excess food stocks to produce fuel seems to be the most sustainable solution to farm income distress.

Globally, ethanol is produced using corn, sugarcane & sorghum as most of these crops can produce ethanol, which reduces 40-60% less greenhouse gases (GHG) emission. Similarly, biodiesel can be produced from vegetable oils or animal fats, and is used in diesel engines. In India, the opportunity for ethanol blending with petrol is much larger considering the availability of enough feedstock in terms of sugarcane for producing ethanol. However, availability of vegetable oil & animal fat is not enough given India does not produce enough oilseeds for human consumption. Hence, diverting them for manufacturing is unlikely.



Source: ISMA

In the earlier bio-fuel policies, the government only allowed ethanol manufacturing through non- food crops due to the global debate on food vs. fuel. However, due to excess food grain production, the government allowed ethanol manufacturing through food grains in 2018 biofuel policy.

3.0 Excess Food Grain Diversions to Ethanol

One of the other successful crops for ethanol production has been field corn. US is largely producing ethanol through field corn. US ethanol production has significantly increased from 600 Crore litre at the start of the millennium to 6000 crore litre in 2018. Though sugarcane remains one of the best and commercially viable crops for ethanol production, India can still manufacture ethanol through other food crops whenever there is a decline in sugarcane production due to deficit rainfall or lack of water availability. India's current maize production is at 27-28 MT. Maize can be used for human as well as animal consumption. Moreover, it also has multiple industrial usage. Moreover, in the 2018 biofuel policy, the government has allowed to manufacture ethanol through sugar beet, sweet sorghum, wheat, broken rice and other food crops during surplus phase. With the new capacities and additional feedstock, 20% ethanol blending with petrol would not be a very difficult task.

Diversion of food grain to produce ethanol can work as a price stabilization mechanism. In recent times, excess food grain has been one of the major reasons for rural distress. Income levels of farmers are depressed mainly due to concentrated production of wheat and paddy in the country. Moreover, paddy also requires good amount of water at the time of cultivation,

which makes it highly dependent on rainfall. On the other hand, oilseed production has not been scaled up according to the increase in demand for edible oils. Hence, the diversion of wheat, paddy crops towards oilseed is the most reasonable solution to reduce excess inventories in the system. Also, increasing ethanol capacity, which can convert excess food grain to ethanol can help achieve the ethanol blending target of 20% by 2030. Both measures can work as a price stabilisation mechanism and, in turn, ensure that farmers sell their crops at or above the minimum support prices. Ultimately these measures can reduce the import bill of India and also increase the income levels of farmers providing a win-win solution for all.

1B. GOVERNMENT POLICY AND SCHEME ASSISTANCE

1.0 Scheme notification by Ministry of Consumer Affairs, Food and Public Distribution

The Central Government with a view to increase production of ethanol and its supply under Ethanol Blended with Petrol (EBP) Programme, vide notification No. 148 (E) dated 14th January, 2021, notifies the following modified scheme namely- "Scheme for extending financial assistance to project proponents for enhancement of their ethanol distillation capacity or to set up distilleries for producing 1st Generation (1G) ethanol from feed stocks such as cereals (rice, wheat, barley, corn & sorghum), sugarcane, sugar beet etc."

2.0 Eligibility

Assistance under the scheme shall be available to the entrepreneurs for:

I. Setting up grain based distilleries/expansion of existing grain based distilleries to produce ethanol. However, benefits of interest subvention scheme are to be extended to only those distilleries which are using or will be using dry milling technique to produce Dry Distillers Grain Soluble (DDGS).

II. Setting up new molasses based distilleries/expansion of existing distilleries (whether attached to sugar mills or standalone distilleries) to produce ethanol and for installing

any method approved by Central Pollution Control Board for achieving Zero Liquid Discharge (ZLD).

III. To set up new dual feed distilleries or to expand existing capacities of dual feed distilleries.

IV. To convert existing molasses based distilleries (whether attached to sugar mills or standalone distilleries) to dual feed (molasses and grain/ or any other feed stock producing 1G Ethanol); and also to convert grain based distilleries to dual feed.

V. To set up new distilleries / expansion of existing distilleries to produce ethanol from other feed stocks producing 1G ethanol such as sugar beet, sorghum, cereals etc.

VI. To install Molecular Sieve Dehydration (MSDH) column to convert rectified spirit to ethanol in the existing distilleries

3.0 Assistance under the Scheme

I. Interest subvention @ 6% per annum or 50% of rate of interest charged by banks/National Cooperative Development Corporation (NCDC)/ Indian Renewable Energy Development Agency Limited (IREDA)/ Non-Banking Financial Companies (NBFCs)/ any other financial institutions which are eligible for re-finance from NABARD, whichever is lower, on the loans to be extended by banks/ NCDC/ IREDA/ NBFCs/ any other financial institutions which are eligible for re-finance from NABARD, shall be borne by the Central Government for five years including one year

moratorium against the loan availed by project proponents.

II. Interest subvention under the scheme shall be provided on loan amount sanctioned and disbursed in respect of each project based on the proposed capacity, limited to the in principle approval by Department of Food and Public Distribution (DFPD).

III. Interest subvention would be available to only those distilleries which will supply at least 75% of ethanol produced from the added distillation capacity to OMCs for blending with petrol.

IV. Assistance shall not be available to sugar mills and distilleries which have availed benefits under any other scheme of Central Government for the same project.

V. In case of grain based distilleries, interest subvention would be applicable only if they are using or will be using dry milling technique to produce DDGS.

4.0 Submission of application

For availing assistance under the Scheme, the sugar mills/distilleries/entrepreneurs would be required to submit an application cum-proposal in the prescribed proforma to the Director (Sugar), Directorate of Sugar and Vegetable Oils, Department of Food & Public Distribution (DFPD), Krishi Bhawan, New Delhi within 30 days from the date of notification of the scheme through online on the DFPD portal **(http://sugarethanol.nic.in/)** and in future, whenever a

window is opened by DFPD from time to time to invite fresh applications to avail benefit under the Scheme.

5.0 Appraisal/ Approval of applications

DFPD will constitute two Committees viz. Screening Committee and Approval Committee. The proposals received under the Scheme would be placed before Screening Committee and Approval Committee and thereafter in-principle approval would be accorded by DFPD to the eligible applicants. The said Committees shall scrutinize the applications keeping in view the parameters as deemed necessary.

6.0 Modalities of the Scheme

I. After scrutinizing the applications cum proposals, DFPD will accord in principle approval and recommend such approved proposals to the lending banks/financial institutions for considering sanction of loan. Banks/NCDC/IREDA/NBFCs/any other financial institutions which are eligible for re-finance from NABARD would be at liberty to sanction/release the loan as per their commercial norms/policies and in compliance with regulatory guidelines, including the restructuring guidelines, as notified by RBI from time to time.

II. The applicant should get the loan disbursed from the bank/ NCDC /IREDA / NBFCs / any other financial institutions which are eligible for re-finance from NABARD, within 1 year from the date of in-principle approval of DFPD, failing which the in-principle approval

for the project will stand cancelled. Further, the project should be completed within 2 years from the date of disbursement of 1st installment of loan from bank/ NCDC/IREDA/NBFCs/any other financial institutions which are eligible for re-finance from NABARD.

III. The applicant should adhere to the time line as specified by DFPD for various activities viz. arrangement of land for the project, submission of application for seeking approval of environmental clearance in parivesh portal of Ministry of Environment, Forest & Climate Change (http://parivesh.nic.in/) and submission of loan application to the bank/ NCDC/IREDA/NBFCs/any other financial institutions which are eligible for re- finance from NABARD; updating progress on the DFPD portal (http://sugarethanol.nic.in/) every month, failing which the in-principle approval for the project may be cancelled by DFPD.

IV. The disbursement of loan under the scheme shall be in a separate account so that the utilization of the money for the said purpose is easily monitored.

V. The Department of Financial Services (DFS) will issue suitable instructions to the banks/NCDC/IREDA/NBFCs/any other financial institutions which are eligible for re- finance from NABARD to operationalize the scheme including appointment of NABARD as a nodal bank.

7.0 Modalities for payment of interest subvention

I. Payment of interest subvention on loan amount under the scheme will be limited to only 5 years including one year moratorium period.

II. The benefit of interest subvention will be provided by Government of India only if the account of applicant sugar mill/distillery is Standard and will not be available as long as account is NPA. The sugar mill/distillery will be responsible for repayment of interest including penal interest for the period of default along with the principal. Further, banks will be free to take necessary action against the defaulting borrowers as per banking norms and applicable regulatory guidelines.

III. In the event of surplus cash flow with the sugar mills/distilleries, accelerated payments may be decided by the bank/NCDC/IREDA/NBFCs / any other financial institutions which are eligible for re-finance from NABARD and the interest subvention liability of DFPD towards loan account would accordingly get reduced.

IV. The Department of Food and Public Distribution (DFPD) will release the interest subvention amount on quarterly basis in advance to the nodal bank as appointed by DFS. The interest earned on the interest subvention paid in advance shall be adjusted in the next quarterly installment.

V. DFPD will work out the modalities of release of Interest Subvention in consultation with NABARD.

8.0 Project Completion Certificate

The concerned entrepreneur/sugar mill/distillery shall submit a certificate duly verified by the Central Pollution Control Board certifying that zero liquid discharge has been achieved through the method proposed at the time of submitting application for such purpose. Sugar mills/distilleries/entrepreneurs availing loan to establish new distilleries or expansion of the existing distilleries shall submit a certificate duly verified by the Excise Commissioner of the State concerned and the Chartered Engineer certifying respectively that the new distillery has commenced production and has been installed or expansion of the existing distillery has been completed and enhanced production of ethanol has commenced. Any failure to submit such certificates shall lead to non reimbursement of interest subvention by the Central Government.

9.0 Utilization Certificate

The concerned distilleries/entrepreneurs shall submit utilization certificate for the sanctioned loan amount within three months of the completion of the project, duly verified by the respective Excise Commissioner or any other authority designated by the State Government certifying that the loan amount has been utilized for the purpose specified in the scheme. The said authorities shall also monitor the utilization of the loan. Any failure to submit the utilization certificate shall lead to non-reimbursement of interest subvention by the Central Government.

10.0 Guidelines cum (SOP) for Extending Financial Assistance

Guidelines cum Standard Operating Procedure (SOP) for Extending Financial Assistance to Project Proponents for Enhancement of Ethanol distillation capacity or to set up distilleries for producing 1st Generation (1G) ethanol from feed stocks.

S. No:		Parameter	Guideline cum SOP
1.	Eligibility		i. For setting up grain based distilleries / expansion of existing grain based distilleries to produce ethanol. ii. For setting up new molasses based distilleries / expansion of existing distilleries (whether attached to sugar mills or standalone distilleries) to produce ethanol and for installing any method approved by Central Pollution Control Board for achieving Zero Liquid Discharge (ZLD). iii. To set up new dual feed distilleries or to expand existing capacities of dual feed distilleries. iv. To convert existing molasses based distilleries (whether attached to sugar mills or standalone distilleries) to dual feed (molasses and grain / or any other feed stock producing 1G Ethanol) and also to convert grain based distilleries to dual feed.

		v. To set up new distilleries / expansion of existing distilleries to produce ethanol from other feed stocks producing 1G ethanol such as sugar beet, sorghum, cereals etc.
2.	Assistance under the Scheme (as per GoI guidelines- Interest Subvention)	i. Interest subvention @ 6% per annum or 50% of rate of interest charged by banks which are eligible for re-finance from NABARD, whichever is lower, on the loans extended by banks which are eligible for re-finance from NABARD, shall be borne by the Government of India for five years (including one-year moratorium). ii. The benefit of interest subvention will be provided by the Government only if the account of applicant sugar mill / distillery account is Standard. The benefit will not be available as long as account is NPA. The sugar mill/distillery will be responsible for repayment of interest including penal interest for the period of default along with the principal. iii. Loan accounts settled by borrowers under One Time Settlement scheme/ compromise etc. will not be eligible for interest subvention. iv. Interest subvention under the scheme shall be provided on loan amount sanctioned and disbursed in respect of each project based on the proposed capacity, limited to the in- principle approval by Department of Food and Public Distribution (DFPD). v. Interest subvention would be available to only those distilleries which will supply at least 75% of ethanol produced from the added distillation capacity to OMCs for blending with petrol.

		vi. In case of grain based distilleries, interest subvention would be applicable only if they are using or will be using dry milling technique to produce DDGS. vii. Assistance shall not be available to sugar mills and distilleries which have availed benefits under any other scheme of Central Government for the same project. viii. The DFPD will release the interest subvention amount on quarterly basis in advance to the nodal bank. The interest earned on the interest subvention paid in advance shall be adjusted in the next quarterly instalment.
3.	Submission of application to appropriate authority for seeking in principle approval	Application-cum-proposal on the prescribed Proforma shall be submitted by the borrower for in principle approval to the Director (Sugar), Directorate of Sugar and Vegetable Oils Department of Food & Public Distribution (DFPD), Krishi Bhawan, New Delhi. After getting in principal approval, borrower shall approach to the lending bank for further process.
4.	Assessment / Quantum of Loan / Pricing	As per bank's extant guidelines / instructions applicable for term loans.
5.	Risk Advisories about the sector / industry	As per CRMD guidelines.
6.	Time line for Processing application received	Within 30 days of receipt of all documents / papers.

7.	Type of Loan	Term Loan
8.	Tenor of loan	Tenor of loan shall be as per existing bank's norm. However, payment of interest subvention on loan amount under the scheme will be limited to only 5 years including one year moratorium period.
9.	Margin	5% of the project cost wherever tripartite agreement amongst the project proponents, the bank and the OMC for purchase of ethanol is executed.
10.	DSCR	Minimum: 1.10
11.	Security	**Primary Security:** • Term Loan: The project proponents would be required to makeavailable first exclusive charge / first pari passu charge on its Fixed Assets, as primary security purchased out of bank finance. **Collateral Security: 5% of the loan amount** • Extension of 1st / 2nd (pari passu) charge on other existing securities or other securities where residual value is available /which are free from encumbrances as the case may be. • Personal guarantees of Promoters / Directors should be obtained for the proposed loan. Waiver may be permitted bythe Sanctioning Authority.

12.	Escrow Agreement	The tripartite agreement shall ensure that the payment from the OMC is routed through a dedicated escrow mechanism whereby it is to be ensured to deduct the amount of installment for repayment of loan and the interest (after deducting the interest subvention amount to be paid by the Government) after which the balance is to be released to the concerned Project Proponent's account for its other uses. The exercise will be carried out every month.
13.	Disbursement	i. A tri-partite agreement (TPA) among the producers of ethanol (project proponents), OMCs and the lending bank is to be signed as per proforma before disbursement. ii. The financed unit shall submit a certificate duly verified by Central Pollution Control Board certifying the zero-liquid discharge will be achieved through the method proposed. iii. Opinion report on the suppliers of equipment/ machinery to be obtained as per extant instructions. iv. Disbursement shall be made direct to the suppliers of equipment/ machinery proposed to be installed.

14.	Modalities of the Scheme	i. Loan to be disbursed which are eligible for re-finance from NABARD, within one year from the date of in principle approval by DFPD, failing which the in-principle approval for the project will stand cancelled. ii. The project should be completed within two years from the date of disbursement of first installment of loan which are eligible for re-finance from NABARD. iii. The applicant should adhere to the time line as specified by DFPD for various activities viz. arrangement of land for the project, submission of application for seeking approval of environmental clearance in parivesh portal of Ministry of Environment, Forest & Climate Change (http://parivesh.nic.in/) and submission of loan application to the bank which are eligible for re-finance from NABARD, updating progress on the DFPD portal (http://sugarethanol.nic.in/) every month, failing which the in-principle approval for the project shall be cancelled by DFPD. iv. While implementing the respective project, the sugar mills / distilleries shall strive to seek convergence with the Make in India scheme of the Government from capacity addition/up-gradation in ethanol production.

15.	Modalities of payment of interest subvention	i. Payment of interest subvention on loan amount under the scheme will be limited to 5 years only, including one-year moratorium period. ii. NABARD has been appointed as the 'Nodal Agency' for interacting with the DFPD and managing the subsidy funded for onward reimbursement to respective Banks. iii. Interest subvention will be released by NABARD on quarterly basis, in advance on furnishing details of disbursement of bank loan. Subsequent installments will be release in three tranches on a quarterly basis on furnishing of utilization certificate. The individual banks shall identify one nodal branch for the purpose of collating the application for claim and submit the consolidated claim request to NABARD within two weeks of end of a quarter. Individual branches of a bank, shall submit their claims to the nodal bank branch within one week of end of the relevant quarter. iv. The Funds released by NABARD, in advance - towards interest subvention, shall be parked in interest bearing account at the Nodal Branch. v. The amount shall be released in advance subject to furnishing of disbursement particulars as well as interest earned by the Bank on the amount released in the previous quarter. Interest earned on subvention advance shall be adjusted in the quarterly installments from 2nd quarter onwards.

16.	Utilization Certificate	The concerned distilleries / entrepreneurs shall submit utilization certificate for the sanctioned loan amount within three months of the completion of the project, duly verified by the respective Sugar / Cane Commissioners, Excise Commissioner or any other authority designated by the State Government certifying that the loan amount has been utilized for the purpose specified in the scheme. The said authorities shall also monitor the utilization of the loan. Any failure to submit the utilization certificate shall lead to non- reimbursement of interest subvention by the Central Government.
17.	Project Completion Certificate	i. The concerned entrepreneur / distilleries shall submit a certificate duly verified by Central Pollution Control Board certifying the zero-liquid discharge has been achieved through the method proposed at the time of submitting application for such purpose. ii. Distilleries/entrepreneurs availing loan to establish new distilleries or expansion of the existing distilleries, shall submit a 'Completion & Commencement Certificate' duly verified by the Excise Commissioner of the State concerned and a Chartered Engineer certifying respectively that the new distillery has been installed and has commenced production or the expansion of the existing distillery has been completed and enhanced production of ethanol has commenced. Any failure to submit such certificates shall lead to non-reimbursement of interest subvention by the Central Government.

18.	Operational Guidelines	i. Purchase agreement executed between the OMCs and Project proponents to be scrutinized and ensured that there is nothing against the interest of the bank. ii. To be ensured that the margin for term loan for ethanol project is brought by the borrower upfront and source of margin ensured. iii. Under no circumstances, the working capital limits sanctioned for manufacturing sugar shall be diverted for ethanol productions. iv. The ethanol manufactured should be sold to Oil Marketing Companies (OMC). v. A tri-partite agreement (TPA) among the producers of ethanol (project proponents), OMCs and the lending bank is to be signed. vi. In case of any exigencies or problems in supplies, because of which the revenue generation is lower than the amount of repayment of loans and interest, the sugar mill / distilleries / entrepreneur has to undertake to service the debt and interest from its other sources of income. vii. All environment clearances to be obtained before disbursement. viii. DSRA to the extent of three months' repayment (of principal + interest) is to be built up within one year of commencement of commercial production.

		ix. In case of Consortium / Multiple Banking Arrangement, participating banks will sanction loans under the scheme in the same proportion as their share in the existing working capital limits and remit the amount to the separate account to be opened with the lead bank / lender. The lead bank / lender will disburse the full amount of loan to the borrowing unit and obtain the utilization certificate on behalf of all the lenders. x. In case of Consortium / MBA, our terms of sanction / disbursement shall not be inferior to those stipulated by other banks. xi. While assessing the viability of the project vis-à-vis repayment capacity, any government notification regarding tagging of ethanol prices shall be accounted for. xii. In the event of surplus cash flow with the sugar mills, accelerated payments may be decided and the interest subvention liability of DFPD towards loan account would accordingly get reduced. xiii. TEV study to be done as per bank's extant instructions. xiv. A copy of notification dated 14.01.2021 issued by Department of Food and Public Distribution, Ministry of Consumer Affairs, Food and Public Distribution, Government of India (GoI) is attached as per xv. Letter from Ministry of Consumer Affairs, DFPD dated 08.04.2021.

1C. STATUTORY APPROVALS

1.0 STATUTORY APPROVALS REQUIRED FOR THE PROJECT

1.1 Prior to Establishment

1. Approval on Excise License – Excise Letter of Intent / NOC
2. Permission to draw water from the Local Panchayat
3. 'Environmental Clearance' from MoEF & CC / SIA-SAC Committee - TNPCB
4. Consent to Establish from TN Pollution Control Board

1.2 Post Establishment

1. Consent to Operate from TN Pollution Control Board, once plant is installed.
2. Approval from Factory Inspector & Industrial Safety /Health
3. Approval from Boiler Inspector
4. Approval from Electrical Inspector
5. Approval from Weights & Measures
6. NOC from Fire Department
7. NOC from Petroleum And Explosives Organization (PESO)

1.3 Status of the approvals

The Company has to apply for IEM license for distillery from the Ministry of Commerce & Industries. Subsequently proceed with revised interest subvention approval, Environmental Clearance & consent to establishment from Tamil Nadu Pollution Control Board. The company shall also need to procure NOC from local gram panchayat, water drawl permission etc., before proceeding for the project.

List of NOC's / Approvals / Permissions required is indicated in the following table:

S. No	Statutory approval	Competent Authority
1.	Certificate of Incorporation	Registrar of Companies, Tamil Nadu
2.	IEM License for Distillery	Ministry of Commerce & Industry,Govt. Of India
3.	NOC from Local Gram Panchayat	Gram Panchayat
4.	Permission of water withdrawal	Govt of TN
5.	Consent to Establish from PCB	TNPCB
6.	Environment Clearance for Distillery	Ministry of Environment & Forest
7.	Interest Subvention Approval	Dept of Food & Public Distribution
8.	Approval for Boiler	Inspector of Boilers
9.	Factory Licence	Inspector of factories
10.	Power Load	TNEB
11.	Fire Approval	Tamil Nadu Fire & Rescue Services
12.	NOC for petroleum products	Petroleum And Explosives Organization

1.4 The following are the specific approvals needed for installation of Cogeneration Power plant which will be part of the Distillery complex:

a. State Power Approval for co-generation of power

b. Boiler certificate from boiler inspector

c. DG Set approval from Chief Electrical Inspector for stand-by power generation

2.0 PLANT AND EQUIPMENT DESIGN CRITERIA

2.1 General

The proposed 200 KLPD distillery of SLB Ethanol Private Limited (SLBEPL) will be operating almost for about 335 days in a year with grain (Broken Rice). The plant will be producing Absolute Alcohol (AA). All the plant and systems shall be designed to achieve the best possible efficiency under the specified operating conditions. The steam generated in the boiler will be supplied to a turbogenerator for power generation and the exhaust steam will meet with all the process steam requirements..

The complete plant instrumentation and control system for the distillery, and the 5.0 MW co-generation plant shall be based on Distributed Control System (DCS) philosophy, covering the total functioning requirements of measuring, monitoring, alarming and controlling, logging, sequence interlocks and equipment protection, etc.

The plant layout shall make optimum use of the land and facilities to minimize the cost of installation. The optimum arrangement of the equipment shall be determined by the considerations of functional requirements, economy of piping and electrical cables, economy of equipment supports, installation and maintenance access requirements, ventilation requirements and equipment generated noise and vibrations.

2.2 Plant & Machinery design criteria

This section of the report gives the basic criteria for the design of the plant. The design parameters like the size, layout, ratings, quantities, materials of construction, type of equipment etc., described in this report are tentative and

approximate. **Necessary changes could occur as the detailed engineering of the plant progresses and such changes are permitted as long as the detailed engineering of the plant achieves the intent of this report.**

2.3 Ambient Conditions

Plant Elevation above Mean Sea Level (MSL) : 120 meters

Temperatures:

- Maximum Temperature : 45 Deg.C
- Minimum Temperature : 22 Deg.C
- Plant Design Temperature (Dry Bulb) : 30 Deg.C
- Plant Design Wet Bulb Temperature : 28 Deg.C
- Plant Design Temperature for Electrical Equipment : 50 Deg.C

Relative Humidity:

- Maximum : 95.0 %
- Minimum : 35.0 %
- Plant Design Relative Humidity : 70.0 %

Precipitation:

* Total Annual Rainfall, average : 1435 mm

Wind:

* Wind Direction : West to East & East to West

* Design Wind Velocity : As per IS:875

Seismic Coefficient:

* Design : As per IS:1893

Soil Bearing Capacity:

* At 2.5 m Depth : 18 MT/Sq.M

2.4 Plant input specification

2.4.1 Broken Rice:

The Broken rice is the raw material should be used to produce various grade of ethanol. The starch content is the most important criteria to decide on the quantity of ethanol that could be produced from the rice. The rice proposed to be used is expected to have an average starch content of 68 %. With this starch content the ethanol (AA) yield in the distillery will be around 450 litres per MT of rice. For the proposed 218 KLPD distillery at SLBEPL an average rice requirement with the Starch content of 68% will be 444.44 MT/day. The plant will be operated for 335 days by using rice and the rice shall have the following characteristics. The below mentioned values are taken for our calculations.

Starch content	:	68% (w/w)
Total Solids	:	88.5% w/w
Moisture	:	11.0% w/w
Proteins	:	6% w/w
Fats	:	2.5% w/w
Crude fibre	:	9.0% w/w
Total ash	:	1.00% w/w

2.5 Other Distillery Chemicals

In addition to the grain requirement, the distillery process also requires other chemicals, the composition of which is given below:

2.5.1 Concentrated commercial Sulphuric Acid

Composition	**:**	**Value in % w/w**
Purity	:	97 % Min.
Lead	:	0.001 Max.
Arsenic	:	0.0001 Max.
Iron	:	0.03 Max.
Moisture	:	2 Max.
Density	:	1840 kg/cu.m
Liquid form	:	Clear, colourless, odourless liquid

2.5.2 Antifoam agent: Turnkey Red Oil

Composition	**:**	**Value in % w/w**
Degree of Sulphation	:	6 Min.
Total Alkali (KOH)	:	4 Max.
Total fatty matter (TFM)	:	60 Min.
Total Ash	:	8 Min
pH	:	6.5 - 7.5
State of fluid	:	Liquid

2.5.3 Di-ammonium Phosphate

Di-ammonium phosphate (DAP), in the form of granules, confirming to following specifications. Values given below are in w/w %.

Composition	**:**	**Value in % w/w**
Available Phosphorus as P2O5	:	50% Min.
Total Nitrogen	:	20 Min
Arsenic	:	0.0001 Max
Iron	:	0.01 Max.
Lead	:	0.01 ax

2.5.4 Urea

Urea shall be in the form of granules, confirming to following specifications. Values below are in w/w %.

Composition	**:**	**Value in % w/w**
Total Nitrogen	:	46 % w/w
Density	:	1330 kg/Cu.m
Solid form	:	Granular in shape

2.5.5 In addition to the above, the process requires chemicals like, Caustic (47% w/w) for neutralisation, Phosphoric acid (1% w/w) for membrane cleaning and Sodium Meta bisulphate (1% w/w) for membrane storage in the condensate and spent lees treatment unit. Caustic solution is required for CIP (Cleaning in Process) in the fermenters and Caustic solutions and Nitric acid are required for in process cleaning (CIP) of the distillation and evaporation sections.

2.5.6 The Grain (rice) plant, Liquefaction, Saccharification and fermentation process requires Liquefying enzyme (Alpha-amylase), Saccharifying enzyme (Gluco-amylase) and dried yeast or culture yeast for the conversion of starch to glucose into ethanol and Carbon-di-Oxide. Yeast culture will be supplied by the distillery supplier in the form of slant during the plant start up. The distillery should further develop the culture for regular use during plant operation.

2.5.7 Water requirement for the Distillery

The raw water supply for the plant will be from the bore wells located within the plant. This raw water will be treated as required and used as make up for the losses in the process steam, boiler blow down, cooling tower blow down, service water, boiler make up water, etc. In addition, water is required for fermentation section, make up water for the process cooling towers etc.

The design of the water treatment system will be based on the chemical analysis of the raw water at site.

Distillery Product Specification

The expected product output specifications shall be as given below. The Detailed Project Report is based on a plant that could give the specification requirement as given below:

2.5.8 **Anhydrous Alcohol**

Specifications Indian Standards IS 15464 – 2004 Requirements of Absolute Alcohol for use in Automotive Fuel:

Sl.No.	Absolute Alcohol	Special Grade
1.	Relative Density @ 15.6/15.6 Deg.C	Max. 0.7961
2.	Ethanol content @ 15.6 Deg.C, Vol%	99.50
3.	Miscibility with water	Miscible
4.	Alkalinity	Nil
5.	Acidity (CH3COOH), mg/lit	Max. 30
6.	Residue on evaporation, wt%	Max. 0.005
7.	Aldehydes, as (CH3CHO), mg/lit	Max. 60
8.	Copper, mg/kg	Max. 0.1
9.	Conductivity, micros/m	Max. 300
10	Methyl Alcohol, mg/lit	Max. 300
11.	Appearance visual	Clear and bright

2.6 Distillery Mode of Operation

The distillation system of the Distillery shall be designed for Wash to Absolute Alcohol (AA) mode of operation.

The distillation system shall be designed for accepting fluctuation in the Grain quality. The plant should be capable of producing Absolute Alcohol (AA) only. The Absolute Alcohol production shall be 200,000 litres per day. The total spirits production shall be 218,000 litres per day.

2.6.1 Distillery Equipment Design Criteria

2.6.1.1 Equipment for Grain based distillery plant

Fermentation system, with covered batch/continuous/fed batch Stainless Less (SS) fermenters with all appurtenances, nozzles and fittings including roof manholes, air/carbon dioxide spargers and or motor driven agitators, sight and light glass assemblies, level indicators, de-foaming oil sensors, pressure relief devices, grain broth mixers, fermented wash/mash recirculation pumps, fermented

wash/mash coolers, fermented wash/ mash transfer pumps (Fermenter Discharge Pumps), automatic chemical/ acid dosing system, process water inlet, recycled thin slop inlet, carbon-di-oxide extraction nozzle, cleaning nozzles for the fermenters, the complete piping for grain slurry, process and cooling water, thin slop, chemicals, fermented wash/mash, carbon dioxide, etc., valves and fittings etc.

Adequate slope should be given in the fermenter for sludge to settle. The fermenter outlet for wash/mash should be located above the sludge level so that sludge will not enter into the distillation column.

The fermenter coolers should be designed to keep the temperature below 33 Deg.C to achieve maximum fermentation efficiency. Proper agitators should be placed in such way that the mash is homogenous in nature. The coolers and cooling towers should be designed for alcohol of 11% v/v in the fermenter.

Fermented wash / raw stillage sludge decanting system containing (Two working and One stand by decanters) with drives and all appurtenances, decanter feed pumps, decanted liquid transfer pumps, the complete piping for sludge, mash etc., valves and fittings etc.

Complete set of yeast culture vessels with heating, cooling arrangement/jackets and external coolers as the case may be, sterile air supply and sparging system, sight and light glasses, relief valves, necessary nozzles and fittings, activated yeast or cell mass transfer pumps, connecting hoses to the cell mass transfer pumps, raw material diluters, the complete piping for process air, process and cooling

water, chemicals, nutrient, cell mass etc., hoses, valves and fittings etc.

Yeast activation / final propagation vessels / pre-fermenters with covered tanks with all appurtenances, nozzles and fittings including roof manholes, sterile air spargers, sight and light glass assemblies, level indicators, de-foaming oil sensors, pressure relief devices, raw material broth mixers, fermented mash recirculation pumps, fermented mash coolers, fermented wash/mash transfer pumps, automatic chemical / acid dosing system, process water inlet system, cleaning nozzles for CIP, the complete piping for raw material, process and cooling water, thin slop, chemicals , cell mass, carbon dioxide scrubber water, nutrient, etc., hoses, valves and fittings etc.

Wash/ Mash holding tank with manholes all nozzles and fittings, mash transfer pumps/mash feed pumps with motors, base frames, coupling, the complete piping for mash, process water etc., valves and fittings.

Process (sterile) air blowers with motors couplings and base frames, liquid separator, steam heater and water coolers for the air, suction air filter, the complete piping for air, process and cooling water etc., valves and fittings.

Carbon dioxide scrubbing system, including the sieve tray column type scrubber with nozzles and fittings. Process water and scrubber outlet water piping, valves and fittings.

Caustic cleaning system including the bulk caustic lye tank with all nozzles and fittings and steam heaters, caustic lye transfer pumps with drive motors, couplings and base frames, CIP (Cleaning In Place) solution storage tank with nozzles and fittings, CIP pumps with drive motors, couplings

and base frames, complete piping for spent lees, process water, caustic lye, CIP solution etc., valves and fittings. It has been noted that cleaning with formaldehyde is much more effective under some circumstances and the system offered should be suitable for spraying formaldehyde for the cleaning of the pre-fermenters and the fermenters.

Anti foaming chemical dosing tank with suitable capacity and level indication, nozzles and fittings, dosing pumps with drive motors, couplings and base frames, all piping for anti foaming solution, process water, valves and fittings.

Sulphuric acid dosing tank with suitable capacity and level indication, nozzles and fittings, acid dosing pumps with drive motors, couplings and base frames, all piping for acid handling, process water, valves and fittings.

Nutrient dosing tank with suitable capacity and level indication, nozzles and fittings, dosing pumps with drive motors, couplings and base frames, all piping for nutrient solution, process water, valves and fittings.

The complete distillation plant consisting of:

- Distillation columns for degassing, stripping, pre rectification, rectification, purification, refining, recovering various products, with suitable trays, tray supports, downcomers, appurtenances, access openings, nozzles and fittings, supports.

- All columns should be skirt mounted.

- All the columns will be designed considering wind and seismic load as per applicable IS standards. All the columns will be designed to have very minimum alcohol loss in thick slop,

spent lees and vent. Down comer should be properly designed for smooth flow.

- Weir height and sieve opening should be designed to have maximum tray efficiency. The impure spirit cut should not go beyond 5% of total output on Rectified Spirit (RS) production.

- Coolers and heaters of shell and tube or plate type to cool or heat the intermediate products as well as the final product cooling. The coolers / heaters will be complete with all appurtenances, nozzles and fittings.

- Adequate number of plate type heat exchangers with wide gap plates shall be used.

- Adequate number of re-boilers of shell and tube type for the various columns with all appurtenances, nozzles and fittings.

- Adequate number of condensers, vent condensers, vapours bottles for the various columns with all appurtenances, nozzles and fittings.

- Various feed tanks, intermediate storage tanks; flash tanks reflux tanks, collection tanks with all appurtenances, nozzles and fittings.

- Intermediate storage tank for RS with all appurtenances, nozzles and fittings.

- Fusel oil decanters with all appurtenances.

- All process pumps including the vacuum pumps with drive motors, couplings, base frames.

- All the piping for fermented wash, process water, rectified spirit, AA, impure spirit, fusel oil, alcohol water liquid, alcohol water vapour and alcohol vapor, including all valves and fittings, supports.

- Cooling water supply and return piping including valves, fittings and supports, from near the plant to all equipment requiring cooling water supply.

- Thick slop piping from distillation plant to thin slop storage tank or evaporation system. Thin slop pump suction and discharge piping from storage tank to evaporation system.

- Instrument air piping including valves, fittings and supports near the plant to all equipment transporting instrument air.

- All steam lines including valves, fittings and supports near the plant to all equipment transporting steam.

The Complete Molecular Sieve Dehydration Unit consisting of:

- Evaporation column with suitable trays, tray supports, down-comers, appurtenances, access openings, nozzles and fittings, supports.

- Feed pre-heater, product cooler, regeneration pre-heater and regeneration cooler, with all appurtenances nozzles and fittings.

- Feed filter and regeneration filter.

- Evaporator column re-boiler of shell and tube type with all appurtenances, nozzles and fittings.

- Feed super heater of shell and tube type with all appurtenances, nozzles and fittings.

- Molecular sieve beds with desiccant, internals all appurtenances, nozzles and fittings.

- Regeneration condenser with vacuum ejector/eductor with all appurtenances, nozzles and fittings.

- Product condenser, product receiver and product filter.

- All process pumps like the feed pump, regeneration pump and product pump, with drive motors, couplings and base frames.

- All piping for alcohol, alcohol water liquid, and alcohol water vapor, steam, cooling water with valves, fittings and supports.

The evaporation section consisting of:

- Falling film/raising film/forced circulation evaporators, vapour liquid separators, thin slop pre-heaters, feed tanks and intermediate feed tanks, thin slop feed tank (MOC will be SS 304) , product transfer pumps with motors couplings and base frames, surface condenser, steam condensate tank, condensate storage tank. All appurtenances, nozzles and fittings for the above.

- Adequate spare bodies for the falling film and forced circulation bodies shall be provided and the system should be designed for continuous operation.

- All recirculation pumps should have maximum flow to avoid scaling.

- All process pumps, steam and process condensate pumps, including the vacuum pumps with drive motors, couplings and base frames.

The product storage section consisting of:

- Adequate number of Receivers, Bulk and Issue tanks for Absolute Alcohol, Technical Alcohol (TA) and Fusel oil (FO) respectively.

- Product piping from the distillery section to the receivers, from receivers to the bulk storage section, from bulk storage to issue tanks and flow meters, hoses. All valves, fittings, appurtenances in the piping.

- Flame arrestors for the receiver and bulk storage tanks.

- Vent condensers for the receiver, bulk storage.

- Products transfer pumps from receiver to bulk storage, bulk storage to issue tank and issue pumps from issue tank to tankers, with drive motors, suction strainers, couplings, base frames, etc.,.

- Positive displacement flow meters (for Issue) for the products.

2.6.1.2 Additional equipment required for the grain mode of operation.

2.6.1.2.1 Grain handling section

The storage of grains is planned both by logistics and financial aspects. The capacity may be decided depending upon the availability in local and distance from where the grains are procured. Depending upon the distance from plant storage capacity can be arrived. 4 x 7500 MT capacity Silos for 60 days storage are considered for storage of grains. The availability of the grains in a year and period which

grains can be procured has to be done carefully to arrive at the storage capacity of silos.

The Grain storage system consists of the Bucket elevator, Receiving hopper, Pre-cleaner, Supporting structural's, Galvanized corrugated silo with accessories, Level switches, Aeration system, Supporting frames, Discharge gates and Chain conveyor etc.

Proper sanitation arrangement should be done to avoid contamination of the raw material.

The Grain handling system consists of the Bucket elevators, Magnetic Separator, De-stoner, Hammer milling system, Conveying system, Aspiration system, Flour bins with load cell and vibrators, Flour feed to Blunger tank and instrument & control system etc.

Complete Liquefaction and Saccharification system consists of the Blunger tank, Mixing tank with recirculation transfer pump, Hot water tank assembly with recirculation and transfer pumps, Jet cooker assembly and holding coil, Flash vessel, Slurry transfer pump, Liquefaction tank with pumping system, Saccharification tank with pumping system, Mash cooler, Enzymes dosing tank with pumps, Caustic soda and Nutrient dosing tank with pumping system, Instrumentation & Control system etc.

2.6.1.2.2 Distillers Dries Grain Soluble (DDGS) Dryer Area:

- One number of high speed mixer along with flame proof motor & associated accessories.
- One number feeding conveyor for DDGS dryer along with flame proof motor & associated accessories.

- One number of recycling conveyor to high speed mixer along with flame proof motor & associated accessories.
- One number of dryer vapour cyclone along with support brackets, vortex breaker, discharge valve & associated accessories.
- Two numbers of fan (one working & one standby) for dryer vapour cyclone along with motors.
- One number of discharging conveyor along with motor.
- One number of wet scrubber along with pumps , motors and associated accessories.
- One number of chimney & associated accessories.
- Two numbers of cyclone separators, two numbers of rotary air lock valves & motors for pneumatic conveying system & associated accessories.
- Two numbers of fan (one working & one standby) along with motors for cyclone separators & associated accessories.
- One number of bag filter, rotary air lock valve & motors and associated accessories.
- One number for air cooler along with motor and associated accessories.
- One number of product storage silo along with slide gate valve and associated accessories.
- One number of semiautomatic bagging machine along with bag top stitching facilities and associated accessories.
- One number of belt conveyors along with motor for transporting the final product (DDGS) to storage area.

2.7 Design & Guarantee Fuel for the Boiler

The design and guarantee fuel for the Boiler cogeneration plant will be 100% Rice Husk & 100% Coal. However, in this DPR, year round operation with coal only is considered. The following will be the analysis and the Gross Calorific Value (GCV) of the various fuels.

2.7.1 Rice Husk Composition and GCV of Rice Husk

Carbon	:	37.85%
Hydrogen	:	5.2 %
Sulphur	:	0.61%
Oxygen	:	27.65%
Moisture	:	10.4%
Nitrogen	:	0.14%
Ash	:	18.15%
Gross Calorific Value	:	3150 Kcal/Kg

2.7.2 Coal Composition and GCV of Coal

Carbon	:	44.17%
Hydrogen	:	3.42 %
Sulphur	:	0.75%
Oxygen	:	13.15%
Moisture	:	32.89%
Nitrogen	:	0.79%
Ash	:	4.83%
Gross Calorific Value	:	4470Kcal/Kg

2.8 Steam Generator & Auxiliaries

The new steam generating system for the Cogeneration plant of the distillery will consist of One (1) Rice Husk / coal fired boiler with a Maximum Continuous Rating (MCR) of 45 TPH, with the outlet steam parameters at 68 ata and

485 Deg.C. The tolerance on the super heater outlet temperature shall be $\pm 5^0C$ and -0^0C. The 45 TPH of MCR capacity is arrived at considering the steam to be supplied for Distillery process and Deaerator during Grain mode of operation. Considering the type of fuels to be fired in Boiler which is Rice husk or coal, The combustion system of the boiler shall be Atmospheric Fluidized bed combustible (AFBC). The Boiler efficiency shall be a minimum of 80% and 84% on the GCV basis while firing Rice Husk and coal respectively. The boiler shall be designed to meet with the requirements of the Indian Boiler Regulations.

The dust Concentration in the flue gases leaving the boiler shall be a maximum of 50 mg/N.Cum and the boiler shall be provided with a Electro Static Precipitator.

The design of the boiler shall be of single drum, natural circulation; radiant furnace with water cooled membrane walls, two stage superheater with interstage Desuperheater and balanced draft. The boiler shall be top supported and shall be of semi-outdoor type. The boiler shall be capable of a peak generation of 110% of the MCR generation for a period of One (1) Hour in a shift.

Boiler Feed Water

The boiler shall be capable of operating with the following feed water quality requirements.

-	pH	:	8.8 - 9.2
-	Oxygen	:	0.007 ppm
-	Hardness	:	0
-	Total Iron	:	0.01 ppm
-	Total Copper	:	0.01 ppm
-	Total Silica	:	0.02 ppm

- Hydrazine : 0.01-0.02 ppm
- Specific Electrical Conductivity at 25°C measured after Cation exchanger in the H + form and after CO2 removal (max) : 0.5 micro-ohms/cm

Steam Purity

The boiler shall be capable of supplying uninterrupted steam at the MCR rating with the following steam purity levels.

- Total Dissolved Solids : 0.1 ppm (max)
- Silica (max) : 0.02 ppm

Performance Guarantee Tests

* Maximum Continuous Rating (MCR) of the boiler while firing Rice Husk, with the feed water temperature of 150°C and super heater outlet parameters of 68 ata and 485°C + 5°C and - 0°C.

* Boiler Efficiency at MCR on GCV basis while firing Rice Husk.

* Auxiliary Power Consumption under MCR operating conditions.

* Steam purity for all operating loads.

* Dust Concentration in the flue gases leaving the ESP, while firing Rice Husk.

2.9 Turbogenerator & Auxiliaries

The TG shall be a 5.0 MW nominal capacity Back Pressure TG with the exhaust at 5.5 ata. The following shall be the

salient design parameters. The speed of the turbine shall be preferably less than 8000 rpm. The inlet steam parameter for the turbo generator shall be 65 ata and 480^{0}C. Under the normal operating conditions, during Broken rice operation, with the boiler generating 37.57 TPH of steam with 31.05 TPH of steam supplied at the inlet of TG, the power generation in the turbogenerator shall be 4.085 MW which will meet the power requirements of the distillery complex.

The generation voltage shall be 11,000 V and the system shall operate parallel with the grid.

Performance Guarantee Tests

The performance test shall be conducted for the following parameters as per ASME PTC 6 and DIN 1943:

- Power Output at Generator Terminals with the Inlet steam parameters of as specified.
- Auxiliary Power Consumption under Guarantee conditions.
- Maximum temperature rise in the generator windings.

2.10 Auxiliary Plant and Equipment

2.10.1 Fuel handling

The fuel for the distillery cogeneration plant operation is Rice husk or coal. Rice husk will be used as fuel for about 170 days and Coal will be used for about 165 days in an year. The Rice husk or coal shall be conveyed to the new 45 TPH boiler by belt conveyors from the storage yard. The bulk density of Rice Husk and coal shall be 90 Kg/Cum and 800

Kg/Cum respectively. Allowable inclination for the belt conveyor is 18° to 20°. The Belt speed shall be approximately 1.00 meters/sec.

2.10.2 Ash handling

The ash handling system envisaged for the cogeneration plant is of two types:

- Bed Ash Handling system
- Dense phase handling system for fly ash

All the bed ash and fly ash will be collected in separate storage silos having a suitable capacity & will be disposed-off by trucks / trailers.

2.10.3 Cooling Towers

The cooling tower shall be FRP type cross flow induced draft cooling tower of adequate capacity for the various applications of the distillery plant. The cogeneration plant, evaporation and distillation sections shall be cooled by Air cooled condensing method. The capacity of Fermentation section cooling tower shall be approximately 1500 Cu.M / Hr. This cooling tower shall be designed for a cooling range of 2°C for the fermentation section with an approach of 4°C while operating under the atmospheric wet bulb temperature of about 27 °C. The cooling tower shall be carefully sited such that there is no re-entrainment of the vapours into the cooling tower. The location shall also be such that there will be no major contamination of the cooling tower basin water with the rice husk / coal.

2.10.4 Pumps

The head / flow characteristics of pumps will be such that the head continuously rises with decreasing capacity until a maximum head is reached at zero flow. Maximum run-out flow should at least 130% of duty point flow.

The shut off head should be at least 1.1 times the duty point head and should not be more than 1.2 times the duty point head.

The power curve should be of non-overloading type with the maximum power occurring at or near duty point or towards maximum runout flow.

NPSHR curve should be a continuously rising one in the range of operation, from the minimum flow in the range to the maximum flow in the range. Required NPSH values shall not exceed available values over the entire range from minimum to rated flow.

2.10.5 Condensate System

The process condensate and spent lees mixture shall be treated in a treatment plant, based on anaerobic digestion, aeration, clarification, filtration, ultra filtration and reverse osmosis with recovery of approximately 90%. This recovered water shall be recycled and used as make of water for cooling towers of the process plant and cogen plant. Necessary piping, vales, fittings, instruments shall be installed as required.

Process Steam from turbine extraction shall be supplied to the reboilers of pre rectifier cum exhaust column, rectifier cum exhaust column and extractive distillation column in the distillery process plant. The condensate from these

reboilers outlet will not be contaminated and hence can be reused in the boiler. The pure condensate from the process area shall be stored in a condensate recovery tank from where it will be fed to the deaerator of the Boiler.

2.10.6 DM Plant

The Demineralized water quality at the outlet of the DM plant shall be as follows:

*	Hardness (ppm)	:	≤ 0.004
*	pH @ 25°C	:	8.5 - 9.2
*	TDS (before pH correction)	:	≤ 0.1
*	Conductivity @ 25°C (microsiemen / Cm)	:	≤ 0.2
*	Total Iron as Fe (ppm)	:	≤ 0.01
*	Total Copper as Cu (ppm)	:	≤ 0.003
*	Total Silica (ppm)	:	≤ 0.02

The DM water required for the distillery and the Boiler will be supplied from a new dedicated water treatment plant. Necessary piping, valves, fittings, instruments shall be installed for the DM water to the boiler and distillery plant.

2.10.7 Vessels & Heat Exchangers

The design shall be as per ASME Sec.VIII, HEI and TEMA. All heat exchangers and vessels for steam application shall be designed for full vacuum conditions. The heat exchangers shall be provided with start up vent connections. The design shall have provision for complete drainage on both shell and tube sides. The heat exchangers shall be provided with emergency drains, shell side safety valves, and individual bypass with manual valves. A minimum corrosion allowance of 3 mm shall be provided. The tube bundle shall

be of removable type. The tube material shall be stainless steel, unless otherwise specified in the specifications.

