



## *Sugar Mill Calculations*

*Free resource for Sugar Mill Calculations .....*

### **SPECIFICATIONS OF 5000 TCD CANE SUGAR SULPHITATION SUGAR PLANT EXPANDABLE TO 7500 TCD**

**SPECIFICATIONS OF CRUSHING 5000 TONNES OF CANE PER DAY AND  
SUITABLE FOR EXPANSION TO 7500 TONNES OF CANE PER DAY TO  
PRODUCE DIRECT CONSUMPTION WHITE PLANTATION SUGAR**

**(I) CANE MILLING PLANT**

**(a) Cane Handling and Feeding Arrangement**

**(i) Cane Handling**

**ALT - I**

For 5000 TCD - Two Bridges with two trolley, each having sling bar system –  
Two motion type and one hydraulic truck tippler with auxiliary  
cane carrier

For 7500 TCD - Addition of one more bridge with two trolleys.

The crane shall be 2 motion 7.5 tonnes S.W.L. electrically operated overhead unloading crane conforming to Class IV IS specifications and capable of 20 lifts per hour. In each lift, sling shall lift at least 6.0 tonnes of cane. The crane shall be complete with its accessories, attendant platform along with the length of the gantry on both sides, cat ladder – 2 nos., etc. It shall be heavy duty type and suitable for continuous outdoor working. All operations shall be electrically controlled from the Operator” cabin. The crane span shall be 30 metres.

Design Code - IS. 3177 & 807

All electric motors shall be of crane duty T.E.F.C. enclosures suitable for 300 operations per hour with following specifications :

Particulars	Type of Motor	H.P.	Rating	Duty
Hoisting drum drive	Squirrel cage	35	1 hr.	S4
Holding drum drive	Squirrel cage	35	1 hr.	S4
Cross travel drive	Slipring	10	½ hr.	S4

For operation of these motors push button type panel shall be provided and its location shall be in the cabin attached to the trolley.

The following speeds shall be provided for various motions :

Hoisting	12 meters / minute
Holding	12 meters / minute
Cross travel	20 meters / minute

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**Alternatively** - hydraulic drives with equivalent output powers can be considered.

The height of the lift shall be 10 metres. All gear boxes shall be totally enclosed, dust proof, helical type gear and shall be designed with a service factor of 2. All couplings shall be flexible gear type / centrifugal type with periodically greasing arrangement. All brakes shall be of electrohydraulic thruster operator type. A suitable shed shall be provided for the trolley. The structure and each bridge should be designed for 2 Nos. trolleys each of 7.5T SWL capacity. Each bridge shall be of box type construction made of IS 2062.

### **ALT - II**

For 5000 TCD - 2 Nos. bridges with one trolley each of three motion, having grab system (5T SWL Capacity) and one hydraulic truck tippler of minimum 40T/hr capacity, 10 to 12 tip/hr with auxiliary cane carrier.

For 7500 TCD - 1 No. additional bridge with one trolley each of three motion with sling or grab system.

The crane shall be of 3 motion electrically operated overhead unloading crane conforming to class IV IS: specifications and capable of 20 lifts per hour. In each lift, grab shall lift at least 2.5 tonnes cane.. The crane shall be complete with its accessories, gantry columns, attendant plat-form along the length of the gantry on both sides 2 Nos. cat-ladder, etc. It shall be heavy-duty type and suitable for continuous outdoor working. All operations shall be electrically controlled from the operator's cabin. The crane gantry span shall be 30 metres. The crane gantry shall be 40 metres in length with gantry columns 10 metres apart for initial capacity and shall be extended by 10 mtrs. for ultimate capacity. Bridges shall be box type construction made of IS 2062 or equivalent gantry columns shall be L shape construction but the 4 end columns should have double L construction at 90 deg. End columns shall be provided with the tie beam on each end.

The structure of the gantry shall be of adequate strength to provide additional crane of identical specifications for expansion to ultimate capacity.