2.10.8 Tanks

The distillery plant tanks should have storage capacities as required by design of the systems, requirement from the statutory authorities and necessity to have storage facilities built in the plant to match with marketing of the products. Tanks will be of the closed top type. The Tanks will be fabricated in accordance with the guidelines established by Indian Standards, IS 803, API–650,. The tanks shall be provided with proper feeding arrangement of the product into the tank. Drain valves, discharge valves, manhole, safety railing, vent, vent condensers as applicable, ladders shall be provided for the tanks. The AA storage tanks shall strictly adhere to the safety regulations.

2.10.9 Piping

All piping system shall be designed as per ASME B 31.1. In addition, statutory requirements of the Indian Boiler regulations shall be complied with, wherever applicable.

Stress Analysis shall be carried out for all possible operating modes and shall be as per IBR and ASME B 31.1 requirements. Supports, guides, Directional Anchors shall be selected to satisfy all the operating conditions.

All piping shall be sized considering the allowable velocity and allowable pressure drop in the system. The suggested flow velocities of various mediums are,

* Superheated Steam : 45 to 55 M/Sec
* Saturated Steam : 15 to 30 M/Sec
* Boiler Feed Water

- Pump Suction : < 1M/Sec
- Pump Discharge : 2.5 to 4 M/Sec

* Water
- Pump Suction : < 1M/Sec
- Pump Discharge : 2.5 M/Sec

* Condensate
- Pump Suction : 0.6 to 0.7 M/Sec
- Pump Discharge : 2.5 M/Sec

* Compressed Air : 12 to 18 M/Sec

* Lube Oil
- Pump Suction : 0.3 to 0.4 M/Sec
- Pump Discharge : 1.0 M/Sec

2.10.10 Piping Materials

The piping material selection shall be based on the following recommendations.

- For temperature 427°C to 510°C, SA 335 Gr. P11/P12/P22 shall be used.

- For temperature 426°C & below SA 106 Gr.B/C or ASTM A-53 seamless shall be used.

- For HP/LP chemical dosing SA 312 TP 304, Stainless Steel shall be used.

- All pipe fittings other than those mentioned shall confirm to ASTM A 234 standard and dimension as per ANSI B 13.9 / B 13.28 / B 13.11.

- For Cooling water, Raw water, Service Water, Safety/ Relief valve exhaust carbon steel ERW pipes shall be used.

- For the alcohol system stainless steel AISI – 304 shall be used.

- For Service air applications the piping shall be carbon steel Black Medium Class.

- For instrument air applications: Galvanized pipe shall be used.

2.10.11 Insulation

All exposed portions of the plant which operate at temperatures of 60°C and above during normal operation shall be thermally insulated so that the temperature on the outer surface of the cladding shall not exceed by more than 20°C above ambient, based on an ambient temperature indicated in site data. The specified insulation thickness shall not include the thickness of wire netting, finishing cement or any other finishing or weatherproofing application. Insulation shall not fill the contours of the expansion bellows. Piping and equipment that are not insulated but having a surface temperature exceeding 50 Deg.C shall be insulated for personnel protection.

2.11 Civil & Structural

The reinforced concrete structures shall be designed in accordance with the latest version of Indian Standards. The structural steel design shall be as per Indian Standards. The design wind speed and seismicity shall be in accordance with the applicable Indian Standards. The structures shall be designed to withstand the calculated Dead loads, Live loads, along with the wind and seismic loads in appropriate combinations recommended by the Codes. The minimum dead and live loads for the design of the platforms and walkways shall be 500 kg/sq.m.

Structural steel shapes, plates and other structural materials shall conform to IS, with minimum yield strength of 25 kg/sq.mm. Welding electrodes shall be as per AWS. HYSD reinforcement steel bars shall conform to IS standards. All structural steel and MS members will be painted with two coats of red oxide zinc chromate paint and two coats of synthetic enamel paint.

All the foundations shall be raft type based on the soil bearing capacity which is assumed 18 MT per Sq.m at a depth of 2.5 meters. This is the soil bearing capacity assumed for the area and detailed soil investigation report to be carried out. The above soil bearing capacity shall be verified by soil investigation in the distillery area before the final design. The site is assumed to be relatively flat, requiring minimal grading & levelling (levelling & grading upto ± 0.5m). Minimum grading / levelling works are envisaged, as the land area is presently under cane cultivation. All the piping will be cast-in-situ piles and all other excavation work shall be done by conventional manual methods or by mechanical equipment method (wherever required). For substructures & superstructures Ordinary Portland Cement (grade 43) will be used. Grade of Concrete for steam turbogenerator & heavy rotating equipment foundations & chimney shall be with a compressive strength of 25N/sq.mm for a 150mm test cube at 28 days and all other foundations / pedestals / buildings etc. shall be with a compressive strength of 20N/sq.mm for a 150mm test cube at 28 days.

2.12 Electrical system

All equipment for the distillery plant cogeneration unit shall be designed for satisfactory operation for a life time of minimum 30 years under specified site conditions. All equipment shall be suitable for rated voltage of ±10% and

frequency of 50 Hz with ±5% variation and 10% (absolute sum) combined voltage and frequency variation.

The generator shall be of synchronous type with brushless excitation system, and shall be designed for rated voltage & frequency of 11,000 V & 50 Hz, with corresponding variations of ±10% and ±5%. The generator shall have closed circuit air-cooled system with external water circuit (CACW cooing) and the windings shall have class 'F' insulation, with temperature rise limited to class 'B' insulation limits, under specified cooing water & ambient air temperatures.

Three(3) Nos. Of 3.15 MVA each convertor transformers shall be envisaged for distribution of power which generated at 11 kV voltage level.

The nominal voltage of main DC system for protection & control systems and turbine emergency oil pumps shall be 110 V.

UPS system with rated voltage of 230 V AC shall be envisaged, for meeting UPS power requirements of the plant DCS and other instrumentation / control loads.

All equipment shall comply with the applicable provisions of relevant IS / IEC / IEEE standards, as listed elsewhere in this document.

Breakers for LV system shall be Air break type circuit breaker.

Sizing of cables shall be as follows:

The cables shall be derated for the site ambient and ground temperatures, grouping and soil resistivity. Cables shall be selected to limit the maximum voltage drop at equipment terminals, during normal operation and starting conditions, to be well within permissible values.

Cables in circuits controlled by circuit breakers shall be capable of withstanding the maximum system fault currents till the breaker opens by main protection. For 11 kV grade cables, screen shall be suitable for carrying earth fault current of 1 kA for a duration of 1 sec.

Current ratings of the cables shall be assigned considering continuous conductor temperature of not more than 70 Deg.C for PVC and 90 Deg.C for XLPE. Cables should also be sized to carry system fault current for the duration specified above without exceeding the temperature limit of 160 Deg.C for PVC and 250 Deg.C for XLPE.

For 415V system, ACBs shall be provided for rating 630A and above, and MCCB shall be provided for lesser ratings. Motor feeders shall have fuse MCCB / MPCB, over load relays and air-break contactors. Motors of rating above 30 kW shall be provided with star-delta starters, depending on application.

All motors shall be of squirrel cage type and shall have class 'F' insulation, with temperature rise limited to class 'B' limits under specified ambient and voltage / frequency conditions.

Fault Level

All equipment shall be designed to withstand the maximum fault, under voltage variation of ±10%, 44 kA for 3 sec in 11000 V system.

Auxiliary transformers and all accessories shall be capable of withstanding for two seconds without damage during any external short circuit at the terminal.

All Switchgears, MCC & Distribution Boards shall be capable of withstanding the maximum fault currents that may arise, duly considering the maximum fault levels on high voltage system, negative tolerance on transformer impedance and maximum possible motor contribution for maximum possible fault clearing time on ultimate backup protection but not lower than one second in any case.

Degree of Protection

*	Synchronous Generator	:	IP54
*	LT Switchgears	:	IP52
*	Switchgears located outdoor	:	IP55.
*	LT busduct Enclosure	:	IP52 (in the indoor portion)
		:	IP55 (in the outdoor portion)
*	Control Panels	:	IP42 (in air-conditioned area)
		:	IP52 (in other areas)
*	Push Button Stations	:	IP54 (indoor)
		:	IP55 (outdoor)
*	Induction Motors	:	IP54 (indoor)
		:	IP55 (outdoor)

DCS Interface

The system shall be compatible for accepting / sending signals from / to DCS. Winding, bearing and cooling circuit (where applicable) RTDs shall be hooked up to DCS for signal processing and necessary tripping shall be arranged from DCS, for tripping of the corresponding motor.

Signals from all transformers for winding temperatures, oil temperatures, oil level gauges, Buchholz relay outputs for alarm and tripping shall be brought to DCS.

Status (ON/OFF/TRIP) of all breakers, LT breakers in PCCs and all motor feeders shall be brought to DCS, for plant monitoring. Control of motor feeders, as per system requirement, shall also be arranged for control from the DCS system.

2.13 Instrumentation & Control system

The distillery and cogeneration plant's Instrumentation and Control system, based on Distributed Control System philosophy, will be designed to provide monitoring and control capabilities to ensure safe and reliable operation, minimize operator manual actions and alert operators on any conditions or situations requiring manual intervention in a timely manner. The control functions shall be backed up by interlocks and safety systems which cause pre-planned actions like tripping or sequential shut down of equipment during situations where unsafe conditions develop faster than the controls or the operator's reaction time. All I&C equipment will be of proven design and will be selected to achieve highest level of plant availability and facilitate equipment maintenance.

Signals of various process parameters shall be electrical signals generated by field mounted micro processor based smart type transmitters. The above signals will be processed in the DCS to produce electrical signal outputs which will control the final actuators through converters. All computation, signal conditioning and control function generation will be done in the DCS.

2.14 Codes & Standards

Systems and equipment will be designed in accordance with the applicable sections of the following codes, standards and regulations in effect at the date of this Contract. Applicable sections of codes, standards and regulations will be defined in specifications.

Bureau of Indian Standards (BIS)

IS:325: 1996	Three-phase induction motors
IS:456: 2000	RCC Structures
IS 800: 2007	Code of practice for construction in Steel
IS:807: 1976	Code of Practice for Design, Manufacture, Erection and Testing (Structural Portion of Cranes & Hoists)
IS:875: 1987	Code of practice for Design loads for building structures
IS:1554:1988	PVC insulated (heavy duty) electric cables
IS:1893:2002	Criteria for Earthquake Resistant - Design of Structures

IS:2042:2002	Insulating bricks
IS:2309:1989	Practice for the protection of the buildings and allied structures against lightning - code of practice
IS:2429:1987	Round Steel Short link chain electric butt welded Gr.30
IS:2544:1973	Porcelain post-insulators for systems with Nominal voltage greater than 1000 V.
IS:2705: 1992	Current Transformers
IS:2825:1969	Code for unfired pressure vessels
IS:3043:1987	Code of practice for earthing
IS:3144:1992	Methods of test for Mineral Wool Thermal Insulation Material
IS:3156:1992	Voltage Transformers
IS:3177:1999	Code of Practice for design of Electric Overhead Traveling Crane and Gantry Cranes
IS:3646:1992	Code of practice for interior illumination
IS:3832:1986	Hand Operated Chain pulley blocks
IS:3938:1983	Specification for Electric Wire Rope Hoists
IS:4503:1967	Shell and Tube Heat Exchangers

IS:4776:1977	Troughed Belt Conveyors
IS:5422: 1996	Turbine type generators
IS:7098:1973	Cross linked polyethylene insulated PVC Sheathed cables
IS:7155:1990	Code of recommended practice for Conveyor Safety
IS:8183:1993	Specification for Bonded Mineral Wool
IS:8531	Pulleys for Belt Conveyors
IS:8623: 1993	Low voltage switchgear and control gear assemblies
IS:9921:1985	Alternating current disconnectors (isolators) & earthing switches for voltage above 1000V
IS:11592:2000	Code of Practice for Selection and Design of Belt Conveyors
IS:13118:1991	High voltage alternating current circuit breakers
IS:13947:2004	LV switchgears and controlgear
IS:13779:1999	Static watthour meters, class 1 and 2
IS:14164:1994	Industrial application and finishing of Thermal insulating materials at temperatures above 80°C and upto 700 Deg.C

IS:1162:1958	Specification for cane molasses
IS:323:1959	Rectified spirit specification
IS:324:1969	Specification for ordinary denatured spirit
IS:6613:2002	Neutral spirits for alcohol drinks specification
IS:321:1964	Specification for absolute alcohol
IS:15464:2004	Test methods for absolute alcohol

American Society of Mechanical Engineers (ASME)

ASME Section I	Rules for construction of power Boilers
ASME Section IX	Welding & Brazing Qualifications
ASME section VIII	Unfired Pressure Vessels Code
ASME Section IX	Welding Qualification

ASME Performance Test Code

ASME PTC 4.1	Steam Generating Units
ASME PTC 4.3	Air Heaters
ASME PTC 3.0	Guide for evaluation of Measurement Uncertainty in Performance test of Steam Turbine

ASME PTC 19.11	Water and Steam in the Power Cycle (Purity and Quality, Leak detection and Measurement)
ASME PTC 25.3	Safety and Relief Valves

American National Standards Institute

ASME B13.5	Pipe flanges and flanged fittings
ASME B 13.9	Butt welding fittings
ASME B 13.1	Socket Welding and Threaded Fittings
ASME B 31.1	Code for Power piping

IEEE Standards

IEEE:141	Recommended Practice for Electric Power Distribution for Industrial Plants
IEEE:142	Recommended Practice for Grounding Of Industrial and Commercial Power Systems
IEEE:241	Recommended Practice for Electric Power Systems in Commercial Buildings
IEEE:242	Recommended Practice for Protection And Coordination of Industrial and Commercial Power Systems
IEEE:446	Recommended Practice for Emergency and Standby Power for Industrial and Commercial Applications.

IEEE:493	Recommended Practice for the Design of Reliable Industrial and Commercial Power systems.

IEC Standards

IEC:34	Rotating Electric machines
IEC:44	Instrument Transformers
IEC:56	HVAC circuit breakers
IEC:71	Coordination of Insulation
IEC:85	Thermal evaluation and classification of Electrical insulations
IEC:99	Lightning Arrestors
IEC:129	Alternating current disconnectors (isolators) and earthing switches
IEC:144	Degrees of protection of enclosures for low Voltage switchgear & controlgear
IEC:137	Bushings for Alternating Voltages above 1000 V
IEC:183	Guide for selection of HV Cables
IEC:185	Current Transformers
IEC:186	Potential Transformers
IEC:214	On load tap changers

IEC:227	PVC insulated electric cables
IEC:255	Electrical relays
IEC:269	LV Fuses
IEC:270	Partial discharge requirements
IEC:296	Insulating oils
IEC:298	AC metal enclosed switchgear and controlgear for rated voltages above 1 kV and upto and including 52 Kv
IEC:376	Specification and acceptance of new sulphur hexafluoride
IEC:439	LV switch gears and controlgear assembly
IEC:502	Extruded solid dielectric insulated power for rated voltages from 1 kV upto 30 kV
IEC:529	Classification of degree of Protection
IEC:542	Application guide for on load tap changers
IEC:694	Degrees of protection provided by enclosure (IP code)
IEC:885	Electric test methods for electric cables
IEC:909	Short-circuit current calculation in three phase AC systems
IEC:947	LV switch gears and control gear
IEC:1036	Static meters

Industry Standards

American Gear Manufacturers Association (AGMA)

American Petroleum Institute (API)

American Society for Heating, Refrigeration and Air-conditioning Engineers (ASHRAE) Handbook

American Society for Testing and Materials (ASTM)

American Water Works Association (AWWA)

American Welding Society (AWS) Structural Welding Code (AWS D1.1)

Conveyor Equipment Manufacturers Association (CEMA)

Cooling Tower Institute (CTI)

Heat Exchange Institute (HEI)

Hydraulic Institute (HI)

Institute of Electrical and Electronics Engineers (IEEE)

Instrument Society of America (ISA)

Manufacturers Standardization Society (MSS) of the Valve and Fitting Industry

National Electrical Manufacturers Association (NEMA)

National Fire Protection Association (NFPA)

Pipe Fabrication Institute (PFI)

Tubular Exchanger Manufacturers Association (TEMA)

Turbine:

IEC Recommendation Publication No: 45

CSN 080030

DIN 1943

British Standards

BS 4592	Industrial type metal floors, walkways and Stair treads
BS 5395	Stairs, ladders and walkways
BS:2573	Permissible Stresses in Cranes
BS:466	EOT Cranes for general use in factories, workshops and Ware houses.
BS:5316	Performance Testing of Pumps Part-I Class C

3.0 PROCESS DESCRIPTION OF PLANT MECHANICAL EQUIPMENT FOR THE DISTILLERY PROCESS PLANT

3.1 Process & Technology

The various sections involved in the process of Manufacture of Alcohol in a multi product zero effluent discharge distillery are:

- Grain receiving, storage and handling section
- Liquefaction and saccharification section
- Feed stock weighing, distribution and Fermentation Section.
- Distillation section for the production of RS and Absolute Alcohol.
- Molecular Sieve Dehydration section (MSDH)
- Decantation and Evaporation
- DDGS drying section
- AA, TA & FO Daily Receiver & Bulk Storage Section
- Utilities comprising of Boiler, TG, DM water plant, Cooling towers, compressed air system and Electrical Section
- Laboratory, stores.
- Fire fighting and alarm systems for the plant
- Civil and structural work for the complete plant

3.2 Manufacturing Process

3.2.1 Grain Mode:

The production of alcohol from grain is based on the property of some specific enzymes in metabolizing the starch content to glucose and then glucose to alcohol. These activities are generally termed as Fermentation. This practice of fermentation of glucose into alcohol is widely prevalent all over the world in cane sugar, beet sugar and grain based distilleries. Being a biological and renewable source Grain continues to occupy a predominant position as a feed stock of alcohol production in the world, though other sources like corn, dilute cane juice etc. are also widely used for this purpose. The grain based distillery is gaining momentum because of superior quality of alcohol and also to avoid pollution to the environment.

3.3 Different plant sections of the distillery

3.3.1 Exclusive sections for Grain Mode:

- Grain storage -: Grain storage can be planned with Sixty (60) days storage in silos. There will be four (4) numbers of 7500 MT capacity of each silos will be installed in the distillery premises.

- Grain handling and milling -: Grain is lifted by bucket elevator and feeds to the pre-cleaner. The pre-cleaner removes light impurities before stored into the silo. From the pre-cleaner another bucket elevator lifts the grain and unloaded into grain silo. Another bucket elevator lifts the grain and feeds to vibratory pre-cleaner. The pre-cleaner removes light impurities like straws, stem and fine dust. Grain from precleaner is fed by gravity to magnetic separator where the iron particles are removed. It is fed by gravity to de-stoner where the heavier particles like stones are removed. From de-stoner grain is fed by gravity to hammer mill where grain is converted to flour.

- Liquefaction and saccharification -: The flour from the mill during grain processing is mixed homogenously in the mixing tank where process water, with process condensate from evaporator and thin stillage is used for dilution. Some quantity of liquefying enzyme (Alpha-amylase) is added here. The slurry is cooked in the jet cooker. The slurry is pumped to a jet cooker where with steam the slurry is instantly cooked by raising the temperature of slurry to 105 Deg.C. The slurry is cooked for a specific period by allowing specific retention time in coil. The cooked slurry is pumped to liquefaction tank where liquefying enzyme (Alphaamylase) is added and the starch is converted to dextrin's (Glucose polymer). The converted dextrin's is taken to saccharification tank where saccharifying enzyme (Glucoamylase) is added and the dextrin (glucose polymer) is converted to dextrose (glucose media). Then the Glucose media is cooled and pumped to fermentation section where the glucose is fermented in the fermenter.

- Wet cake from decanter and concentrated Stillage from evaporator is mixed in a tank and taken to the dryer where the maximum amount of moisture is removed and collected as a Distillers Dried Grain Solids (DDGS). It contains 88-90% w/w solids. The DDGS produced from the distillery will be used as a raw material for fish feed plant.

3.3.2 Sections for Grain Based Distillery plant:

- Fermentation Section –: Consisting of fermenter system which can operate on batch or continuous mode. This section shall also include grain weighing, yeast propagation and activation, tank for fermented wash holding etc.

- Raw stillage generated in the distillation section/ fermentation section, is taken to the decanter which is used to separate the solids from liquid-solids mixture. Wet cake of 30 % w/w is produced in the decanter,

- Multi Pressure Wash to RS Distillation Section: Consisting of Seven column distillation unit with columns operating on different pressures. Flexibility to draw Rectified Spirit, Extra Neutral Alcohol as per the requirement. This will be an automated plant with DCS based instrumentation.

- Molecular Sieve Dehydration Section: Two bed molecular sieve dehydration units for the production of Fuel ethanol plant, based on pressure swing adsorption principle.

- Thin stillage Evaporation Section: Consisting of an independent falling film and forced circulation or only forced circulation evaporation system. This will achieve 30 -35 %w/w solids for Thin stillage.

- Condensate Treatment Section – Based on UASB, aeration, clarification and cross flow membrane technology to recover re usable water which can be used in process.

- Rice Husk / coal fired Boiler along with turbogenerator with Rice Husk &c coal as fuel

- Utilities for the above sections including cooling towers, cooling water recirculation pumps, water treatment plant and instrument air compressor etc.

- Product Storage Section – Consisting of AA daily receivers, bulk storage, AA transfer pumps, delivery meters etc.

3.4 Raw material for alcohol production

3.4.1 Grains

Broken Rice is the raw material for production of alcohol, in the proposed distillery. Required amount of liquefying and saccharifying enzymes are added to the process, to break the starch in these feed stock materials into monosaccharides. Rice

to be used as feed stock for this project contains as an average value of about 68 % w/w starch content.

During the fermentation, yeast strains of the species Saccharomyces cerevisieae or Pombe are used as alcohol producing micro organism. This living micro-organism belonging to class fungi converts the monosaccharide sugars such as glucose into alcohol and carbon-di-oxide.

3.4.2 Yeast

Each yeast cell by itself is an independently existing living entity. Of the different types of yeast, Saccharomyces cerevisiae is the industrially important yeast for alcohol fermentation. Saccharomyces cerevisiae consists of different strains and varieties.

Criteria for Selection of yeast for Fermentation:

- Fast fermenting
- High alcohol tolerance
- High sugar tolerance
- High salt tolerance
- High temperature tolerance
- Produce less amount of by-products
- Resistance to contamination

Yeast can grow aerobically as well as anaerobically. Aerobic conditions favours yeast cell production, which is not of interest to ethanol producers. However, growth during anaerobic condition is very marginal and major reaction is conversion of sugar to ethanol for energy production. For growth and multiplication, yeast requires utilizable organic carbon (sugars), nitrogen source, and various organic and inorganic trace growth factors. Proper nutrition, like for any other living organism, is the key to making yeast thrive and to obtain optimum performance. The two most important nutrients for growth are nitrogen and oxygen. In addition to this, optimum environmental parameter i.e. temperature is also required. The ethanol production process from glucose is an exothermic reaction and this heat is to be removed to maintain the optimum temperature for high yeast

activity. At lower temperatures the yeast becomes dormant and at higher temperatures the yeast loses its ability to produce alcohol and dies.

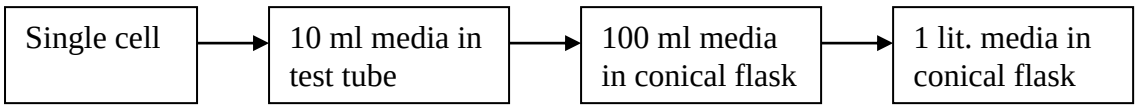
Propagation of yeast culture

Culture yeast is grown in the laboratory during the plant start up. Yeast propagation section has hygienically engineered yeast culture vessel equipped with heating, cooling and air sparging facilities. The Purpose of propagation is:

- For Cultivation of yeast culture in pure form
- To obtain yeast culture in required amount
- Required to reduce the time for fermentation
- To have Maximum viability & vitality of yeast
- To improve ethanol tolerance of yeast.

Yeast propagation method:

Initially yeast is developed in the laboratory from the single cell yeast culture. Laboratory propagated cell mass is scaled up in a series of culture vessels. Sterile air from air blower is sparged in pasteurised and cooled media in the Culture Vessels for optimum growth of culture yeast. Temperature is maintained at 30^0C-32^0C by cooling water. Yeast development in laboratory is as follows. –



Flask contains the sterilized syrup media solution. It is necessary to adjust the pH of the syrup solution in the range of 4.5 to 5.0, add nutrients such as ammonium sulphate or urea, DI-ammonium phosphate etc. Each stage of development of yeast from 10 ml to 500 ml and 500 ml to 5000 ml requires 8-12 hours in the laboratory. On the plant side, there are again 3 stages of propagation viz., 100 litres, 500 litres and 5000 litres, boiling syrup solution in order to sterilize it and cool to bring it to the 32^0C. Heating and cooling of the syrup and introducing culture etc. is done in aseptic manner. Further stages of yeast propagation are done in tanks. i.e. in the pre-fermenter which requires about 8

hours in order to build up necessary concentration of yeast in them.

3.5 Distillery Fermentation Area

3.5.1 Liquefied Grain slurry distribution(Grain mode)

Liquefaction and Saccharification is done to achieve hydrolysis of starch into dextrose (fermentable sugars). This is done through enzyme of a – amylase followed by gluco-amylase. To gain access for a – amylase the starch has to be broken down in process called gelatinisation. When the starch slurry is cooked, the water is absorbed by starch and gel is formed from crystal in structure of starch. There are two types of starch, one is amylase and other one is amylopectin. These types are varying from one grain to another grain. a – amylase is added to convert starch into dextrin during cooking at 105 Deg.C. During liquefaction pH is maintained at 4.5 – 5.0 after adding sulphuric acid. After that gluco-amylase is added to convert into dextrose (glucose). The slurry is cooled and taken to fermenter where yeast addition is done.

3.5.2 Plant Fermentation Section

3.5.2.1 Grain mode:

For the preparation for fermentation, glucose media is diluted with water to give a required sugar and starch concentration. This glucose media is usually not sterilized, although in certain cases it has been pasteurised with a resultant slight increase in efficiency. The mash is adjusted to pH of 4 to 5 with Sulphuric acid, if required. Although the optimum pH for maximum efficiency varies with different raw material used, an initial pH of 4.8 to 5.0 is usually considered the best.

3.5.2.2 Fermentation process

The fermentation process converts the glucose in feed stock into alcohol using yeast. During fermentation, glucose molecules are broken down into alcohol and carbon-di-oxide. Significant heat release takes place during fermentation. However, the

fermentation temperature is maintained at around 33^0C by forced recirculation flow of mash through mash coolers using fermented mash recirculation pumps.

3.5.2.3 Fermentation time:

Fermentation begins promptly after the fermenter is filled and usually active after 2 to 4 hours. Fermentation time vary with the Grain used, but blackstrap fermentation is usually complete in 36 hours. After fermentation is complete the fermented mash known as "beer" and containing 9% to 12% alcohol is pumped to a temporary storage tank or also known as wash holding tank prior to distillation.

3.5.2.4 Contamination:

The mash in fermentation is usually not sterilized, the chief defence against contaminants being the adjustment of the acidity to pH 5.0 or slightly below. Many contaminants will not grow readily at such pH levels. The fermentation is usually so vigorous that anaerobic conditions are quickly established and the alcohol produced tends to inhibit those lactic and butyric organisms that do develop. Feed stock itself usually contains a relatively small flora consisting of spores of moulds, bacteria, and yeasts.

3.5.2.5 Thin Stillage recycling

The Thin Stillage recycle to the fermentation is a function of grain quality and the operating parameters maintained in the fermentation. This recycle helps reduce the water consumption for the distillery process.

Thin Stillage received from decantation system is fed to fermenters so as to reduce the usage of fresh water for glucose media dilution in the fermentation process.

3.5.2.6 Alcohol Production from starch (Grain Mode)

Starch is converted into dextrin's (Glucose polymer) by addition of liquefying enzyme in the liquefaction section and dextrin's

(Glucose polymer) is converted into dextrose (Glucose) by addition of saccharifying enzyme in the saccharification section.

Yeast consumes fermentable sugar (glucose) present in grains and converts it into alcohol. Alcohol so produced in yeast cell diffuses out of its body cell wall and get accumulated in fermenter. Alcohol yield varies with yeast strain and type of grains. The biochemical reaction occurring in yeast cell and total amount of alcohol synthesized in process per metric ton of starch is as follows:

Biochemical reaction:

I) $(C_6H_{10}O_{5)n} + n(H_2O) \xrightarrow{Enzymes} (C_6H_{12}O_{6)n}$

Starch *Glucose*

162 + 18 180

II) $C_6H_{12}O_6 \xrightarrow{Yeast} 2C_2H_5OH + 2CO_2$

180 $2 \times 46 + 2 \times 44$

GLUCOSE **Ethyl alcohol + Carbon di-oxide**

Thus theoretically, 0.9 MT of starch will give only 1.00 MT of glucose under ideal conditions. Depending on the quantity of starch in grains the alcohol production per MT of grains will be varied. The rice contains around 68% starch and the Absolute alcohol production will be 450 Litres per MT of rice. The amount of heat liberated during the fermentation agrees with the theoretical value.

$C_6H_{12}O_6 \longrightarrow 2C_2H_5OH + 2CO_2 +$ 26 Kilo Calories

The heat produced from a fermentation involving 100kg of glucose (monosaccharide) is 14,000 kilo cals.

3.6 Distillation Section

When we consider distillation system employed in distillery on the basis of steam consumption and quality of spirit, multi pressure vacuum distillation will be the preferred choice. In multi pressure

vacuum distillation best quality of Absolute Alcohol at affordable steam consumption is possible to be produced. In case of atmospheric distillation unit, steam and energy consumption will be at higher side & at the same time quality Absolute Alcohol produced is on the inferior side as compared to that produced by vacuum distillation.

One of the important reasons for selection of vacuum distillation is not only Quality but also great improvement in plant cleaning period. In vacuum distillation as boiling of fermented wash is carried out at low temperatures, calcium induced hard scale deposition is low and the cleaning requirements get reduced greatly.

3.6.1 Distillation Technologies

Distillation is a process of separation of a multi product liquid into its components, by using the difference in the boiling points of the various constituents. This is achieved by boiling the liquid and condensing the various constituents at appropriate locations depending on the boiling temperatures and hence is an energy intensive process.

3.6.2 Multi pressure vacuum distillation:

After fermentation the next stage in the manufacture of alcohol is to separate alcohol from fermented wash and to concentrate it to 95% alcohol called as rectified spirit. For this purpose, distillation process is employed.

Distillation consumes a considerable amount of energy and is also a deciding factor in the quality of ethanol produced. Hence, in line with the demand of the industry, efforts have always been made to minimize requirement of energy and to improve the basic quality of alcohol produced. Ease of operation, reliability, lower down time and flexibility of operations are other parameters considered during the design.

3.6.3 Benefits of Multi Pressure Vacuum Distillation

Following are the advantages of pressure vacuum distillation.

- Since the columns operate under different pressures, the vapours from one column could provide the energy required for driving the other column. As the system operates to some extent like a multiple effect evaporator system, good steam economy is achieved.

- Since the analyzer column operates under vacuum, the formation of by-products such as acetal may be minimized there by improvement in quality of alcohol.

- Pre-rectification column ensure removal of sulfur compounds/mercaptans and also reduces load of lower boiling volatile compounds passing on to Rectifier cum exhaust column.

- The chances of scaling due to invert solubility of certain precipitating inorganic salts are minimized in vacuum distillation.

- Vacuum distillation requires low steam consumption with reboiler

3.7 Manufacture of absolute/anhydrous alcohol

Anhydrous alcohol is an important product required by industry. Alcohol as manufactured by distilleries is rectified spirit, which is 94.68 % alcohol, and rest is water. It is not possible to remove remaining water from rectified spirit by straight distillation as ethyl alcohol forms a constant boiling mixture with water at this concentration and is known as azeotrope. Therefore, special process for removal of water is required for manufacture of anhydrous alcohol.

The various processes used for dehydration of alcohol are as follows.

- Azeotropic Distillation
- Molecular Sieves

As azeotropic distillation calls for an entrainer like cyclohexane or Benzene and needs some make up and also the steam requirement for this process is comparatively high, this process is not as widely used as the molecular sieve dehydration. It is proposed to go with molecular sieve dehydration for the proposed distillery project.

3.7.1 Dehydration with Molecular Sieve Process

Molecular sieve dehydration technology is commonly used in Indian distilleries for dehydration of rectified spirit to produce fuel ethanol because of easy operation and low steam requirement.

Rectified spirit containing 94.68% to 95% v/v alcohol is pumped from RS collection tank to dehydration section. Rectified spirit is preheated in feed pre heater with the help of product vapours and fed to top tray of evaporator column. The objective of evaporator column is to evaporate the rectified spirit. Evaporator column operates under pressure. Energy is supplied to evaporator column by evaporator column re boiler with steam condensing on the shell side. Overhead alcohol feed vapours from evaporator column are pass through super heaters where the alcohol vapour is superheated. Energy for super heating is supplied by steam condensation on the shell side of the super heater.

Superheated hydrous alcohol vapours are sent to twin Adsorbent Beds. The twin Adsorbent Beds operate in cyclic manner. Twin beds are provided to allow for bed regeneration in continuous operation. While one bed is in dehydration mode, the other is in regeneration mode. Depending on feed and product specification, dehydration regeneration exchange takes place approximately every few minutes. The feed alcohol vapours are passed through

the bed under dehydration mode. The Adsorbent Bed will absorb moisture present in feed vapours and dehydrated product alcohol vapours are obtained from bottom of the bed. The dehydration is done by adsorption by the desiccants which has pore sizes of 3 Angstrom units. The water molecules having a size of 2.5 Angstrom units are adsorbed in the pores and the alcohol molecules with the size of 4 Angstrom units go through the desiccant bed in a dehydrated condition.

The product alcohol vapours are then passed through Regeneration pre heater for heat recovery. The Product alcohol vapours are then passed through Product Condenser where product vapours are condensed with the help of cooling water. Condensed product alcohol is collected in product receiver. The Product alcohol from Product Receiver is pumped to Product Cooler where it is cooled with the help of cooling water and then sent for anhydrous alcohol storage. The life of molecular sieve may be around five to seven years. However, the operating cost is considerably less than azeotropic distillation.

3.8 Various by products of alcoholic fermentation

3.8.1 Fusel Oil:

The high boiling fraction (100 to 150°C) obtained in the distillation of fermented wash is known as fusel oil. It is generally 0.2-0.4 percent of spirit production. Fusel oil from Grain is a mixture of isopropyl and n-propyl, isobutyl and n-butyl, isoamyl and d-amyl alcohols. Over 50% of the total fusel oil consists of isoamyl and d-amyl alcohols. The ammonium salts depress the yield of fusel oil, since yeast preferentially uses the ammonium ion directly rather than delaminating amino acids. The use of acid to adjust the pH of the mash likewise decreases the fusel oil yield.

3.8.2 Carbon Dioxide:

Carbon dioxide will be available in large quantities as a by-product of the fermentation industry. From every 100 kg of monosaccharide fermented, approximately 51.1 kg of alcohol and 48.9 kg of Carbon-di-oxide are produced. Thus, from a fermentation process large amount of Carbon-di-oxide is formed.

About 75% of the produced carbon di oxide can be recovered. Depending on the market conditions and seasonal demand for carbon dioxide the carbon di oxide could be sold in the solid form (dry ice) or in cylinders for carbonating beverages. Carbon-di-oxide is collected from closed fermenters after a vigorous fermentation has set in and the dissolved gases and air have been purged from the fermenter. The CO2 is taken to a scrubber where it is washed with water to recover the entrained alcohol. The scrubbed CO2 can be taken to either a CO2 plant or vented to atmosphere. The scrubbed water is transferred to mash holding tank. The gas at this stage while relatively pure (99.5%) contains traces of entrained solids, aldehydes, alcohol and minute amounts of other impurities These are responsible for an odour which must be removed before the gas can be utilized to carbonate beverages or be processed into solid Carbon-di-oxide. Of the total Carbon-di-oxide produced in the fermented only about 70% can be recovered as liquid or solid Carbon-di-oxide. For a 218 KLPD plant this recoverable Carbon-di-oxide works out to about 115.8 MT per day.

3.8.3 Distillers Dried Grain Soluble:

The raw stillage from the mash column is taken to the decantation, where suspended solids are concentrated and removed as a wet cake and overhead is collected as thin Stillages. The thin Stillage is recycled to the process and remaining is taken to the evaporation where it is concentrated to 30% w/w solids. The wet cake and concentrated cake is mixed in the mixing tank and taken to the dryer and concentrated to 90% w/w solids. The product is called Distillers Dried Grain Soluble (DDGS). The DDGS produced from Rice is 88.89 MT / Day.

4.0 UTILITY REQUIREMENTS AND LIST OF EQUIPMENT FOR THE DISTILLERY PLANT

4.1 Raw material and utilities requirement for the 200 KLPD distillery

4.1.1 Grains

Rice (68% starch) requirement for proposed 200 KLPD Ethanol plant will be 444.44 MT / day.

4.1.2 Raw Water

The average raw water requirement is 1700 cu.m per day with Broken rice as feed stock without recycling. However, since CPU treated water of about 900 Cu.M / day will be recycled, the fresh water requirement from Bore wells shall be 800 Cu.m per day. The water is required for the distillery process in the fermentation section, cooling tower make up for the fermentation cooling tower.

To optimize the water usage, the 218 KLPD distillery section will have a process condensate and spent lees treatment and polishing unit, the recovered water of which will be used for process make up or cooling tower make up.

4.1.3 Steam Requirement

The steam requirement for the distillery plant is given below:

S.No	Description	Unit	Grain mode
1	Distillation and Evaporation	TPH	24.15
2	Liquefaction and DDGS Dryer	TPH	10.37
3	Total Steam	TPH	34.52

In addition to the above, the Boiler is provided with deaerator which requires steam for deaeration purposes.

Considering all the above, the Boiler is sized for this project to have a MCR output of 45 TPH at 68 ata & 485^{0}C. The steam produced in the boiler will be fed to the Back Pressure turbo alternator for power generation. The Exhaust steam of turbine shall be slightly superheated and shall have a pressure of about 5.5 ata, which will be used for meeting the distillery plant steam requirements.

4.1.4 Power Requirement

The total power requirement (at 415V, 3 PH, 50 Hz level) for the distillery plant including the cogeneration plant during Grain operation will be 4085 KW.

4.1.5 Chemical Requirement

The distillery fermentation section requires Sulphuric acid, anti foaming agent, nutrients and yeast for the process. In addition, the condensate and spent lees polishing unit requires chemicals for neutralization, membrane cleaning etc. The tentative requirements of major chemicals when the distillery is operating at its rated capacity during grain operation is as indicated the financial calculations of Section 15 of this report.

4.2 Output from the Distillery

The proposed distillery will be designed to give a total output of 218 KLPD of total spirit. As finished product the plant will produce 200 KLPD Anhydrous Alcohol (fuel ethanol). In addition, the Technical alcohol and Fusel Oil production will be 6540 LPD and 200 LPD respectively. The recoverable Carbon-di-oxide

production will be 115.8 TPD from the fermentation section of the distillery. The DDGS production will be 88.89 TPD.

4.3 Effluent production from the distillery

4.3.1 Grain Mode:

The proposed 218 KLPD distillery is designed as a "Zero discharge" unit. The Raw stillage from the mash column is taken to the decantation, where suspended solids are concentrated and removed as a wet cake and overhead is collected as thin Stillages. Around 30- 50 % of the thin Stillage is recycled to the process and remaining is taken to the evaporation where it is concentrated to 30% w/w solids. The wet cake and concentrated cake is mixed in the mixing tank and taken to the dryer and concentrated to 90% w/w solids. The product is called Distillers Dried Grain Soluble (DDGS).

4.4 List of equipment

The following gives the typical list of plant and machinery in each section of the distillery process. It is possible that depending on the supplier, there could be some marginal changes in the list of equipment.

4.4.1 Grain handling, milling and processing

- Bucket elevators
- Pre-cleaners
- Silo
- Magnetic separator
- De-stoner
- Hammer mills
- Hopper bins
- Screw conveyor

- Cyclone
- Bag filter

4.4.2 Liquefaction, Jet cooking and Saccharification

- Mixing tank
- Liquefaction tank
- Steam jet cooker
- Retention vessel
- Flash vessel
- Circulation/transfer pumps
- Coolers for Liquefaction and Saccharification tank
- Man holes, sight glasses, nozzles etc..
- Antifoam dosing tank
- Acid dosing tank
- Caustic dosing tank
- Caustic lye bulk storage tank
- Enzyme dosing tank
- CIP tank

4.4.3 Fermentation Section

- Grain slurry Diluter
- Culture Vessels
- Air Sparger for Culture Vessel
- Cell Mass transfer Pump
- Fermenters
- CO2 Scrubber
- Mash Cooler for Fermentor
- Fermented Mash Recirculation / Transfer Pump with Motor
- Mash Transfer Pump with Motor
- Safety System for Fermentors
- Cooler for Prefermentor
- Recirculation cum Transfer Pump

- Air Sparger for Prefermentor
- Agitator for Nutrient Dosing Tank with motor
- Air Blower with Motor
- Air Filter
- Liquid separator for Air Blower
- Antifoam Dosing Pump with Motor
- Acid Dosing Pump with Motor
- Nutrient Dosing Pump with Motor
- Nutrient Dosing Tank
- Thin Stillage Recycle Cooler
- Thin Stillage Recycle Pump with Motor
- Piping, Valves, Fittings, supports etc
- Field Instruments for Fermentation Section
- Electrical Equipment MCC / Cables etc., lighting, earthing, for fermentation section

4.4.4 Distillation Section

- Mash / Analyzer Column
- Degasifying (DG) Column
- Rectifier cum Exhaust Column
- Alcohol scrubber
- Fermented Mash Pre-heater
- Mash Column Re-boiler
- Rectifier Column Re-boiler
- DG Condensers
- Impure Spirit Cooler
- Mash Column Vent Condenser
- Pre-Rectifier PCV Condenser
- Rectifier PCT Condenser
- Product Cooler
- Rectifier LFO / HFO Cooler
- Pre-Rectifier LFO / HFO Cooler
- Recovery LFO / HFO Cooler
- TA Mixing Bottle

- Rectifier Feed Pre-heater
- Pre-Rectifier Feed Pre-heater
- DM Water Feed Pre-heater
- Pre-Rectifier Feed Tank
- Pre-Rectifier Feed Pump with motor
- CIP Pump with motor
- Mash column Bottom transfer Pump with motor
- Pre-Rectifier Reflux Tank
- Pre-Rectifier reflux Pump with motor
- Rectifier Reflux Tank
- Rectifier Reflux Pump with motor
- Pre-Rectifier Spent Lees transfer Pump with motor
- Steam Condensate Pump with motor
- Rectifier Spent lees Transfer pump with motor
- Fusel oil washing tank
- Fusel oil washing pump with motor
- Recovery Feed Tank
- Recovery Feed Pump with motor
- Vacuum Pump with motor
- Fusel Oil Decanter
- Flash tank for Mash Column Re-boiler System
- Vapour bottles
- Piping, Valves, Fitting & Supports
- Field instruments and Cabling
- Plant electrical, MCC, Cables, plant lighting, earthing, etc.

4.4.5 MSDH Section

- Feed Pump.
- Feed Filters.
- Evaporator Columns.
- Superheater
- Molecular Sieve beds.
- Regeneration condenser

- Regeneration Preheater.
- Feed Preheater.
- Regeneration Receiver.
- Regeneration Pump
- Vacuum Eductor.
- Regeneration Cooler.
- Product Condenser.
- Product Receiver.
- Product Pump with motor.
- Product Cooler.
- Product filter.

4.4.6 Standalone Evaporation

- Falling Film Type / forced circulation Evaporators & finishers
- Vapour Liquid Separators
- Process Condensate Pot
- Recirculation Pumps with motors
- Product Transfer Pump with motor
- Process Condensate Pump with motor
- Steam Condensate Pump with motor
- CIP Pump with motor
- Vacuum Pump with motor
- Piping, Valves, Fittings & Instrumentation
- MCC and other Electricals

4.4.7 Decantation System

- Centrifugal decanter common for fermented wash/ Raw stillage along with adequate number of feed and product tanks.
- Piping and valves
- Instrumentation & Control

4.4.8 DDGS Drying section

- Shell & Tube dryer assembly
- Screw conveyor
- Cyclone separator
- Air blower
- Vapour fan
- Piping and valves
- Instrumentation and control

4.4.9 Product storage tanks with pumps, valves and piping

4.4.10 Day tanks & issue tanks with pumps, valves and piping

4.4.11 Air compressors & compressed air system

4.4.12 Cooling towers for the various sections of the distillery

4.4.13 DCS system for the plant control

4.4.14 Laboratory Instruments & Glassware

The distillery should have a laboratory with testing instruments, glass wares etc. The co-generation plant and water treatment plant laboratory could also be integrated with the distillery laboratory. The suggested list of laboratory equipment is given below.

- Spectrophotometer
- Laboratory Turbidity meter
- Conductivity meter
- pH meter
- Digital titrator
- Carbon di oxide measuring kit
- Total bacteria count kit

- Sulphate reducing bacteria count kit
- Dry Thermostat Reactor for Total Phosphate, COD & TOC analysis.
- Lab wares & glass wares
- Analytical balance
- Magnetic stirrer with hot plate
- Bomb calorimeter
- Muffle furnace
- Labratory oven
- Sieve shaker & sets
- Dessicator
- Bunsen burner
- Orsat analysis
- Portable oxygen analyser
- Portable flue gas analyser
- Surface pyrometer (Non contact IR thermometer)
- Pitot tube with probe & Digital manometer
- Anemometer (Digital)
- Sound level monitor
- Portable vibration meter
- Tachometer (Non contact & Contact type)
- D-Meter - To measure the thickness of tubes / plates.
- BOD probe
- BOD incubator
- Reagents

4.5 Fire Fighting System for the distillery

The fire fighting system for the distillery shall comprise of the following.

- Fire hydrant system for the entire distillery plant
- Foam system for Ethanol storage tanks
- Automatic fire detection and alarm system for MCC rooms

- Portable fire extinguishers for the entire distillery plant

4.5.1 The ethanol storage tanks shall be protected with water spray system in the form of a ring along the top edge of the vertical face of the tank. The foam system shall be designed as per latest edition of NFPA 11 & water spray system shall be designed as per Regulations. The water required for foam system shall be taken from the nearest hydrant main. If the water requirement for foam system exceeds 410 cum/hr, then the fire hydrant pump capacity shall be revised accordingly.

4.5.2 The MCC room for the fermentation plant, distillation plant and effluent treatment plant shall be provided with automatic fire alarm and protection system. The automatic fire detection & alarm system for MCC rooms shall be designed as per existing regulations.

4.5.3 Two Nos. of pumps (one working & one standby) shall be envisaged for fire hydrant system. Main pump shall be electrical motor driven and standby pump shall be diesel engine driven. In addition to the above, jockey pump shall also be envisaged to maintain the pressure in the system. The pump and electric motor shall be mounted on a common base frame with 'tyre' type coupling, coupling guard, foundation bolts and nuts.

4.5.4 The under ground piping shall be applied with PYPKOTE tar based polymeric corrosion protection tape of 4 mm thk. for the protection of external surface of the pipes.

4.6 Product Storage

4.6.1 The distillery products will be stored in the tanks to be located in the product storage yard. As the storage and distribution will come under the control of the Government authorities, there

will be strict control on the quantity of alcohol produced, stored and distributed. The produced ethanol will be received in the daily receiver tanks and after certification will be transferred to the bulk storage tanks. There will be receiver, issue and bulk storage for the AA & TA,. Only Issue storage is proposed for the fusel oil. The issue will be from the bulk storage tanks through certified flow meters to the trucks.

4.7 DM Water Plant

The total DM water requirement for the distillery and for the boiler is approximately 400 cu.m per day. To cater to the DM water requirements of the distillery and the Slop fired cogen power plant, a water treatment plant (WTP) based on the Ion exchange process is proposed. Based on the quality parameters of the raw water, MGF, RO, Degasser, Strong Acid Cationic exchanger, Strong base anionic exchanger and Mixed bed exchanger is envisaged to produce Demineralised water quality. The capacity of the water treatment plant will be 20 Cu.m/hr.