Design Code - I.S. 3177 & 807

All electric motors shall be of crane duty T.E.F.C. enclosures suitable for 300 operations per hour with following specifications:

Particulars	Type of motor	H.P.	Rating	Duty
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Hoisting Drum Drive	Squirrel cage	25	1 hr.	S4
Holding Drum Drive	Squirrel cage	25	1 hr.	S4
Long travel drive	Slipring	10	½ hr.	S4
Cross travel drive	Slipring	7.5	½ hr.	S4

For operation of these motors push button type panel shall be provided and its location shall be in the cabin attached to the trolley.

The following speeds shall be provided for various motions:

Hoisting	-	12 metres/minute
Holding	-	12 metres/minute
Long Travel	-	20 metres/minute
Cross Travel	-	20 metres/minute

**Alternatively** hydraulic drives of equivalent output can be considered

The height of the lift shall be 10 metres. All gear boxes shall be totally enclosed, dust proof, helical type gear and shall be designed with a service factor of 2.0 All couplings shall be of flexible gear type / centrifugal type with periodically greasing arrangement. All brakes shall be of electrohydraulic thruster operated type. Ratio of the pully diam (PCD) to wire rope dia shall not be less than 20.

The crane shall be provided with sling bar or grab attachment as decided by the Purchaser. A suitable shed shall be provided on the trolley.

### **Hy. Truck Tippler and Aux. Cane Carrier.**

#### **1 No: Hy. Truck Tippler**

The truck tippler having loading capacity 40 tons with an angle of 55 deg. max, complete with platform suiting the truck size, tilting gear mechanism complete with hy. equipment, rear slope, front hooks and power pack with control system shall be provided.

The tippler shall be suitable for 10 to 12 tips per hour.

#### **1 No: Aux. Cane Carrier**

One Aux. Cane Carrier 4080 mm wide and loading length 20 M with 15° inclination with suitable elevation to feed main cane carrier. It shall have six strands of chains of 200 mm pitch. The breaking strength of the chains shall be minimum 60,000 kgs. The cane carrier and

its structure shall be of all steel construction, the slats 6 mm thick shall be as per IS: 8236 and fastened to chain by bolts and nyloc nuts or by bolts and check nuts.

The tail portion of the carrier shall be arranged below the ground level. Space of minimum 750 mm shall be left in the pit on either side of the carrier for inspection and cleaning purpose. The carrier framework shall not be less than 8-mm thick and mild steel plate extending along the complete length of the carrier.

The other details shall be as provided for the Main Cane Carrier.

It shall be driven by 75 BHP with constant torque characteristics and operating speed range. The motor with AC variable frequency panel shall be directly coupled to helical gearbox to provide 3 to 7 mtr/minute variable speed.

- (ii) **Feeder Table** : For 5000 TCD - 2 Nos:  
For 7500 TCD - Additional 1No:

Cane feeder table of minimum 6-metre width and 7 metres in length to be installed at right angle to the cane carrier. The feeder table shall be of all steel construction fitted with 8 strands of 150-mm pitch heavy-duty steel drag type chains having breaking strength of minimum 40,000 kgs. The feeder table shall be complete with cast steel sprocket wheel having machine cut teeth shafts, bearings etc. The feeder table shall be driven by a 15.H.P., T.E.F.C. squirrel cage motor and coupled to a variable speed drive and a reduction gear so as to provide speed regulation from 1 to 3 mtrs/min. The feeder table shall be suitably supported on steel structure designed to withstand heavy shocks. It shall be installed in a manner so that it is horizontal.

Operator's cabin on a suitable height shall be provided to have a clear view of the loading of the cane carrier. A suitable ladder shall be provided to this cabin.