The treated and de-mineralized water will be stored in a rubber lined or epoxy coated 1 no. of 200 Cu.m capacity storage tank.

4.8 Circulating water Chemical treatment

Cooling towers is envisaged at process plant and slop fired cogen plant for continuous cooling water requirements. Due to its continuous operation, after over a period of time scaling, corrosion and bio fouling starts to accumulate. To prevent this chemical treatment is performed for the circulating water. Selected chemicals are dosed in the circulating water at calculated dosage and concentration to prevent Scaling, corrosion and bio-fouling. Regular monitoring is done by envisaging corrosion rack, bio film monitor and scale deposit

monitor to ensure that the scaling, corrosion and bio fouling is under control.

4.9 Compressed Air System

The requirement of compressed air for instruments and the control systems of the proposed distillery complex will be supplied by three (3) instrument air compressors with two (2) working and the other one (1) standby. Each of the compressor shall be rated for 700 N.Cu.m/ hr at 7 kg/sq.cm (g). All the compressed and service air requirements of the distillery process plant, the effluent treatment and polishing plant and the power plant will be met by these compressors.

The air compressor shall be provided with accessories like Inter cooler, After cooler, Moisture separators, Air driers, Air receivers and control panel.

The service air requirement of the plant, being very low will also be met by the instrument air compressors. However the service air will be directly tapped off from the air receiver bypassing the dryer units.

4.10 Air Conditioning System

The main plant control rooms housing the controls for the Distillery, concentration plant and the power plant shall be air conditioned with ductable package air-conditioners, which will be located in a plant A.C. room, adjacent to the control room. The condensers will be located above the plant A.C. room and the conditioned air will be distributed by means of ducting in the control room. Suitable humidity control devices shall be provided. A temperature of 22.2°C $\pm$ 1.1°C and a relative humidity of 55 $\pm$ 5% will be maintained in the control rooms.

4.11 Ventilation System

The ventilation requirement for various area in the TG building and Electrical panel room in TG building, Panel rooms in the Fermentation section of the can be broadly classified under two sections:

- Area which need positive pressure to avoid outside air infiltration, which is to be achieved by continuous fresh supply.

- Area which need exhaust ventilation and have adjacent sufficiently large wall to fix exhaust fans.

The areas which require to maintain the positive pressure are the Electrical panel room. The temperature inside shall not increase considerably (not more than 4-5°C under maximum load conditions) due to the equipment load inside; further area where infiltration is to be avoided shall be maintained at slight positive pressure to ensure the same. Frequency of door opening in these areas can be considered to be minimum.

The areas which require to maintain the exhaust ventilation system are the TG hall at various levels and toilets. Exhaust fan of sufficient size and numbers shall be installed in these areas which need exhaust by propeller fans. These areas shall have sufficient air intake opening in the opposite wall where fans are to be fixed. These opening will enable drawing air from the TG bay.

4.12 Green belt development

Green belt development for the project shall be considered with ecological perspectives taking into consideration the nature of pollutants, availability of space and dominant wind directions.

The inter-spaces within the plant are to be laid with shrubs/grass bed. The green belt or tree plantation around the proposed project will help to arrest the particulate, matter in the area and hence attenuate the pollution to a great extent. The following characteristics would be taken into consideration while selecting plant species for green belt development and tree plantation.

- They should be perennial and evergreen.
- Fast growing and tall trees
- They should have thick canopy cover.
- They should have large leaf area index. They should not have any noticeable effect on the plant yield due to gaseous pollutants.
- The planting should be in appropriate alternate rows around the proposed site to prevent lateral pollution dispersion.
- The trees should maintain regional ecological balance and conform to soil and hydrological conditions. Indigenous species would be preferred.

5.0 GRAIN PROCESSING, RAW STILLAGE CONCENTRATION AND DISTILLERS DRIED GRAIN SOLUBLE SECTION

The proposed 218 KLPD grain based distillery facility at SLBEPL will be operating for about 335 days in a year with Broken rice as feed stock. The plant will be planning to produce Absolute Alcohol during grain operation.

5.1 Grain Handling and Milling

5.1.1 Grains

The grains (Broken rice) will be bought from the market and stored in the storage godown. The grain is taken to milling through two stages of pre-cleaning, magnetic separation and de-stoning. The grain will be charged manually from the storage on to the unloading platform. Bucket elevator lifts the grain and feeds it to the first pre-cleaner. This pre-cleaner removes light impurities like straw, stem and fine dust. The cleaned grain from the first pre-cleaner is lifted by another bucket elevator to the silo. The grain from silo is taken through a third bucket elevator to the second pre-cleaner where some fine impurities are removed. It is fed by gravity on to a magnetic separator to remove iron particles. Grain from the magnetic separator is fed by gravity to de-stoner to remove heavier non-magnetic particles like stones and then from the outlet of the de-stoner to the hammer mill. The material flow from the de-stoner to the hammer feed hoppers will be by gravity. The hammer mills receive the grain through screw feeders from the feed hoppers and the flour from the outlet of the mills is conveyed through screw conveyor and bucket elevator to the storage bin. There will be two storage bins, each with the capacity of around four hour's production of hammer mill. The storage bins will alternately get filled and evacuated. The flour

from the storage bin is fed to the liquefaction section through screw conveyor.

5.1.2 Sanitation in grain handling

Sanitation in grain handling is very important step in grain based distillery. It is important that different forms of contamination may be possible in the raw material brought for processing. The contamination should be detected in every possible way before it enters into the storage (silo). If it is found it should be removed or destroyed before consumption. Insects, rodents and birds, stone, cobs, weed seeds, residual insecticides, fumigants, water, bacteria, mould, Mycotoxin are the reasons for the contamination. Spillage of grains should be avoided to attract birds and insects.

The cleaning cycle schedule should be decided with the insect's life cycle in mind. Grain receiving station, conveyors, and dust collectors should be frequently inspected. Frequent inspection for cleaning and fumigation should be done on regular basis. Hence full attention should be paid in all phases of operation. Storage area for DDGS must be evaluated from a sanitation perspective. It should be from attack from insects, birds, dogs and rodents. Mould and Mycotoxin formation will have greater impact on the acceptance of DDGS and forms part of human food chain and formation should be eliminated.

5.1.3 Storage Area Requirement for Raw Material

There will be four (4) numbers of each 7500 MT of capacity grain silo to be installed in the complex to store the Broken rice. Approximately, these four (4) numbers of silos will meet the maximum grain requirements of the distillery for about 60 days of operation.

5.2 Raw Stillage Concentration and Distillers Dried Grain Soluble Section

Raw stillage from stripper column bottom is taken to decanter where wet cake and thin stillage are separated. The recovered thin stillage from decanter is concentrated in the evaporator up to 30% concentration. The evaporator uses the heat from low pressure steam and DDGS vapours for the desired final concentration. Concentrated stillage from evaporator and wet cake from decanter are mixed in the feed mixer and then taken in to the DDGS dryer by using conveyor. Steam is used as a heating medium in the dryer. Cyclone separator is connected in the dryer vapour exhaust line to collect the dust particle and the collected dust particles are manually fed into the dryer. The vapour from the cyclone separator is used as a heating medium for evaporator calendria. The partially concentrated product from tube bundle rotary dryer is passed through Vapour Fluidized Bed Dryer (VFBD) to achieve the required concentration of 90% solids & 10% moisture content. Hot air is supplied to the fluidized bed dryer by using air heater. The steam condensate from the dryer is used as heating medium in the air heater to supply hot air to fluidized bed dryer. The final DDGS product from fluidized bed dryer is taken through pneumatic conveying system to cyclone separator and then fed into DDGS silo. From the silo, the final product DDGS is collected manually in the bags and then sold out.

6.0 ENVIRONMENTAL IMPACT AND EFFLUENT DISPOSAL

6.1 General

6.1.1 An ethanol distillery plant is considered as a highly polluting industry and the environmentalists look at the distillery with a lot of suspicion. Environmental protection and the control of discharge of the solid, liquid and gaseous effluents are the key elements in the design of the distillery. The emissions from the industries are tightly regulated by Governments and applicable specific rules and requirements controlling the emissions are constantly changing.

6.1.2 At present, the most significant of these emissions, concerning the distillery are waste water effluents with high BOD and COD, oxides of sulphur (SO_x), fine airborne particulate, and sludge from Fermentation.

6.1.3 Environmental control is primarily driven by Government legislation and the resulting regulations at the local and National levels. These have evolved out of a public consensus that the real costs of environmental protection are worth the tangible and intangible benefits now and in the future.

6.1.4 Distillery conventionally has three major sections, which let out pollutants. One is the fermentation section, the second is the Distillery Section and the third is the power plant section which generates the steam and power required for the distillery operations. The emissions discharged from the distillery fall under the three categories of atmospheric air borne emissions, aqueous emissions and solid emissions.

6.1.5 Atmospheric air borne emissions arise primarily from the by-products of the combustion of the fuels in the boiler like SO_2, NO_x, particulate fly ash, volatile organic compounds (VOC) and some trace quantities of other materials and are exhausted from the stack. A second source of particulate is fugitive dust from fuel handling equipment. A third source of air emissions is the cooling tower and the associated thermal rise plume which contains heat and some trace materials along with the water vapour. Another pollutant, under today's context of reduction of green house gases is the carbon-di-oxide emissions from the fermentation section of the distillery.

6.1.6 Aqueous discharges from the distillery are the most worrisome of all the pollutants. Primary of these emissions is the discharges from the distillation column bottoms, called spent lees. The third source include other waste water and these include cooling tower blow down, sluice water from the bottom ash handling system, boiler chemical cleaning solutions, CIP waste solutions, as well as a variety of low volume wastes including ion exchange regeneration solutions from the Demineralized Water Plants, boiler blowdown, sewerage system discharges from buildings and plant floor drains.

6.1.7 The solid effluents generated in the distillery are the sludge from the fermentation section, yeast spent residue and the boiler ash.

6.2 SLBEPL's Distillery Effluents and Disposal

6.2.1 SLBEPL's 218 KLPD distillery is designed on the "Zero Effluent Discharge" concept. The design philosophy being that the effluents will be used within the distillery or treated and let

out as a non-polluting discharge. Even the streams with lesser pollutants are properly treated and let out.

6.2.2 Fermentation Section:

6.2.2.1 In grain mode the starch is converted into dextrose and then to Alcohol and carbon di oxide during fermentation by yeast. There will be no wash water generation from the fermentation section under the normal operation. Whenever any infection occurs, the fermenters are washed with caustic solution and the washed caustic solution is taken to the CIP tank for reuse. The Caron-di-oxide generated in the process will be let out to the atmosphere. At a later date, SLBEPL may add a CO_2 bottling plant to capture and sell the CO_2 in the market. However the CO_2 emission is only a fraction of the CO_2 sequestered by the sugar cane during its growth. Hence the emission of CO_2 from the distillery will not add any net green house gases to the atmosphere. In the proposed batch fermentation section there will be no yeast separation and the wash along with the yeast will be taken to the distillation section for processing. Similarly there will be no sludge separated in the proposed batch fermentation section.

6.2.3 Distillation Section:

6.2.3.1 The distillation section is where the alcohol is separated from the fermented wash. The fermentation in addition to ethanol, also produces, depending on the fermentation process and impurities, higher alcohols and other organic compounds. These organic compounds and higher alcohols are separated out in the distillation section along with traces of ethanol and sold off as Fusel oil. The major aqueous effluents from the distillation section is the Thick slop and spent lees from the grain mode of

operation. Thick slop is the fermented wash devoid of the alcohol.

6.2.3.2 In some cases, where the Thin stillage recycling is employed, some percentage of the Thin stillage generated in the process will be recirculated to the fermentation section. In the grain mode of operation 30 % of Thin stillage is recycled.

In Grain mode of operation, the Raw stillage from mash column bottom is sent to decantation, where suspended solids are concentrated and removed as a wet cake (30% w/w solids) and overhead is collected as a Thin stillage. Around 30% of the thin Stillage from the decanter is recycled to the process and remaining is taken to the evaporation section where it is concentrated to 30% w/w solids and it is called as concentrated cake. The concentrated cake from the evaporator and wet cake from the decanter is mixed in the mixing tank and taken to the dryer where substantial percentage of the moisture is removed. The final product from the dryer is called as Distillers Dried Grain Soluble (DDGS). It contains 90% w/w solids. It is packed in the polythene bags and used as an animal feed. The approximate quantity of DDGS produced from rice is 88.89 MT/Day.

6.2.3.3 The spent lees are the bottoms collected from the various distillation columns and this is essentially water with small traces of alcohol and other organic compounds. All these spent lees streams will be collected from the distillery for disposal.

6.2.3.4 Condensate Polishing Unit :

Two streams of liquid discharges from the distillery, with the Thin stillage evaporation system are the evaporator process

condensate and the spent lees from the distillation section. These two streams are proposed to be treated in a system with the combination of Anaerobic reactor (conventional UASB reactor / high rate reactor), extended aeration system, Clarification, media filtration, Ultra filtration and Reverse osmosis (RO) system. The plant is designed for removal of organic acids, COD, BOD, colloidal and reactive Silica and total dissolved solids. The condensate treated by such system can be reused in the alcohol manufacturing process as process water for fermentor dilution and as cooling water make-up thereby reducing the requirement of fresh water as well as solving the problem of waste disposal to a great extent.

The proposed treatment methodology is based on following principle operating systems:

Up flow Anaerobic Sludge Blanket (UASB) reactor is provided for the primary anaerobic treatment of Condensate & Spent lees effluent. The UASB reactor shall be constructed in MS with suitable epoxy coating inside the tank. The liquid to be treated enters into the bottom through influent distribution zone and uniformly distributed in the tank. In the reaction zone the anaerobic bacteria are maintained in the form of sludge blanket. When the upward rising waste water penetrates through the sludge blanket, the organic matter in the waste water comes in contact with the bacterial population and is degraded anaerobically to methane rich biogas, the end product of anaerobic digestion. The biogas so produced is bubbled through the effluent and is separated out in the third section i.e. Gas-Solid-Liquid separation zone. The suspended solids, rich in bio-mass, are retained to prevent escape of biomass from the reactor. In gas solid liquid separation a hood fabricated in Mild Steel and duly painted with corrosion resistant paint is

provided. The hood separates the solid from the overflowing reactor content. Gas collectors are provided for collection and conveyance of gas. Similarly, High rate reactors instead of conventional reactors with some internal arrangements to facilitate the above described activities may also be engaged. High rate reactors are preferred over conventional reactors due to their easy operation and better efficiency, all but with some additional capital cost. BOD, COD & volatile acids are reduced at the outlet of the anaerobic reactor. The treated effluent overflows through a launder/overflow line and will be taken to downstream treatment systems.

6.2.3.5 The anaerobic reactor outlet is taken to holding tank to retain the biomass carried over. The same is then fed to Extended aeration tank for aerobic reaction to further reduce the organic acids, BOD & COD. The outlet of extended aeration system is taken to secondary clarifier for settling and to tertiary clarifier for coagulation and flocculation. It is to be noted that the Inorganic effluents like process plant and slop fired cogen plant cooling tower blowdown, boiler blowdown and sidestream filter backwash is introduced in tertiary clarifier and treated along with biologically treated process condensate and spent lees. Turbidity is reduced to the desired level at the outlet of tertiary clarifier and is fed to multi grade filter and activated carbon filter and stored in filtered water storage tank. Part quantity of filtered water storage tank is taken through Ultraviolet system for fermentor dilution and the balance quantity is fed to ultrafiltration and reverse osmosis system to reduce dissolved solids, colloidal silica and reactive silica to the desired level. The permeate of the RO system, will be collected in RO permeate tank and is used as make up water for the process plant cooling towers. The sludge generated from clarifier will be collected in the sludge pit and taken to

decantation system for separation of solids and the separated solids will be disposed off suitably. The filtrate from the decantation system will be recycled to equalisation tank/clarifier. The drawing No. enclosed with section 16 of this report gives the process flow diagram for the above described effluent treatment plant.

6.2.4 Boiler Section:

The proposed boiler for the distillery will be firing 100% Rice Husk or 100% Coal.

6.2.4.1 The air borne pollutants that are discharged from the proposed boiler unit are,

- Dust particulate from fly ash in flue gas
- Sulfur-di-Oxide in the flue gas.

6.2.4.2 Electro static Precipitator (ESP) is proposed as the gas cleaning equipment for the boiler, to contain the dust emissions from plant to a level of 50 Mg/N.cum under all the fuel firing conditions. While firing 100% Rice husk as fuel in the Boiler, the ash quantity generated will be equal to 1.1 TPH and out of that 80% will be go out of the boiler as fly ash. Balance of 20% will be discharged as bed ash. The bed ash will fall on the water impounded belt conveyor and will be discharged into a trailer for disposal. Some amount of this fly ash will be captured in the hoppers of the horizontal pass of the boiler and the balance will be captured in the ESP Hoppers. A suitably designed dense phase ash handling system will be provided for the collection and transportation of the fly ash to the fly ash silo. The height of the stack for the design capacity of 50 TPH steam generation from boiler, which disburses the pollutants,

has been fixed at 68 meters, based on the sulphur-di-oxide emissions from the chimney.

6.2.5 Cooling Tower Blow Down water

The Distillery will be designed with a cooling tower for meeting specific requirements. The fermentation section will have individual cooling tower. The capacity of the cooling tower will be 1500 Cu.m/hr. The expected blow down from the cooling tower is estimated to be about 3 Cu.m/hr. In the cooling water, residual chlorine of about 0.2 ppm could be maintained mainly to prevent biological growth in the cooling tower system. This Chlorine content would not result in any chemical pollution of water. The blow down water will be let into the neutralizing pit of the DM plant and will be pumped after neutralization for gardening.

6.2.6 Steam generator blow down

The salient characteristics of blow down water from the point of view of pollution are, the pH and temperature of water since suspended solids are negligible. The pH would be in the range of 9.8 to 10.3 and the temperature of blow down water will be 100 Deg.C The quantity of blow down is only about 2% of the boiler capacity (0.9 TPH) and it is proposed to put the blow down into the DM plant neutralizing pit, after running it through the open drains, for disposal.

6.2.7 Sewage from various buildings in the plant

Sewage from various buildings in the power plant area will be conveyed through separate drains to the septic tank. The

effluent from the septic tank will be disposed in soil by providing disposing trenches.

There will be no ground pollution because of leaching due to this. Sludge will be removed occasionally and disposed-off as land fill at suitable places.

6.3 Thermal Pollution

A close circuit cooling water system with cooling towers has been proposed for various applications in the Distillery. This eliminates letting out of warm water into the canals and prevents thermal pollution. Blow down from the cooling tower will be trenched out to the DM plant's neutralizing pit and disposed off the sugar mill effluent treatment plant. The water evaporated form the cooling tower will be discharged through the fan stack as water vapour. As this vapour quantity is small and also it is let out at a higher temperature there will be no thermal pollution on account of this.

6.4 Noise Pollution

The rotating equipment in the Distillery and the Cogeneration plant will be designed to operate with a total noise level of not exceeding 85 to 90 db(A) as per the requirement of Occupational Safety and Health Administration (OSHA) Standards. The rotating equipment is provided with silencers wherever required to meet the noise pollution. The frequently blowing safety valves will also be provided with silencers to meet with the norms for the noise levels.

6.5 Monitoring of Effluents

The characteristics of the effluents from the proposed distillery plant will be maintained so as to meet the requirements of Pollution Control authorities and the minimum national standards for effluent from Distillery. Air quality monitoring will also be undertaken to ensure that the dust pollution level is within limits.

6.5.1 Monitoring Programme

The purpose of air quality monitoring is the acquisition of data for comparison against the prescribed minimum standards and thereby, assures that the air quality is maintained within the prescribed levels.

The following will be monitored from the stack emissions.

- Suspended Particulate Matter.
- Sulfur-Di-Oxide.

The Laboratory attached to the Power plant will be equipped with the necessary instruments for carrying out air quality monitoring. It is also proposed to monitor the particulate emission at the stack to keep a continuous check on the performance of the ESP. Adequate sampling openings will be provided in the stack.

Also the aqueous samples will be collected and tested periodically in the laboratory, to ensure that there is no pollutant discharged outside the plant.

6.6 Impact of the Pollution on the Environment

The SLBEPL's distillery is designed such that there will be no pollutant discharged from the distillery. As discussed above all the pollutants normally expected out of the distillery will be adequately treated and used internally within the distillery. Only the aqueous discharges from the DM plant, cooling tower blowdown and the boiler blowdown which are neutralized are discharged out for gardening and dust suppression. Any way these are not pollutants and they are let out only after neutralization. The only solid waste will be the ash which has enormous value as a fertilizer and hence cannot be treated as an effluent. On the whole the Distillery at SLBEPL will not affect the environment and ecology of the surroundings.

7.0 COGENERATION PLANT SYSTEM

7.1 Selection of steam generator for the power plant

7.1.1 Rice Husk / coal can be burned in number of ways depending on the characteristics of fuel and the application. Some of the technologies available are Stoker boiler and fluidized bed boiler. For this project, Atmospheric Fludized Bed Combustion (AFBC) type Boiler is selected.

7.1.2 Fluidized bed combustion is not a new technology, but has been revived in this country, because of the present increase in the fuel cost, availability of low quality fuel and stringent pollution norms. In 1970's, fluidized bed combustion technology was first applied in a large scale utility unit, to explore the new ways of burning high sulphur coal, in an environmentally acceptable and efficient manner. Fluidized bed combustion technology has been progressed from the first in to second and third generation of development.

In concept, fluidized bed will burn fuels in an air suspended mass (or bed) of particles. By controlling bed temperature and using reagents such as lime stone on bed material, emissions of NOx and SOx can be controlled. By staged combustion in the fluidized bed boiler, NOx can be controlled.

7.2 Selection of Turbo-generator for the Power plant

7.2.1 Steam turbines are broadly classified in to condensing steam turbines and non condensing steam turbines. The non-condensing steam turbines are also called as back pressure

turbines. The Back Pressure type Turbo Generator is selected for this project.

7.3 Selection of Pollution control equipment to control the Particulate emission.

7.3.1 The increased awareness on the harmful effects of particulate emission from power plants and other industries has resulted in demand on suitable measures to reduce the emissions from chimneys by adopting additional equipments / controls.

7.3.2 ESP's are widely used for removal of solid particles from Industrial gases with collection efficiencies exceeding 99% for wide range of particle size. They can handle large volume of gases with relatively low pressure drop and can operate continuously with little maintenance.

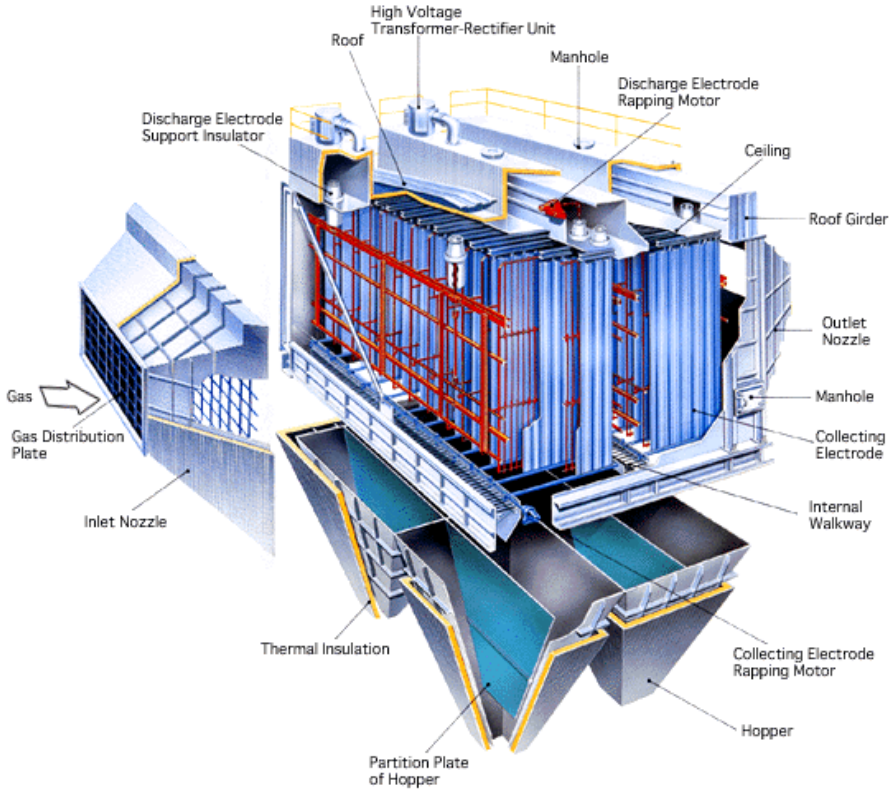


Fig: 6.4. Typical arrangement of ESP.

7.3.3 The above Figure – 6.4, gives the construction arrangement of the ESP. The main parts of ESP are the collection and the emitting electrode, Gas distribution screens at the inlet and outlet, High voltage electrical system, Rappers, outer shell, including hoppers.

7.3.4 The ESP works on precipitation principle where dust particles are charged by a flow of ions from the discharge electrode & drift under the influence of the electrical field, towards collecting electrode. The dust then dislodged through the effective Rapping mechanism. (Refer the figure – 6.5)

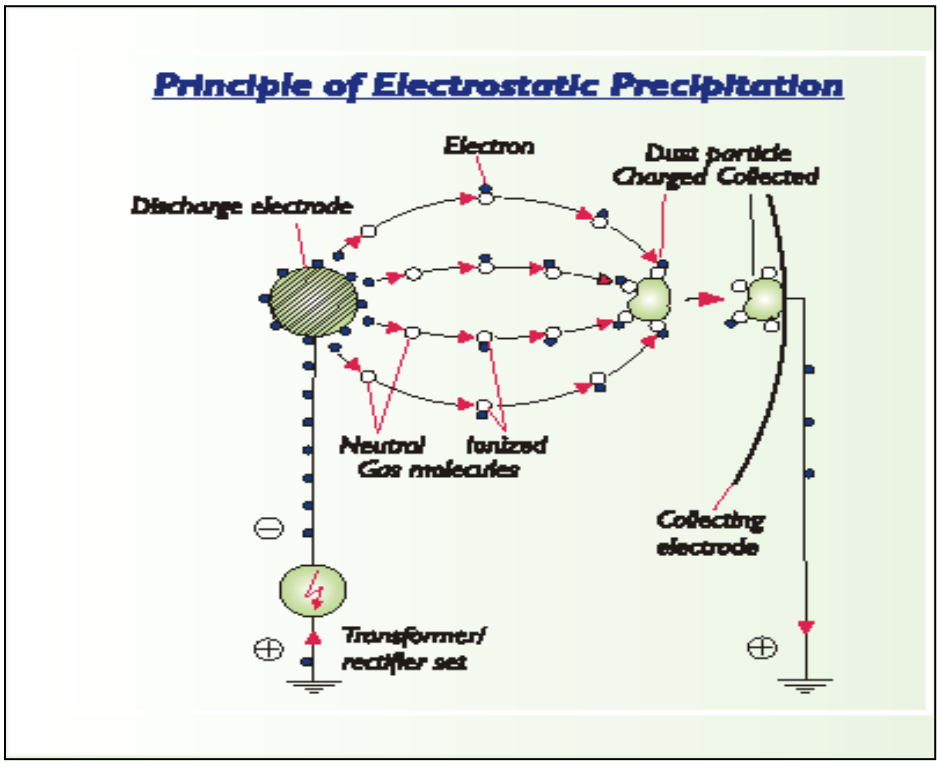


Fig: 6.5. Working principle of ESP.

7.4 Operation of the proposed 5.0 MW Cogeneration system

7.4.1 Fig. 1 enclosed with section 16 of this report gives the Scheme of the proposed cogeneration plant Broken Rice as feed stock. The 45 TPH Boiler will operate to generate 37.57 TPH of Steam at 67 Kg/Sq.cm(g) and 485 Deg.C.

Out of 37.57 TPH, 6.52 TPH of steam will pass through 67 / 4.5 Kg/Sq.cm(g) PRDS system where 1.88 TPH of spray water will be added to produce 8.4 TPH at the PRDS outlet. The balance 31.05 TPH will flow to the Turbine. Being a back pressure turbine, all the steam will pass through the exhaust of the Turbine at a pressure of 4.5 Kg/Sq.cm(g). From the turbine exhaust, around 5.73 TPH of steam will be supplied to

Deaerator where feed water will be heated upto 150 Deg.C. After addition of 0.8 TPH of spray water in the exhaust Desuperheater, a total 34.52 TPH of steam will be available at 4.5 Kg/Sq.cm(g) for the distillery process.

7.5 Steam Generator

7.5.1 The steam generator shall be designed to generate steam at rated capacity and at the rated steam parameters as mentioned in Section 4.0 of this report. The steam generator is capable of peak generation of 110% of the MCR generation for a period of half (1/2) an hour in 8 hour shift.

7.5.2 The steam generator shall be provided with one steam drum of fusion welded type, provided with Torispherical / Semi-Ellipsoidal / hemispherical dished ends fitted with man-ways at either ends. The drum shall be liberally sized to assure low steam space loading, with adequate space to accommodate the internals. The drum design pressure shall have a minimum margin of 6% over drum operating pressure.

The drum shall be provided with internals of proven design and shall be of bolted connection. The drum internals consist of the primary and secondary separators, to ensure that, the steam of highest purity with dissolved silica carry over limited to 0.02 ppm, Conductivity of max. 0.2 Micro Siemens / cm at all loads of the boiler. The internals design shall be optimized to give the required steam purity with the minimum pressure drop of less than 0.1 kg/sq.cm.

The necessary nozzle connection for the steam outlets, safety valves, feed water inlets, down comers, continuous blowdown, level indicators, chemical dosing, sampling connection, drains and vents shall be provided on the drum. All nozzle connections shall be of welded type and feed water inlet shall be provided with a suitably designed thermal sleeve.

7.5.3 The furnace envelope shall be constructed of water cooled membrane walls. The furnace shall be gas pressure tight and strengthened by providing buck stays and tie-bar system. The furnace EPRS should be so selected to give acceptable Furnace Outlet Temperatures (FOT) for the specified type of fuel. The FOT selected for the boiler design shall be well below the Initial Deformation Temperature of the ash. The furnace design shall incorporate necessary man holes, peep holes and openings for fuel distributors etc. The downcomers, supply pipes and risers sizing shall be based on circulation calculations.

7.5.4 Superheater system shall be of minimum two(2) stage design with inter-stage de-superheating to achieve the rated steam temperature over the indicated range of the boiler load. The superheater shall be of convection type or combination of convection and radiation type.

The tube spacing of the superheater shall be designed to minimize bridging and tube erosion and shall be suitable for proper on-load cleaning by means of soot blowers (if required). Suitable spacers shall be provided in both longitudinal and transverse to the gas flow direction. The superheater system shall be complete with seamless pipe headers, interconnecting piping, tube spacers, valves, fittings, supports, vents and drains,

etc. The sealing at the superheater tube penetrations with the boiler roof or with the wall shall be 100% leak tight. Complete superheater coils shall be constructed with seamless steel tubes, with material of construction as per the metal temperature.

7.5.5 Two (2) stages of attemperator system are considered for the proposed boiler. The inter-stage attemperator is of spray type and shall be located between the superheater stages to control the final steam temperature within the tolerance limit of $\pm 5^{\circ}C$ between 60% to 100% MCR load, using the boiler feed water tapped off at the outlet of the boiler feed pumps. The system shall be complete with control valve, bypass valves, isolating valves, interconnecting piping, supports etc.

7.5.6 The economiser shall be located immediately downstream of the superheater, and it shall be of inline arrangement. The design shall be of bare tube construction, and counter flow type. Suitable spacers shall be provided in both longitudinal and transverse to the gas flow direction. Economiser shall be arranged such that there is space for the future addition of about 10% of the installed heating surface area without disturbing the existing coils.

Suitable number of soot blowers (if applicable) shall be located in the economiser for effective cleaning of the heat transfer area. The water velocity in the economiser shall not be less than 0.9m/s.

Economiser may be divided into suitable number of banks for maintenance of the economizer coils. The economiser gas path

shall be pressure type construction with proper design of the seals at the tube penetrations with the casing / water walls.

Complete economizer coils shall be constructed with seamless steel tubes, with material of construction as per the metal temperature. Generally used material in the economiser coils will be SA 210 Gr.A1.

7.5.7 Air heater shall be arranged as the last heat recovery section downstream of economiser. Air heater shall be recuperative type with flue gas flowing outsides the tubes and the combustion air flowing inside the tubes. The arrangement shall be provided for adequate access, for maintenance / replacing the tubes. Suitable precautions shall be taken to prevent the tube corrosion at the air inlet side of the air heater. Minimum one block of air heater tubes shall be of corten steel tubes to prevent cold end corrosion.

7.5.8 The steam generator shall be designed for firing the proposed fuel (single fuel or in combination) in the boiler, without any support oil requirement.

The sized fuel will be made available at the inlet of fuel bunkers through a system of conveyors. The fuel feeding system shall include bunkers with adequate storage capacity, fuel feeders with variable speed attachment, feed chutes and the distributor. The fuel input to the steam generator shall be regulated by the feeding system.

The fuel conveying, feeding and firing systems and equipment shall be of the most reliable and rugged type requiring very

minimum maintenance and operational care, while firing the range of fuels specified.

The feeders shall be with variable frequency drive. The feeders shall be easily approachable for maintenance with adequate provision for on line observation of the operation of the feeders. Fuel feeders shall be sized to meet the peak load fuel requirements provided with an independent feed control system for varying the rate of fuel feed. The fuel feeders shall meet the 100% MCR requirements at (n-1) condition also. All feeder units shall function in unison, feeding fuel on to the identified combustor section / equipment or system, as per the system design and arrangement. All the feeders shall be provided with proximity type zero speed sensors. Mixing of fuels shall be done after fuel extraction conveyors from respective bunkers.

7.5.9 Lime stone feeding is envisaged in the boiler, to limit the SOx emission levels, while firing high sulphur fuels. The lime stone system shall have separate bunkers, feeders with variable speed attachment, feed chutes, etc. Separate bed material feeding system is also envisaged in the system with required bunkers, feeders, feed chutes, etc.

The fuel and lime stone bunkers shall be provided with SS lining at the bottom conical portion. Required number of air canons shall be provided in the fuel bunker. Radar type continuous level monitoring system for fuel and limestone bunkers and one number level transmitter in bed material bunker.

7.5.10 The firing system for the steam generator shall consist of Air box with distributor plate and fluidising air nozzles. The combustion air from the PA and SA fan is heated in the air heater. The hot air from the PA fan circuit shall be uniformly distributed through the air nozzles. The hot air for distribution of fuel shall be supplied by the SA fan.

7.5.11 Fly ash recycling equipment shall be a compact separator or Hot cyclone or by "U" Beam Arrangement or a cold cyclone technology.

7.5.12 The Draft system for the steam generator shall be suitable of producing a balanced draft with sub atmospheric pressure conditions in the furnace. All the fans shall be of simply supported construction.

- The system shall be comprising of 1 x 100% PA fan with variable speed drive motor and inlet guide van with power cylinder complete, with necessary base frames, base plate, foundation bolts, supports, covers, couplings, lubrication system etc.

- 1 x 100% ID fan with variable speed drive motor and multi louver damper with power cylinder, complete with necessary base frames, base plate, foundation bolts, supports, cover, couplings, lubrication system, etc.

- 1 x 100% SA fan with variable speed drive motor complete, with necessary base frames, base plate, foundation bolts, supports, covers, couplings, lubrication system, etc.

7.5.13 Air and flue gas ducting shall be with required stiffeners, expansion joints, guide vanes for bends, dampers, insulation, cladding, supports, etc. All the air ducts shall be fabricated from steel plates of minimum 5.0mm thick and all flue ducts shall be of minimum 6.0mm thick. The duct plate material shall conform to IS 2062.

The duct corners shall be stitch welded internally and full welded on the outside. All ducts, exceeding 600 mm width or depth, shall be suitably stiffened and reinforced on the outside and designed to withstand the pressures encountered. Also duct design pressure shall be compatible with the furnace design pressures. Ducts will be sized considering a maximum velocity of 18m/s for hot air and flue gases and 15m/s for cold air.

The ducting expansion joints are provided to take care of the duct expansions and shall be of saw tooth square corner type. The number of expansion joints required shall depend on the ducting thermal movement considerations.

7.5.14 Air pollution control system comprising of one number of Electrostatic Precipitator with all its accessories shall be designed to provide the desired outlet dust concentration level, with the boiler operating with the fuels identified for the project. The aspect ratio of the ESP shall be optimally selected so as to minimise re-entrainment and carryover of the collected dust, and for assured performance.

The system shall be complete with inlet and outlet funnel, deflector plates, ash hoppers, collecting electrode system,

rapping mechanism, high voltage transformer, automatic voltage control system, insulators with thermostats, MCC, high voltage bus duct connection, complete lifting and handling arrangement for the transformers, expansion bellows at inlet and outlet funnels, stairways and walkways, sliding supports for thermal expansion of casing, etc.

Ash storage capacity shall be minimum 8 hours with the rated conditions specified in this specification. A margin of 10% shall be provided in the hopper capacity over the calculated values. Adequate number of pneumatically operated vibrators shall be provided in each of the hopper to enable the free discharge of the ash from the hoppers. The internal surface of the hopper shall be free from ridges. Stainless steel liner of a minimum of 2.0 mm shall be provided on the inner surface of the hopper for the 1/3 rd of the conical length for the free flow of ash. The outlet of the hopper shall be provided with a thermostatically controlled hopper heating system of adequate capacity to ensure free flow of dust from the hoppers and close them at present with a suitable leak proof door to be manually operated.

Each hopper shall be provided with suitable dust level monitoring system incorporating all the necessary accessories including level switches for high and low level indications suitable for 200 °C, local and remote signalling lamps and high level alarm. A timer shall also be provided for de-energizing the affected electrical section.

7.5.15 Boiler integral piping consisting of all interconnecting piping between the economiser inlet stop valve and the superheater outlet header. The piping shall be properly supported and

provided with necessary tapings for instruments for measurements.

The design of the piping system shall be based on the ANSI B 31.1. The correct locations of hangers and supports shall be considered for the flexibility analysis.

Suitable expansion loops, restraints and anchors shall be provided so as to ensure code compliance's and to limit the stresses within the allowable values. The materials for the piping and fittings shall be properly selected for the various services in the boiler integral piping. Complete boiler integral piping shall be provided with valves, fittings, drains & vents, safety valve exhaust piping, start-up vent with silencer, blow down systems etc.

7.5.16 The boiler shall be provided with a tri-sodium phosphate based High pressure (HP) dosing system and sodium sulphite based Low Pressure (LP) dosing system. The HP dosing system shall add the chemical to the boiler water to take care of the ingress of the hardness salts and to increase the boiler water pH. The LP dosing is done to the feed water preferably at the outlet of the de-aerator to scavenge the last traces of oxygen and to increase the feed water pH.

The HP dosing pump shall be of simplex reciprocating plunger type stroke adjustable while the pumps in operation or stationery for the 0 – 100 % capacity range. For the LP dosing pumps diaphragm type pumps shall be provided. The pumps shall be designed according to Hydraulic Institute Standard.

The wetted part of the pumps shall be of stainless steel. The tank usable volume shall be on 24 hours basis and on a residual phosphate level of minimum 7.0ppm in the boiler water. Each dosing system shall include a stainless steel mixing tank with an electric motor driven agitator. The tanks shall be provided with dished ends at the bottom and flat covers at the top. The top cover will be provided with an observation door with swivel bolts and wing nuts.

The HP and LP dosing systems shall be mounted on individual skids with their respective tank, pumps along with all required piping, valves, fittings, relief valves, supports etc.

7.5.17 One Continuous Blow down (CBD) tank and one Intermittent Blowdown tank (IBD) shall be provided for the boiler. The flash steam from the CBD tank outlet shall be piped to the de-aerator and the outlet of the IBD tank shall be vented to atmosphere to a safe elevation. The level control system and the safety valve for the CBD tank, required supports, drain valves, level gauges, and necessary piping etc., for both CBD and IBD tanks shall be provided. The internals of the CBD shall be designed to prevent entrainment of water particles in the vapour as it is vented out and the walls shall have extra thickness at and around the point of entry of drum water.

The IBD tank shall be provided with a loop seal for the draining of the blowdown water and a syphon breaker arrangement shall be provided to prevent the water getting drained completely from the tank due to the syphon effect.

7.5.18 One (1) de-aerator of de-aerating capacity equal to Ten percent (10%) higher than the gross MCR steam generation capacity of the boiler with a de-aerated water storage tank of net useful capacity (Normal water level to Low water level) equivalent to ten minutes (10 minutes) of MCR generation capacity of the boiler shall be provided. The de-aerator shall be mounted at a higher elevation at the top of control room. The material of the de-aerator, de-aerated water storage tank is SA 515 Gr.70 / IS: 2002 Gr.2.

The design of the de-aerator and de-aerated water storage tank shall be as per ASME Section VIII and wherever applicable the minimum statutory requirements of IBR shall be met with. The de-aerator and the de-aerated water storage tank shall be designed with a minimum corrosion allowance of 3 mm.

The de-aerator shall be of either spray-cum-tray type or spray type with counter flow of steam and water. Material of trays shall be SS confirm to a minimum of AISI 304. The de-aerator and the storage tank shall be complete with all the fittings and mountings like vents, controlled vent, drains, gauge glasses, pressure indicators, relief valve, steam and water inlet and outlet nozzles etc. Steam (from turbine extraction) at a required pressure shall be supplied at the inlet of the de-aerator.

The level control station shall be located at the outlet of the CEP, which pump the condensate from the condensate receiver tank to the de-aerator. A vent loss of 2% of the steam supplied to the de-aerator and vent condenser, designed suitably as per

HEI / TEMA shall be provided. The condensate from the HP Heater shall be let into the de-aerated water storage tank through appropriately designed sparger pipe. Spargers shall also be provided for de-aerating steam and pegging steam line.

7.5.19 The feed water pump shall be capable of meeting the peak generating capacity of the boiler and the blow down requirements. The design margin for the calculation of the rated pump capacity shall be 10 % of the feed water requirements for the peak load operation and blow down requirements of the boiler. The design margin for the calculation of the rated head of the pumps shall be 5% of its maximum discharge pressure requirements.

The pump shall be single suction, multi stage centrifugal type with drive motor of suitable rating, coupling, common base frame, foundation bolts, etc. The boiler feed pumps shall be designed with "Mechanical Seals". All mechanical seals shall be provided with conversion kit for commissioning. The pump shall be supplied with an automatic re-circulation valve of approved make. Lift off devices shall be provided for the boiler feed pumps. Accelerometer type vibration monitors and temperature monitors shall be provided in the both drive end and non-drive end of each bearing.

The material of construction for the pump is as follows:

Suction casing	:	SA 216 Gr. WCB
Discharge casing	:	CA6NM
Impeller	:	CA6NM
Shaft	:	AISI 410
Casing wearing ring	:	CA6NM

The feed pumps shall be provided with suitable recirculation and balance leak off arrangement. Recirculation flow under low load conditions shall be automatically controlled. The minimum stable flow of the boiler feed pump shall be as low as possible; so as to operate the boiler feed pumps continuously at low loads. The automatic recirculation valve shall be sized for the higher of the minimum flow thermal and minimum flow stable values. Pressure switch shall be provided in the individual discharge piping of the boiler feed pump upstream of the ARC valve.

Removable conical type suction strainers, with free flow area equal to four (4) times the flow area of the pipe shall be provided. Pressure drop in the strainers shall be limited to a maximum of 0.1kg/cm^2 at the design flow in clean conditions and to a maximum of 0.15kg/cm^2 at 50% clogged conditions at design flow. The strainer shall be made of stainless steel 304 material. The size of the conical strainer shall be equal to the suction pipe size and not the pump suction flange size.

Head - Flow Characteristic Curve shall be a stable curve with the head continuously increasing from maximum flow condition to zero flow condition with a maximum head being at closed delivery valve (zero flow). Both flat curve as well as heavily drooping curves are not acceptable. Maximum run-out flow should at least be 130% of duty point flow. Specified normal pump capacity shall be less than rated capacity and these two points shall lie to the left of capacity at Best Efficiency Point (BEP).

7.5.20 Boiler shall be provided with supporting structures, steel work, platform, ladders, galleries, and staircases with fabricated floor grating including complete roof, side cladding above the drum operating floor level along with cladding structures for protection against rain and other climatic conditions.

7.6 Steam Turbines and Auxiliary System

The Turbogenerator proposed will be of Back Pressure type with the generation capacity of 5.0 MW with the inlet steam parameters of 64 Kg/Sq.cm(g) and 480 Deg.C. The steam Turbine shall be a reliable and efficient system with state-of-the-art proven design with good performance over a long period. The Turbine shall have the following design and engineering features:

- Highest possible thermal and energy efficiency.
- State-of-the-art technology and well proven in actual operation over a long period.
- Rugged, conservatively designed, proven components and systems.
- Minimum outage for field maintenance and routine inspection.
- Better operability at various load conditions.
- Advanced instrumentation, control systems, shut-down and protection system, very reliable online supervisory and surveillance system, with diagnostics.
- Minimum requirement of operating and maintenance man-power and amenability to unattended automatic operation.
- Suitability for harsh tropical ambient conditions prevailing at site.
- Simple design and ease of installation.

The turbine shall be horizontal, single cylinder, back pressure type. The exhaust shall be at 4.5 Kg/Sq.cm(g)

All casings and stator blade carriers shall be horizontally split or otherwise and the design shall be such as to permit examination of the blading without disturbing shaft alignment or causing damage to the blades. The design of the casing and the supports shall be such as to permit free thermal expansion in all directions. The casing shall also permit the inspection of the bearings without dismantling of the casing. The exhaust ducting shall be located on the lower half of the casing.

The turbine shall have solidly forged and machined rotor with integral disks. The rotor after fully machined and bladed shall be dynamic balanced accurately in the shop and shall be given an over speed test under vacuum. None of the critical speeds of the rotor shall fall within the range of 20% above and 20% below the normal running speed of the rotor. The material of construction shall be consistent with proven practices and standards.

The blading shall be designed to withstand all vibrations, thermal shocks, and other loading that may be experienced during service and system disturbances. The blades shall be machined from forged bars or die forged and the materials used shall be chromium steels suitable for the temperatures encountered, resistant against corrosion and erosion and consistent with proven experience and standards. In the low pressure stages, if warranted where the moisture percentage is higher, additional protection against erosion shall be provided.

The blading depending on the staging shall be adequately fastened, with proven methods of fixing. The rotating blades are either shrouded or tied with lacing wires depending on the stresses and the excitation frequencies.

The glands shall preferably be of labyrinth type and sealed with steam. The gland packing shall be of 13% chromium stainless steel. The labyrinths shall be of multi-section spring backed type which would allow for any temporary deformation of the rotor shaft without overheating the rotor due to friction. The complete piping, valves, pressure gauges, regulators etc. required for the end seals shall be provided.

The Turbine shall be provided with liberally rated hydrodynamic radial and thrust bearings. The radial bearings shall be split for ease of assembly, and of the sleeve or pad type, with steel shell backed, babbitted replaceable pads. These bearings shall be equipped with anti rotation pins and shall be positively secured in the axial direction. The thrust bearings shall be of, Mitchell tilting pad type, the steel backed babbitted multiple segment, designed for equal thrust capacity in both directions. A liberal flow of lube oil under pressure shall be supplied to all the bearings for lubrication and cooling.

All bearings shall be accessible without having to remove cylinder covers. The metal temperatures of all the bearings shall be monitored by thermocouples with extension right into the white metal layer. Provision shall be made for measuring the temperature of the oil leaving the bearings.

A pressure lubrication and control oil system shall be furnished for the turbo generator unit to supply oil at the required pressure to the steam turbine, gear box, generator and governing system. The lubrication oil system shall supply oil to the turbine generator under all the load conditions, including the turning gear operation. The oil system of the turbogenerator shall be designed with adequate redundancy and emergency provisions such that a failure of a single active component will not prevent the safe operation or a safe shutdown of the turbogenerator. Oil in the reservoir shall be maintained at an appropriate temperature when the TG set is

idle by providing suitable electric heaters and temperature controls if required.