**NOTE – Feeder Table recommended only in case of unloader with sling arrangement.**

**Cane Carrier and Preparatory Devices: To suit the installation of Fibrizer.**

**(b) Cane Carriers**

**(i) Cane Carrier:**

One cane carrier 2140 mm wide and horizontal loading length 40 mtrs shall be provided. The length of its inclined portion shall be such that it gives an inclination of 18 deg. for the leveller with a minimum length of 8 metres having a slope of not more 6 deg. before fibrizer. It shall have suitable elevation to suit the installation of fibrizer. It shall have three strands of chains of 200 mm pitch. The breaking strength of the chains shall be minimum 60,000 kgs. The cane

carrier and its structure shall be of all steel construction, the slats 6 mm thick shall be as per IS: 8236 and fastened to chain by bolts and nyloc nuts or by bolts and check nuts.

It shall be driven by 125 BHP with constant torque characteristic and operating speed range. The motor with AC variable frequency panel shall be directly coupled to helical gear box with open gearing to provide 3 to 7 m/minute variable speed.

The horizontal portion of the carrier shall be arranged below the ground level in such a way so that the sloping sides of the carrier are about 300 mm above the ground level. Space of minimum 750 mm shall be left in the pit on either side of the carrier for inspection and cleaning purpose. Arrangement for adjusting the clearance upto 50-mm between tip of knives and the slats in the cane leveller shall be provided in the inclined portion. The carrier frame work of mild steel plate extending along the complete length of the carrier shall not be less than 6 mm thick except at the place of cane leveller where the thickness should be 10 mm for about 2500 mm length.

The framework shall be adequately stiffened at the top and bottom by angle iron welded to the side plates. The side plates shall be bolted to and supported by rolled steel 250 mm x 80 mm channels or sections of equivalent strength and be provided with base plate of ample area reinforced by gusset plates of angle plates. Two foundation bolt holes would be provided in each base plate. The columns in the immediate vicinity of the cane knife set shall be 350 mm x 90 mm double channels or sections of equivalent strength. All the Columns at drive end should be adequately braced by angle cross pieces of heavy section secured by gusset plate and bolts or by welding. Three longitudinal 150 mm ISMB runners with renewable 10 mm thick mild steel wear pads would be bolted on the top side of the cross pieces to support the cane carrier chain rollers. The distance between the adjacent supporting columns should not exceed 3.5 metres. The runners would be lowered slightly where the chain arrives at and leaves the runners. 8 mm x 75 mm flat iron should be tag welded/bolted on the side plates of the cane carrier so that cane carrier slats touch the flat iron only to avoid wearing on side plates.

The return side of the apron can slide on the guide angle runners with 8 mm thick wear flat provided the slats are equipped with renewable wear pads or alternatively be supported on idler pulleys of 60 m/m width, 280m/m dia with 75mm dia of 40C8 shaft running in G.M. bushes with grease cups..

The carrier chain driven by means of cast steel sprockets having machine cut teeth atleast 16 in number and mounted on minimum 280 mm central dia. head shaft of 40 C8 quality or equivalent and shall run in 220 mm size split gunmetal line cast steel plummer block. The columns under the head shaft and carrier drive shall be extra heavy section to withstand vibrations. At the non-driving end of the cane carrier, the chain shall be mounted on cast steel sprockets having machine cut teeth on minimum 170 mm central dia tail shaft of 40 C8 quality or equivalent running in minimum 140 mm size gun metal lined cast steel slide rails with tension bolts for tightening the chain.

The head and tail shaft shall be hot forged and ultrasonically tested.

Pneumatic arrangement to be provided on the head shaft of cane carrier to clean slats and chains to remove dust - dust from the carrier chain.

## (II) Rake Carrier :

Rake type conveyor shall be of steel construction having suitable width trough to accommodate 2140 mm rake width and of suitable length to suit minimum feeding height of 3 mtrs. above top roller of GRPF of new mill. The inclination of the rake carrier shall be 45 deg. max. and the boot having no horizontal portion. The tail shaft centre of rake carrier shall be in line with head shaft centre of cane carrier. The rake carrier and its structure shall be of all steel construction with two strands block type forged chain of 300 mm pitch, having 80,000 kgs. breaking strength having locking arrangement with nyloc nuts or check nuts. Flights would be made out of 10 mm thick mild steel plate of suitable shape and profile and welded on pipe or box construction beams. These beams shall have suitable arrangement for fitting with the chain attachment at every fourth link with the help of bolts, nyloc nuts or check nuts.

The rake carrier should have runners of channels angle iron with 10 mm wear flats and 10 mm thick mild steel bottom trough plate with stiffeners and should be supported on steel channel columns of adequate strength provided with rigid base plate. The columns should be adequately braced to avoid vibrations. The elevator chain shall be driven over two cast steel sprockets mounted on 225 mm central dia. head shaft of 40 C8 or equivalent quality running in minimum 180 mm size gun metal lined cast steel bearings secured to head shaft columns. The tail shaft of minimum 170 mm central dia. 40 C8 or equivalent quality should have two cast steel sprockets having 16 machine cut teeth to guide the chains and would run in minimum 140 mm size gun metal lined, cast steel plummer blocks attached to the rake carrier boot.

The portion of the chain below the fibrizer shall be suitably covered to avoid damage due to prepared cane thrown by the fibrizer. The tightening arrangement shall also be provided near the centre of carrier in vertical direction by providing idler sprockets.

### c) Cane Carrier / Rake Carrier Drive

- |      |              |   |            |
|------|--------------|---|------------|
| (i)  | Cane carrier | - | 125 B.H.P. |
| (ii) | Rake carrier | - | 100 B.H.P. |

Each carrier drive shall have a constant torque characteristic over operating speed range. The motor with AC variable frequency panel shall be directly coupled to helical

gearbox having service factor of 2.0 with open gearing to provide following apron speeds.

- (i) Cane carrier - 3 metres to 10 meters/ minute.
- (ii) Rake carrier - 10 to 25 metres/minute.

**(d) Rake type Intercarrier for new mill – one no.**

Rake type intercarrier, between the future New mill and first mill whose centre distance shall not be less than 14000 mm shall be provided. The width of the carrier trough shall be suitable to accommodate 2140 mm rake width and its cross section suitable for handling bagasse of ultimate crushing rate of ultimate capacity . It shall be similar in construction as described under rake carrier item b (ii).

Rake carrier drive shall consist of the TEFC motor of 60 BHP, 1440 RPM with enclosed helical speed reducer, having service factor of 2.0, electrodynamic, with open gearing variable speed coupling, common bed frame and set of open spur gearing / sprockets and chains with guards. The linear speed shall not be more than 25 m/minute. A suitable M.S. fabricated zero mill by pass chute shall be included in the scope.

**NOTE :** Alternatively, in place of this carrier, the rake elevator of increased centre distance directly feeding the 1<sup>st</sup>. mill can be considered in which case its drive should be 125 HP instead of 100 HP.

**(e) Cane Preparation**

**(i) Cane Chopper**

One cane chopper set having not less than 36 knives secured to cast steel hubs of IS:1030 grade 280 – 520W mounted on a forged steel shaft of 220 mm dia. of 40 C8 quality. The dia. over the tips of knives shall not be less than 1600 mm. The knife shaft shall be supported at 180 mm bore, heavy duty self aligning double row spherical roller bearings with adopter/withdrawal sleeve in steel plummer blocks. The knives shall be of special shock resisting steel having hard faced cutting edges, hardness 45 to 48 HRC and tenoned into the hubs eliminating the shear on the bolts which should be of EN8 steel or of equivalent strength with nyloc nuts. The knives shall conform to IS: 8461. A suitable fly wheel of CI grade FG 260, IS – 210 duly machined and well balanced shall be provided at the outer end of the shaft.

Cane chopper set shall be driven by a continuously rated drip proof/screen protected slipping motor of 200 B.H.P and 600 R.P.M. synchronous speed at a total slip of 15 percent. It shall be coupled through suitable helical gearbox having service factor not less than 2 by means of geared coupling to get final speed of 300 RPM capable of transmitting 200 B.H.P continuously. The motor shall be complete with starter (current not exceeding 300% of FLC) and suitable buffer resistance. Provision for additional identical motor drive with load balancer on other end should be made for ultimate capacity.