- One hundred percent (100%) capacity centrifugal/gear type, Main oil pump shall be driven by A.C electric motor driven main oil pump.

- One (1) No. of one hundred (100%) capacity A.C motor driven auxiliary oil pump of centrifugal type, arranged to cut in automatically if the oil pressure falls to a preset value. This pump shall also meet the requirements during the start up and shutdown.

- One (1) D.C motor driven, centrifugal type, emergency oil pump of adequate capacity to provide adequate lubrication in the event of a failure of the A.C motor driven pump(s). This pump also shall cut in automatically at a pre set value of the oil pressure. The minimum capacity of this pump shall be to ensure a safe shutdown of the turbogenerator.

- **All the above pumps shall be provided with mechanical seals.**

- Two 100 % capacity (one working and one standby) water cooled oil coolers.

- Two 100 % duty oil filters arranged in such a way that it is possible to clean one oil filter while the other is in service. The filters and the coolers shall be arranged with continuous flow transfer valves.

- Oil storage and settling tank with adequate reservoir capacity, strainers, level indicators with float switches and alarm contacts, vent and oil mist eliminators and 2x100% capacity vapour exhaust fans.

- Flow and temperature indication for oil from every bearing.

- Centrifugal oil purifier with drives, interconnecting piping and valves.

- Emergency gravity lubricating oil system

  If the system envisages separate control oil circuit from the lube oil system, there shall be independent two nos. of control oil pumps and 2 x 100 % duplex oil filters for the control oil circuit.

  The auxiliary oil pumps and the emergency oil pumps shall be arranged to have flooded suction.

  The oil coolers shall be water cooled with a duplex arrangement and changeover valves. The coolers shall be of shell and tube type with removable tube bundle. The coolers shall be constructed in accordance with TEMA class C. The provided surface area shall be adequate to cool the oil with the inlet cooling water temperature indicated in the design basis, even with 20 % of the tubes plugged. The cooler shall be of vertical type.

  The sizing of the coolers shall consider a tube side (water side) fouling factor of 0.0002 Hr.Sq.M.Deg.C/Kcal. The water velocity shall be not less than 1.5 M/sec. A corrosion allowance of a minimum of 3 mm shall be applied to the design thickness of each of the component, other than the tubes.

  Full flow twin oil filters shall be used, for the lube oil, downstream of the coolers and shall be piped in a parallel arrangement with a continuous flow transfer valve with necessary two way change over valves. Filter size shall be 40 microns nominal for the lube oil. Filter cartridges shall have a minimum collapsing differential pressure of 3.5 Kg/Sq.cm. The minimum design pressure for the filters shall be the maximum discharge pressure of the oil pumps. Differential pressure gauge with alarm shall be provided across the filters.

The filters shall be either common or separate for the lube and control oil circuits. The filter grade for the control oil shall be 10 Microns nominal. If a common filter is used for lube and control oil, the filter grade shall be 10 microns nominal.

A centrifugal type oil purifier shall be provided for the removal of water, sediments and other oxidation products from the Lube oil system on a continuous basis. The purifier shall be a separate complete package, mounted on a skid, complete by itself with drive motor, piping, valves and fittings. The capacity of the purifier shall be at least two (2) percent of the rate of normal flow through the reservoir. Feed to the purifier shall be from the drain end of the reservoir and its operation shall be independent of the oil system.

Emergency gravity lubricating system shall be provided to assure the lubrication at the time of an emergency due to the failure of the DC operated lube oil pump. This system shall draw lube oil from an overhead tank, under gravity, and shall be designed to supply oil for the coasting down period of the machine. The overhead tank shall be SS lined and the complete piping to and from the tank, shall be of SS 304 material. The tank elevation shall be finalised based on the oil pressure requirements at the bearings.

The turbine governing system shall be electro-hydraulic designed for high accuracy, speed and sensitivity of response. The electrical/electronic and hydraulic components of the control system shall be selected on the basis of reliability over a wide range of operating conditions. All components used shall be well proven to assure overall system reliability and shall be designed for easy and quick replacement when necessary. The governor shall be configurable in the field.

The governor shall ensure controlled acceleration of the turbo generator and shall prevent over speed without tripping the unit under any operating condition or in the event of maximum load

rejection. The governor shall have linear droop characteristics with a suitable range for stable operation and shall have provision for adjusting the droop in fine steps.

The governing system shall have the following important functions:

- Speed control
- Over speed control
- Load control
- Inlet Steam pressure control
- Extraction steam Control

The turbine control shall be through the centrally located Distributed Control System, described in another section of this Report. The control system shall provide redundancy for key functions by use of separate sensors and monitors. The control system shall include all the standard control monitoring and alarming. Only proven equipment that has been used in similar systems before shall be provided. Control panels shall be supplied fully wired and complete with all necessary special wiring for interconnection of panels. Vibration detectors/ proximity meters/ axial position detectors monitors shall be provided for all bearings including the bearings of the generator. Solid state annunciation units wherever located shall be of the first out type. Individual alarm windows shall be provided for all critical points parameters. The alarm sequence shall be as per international standards. Separate windows shall be provided for pre-alarm and shutdown with simultaneous alarm.

The steam turbine and the other high temperature parts, including piping supplied, shall be insulated with low conductivity inert material, where required, reinforced by stainless steel wire net between applied layers. The insulation shall be so arranged that it can be removed for access to the flange

bolting, control valves and other parts that require periodic maintenance. The insulation shall be designed, such that the outer surface temperature of the insulation does not exceed 20 Deg.C above the ambient temperature.

8.0 DESCRIPTION OF PLANT ELECTRICAL SYSTEM

8.1 Proposed System

8.1.1 The distillery plant shall be planned with its own power generating plant to meet with the power requirements of these plant auxiliaries. The Boiler of 45 TPH, 68 ata, 485 deg. C and TG of 5.0 MW shall be installed to meet the plant's power requirements. The cogeneration auxiliary load shall be 745 kW. The auxiliary loads for Distillery plant shall be 3340 kW. The electrical scheme of the distillery plant will consist of one no. 11kV, 50 Hz, 3 Phase, 0.8pf synchronous generator having nominal capacity of 5.0 MW.

8.1.2 The power generated in the turbogenerator will meet the power requirements of the power plant auxiliary loads and distillery plant auxiliary loads and there will be no excess power available. Power plant auxiliary loads and the Distillery plant auxiliary loads shall be fed from the following configurations of transformers:

- Three (3) numbers of 3.15 MVA, 11 / 0.433-0.433kV Converter Duty transformers

8.1.3 The drawing attached to this report, depicts the electrical scheme planned for the proposed 5.0 MW power plant at the Distillery.

8.2 Generator

8.2.1 The generator will have nominal rating of 5.0 MW with the generation voltage of 11kV, three phase, 50 Hz, at a rated power factor of 0.8 (lag). The saturated rated direct axis sub

transient reactance of generator should not be less than 14% and not more than 19% without any tolerance. The machine will run at 1500 rpm, and will operate with the voltage and frequency variation of ±10 % and ±5 % respectively, with a combined voltage and frequency variation of ± 10%. The enclosure will be of dust, vermin and water proof. The generator will meet other requirements as stipulated in IEC:60034. The generator will be complete with base frame, closed air circuit water cooled (CACW) cooling system, brushless exciter, automatic voltage regulator, relay, metering and control panels, instrumentation control and safety devices and other accessories, spares and special tools that will be required for satisfactory erection and efficient operation of the station. The generator coupled to the steam turbine will be suitable in all aspects for operating in parallel with grid. The generator will match with the turbine in respect of speed, over speed, moment of inertia, overload capacities, coupling and other relevant requirements.

8.2.2 The stator and the rotor of the generator will have class 'F' insulation but the temperature rise will not exceed the limits specified for class 'B' insulation. The generator will be fitted with RTDs, space heaters and temperature indicators. RTDs as mentioned below shall be provided:

a. Coil sides : 4 Nos. per phase
b. Stator core : 4 Nos.
c. Bearings : 2 nos. each for DE and NDE
d. Cold & Hot air streams : 2 Nos. per stream

8.2.3 The generator terminals will be suitable for connecting to 11kV switchgear panel through HT cable. The current transformers for metering and protection will be housed in the 11 kV switchgear panel, LAVT and NGR cubicle. The drawing enclosed to this report gives the protection scheme for the generator.

8.3 Excitation System & Synchronizing Panels

8.3.1 The excitation system will be of brushless type and will be provided with the following features:

a. Generator voltage control
b. Excitation current control
c. Excitation build up during start up and field suppression on shutdown
d. Limiter for the under excited range and delayed limiter for overexcited range
e. PT fuse failure detection and auto changeover
f. Auto power factor control

8.3.2 The system will have double auto and manual channels, with bump less changeover facilities. Alarms will be arranged for AVR fault, AVR automatic changeover to second auto channel / manual mode and for diode failure.

8.3.3 Synchronising panel complete with running and incoming voltmeters, running and incoming frequency meters, synchroscope, synchronizing check and guard relays, no volt relays, synchronizing cut off switch, lamps etc. will be provided. Automatic synchronizing with inputs to governor and AVR control will be made possible.

8.4 Unit Control Panel

8.4.1 The unit control panel will comprise of control and metering system, synchronising system, protective relays, start / stop system, alarm / annunciation and temperature measurement system. The control panel will have provision for closing / synchronising through the generator breaker and tie breaker. Dead bus closing arrangement will also be provided in the control panel. The panels may be split up into control panel, metering panel and relay panel for convenience.

8.4.2 Each panel will have digital / electronic PQM, ammeters, voltmeters, frequency meter, power factor meter, kW and kVA meters. The following minimum protections will be provided for the generators:

a. Over voltage, under voltage relay
b. Voltage restrained over-current relay
c. Field failure relay
d. Reverse power (active & reactive) relay
e. Differential protective relay
f. Stator earth fault relay
g. DC failure trip relay
h. Under/Over frequency relay
i. Stator and rotor winding temperature trip relay for alternator.

8.5 LAVT and NGR Cubicles

8.5.1 The LAVT cubicle will house surge capacitors, potential transformers for protection (class 3P), metering (class 0.5) & AVR sensing / excitation supply, lightning arrestors, cable box etc. The NGR cubicle will comprise of current transformers

(class PS and 5P20), neutral isolating switch and grounding resistor (punched grid type stainless steel grids). The enclosure for the panels shall be of cold sheet of 3 mm thick for front and back and 2.5 mm thick for rest.

8.6 11 kV Switchgear Panel

8.6.1 The broad specification for the 11 kV switchgear panel for slop power plant will be as follows:

Rated Voltage	:	11 kV, 3 Phase, 50 Hz
Maximum Voltage	:	12 kV
Power frequency Voltage	:	28 kV rms/ 35kV rms
Impulse withstand Voltage	:	75 kV peak / 95kV peak
System Fault level	:	40kA for 3 sec
Maximum bus bar Temperature	:	As per IEC
Operating Duty	:	O-0.3sec-CO-3min-CO
Control Voltage	:	110 V DC

11 kV indoor switchgear panel to be located in the slop power plant power house shall be used for distribution. The board will be metal clad, free floor standing, totally enclosed, dust and vermin proof with draw out type vacuum circuit breakers. The boards will conform to IS:3427 and the breaker will conform to IS:13118 / IEC:56. Each breaker will have distinct positions for service, test and isolation mode and will have independent earth switch for earthing the cable side terminals. All panels will have earth switch with interlock or separate earthing trolley. The panels will be suitable for bottom cable entry for TG incomer & outgoing feeders. Details of incomer and outgoing

feeders of the HT panel shall be as in the schematic diagram attached to this report. Current and Potential transformers will conform to IS:2705 / IEC:185 and IS:3156 / IEC:186, respectively.

8.6.2 The switchgear panels will be complete with necessary CTs and PTs for metering and protection which will be of cast resin type conforming to relevant Indian standards. Neutral displacement relay will be provided in bus to detect earth fault conditions when the system is operated without neutral (i.e. operated with PSPCL supply when generator is out of service). The auxiliary transformer feeders will be provided with the necessary relays and meters as shown in the protection scheme drawing enclosed to this report. Energy managers with RS ports shall be provided for all the feeders of this switchgear, to ensure that data in any fashion on energy consumption / generation / export could be made available during operation.

8.7 Auxiliary Transformers

8.7.1 It is proposed to install three (3) numbers of 3.15 MVA, 11/0.433-0.433kV converter transformers, for meeting the distillery and power plant auxiliary power consumptions

8.7.2 The distribution & converter transformers conforming to IS:2026 / IEC:76 for supplying power to the slop power plant & Distillery plant auxiliary loads will be as per the following specification:

Type of Transformer	:	Converter
Quantity	:	3
Transformer Rating	:	3.15 MVA

Cooling	:	ONAN
Ratio	:	11/0.433-0.433 kV
Highest system Voltage	:	12 kV
Power frequency Voltage	:	28 kV rms
Impulse Withstand Voltage	:	75 kV peak
Taps and Range	:	Off-circuit, + 5% in steps of 2.5%
Voltage Vector	:	Dyn11zn0
Impedance	:	6.0% / 6.0%
Neutral Earthing	:	Solid Earthing

8.7.3 Converter transformers intended for connecting directly to AC / DC loads (thyristorised loads) will be suitable for Class-E loading cycle as per IS:4540 (100% - continuous, 150% - 2 hr and 200% - 60 sec.). Special precaution at design stage will be ensured to suppress harmonics that may arise due to thyristor circuits, and the loads on both the secondaries shall be maintained equally, to the possible extent.

8.7.4 The transformers will be protected by over current and earth fault relays at HV side and Restricted Earth Fault (REF) relay at neutral end in addition to in-built protective devices like Buchholz relay, Magnetic Oil Level Gauge (MOG), Oil and Winding Temperature Indicators (OTI & WTI). Neutral bushing CT before bifurcation of neutral will be provided for REF protection of secondary winding of the transformers

8.7.5 The envisaged arrangement shall facilitate operation of the plant at full load, even during outage of any one of the distribution transformer / converter transformer provided to feed the loads of slop power plant and distillery plant loads.

8.8 LT Distribution System

8.8.1 The LT distribution panels conforming to the latest revision of IEC:61439 will be of dust & vermin proof construction, sheet steel clad, totally enclosed, floor mounted, self standing single front type, with both front and rear access for PCCs and front access for MCCs. All panels will be of single bus bar type with bottom cable entries. The MCCs shall be of compartmentalised design with cable alleys at the sides. PCCs shall have the cable chambers at the rear. The busbars shall be of electrolytic grade aluminium alloy, designed for 85°C end temperature with an ambient of 50°C. All panels shall have neutral bus, sized to carry half the phase current. All panels shall be designed for 50 kA for 1 sec.

8.8.2 PCCs shall have ACBs for ratings of 630A and above. All breakers shall be of draw-out type with spring charged motor operated closing mechanism for incomer feeders and manual draw out type breaker for motor and other outgoing feeders. For ratings less than 630A, MCCB shall be provided.

8.8.3 MCC feeders shall be envisaged with MPCB and contactor for motors of rating up to 30 kW. For ratings beyond 30 kW, MCCB, contactor and microprocessor based Overload relay shall be provided. Ammeters of suppressed scale (above 5.5 kW) and indication lamps, suitable for remote operation shall be envisaged.

8.8.4 Motors feeders of rating less than 30 kW will be provided with DOL starter in MCC. Higher sized motors may be provided with star / delta starter depending on application.

8.8.5 Busducts of rating 2000A, 50 kA for 1 sec. shall be provided for connection between the secondaries of the converter transformers and the VFDs and similarly busduct rated for 4000A and 5000A, 50kA for 1 sec shall be provided for connection between the secondary of the distribution transformers with the Slop power plant PCC and Distillery Plant PCC. The busduct shall be with aluminium enclosure and aluminium alloy conductors. The busduct shall be of non-segregated phase busduct type interleaved design and shall be complete with flexibles, bellows, vertical & horizontal bends, seal-off bushing, outdoor hoods, etc.

8.9 Motors

8.9.1 All motors shall be of squirrel cage type conforming to IEC:60034, totally enclosed and fan cooled. Motors shall be of 'premium energy efficient (IE3)' type as per IS 12615 – 2011. The windings will be insulated by class `F' insulation material and maximum temperature rise shall be limited to class 'B' insulation limit over an ambient of 50 Deg. C.

8.9.2 Motors controlled by VFD shall be provided with double enamel coating and VPI treatment for the windings. NDE bearings of motors of rating 110 kW and above shall be insulated.

8.9.3 Motors to be located in hazardous area shall be of flame proof, Ex (d) type suitable for zone – 2 area of classification.

8.9.4 Motors for Boiler Feed Pumps, ID fan, FD Fan, SA fans, MCW Pumps, CT Fans, ACW Pump (Distillation, Fermentation & Evaporation and Air Compressor shall be VFD suitable.

8.9.5 BTDs shall be provided for motors of rating 110kW and above. The motors for fuel feeders will be provided with thermistor. The windings of VFD motors shall be VPI treated and two coat enamelled. Insulated bearings shall be provided for VFD motors of rating 110kW and above

8.9.6 Motors of rating up to 30 kW will be provided with DOL starters in MCC. Higher sized motors may be provided with star / delta starter depending on application. Motor feeders will be complete with contactor, over load relay, MCCB/MPCBs.

8.10 Plant Start-up

8.10.1 The power plant auxiliary loads shall be started by using the proposed two (2) nos. of 1250 kVA, 415V DG sets, which shall be paralleled among them. These DG sets shall be used to meet the emergency loads of the power plant, meeting the emergency load of distillery plant, process continuity of the distillery plant and the same DG sets shall be used for start-up of co-generation plant.

8.10.2 The diesel engine shall be of direct injector four stroke with vertical 'in line' / 'V' type cylinders, radiator cooled complete with engine auxiliaries with operating speed of 1500 rpm and shaft power corresponding to rated output at terminals of the generator. The engine shall confirm to BS:5515.

8.10.3 The generator will be of synchronous type with brushless exciter, self-regulated to deliver 1250 kVA at 415V, 50 Hz, 0.8

PF. Insulation will be of class 'F' but the temperature rise will be limited to temperature corresponding to that of class 'B' insulation. The terminals shall be suitable for cable connection. The generators shall confirm to IEC:60034 and IS:4722.

8.10.4 The DG set shall be provided with the following minimum protective relays:

a. Differential relay
b. Voltage controlled O/C relay
c. Stator E/F relay
d. Under / Over frequency relay
e. Under / Over voltage relay
f. Reverse power (active & reactive) relay
g. Thermal overload relay

8.11 Earthing System

8.11.1 Neutral point of the distribution transformers and neutral of the TG set generators shall be effectively connected to individual earth pits and shall be interconnected, as per IEEE:80 recommendations. The neutral of LV of side of transformer shall be kept open, when the TG is running in parallel with co-generation plant and grid.

8.11.2 Non-current carrying parts of all electrical equipment viz. generator, PCCs, MCCs, distribution boards, control panels, and motors shall be earthed rigidly, to ensure safety. The armour of the cables, steel structures cable supports and all lighting fittings shall also be earthed.

8.12 Cables

8.12.1 The outer sheath of all cables in the hazardous area shall be of FRLS type.

8.12.2 All cables shall be selected to carry the load current under site conditions, with permissible voltage drop. In addition, high voltage cables shall be sized to withstand the short circuit current. The following types of cables shall be used.

8.12.3 Power cables for 11 kV system will be with three core aluminium conductor, XLPE insulated, screened, armoured and overall PVC sheathed confirming to IEC:502.

8.12.4 The power cables of 1.1 kV grade will be XLPE insulated, aluminium conductor, inner sheath PVC taped strip / wire armoured with outer sheath of PVC compound conforming to latest version of IEC: 227.

8.12.5 The control cables for control / protection / indication circuit of the various equipment will be of 1.1 kV grade, PVC insulated annealed high conductivity stranded copper conductor, inner sheath PVC taped, flat/round wire armoured with outer sheath of PVC compound conforming to latest version of IEC:227.

8.13 DC supply system

8.13.1 Battery, battery charger and DC distribution board unit will be provided in common for the power house DC load requirements (viz. turbine emergency oil pumps, control & protection).

8.13.2 Valve regulated lead acid battery (110V) with 2V cells along with accessories shall be provided.

8.13.3 The battery sizing will be on the basis of the following type of loads:

- Momentary load for 1 min.
- Emergency load for 2 Hrs
- Continuous load for 10 Hrs.

8.13.4 The battery charger will be of SCR controlled with dual float cum boost charging (FCBC) equipment housed in a free standing, floor mounting cubicle having hinged half doors made out of 14 SWG CRCA sheets.

8.14 UPS System

8.14.1 Adequately sized UPS system will be planned for the slop power plant and also for the Distillery plant for catering control supply requirement to the plant DCS system and field instruments. UPS system will have redundant inverters, servo stabilizer in by pass along with static transfer switch. The battery backup will be sized for not less than four hours for the intended loads. The battery system will be with 1x100% battery bank and SMF type. Separate UPS DB will also be planned with adequate spare feeders to cater supply.

8.15 AC Auxiliary Supplies

8.15.1 AC supplies of single and three phase, needed for internal use for several functions such as Illumination, Battery charging, UPS, Excitation supply, communication equipment and generators space heater shall be arranged from minimum two supply sources one from the main switchboard of the distillery

and other from LT distribution of the plant. For extremely critical AC loads, UPS supply system will be envisaged.

8.16 Lighting System

8.16.1 Good lighting in the distillery plant will be ensured to facilitate normal operation and maintenance activities and at the same time to ensure safety of the working personnel. The lighting system would comprise of normal and emergency power supplies. Main lighting system shall receive supply from reliable supply sources and the emergency lighting system will be supplied from battery units. Emergency lighting will be provided at strategic points in the power station, and in control rooms. LED fitting shall be planned in the various areas of the plant.

8.16.2 Light fittings provided in the hazardous area shall be of flame proof type suitable for zone-0 with class duty of IIA/IIB.

8.17 Lightning Protection

8.17.1 Building lightning protection system will be provided as per IEC/IS: 62305. The protections consisting of roof conductors, air terminals and down conductors will be provided for the power house.

8.17.2 All tall structures of the distillery plant including tanks shall be protected against direct lighting strokes, by providing air finials / horizontal conductors and down conductors up to the earth electrodes, as per IEC standards.

8.18 Suitability of Plant to operate in parallel with grid

It is important that the plant is designed to operate satisfactorily in parallel with the grid under extremely high voltage and frequency fluctuation conditions, so as to export the maximum possible units to the grid. It is also extremely important to safeguard the system during major disturbances, like tripping / pulling-out of big generating stations and sudden overloading during falling of portion of the grid loads on the plant in island mode, under fault / feeder tripping conditions.

For the northern grid, to which the plant will be connected, the frequency varies between 47.8 Hz to 51.5 Hz under normal conditions. The plant generator should be sized to operate at it is full capacity at extreme frequency levels under all conditions.

8.19 Protection, Metering & Control Cubicles

The generator transformer will have the following minimum protections, in addition to the in-built protections (Buchholz relay, Oil & winding temperature relays, magnetic oil level gauge), to isolate the equipment during fault conditions:

- Over current & earth fault relays on HV & LV sides
- Differential relay
- Restricted earth fault protection at HV side
- Over voltage relay
- Over fluxing protective relay

The feeders linking the plant substation and the substation will be protected with line differential protection with back up of directional as well as non-directional over current & earth fault

relays. Rate of change of frequency (df/dt) relay with under frequency protection and vector surge protective relay will also be provided to isolate the generating system during grid disturbances / over loading conditions.

Meters for monitoring the electrical parameters, mimics, transducers, annunciators for fault signals, control switches will be provided in the control panels, as per the drawings. Interlocking between breakers / isolators / earth switches for safe operation of the system will also be ensured.

All the protection, metering & control cubicles and Remote Tap Changer Control (RTCC) panels will be housed in the plant's common control room.

8.20 Instrument transformers

The instrument transformers and accessories will conform IEC 61869. Instrument transformers will be hermetically sealed units with in-built provision to dissipate any excessive pressure build up. Current Transformers will be of ring type with suitable construction at the bottom for bringing out secondary terminals.

8.21 Structures

The structures will be made up of hot-dip galvanized steel and designed to withstand forces during normal conditions (viz. wind loads & dead load of switchyard components) and abnormal conditions (viz. short circuit, earthquake etc.).

8.22 Safety Regulations

Statutory regulations on safety measures shall be strictly followed. Safety appliances, viz. fire extinguishers, sand buckets, earth rods, gloves, rubber mats, danger sign boards, safety regulation charts, etc. shall be procured and installed as per safety norms. Oil collection pits and soak pits for the transformers shall also be constructed. All cables in switchyard shall be neatly laid / dressed and shall be barricaded inside trenches along the length with fire proof bricks.

8.23 Communication system

A dedicated hot line telephone system, in addition to the normal P&T's telephone service, shall be arranged for communication between the plant's control room and the slop power plant and distillery units, to ensure proper co-ordination during energization of the line and tripping.

9.0 INSTRUMENTATION AND CONTROL SYSTEM

This Section of the Report gives the general philosophy of the Instrumentation and Control system proposed for the 218 KLPD distillery plant and 5.0 MW cogeneration power plant.

9.1. The plant will be complete with the basic instrumentation and control system necessary for its safe and efficient operation.

9.2. Comprehensive instrumentation and control equipment will be provided for each major area of the plant.

9.3. The control system shall be based on the **State-Of-The-Art DISTRIBUTED CONTROL SYSTEM (DCS) technology with Data Acquisition and control** for controlling / monitoring the different sections of the distillery plant and the Boiler & 5.0 MW co-generation plant. The **Data Acquisition and control** of the entire plant shall be achieved by a popular **DCS** package.

9.4. The tentative quantities of I/Os for the proposed Ethanol plant shall be as given below:

i. POWER HOUSE CONGTROL ROOM

S. No.	Description	Boiler		Turbine & BOP		Total
		Process	Electrical	Process	Electrical	
1	Analog Input	198	34	212	24	468
2	Analog Output	31	17	8	8	65
3	Digital Input	437	578	380	275	1670
4	Digital Output	203	403	155	230	991
5	RTD	88	0	0	47	134

6	Thermocouple	18	0	0	0	18
Total I/O counts						**3347**

ii. DISTILLERY PLANT CONTROL ROOM

S. No	Description	Fermentation		Distillation		Evaporator		Total
		Process	Electrical	Process	Electrical	Process	Electrical	
1	Analog Input	35	0	68	0	50	0	153
2	Analog output	2	0	28	0	20	0	50
3	Digital Input	31	488	8	104	137	136	905
4	Digital output	12	446	1	104	67	133	764
5	RTD	47	0	67	0	31	0	145
Total I/O counts								**2017**

iii. CONDENSATE POLISHING UNIT CONTROL ROOM

S.No	Description	Process	Electrical	Total
1	Analog Input	33	22	54
2	Analog Output	1	11	12
3	Digital Input	7	227	234
4	Digital Output	14	282	296
Total I/O counts				**596**

9.5. The centralized control / monitoring of the plant shall be from a **Remote Central Control Room** where the DCS and its sub-systems including the operator console shall be located.

9.6. The Instrumentation and control system of the distillery plant and co-generation power plant shall be realized as given below and the drawing "Overview of the control system" for the plant is given in section 16 of this report.

9.7. Distillery section and its auxiliaries control

The control of the total Distillery section operation start up / shutdown / trip shall be realized directly through DCS. The distillery controls will be for the manufacture of AA.

Flow measurement for remote monitoring includes Process steam flow, cooling water flow, Condensate flow, Products output flow from the process and Flow of products outlet from the plant. In addition to the above flow measurement,

The major controls of Distillery plant include the following:

- Fermented wash Flow Control
- Level control for analyser column
- Level Control for Rectifier column and its reflux tank
- Level Control for Pre Rectifier column and its reflux tank
- Level Control for Fuse oil reflux tank
- Soft water flow Control for Flash tank
- Flow control for pre-rectifier RS draw control
- Flow control for rectifier RS draw control

9.8. Boiler and its auxiliaries control

The control of the entire boiler operation / Start-up / Shut-down / Trip shall be realized directly from the DCS. All the signals required for controlling the boiler operation shall be

processed by the DCS and necessary actuating signals or the various final control elements shall be driven from the DCS.

The Major control of the boiler includes the following as a minimum:

- Drum level (3 element) control
- Combustion control
- Deaerator level control
- Deaerator pressure control
- Furnace Draft pressure control
- Superheated Steam Temperature Control (2 element)

Signals from the following shall be taken to the DCS for monitoring / interlocking purpose.

- Boiler Feed Pumps
- Deaerator
- Chemical dosing
- Boiler safety and protection interlocks

9.9. Turbine and its Auxiliaries control

Turbine control shall be performed by the DCS. Turbine Protection and safety interlocks shall be performed by DCS. Signals from the following major equipment shall be taken to DCS for monitoring / Interlock purpose.

- Lube oil system
- Control oil system
- Generator cooling system
- Turbo supervisory system

Dedicated independent micro processor based systems shall be considered for the following systems of the TG and shall be interfaced with the **DCS** through serial communication for monitoring / interlocking purpose:

- Turbine Vibration Monitoring system
- Turbine Governing system

The turbine shall be provided with and electro-hydraulic governing system. The system shall be designed such that the governing of the turbine shall be automatic and provides for safe operation.

The information of the following shall be monitored by the DCS for Data logging / Interlocking purpose:

- Power generation details
- MOP/ AOP / EOP status
- Temperature of turbine bearings
- Temperature of windings / Bearings of Generator

The following details on the **electrical signals** shall be processed / monitored by the DCS for interlock / data acquisition purpose:

- Safety Relay status
- Breaker status
- Generated Voltage, Current, Kilowatt, KVAR, Power factor, Frequency
- Line Voltage, Current, Kilowatt, KVAR, Power factor, Frequency

9.10. Various electrical inputs from the transducers and the digital signals from MCC panels shall be processed in the DCS system for monitoring and achieving the necessary interlocks / controls.

9.11. The control and monitoring of the Instrument Air Compressor shall be realized directly from the DCS.

9.12. The operation and control of Ash Handling System shall be from DCS only.

9.13. The operation and control of Fuel Handling System shall be from DCS only.

9.14. The PRDS functions shall be directly processed by the DCS.

9.15. The control and monitoring of auxiliary cooling water System shall be realized directly from the DCS.

9.16. The operation and control of water treatment system shall also be directly processed by the DCS. Dedicated operator station and respective IO panel shall be envisaged for the same.

9.17. The design of the total control system will be such that the following sub-system's functions will be handled by the respective equipment:

a. **Data acquisition, Display and logging** sub-system for monitoring, display, logging and printing of process parameters like flow, temperature, pressure, level, current, voltage, analytical and status will be performed by the operator station.

b. **Start / Stop Sequence & Interlock** sub-systems consisting of the safety interlocks, Sequence of starting and stopping of the distillery plant and alarm generation will be achieved through the DCS.

c. **Closed loop control** sub-system consisting of the continuous monitoring of the operational parameters like Level, Pressure, Flow etc., and controlling of the same using the PID functions will be achieved by DCS.

d. **Engineer / Operator interface** sub-system consisting of setting / changing the operational parameters based on the experience of the operator and as a reaction to emergency situations will be achieved by the computers used as the operator station.

e. **Communication** sub-system for interconnecting all the above systems.

f. **Data highway and network** for connecting the control and data acquisition sub-systems, operator interface sub-systems to a duplexed data highway such that there will be information exchange among each one of them.

g. **Auxiliary units** such as system cabinets, printer consoles, marshaling cabinets and power supply distribution cabinets.

9.18. The Distributed Control system is proposed for Control and Instrumentation system, keeping in view the safety, reliability and availability for comprehensive presentation of plant operation status, trends and essential operator interaction facility.

The Distributed Control System based plant control will have the following inherent advantages:

- Integration of information from different individual controls provides centralized data on plant operation.
- Increased reliability due to the use of Large Scale Integrated (LSI) components.
- Increased flexibility for modification at any stage due to software configuration capability.
- Modular design concept provides easy expandability for future in hardware and software.
- Higher maintainability due to improved self-diagnostic and display features.
- Less number of operating personnel.

The major design aspects of the system will be as follows:

- Control will be of the type which normally relieves the operator of continual regulating duties and will be backed up by interlocks and safety systems that will take pre-planned action in cases where unsafe trends and/or conditions develop faster than the operator's ability to respond.
- Continuous self checking features shall be incorporated in system design with automatic transfer to healthy/redundant circuits to enhance the reliability of the complete system.

- All the closed loop analog signals, open loops, safety and interlock signals and digital signals shall be processed by the DCS.

- Redundancy will be provided in the Central Processing unit, power supply and Communication modules (both between the controller & the operator station and between the I/O modules and the controller).
- Redundancy will also be provided for the communication cables.

- Power supply used for interrogation with field devices shall also be redundant.

- The Input/Output modules will be provided with noise filter and galvanic / opto isolation from external control source.

- All analog signals from distillery area to DCS and from DCS to distillery area shall be routed through signal barriers.

- The Inputs / output module shall also be provided with protection against reversal of polarity of supply voltage.

- The input modules shall be suitable for processing the field signals. The outputs will be short circuit proof and protected by fuses.

- The memory will be non-volatile or battery backed up as required.

- The control logic building shall be user friendly based on windows based software.

- The graphic displays on the operator station shall be developed using windows based software.

- On-line replacement of modules shall be possible without affecting the process.

- Auto boot up facility for the DCS shall be within 2 minutes.

- Display response time shall be less than 2 Sec.

- Data communication network response time shall be less than 100m Sec.

- Closed loop control task execution (Control response time) shall be done within 250 msec.

- Sequence control / Interlocks scan time should be within 100 msec.

- Display update time shall be less than 1 sec.

- The system shall be designed so that the failure of any monitoring device or control components or spurious intermediate grounding in the signal path shall not open the signal loop nor cause the loss or malfunction of signal to other devices using the same signal.

- All equipment/systems located in the field shall be suitable for continuous operation without loss of function, departure from the specific function or damage at the ambient temperature and humidity conditions.

- The control system software shall have all the essential capabilities to perform advanced control algorithms as a minimum. It shall be user friendly, easily programmable and have excellent Data acquisition, Graphic display and logging capabilities.

9.19. The field instruments those are primarily responsible for measuring the process parameters will be having the following major design features:

- All the field instruments/equipment that are used shall be of the same make for ensuring the smooth & optimal maintenance including efficient spare parts management.

- All field instruments used for sensing, transmission and measuring shall be of electronic smart type with local indication & signal transmission in current mode of 4-20 mA.

- All control valves and control damper drives will be of pneumatic type because of their fast response and ease of maintenance.

- All the field instruments, control valve positioner and Junction boxes shall comply explosion proof/ intrinsically safe requirements

- Cable glands used in hazardous area shall be of double compression, flame proof type.

- Materials of construction of instruments shall be consistent with temperature, pressure and corrosion conditions.

- Appropriate derating of electronic components and parts.

- Important plant parameters, that are required to assess the plant efficiency, must be serially communicated to the operator station for the purpose of display / logging.

- All solid state systems/equipment shall be able to withstand the electrical noise and surge as encountered in actual service conditions and inherent in a distillery plant, and shall meet the specification requirements of surge protection.

- All solid state electronic system/equipment furnished shall meet the requirements of Burn-in and Elevated temperature test.

- All the instrumentation cables shall be flame retardant low smoke type.

- The instrumentation cables and wires shall function without breakdown for surges experienced in the control system. Voltage class and insulation level shall be compatible with the signals they convey.

10.0 PROJECT CIVIL & ARCHITECTURAL REQUIREMENTS

This section of the report covers the basic requirements of civil work to be executed in the distillery Project. More detailed specifications are to be drawn at the time of Project engineering stage, depending upon the nature of the soil and based on the soil investigations for the project execution.

10.1 Geo-technical investigation

The Geo-technical investigation shall cover the entire distillery area including the power plant. Required and adequate field tests in the form of test boring including drilling through rocks (if required), direct load tests, trial pits, tests for dynamic properties, electrical resistivity tests etc. and necessary laboratory tests shall be conducted to determine soil and sub-soil characteristics required for site preparation and foundation design. Soil Investigation tests shall be conducted at all major structure / foundation / building locations within the battery limits of the plant. A comprehensive report on soil investigations shall be prepare incorporating all the data collected and firm recommendations with regard to the type of foundations shall be given supported by calculations.

Contour mapping of the site with proper surveying should be obtained by taking spot level of ground at every 5 meter intervals in both directions. Bench marks with co-ordinates and reduced level for the site should be established. Based on the preliminary contour survey, the level difference across the distillery plant is around 1 to 2 meters.

10.2 Equipment Foundations

10.2.1 Foundation for rotating machinery

The foundation design will take into considerations all the loads from the machine including dynamic loads as per the manufacturer's loading data. The design and construction will be done as per provisions laid down in applicable Indian Standards. The Grade of concrete for the complete foundation including the top deck shall be at least M25 (specified characteristic compressive strength of 25N/sq.mm for a 150mm test cube at 28 days). The High strength deformed reinforced steel bars used for reinforced concrete shall conform to Indian standards.

Detailed static and dynamic analysis shall be done for the foundation. The static analysis shall include all the operating condition loads as well as abnormal loads. A fatigue factor of at least 2 shall be considered for all dynamic loads. The mass of the foundation block shall be not less than three times the mass of the machine.

Dynamic analysis shall be carried out to calculate the natural frequency and mode shapes and to evaluate the dynamic response of the foundations to the applied dynamic loads. Unbalance loads for the normal operating conditions as given by the manufacturer or VDI 2060, whichever is more conservative shall be used for calculating the dynamic response. Transient dynamic analysis shall be carried out for the short circuit condition with an appropriate forcing function.

The detailed design and vibration analysis shall be carried out to:

- The determination of the natural frequencies of the system, to ensure that at least 20% frequency separation exists.

- Ensure the suppression of vibration amplitudes to acceptable limits.

- The provision for adequate foundation bearing capacity and settlement, limited to acceptable amounts.

The reinforcements shall be designed to the working stress methods for the worst load combinations of static and dynamic loads.

All necessary provisions by way of cut-outs, embedment and foundation bolt assemblies shall be incorporated into the foundation block to meet the functional requirements.

The foundation shall be isolated from adjoining parts of buildings and other foundations for vibration control. Joints at floor / grade shall be suitably sealed.

For foundations supporting minor equipment, weighing less than One Tonne or if the mass of the rotating parts is less than one-hundredth of the mass of the foundations, no dynamic analysis need be done. However, if such minor equipment is to be supported on buildings, structures etc. suitable vibration isolation shall be provided by means of springs, neoprene pads etc. and such vibration isolations system shall be designed suitably.

10.2.2 Static Equipment Foundations

All the static equipment foundations shall be constructed with cast-in-situ reinforced concrete. All foundations shall be extended to a depth, which conforms to the allowable bearing pressure of the soil.

The design of foundations will take into account all the loads from the equipment as per the equipment manufacturer's loading data. The design and construction will be done as per provisions laid down in Indian Standards. The grade of concrete shall be at least M20. (Specified characteristic compressive strength, of 20N/ sq.mm for a 150mm test cube at 28 days). The High strength deformed reinforced steel bars used for reinforced concrete shall conform to applicable Indian standards.

The design of foundations shall be carried out by Limit State Method. All necessary provisions by way of cut-outs, embedment, and foundation bolts assemblies shall be incorporated into the foundation block to meet the functional requirements. The foundations will be isolated from building foundations and superstructures.

10.3 Buildings

10.3.1 General

All buildings will be designed and constructed as per applicable Indian standards and codes. Loads shall be calculated based on IS 875, and Earthquake loads shall be as per IS 1893. The analysis and design of structures shall be carried out by Limit state method and by using standard computer programs as per

technical specifications and using reinforced concrete Grade of concrete M20 (specified characteristic compressive strength of 20N/ sq.mm for a 150mm test cube at 28 days). The High strength deformed reinforced steel bars used for reinforced concrete shall conform to relevant Indian standards.

The buildings shall be designed to suit the climatic conditions of the region. Roofs of all the buildings shall be weatherproof and leak-proof under all conditions. Proper drainage arrangement will be made and these are connected to main storm water drains. All buildings shall be provided with suitable approach roads connecting to main plant roads. The buildings will be properly ventilated and illuminated to meet their functional requirements.

10.3.2 Non Plant Buildings

Non Plant Buildings like, Laboratory building, MCC Rooms, Pump house, excise authority building, security cabin, office building etc., will be of concrete shallow foundations and superstructure with reinforced concrete / Structural steel frame work, reinforced concrete cast in situ / Plastic coated steel sheeting roof. External walls shall be of 230 mm thick brick masonry and internal walls will be of 115 mm thick brick masonry depending upon the functional requirement of the buildings.

Exterior and interior walls, ceiling shall be plastered and painted with approved colour and brand. Doors and rolling shutters with steel frame and adequate windows / ventilators with steel frame with 6 mm thick glass shall be provided. Flush doors and glazed windows shall be provided as per requirement. Exhaust fans shall be provided as required. Around the

buildings a 10 m wide smooth finished concrete walkway and necessary steps and ramps shall be provided.

10.4 Distillery plant civil works

The bulk storage tanks shall be open to atmosphere with suitable foundation. Covered area is required for fermentation section (fermenters wash settling, yeast and grain handling area), distillation section, daily receiving section, etc. These buildings can be of MS steel structure buildings with plastic coated steel sheet roofing on MS trusses and purlins. The structural steel buildings shall have civil work up to plinth + 0.3m above ground. Platforms at 3m intervals shall be provided. The daily receiver building shall have brick masonry up to 2m height and RCC grill above the masonry wall. The tank and equipment foundation will be in concrete. The floors of the building shall be of steel platforms and wherever required they should be of removable type. Some of the operating floors will be of chequered plates to avoid spillage reaching the floors below. The flooring at ground floor shall be hardened concrete flooring 50 mm thick.

The bulk storage section shall have Uncrushed Rubble masonry in plinth, chain link fencing of 1.2 M high above the wall all around and gate for entry purposes. The excise authority office, security cabin and distillery office will be of RCC construction with floor slabs and RCC roofs.

.It shall be constructed of masonry / brick work with impervious one using composite PVC lining duly finished and Sulphate resistant cement shall be used.

10.5 Tank Foundations

Flat bottomed steel tanks are extensively used for storage of liquids such as water, products in the distillery. These are placed directly on grade; by just levelling the ground if the strata below are firm or improving the strata by compacting the soil to desired density or replacing the top layer by well compacted sand layer. The foundations for steel storage tanks supported directly on firm grounds can be economically constructed by allowing larger settlements than permitted for framed structures or equipment foundations. Since the loading on soil resulting from these tanks is necessarily uniform hydrostatic load the settlements are also uniform over well prepared grade.

Loose soil under the tank area is first removed and the soil below is compacted using 10 T rollers after watering at optimum moisture content. The prepared grade is overlain by well compacted sand layer of min 150mm thicknesses. The area under the tank is enclosed in concrete ring wall. The diameter of this ring wall is approximately 2m more than the tank diameter. The tank is placed entirely on soil. The purpose of the ring wall is to confine the soil under the tank and take care of the resultant hoop tension resulting from tank load and lateral pressure from soil. The tank is then placed on 50 mm thick Bitumen mastic layer with 6 mm stone-grit and coarse sand mixed with 80/100 grade bitumen.

The tank shall be supported on well designed foundations, installed in the open and surrounded by wall or embankment not more than two meters high and made of earth, steel, concrete or solid masonry capable of withstanding full hydrostatic load. Ground within the enclosure shall not be lower than the level of

the ground outside the enclosure and shall be finished to form a slope of not less than half a percent from tank to drain or sump.

The drainage from the enclosure shall be controlled by a valve which shall be accessible in fire conditions and capable of being operated from outside the enclosure. Where Petroleum class A (Ethanol) or Petroleum class B is stored in an enclosure, the capacity of the enclosure shall be hundred percent of the capacity of the largest tank in the enclosure after deducting the volume upto the height of the enclosure wall of all other tanks in the same enclosure.

10.6 Cooling Towers

The basin underneath the cooling tower for the collection of the cold water shall be of grade M25 concrete. The raft slab shall be checked for uplift forces considering empty condition of the basin with ground water table at the maximum level. A minimum factor of safety of 1.2 shall be ensured for the condition that the basin walls are constructed up to finish ground level and there is no water in the basin and superstructure columns are not constructed and the ground water table is at the maximum level. The basin shall be water tightness, to prevent mixing of the ground water with the cooling water in the basin.

Water proofing admixture (plasticizer cum water proofing compound), shall be added to the concrete for basin, channels, drain pits, hot water basins etc. Two (2) Nos. of Stairs, one at each gable end shall be provided. The stairs shall be of steel construction with galvanized step treads and hand railing.

10.7 Pipe Racks

Pipe rack supporting structure will be of structural steel columns with interconnecting longitudinal & transverse beams, properly braced with vertical & horizontal bracings. All structural steel members will be painted suitably. Width and tier of the rack shall be as per the system requirements. Access ladders at suitable places will be provided.

The steel columns will be resting on RCC pedestals / footings (grade M20). The analysis and design of structures and foundations will be done as per provisions laid down in the codes.

10.8 Cable / Pipe Trenches

Cable trench walls and base slab will be of cast in situ reinforced concrete (Grade of Concrete M20) (specified characteristic compressive strength of 20 N/sq.mm for a 150mm test cube at 28 days). The High strength deformed reinforced steel bars used for reinforced concrete shall conform to relevant Indian standards.

Trenches shall be covered with precast RC cover slabs of standard design. Suitable slope in the longitudinal direction shall be provided and to be connected to nearby plant drainage system. Necessary embedment and edge protection angles shall be provided as per functional requirements.

10.9 Roads and Pavement

All roads within the plant shall be either double lane roads with 6.0 m black topping or 2.5 wide shoulders on either side of the

roads or shall be single lane roads with 4.0 m black topping and one meter wide shoulders on either side of the road. Roads geometry and construction shall be in accordance with applicable Indian standards for road construction. All the roads shall be designed to withstand the largest expected loads. Minimum longitudinal slope of the road shall be 1 in 200 where there are curbs on each side. Without curbs the roads may be laid flat. Slope from crown to edge should be 1 in 50 generally on straight stretches. Super elevation shall be provided on curves.

The sub grade shall be compacted to the levels, falls, widths and cambers as per the grade requirements. Sub base will be laid on a prepared sub grade. Base and final road surfacing shall be of bitumen macadam. Seal coat will also be provided. Precast RC kerbs on both sides of road shall be provided. The rainwater shall be collected in road side gullies and let into the plant surface drainage system.

Paving areas shall be properly graded and compacted to required grade and slopes before providing the base layer. Reinforced concrete paving (grade M 15) shall be done in alternate panels not exceeding 3.0 m x 3.0 m in size. Construction joints shall be filled with sealing compound. Around equipment foundations / columns isolation joint shall be provided up to full depth of the pavement. Expansion joints shall be provided at a spacing of 15m (max)

Top surface of the pavement shall be provided with adequate slopes as required for the surface drainage.

10.10 Surface Drainage

All the paved and unpaved areas shall be adequately drained. The surface drainage system shall be designed for surface washings and / or rain / fire water as the case may be.

Contaminated area surface drainage shall be collected and discharged through catch pits. The catch pits shall of RCC construction and shall be covered with CI / MS gratings. Uncontaminated areas surface drainage shall be done through rectangular RCC drains to be connected to open storm water drains.

The catch pits, interconnecting pipes and rectangular / trapezoidal drains shall be sized for carrying the design discharge when running full. Adequate bottom slope shall be provided to maintain minimum velocity. The paved areas shall be sloped towards the catch pits drains. At the road and other crossings suitable pipe / open RC culverts shall be provided.

10.11 Plumbing and Sanitary System

Plumbing and sanitary system shall serve all toilets, showers, bathrooms, kitchens and laundry room. Wherever possible all discharge pipes shall be fully vented. The design, installation, testing and maintenance of all plumbing systems & sanitary appliances shall comply with latest applicable Indian Standards.

Toilets shall have western style water closets. All piping shall be concealed. Floor drains shall be designed in such a way that their taps are always filled with water to guard against odours as well as insect and rodent infiltration.