The knife set shall be installed on the horizontal portion of the carrier before leveller and clearance in between the slats and Knives tips shall be maintained as 1200 mm The knife set shall be totally enclosed by suitably reinforced hood of 10 mm thick and mild steel plate attached to the cane carrier frame work and provided with suitable swing flaps and bolted doors at top of the hood to suit reverse rotation.

### (ii) Cane Leveller :

One cane leveller set having not less than 60 knives secured to cast steel hubs of IS:1030 Grade 280 – 520W mounted on a forged steel shaft of 300 mm dia. of 40 C8 quality. The dia. over the tips of knives shall be not less than 1600 mm. The knife shaft shall be supported at 220 bore, heavy duty self aligning double row spherical roller bearings with adopter / withdrawal sleeve in steel plummer blocks. The knives shall be of special shock resisting steel having hardfaced cutting edges, hardness 45 to 48 HRC and tenoned into the hubs eliminating the shear on the bolts which should be of EN8 or of equivalent strength with nyloc nuts. The knives shall conform to IS. 8461

A suitable fly wheel of CI grade FG 260, IS - 210 duly machined and well balanced shall be provided at the outer end of the shaft.

Cane leveller set shall be driven by a continuously rated drip proof / screen protected slipping motor of 500 B.H.P. and 600 R.P.M. synchronous speed at a total slip of 15 percent. It shall be directly coupled by geared coupling capable of transmitting 500 B.H.P continuously. The motor shall be complete with starter (starting current not exceeding 300% of FLC) and suitable buffer resistance.

The knife set shall be installed on the inclined portion of the carrier and be provided with a suitable device for adjusting clearance in between the knives tip and slats from 250 to 300 mm. The knife set shall be totally enclosed by suitably reinforced hood of 10 mm thick and mild steel plate attached to the cane carrier frame work and provided with suitable swing flaps and bolted doors at top of the hood.

Provision for identical additional motor drive on other end should be made with load balancer for ultimate capacity.

### (iii) Swing Hammer Fibrizer

Swing hammer type - located at the head end of carrier, to suit 2140 mm wide cane carrier having 150 hammers. Weight of each hammer shall not be less than 20 kg. The hammer shank shall be 30 mm thick minimum.

The rotor shaft shall be heavy duty minimum 400 mm dia at the hubs and 280 mm dia. at the bearing journals and shall be 40 C8 steel as per IS:1570.

Anvil plate shall be pocketed design, having wrap angle of not less than 160-deg minimum. The base plate thickness of the anvil shall be minimum 32 mm. Hard facing on the anvil working surface shall be having minimum hardness 600 BHN. Anvil plate shall have provision

for adjusting the anvil clearance. A suitable guide plate/floating flap of 20mm thick to be provided at the entry point of anvil.

Rotor shall be supported on two heavy duty self aligning double row spherical roller bearings. Bearing shall be mounted on shaft with adapter / withdrawal sleeve. Tip dia. of hammers shall have 1830mm swing dia when running at 1000 rpm.

The fibrizer should have detachable domite tips made of special shock resistance alloy steel and secured through 50mm dia S.S. pins, the hammer shank and fibrizer disc should have G.M. bushes to suit S.S. pins. 50mm hubs shall be of C.S./forged steel fitted on rotor shaft. Deflector plate of 20mm thickness with 2.5mm S.S. lining shall be provided.

The fibriser rotor shall be completely covered by reinforced mild steel fabricated hood made out of 12 mm thick plate attached to the cane carrier frame work and will be complete with deflector plate, adjustable mild steel fabricated anvil plate, anvil suspension gear, front adjustable cover, rear chute of 12 mm thick with 2.5 thick SS lining, bolted doors on the top of the hood. Rotor bearing plummer blocks shall be cast steel Pressure lubricating system for bearings shall be provided with 2 nos. pumps, 2 nos. coolers (one each as standby) oil reservoir, pressure gauge, piping, return line, needle valve fitting etc. with provision for auto start of standby pump.

## Drive for Fibrizer:

**For 5000 TCD** – 1 no. 2.5 MW Turbine

**For 7500 TCD** – Turbine shall be upgraded to 3MW by unblanking of nozzles. The turbo set for Fibrizer drive shall be suitable of developing continuously rated power of 2.5MW at 750 rpm even when both the overload valves of the turbine are closed.

The steam turbine shall be designed for operation for the following ranges of steam parameters:

### Inlet Steam parameters:

Maximum	:	67 kg/cm <sup>2</sup> g
Normal	:	65 kg/cm <sup>2</sup> g
Minimum	:	60 kg/cm <sup>2</sup> g

### Inlet Steam Temperature:

Maximum	:	495 deg. C
Normal	:	480 deg. C
Minimum	:	450 deg. C

### Exhaust Steam Pressure:

Maximum	:	1.5 kg/cm <sup>2</sup> g
Normal	:	1.0 kg/cm <sup>2</sup> g
Minimum	:	0.5 kg/cm <sup>2</sup> g

The turbine shall be so designed that it suffers no damage if exhaust pressure occasionally goes down to atmospheric pressure and/or live steam temperature goes upto 500 deg. C. for 67 kg/cm<sup>2</sup>g.

The turbine shall also be capable of developing 2500 kW when steam pressure at inlet stop valve is 60 kg/cm<sup>2</sup>g and temperature 450 deg. C and both overload valves open.

The specific steam consumption at its rated speed and on normal steam operating pressure while delivering 2500 KW shall not exceed: 7.0 kg/KW/hour with 67 kg/cm<sup>2</sup>g

The turbine shall be coupled to a suitable enclosed reduction gear box of hardened and ground/ nitrided gears designed to transmit 3000 KW continuously at turbine rated speed at an ambient temperature of 45 deg. C. with a service factor not less than 2.0. Speed at the output shaft of the gearbox shall be 1000rpm at 90% rated speed of the turbine. The gearbox shall be coupled to the Fibrizer through suitable resilient coupling, capable of transmitting 3000 KW continuously. The gearbox shall be designed as per relevant DIN/IS/BS/AGMA standard. Necessary cooling arrangement having double cooler and double pump for the gear box shall be provided.

The speed regulation of the turbine (Droop characteristic) shall not exceed 15 percent at 3000 KW full load of the Fibrizer. The turbine shall be provided with a variable speed type hydraulic or mechanical governor, capable of full governor control from 110% to 60% of the full rated speed of the turbine.

The turbine shall be complete with high pressure stop and emergency valve, steam strainer, steam traps, sentinel valve, main oil pump, auxiliary electric motor driven oil pump, one steam turbine driven standby oil pump, oil cooling system consisting of two Nos Oil coolers with necessary pipes and valves so that one of the two coolers can be cleaned when the turbine is working on load, steam and oil temperature and pressure gauges, gauge type spot mounted bearing temperature indicators for turbine and gear box local/direct mounted speedometers and one remote reading tachometer, oil pockets with stem type thermometers in the live steam inlet and exhaust steam outlet lines, steam flow meter for measuring the steam consumption of the turbine. Necessary oil reservoir, two oil pumps, 2 coolers and strainers to be provided, duplex micronic felt/self cleaning type oil filters, oil strainer, interconnecting oil, water and steam pipe work with valves and non-return valves etc, and arrangement for automatic starting of auxiliary oil pump in case of low oil pressure shall be provided The following safety devices shall be provided for the turbine :-

- (i) Overspeed trip with audio visual alarm.
- (ii) Low oil pressure trip with audio visual alarm.

- (iii) Power failure trip..
- (iv) Remote operated manual trip with audio visual alarm.
- (v) Manual trip knob/handle on turbine.
- (vi) Axial movement trip.
- (vii) High back pressure trip.

Special maintenance tools for the turbine shall be supplied along with the turbine.

One remote control panel fitted with stop push button, temperature and pressure gauge, turbine speed indicator, push button for raising and lowering turbine speed and push button for starting auxiliary oil pump shall be provided.