All wash basins shall be equipped with pop up drain stops. All sinks shall have water taps.

All urinals and water closets shall have flush valves. The minimum acceptable mounting height of a shower head shall be 1.8 m from the finished shower floor.

10.12 Sewerage Drainage System

The sewerage drainage system consists of connecting the sanitary waste disposal from different buildings to the Septic tank through necessary pipeline. All the pipes shall be of RCC material. Minimum size of pipe at a service connection shall be 100 mm and the minimum size of pipe for sewers shall be 200 mm. Minimum slope in service connections shall be 1 in 40 and in sewers 1 in 400. All sewers shall be located along with roadways or public open spaces. Manholes shall be provided at the head of each sewer, at all changes in slope, direction or pipe size or at junctions of sewers. Maximum distance between manholes shall be 50m.

10.13 Site Clearance

All the materials and equipment employed for construction purpose shall be taken away from the site. All the rubbish and unwanted plant material shall be cleared and dumped away from the site. All areas within and outside the site which have been used during the construction shall be cleared and the ground surface shall be left in a safe and aesthetically good condition.

10.14 Fencing / Compound Wall

The storage area, loading, unloading area etc should be provided with suitable Compound wall / Fencing for a height of 2.5 m and steel gate with security room. Compound wall shall be provided wherever necessary for isolation of specific plant areas.

11.0 SITE FEATURES AND PLANT LAYOUT

11.1. Location and Features of the Plant Site

The proposed Grain based Distillery of SLBEPL will be located in a newly procured Greenfield land allotted at Thervoy Kandigai Industrial Estate in the district of Tiruvallur in Tamilnadu.

After analysis of land availability, water resources, feedstock potential, environmental aspect, logistics suitability, SLBEPL have approached Tamilnadu state Government for allotment of site in Thiruvallur district which is close to the capital city of Chennai. Govt of Tamilnadu has recently allotted 25 acres of land to SLBEPL in the Thervoy Kandigai SIPCOT Industrial Estate in Thiruvallur district. This portion of land being located in an Industrial estate complies to the state and central norms. SLBEPL will take-up a detailed survey of the allotted land to develop the layout to suit for dimensions of the land allotted.

The Drawing enclosed with Section 16 of this report gives a typical Layout for the complete distillery complex in 25 acres land. The layout is made for the complete distillery including the fermentation, distillation, evaporation, Condensate and spent lees treatment system, Cogeneration power plant and the product storage (daily and bulk).

The following specific features of the site have been discussed in this section of the report.

- Availability of adequate space for locating the Distillery and associated plants and adequate space for the construction activities.
- Suitability of the site from topographical and geological considerations.
- Availability of rail and road connections for material movements.
- Availability of adequate quantity of water for meeting the plant's water requirements.
- Availability of adequate fuel and its transport.
- Availability of Raw materials.
- Ecological Impact.

11.1.1 Space Availability

Adequate land will be procured within the identified area premises for locating the Complete Distillery including all the sections like the Fermentation, Distillation, Evaporation, Condensate treatment, Product Storage etc. The Distillery is an independent plant and could be located anywhere as long as adequate space is available for the installation of all the sections. However the whole lot of logistics have to be developed for accommodating the plant with all the associated plants. There are definite advantages in locating the plant independently by suitably considering the transportation and storage of grain, transportation and storage of fuel, arranging for water for the plant operation.

The main plant consisting of the Grain handling and storage section, Fermentation section, Distillation & Evaporation section will be located on the Eastern side of the plant. The product storage Section will be located on the Northern side of the plot. The 5.0 MW Cogeneration power plant and the Rice Husk

/ coal fired Boiler will be located on South western side of the plant. The boiler will be laid out with its axis in the East - West direction with the Chimney on the western side.

The Condensate polishing unit will be located on western side of the plant.

11.1.2 Topographical and Geological Aspects

The soil is expected to be clayey and the bearing capacity is good. The bearing capacity is expected to be 18 Metric Tonnes per Sq.M at a depth of Two and half (2.5) meter into the virgin soil. Raft foundations can be considered for all the Buildings and equipment in the distillery complex.

11.1.3 Rail and Road Facilities

The nearest railway station is the Town of Thiruvallur. All plant and machinery can be transported only by road as the plant is located near to the state highway, thus providing easy access for transfer for machinery. Main entry gate for the distillery complex will be located on the Eastern side of the plot.

11.1.4 Water Availability

Distillery plants are water intensive. The water required for the distillery also varies in quality requirements for different applications. Process water that is required should be bacteria free and a higher TDS in the water is not a problem. The cooling tower make up water need to be at least filtered and treated to bring the TDS to some acceptable level. The DM water is required for Extractive Distillation and for boiler make up. SLBEPL's distillery is being designed as a "Zero Effluent

Discharge" plant and some of the aqueous effluents will be treated and used as process water or cooling tower make up water. Nevertheless there will still be requirements for a large quantity of water from the raw water source. It is proposed to get this water from the bore wells located in the complex.

11.1.5 Availability of Fuel

As the proposed Distillery will be having its own Cogeneration plant, there is no need for any steam supply from external sources. For the SLBEPL's distillery, it is proposed to use Rice husk and coal as the fuel in the Boiler. The Rice husk and coal will be stored in a separate storage shed in the south west corner of the plot and will be fed to the boiler through a system of conveyors.

11.1.6 Availability of Raw Material

The raw material for the distillery operation is Bought grains like Broken Rice, which is abundantly available in the vicinity of the selected land.

11.1.7 Ecological Impact

A Distillery is considered as highly polluting. However the SLBEPL's Distillery is designed as "Zero Liquid effluent Discharge" plant and hence no pollutant is let out. On account of this there is no impact on the ecology consequent to the implementation of the distillery.

11.2. Distillery Plant Layout

11.2.1 As seen elsewhere, the layout enclosed to this report gives the location of all the sections of the distillery. The proposed Distillery Plant will be located in Thiruvallur District of Tamilnadu. The Main plant consisting of the fermentation section, Distillation section, Evaporation section and the product storage section is located on the Northern side of the complex. The Grain silos, fermentation section and distillation section are arranged next to each other in South to North direction with the Distillation / Fermentation section on the Eastern side. The Decantation and dryer sections are located adjacent to the Evaporation section. The product storage section will include all the daily receiver tanks and bulk storage tanks and the storage tanks shall be located as per PESO guidelines for storage of AA. The water treatment plant and Condensate polishing unit shall be located on the Western side of the main distillery equipment.

11.2.2 Another major section of the Distillery is the Boiler and the turbogenerator which provides the required process steam and the power for the operation of the distillery. As seen elsewhere in this report, the boiler will be firing Rice Husk / coal for the generation of steam required for the operation. The boiler, which will be of 45 TPH MCR capacity and will be located on the South western side of the distillery complex. The TG house to accommodate the 5.0 MW TG will also be located in the same area East of the proposed new boiler. All the electrical and instrumentation systems related to the power generation and distribution to the distillery will be located in a separate Electrical panel room adjacent to the TG building.

The Drawing enclosed with section 16 of the report gives the general arrangement of the boiler. The boiler will be provided with only an economizer and air heater is not provided mainly from the point of view of low temperature corrosion. ESP will be used for dust separation from the flue gases and the same is located between the boiler economizer sections and the ID fans. The boiler will be provided with a new RCC chimney of 62 m height.

An ash silo will be located in the area of the new boiler chimney. All the ash from the discharge points shall be stored in this silo for disposal to the fields as fertilizer.

11.2.3 The most important section of the distillery which is the product storage is located separately from the main distillation plant. The location of the product storage is also decided based on the requirement of easy accessibility for the excise authorities. Adequate approach roads shall be provided. The product storage will have the daily receiver tanks and the bulk storage tanks for Anhydrous Alcohol. There will also be a small bulk storage tank for the Technical Alcohol and Fusel oil. The product from the distillation section will be pumped to the daily receiver tanks. Each of the daily receiver are designed to accommodate the production made in a day. Once the daily receiver tank is filled at the end of the day and after inspection by the excise authorities, the product will be pumped to the bulk storage. All the pumps required for pumping the product to the bulk storage tank and for the final issue to the tankers will be located in the same area. This product storage area will be fenced and the daily receiver tank area will be kept in a lockable space.

11.2.4 Adequate construction space is available for the storage of materials of the various contractors and for them to carry out pre-fabrication work. Specific areas to be identified at the time of start of the site activities.

12.0 OPERATION AND MAINTENANCE REQUIREMENTS

12.0 General

12.0.1 This section of the report outlines the operation and maintenance philosophy to be adopted for the new 218 KLPD distillery plant with AFBC boiler and a 5.0 MW TG. These broad outlines given here will provide useful guidelines for the basic and detailed engineering of the plant, so that all the requirements of the operation and maintenance of the Distillery plant are met and provided for in the engineering stage itself.

12.0.2 The production of alcohol from Grains involves the interaction of several major sections of the distillery. The fermentation section supplies the fermented wash at the appropriate concentration of alcohol to the distillation section for further processing into AA. The MSDH section purifies the RS to absolute alcohol (AA) through molecular sieve dehydration system. The Boiler and turbo generator supply the steam and power requirement of the distillery for the various conditions of operation. The incoming grain and the product should be measured and stored appropriately for further distribution. The water treatment plant supplies the DM water required for the process and for the power plant. Different cooling towers circulate cooling water for maintaining appropriate temperature of the process fluids in the various sections of the distillery.

12.1 System Design Philosophy

12.1.1 The main O&M objective is the high availability and reliability of the plant. In order to achieve the main objective, the following principles would be adopted.

- Optimum margins on the operating parameters of all important equipment and auxiliaries and systems to ensure operation of the plant at rated capacity under all modes of operation.

- Providing redundant and standby capacity for all critical equipment.

- Use of Equipment and systems with proven design, performance and have a high availability track record under similar service conditions.

- Selection of the equipment and adoption of a plant layout to ensure ease of maintenance.

- Strict compliance with the approved and proven quality assurance norms and procedures during the different phases of the project.

12.1.2 The basic and detailed engineering of the plant will aim at achieving high standards of operational performance especially with respect to the following key parameters.

- Optimum efficiency of the equipment.
- Low Auxiliary power consumption.
- Low make up water consumption.
- Low process steam consumption
- No effluent discharge (Zero Liquid effluent discharge)

12.1.3 The plant Instrumentation and control system should be designed to ensure high availability and reliability of the plant to assist the operators in the safe and efficient operation of the plant. It should also provide for the analysis of the

historical data and help the plant maintenance engineers to take up the plant and equipment on preventive maintenance.

12.2 Operation Requirements

12.2.1 The operation of the plant starts with the Commissioning of the various sections of the distillery and the boiler. In broad terms commissioning can be defined as setting up of the plant to work safely and on program. It is necessary to ensure that all equipment is completely erected before operations begin. Although this may be considered difficult, the other extreme of operating a plant with insufficient instrumentation, controls and alarms is very dangerous. Although some compromise can be made with regard to plant completion, the commissioning procedures should never compromise personnel and the system safety.

12.2.2 A proper checklist must be drawn up, which shall include all the sections of the plant and shall take into account, the contractual responsibilities, the technological relationship between the various sections, pre-commissioning, cleaning requirements, etc. The checklists procedure helps in the following:

a) To ensure that the necessary checks are carried out on each item of the plant before it is put into commercial service.
b) To indicate a contractor's commissioning requirements from the client or from other contractors.
c) To ensure that energy is supplied to equipment or a plant when it is safe to do so.
d) To facilitate the recording of the progress on the various commissioning activities.
e) To provide a basis for the plant history.

12.2.3 The Operation of the multi product distillery is an activity that must be co-ordinated well with the factory management and marketing section of the factory to decide on the product mix of the distillery. In addition the raw material input quality and product quality shall be recorded and ensured at all times of operation of the distillery.

12.2.4 The operation of a multi product distillery demands closely controlled operating conditions. The unit start-ups, shut-downs and even emergency shut downs must strictly follow the carefully laid down procedures given in the operational Manuals. Generally, the plant shall be sufficiently instrumented to permit close checks on such operating parameters of the various columns in the distillation section and the various parameters in the fermentation section.

12.2.5 An important feature of the modern DCS system for the distillery plant is the automatic safety lock-out devices. While sufficient thought goes into it at the design stage, it remains the responsibility of the operating staff to ensure that the safety devices are set correctly and kept in operation.

While safety of the plant and personnel is the foremost importance in the operation, the efficient operation of the plant cannot be ignored. While operating, it is important to check the essential parameters of the plant and equipment to ensure that the plant performance is at the optimum level. Any variations in the operating parameters or any deviations from normal performance of the equipment or plant shall have to be analysed immediately to diagnose the problem and to take remedial measures to bring back the plant and equipment to its original parameters.

12.3 Distillery Operation

The detailed treatise on the operation of the distillery is beyond the scope of this **report. However, the important areas are highlighted.**

12.3.1 The factory should have a good quality control programme to establish product specifications, develop and implement sampling & testing methods and recording/ reporting of results. Quality checks must be in place to maintain consistent quality of the raw materials to reduce the chances of down stream processing problems stemming from the use of sub standard materials.

12.3.2 Effective testing and monitoring of fermenters is important to maintain fermentation efficiency and finished product quality. The fermentation section plays a major role in ensuring the efficient operation of the distillery. The specific gravity of mash, pH, Acidity, temperature, bacterial level, yeast count, concentration of alcohol has to be closely monitored to ensure the quality of down stream products. Low pH in the fermenter usually suggests a thriving population of bacteria, which, if left unchecked can disrupt both enzyme activity and yeast growth. Proper control of process temperature in fermentation section is very important for maintaining performance and quality. Proper control of microbial activities in the fermenters is essential to maximising the efficiency of alcohol production and in maintaining the quality of distillate.

12.3.3 Continuous checks on the quality of grain to assess its grade, Starch content etc., laboratory test for fermentation characteristics and alcohol yield potential are important. The

quality of water used for dilution should be good with out any bacterial contamination. Good scrubbing of CO_2 from fermenter outlet is necessary to arrest escape of alcoholic vapours. Wash feed rate into distillation column and product outflow rate should be monitored continuously. Precise control of multiple effect evaporation system in the distillation area ensures steam economy and optimisation of the auxiliary fuel consumption.

12.3.4 A properly implemented sanitation programme is essential for the distillery operation. This should cover establishment of physical, chemical and bacteriological cleanliness standards covering all areas of production, house keeping, process and maintenance equipment cleanliness etc.,

12.3.5 Effluent generation should be controlled and condensate polishing reduce the total water requirement for the distillery complex.

12.3.6 Ensuring good quality of water assumes greater importance for the distillery and the co-generation plant. Maintenance of water quality shall be ensured for both feed water and boiler water within limits for proper operation of the boiler and avoiding scale or deposit formation in turbogenerators. A routine check-up of the feed water quality during the start-up of the plant and also periodic check-ups result in the elimination of any serious problem due to the water quality. Similarly, the monitoring of water treatment plant and the water quality at DM plant outlet, the water quality at the inlet of the DM plant and cooling tower is of utmost importance.

12.3.7 The modern ethanol plant like the one envisaged for SLBEPL cannot be effectively operated without proper instrumentation

and control system. An effectively designed instrumentation and control system performs the following functions:

- Provides operators with the indication or record of the instantaneous, averaged or integrated value or condition of the various operating parameters such as temperatures, pressures, flows, levels, position of valves, switches, currents, voltages, power, etc.

- It also provides at convenient locations either local, remote or automatic control system to control the above operating parameters and gives alarms and even ensures automatic trip outs, when operating parameters reach beyond the normal range to the unsafe or undesirable range.

Instrumentation is increasingly taking over many functions of the operator. Its response to changing and transient conditions, its ability to anticipate, detect and discriminate faulty conditions and act accordingly is quicker and for more accurate if well designed. With the ability of the microprocessor based systems to include data acquisition and processing capabilities, the systems' ability, to log and process periodically the plant data, is also far superior and permits more timely corrective actions. Presently some of the responsibilities of the operation section are taken over by good instrumentation. The most difficult thing to be encountered in the initial stages of plant operation is the necessity to develop in the operation staff a faith in the instrumentation. Many times the operators' first response to a meter reading too high or too low is to disbelieve it on the ground that it may be reading incorrectly. If instruments are not checked and calibrated frequently an operator will delay taking corrective actions.

The plant operator should follow the guidelines given below:

- Frequent checking and calibration of instruments
- Developing a habit of cross checking instrument indications with each other to determine whether the instrument is faulty or there is an abnormal operating condition; and
- Developing a habit of analysing indicated data to determine accurately what could be wrong.

12.4 Maintenance Requirements

12.4.1 The main objectives of the maintenance section are to keep the plant running reliably and efficiently as long as possible. Reliability is impaired when a plant is thrown to forced and unforeseen outages. This aspect assumes greater significance in the distillery, since the profitability of the distillery entirely depends on the product output and the quality of the product.

12.4.2 Efficient operation implies close control not only over the cost of production but also over the cost of maintenance. There are two components in maintenance cost, one is the direct cost of maintenance i.e., the material and labour and the other is the cost of production loss.

12.4.3 There are two categories of maintenance work. One is the irksome breakdown maintenance, which is expensive. Much as it is desirable to avoid or minimize this, its existence must be accepted. Secondly, it is the preventive maintenance with proper planning and execution of plant and equipment overhauls. This maintenance activity should be clearly planned with regard to the availability of material and labour. It is also essential to develop proper inspection procedures with non-destructive

testing methods. Such inspections, by trained personnel reveal defects not necessarily detected by mere visual inspection.

12.4.4 The following help in reducing the breakdown maintenance and also help in planning for preventive maintenance.

- Careful logging of operation data/historical information from the DCS and periodically processing it to determine abnormal or slowly deteriorating conditions. Walk down checks of the plant.

- Careful control and supervision of operating conditions. Careful control of the raw material and products to ensure quality output.

- Regulate routine maintenance work such as keeping equipment clean, cleaning heat exchangers, filters, effectively executed lubrication program, effective operating supervision over bearings, commutator or slip ring brushes, mechanical seals, vacuum systems etc.

- Correct operating procedures.

- Frequent testing of plant equipment to determine internal condition of equipment such as heat exchanger and pump performance tests, generator and turbine shaft vibration tests, turbine lube oil testing, etc.

- Close coordination with the manufacturers to effect improve-ments in plant layouts and design, use of better material, introduction of such facilities as cathodic protection, use of better protective paints, etc.

12.4.5 It is extremely important that proper records are maintained not merely for the maintenance work done but also of the

material used and actual man hours spent, etc. Some sort of a card system shall have to be introduced to keep records that are most useful in future planning of outages and providing for effective control.

12.4.6 Another important requirement of a good maintenance program is to ensure that spares are ordered in time and good stocks of the frequently required spares are maintained.

13.0 MANPOWER AND TRAINING

13.1 General

13.1.1 Growth of industrial activity in the country in general and in particular the growth in the sugar, distillery and power generation industry, has brought about shortage of skilled and trained manpower. Hence, it is essential that the manpower requirement for the new distillery plant is well planned and a proper program of recruitment and training is thought of at the beginning stage of the project itself. **The Plant, operating and maintenance personnel must be trained and available before the plant commissioning commences and therefore, it is essential that appointments are made well before the programmed plant commissioning date.** The staffing and the organizational structure should be decided considering the specific requirements of the plant operation and the company practices.

13.1.2 The recruitment of the personnel required must be based on the rational assessment of the following factors:

a) The nature of the plant and machinery i.e modern distillery with multi product system, evaporation system, Boiler, in house power generation and distribution etc.,
b) Socio economic conditions.
c) Availability of personnel with the right back ground and experience.
d) Company's policy regarding recruiting permanent labour and contract labour.

13.1.3 Once the staffing is finalized and agreed, a suitable training scheme shall be programmed and implemented. The objective of the training program must be to equip each and every individual to carry out his particular function with skill and confidence. The training program shall be based on the classification of the main functions as Operation and Maintenance, and within this main classification, designed to cater to engineers, supervisors, skilled workers, etc.

13.2 The organisation proposed for SLBEPL's 200 KLPD Ethanol plant assumes that the distillery will have a General Manager in charge of complete distillery operations, who will be assisted by the Distillery Production Manager, Manager Utilities, Manager Purchase & sales, Senior Engineer in charge of Maintenance, Manager accounts and Manager Administration. There will be separate department headed by a senior engineer in charge of quality control and effluent monitoring who which will be reporting directly to the General Manager.

The staffing recommended here takes care of the operation, maintenance, procurement, administration and record keeping for the entire plant. There could be some overlapping of functions between the staff of various sections; however the responsibility of each group will be well defined. The drawing enclosed with Section 16 of this report gives the organization chart proposed for this project.

13.3 The Production Manager will be responsible for the various sections of the process plant operation. He will have Senior Engineers in each shift taking care of the operations, for the complete process plant, for the three shifts. The Distillery plant laboratory will be under the control of the Senior Engineer – process Operation. The Manager Utilities operation

will be responsible for the operation of boiler & auxiliaries, water treatment plant, fuel systems, Turbo generator, cooling tower, compressed air system etc. He will be assisted by the Senior Engineer Utilities. The senior engineer will have the boiler operators, TG and electrical system operator and the auxiliary systems operator reporting to him.

13.4 The Senior Engineer – process Operation will have the following persons assisting him for each shift operation.

- Supervisor - Instrumentation (1)
- Plant Operators - Fermentation Area (2)
- Plant Operators – Distillation and Evaporation area (1)
- Laboratory & ETP – Chemist - (1)

13.5 The Senior Engineer – Utilities Operation will have the following persons assisting for each shift operation.

- Boiler Operator - (1)
- TG and Electrical Supervisor – (1)
- Auxiliary system Operator – (3)

13.6 The Manager – Purchase & Sales will take care of the procurement of Grains, Chemicals, Product despatch, procurement of fuel, procurement of spares etc. In addition he will be responsible for co-ordinating with Excise authorities, plant stores and also transportation of goods. He will be assisted with the following persons in the general shift. Contract labour will be utilized for loading, unloading operations of the materials coming into the plant and going out the plant.

- Officer Procurement
- Store Keeper

- Loading Operator

13.7 The Distillery plant will have a separate Senior Engineer to take care of the maintenance of the plant. The Senior Engineer / maintenance will be assisted by the following persons for all the three shifts.

- Mechanical Technician (2)
- Electrical Technician (2)
- Instrumentation Technician (2)

13.8 There will be a separate Accounts manager, Accounts officers and Administrative officer for the complex.

13.9 The Quality Control and effluent monitoring cell is an important section, which serves both the operating and maintenance sections by providing useful feed back to the operating staff and valuable information to the maintenance staff on the performance and the healthiness of the various equipment. There will be a senior engineer in charge of this cell. The major responsibilities of this cell are :

a) To collect the daily operating data from the DCS system in the control room.

b) To analyze the daily plant performance data to detect departures from normal expected performance and to keep track of trends indicating gradual deterioration.

c) To establish from the design and plant acceptance test data, as well as after-overhaul test data norms against which day-to-day performance can be monitored.

d) To carry out frequent tests on the plant and individual equipment to determine their internal conditions to help maintenance scheduling.

e) To investigate special problems as and when they arise.

f) To monitor the quality of product and advice the process section for adjusting parameters.

g) To monitor the effluents and advice the process section and utilities section for achieving zero effluent discharge.

The analysis and the data provided by the quality control and effluent monitoring cell, enables plant operation and maintenance personnel to take suitable corrective actions promptly and with proper priorities.

13.10 The documentation of the engineering office is in the charge of the Senior Engineer - Quality control and effluent monitoring cell reporting to the Distillery General Manager. He is responsible for maintaining the master copies of all the technical documentation of the process area and utilities area. The Senior Engineer in charge of quality control and effluent monitoring cell will be assisted by One Designer for the functioning of the section.

13.11 The distillery will have a full fledged plant laboratory for the process and utility area. The plant laboratory will analyse the raw material, products, water quality in addition to growth of culture etc. There will be one Chemist for each shift, discharging the function in the laboratory, reporting to the Senior Engineer – process Operation.

13.12 Few labour contractors could be registered with a Company for meeting the surge load requirements of the operating and maintenance group to handle major break down / maintenance work. In addition to the above, sufficient number of contract labourers may be required for assistance in ash disposal, fuel feeding, cleanliness operation, loading and unloading etc.

13.13 The distillery will be a separate profit centre having its own accounts and administration departments. The Manager accounts will take care of the accounting and finance functions. He will be assisted by accounts officers. There will be manager in charge of administration who will take care of the Administrative activities, Services, Personnel, Legal, Security, Statutory authority cooperation etc.. The service activities like Secretaries, Office Assistants, Security, Driver etc could be on contract basis to be administered by Manager Administration. The manager administration will report to the General Manager.

13.14 It is necessary that SLBEPL identifies the General Manager and the other senior persons for the distillery at the start of the project itself so that they will be associated with the project during the initial stages of finalisation of the packages and the project execution by the Contractor. It is also necessary that the General Manager is assisted by Two Mechanical and One Electrical cum Instrumentation Engineer during the course of the project execution so that these Engineers could assume Senior Positions, later in the Distillery Operation. The other operating staff should be recruited three months before the scheduled commissioning of the distillery so that all the operating staff will be in position and will be ready to assume charges right from the commissioning of the project.

13.15 Training

13.15.1 The major objectives of the operational training shall be to acquaint the operators of the following:

- The nature, purpose and limitations of all plant and equipment.
- The detailed operating instructions of each section and equipment of the plant.
- Normal start up and shutdown program for the unit.
- The emergency procedures.

13.15.2 The basis for the training shall be the Plant's operating and Maintenance Manuals, which are compiled from the manufacturers' instructions, the contract documents and the drawings. In addition, the information gathered from the visits to the other operating plants and to the manufacturers works shall also be included in the training. Supervision and co-ordination of the training program requires full time attention of a senior executive of the plant, and the consultant's assistance may also be taken. **The training program shall include lectures, expositions by experienced plant operators and maintenance personnel, informal discussions and visits to operating plants and manufacturer's works. The training programme shall also include training provided by various vendors to the SLBEPL's operating personnel, during erection and commissioning of the plant and machinery of the distillery plant.**

13.15.3 The maintenance training program should be based on the requirements of the individual maintenance functions, like mechanical, electrical, instrumentation etc. The engineers and the technicians should be sent to the manufacturers' works to

witness the production and be associated with the erection of the plant and machinery.

13.16 The plant should be equipped with proper measuring/testing instruments for the periodic cross checking of parameters displayed in the control room monitors and plant area local gauges. Logging of data and periodic review of the plant operation, review of failures, break downs, etc. should be done to improve the availability of the plant. The proposed DCS based control system takes care of almost all the above requirements.

14.0 PROJECT IMPLEMENTATION AND SCHEDULE

14.1 General

14.1.1 The most essential aspect regarding the implementation of this "Zero Liquid Effluent discharge" Distillery complex consisting of 218 KLPD distillery with 5.0 MW Co-generation power plant is to ensure the project completion within the schedule, spanning for Eighteen(18) months from the date of ordering of the main distillery and the Boiler which are long lead items for the project. **While financial closure, permits and statutory authority clearances are being processed, tender documents could be floated for Distillery and the boiler after completing the basic design so that order can be issued for these long lead packages by 1st January 2022. The distillery project could be commissioned and commercial production can be started by 1st June 2023.**

14.1.2 With the final Detailed Project Report available by Lastweek of November 2022, SLBEPL will take action for the tying up of the finances for the project and will also finalize the land procurement. It is expected that the financial closure, permits & statutory authority clearance could be obtained by end of December 2022. The basic design and the tender documents preparation for the long lead items could be started so that the ordering of the main equipment could be done by First of January 2022.

14.1.3 A good planning, scheduling and monitoring program are imperative to complete the Distillery project along with 5.0 MW co-generation power plant on time and without cost overruns.

14.2 Project Team

14.2.1 The successful and timely implementation of the project and the avoidance of overspending and frustration depend on the performance of the project team. This project team shall be formed within the company and will be assisted by the consultancy organisation. This project team shall be directed by a Project Manager, who has experience in the implementation of similar projects. The engineers from this group should be involved from the early stages of the execution of the project, right from the engineering and procurement stages of the project. This would give them ample opportunity to familiarize themselves with the equipment and the systems being procured.

14.2.2 Subsequently, at the time of installation at site, these personnel should be involved with the critical phases of installation and commissioning. These engineers should also be trained at the distillery plant & machinery manufacturer's works and or at similar plants operating elsewhere. After the plant has been commissioned, these engineers would occupy key positions in the organizational structure for the operation and maintenance of the plant. This approach ensures a smooth transition from engineering and procurement to erection and commissioning and finally to operation and maintenance.

14.2.3 The responsibilities of this project team shall be;

a) Plan and program all the work and resources required for the project completion.
b) Project engineering and co-ordination involving the Design of the plant, plant support systems and the inter-package engineering.

c) Co-ordination with various vendors and furnishing data at terminal points.
d) Inspection of the major items and expediting.
e) Organize the construction and commissioning of the plant by progressively integrating individual systems.
f) Monitor and control the project progress with regular interactions and co-ordination.

14.3 Contract Strategy

14.3.1 The first step to be taken in the execution of the project is the constitution of an appropriate project organization, as discussed above, which would be responsible for the execution of the project. The development and the size of the project organization must be based on the tasks that need to be performed in the project. For a Distillery complex project the following are the identified important phases. These phases are not mutually exclusive and some degree of overlapping is envisaged.

- Appraisal of the Project Report by Financial Institution.
- Financial Closure
- Statutory authority clearances.
- Planning, marketing of the products and outlets.
- Procurement of Packages including Inspection and Expediting.
- Inter-package Engineering.
- Project management
- Construction Phase.
- Commissioning and performance testing.

14.3.2 The plant should form an effective Project management group within their organization for the project execution involving the above mentioned phases of the project. The consultancy organization shall take care of the procurement, inter-package engineering, project engineering and will technically assist the project team in the other activities.

14.3.3 The nature of the project calls for the division of the project into recognizably discrete plant areas with specific terminal points that can stand alone for engineering and contract purposes. An appropriate contract strategy involves, the decision on the number and the type of contracts to be let, vendor evaluation, formulation of contract agreement defining respective obligations, the basis for discharging them and remedies for default.

The major points to be considered in packaging are:

- The packages proposed are compatible, which ensures adequate competition in bidding and consequent procurement at optimum cost either within the country or from overseas vendors.

- The packages include such combination of equipment and services that can be advantageously engineered for the preparation of specifications for bidding and subsequent design including manufacture/construction.

- The packages formed are mutually exclusive as well as collectively exhaustive.

- The number of packages and their sizes are optimum for effective implementation.

- The terminal points of each of the packages are clearly defined and proper tie-ups of these points between the packages are ensured.

14.3.4 The following gives the tentative list of contract packages for this project. Each package is an EPC package, wherein, the responsibility of engineering, procurement and construction is left to the vendor with guarantees for each package clearly defined. The package route also gives an advantage in choosing the vendor considering the availability of after sale service, spare parts, factory preferences and technical support from the vendor.

- Distillery process area with fermentation, distillation, evaporation, electrical within the process plant area and Product storage sections.
- Grain Handling and Milling section
- Condensate & Spent Lees treatment and polishing.
- Boiler and auxiliaries
- 5.0 MW co-generation TG with its auxiliaries
- DDGS Dryers
- Balance of plant mechanical system consisting of plant piping system, product and daily storage tank for the distillery, distillery building structures, Air conditioning & ventilation system, piping from boilers/TG to distillery process area, utility piping up to distillery battery limit, fabrication of tanks for the utilities, fire fighting system etc.
- Balance of plant electrical system consisting of transformers, Electrical distribution, MCC, PCC, cables, lighting & installation package
- DCS for the process and utilities and Balance Of Plant (BOP) Instrumentation Package
- Civil works package

14.3.5 Preparation of the Tender Specifications, obtaining offers from qualified bidders, technical and commercial evaluation of offers, finalization of the vendor, formulation of the contract agreement, contract reviews, vendor drawing review and approval etc. are the major activities for each of the packages. The scope of the package vendors will be the design and engineering, procurement, manufacturing, inspection, testing, transportation to the site, installation and commissioning & performance guarantee of the respective packages.

14.3.6 The specifications for major equipment like the Boiler, turbogenerator, cooling towers, Distillery process area equipment etc., technical information of which is essential to the development of the plant design and in particular to the civil design, shall be drawn up at an early stage of the project. Program of design information submission from the mechanical and electrical contractors that satisfies the overall project schedule shall be drawn up. The most important among such information are the location of the individual plants, floor loading, support requirements etc. which are required for the civil design.

14.3.7 Since the project execution calls for closer coordination among the contractors, consultants and the power plant, proper contract co-ordination and monitoring procedures shall be formulated. Detailed bar charts or networks shall be made to plan and monitor the project progress. Contract drawings and documents requiring approval from statutory authorities shall be clearly identified and scheduled so that the procedural formalities do not affect the project progress.

14.3.8 Procurement

14.3.8.1 Procurement is an important function in the implementation of the Project. The procurement of the systems equipment and services will be through a series of suitably packaged contracts as outlined earlier. The Project team with the consultants floats the enquiries with the appropriate commercial conditions, delivery requirements, guarantees etc. to renowned suppliers. The technical specifications for the procurement of the equipment and systems will be provided by the consultants.

14.3.8.2 Evaluation of the offers is done by the consultants, with coordination form other related members of the project team, based on the evaluation criteria stipulated in the tender documents. After evaluation and taking a decision on placement of the order, the contract agreement with commercial terms and conditions, delivery schedule and guarantees etc. are drafted and purchase order placed on the selected bidder. Once the purchase order is placed, the project team follows up regularly to ensure smooth and timely execution of the contract and for obtaining technical information for the inter-package engineering. The procurement activity includes the review of the vendor drawings by the consultant/project team, expediting, stage and final pre-delivery inspection, supervision of installation and commissioning.

14.3.8.3 When the contract for the packages are awarded, detailed program in the form of network are tied up with the contractor to clearly indicate the Owner's obligations and the supplier's responsibilities. The factory inputs are in terms of land availability, construction power and water availability, civil fronts, etc. while that of the contractors are in terms of drawing submission, manufacture, supply, transportation,

erection and commissioning. The progress for each work package against the schedules drawn up is evaluated regularly. Such evaluation indicates the causes for the delay, if any, in meeting the schedules and identifies actions to be taken for rectifying the delays.

14.3.8.4 To expedite supplies from the contractors, regular visits to the supplier's works will have to undertaken by the project engineers/consultants. The manufacturing program and the quality plans finalized at the time of contract award are utilized by the engineers for the monitoring of the manufacturing and quality status. Regular reports shall be prepared indicating the schedule variations, if any, their likely impact on the delivery schedule and the recommendations to meet with the schedules.

14.3.9 The Construction Phase

14.3.9.1 This is the critical phase of the project where work progresses in almost all the fronts. The erection and commissioning phase of all the contracts proceed simultaneously and it is important to ensure that the various contractors have adequate facilities and are established on the site in time to meet their programmed commitments. Adequate power and water shall be made available for the construction.

14.3.9.2 The construction manager from the Distillery plant side takes the overall responsibility of the site, assisted by the resident engineer from the consultant's side. The construction team's key task is to continuously monitor the site progress against the agreed program and to initiate whatever corrective action is necessary to maintain satisfactory site progress. During the execution stage of the project at site, quite a few of the various contracts progressing simultaneously are interrelated

and hence, the delay in the activities of one contractor will invariably affect the progress of the other contractors and ultimately the project progress.

This aspect emphasizes the importance of progress review, project monitoring and timely remedial measures, for the smooth and `within the budget' execution of the project.

14.3.9.3 Certain basic responsibilities of the construction management are:

a) The contractors shall be encouraged to give the earliest possible warning of actual or potential difficulties.
b) Ensure that the senior management in the contractors' organisation are made aware of the serious problems at an early date.
c) Provide a focus for early discussion of any potential problem and possible remedial measures, while clearly maintaining the contractor's responsibility for recovering delays.
d) Help to foster a climate among all concerned that no extension of site deliveries and erection schedule are allowable.

14.3.9.4 A fortnightly progress review meeting will be held with each contractor, where formal reports are tabled, giving an agreed progress statement. From these agreed progress statements, an accurate prediction of the state of the project is available which helps the construction team to adjust, if necessary, the activities of the particular contractor and also the activities of any affected contractor.

14.3.9.5 Major problems such as non-availability of drawings, clarifications, documents from various disciplines of engineering group, non-receipt of required materials from the various

contractors, reasons for the default, remedial measures initiated, impact of such delays on the project progress will be taken up and resolved in the progress review meetings.

14.3.9.6 Interface problems among engineering, contracts and site groups of the Owner/Consultant and between the factory and the contractors affecting the project progress will also be reviewed and appropriate decisions taken to expedite the release of drawings, materials and such other requirements.

14.3.10 Plant Commissioning

14.3.10.1 The commissioning phase in a project is the one where the design, manufacturing, erection and quality assurance expertise are put to test. The commissioning team for each plant will consist of representatives from the contractor, consultant and the power plant. As discussed earlier, it is essential to associate the staff identified to operate the plant in the commissioning stage itself.

14.3.10.2 When construction work is complete, the checklists, designed to ensure that the plant has been properly installed and appropriate safety measures have been taken are gone through and all the documentation pertaining to the statutory inspections and approvals are presented, the commissioning team shall take over. The commissioning team will follow scrupulously the commissioning and operating instructions laid down by the plant & equipment manufacturer/supplier, to prove that the plant/equipment is in every respect, fit for service. The plant shall be subjected to a performance test, after the stipulated trial operation and the reliability run. After the successful completion of the performance test the plant will be taken over by the power plant.

14.4 The Responsibilities of the Factory

14.4.1 Since the Distillery project is coming up in a newly procured land, it is important that the area identified for the Distillery plant is cleared for the early start of the civil work. The soil investigation and site grading shall be taken up in the very beginning so that the civil work can proceed without any hindrance. The site development shall include the levelling of site, clearing the site for construction of the Distillery process section buildings, identifying or constructing adequate storage space, providing lighting, water connection, construction power in the work area, etc.

14.4.2 It is essential that before the Zero Date of the project all the clearances from Government & statutory authorities are obtained. **It is also essential that uninterrupted fund flow is ensured for the successful execution of the project on schedule.**

14.5 Project Schedule

14.5.1 The schedule envisages the project commissioning and synchronization in Eighteen (18) months from the date of ordering of the Boiler and the distillery process plant.

14.5.2 For the major packages, the schedule includes the following applicable activities. The time period requirement for these activities has been included in the periods shown against each package.

a) Basic Study

b) Tendering

c) Receipt of offers, evaluation, discussions and Purchase order placement.

d) Manufacturing and delivery

e) Erection and other work at site

f) Commissioning, trial run and testing

14.5.3 In the Distillery plant and the Boiler are the long lead items and the planning of the schedule for the project implementation should provide adequate time period for the installation of these equipment.

14.5.4 Once the project gets started, it is essential that a more detailed bar or network chart is prepared incorporating all the contract activities, so that the planning and the monitoring is effectively carried out.

15.0 PROJECT COST ESTIMATE

15.0 Methodology of Cost Estimate

This section of the Detailed Project Report gives the project cost estimate for the proposed 218 KLPD Ethanol plant and a 5.0 MW Cogeneration power plant at SLBEPL's proposed distillery plant. The distillery and the utilities will be located as discussed in the earlier sections of this report. T**he project will be executed through the package route and not through the EPC route.** The cost estimates are based on the recently finalized orders for similar plant and equipment and from the data bank of Avant-Garde.

The costs indicated in this section include all taxes and duties and erection and commissioning.

Tables 15.1 and 15.2 give the estimate of the project cost. The Table 15.1 cover all the works costs for the project. Table 15.2 gives the total project cost inclusive of the pre-operative cost, interest during construction and the working capital margin.

The works costs are divided into Land, civil, Process plant, Boiler, TG and Balance Off Plant. All the commissioning spares required for the commissioning of the project are included in the cost. **However as the two year operational spares are not capital items, they have not been included in the cost estimate**. The cost of the two year operational spares will be approximately 2% of the equipment costs.

15.1 Cost of Civil Works

The cost of civil works include the cost of the land, cost of survey and soil investigation, cost of all the plant buildings, equipment foundations, pipe rack and conveyor foundations, cooling tower, RCC chimney for the Boiler and its foundation and drains and trenches. The civil cost also includes the approach road to the distillery plant equipment. Considering the topography of the proposed site, cost of site grading and levelling is included in the civil works cost.

As a detailed soil investigation has not been done for the area where the proposed distillery will be located, the cost of foundations had been worked using the typical soil characteristics from the data bank of Avant-Garde. The soil is assumed to be clayey and the soil bearing capacity is moderately assumed at 14 T/Sq.m at the depth of 2.5 meters. This soil characteristics necessitates normal raft foundation for all the foundations. The foundation cost had been estimated on the above basis. Separate Raw water reservoir for the storage of the plant's requirement of the raw water is envisaged for the distillery. The water for the distillery will be drawn from the deep bore wells,

The civil works cost also include the cost of land for locating the complete distillery plant. The civil cost for non-plant buildings like a new administration office, temporary site offices and staff quarters, temporary stores, vehicle parking sheds, etc., and Separate workshop and stores are not considered in the project cost. A separate laboratory has been considered for the distillery.

The civil work quantities and the cost of civil works given are only estimates and will have to be suitably modified and firmed up after the equipment supply is finalized and adequate data regarding the loading and dimensions of equipment are available from the manufacturers and suppliers during the engineering stage, and also on the actual soil conditions encountered at different stages of construction.

Around 25 acres of land is required for the installation of the Grain based distillery plant with sufficient Greenery. The cost of Land is expected to be Rs. 3000 Lakhs. The total Cost of civil works including land is estimated to be Rs. 4880 Lakhs.

15.2 Cost of Plant Machinery

The cost of the Plant Machinery include the process sections of distillery, Boiler, Turbo Generation and Balance off Plant. The distillery process plant, Rice Husk & Coal fired boiler and turbogenerator are the major ones in the project and have substantial influence on the cost of the project. The costs for the above are based on the recently finalized orders for similar equipment.

The distillery process plant cost includes the cost for fermentation, Grain handling & Milling section, distillation section, decantation & DDGS dryer section and storage of the product and raw material. The distillery will produce AA as specified in earlier sections. The impure spirit or Technical Alcohol, fusel oil and DDGS will be the by products. The CO_2 generated in the fermentation section could be utilised by installing a bottling plant consisting of cleaning and drying system for the Carbon-di-Oxide gas emanating from the fomenters. This carbon-di-oxide has a variety of uses in the

food & beverage industry, welding and pharmaceutical industries etc. **However, this report does not include the addition of Carbon-Di-Oxide plant to the distillery. It is proposed to sell the raw Carbon-Di-Oxide produced from the distillery as there are others who are willing to put up a CO2 plant near the distillery and take the CO2 from the distillery.**

Included in the cost of the boiler are the auxiliary systems like the fans, boiler feed water pumps, deaerator, dosing system, desuperheating system, pressure reducing and desuperheating stations (PRDS) for meeting with the process steam requirement, Ash handling system with silo, piping, instrumentation for the complete boiler package etc.

The cost of the turbogenerator includes the cost of all its auxiliary systems like lube oil system including the emergency lube oil system, governing system, turbine and generator control system, generator protections etc., The power generation is at 11000V from the turbogenerator for power distribution within the distillery.

The Cost of Balance of plant includes the cost of conveying the fuel, Condensate treatment plant, Raw water treatment plant, Cooling towers, Aux pumps, Interconnection piping & cabling between various sections, Air compressors, Fire fighting system, Air conditioning system, MCC, PCC & VFD Panels, DG Sets, DCS System and plant instrumentation.

The fuel handling system will be with belt conveyors and slat chain conveyors and the fly ash handling will be based on the dense phase pneumatic handling system. The main fuel storage yard for the Rice husk will be a closed storage shed. From this

Storage yard, system of conveyors will be installed to feed Rice Husk to the Boiler.

To meet cooling requirement of the auxiliaries of the plant like the oil coolers, generator air coolers etc., a Air cooled type cooling arrangement is included in the project. The cost of the such air cooled condenser, the cooling water pumps and the piping from the cooling water pumps, to the various equipment and the return piping from the equipment to the cooling tower are included in the cost estimate. This will be in addition to the process cooling towers which are already included in the process plant.

In the distillery and for the boiler, the supply of treated good quality water to the boiler and distillery is an important factor for the reliable operation of the plant. This calls for a suitable water treatment plant which will supply the treated water to the boiler and distillery to the required quality. The necessary membrane system based water treatment plant is included in the cost estimate.

The costs of all the electrical & Instrumentation equipment are estimated, in the same way the cost of other mechanical systems is estimated. For the cost estimate for the electrical and instrumentation items, in house data of Avant-Garde and the data based on similar projects have been used.

The power generation in the proposed back pressure 5.0 MW TG will be at 11 kV level in the distillery. The project cost estimates include, auxiliary transformers, cabling, protection system, etc. The internal power distribution for the distillery, Thin stillage evaporation etc., and plant is considered in the project cost estimate. All the cost towards the distribution

transformers, Power control centres (PCC), Motor Control Centres (MCC), Variable Frequency Drives (VFD) for meeting the internal power requirements are included in the cost estimate. Judicious use of the VFDs have been made to reduce the internal power consumption of the plant.

The cost of cabling from the co-generation plant to the distillery and protection devices required are also included in the distillery plant cost estimation.

The plant operation and control is envisaged through a well designed Distributed Control System (DCS). All the field instrumentation is included in the scope of the individual package suppliers. The package suppliers will terminate the signal cables at the I/O rack of the DCS. The scope of the DCS system supplier will be to take the signals at the I/O racks, process the signals and give the output signals at the I/O racks for the individual package suppliers to take the same for operation of the control elements in the field. The cost of the complete DCS system along with the cost of the balance of plant instrumentation is included as part of the cost estimate for the project.

The cost of Process plant is estimated to Rs. 9800 Lakhs. The cost of Boiler and TG are estimated to be Rs. 3190 Lakhs and Rs.850 Lakhs respectively. The cost of the Balance of plant system (Mechanical, Electrical and Instrumentation) is estimated to Rs. 3625 Lakhs. The miscellaneous fixed assets are estimated to be Rs.45 Lakhs. The total works cost for the complete 200 KLPD Ethanol plant with the 5.0 MW Power Plant works out to be Rs. 22,390 Lakhs. This cost is inclusive of GST of 18 % average.

15.3 Contingency

The project implementation is expected to be completed in about fifteen (15) months from the date of issuing order for major equipment which are the process plant and Boiler. There could be some escalations in the cost because of the escalation in the price of the commodities. As the detailed engineering is not yet completed, the budgetary specifications used for getting the budgetary quotes are likely to undergo some changes when the purchase specifications are issued after the detailed engineering of the project. To accommodate all such variations, a contingency provision of 3% is made on the non-firm costs (all the costs estimated are non-firm at this point of time). The calculated contingency for this project is Rs. 672.00 Lakhs.

15.4 Project Financing

SLBEPL will be approaching any reputed financial institution for the funding of this ethanol distillery and Cogeneration projects. For the purpose of this Detailed Project Report, SLBEPL has assumed the following with regard to the funding.

- The Debt Equity Ratio is assumed to be 19.0. The promoters' equity shall be 1% of the project cost. The contribution from Term loan will be 95%.

- It is assumed that the interest rate for term loan will be 8.0%.

- The maximum loan repayment period inclusive of the moratorium will be Eleven and half (11.5) years. It is also presumed that the moratorium period will be One and half (1.5) years and

the moratorium period starts from the first loan disbursement. The repayment will be in Forty (40) Quarterly instalments.

- It is also assumed that the disbursement of term loan will be made available only in the third quarter after the project "zero" date. As the processing of the term loan takes time and based on the past experience this assumption is made. To meet with the project fund flow requirement, apart from pumping in the equity, the company will have to make some arrangements for a bridge loan. It is assumed that the cost of bridge loan will be 9.0% and the interest is included in IDC and capitalized.

15.5 Other costs

15.5.1 Preliminary expenses.

Preliminary expenses include the cost of the initial studies, Environment Impact assessment studies, statutory authority clearances, project management, travel, third party inspection charges, training, plant start up and all such expenses prior to the start of the project itself.