## AUTO CANE FEED CONTROL SYSTEM

The automatic cane feeding control system shall be installed on cane carriers. The system shall ensure the uniform feed rate to the 1<sup>st</sup> mill with provision to change the feed rate at any time having a variation not more than  $\pm 5\%$  set rate. Primary cane carrier shall follow speed of secondary cane carrier in a fixed ratio. Load of all cane preparation devices shall override the speed signal of each cane carrier. When load of any cane preparation device exceeds 80% of rated load, the speed of that cane carrier shall be proportionately reduced. If load exceeds 100% of rated load, that cane carrier will stop. It will restart automatically when overload condition on that cane preparation device becomes normal. These overload settings shall be adjustable from the control panel. The system shall have the following provisions.

- Sensors** : For load sensing of cane preparatory devices such as chopper, leveler, fibrizer and 1<sup>st</sup> mill, suitable current transformers / two wire electronic analogue pressure transmitters with capacitance sensing technology with 4-20 mADC output and configurable for calibration to the required pressure ranges within the designed pressure span of the transmitter. In addition to this level sensing of prepared cane at donnelly chute may be considered as option.
- Control Action** : The system should be provided with two control actions i.e. proportional and ON-OFF control actions. Proportional control as per the 1<sup>st</sup> mill load. ON-OFF control as per the high load settings of the cane preparatory devices and first mill.
- Set Points** : Following settings are to be provided,
- i) For loads of various cane preparatory devices and 1<sup>st</sup> mill drives precision load setters of 1 K 10 Turns helipots with dial knobs.

- ii) For average height and feed rate precision 10 K 10 Turns helipots with dial knobs.

**Visual Indication** : Coloured lamp indicators for the high set load values.

**Carrier Speed Adjustments :**

The speed of the cane carriers can be adjusted from zero to the rated RPM with the settings provided on the control panel at operators console.

**Indicators** : Analogue load indicators (i.e. current or pressure indicators) and speed indicators.

**Power Supply** : 230 V AC, 50 Hz

**(g) Milling Plant**

**(i) Mills :**

For 5000 TCD : 4, three roller mills 1020 mm dia. x 2040 mm long full size grooved under feed rollers and Donnelly type chutes

For 7500TCD : Addition of 1 No: 1070 dia. x 2140 long as zero mill and GRPF on zero and last mill 1020 dia x 2040mm long

Each mill roller shall be minimum nominal dia. of 1020 mm x 2040 mm length and journals of minimum 500 mm dia x 650 mm length and journal centre distance of minimum 3100 mm. The rollers shall be of coarse grain cast iron having hardness 180 -210 BHN. The composition of the shell material shall conform to IS : 1985 and shall be :

Total carbon	-	3.20 to 3.6 percent.
Manganese	-	2.2 to 3.2 percent
Silicon	-	1.2 to 2.2 percent
Phosphorus	-	0.5 per cent Max.
Sulphur	-	0.15 percent Max.

The cast iron shell shall be hot shrunk on forged steel shaft of 40C8 quality conforming to IS: 1570 or equivalent having a minimum tensile strength of 58 kg/mm<sup>2</sup>. All the shaft shall have square ends, not less than 425 mm square. Top roller shall be fitted with stationary flanges and juice rings in two halves. The bottom roller shall be provided with juice rings and

removable guards to prevent entry of juice into the bearings. The cast steel crown pinions shall have minimum 550 mm face width and conform to IS :2708 Grade 3 having 17 no. machine cut teeth, keyed to roller shaft and suitable mild steel guards and troughs.

The headstocks shall be of cast steel as per IS:1030 grade 280/520 W. These will be of king boltless type. Removable hard steel/cast steel/gun metal/fibre wearing plates on feed side as well as discharge side and with lubricating arrangement between top roller bearings and wearing plates shall be provided. The top and side caps shall be of cast steel as per IS:1030 grade 280/520 W and shall be securely locked in position for quick assembly. Stainless steel strip of 8 mm thick shall be provided in the side roller bearing face of the head stock. The eccentricity between top roller bearing centre and hydraulic cap centre shall be kept suitably towards the feed side of the headstock , except in case of inclined headstock.