The preliminary expenses also include the site clearances, arranging construction power and water requirements for the various contractors, arranging space (both open and covered) for the storage of the equipment and materials at the site and space for the pre-fabrication for the various contractors, arranging site communication facilities, accommodation for the visiting personnel related to this project. The estimated cost under this head is Rs.300.00 Lakhs.

15.5.2 Cost of Technical Know how and consultancy

The cost estimate provides the estimated Consultancy fees for the detailed engineering services and for the construction and commissioning supervision services for the distillery project. The estimate is Rs. 200.00 Lakhs.

15.5.3 Interest During Construction

The interest during the construction (IDC) period is capitalized to calculate the total project cost. The rate of interest considered in the computation of the IDC is 9.0 % for term loan from the financing institution. In the computation of the IDC, the project fund flow what is required for a project of this nature proposed for SLBEPL is considered. The Table 15.3 gives the, quarterly project fund flow and the IDC calculation, drawl of loan etc. The project construction period is taken as Fifteen (15) months.

While calculating the IDC, considering the fact that the processing of the term loan takes some time, it is assumed that the drawl of the term loans from the Financial Institution will commence only from the third quarter of the project construction period. The project's fund flow requirements for the initial period will be met with the Equity and a short term bridge loan. An interest rate of 9.0% is assumed for the bridge loan.

The IDC calculated for the proposed SLBEPL project is Rs.669.95 Lakhs.

15.5.4 Working capital margin.

The working capital is required, to take care of the expenses, for the running of the Distillery plant, like purchase of fuel for the boiler, purchase of Feed stock for the distillery operations, and Repairs and Maintenance expenses. In addition the working capital is required to tied over the situation due to the non receipt of the receivables and holding the stock of finished product in the bulk storage tanks and raw material for a period of 30 days. The estimated working capital for this project is Rs.6374.98 Lakhs. Seventy Five percent of this working capital will be raised as short term loans and the balance will be the margin money for the working capital. The estimated working capital margin for this project is Rs.1593.75 Lakhs and this is capitalized.

15.5.5 **Cost of Arranging for the Finance:**

It is assumed that the expenses towards the arranging and processing of the term loan will be One (1) percent of the term loan value. This also includes the legal fees and the stamp duty etc

15.6 Total Installed Project Cost

The total works cost for the proposed Distillery project is Rs. 22390 Lakhs. The total installed project cost inclusive of the pre-operative expenses, contingency and working capital margin is estimated to be Rs. 27020.07 Lakhs.

SL.NO	DESCRIPTION	UNIT	QUANTITY	RATE (Rs)	WORKS COST Rs. In Lakhs
A	CIVIL WORKS				3000.00
1	Land				
2	Land Development, grading & Levelling				50.00
3	TG Building				380.00
4	Plant Buildings for the Fermentation Control Rooms, Electrical rooms, WTP Alcohol Issue area				350.00
5	Foundation for the complete distillery & power plant & Tanks, grain handling, DDGS Dryer etc.,				490.00
6	Raw Water Tank				140.00
7	Conveyor Foundations				60.00
8	Road and Drain Work - Land & Site				120.00
9	Pipe Rack Support & Cable Rack				130.00
10	Concrete Chimney				160.00
	TOTAL FOR CIVIL WORKS				**4880.00**
	MECHANICAL WORKS				
1	Complete distillery plant (fermentation distillation, evaporation) including Grain storage (60 days) , handling & milling, liquefaction & Saccharification, DDGS Dryers, Interconnecting piping, structural supports, Cooling tower & Pumps MCC & VFD Panels etc..	No.	1		9800.00
2	Day receiver and Bulk Storage Tanks for the products				450.00
3	Condensate & Spent lees treatment and Polishing				560.00
4	45 AFBC Type Steam Generator including ESP, fans, pumps, valves and specialities piping, PRDS, Ash handling system, MCC & VFD Panels and other Auxiliaries	No.	1		3190.00
5	MW Back Pressure turbogenerator unit, including all auxiliaries, piping, governor turbovisory, controls and Instrumentation and MCC Panels.	No.	1		850.00
6	Fuel handing system with all its accessories	LS			150.00
7	Induced draft cooling tower For Power Plant	LS			20.00
8	Centrifugal Pumps(BOP) with base frames and electric motor drives for the Distillery and Cogeneration plant	LS			30.00
9	Steam, Water piping and valves & supports from the power plant. Tanks for DM & Process water.	LS			300.00
10	Water Treatment plant	LS			220.00
11	Power House EOT Crane	LS			30.00
12	Air Conditioning system & Ventilation system for the TG building, MCC room & control rooms in process plant & cogen. Plant	LS			60.00
13	Air Compressors for both Process and cogeneration plant	LS			50.00
14	Fire Protection Systems for the process and cogeneration plant	LS			440.00
15	Laboratory Equipment	LS			35.00
16	Weigh Bridge				30.00
	TOTAL FOR MECHANICAL WORKS				16215.00

	INSTRUMENTATION WORKS				
1	Distributed Control system & Misc. Instrumentation other than those covered by other packages and UPS				180.00
2	Balance of Plant Instrumentation				150.00
	TOTAL FOR INSTRUMENTATION WORKS				**330.00**
D	ELECTRICAL WORKS				
1	Plant Electrical Package including Transformers, cables, LT Panels, VFD Panels, contract package etc.				780.00
2	DG Set Package	Nos	2		140.00
	TOTAL FOR ELECTRICAL WORKS				**920.00**
E	MISCELLANEOUS FIXED ASSETS				
1	Furnitures for Office, WTP building office including computers, EPABX etc.				15.00
2	Furnitures for process control rooms and office				10.00
3	Plant Vehicles				15.00
4	Office Air Conditioning & Ventilation Equipment, Lighting, s etc.				5.00
	TOTAL FOR MISC. FIXED ASSETS				**45.00**
	TOTAL WORKS COST				22390.00
	Basic Works Costs				
	Civil Works				4730.51
	Plant And Machinery				14800.85
	Misc Fixed Assets				38.14
	Total works cost (Basic)				19569.49
	Average GST On the Works Cost				2820.51

1	SUMMARY OF PROJECT COST	ESTIMATE (Rs. In akhs)
1.1	Land	3000.00
1.2	Buildings And Civil Works	900.00
1.3	Plant And Machinery and Misc. Fixed Assets including foundations	18490.00
1.4	Preliminary expenses. *	300.00
1.5	Technical Knowhow Fees	200.00
1.6	Contingencies (~3%)	672.00
1.7	Front end Fee to the FI (@ 1 % of the Loan Amount)	256.69
1.8	Working Capital Margin	2531.43
	Total Cost Including contingency & WCM But Excluding IDC	26350.12
2	CALCULATION OF INTEREST DURING CONSTRUCTION	15.00
2.1	Construction Period (Months)	9.00
2.2	Rate Of Interest for Term Loan (%)	
2.3	GOI's Interest Subvention (50% of the Interest or Rate or 6% whichever is less)	50.00
2.4	Actual interest Rate for term loans	4.50
2.5	Rate of Interest for Bridge Loan **	10.00
2.6	Debt Equity Ratio	19.00
2.7	Total IDC Rs. in Lakhs	669.95
3	Total Project Cost Including IDC & WCM Rs. in Lakhs	27020.07
4	Equity Rs. in Lakhs	1351.00
5	Term Loan Rs. in Lakhs	25669.06

16.0 FINANCIAL ANALYSIS

16.1 General

This section of the report gives the financial viability analysis of the proposed 218 KLPD Green Field Grain based distillery project of SLB Ethanol Private Limited., (SLBEPL) which will be located at a newly procured land in Thiruvallur District of Tamilnadu. The financial analysis based on the cost estimates given in the earlier section on the 'Project Cost Estimate' and on the technical data on the input and output and the operating costs discussed in the various sections of the report. The financial analysis gives the details of the operation and profitability, cash flow for a period of ten (10) years from the date of commissioning of the project facilities. The analysis also gives the Internal Rate of Return (IRR) for the project, Debt Service Coverage Ratio (DSCR) and payback period.

The Financial viability of the project is worked out based on certain assumptions.

16.2 Mode of Financing

The total project cost with the interest during construction and working capital margin is estimated to be **Rs.27020.07** Lakhs. 95% of the project cost will be funded by Financial Institution. The total project cost will be funded with, an equity of Rs. 1351 Lakhs, Term loan of Rs. 25669.07 lakhs

Based on the information provided by SLBEPL, it is assumed that the term loan from the FI will be available at an interest rate of 8.0% and the repayment will be quarterly over a period of Ten (10) years with a moratorium of One and Half (1.5) year.

16.3 Plant Operation

The proposed plant will produce Anhydrous Alcohol (AA). The capacity of the plant in terms of total spirit production is 218 KLPD. And the plant can produce 200,000 Litres per day of AA. The plant will also produce as by product, 6540 Litres per day of Technical Alcohol and 200 Litres per day of Fusel Oil. Eventhough the plant is capable of operation in RS, only AA production is assumed for the study of the viability of the project. This assumed product is based on the potential for growth in the consumption of AA, and based on the fact that the blending with gasoline is likely to take off seriously and there is shortage in the availability of anhydrous alcohol to meet even 10% blending.

The raw material for the production of alcohol is grains. The plant will operate for 335 days in an year with Broken rice as feed stock, and will produce AA. The starch content in Broken rice is 68%. Based on the feed stock availability and pricing, the plant can operate with other grains like maize and millets as feed stock.

The landed cost of Broken rice shall be Rs. 17000 per MT.

The distillery will generate the necessary steam and power in house. There will be no external steam or power supply for the distillery operations. The process steam requirement during Grain based operation will be met from a 45 TPH AFBC Boiler. The viability of the project is studied by considering year around operation of 335 days with Coal. The estimated coal consumption in the plant to supply steam to Distillery will be 6.88 TPH. The cost of Coal is assumed as Rs. 7626 per MT.

In Addition, Rs. 400 / MT of Levy and Rs. 400 / MT of Inland transportation cost is applicable on the above cost.

The high pressure steam generated in the boiler will be used in a Back pressure turbine to generate the required quantum of power for the operation of the distillery.

The fermentation process will also produce Carbon-di-oxide along with ethyl alcohol. The 200 KLPD AA productions will be accompanied by 165.43 TPD of Co2 production. This CO2 comes out of the fermenters and as the fermentation process is a batch process all the CO2 is not recoverable as some of the CO2 produced will be diluted with air. About 70% of the produced CO2 could be recovered for purification and that quantity comes to 115.8 MT per day.

16.4 Alcohol, DDGS and CO2 Production and Sales

The plant will produce 670 Lakh litres of AA per annum, from the Second year of operation, once the capacity utilization reaches 100%. In addition, the plant will also produce 21.91 Lakh Litres of Technical Alcohol and 0.67 Lakh Litres of Fusel oil. The prevailing sale price of AA from Broken Rice is Rs. 51.55 per litre. The price of TA and FO is expected to be Rs.25 per Litre. In the viability analysis, certain escalations are considered on the above indicated sale prices which are as listed below.

5% Yearly Escalation is considered for cost of coal. Raw water, Technical alcohol, Fusel Oil, CO2, Repairs & maintenance, Utilities, Salaries & wages, Administrative expenses. 2.5% yearly Escalation is considered for cost of Broken rice and DDGS. For the selling price of AA, the price is taken as

constant for first five (5) years and then an increase is 5% is considered for the next five years.

During operation of the plant with Broken rice as feed stock, around 88.89 MT per day of DDGS will be produced. The expected selling price of this DDGS shall be Rs. 24000 per MT.

SLBEPL shall initiate discussions with potential business houses interested in taking the raw Carbon-di-oxide produced in the distillery. The selected company will put up the facility for the purification and bottling of the Carbon-di-oxide, adjoining the distillery and taking the raw CO2 from distillery. It is assumed that the raw CO2 supplied to the purification plant will fetch a price of Rs.2.00 per kg of CO2.

16.5 Other Input Costs:

The distillery plant uses a lot of chemicals and utilities for its operation. The chemicals are used for various applications from being a nutrient to yeast, for pH correction, cleaning, preventing scaling etc. The major chemicals are urea, Di-ammonium phosphate, sulphuric acid, anti foaming oil, nitric acid, phosphoric acid, caustic soda, Alpha Enzyme, Beta Enzyme etc. .

Apart from the various chemicals, the plant also uses a lot of raw water, Demineralised water and soft water for the process as well as for the boiler make up. The DM plant is part of the distillery and the cost of the DM plant and its operation costs are already included in the project cost and other operating costs.

Other Utilities Cost:

A provision of Rs.400 Lakhs per Annum is made towards the Cost of Balance of the Utilities, Other Chemicals & Yeast Culturing. This also includes the cost of chemicals and other consumables used in the plant occasionally or in small quantities.

16.6 Operation and Maintenance Cost

The repairs and maintenance cost for this project is assumed as 2.0% of the works cost of the plant and machinery which comes to Rs.349.3 Lakhs per annum for the first year. In reality this cost will not be incurred in full for the first year of operation as the plant will be under warranty. Still this cost is considered for all the operating years from fourth year onwards. The salaries and wages of the operation and maintenance personnel of the plant and the administrative expenses are respectively considered as Rs.800 Lakhs and Rs.200 Lakhs per annum.

16.7 Insurance

The cost of insurance, for the distillery and cogeneration plant equipment has been taken to be 0.38% of the cost of the plant and machinery and the civil works. This cost works out to Rs.84.91 Lakhs per annum.

16.8 Depreciation

A straight line depreciation rate of 3.34% for the buildings and civil works and 6.33% for the plant and machinery is considered in the financial analysis. For Income-tax calculation purposes, 10% depreciation for buildings and civil works and 15%

depreciation for the plant's plant and machinery, on the Written Down Value (WDV) is considered.

16.9 Sales and Profitability Statement

The saleable products are AA, DDGS, Technical alcohol, Fusel oil and carbon-di-oxide. The interest for the working capital loan is taken as 8.0%. An amount of about 30% of the total working capital requirement is considered as margin money and the balance is considered as loan from banks.

Provision is made for Income Tax in the analysis of the profitability. Income tax at the rate of 30%, with a surcharge of 5% or 10% (depending on the net taxable income being less than Rs.1000 Lakhs or more) and a Cess of 3% is considered in the financial analysis of the project. Minimum Alternate Tax (MAT) as per Income-Tax Act is at the rate of 18.5% with surcharge of 5% or 10% (depending on the book profits being less than Rs.1000 Lakhs or more) and a Cess of 3% is also considered in the analysis.

16.10 IRR, DSCR and Payback

The project post tax IRR works out to 19.68% and the **DSCR** values are given for the operating years in the table. The minimum value of DSCR is 1.08 and the maximum value is 1.82. However considering the first 11 years, the **average DSCR comes to 1.54**. While computing the IRR the terminal value of the equipment in the fifteenth year is taken into the calculations. Considering technological obsolescence and the fact that the plant would have served a substantial part of its useful life, it is assumed that the dismantling and selling will fetch about 50% of its original value. It is assumed that the

income tax is payable on the disposal value of the equipment and the currently applicable rate of tax is used in the computations.

Lakhs. The equity and the Institution Term loan works out to 2525%and 755% of the total capital employed. The WACC is calculated to be 12.75%.

The return on Equity is calculated to be **251%** based on the ten years of operation. The calculated simple payback period is 3.5 years.

16.11 SWOT ANALYSIS

A. Strength

The promoters are from the reputed Business group and having business experience more than decades

- Adequate grain availability in the area of operation
- Ability of the SLBEPL to raise the equity
- Required land is already allotted
- Professionally and efficiently managed organization by SLBEPL promoters and technical team
- Financial Assistance scheme support from Govt of India
- Availability of basic infrastructure
- Environment friendly power generation
- Decreased dependence on sugar margins

- High demand of Ethanol to Oil marketing companies, the entire product could be sold to Oil marketing companies thorough tripate agreement between Producer/Lender/OMC. Hence marketing would not be a big task.

B. **Weakness**

- Delay in project implementation may increase capital cost
- The company has no prior experience in handling similar projects

C. **Opportunities**

- Opportunity for expansion
- National Policy on Biofuels has laid out indicative targets of achieving 20% blending of ethanol in petrol in the whole country by 2025.
- Socio- economic & environmental value to the local population
- Only 5% as Promoters margin as per new guidelines / SOP from Govt of India

D. **Threats**

- Changes in Government policies at Centre & State
- Delay in implementation (tight monitoring on all project activities will be essential)
- Possibility of Inadequate operation management and lower capacity utilization

16.12 Conclusion

SLB Ethanol Private Limited is in the process of installation of 200 KLPD Grain based Ethanol plant in Tamilnadu.

The Indian Government is encouraging blending of Absolute alcohol with petrol. Due to continuous increase in petrol consumption, there is increase in demand of Absolute alcohol. The price of Absolute alcohol will have tendency to go up as petrol prices are increasing. There is no threat to environment as the plant is adopting zero liquid discharge. Also, the raw material required for production of alcohol i.e Broken rice abundantly available in the vicinity of the plant. Considering the above advantages and based on the financial analysis discussed in this section of the report, the Distillery plant is technically feasible and financially viable.

			SLB ETHANOL PRIVATE LIMITED-BASIS OF WORKING 1									
SL. No.	**Description**	**Unit**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Yaer 9**	**Year 10**
1	Distillery capacity in terms of total spirit	LPD	218000	218000	218000	218000	218000	218000	218000	218000	218000	218000
2	Toatl no of days of operation annualy		335	335	335	335	335	335	335	335	335	335
3	No of days operation with broken rice		335	335	335	335	335	335	335	335	335	335
4	No of days operation with maize		0	0	0	0	0	0	0	0	0	0
5	Absolute alcohol	LPD	200000.00	200000.00	200000.00	200000.00	200000.00	200000.00	200000.00	200000.00	200000.00	200000.00
6	Technical alcohol	LPD	6540.00	6540.00	6540.00	6540.00	6540.00	6540.00	6540.00	6540.00	6540.00	6540.00
7	Fusel Oil	LPD	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00	200.00
8	RS as % of annual production	%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	ENA as % of annual production	%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	AA as % if annual production	%	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
11	Plant capacity utilization	%	90.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
12	Possible annaul production of AA	KLPA	60300	67000	67000	67000	67000	67000	67000	67000	67000	67000
13	Possible annual production of TA	KLPA	1972	2191	2191	2191	2191	2191	2191	2191	2191	2191
14	Possible annual production of FO	KLPA	60	67	67	67	67	67	67	67	67	67
15	Recoverable CO_2 from Fermentation	TPA	34914	38793	38793	38793	38793	38793	38793	38793	38793	38793
16	Surplus power available from process	MU	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17	Surplus power sold to grid	MU	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

SLB ETHANOL PRIVATE LIMITED-BASIS OF WORKING 2												
SL. No.	**Description**	**Unit**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Yaer 9**	**Year 10**
1	Baisc selling price of AA from broken rice	Rs/l	51.55	51.55	51.55	51.55	51.55	54.13	54.13	54.13	54.13	54.13
	GST on AA @ 5%	Rs/l	2.58	2.58	2.58	2.58	2.58	2.71	2.71	2.71	2.71	2.71
	Total selling cost	Rs/l	54.13	54.13	54.13	54.13	54.13	56.83	56.83	56.83	56.83	56.83
2	Basic selling price of TA / FO	Rs/l	25.00	26.25	27.56	28.94	30.39	31.91	33.50	35.18	36.94	38.78
	GST on TA / FO @ 18%	Rs/l	4.50	4.73	4.96	5.21	5.47	5.74	6.03	6.33	6.65	6.98
	Total selling cost	Rs/l	29.50	30.98	32.52	34.15	35.86	37.65	39.53	41.51	43.58	45.76
3	Basic selling price of CO_2	Rs/T	1800.00	1890.00	1984.50	2083.73	2187.91	2297.31	2412.17	2532.78	2659.42	2792.39
	GST on CO_2 @ 18%	Rs/l	324.00	340.20	357.21	375.07	393.82	413.52	434.19	455.90	478.70	502.63
	Total selling cost	Rs/l	2124.00	2230.20	2341.71	2458.80	2581.74	2710.82	2846.36	2988.68	3138.12	3295.02
4	Basic selling price of DDGS	Rs/T	24000.00	24600.00	25215.00	25845.38	26491.51	27153.80	27832.64	28528.46	29241.67	29972.71
	GST on DDGS @ 18%	Rs/l	4320.00	4428.00	4538.70	4652.17	4768.47	4887.68	5009.88	5135.12	5263.50	5395.09
	Total selling cost	Rs/l	28320.00	29028.00	29753.70	30497.54	31259.98	32041.48	32842.52	33663.58	34505.17	35367.80
5	Price for exported energy to gris	Rs/unit	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	Salaries and wages including labour contracts	Rs lacs	800.00	840.00	882.00	926.10	972.41	1021.03	1072.08	1125.68	1181.96	1241.06
7	Repairs and maitenance @ 2% of PM cost	Rs lacs	349.30	366.77	385.10	404.36	424.58	445.81	468.10	491.50	516.08	541.88
8	Cost of balance utilties and other chemicals	Rs lacs	400.00	420.00	441.00	463.05	486.20	510.51	536.04	562.84	590.98	620.53
9	Administrative expenses	Rs lacs	200.00	210.00	220.50	231.53	243.10	255.26	268.02	281.42	295.49	310.27
10	Interest on term loan	%	8.00%	8.00%	8.00%	8.00%	8.00%	8.00%	8.00%	8.00%	8.00%	8.00%
11	Interest after subvention	%	4.00%	4.00%	4.00%	4.00%	4.00%	8.00%	8.00%	8.00%	8.00%	8.00%
12	Term loan moratorium	Years	1.5									
13	Repayment period including moratorium	Years	10									
14	No of quarters repayment		40									
15	Interest on WC	%	9.00%	9.00%	9.00%	9.00%	9.00%	9.00%	9.00%	9.00%	9.00%	9.00%
16	Insurance cost on factory assets @ 0.02% on PM and civil works	Rs lacs	84.91	84.91	84.91	84.91	84.91	84.91	84.91	84.91	84.91	84.91
17	Rate of depreciation as per Company Law											
	Buildings and civil works	%	3.34%	3.34%	3.34%	3.34%	3.34%	3.34%	3.34%	3.34%	3.34%	3.34%
	Plant and machinery and misc assets	%	6.33%	6.33%	6.33%	6.33%	6.33%	6.33%	6.33%	6.33%	6.33%	6.33%
18	Rate of depreciation as per IT											
	Buildings and civil works	%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%
	Plant and machinery and misc assets	%	15.00%	15.00%	15.00%	15.00%	15.00%	15.00%	15.00%	15.00%	15.00%	15.00%

FUEL AND FEEDSTOCK

SL. No.	Description	Unit	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Yaer 9	Year 10
1	Rice husk consumption during broken rice usage	TPH	9.11	10.12	10.12	10.12	10.12	10.12	10.12	10.12	10.12	10.12
2	Rice husk consumption during maize usage	TPH	9.57	10.64	10.64	10.64	10.64	10.64	10.64	10.64	10.64	10.64
3	Coal consumption during broken rice usage	TPH	6.19	6.88	6.88	6.88	6.88	6.88	6.88	6.88	6.88	6.88
4	Coal consumption during maize usage	TPH	6.51	7.23	7.23	7.23	7.23	7.23	7.23	7.23	7.23	7.23
5	No of days operation rice husk for broken rice usage		0	0	0	0	0	0	0	0	0	0
6	No of days operation coal for broken rice usage		335	335	335	335	335	335	335	335	335	335
7	No of days operation rice husk for maize usage		0	0	0	0	0	0	0	0	0	0
8	No of days operation coal for maize usage		0	0	0	0	0	0	0	0	0	0
9	Annual rice husk consumption	MTPA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	Annual coal consumption	MTPA	49771	55301	55301	55301	55301	55301	55301	55301	55301	55301
11	Basic cost of rice husk	Rs/MT	3500	3675	3859	4052	4254	4467	4690	4925	5171	5430
	GST on rice husk	%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	Landed cost of rice husk	Rs lacs	3500	3675	3859	4052	4254	4467	4690	4925	5171	5430
12	Basic cost of coal	Rs/MT	7627	8008	8409	8829	9271	9734	10221	10732	11269	11832
	GST / cess on coal	Rs	400	400	400	400	400	400	400	400	400	400
	Inland transportation	Rs	400	400	400	400	400	400	400	400	400	400
	GST on inland trasnportation	%	18.00%	18.00%	18.00%	18.00%	18.00%	18.00%	18.00%	18.00%	18.00%	18.00%
	Landed cost of coal	Rs/MT	8499	8880	9281	9701	10143	10606	11093	11604	12141	12704
13	Raw water consumption	m^3/day	800	800	800	800	800	800	800	800	800	800
14	Basic cost of raw water	Rs/m^3	100	105	110	116	122	128	134	141	148	155
	GST on raw water	%	18.00%	18.00%	18.00%	18.00%	18.00%	18.00%	18.00%	18.00%	18.00%	18.00%
	Landed Cost of raw water	Rs/m^3	118	124	130	137	143	151	158	166	174	183
15	Starch content in maize	%	61.00%	61.00%	61.00%	61.00%	61.00%	61.00%	61.00%	61.00%	61.00%	61.00%
16	Starch content in brken rice	%	68.00%	68.00%	68.00%	68.00%	68.00%	68.00%	68.00%	68.00%	68.00%	68.00%
17	Total spirit production per MT of maize	Liters	395	395	395	395	395	395	395	395	395	395
18	Total spirit production per MT of brken rice	Liters	450	450	450	450	450	450	450	450	450	450
19	DDGS production with maize	TPA	41217.72	45797.47	45797.47	45797.47	45797.47	45797.47	45797.47	45797.47	45797.47	45797.47
20	DDGS production with broken rice	TPA	26800.00	29777.78	29777.78	29777.78	29777.78	29777.78	29777.78	29777.78	29777.78	29777.78
21	Daily requirement of maize	TPD	506.33	506.33	506.33	506.33	506.33	506.33	506.33	506.33	506.33	506.33
	Annual consumption of maize	TPA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
22	Daily requirement of broken rice	TPD	444.44	444.44	444.44	444.44	444.44	444.44	444.44	444.44	444.44	444.44
	Annual consumption of broken rice	TPA	148889	148889	148889	148889	148889	148889	148889	148889	148889	148889
23	Baisc cost of maize	Rs/MT	17000	17425	17861	18307	18765	19234	19715	20208	20713	21231
	GST on maize	%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	Landed cost of maize	Rs/MT	17000	17425	17861	18307	18765	19234	19715	20208	20713	21231
24	Baisc cost of broken rice	Rs/MT	17000	17425	17861	18307	18765	19234	19715	20208	20713	21231
	GST on broken rice	%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	Landed cost of broken rice	Rs/MT	17000	17425	17861	18307	18765	19234	19715	20208	20713	21231

SL. No.	Description		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
		Unit										
1	Urea /DAP	kg/day	240.00	266.67	296.30	329.22	365.80	406.44	451.60	501.78	557.53	619.48
	unit cost	Rs/kg	30.00	31.50	33.08	34.73	36.47	38.29	40.20	42.21	44.32	46.54
	Annual cost	Rs lacs/annum	24.12	28.14	32.83	38.30	44.69	52.13	60.82	70.96	82.78	96.58
2	Antifoam oil	kg/day	150.00	166.67	166.67	166.67	166.67	166.67	166.67	166.67	166.67	166.67
	unit cost	Rs/kg	65.00	68.25	71.66	75.25	79.01	82.96	87.11	91.46	96.03	100.84
	Annual cost	Rs lacs/annum	32.66	38.11	40.01	42.01	44.11	46.32	48.63	51.07	53.62	56.30
3	Sulphuric acid	kg/day	40.00	44.44	44.44	44.44	44.44	44.44	44.44	44.44	44.44	44.44
	unit cost	Rs/kg	30.00	31.50	33.08	34.73	36.47	38.29	40.20	42.21	44.32	46.54
	Annual cost	Rs lacs/annum	4.02	4.69	4.92	5.17	5.43	5.70	5.99	6.29	6.60	6.93
4	Caustic soda	kg/day	1250.00	1388.89	1388.89	1388.89	1388.89	1388.89	1388.89	1388.89	1388.89	1388.89
	unit cost	Rs/kg	25.00	26.25	27.56	28.94	30.39	31.91	33.50	35.18	36.94	38.78
	Annual cost	Rs lacs/annum	104.69	122.14	128.24	134.65	141.39	148.46	155.88	163.67	171.86	180.45
5	Nitric acid	kg/day	50.00	55.56	55.56	55.56	55.56	55.56	55.56	55.56	55.56	55.56
	unit cost	Rs/kg	25.00	26.25	27.56	28.94	30.39	31.91	33.50	35.18	36.94	38.78
	Annual cost	Rs lacs/annum	4.19	4.89	5.13	5.39	5.66	5.94	6.24	6.55	6.87	7.22
6	Yeast	kg/day	40.00	44.44	44.44	44.44	44.44	44.44	44.44	44.44	44.44	44.44
	unit cost	Rs/kg	400.00	420.00	441.00	463.05	486.20	510.51	536.04	562.84	590.98	620.53
	Annual cost	Rs lacs/annum	53.60	62.53	65.66	68.94	72.39	76.01	79.81	83.80	87.99	92.39
7	Alpha enzyme	kg/day	300.00	333.33	333.33	333.33	333.33	333.33	333.33	333.33	333.33	333.33
	unit cost	Rs/kg	480.00	504.00	529.20	555.66	583.44	612.62	643.25	675.41	709.18	744.64
	Annual cost	Rs lacs/annum	482.40	562.80	590.94	620.49	651.51	684.09	718.29	754.21	791.92	831.51
8	Beta enzyme	kg/day	150.00	166.67	150.00	150.00	150.00	150.00	150.00	150.00	150.00	150.00
	unit cost	Rs/kg	675.00	708.75	744.19	781.40	820.47	861.49	904.56	949.79	997.28	1047.15
	Annual cost	Rs lacs/annum	339.19	395.72	373.95	392.65	412.28	432.90	454.54	477.27	501.13	526.19
9	sodium hydroxide	kg/day	2610.00	2900.00	2900.00	2900.00	2900.00	2900.00	2900.00	2900.00	2900.00	2900.00
	unit cost	Rs/kg	22.00	23.10	24.26	25.47	26.74	28.08	29.48	30.96	32.50	34.13
	Annual cost	Rs lacs/annum	192.36	224.42	235.64	247.42	259.79	272.78	286.42	300.74	315.78	331.57
10	Lime dosing	kg/day	596.00	662.22	662.22	662.22	662.22	662.22	662.22	662.22	662.22	662.22
	unit cost	Rs/kg	12.00	12.60	13.23	13.89	14.59	15.32	16.08	16.89	17.73	18.62
	Annual cost	Rs lacs/annum	23.96	27.95	29.35	30.82	32.36	33.98	35.68	37.46	39.33	41.30
11	Nutrient dosing urea	kg/day	606.00	673.33	673.33	673.33	673.33	673.33	673.33	673.33	673.33	673.33
	unit cost	Rs/kg	15.00	15.75	16.54	17.36	18.23	19.14	20.10	21.11	22.16	23.27
	Annual cost	Rs lacs/annum	30.45	35.53	37.30	39.17	41.13	43.18	45.34	47.61	49.99	52.49
12	Nutrient dosing phosporic acid	kg/day	62.00	68.89	62.00	62.00	62.00	62.00	62.00	62.00	62.00	62.00
	unit cost	Rs/kg	70.00	73.50	73.50	73.50	73.50	73.50	73.50	73.50	73.50	73.50
	Annual cost	Rs lacs/annum	14.54	16.96	15.27	15.27	15.27	15.27	15.27	15.27	15.27	15.27

13	Micro nutrient dosing	kg/day	96.00	100.80	105.84	111.13	116.69	122.52	128.65	135.08	141.84	148.93
	unit cost	Rs/kg	100.00	111.11	111.11	111.11	111.11	111.11	111.11	111.11	111.11	111.11
	Annual cost	Rs lacs/annum	32.16	37.52	39.40	41.37	43.43	45.61	47.89	50.28	52.79	55.43
14	Sodium hypo dosing	kg/day	316.00	351.11	351.11	351.11	351.11	351.11	351.11	351.11	351.11	351.11
	unit cost	Rs/kg	12.00	12.60	13.23	13.89	14.59	15.32	16.08	16.89	17.73	18.62
	Annual cost	Rs lacs/annum	12.70	14.82	15.56	16.34	17.16	18.01	18.92	19.86	20.85	21.90
15	Coagulent dosing	kg/day	190.00	211.11	211.11	211.11	211.11	211.11	211.11	211.11	211.11	211.11
	unit cost	Rs/kg	22.00	23.10	24.26	25.47	26.74	28.08	29.48	30.96	32.50	34.13
	Annual cost	Rs lacs/annum	14.00	16.34	17.15	18.01	18.91	19.86	20.85	21.89	22.99	24.14
16	Polymer dosing	kg/day	4.00	4.44	4.44	4.44	4.44	4.44	4.44	4.44	4.44	4.44
	unit cost	Rs/kg	220.00	231.00	242.55	254.68	267.41	280.78	294.82	309.56	325.04	341.29
	Annual cost	Rs lacs/annum	2.95	3.44	3.61	3.79	3.98	4.18	4.39	4.61	4.84	5.08
17	Dewatering polyelectrolyte	kg/day	3.20	3.56	3.56	3.56	3.56	3.56	3.56	3.56	3.56	3.56
	unit cost	Rs/kg	220.00	231.00	242.55	254.68	267.41	280.78	294.82	309.56	325.04	341.29
	Annual cost	Rs lacs/annum	2.36	2.75	2.89	3.03	3.19	3.34	3.51	3.69	3.87	4.07
18	Dechorination dosing	kg/day	6.12	6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80
	unit cost	Rs/kg	22.00	23.10	24.26	25.47	26.74	28.08	29.48	30.96	32.50	34.13
	Annual cost	Rs lacs/annum	0.45	0.53	0.55	0.58	0.61	0.64	0.67	0.71	0.74	0.78
19	antiscaling dosing	kg/day	6.12	6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80	6.80
	unit cost	Rs/kg	250.00	262.50	275.63	289.41	303.88	319.07	335.02	351.78	369.36	387.83
	Annual cost	Rs lacs/annum	5.13	5.98	6.28	6.59	6.92	7.27	7.63	8.01	8.41	8.83
20	Hydrochloric acid dosing for RO	kg/day	18.60	20.67	20.67	20.67	20.67	20.67	20.67	20.67	20.67	20.67
	unit cost	Rs/kg	3.00	3.15	3.31	3.47	3.65	3.83	4.02	4.22	4.43	4.65
	Annual cost	Rs lacs/annum	0.19	0.22	0.23	0.24	0.25	0.27	0.28	0.29	0.31	0.32
	Total basic cost per annum	Rs lacs	**1376.11**	**1605.46**	**1644.92**	**1730.23**	**1820.45**	**1915.92**	**2017.04**	**2124.22**	**2237.95**	**2358.74**
	GST on above	Rs lacs	**247.70**	**288.98**	**296.09**	**311.44**	**327.68**	**344.87**	**363.07**	**382.36**	**402.83**	**424.57**
	Total inout cost for chemicals	Rs lacs	**1623.81**	**1894.44**	**1941.01**	**2041.68**	**2148.13**	**2260.79**	**2380.10**	**2506.58**	**2640.78**	**2783.31**

Loan amount	25669.00	Interest rate	9.0%	Int subvention	4.50%
Loan term including moratorium		10			
Moratorium	0	No. of quarters for repayment		40	

Loan Year	Operation Year	Outstanding at beginning of year	Repayment	Outstanding at end of year	Interest for the quarter	Interest paid annually	Repayment annually made	
		Rs lacs	Rs lacs	Rs lacs	Rs lacs	Rs lacs	Rs lacs	
1	1	25669.00	641.73	25027.28	513.38			
		25027.28	641.73	24385.55	500.55			
		24385.55	641.73	23743.83	487.71			
		23743.83	641.73	23102.10	474.88	1976.51	2566.90	
2	2	23102.10	641.73	22460.38	462.04			
		22460.38	641.73	21818.65	449.21			
		21818.65	641.73	21176.93	436.37			
		21176.93	641.73	20535.20	423.54	1771.16	2566.90	
3	3	20535.20	641.73	19893.48	410.70			
		19893.48	641.73	19251.75	397.87			
		19251.75	641.73	18610.03	385.04			
		18610.03	641.73	17968.30	372.20	1565.81	2566.90	
4	4	17968.30	641.73	17326.58	359.37			
		17326.58	641.73	16684.85	346.53			
		16684.85	641.73	16043.13	333.70			
		16043.13	641.73	15401.40	320.86	1360.46	2566.90	
5	5	15401.40	641.73	14759.68	308.03			
		14759.68	641.73	14117.95	295.19			
		14117.95	641.73	13476.23	282.36			
		13476.23	641.73	12834.50	269.52	1155.11	2566.90	
6	6	12834.50	641.73	12192.78	256.69			
		12192.78	641.73	11551.05	243.86			
		11551.05	641.73	10909.33	231.02			
		10909.33	641.73	10267.60	218.19	949.75	2566.90	
7	7	10267.60	641.73	9625.88	205.35			
		9625.88	641.73	8984.15	192.52			
		8984.15	641.73	8342.43	179.68			
		8342.43	641.73	7700.70	166.85	744.40	2566.90	
8	8	7700.70	641.73	7058.98	154.01			
		7058.98	641.73	6417.25	141.18			
		6417.25	641.73	5775.53	128.35			
		5775.53	641.73	5133.80	115.51	539.05	2566.90	
9	9	5133.80	641.73	4492.08	102.68			
		4492.08	641.73	3850.35	89.84			
		3850.35	641.73	3208.63	77.01			
		3208.63	641.73	2566.90	64.17	333.70	2566.90	
10	10	2566.90	641.73	1925.18	51.34			
		1925.18	641.73	1283.45	38.50			
		1283.45	641.73	641.73	25.67			
		641.73	641.73	0.00	12.83	128.35	2566.90	
			25669.00		10524.29	10524.29	25669.00	

The Prel and Pre operative expenses to be apportioned proportionately (RS. Lacs) 404.00
The contingencies to be captialized proporionately (Rs. Lacs) 570.00

Assest value for depreciation

SL. No	Particulars	Basic cost	Prel Preo	Contin	Total	Rate	Dep
1	Land	2500.00	50.02	70.57	2620.59	0.00%	0.00
2	Buildings and civil works	1880.00	37.61	53.07	1970.68	3.40%	67.00
3	Plant & Machinery	15768.00	315.47	445.09	16528.56	6.33%	1046.26
4	Misc Assests	45.00	0.90	1.27	47.17	6.33%	2.99
		20193.00	404.00	570.00	21167.00		1116.25

Total Depreciation for the project

Particulars	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Depreciation	1116.25	1116.247	1116.247	1116.247	1116.247	1116.247	1116.247	1116.247	1116.247	1116.247
Total Depreciation	1116.25	1116.25	1116.25	1116.25	1116.25	1116.25	1116.25	1116.25	1116.25	1116.25

SLB ETHANOL PRIVATE LIMITED-PRODUCTION COST WORKING											
SL. No.	Description	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
		RUPEES IN LACS									
1	Broken rice	25311.11	25943.889	26592.486	27257.298	27938.731	28637.199	29353.129	30086.957	30839.131	31610.109
	GST payable on broken rice	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	Maize	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	GST payable on maize	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	Imported coal	4230.05	4910.94	5132.38	5364.89	5609.02	5865.36	6134.52	6417.13	6713.88	7025.46
	Cess / GST payable on imported coal	234.92	261.02	261.02	261.02	261.02	261.02	261.02	261.02	261.02	261.02
4	Rice husk	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	GST payable on rice husk	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	Chemicals and consumables	1623.81	1894.44	1941.01	2041.68	2148.13	2260.79	2380.10	2506.58	2640.78	2783.31
	GST payable on Chemicals and consumables	247.70	288.98	296.09	311.44	327.68	344.87	363.07	382.36	402.83	424.57
6	Raw water	316.24	332.05	348.65	366.09	384.39	403.61	423.79	444.98	467.23	490.59
	GST on raw water	48.24	50.65	53.18	55.84	58.64	61.57	64.65	67.88	71.27	74.84
7	Misc utilities and chemicals	400.00	420.00	441.00	463.05	486.20	510.51	536.04	562.84	590.98	620.53
	GST on misc utilties and chemicals	61.02	64.07	67.27	70.63	74.17	77.87	81.77	85.86	90.15	94.66
8	Total utilities and chemicals	2340.05	2646.49	2730.66	2870.81	3018.73	3174.91	3339.93	3514.40	3698.99	3894.44
9	Salaries and wages including labor contracts	800.00	840.00	882.00	926.10	972.41	1021.03	1072.08	1125.68	1181.96	1241.06
10	Repairs and maintenance	349.30	366.77	385.10	404.36	424.58	445.81	468.10	491.50	516.08	541.88
11	Insurance on factory assets	84.91	84.91	84.91	84.91	84.91	84.91	84.91	84.91	84.91	84.91
12	Total factory overheads	434.21	451.68	470.01	489.27	509.49	530.72	553.01	576.41	600.99	626.79
	Production cost estimated annually	33350.34	35054.02	36068.56	37169.39	38309.39	39490.23	40713.68	41981.60	43295.97	44658.88
	Unit cost of production	55.31	52.32	53.83	55.48	57.18	58.94	60.77	62.66	64.62	66.66
13	Interest cost	2406.82	2238.43	2040.28	1842.37	1644.70	1458.24	1261.09	1064.20	867.59	671.28
14	Depreciation	1116.25	1116.25	1116.25	1116.25	1116.25	1116.25	1116.25	1116.25	1116.25	1116.25
	Financing cost estimated annually	3523.07	3354.68	3156.53	2958.62	2760.95	2574.49	2377.33	2180.45	1983.84	1787.53
	Unit cost of financing	5.84	5.01	4.71	4.42	4.12	3.84	3.55	3.25	2.96	2.67
	Total cost prodcution and financing	36873.41	38408.70	39225.09	40128.01	41070.34	42064.72	43091.02	44162.05	45279.81	46446.41
	Total unit cost	61.15	57.33	58.54	59.89	61.30	62.78	64.31	65.91	67.58	69.32

			SLB ETHANOL PRIVATE LIMITED-PROJECTED SALES									
SL. No.	**Description**	**Unit**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Yaer 9**	**Year 10**
1	Annual production of ENA	Lac liters	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	Annual production of AA	Lac liters	603	670	670	670	670	670	670	670	670	670
3	Annual production of TA and FO	Lac liters	20.32	22.58	22.58	22.58	22.58	22.58	22.58	22.58	22.58	22.58
4	Annual exportable energy	MU	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	Annual recoverable CO2	TPA	34913.70	38793.00	38793.00	38793.00	38793.00	38793.00	38793.00	38793.00	38793.00	38793.00
6	Annual production of DDGS	TPA	26800.00	29777.78	29777.78	29777.78	29777.78	29777.78	29777.78	29777.78	29777.78	29777.78
7	Sale price of ENA	Rs/liter	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	Sale price of AA	Rs/liter	54.13	54.13	54.13	54.13	54.13	56.83	56.83	56.83	56.83	56.83
10	Sale price of TS+FO	Rs/liter	29.50	30.98	32.52	34.15	35.86	37.65	39.53	41.51	43.58	45.76
11	Sale proce of exportable energy	Rs/unit	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12	Sale price of recoverable CO2	Rs/MT	2124.00	2230.20	2341.71	2458.80	2581.74	2710.82	2846.36	2988.68	3138.12	3295.02
13	Sale price of DDGS	Rs/MT	28320.00	29028.00	29753.70	30497.54	31259.98	32041.48	32842.52	33663.58	34505.17	35367.80
14	Revenue from ENA sales	Rs lacs	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	GST payable on ENA sales	Rs lacs	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15	Revenue from AA sales	Rs lacs	32638.88	36265.425	36265.425	36265.425	36265.425	38078.696	38078.696	38078.696	38078.696	38078.696
	GST payable on AA sales	Rs lacs	1554.23	1726.93	1726.93	1726.93	1726.93	1813.27	1813.27	1813.27	1813.27	1813.27
16	Revenue from TA and FO	Rs lacs	599.47	699.38	734.35	771.07	809.63	850.11	892.61	937.24	984.10	1033.31
	GST payable on TA + FO sales	Rs lacs	91.44	106.69	112.02	117.62	123.50	129.68	136.16	142.97	150.12	157.62
17	Revenue from exportable energy	Rs lacs	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	GST payable on exportable energy sales	Rs lacs	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
18	Revenue from sale of CO2	Rs lacs	741.57	865.16	908.42	953.84	1001.53	1051.61	1104.19	1159.40	1217.37	1278.24
	GST payable from CO2 sales	Rs lacs	113.12	131.97	138.57	145.50	152.78	160.41	168.44	176.86	185.70	194.99
19	Revenie from sale of DDGS	Rs lacs	7589.76	8643.89	8859.99	9081.49	9308.53	9541.24	9779.77	10024.27	10274.87	10531.74
	GST payable from DDGS sales	Rs lacs	1157.76	1318.56	1351.52	1385.31	1419.94	1455.44	1491.83	1529.13	1567.35	1606.54
20	Gross revenue from sales	Rs lacs	43328.48	48439.45	48745.71	49061.87	49388.31	51625.02	51973.14	52332.70	52704.13	53087.87
21	Total GST payable on sales	Rs lacs	2916.56	3284.14	3329.04	3375.36	3423.15	3558.81	3609.70	3662.22	3716.44	3772.42
22	Nett revenue from sales	Rs lacs	40411.92	45155.30	45416.66	45686.52	45965.17	48066.21	48363.44	48670.48	48987.69	49315.45

SL. No.	Description	Unit		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Yaer 9	Year 10
1	GST payable on broken rice	Rs lacs		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	GST payable on maize	Rs lacs		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	Cess / GST payable on imported coal	Rs lacs		234.92	261.02	261.02	261.02	261.02	261.02	261.02	261.02	261.02	261.02
4	GST payable on rice husk	Rs lacs		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	GST payable on Chemicals and consumables	Rs lacs		247.70	288.98	296.09	311.44	327.68	344.87	363.07	382.36	402.83	424.57
6	GST on raw water	Rs lacs		48.24	50.65	53.18	55.84	58.64	61.57	64.65	67.88	71.27	74.84
7	GST on misc utilties and chemicals	Rs lacs		61.02	64.07	67.27	70.63	74.17	77.87	81.77	85.86	90.15	94.66
	Total GST payable on input materials	Rs lacs		591.88	664.72	677.56	698.94	721.51	745.33	770.50	797.12	825.27	855.09
8	GST payable on capital goods	Rs lacs	2900.00	2324.68	575.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Total ITC available	Rs lacs		2916.56	1240.04	677.56	698.94	721.51	745.33	770.50	797.12	825.27	855.09
9	GST payable on AA sales	Rs lacs		1554.23	1726.93	1726.93	1726.93	1726.93	1813.27	1813.27	1813.27	1813.27	1813.27
10	GST payable on TA + FO sales	Rs lacs		91.44	106.69	112.02	117.62	123.50	129.68	136.16	142.97	150.12	157.62
11	GST payable on exportable energy sales	Rs lacs		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12	GST payable from CO2 sales	Rs lacs		113.12	131.97	138.57	145.50	152.78	160.41	168.44	176.86	185.70	194.99
13	GST payable from DDGS sales	Rs lacs		1157.76	1318.56	1351.52	1385.31	1419.94	1455.44	1491.83	1529.13	1567.35	1606.54
	Total GST payable on revenues	Rs lacs		2916.56	3284.14	3329.04	3375.36	3423.15	3558.81	3609.70	3662.22	3716.44	3772.42
	GST payable after ITC	Rs lacs		0.00	2044.10	2651.48	2676.42	2701.64	2813.48	2839.19	2865.11	2891.17	2917.33

SLB ETHANOL PRIVATE LIMITED-WORKING RESULTS

3	Description	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
		RUPEES IN LACS									
1	Production cost estimated annually	33350.34	35054.02	36068.56	37169.39	38309.39	39490.23	40713.68	41981.60	43295.97	44658.88
	Interest on term loan	1976.51	1771.16	1565.81	1360.46	1155.11	949.75	744.40	539.05	333.70	128.35
	Interest on working capital	430.31	467.27	474.48	481.91	489.60	508.49	516.68	525.15	533.90	542.93
	Total financial expenses	2406.82	2238.43	2040.28	1842.37	1644.70	1458.24	1261.09	1064.20	867.59	671.28
2	Financing cost estimated annually	2406.82	2238.43	2040.28	1842.37	1644.70	1458.24	1261.09	1064.20	867.59	671.28
3	Administrative expenses	200.00	210.00	220.50	231.53	243.10	255.26	268.02	281.42	295.49	310.27
4	Miscellaneous expenses written off	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
	Total cost of production	35987.16	37532.46	38359.35	39273.28	40227.19	41233.73	42272.79	43357.22	44489.05	45670.42
5	Nett revenue from sales	40411.92	45155.30	45416.66	45686.52	45965.17	48066.21	48363.44	48670.48	48987.69	49315.45
8	Gross profit before depreciation	4424.76	7622.85	7057.32	6413.23	5737.97	6832.48	6090.65	5313.26	4498.63	3645.03
3	Depreciation	1116.25	1116.25	1116.25	1116.25	1116.25	1116.25	1116.25	1116.25	1116.25	1116.25
9	Net profit after interest and depreciation	3308.52	6506.60	5941.07	5296.98	4621.73	5716.23	4974.40	4197.01	3382.39	2528.78

SLB ETHANOL PRIVATE LIMITED-WORKING CAPITAL

SL. No.	Description	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Yaer 9	Year 10
		RUPEES IN LACS									
1	Annual net revenue	40411.92	45155.30	45416.66	45686.52	45965.17	48066.21	48363.44	48670.48	48987.69	49315.45
2	Receivable for 30 days	3618.98	4043.76	4067.16	4091.33	4116.28	4304.44	4331.05	4358.55	4386.96	4416.31
4	Feedstock for 30 days	2266.67	2323.33	2381.42	2440.95	2501.98	2564.53	2628.64	2694.35	2761.71	2830.76
5	R&M admin cost for 30 days	110.53	115.67	121.08	126.75	132.71	138.96	145.53	152.43	159.67	167.27
6	Fuel stock for 30 days	378.81	439.79	459.62	480.44	502.30	525.26	549.36	574.67	601.24	629.15
7	Total WC requirement	6374.98	6922.55	7029.27	7139.47	7253.27	7533.18	7654.58	7780.00	7909.58	8043.48
8	Increase in WC	6374.98	547.57	106.72	110.20	113.80	279.91	121.40	125.42	129.58	133.90
9	WC loan @ 75% on total	4781.24	5191.91	5271.95	5354.60	5439.95	5649.88	5740.94	5835.00	5932.19	6032.61
10	Interest on WC loan	430.31	467.27	474.48	481.91	489.60	508.49	516.68	525.15	533.90	542.93
11	Margin money for WC @ 25%	1593.75	1730.64	1757.32	1784.87	1813.32	1883.29	1913.65	1945.00	1977.40	2010.87
12	Increase in Margin money	1593.75	136.89	26.68	27.55	28.45	69.98	30.35	31.35	32.40	33.48

SLB ETHANOL PRIVATE LIMITED-NET PROFIT CALCULATION

SL. No.	Description	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Yaer 9	Year 10
		RUPEES IN LACS									
1	Gross Profit before depreciation	4424.76	7622.85	7057.32	6413.23	5737.97	6832.48	6090.65	5313.26	4498.63	3645.03
2	Depreciation	1116.25	1116.25	1116.25	1116.25	1116.25	1116.25	1116.25	1116.25	1116.25	1116.25
3	Net Profit after Deprection	3308.52	6506.60	5941.07	5296.98	4621.73	5716.23	4974.40	4197.01	3382.39	2528.78
4	Profit before taxation	3308.52	6506.60	5941.07	5296.98	4621.73	5716.23	4974.40	4197.01	3382.39	2528.78
5	Tax rates applicable	29.12%	29.12%	29.12%	29.12%	29.12%	29.12%	29.12%	29.12%	29.12%	29.12%
6	Provision for taxation	468.23	1519.69	1457.43	1357.20	1235.02	1617.24	1455.38	1275.21	1077.42	862.51
7	Profit after taxation	2840.28	4986.92	4483.64	3939.78	3386.70	4098.99	3519.02	2921.80	2304.96	1666.27
8	Add depreciation	1116.25	1116.25	1116.25	1116.25	1116.25	1116.25	1116.25	1116.25	1116.25	1116.25
9	Net cash accruals	3821.43	5968.06	5464.78	4920.93	4367.85	5080.14	4500.17	3902.94	3286.11	2647.42

SLB ETHANOL PRIVATE LIMITED-IT DEPRECIATION												
SL. No.	**Description**		**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Yaer 9**	**Year 10**
1	Buildings		**RUPEES IN LACS**									
	Rate of depreciation	10.00%										
	WDV		1970.68	1773.61	1596.25	1436.63	1292.96	1163.67	1047.30	942.57	848.31	763.48
	Depreciation		197.07	177.36	159.63	143.66	129.30	116.37	104.73	94.26	84.83	76.35
2	Plant and machinery											
	Rate of depreciation	15.00%										
	WDV		17465.00	14845.25	12618.46	10725.69	9116.84	7749.31	6586.92	5598.88	4759.05	4045.19
	Depreciation		2619.75	2226.79	1892.77	1608.85	1367.53	1162.40	988.04	839.83	713.86	606.78
	Total depreciation for IT		2816.82	2404.15	2052.39	1752.52	1496.82	1278.76	1092.77	934.09	798.69	683.13

SLB ETHANOL PRIVATE LIMITED-IT COMPUTATION

SL. No.	Description	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Yaer 9	Year 10
		RUPEES IN LACS									
1	Profit before taxation	3308.52	6506.60	5941.07	5296.98	4621.73	5716.23	4974.40	4197.01	3382.39	2528.78
2	Add block depreciation	1116.25	1116.25	1116.25	1116.25	1116.25	1116.25	1116.25	1116.25	1116.25	1116.25
3	Profit before taxation and dep	4424.76	7622.85	7057.32	6413.23	5737.97	6832.48	6090.65	5313.26	4498.63	3645.03
4	Less depreciation as per IT	2816.82	2404.15	2052.39	1752.52	1496.82	1278.76	1092.77	934.09	798.69	683.13
5	Tax profit	1607.94	5218.70	5004.92	4660.71	4241.15	5553.71	4997.88	4379.17	3699.95	2961.90
6	Carry forward	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	Net taxable profit	1607.94	5218.70	5004.92	4660.71	4241.15	5553.71	4997.88	4379.17	3699.95	2961.90
8	IT as per IT rule 115BAA @ 29.12%	468.23	1519.69	1457.43	1357.20	1235.02	1617.24	1455.38	1275.21	1077.42	862.51
9	MAT not applicable in this case	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	Tax payable	468.23	1519.69	1457.43	1357.20	1235.02	1617.24	1455.38	1275.21	1077.42	862.51

SLB ETHANOL PRIVATE LIMITED-SOURCES AND APPLICATION OF FUNDS											
SL. No.	Description	Pre Production	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Yaer 9	Year 10
	Source of funds	RUPEES IN LACS										
1	Share issued	1351.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	Profit after tax	0.00	2840.28	4986.92	4483.64	3939.78	3386.70	4098.99	3519.02	2921.80	2304.96	1666.27
3	Depreciation provision for the year	0.00	1116.25	1116.25	1116.25	1116.25	1116.25	1116.25	1116.25	1116.25	1116.25	1116.25
4	Increase in term loan from FI	25669.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	Modvat benefits	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	Increase in bank borrowings for WC	0.00	4781.24	410.68	80.04	82.65	85.35	209.94	91.05	94.06	97.19	100.43
	Total	27020.00	8737.76	6513.84	5679.93	5138.68	4588.30	5425.17	4726.32	4132.10	3518.40	2882.95
	Application of funds											
7	Fixed assets	22345.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	Interest during construction	670.00										
9	Current assets											
10	Increase In current Assets	2756.00	3888.98	517.57	76.72	80.20	83.80	249.91	91.40	95.42	99.58	103.90
11	Decrease in term loan from FI	0.00	2566.90	2566.90	2566.90	2566.90	2566.90	2566.90	2566.90	2566.90	2566.90	2566.90
	Total	25771.00	6455.88	3084.47	2643.62	2647.10	2650.70	2816.81	2658.30	2662.32	2666.48	2670.80
12	Opening balance	0.00	1249.00	3530.88	6960.25	9996.56	12488.14	14425.74	17034.10	19102.12	20571.90	21423.82
13	Net cash accruals	1249.00	2281.89	3429.37	3036.30	2491.58	1937.60	2608.36	2068.02	1469.79	851.91	212.15
14	Closing balance	1249.00	3530.88	6960.25	9996.56	12488.14	14425.74	17034.10	19102.12	20571.90	21423.82	21635.97

SLB ETHANOL PRIVATE LIMITED-DEBT SERVICE COVERAGE RATIO

SL. No.	Description	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Yaer 9	Year 10
1	**Debt Service Coverage Ratio (DSCR)**	**RUPEES IN LACS**									
2	Profit after tax	2840.28	4986.92	4483.64	3939.78	3386.70	4098.99	3519.02	2921.80	2304.96	1666.27
3	Add: Depreciation	1116.25	1116.25	1116.25	1116.25	1116.25	1116.25	1116.25	1116.25	1116.25	1116.25
4	Interest on term loan	1976.51	1771.16	1565.81	1360.46	1155.11	949.75	744.40	539.05	333.70	128.35
	TOTAL	5933.04	7874.32	7165.69	6416.49	5658.06	6164.99	5379.67	4577.09	3754.91	2910.87
	Term loan repayment	2566.90	2566.90	2566.90	2566.90	2566.90	2566.90	2566.90	2566.90	2566.90	2566.90
	Interest on term loan	1976.51	1771.16	1565.81	1360.46	1155.11	949.75	744.40	539.05	333.70	128.35
	TOTAL	4543.41	4338.06	4132.71	3927.36	3722.01	3516.65	3311.30	3105.95	2900.60	2695.25
	Debt Service Coverage Ratio (DSCR)	1.31	1.82	1.73	1.63	1.52	1.75	1.62	1.47	1.29	1.08
	Average DSCR	**1.54**									

SL. No.	Description	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Yaer 9	Year 10
1	**Return on Equity (RoE)**										
	PAT										
	Equity										
	-1351.00	2840.28	4986.92	4483.64	3939.78	3386.70	4098.99	3519.02	2921.80	2304.96	1666.27
	RoE	**251%**									

SL. No.	Description	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Yaer 9	Year 10
1	**IRR calculation**										
	Total inflow	4339.30	7737.43	7139.01	6388.94	5629.61	6095.01	5349.32	4545.74	3722.51	2877.39
	Capital expenditure										
	-24488.64	4339.30	7737.43	7139.01	6388.94	5629.61	6095.01	5349.32	4545.74	3722.51	2877.39
	IRR	**19.68%**									

SL. No.	Description	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Yaer 9	Year 10
	Pay back calculation										
1	**Pay back calculation**										
	Total operating flow	5933.04	7874.32	7165.69	6416.49	5658.06	6164.99	5379.67	4577.09	3754.91	2910.87
	Capital expenditure	-24488.64									
	Cumulative net cash flow	-18555.60	-10681.27	-3515.58	2900.91						
		1	1	1	0.547898						
	Pay back period in years	**3.5**	years								

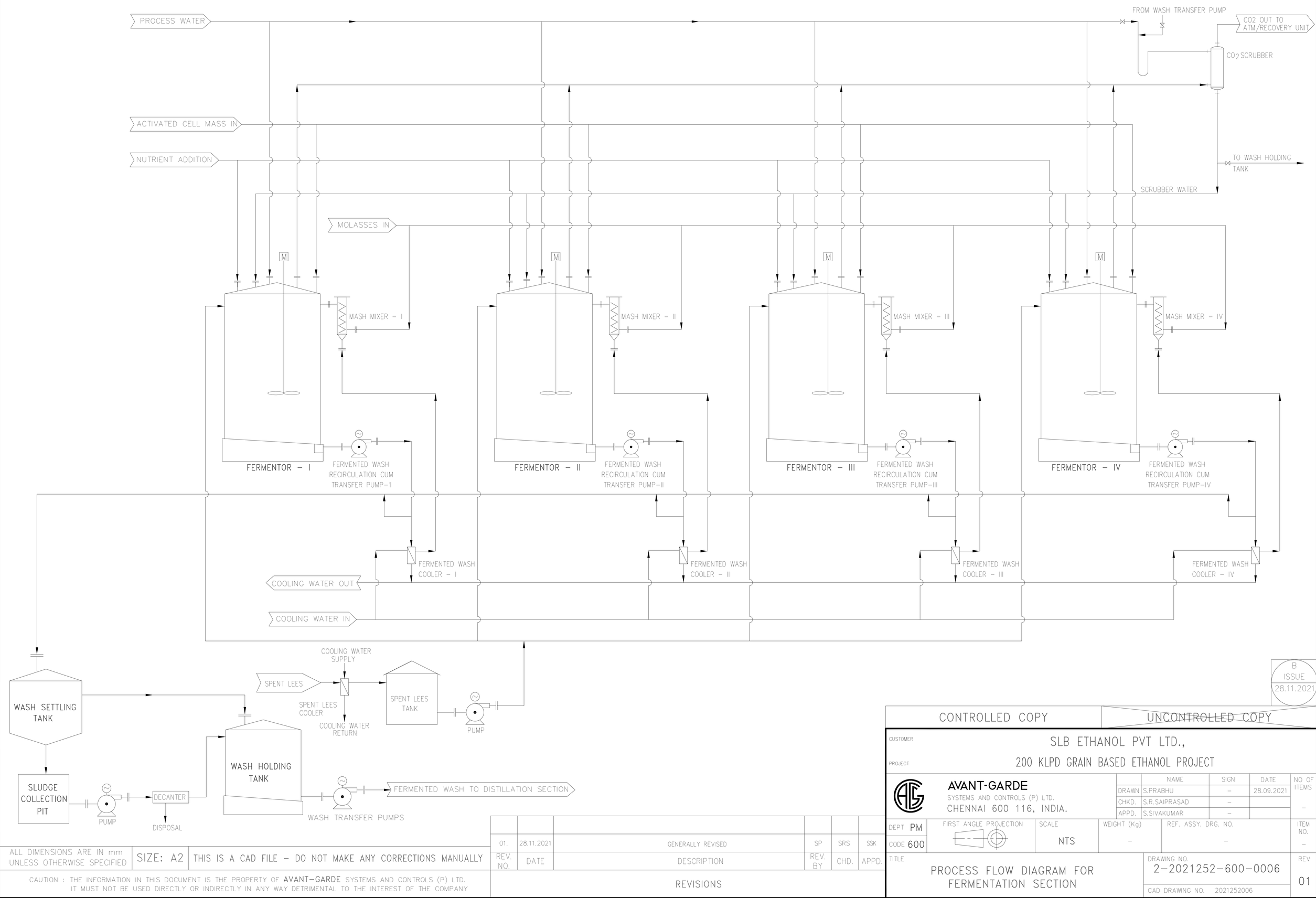
SLB ETHANOL PRIVATE LIMITED-PROJECTED BALANCE SHEET

SL. No.	Description	Before Production	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Yaer 9	Year 10
	Liabilities	**RUPEES IN LACS**										
1	Share capital & Director Loan	1351.00	1351.00	1351.00	1351.00	1351.00	1351.00	1351.00	1351.00	1351.00	1351.00	1351.00
2	subsidies	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	Borrowed capital	25669.00	23102.10	20535.20	17968.30	15401.40	12834.50	10267.60	7700.70	5133.80	2566.90	0.00
4	Reserves and surplus	0.00	2840.28	7827.20	12310.84	16250.62	19637.32	23736.31	27255.33	30177.13	32482.09	34148.37
5	Borrowed working capital	0.00	4781.24	5191.91	5271.95	5354.60	5439.95	5649.88	5740.94	5835.00	5932.19	6032.61
	Total	27020.00	32074.62	34905.31	36902.09	38357.62	39262.77	41004.80	42047.97	42496.93	42332.18	41531.98
	Assets											
6	Gross fixed assets	23015.00	23015.00	21898.75	20782.51	19666.26	18550.01	17433.76	16317.52	15201.27	14085.02	12968.78
7	Less depreciation	0.00	1116.25	1116.25	1116.25	1116.25	1116.25	1116.25	1116.25	1116.25	1116.25	1116.25
8	Net fixed assets		21898.75	20782.51	19666.26	18550.01	17433.76	16317.52	15201.27	14085.02	12968.78	11852.53
9	Current assets	2456.00	6374.98	6922.55	7029.27	7139.47	7253.27	7533.18	7654.58	7780.00	7909.58	8043.48
10	Cash and bank balances	1249.00	3530.88	6960.25	9996.56	12488.14	14425.74	17034.10	19102.12	20571.90	21423.82	21635.97
11	Preliminary expenses	300.00	270.00	240.00	210.00	180.00	150.00	120.00	90.00	60.00	30.00	0.00
	Working Capital Margin											
	Total	27020.00	32074.62	34905.31	36902.09	38357.62	39262.77	41004.80	42047.97	42496.93	42332.18	41531.98

17.0 DRAWINGS

Sl. No	Description	Drawing No.
1.	Process flow diagram for Fermentation Section	2-2021252-600-0006,Rev.01
2.	Process flow diagram for grain handling and milling	2-2021252-600-0007,Rev.00
3.	Process flow diagram of Distillation Section	1-2021252-600-0008,Rev.01
4.	Process flow diagram for Molecular Sieve De-hyderation Section	3-2021252-600-0009,Rev.00
5.	Process flow diagram for thin stillage Evaporation system	2-2021252-600-0010,Rev.01
6.	Process flow diagram for Liquefaction Section	2-2021252-600-0011,Rev.00
7.	Process flow diagram of DDGS Dryer Section	2-2021252-600-0012,Rev.00
8.	Process flow diagram of final Product Storage section	1-2021252-600-0013,Rev.00
9.	Proposed Scheme of condensate Polishing unit	2-2021252-600-0014,Rev.01
10.	Proposed Scheme of water treatment Plant	3-2021252-600-0015,Rev.01
11.	Distillery Plant Layout	0-2021252-600-0016,Rev.01
12.	Process Flow Diagram for Raw Water and DM Water System	3-2021252-600-0017,Rev.01

13.	Process Flow Diagram for Cooling Water System	3-2021252-600-0018,Rev.01
14.	Process Flow Diagram for Plant Steam System	3-2021252-600-0024,Rev.01
15.	Organisation Chart	3-2021252-600-0020,Rev.01
16.	Overview of the Control System	3-2021252-600-0021,Rev.00
17.	Single line Diagram for TG	2-2021252-600-0022,Rev.01
18.	Cogeneration Scheme (Operation With Broken Rice)	FIG.1 , Rev.03



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CUSTOMER: SLB ETHANOL PVT LTD.,

PROJECT: 200 KLPD GRAIN BASED ETHANOL PROJECT

AVANT-GARDE
SYSTEMS AND CONTROLS (P) LTD.
CHENNAI 600 116, INDIA.

	NAME	SIGN	DATE	NO OF ITEMS
DRAWN	S.PRABHU	–	28.09.2021	–
CHKD.	S.R.SAIPRASAD	–		
APPD.	S.SIVAKUMAR	–		

DEPT	CODE	FIRST ANGLE PROJECTION	SCALE	WEIGHT (Kg)	REF. ASSY. DRG. NO.	ITEM NO.
PM	600		NTS	–	–	–

TITLE: PROCESS FLOW DIAGRAM FOR FERMENTATION SECTION

DRAWING NO. 2–2021252–600–0006 REV 01

CAD DRAWING NO. 2021252006

REV. NO.	DATE	DESCRIPTION	REV. BY	CHD.	APPD.
01.	28.11.2021	GENERALLY REVISED	SP	SRS	SSK

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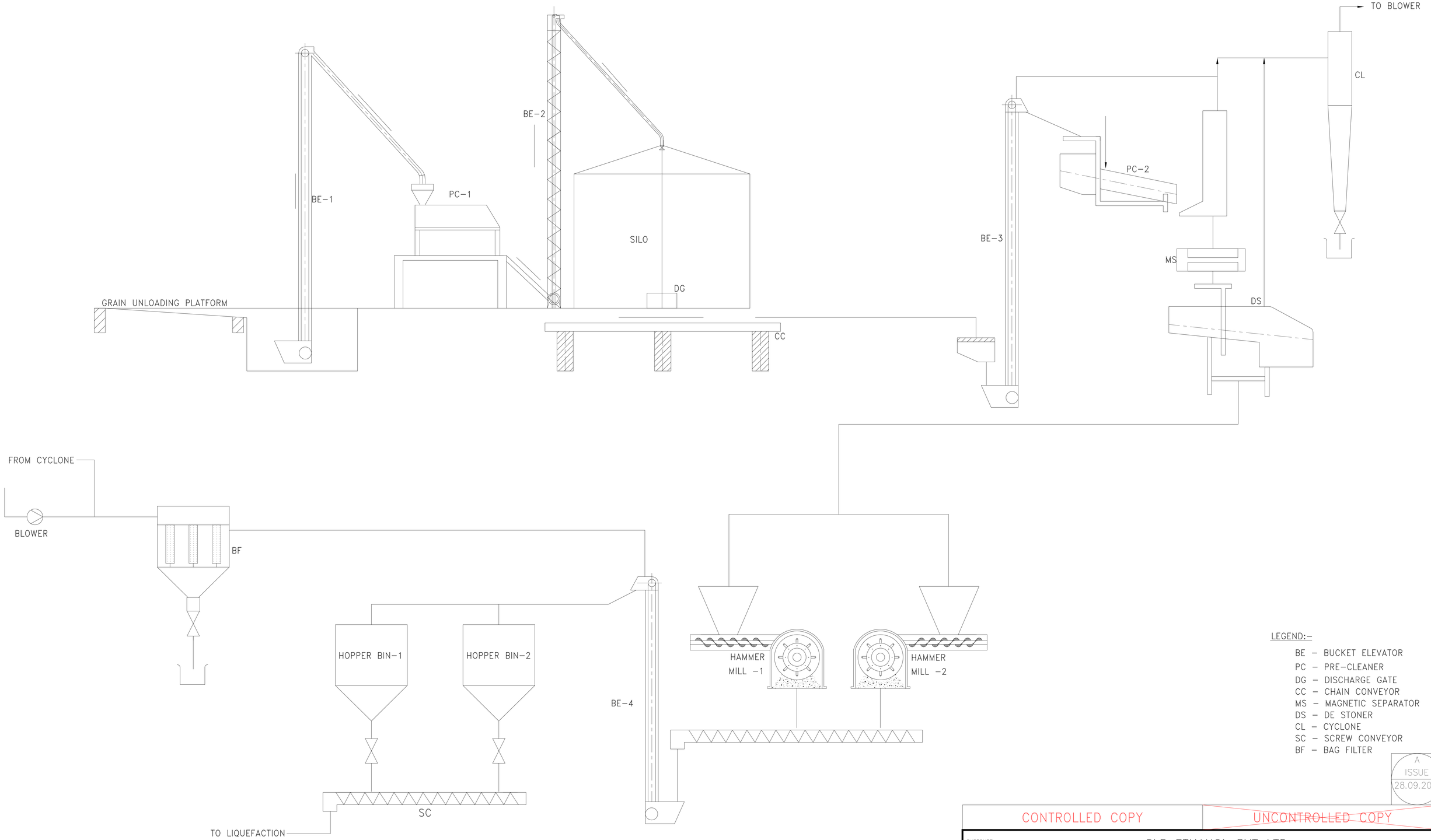

LEGEND:–

BE – BUCKET ELEVATOR
PC – PRE–CLEANER
DG – DISCHARGE GATE
CC – CHAIN CONVEYOR
MS – MAGNETIC SEPARATOR
DS – DE STONER
CL – CYCLONE
SC – SCREW CONVEYOR
BF – BAG FILTER

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CUSTOMER: SLB ETHANOL PVT LTD.,

PROJECT: 200 KLPD GRAIN BASED ETHANOL PROJECT

AVANT-GARDE
SYSTEMS AND CONTROLS (P) LTD.
CHENNAI 600 116, INDIA.

	NAME	SIGN	DATE	NO OF ITEMS
DRAWN	S.PRABHU	–	28.09.2021	–
CHKD.	S.R.SAIPRASAD	–		
APPD.	S.SIVAKUMAR	–		

DEPT	FIRST ANGLE PROJECTION	SCALE	WEIGHT (Kg)	REF. ASSY. DRG. NO.	ITEM NO.
PM		NTS	–	–	–
CODE 600					

TITLE: PROCESS FLOW DIAGRAM FOR GRAIN HANDLING AND MILLING

DRAWING NO. 2–2021252–600–0007 | REV 0

CAD DRAWING NO. 2021252007

REV. NO.	DATE	DESCRIPTION	REV. BY	CHD.	APPD.

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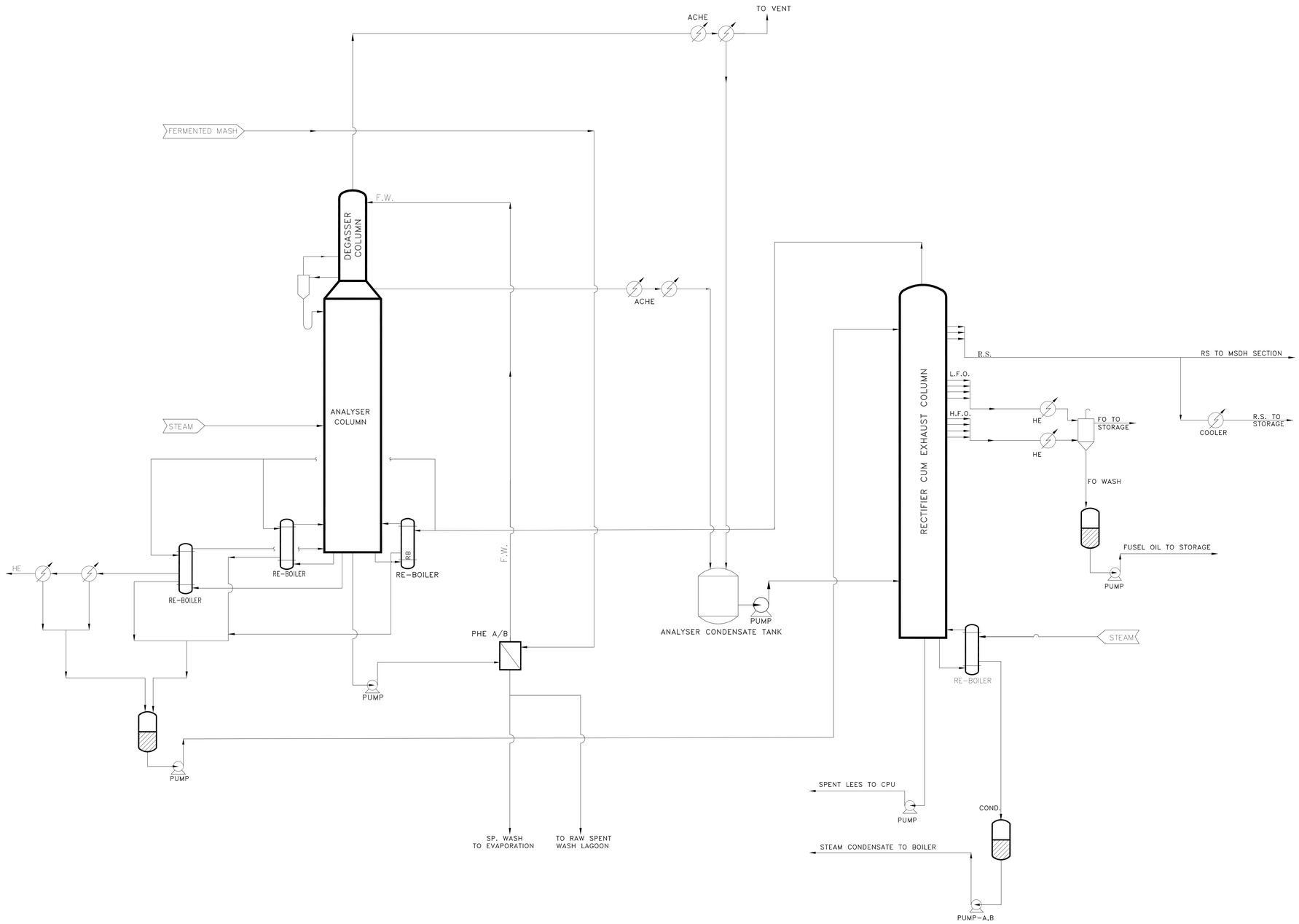

ABBREVIATIONS:–

CWS – COOLING WATER SUPPLY
CWR – COOLING WATER RETURN

THIS DRAWING SHOWS ONLY THE SCHEMATIC REPRESENTATION OF OF THE PLANT. THE EXACT SCOPE, TERMINAL POINT, ETC SHALL BE AS PER THE RELEVANT SECTION OF THE CONTRACT DOCUMENT.

OFF SPACE TANK & DOWNSTREAM TRANSFER PUMP FOR THE PRODUCES TO BE PROVIDED

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CUSTOMER: SLB ETHANOL PVT LTD.,
PROJECT: 200 KLPD GRAIN BASED ETHANOL PROJECT

AVANT-GARDE
SYSTEMS AND CONTROLS (P) LTD.
CHENNAI 600 116, INDIA.

	NAME	SIGN	DATE	NO OF ITEMS
DRAWN	S.PRABHU	–	28.09.2021	–
CHKD.	S.R.SAIPRASAD	–		
APPD.	S.SIVAKUMAR	–		

DEPT PM | CODE 600 | FIRST ANGLE PROJECTION | SCALE NTS | WEIGHT (Kg) – | REF. ASSY. DRG. NO. – | ITEM NO. –

TITLE: PROCESS FLOW DIAGRAM OF DISTILLATION SECTION

DRAWING NO. 1-2021252-600-0008 SH 1 OF 1
CAD DRAWING NO. 20212520008

REV 01

REV. NO.	DATE	DESCRIPTION	REV. BY	CHD. BY	APPD. BY
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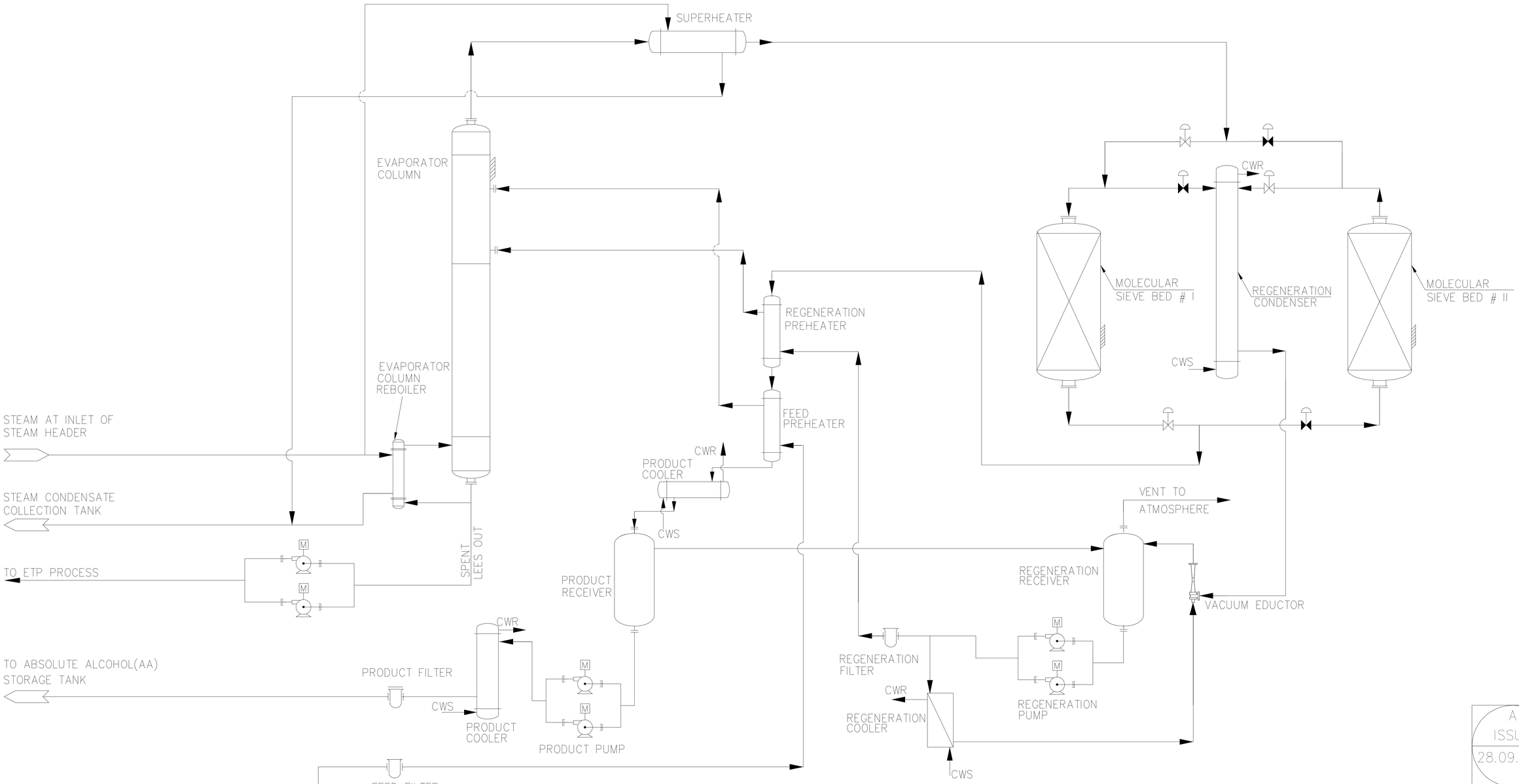

ABBREVIATIONS: –

CWS – COOLING WATER SUPPLY
CWR – COOLING WATER RETURN

REV. NO.	DATE	DESCRIPTION	REV. BY	CHD.	APPD.

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CUSTOMER: SLB ETHANOL PVT LTD.,

PROJECT: 200 KLPD GRAIN BASED ETHANOL PROJECT

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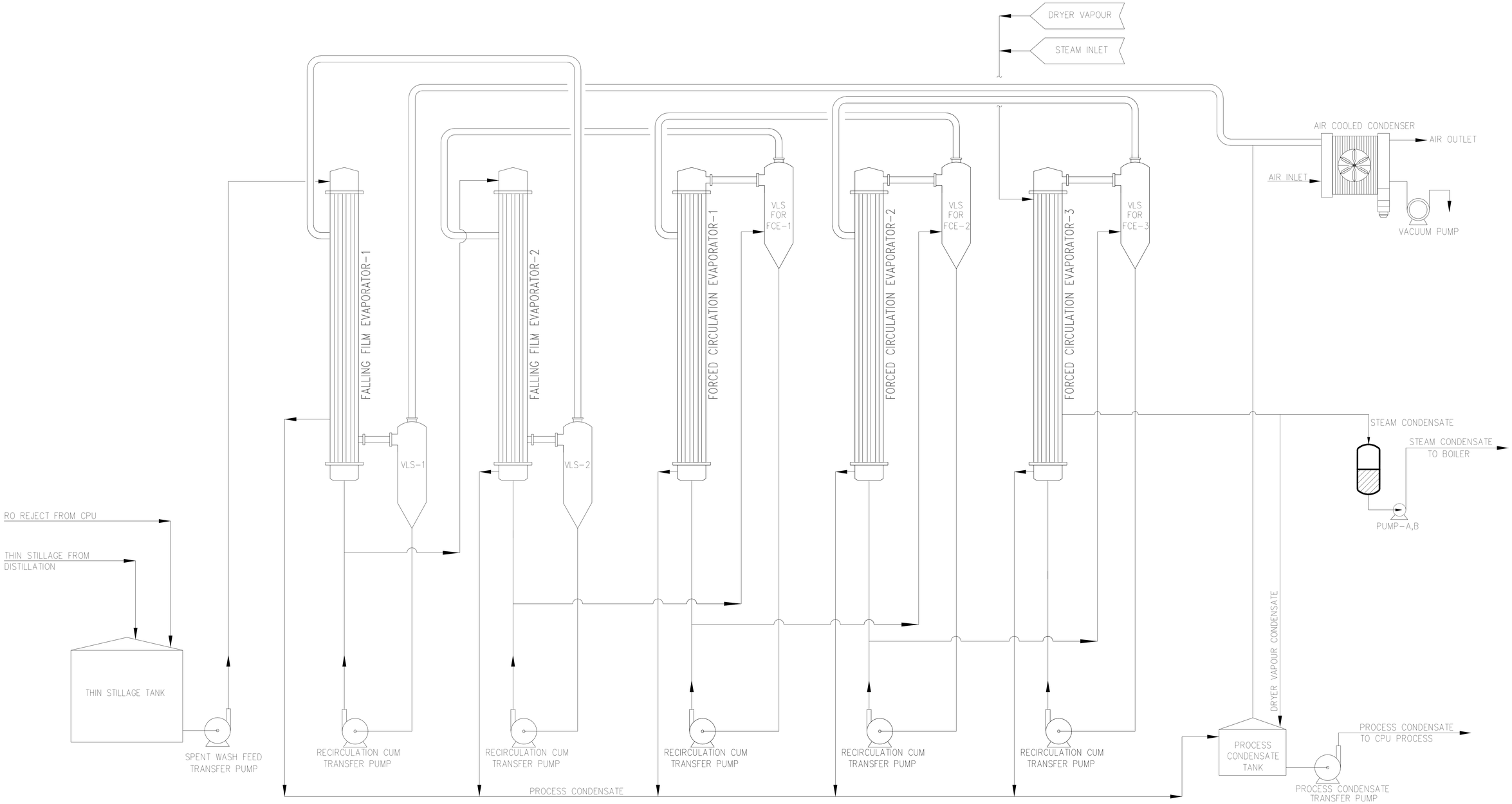
SYSTEMS AND CONTROLS (P) LTD.
CHENNAI 600 116, INDIA.

	NAME	SIGN	DATE	NO OF
DRAWN	S.PRABHU	–	28.09.2021	
CHKD.	S.R.SAIPRASAD	–		–
APPD.	S.SIVAKUMAR	–		

DEPT PM
CODE 600
FIRST ANGLE PROJECTION
SCALE NTS
WEIGHT (Kg) –
REF. ASSY. DRG. NO. –
ITEM NO. –

TITLE: PROCESS FLOW DIAGRAM FOR MOLECULAR SIEVE DE-HYDRATION SECTION

DRAWING NO. 3-2021252-600-0009 SH 1 OF 1
CAD DRAWING NO. 20212520009
REV 0



ABBREVIATIONS:–

VLS – VAPOUR LIQUID SEPARATOR
CPU – CONDENSATE POLISHING UNIT

COMMON STANDBY OF FORCED CIRCULATION EVAPORATOR TYPE TO BE PROVIDED FOR CONTINUOUS OPERATION

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CUSTOMER: SLB ETHANOL PVT LTD.,

PROJECT: 200 KLPD GRAIN BASED ETHANOL PROJECT

AVANT-GARDE
SYSTEMS AND CONTROLS (P) LTD.
CHENNAI 600 116, INDIA.

	NAME	SIGN	DATE	NO OF ITEMS
DRAWN	S.PRABHU	–	28.09.2021	–
CHKD.	S.R.SAIPRASAD	–		
APPD.	S.SIVAKUMAR	–		

DEPT PM | CODE 600 | FIRST ANGLE PROJECTION | SCALE: NTS | WEIGHT (Kg): – | REF. ASSY. DRG. NO.: – | ITEM NO.: –

TITLE: PROCESS FLOW DIAGRAM FOR THIN STILLAGE EVAPORATION SYSTEM

DRAWING NO.: 2-2021252-600-0010
CAD DRAWING NO. 20212520010

REV: 01

REV. NO.	DATE	DESCRIPTION	REV. BY	CHD.	APPD.
01.	28.11.2021	GENERALLY REVISED	SP	SRS	SSK

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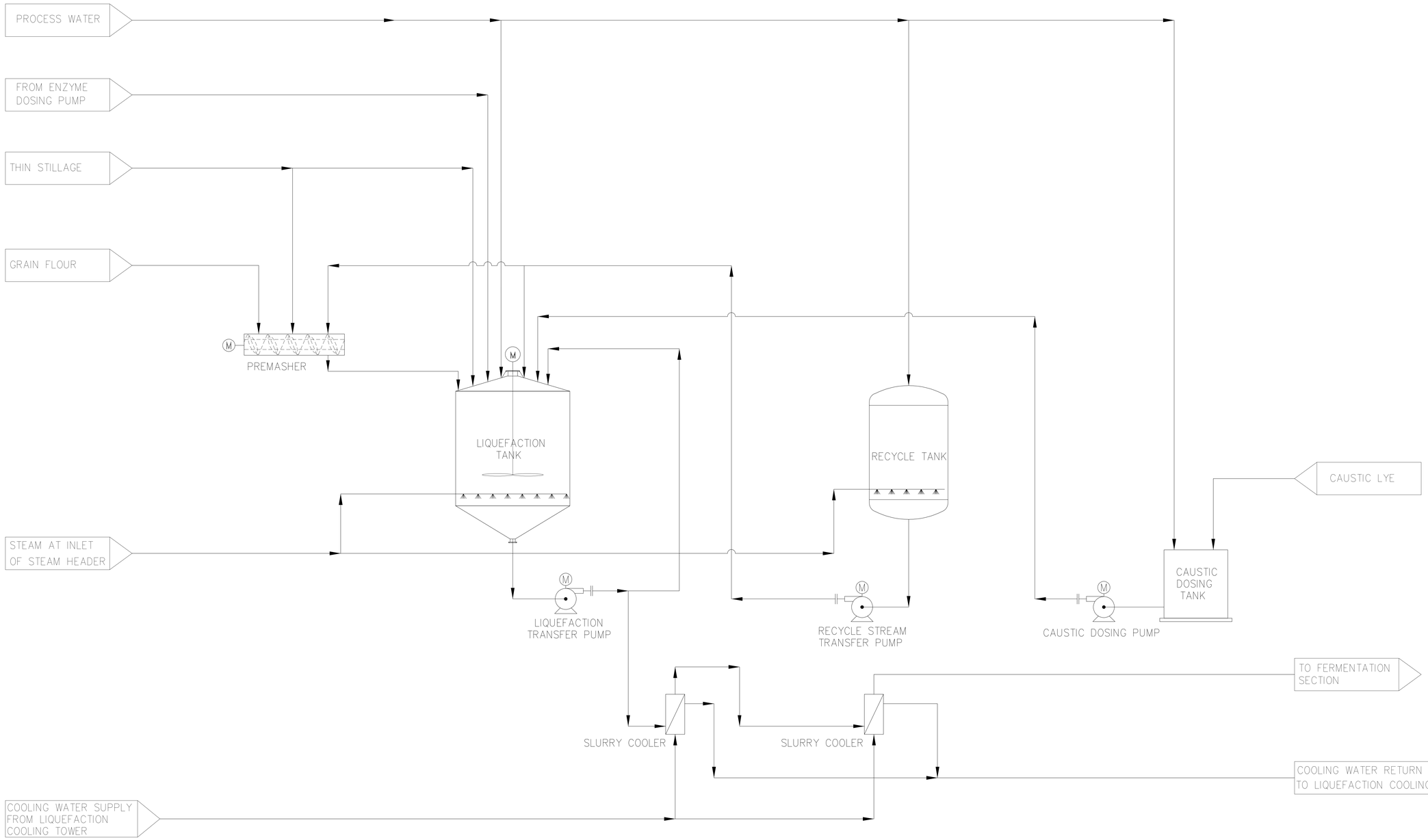

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CUSTOMER: SLB ETHANOL PVT LTD.,

PROJECT: 200 KLPD GRAIN BASED ETHANOL PROJECT

AVANT-GARDE
SYSTEMS AND CONTROLS (P) LTD.
CHENNAI 600 116, INDIA.

	NAME	SIGN	DATE
DRAWN	S.PRABHU	–	28.09.2021
CHKD.	S.R.SAIPRASAD	–	
APPD.	S.SIVAKUMAR	–	

NO OF ITEMS: –

DEPT: PM
CODE: 600
FIRST ANGLE PROJECTION
SCALE: NTS
WEIGHT (Kg): –
REF. ASSY. DRG. NO.: –
ITEM NO.: –

TITLE: PROCESS FLOW DIAGRAM FOR LIQUEFACTION SECTION

DRAWING NO.: 2-2021252-600-0011
CAD DRAWING NO.: 20212520011
REV: 0

REV. NO.	DATE	DESCRIPTION	REV. BY	CHD.	APPD.

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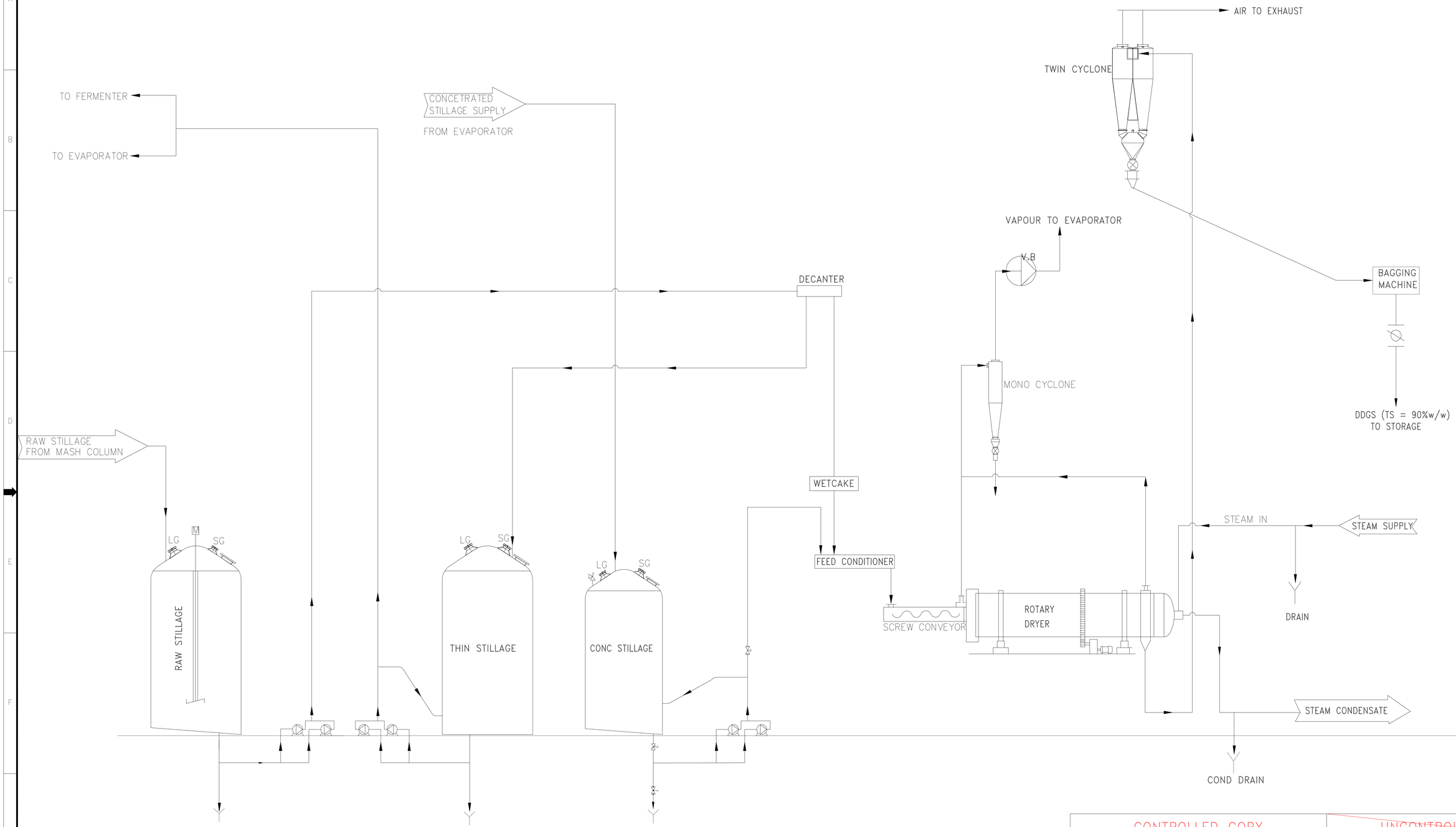

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CUSTOMER: SLB ETHANOL PVT LTD.,

PROJECT: 200 KLPD GRAIN BASED ETHANOL PROJECT

AVANT-GARDE
SYSTEMS AND CONTROLS (P) LTD.
CHENNAI 600 116, INDIA.

	NAME	SIGN	DATE	NO OF ITEMS
DRAWN	S.PRABHU	–	28.09.2021	–
CHKD.	S.R.SAIPRASAD	–		
APPD.	S.SIVAKUMAR	–		

DEPT	FIRST ANGLE PROJECTION	SCALE	WEIGHT (Kg)	REF. ASSY. DRG. NO.	ITEM NO.
PM		NTS	–	–	–
CODE 600					

TITLE: PROCESS FLOW DIAGRAM OF DDGS DRYER SECTION

DRAWING NO. 2-2021252-600-0012

CAD DRAWING NO. 20212520012

REV 0

REV. NO.	DATE	DESCRIPTION	REV. BY	CHD.	APPD.

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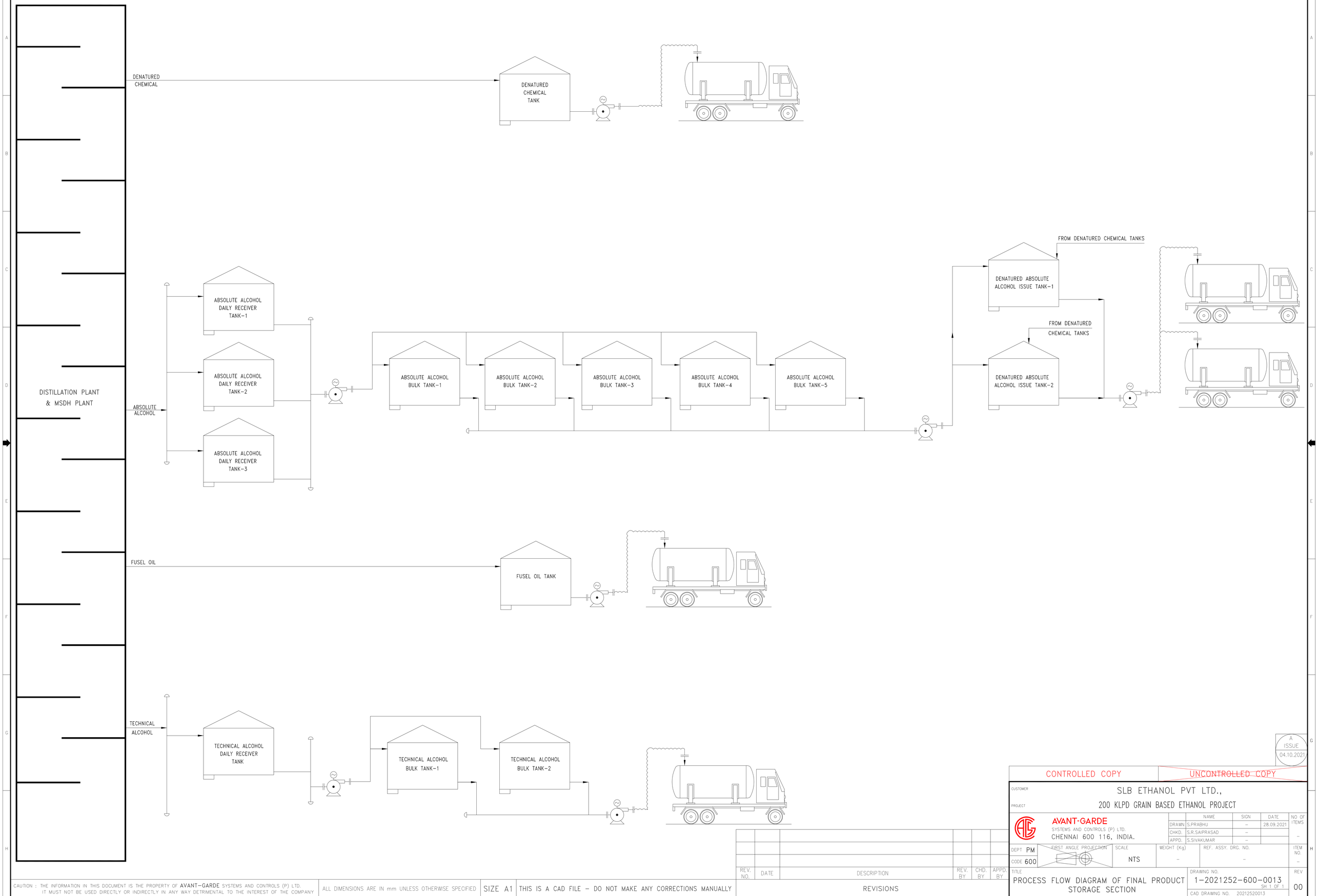

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CUSTOMER
PROJECT
SLB ETHANOL PVT LTD.,
200 KLPD GRAIN BASED ETHANOL PROJECT

AVANT-GARDE
SYSTEMS AND CONTROLS (P) LTD.
CHENNAI 600 116, INDIA.

	NAME	SIGN	DATE	NO OF ITEMS
DRAWN	S.PRABHU	–	28.09.2021	–
CHKD.	S.R.SAIPRASAD	–		
APPD.	S.SIVAKUMAR	–		

DEPT PM
CODE 600
FIRST ANGLE PROJECTION
SCALE NTS
WEIGHT (Kg) –
REF. ASSY. DRG. NO. –
ITEM NO. –

TITLE
PROCESS FLOW DIAGRAM OF FINAL PRODUCT STORAGE SECTION

DRAWING NO. 1-2021252-600-0013 SH 1 OF 1
CAD DRAWING NO. 2021252013
REV 00

REV. NO.	DATE	DESCRIPTION	REV. BY	CHD. BY	APPD. BY

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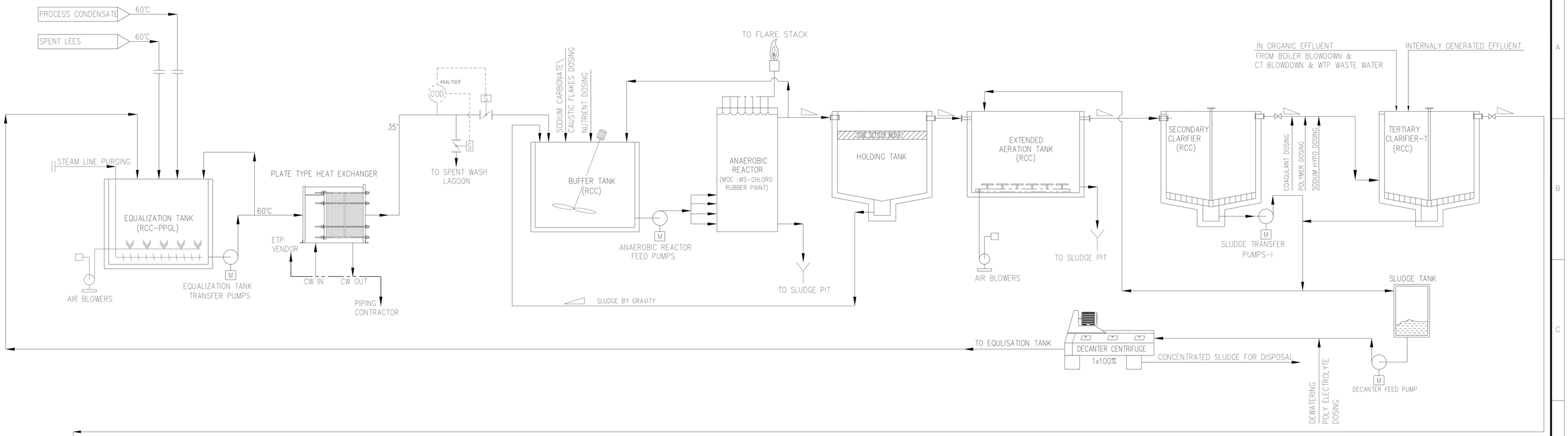

ABBREVIATION:-

CWST	:	CLEAR WATER STORAGE TANK
MGF	:	MULTIGRADE FILTER
ACF	:	ACTIVATED CARBON FILTER
FWST	:	FILTERED WATER STORAGE TANK
UVFP	:	UV FEED PUMP
UV	:	ULTRA VIOLET
UFFP	:	UF FEED PUMP
UF	:	ULTRAFILTRATION MODULE
UFPWST	:	UF PERMEATE WATER STORAGE TANK
ROFP	:	RO FEED PUMP
MCF	:	MICRON CARTRIDGE FILTER
ROHPP	:	RO HIGH PRESSURE PUMP
ROM	:	REVERSE OSMOSIS MODULE
ROPTP	:	RO PERMEATE TRANSFER PUMP
RORTP	:	RO REJECT TRANSFER PUMP
CWTP	:	COLLECTION WATER TRANSFER PUMP
MEE	:	MULTIPLE EFFECT EVAPORATOR
PWST	:	PROCESS WATER STORAGE TANK

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CUSTOMER: SLB ETHANOL PVT LTD.,

PROJECT: 200 KLPD GRAIN BASED ETHANOL PROJECT

AVANT-GARDE
SYSTEMS AND CONTROLS (P) LTD.
CHENNAI 600 116, INDIA.

	NAME	SIGN	DATE	NO OF ITEMS
DRAWN	S.PRABHU	-	28.09.2021	-
CHKD.	S.R.SAIPRASAD	-		
APPD.	S.SIVAKUMAR	-		

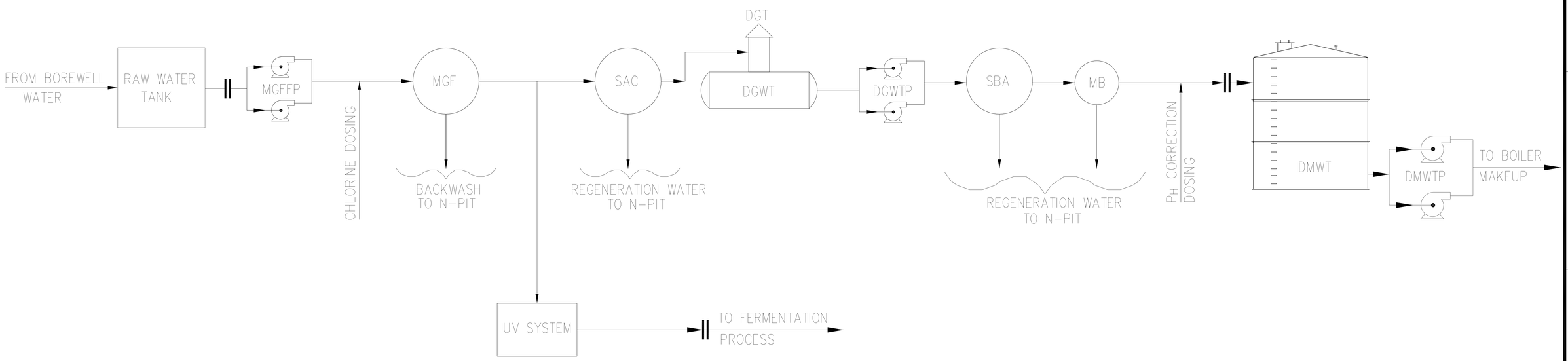
DEPT M2 | CODE 300 | FIRST ANGLE PROJECTION | SCALE: NTS | WEIGHT (Kg): - | REF. ASSY. DRG. NO.: - | ITEM NO.: -

TITLE: PROPOSED SCHEME OF CONDENSATE POLISHING UNIT

DRAWING NO.: 2-2021252-600-0014

CAD DRAWING NO.: 20212520014

REV: 01



ABBREVIATION:-

RWTP	:	RAW WATER TRANSFER PUMP
MGFFP	:	MULTI GRADE FILTER FEED PUMP
MGF	:	MULTI GRADE FILTER
SAC	:	STRONG ACID CATION EXCHANGER
DGT	:	DEGASSER TOWER
DGWT	:	DEGASSED WATER STORAGE TANK
DGWTP	:	DEGASSED WATER TRANSFER PUMP
SBA	:	STRONG BASE ANION EXCHANGER
MB	:	MIXED BED
DMWT	:	DM WATER TANK
N-PIT	:	NEUTRALIZATION PIT
UV	:	ULTRA VIOLET
DMWTP	:	DM WATER TRANSFER PUMP

NOTE:-

01. UV SYSTEM ENVISAGED FOR CONTINGENCY CONDITION ONLY

REV. NO.	DATE	DESCRIPTION	REV. BY	CHD.	APPD.
01.	28.11.2021	GENERALLY REVISED	SP	SRS	SSK

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CUSTOMER: SLB ETHANOL PVT LTD.,

PROJECT: 200 KLPD GRAIN BASED ETHANOL PROJECT

AVANT-GARDE
SYSTEMS AND CONTROLS (P) LTD.
CHENNAI 600 116, INDIA.

	NAME	SIGN	DATE
DRAWN	S.PRABHU	-	28.09.2021
CHKD.	S.R.SAIPRASAD	-	
APPD.	S.SIVAKUMAR	-	

NO OF: -

DEPT M2 | CODE 300 | FIRST ANGLE PROJECTION | SCALE: NTS | WEIGHT (Kg): - | REF. ASSY. DRG. NO.: - | ITEM NO.: -

TITLE: PROPOSED SCHEME OF WATER TREATMENT PLANT

DRAWING NO.: 3-2021252-600-0015 SH 1 OF 1

CAD DRAWING NO.: 20212520015

REV: 01

DISTILLERY BOUNDARY

420000

250000

GREEN BELT

8.0 M WIDE ROAD

GREEN BELT

CONDENSATE POLISHING UNIT
(100mx50m)

30000

75000

RAW WATER/
FIRE WATER TANK

GREEN BELT

8.0 M WIDE ROAD

GREEN BELT

ISSUE STORAGE SECTION

PUMP HOUSE

BULK STORAGE SECTION

RECEIVER
SECTION

8.0 M WIDE ROAD

8.0 M WIDE ROAD

GREEN BELT

10000

FERMENTATION
COOLING TOWER

GREEN BELT

16000

DDGS
SECTION

16000

28600

DISTILLATION &
EVAPORATION SECTION

ADMIN
BUILDING

PARKING

TIME OFFICE

MAIN
GATE

HOLD

N

8.0 M WIDE ROAD

GREEN BELT

AREA FOR
WTP
(50.0M X 40.0M)

DDGS
STORAGE
(60MX40M)

GREEN BELT

GREEN BELT

90000

22000

GREEN BELT

50000

FUEL CONVEYOR

FUEL STORAGE YARD

12450

BOILER

C HALL

42000

GRAIN SILO-1

GRAIN SILO-2

GRAIN SILO-3

GRAIN SILO-4

HOPPER FEED
SHED

HOPPER FEED
SHED

FERMENTATION SECTION

LIQUEFACTION SECTION

MILLING SECTION

WEIGH BRIDGE

WEIGH BRIDGE
ROOM

8.0 M WIDE ROAD

GREEN BELT

8.0 M WIDE ROAD

420000

250000

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CUSTOMER: SLB ETHANOL PVT LTD.,

PROJECT: 200 KLPD GRAIN BASED ETHANOL PROJECT

AVANT-GARDE
SYSTEMS AND CONTROLS (P) LTD.
CHENNAI 600 116, INDIA.

	NAME	SIGN	DATE	NO OF ITEMS
DRAWN	S.PRABHU	-Sd-	28.09.2021	
CHKD.	S.R.SAIPRASAD	-Sd-		-
APPD.	S.SIVAKUMAR	-Sd-		

DEPT: PM | CODE: 600 | FIRST ANGLE PROJECTION | SCALE: 1:400 | WEIGHT (Kg): - | REF. ASSY. DRG. NO.: - | ITEM NO.: -

TITLE: DISTILLERY PLANT LAYOUT

DRAWING NO.: 0-2021252-600-0016 SH. 1 OF 1 | REV.: 01

CAD DRAWING NO.: 2021252016

REV. NO.	DATE	DESCRIPTION	REV. BY	CHD. BY	APPD. BY
01.	28.11.2021	GENERALLY REVISED	SP	SRS	SSK

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SIZE A3

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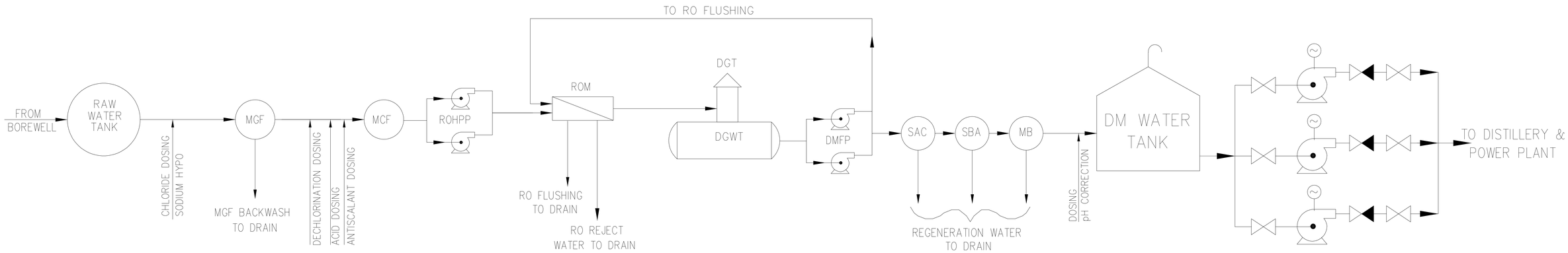

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01.	28.11.2021	GENERALLY REVISED	SP	SRS	SSK

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CUSTOMER: SLB ETHANOL PVT LTD.,

PROJECT: 200 KLPD GRAIN BASED ETHANOL PROJECT

AVANT-GARDE
SYSTEMS AND CONTROLS (P) LTD.
CHENNAI 600 116, INDIA.

	NAME	SIGN	DATE
DRAWN	S.PRABHU		28.09.2021
CHKD.	S.R.SAIPRASAD		
APPD.	S.SIVAKUMAR		

NO OF: –

DEPT PM
CODE 600

SCALE: NTS

WEIGHT (Kg): –

REF. ASSY. DRG. NO.: –

ITEM NO.: –

TITLE: PROCESS FLOW DIAGRAM FOR RAW WATER AND DM WATER SYSTEM

DRAWING NO. 3-2021252-600-0017 SH 1 OF 1

CAD DRAWING NO. 2021252017

REV 01

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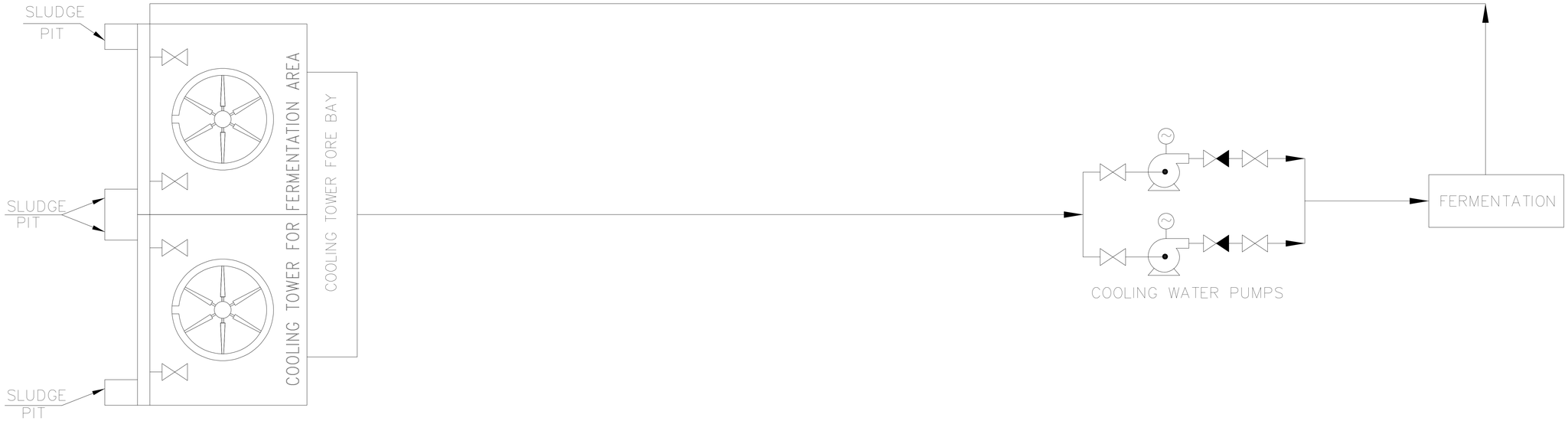

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28.11.2021

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CUSTOMER: SLB ETHANOL PVT LTD.,

PROJECT: 200 KLPD GRAIN BASED ETHANOL PROJECT

AVANT-GARDE
SYSTEMS AND CONTROLS (P) LTD.
CHENNAI 600 116, INDIA.

	NAME	SIGN	DATE
DRAWN	S.PRABHU	–	28.09.2021
CHKD.	S.R.SAIPRASAD	–	
APPD.	S.SIVAKUMAR	–	

NO OF: –

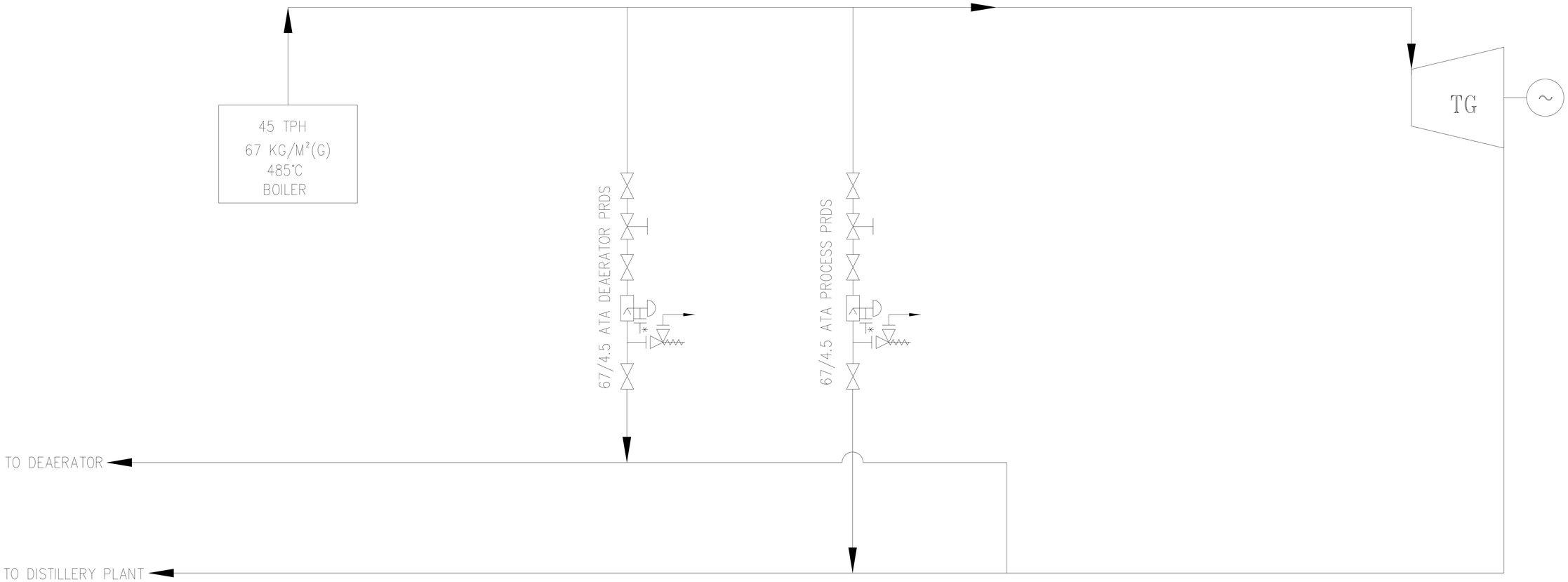
DEPT	FIRST ANGLE PROJECTION	SCALE	WEIGHT (Kg)	REF. ASSY. DRG. NO.	ITEM NO.
PM		NTS	–	–	–
CODE 600					

TITLE: PROCESS FLOW DIAGRAM FOR COOLING WATER SYSTEM

DRAWING NO. 3-2021252-600-0018 SH 1 OF 1

CAD DRAWING NO. 20212520018

REV 01



* SPRAY WATER FROM SPRAY WATER PRESSURE REDUCING STATION

REV. NO.	DATE	DESCRIPTION	REV. BY	CHD.	APPD.
01.	28.11.2021	GENERALLY REVISED	SP	SRS	SSK

REVISIONS

B
ISSUE
28.11.2021

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CUSTOMER: SLB ETHANOL PVT LTD.,

PROJECT: 200 KLPD GRAIN BASED ETHANOL PROJECT

AVANT-GARDE
SYSTEMS AND CONTROLS (P) LTD.
CHENNAI 600 116, INDIA.

	NAME	SIGN	DATE
DRAWN	S.PRABHU		04.10.2021
CHKD.	S.R.SAIPRASAD		
APPD.	S.SIVAKUMAR		

NO OF: –

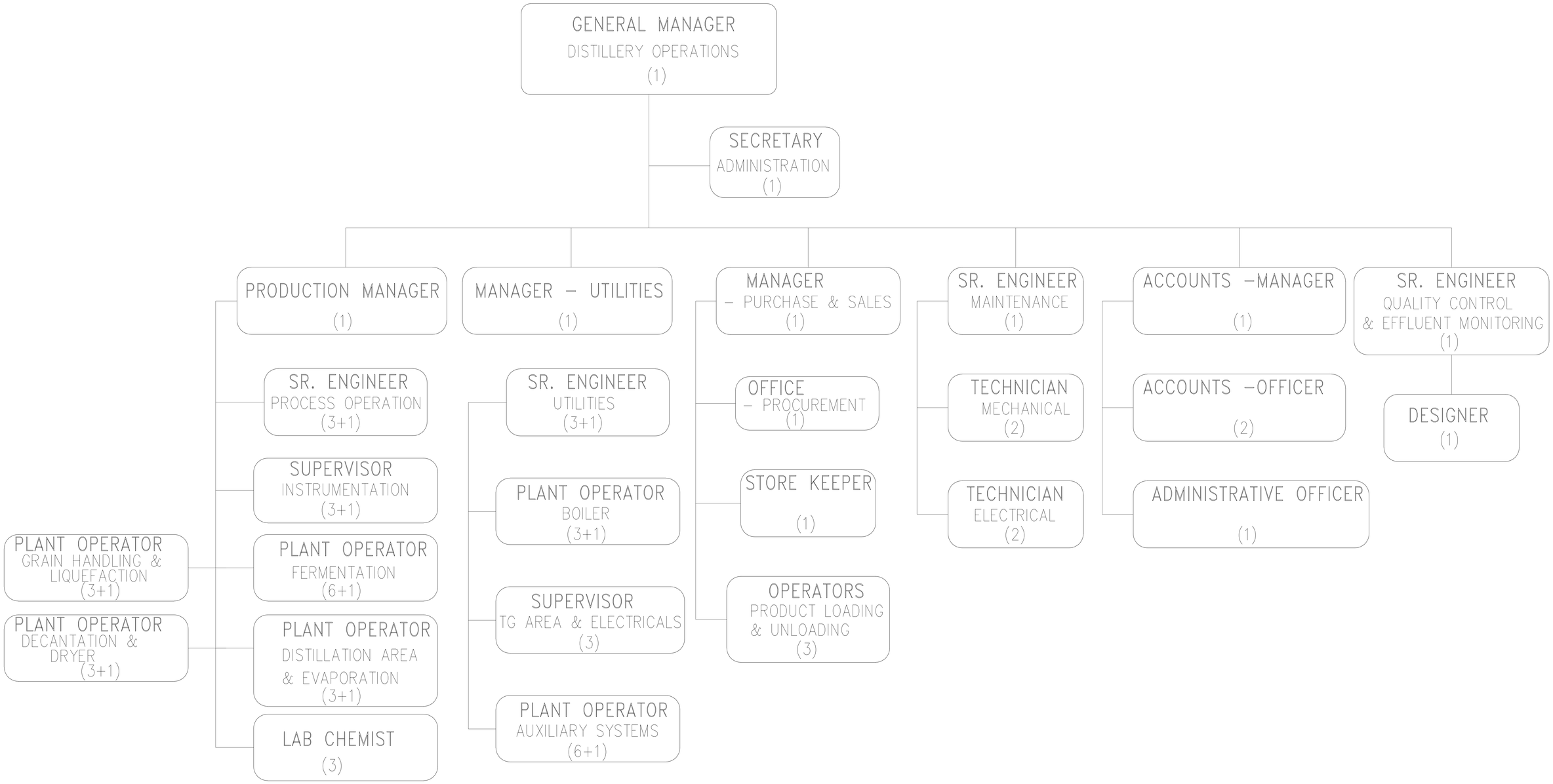
DEPT	CODE	FIRST ANGLE PROJECTION	SCALE	WEIGHT (Kg)	REF. ASSY. DRG. NO.	ITEM NO.
PM	600		NTS	–	–	–

TITLE: PROCESS FLOW DIAGRAM FOR PLANT STEAM SYSTEM

DRAWING NO. 3-2021252-600-0024 SH 1 OF 1

CAD DRAWING NO. 2021252024

REV 01



AVANT-GARDE
SYSTEMS AND CONTROLS (P) LTD.
CHENNAI 600 116, INDIA.

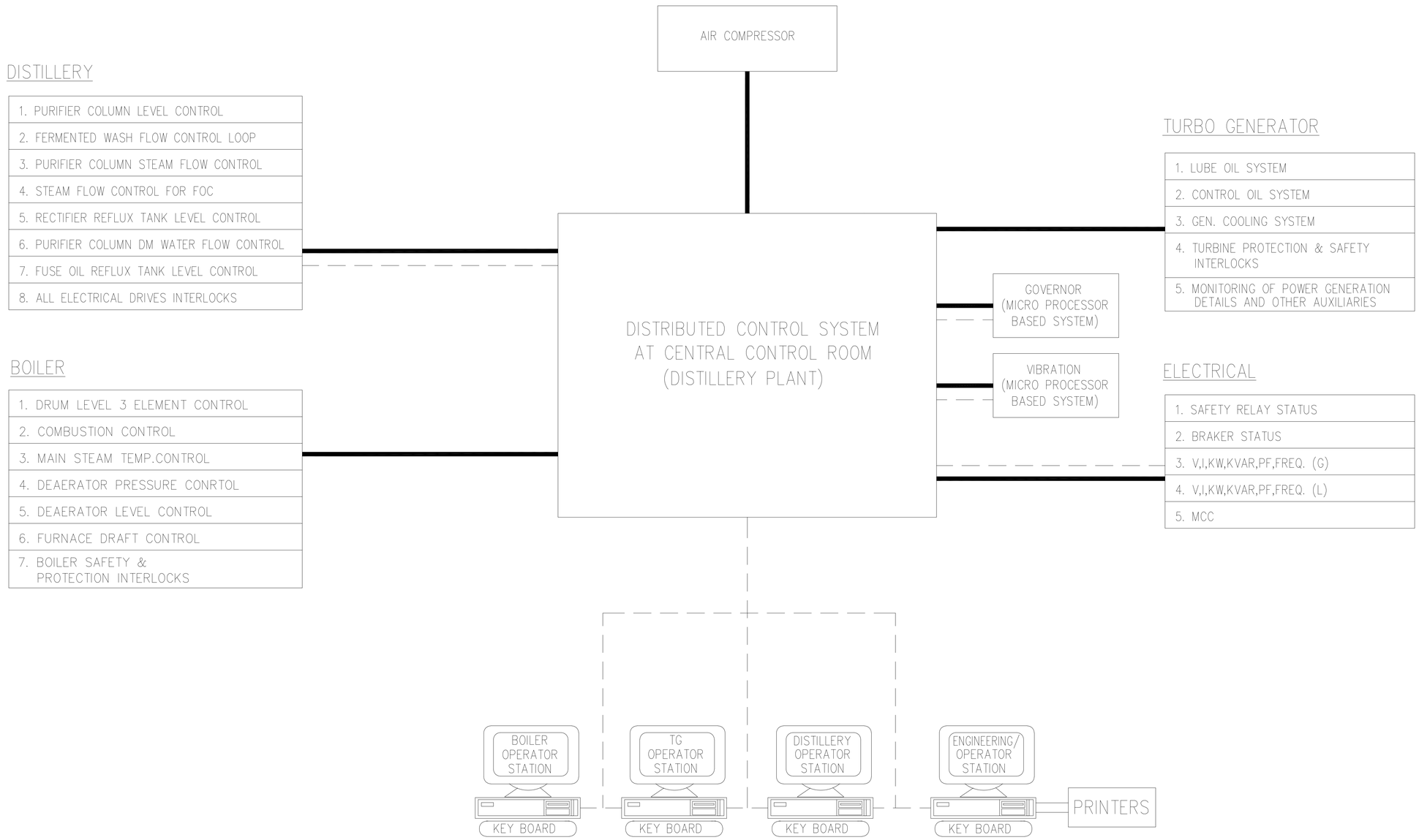
CUSTOMER	SLB ETHANOL PVT LTD.,
PROJECT	200 KLPD GRAIN BASED ETHANOL PROJECT
TITLE	ORGANISATION CHART

	NAME	SIGN	DATE
DRN	S.P		28.11.2021
CHD	SRS		
APPD	SSK		

DRAWING NO. 4-2021252-600-0020 | REV. 01

CAD DRAWING NO. 2021252020

SIZE A4



NOTE:–

SIGNAL/CONTROL CABLES

COMMUNICATION CABLES

AVANT-GARDE
SYSTEMS AND CONTROLS (P) LTD.
CHENNAI 600 116, INDIA.

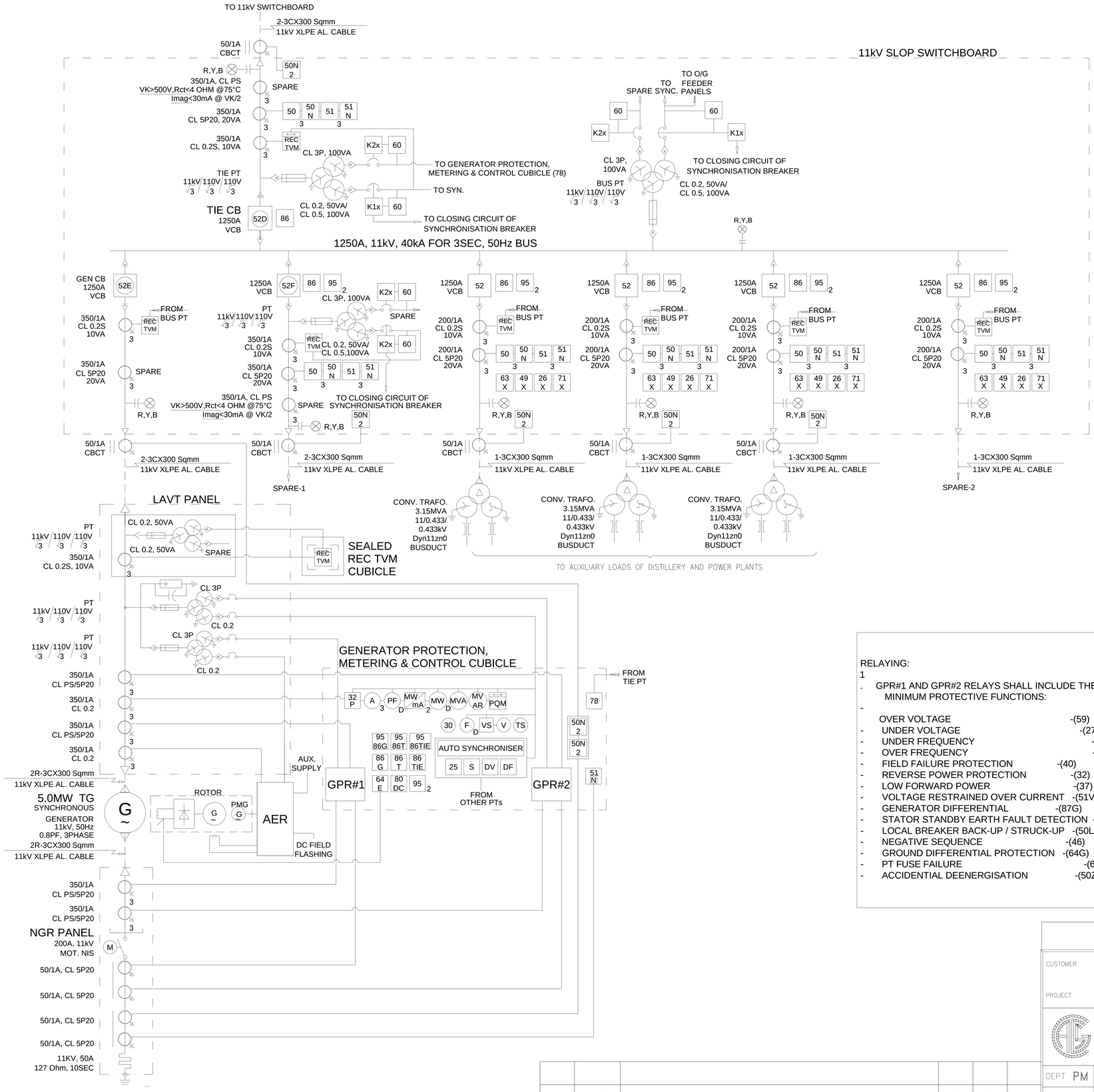
CUSTOMER	SLB ETHANOL PVT LTD.,
PROJECT	200 KLPD GRAIN BASED ETHANOL PROJECT
TITLE	OVERVIEW OF THE CONTROL SYSTEM

	NAME	SIGN	DATE
DRN	SP		28.09.2021
CHD	SRS		
APPD	SSK		

DRAWING NO. 3-2021252-600-0021 REV. 0

CAD DRAWING NO. 2021252021

SIZE A4



LEGEND:

	HRC FUSE	A n	AMMETER n - NO. OFF
n	CURRENT TRANSFORMER n - NUMBER OF CTs X-X/1A-ADOPTED CT RATIO	V n	VOLTMETER n - NO. OFF
	SURGE CAPACITOR	MW D	MEGA-WATT METER D-DIGITAL
	POTENTIAL TRANSFORMER	MVA	MEGA-VOLTAMPERE METER
GPR	GENERATOR PROTECTION RELAY #1 - RELAY#1 #2 - RELAY#2	PF D	POWER FACTOR METER D-DIGITAL
52	DRAW-OUT CIRCUIT BREAKER WITH SYNCHRONISATION FACILITY	MV AR	MEGA-VAR METER
52	DRAW-OUT CIRCUIT BREAKER	REC TVM	DIGITAL TRIVECTOR METER FOR REC PURPOSE E - EXPORT, I - IMPORT
AER	AUTO EXCITATION REGULATOR	VS	VOLTMETER SELECTOR SWITCH
NGR	NEUTRAL GROUNDING RESISTOR	CBCT	CORE BALANCED CURRENT TRANSFORMER
LAVT	LIGHTNING ARRESTER & VOLTAGE TRANSFORMER	S	SYNCHROSCOPE
	LIGHTNING ARRESTOR	DV	DOUBLE VOLTMETER
PQM	POWER QUALITY METER WITH HORMONIC ANALYSING FACILITY	DF	DOUBLE FREQUENCY METER
	INTERPOSING CT	F D	FREQUENCY METER D-DIGITAL
	NEUTRAL ISOLATION SWITCH	AS	AMMETER SELECTOR SWITCH
* mA	TRANSDUCER TYPICAL	K1x....KNx	PT HEALTHINESS AUXILIARY RELAY WITH 5Nos. 'NO' + 1No. 'NC' CONTACTS

RELAYING:

NO.	FUNCTION	NO.	FUNCTION
2	TIMER RELAY	52	CIRCUIT BREAKER
21	DISTANCE PROTECTION RELAY	60	PT FUSE FAILURE RELAY
25	SYNCHRONISM CHECK RELAY	63	BUCHHOLZ RELAY & OIL SURGE RELAY
26	APPARATUS THERMAL DEVICE	64	RESTRICTED EARTH FAULT RELAY
27	UNDER VOLTAGE RELAY	67	DIRECTIONAL O/C RELAY
30	ANNUNCIATOR	71	LEVEL SWITCH
49	TRAFO THERMAL RELAY	78	VECTOR SURGE RELAY
50	INSTANTANEOUS O/C RELAY	86	MASTER TRIP RELAY
51	IDMT O/C RELAY	95	TRIP CIRCUIT SUPERVISION RELAY

SUFFIX FOR RELAYING:

D NEUTRAL DISPLACEMENT	O/F OVER FREQUENCY
dF dF/dt ELEMENT	T TURBINE
E ROTOR EARTH FAULT	U/F UNDER FREQUENCY
G GENERATOR	Z NO VOLT ELEMENT
GT GRID TRANSFORMER	X AUXILIARY RELAY
LBB LOCAL BREAKER BACKUP	LV LOW VOLTAGE
DC DIRECT CURRENT	HV HIGH VOLTAGE
N EARTH FAULT	TS TEMPERATURE SCANNER
de/dt RATE OF CHANGE VOLTAGE	PMG PERMANENT MAGNET GENERATOR
B BUSBAR PROTECTION	CH BUSBAR SUPERVISION
P ACTIVE POWER	R RESTRICTED EARTH FAULT

RELAYING:
1
. GPR#1 AND GPR#2 RELAYS SHALL INCLUDE THE FOLLOWING MINIMUM PROTECTIVE FUNCTIONS:
-
- OVER VOLTAGE -(59)
- UNDER VOLTAGE -(27)
- UNDER FREQUENCY -(81 U/F)
- OVER FREQUENCY -(81 O/F)
- FIELD FAILURE PROTECTION -(40)
- REVERSE POWER PROTECTION -(32)
- LOW FORWARD POWER -(37)
- VOLTAGE RESTRAINED OVER CURRENT -(51V)
- GENERATOR DIFFERENTIAL -(87G)
- STATOR STANDBY EARTH FAULT DETECTION -(51G)
- LOCAL BREAKER BACK-UP / STRUCK-UP -(50LBB)
- NEGATIVE SEQUENCE -(46)
- GROUND DIFFERENTIAL PROTECTION -(64G)
- PT FUSE FAILURE -(60)
- ACCIDENTIAL DEENERGISATION -(50Z)

THIS IS A STANDARD RELAYING & LEGEND. SOME SYMBOLS MAY NOT APPEAR ON THE DRAWING.

B
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29.11.2021

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CUSTOMER: SLB ETHANOL PVT LTD.,

PROJECT: 200 KLPD GRAIN BASED ETHANOL PROJECT

AVANT-GARDE
SYSTEMS AND CONTROLS (P) LTD.
CHENNAI 600 116, INDIA.

	NAME	SIGN	DATE	NO OF ITEMS
DRAWN	M.R.VIGNESWARI	–	28.09.2021	–
CHKD.	S.BARANI	–		
APPD.	N.THIRUMOORTHY	–		

DEPT PM | CODE 600 | FIRST ANGLE PROJECTION | SCALE NTS | WEIGHT (Kg) – | REF. ASSY. DRG. NO. – | ITEM NO. –

TITLE: SINGLE LINE DIAGRAM FOR TG

DRAWING NO. 2-2021252-600-0022

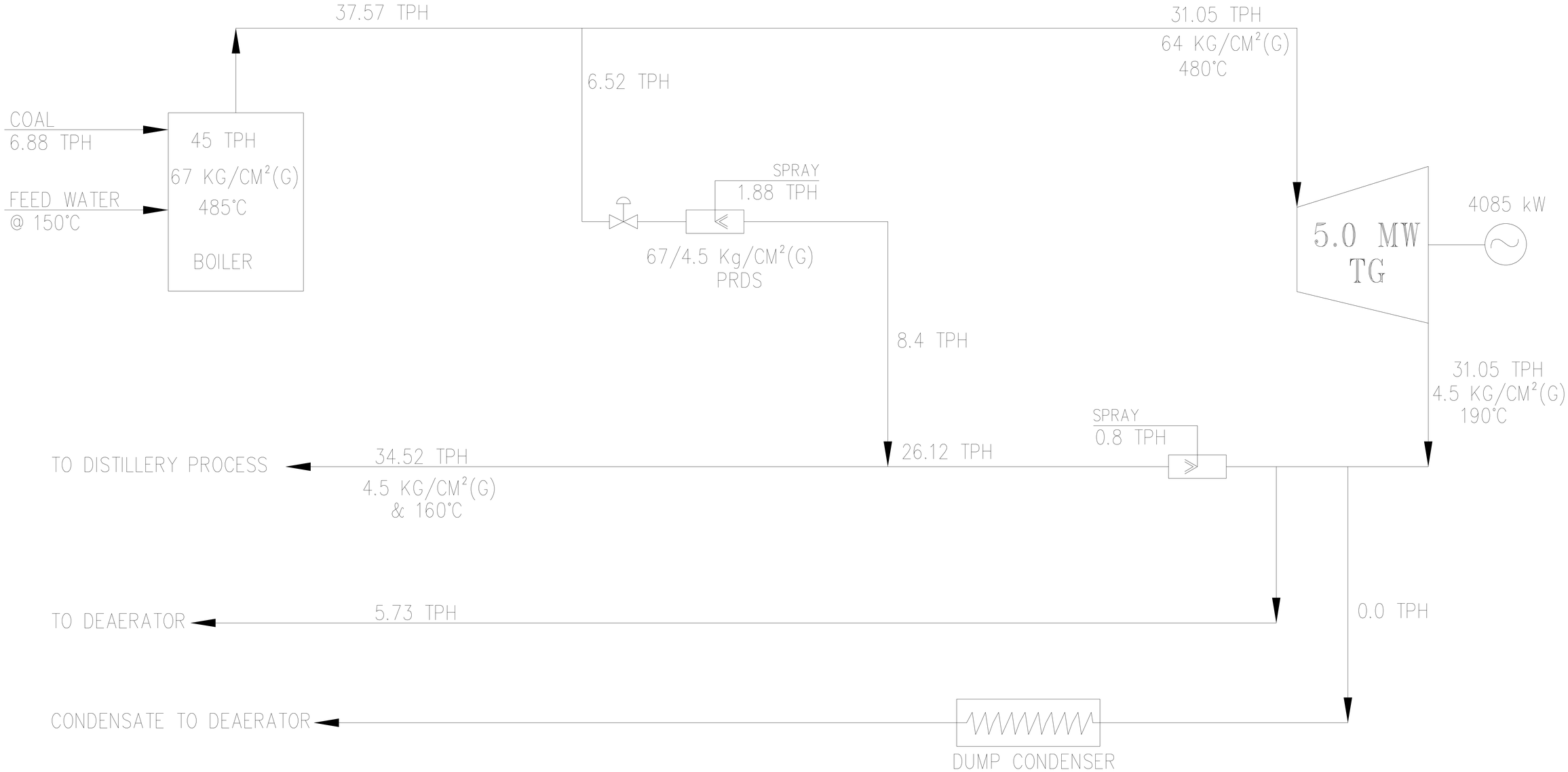
CAD DRAWING NO. 2021252022

REV 01

REV. NO.	DATE	DESCRIPTION	REV. BY	CHD.	APPD.
01.	28.11.2021	GENERALLY REVISED	SP	SRS	SSK

REVISIONS

ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE SPECIFIED | SIZE: A2 | THIS IS A CAD FILE – DO NOT MAKE ANY CORRECTIONS MANUALLY



AVANT-GARDE
SYSTEMS AND CONTROLS (P) LTD.
CHENNAI 600 116, INDIA.

CUSTOMER SLB ETHANOL PVT LTD.,

PROJECT 200 KLPD GRAIN BASED ETHANOL PROJECT

TITLE COGENERATION SCHEME (OPERATION WITH BROKEN RICE)

	NAME	SIGN	DATE
DRN	SP		10.12.2021
CHD	SRS		10.12.2021
APPD	SSK		10.12.2021

DRAWING NO. FIG.1 REV. 03

CAD DRAWING NO. 2021252023

SIZE A4