All rollers shall be coated with surface roughening electrode material and its bearings shall be of cast steel with gun metal lined white metal Gr. 6 as per IS-25 1979 and with water cooling arrangement. The side roller bearing shall be of cast steel housing with renewable gun metal liner as per IS:318.

The Bearing housing shall have water cooling arrangement. All top roller bearings shall be interchangeable. Similarly all feed side and discharge roller bearings shall be interchangeable by their respective bearings.

The mills shall be provided with cast steel trash beam as per IS:1030 grade 280 / 520W and supported on heavy steel brackets with pivoted journals fitted in the head stocks and adjustable by means of tie rods and fitted with removable cast steel trash plate as per IS:1030 grade 280/520 w , bolted by high tensile bolts and nuts. Top roller scrapers shall be of floating type. Scrapers for top and discharge rollers shall have renewable cast iron tips. Messchaert groove scrapers shall be of spring steel secured on square shaft and supported on cast steel/fabricated steel blocks and provided with lever or other suitable adjusting device.

All mechanical parts of the mill shall be designed for ultimate capacity of 7500 TCD.

Each mill shall be provided with hydraulic loading system, consisting of hydro-neumatic accumulator, one for each of the journal of the top roller, one extra as spare and accessories such as pumping set, receiver tank, gauges, remote control panel and roller movement indicator electronic type . The dia. of the hydraulic ram for top cap shall be minimum 400 mm. The hydraulic system shall be designed for a oil pressure of 280 kg/cm<sup>2</sup> g.

One centralised mill lubrication system having positive displacement pump at about 400 bar pressure having dual delivery lines made of SS 304 x 2mm thick (DIN standard) of 16mm dia for main line on both sides of the mills with changeover valves, relief valves and distributors with delivery adjustment arrangement with feed line of 8mm dia SS x 2mm thick provided to the bearings, complete with control panel pressure gauges and audio/video alarm with suitable timer arrangement for controlling pump operations.

Juice trough under the mills shall be made of 8 mm thick aluminum plates or 6 thick SS 409 M. The trough shall be bolted to the headstocks with stainless steel bolts and copper washers. Joint shall be suitably sealed to prevent any juice leakage.

All the mills shall be high set so that no part of the juice tank pumps are situated below floor level. All the mills shall have common gangway on both sides having width not less than 750 mm with chequered plates or gratings and minimum four number staircases one for crusher side, one for bagasse elevator side and two from mill drive platform, along with the cross connections after each mill.

Access from mill platform to rake elevator drive platform with suitable cat ladders shall be provided. All gangways and staircase shall have hand railings.

### ii) Cast iron grooved underfeed roller : 4 Nos.

Cast iron shell hot shrunk fit , grooved inter-meshing type under feed roller of the same material as that of mill roller having minimum nominal diameter 100% of the mill roller nominal diameter. The shaft shall be 40C8 quality conforming to IS:1570 and of 350mm central dia. and supported by means of bush bearing of minimum 250 mm bore. The under feed roller shall be driven by top roller through gears to give surface speed of about 10% higher than the mill roller surface speed. It shall have arrangement to adjust the setting in axial direction by plus-minus 25 mm (axis joining centre line of under feed and top roller).

### iii) Donnelly type Chute : 4 Nos.

The Donnelly type chute fabricated out of 6 mm thick duly reinforced SS 409 M plates shall be provided for each mill. It shall have arrangements to adjust the blanket thickness from front as well as from back side. The height of each chute shall not be less than 3.0 metres and its inclination not less than 80 deg. with the horizontal. Side plate of chute shall have full height transparent sheet to see the bagasse level. First mill chute to have electronic level sensing device to control feeding, suitable indication may be provided to indicate feed level of bagasse in other chutes at mills. Level sensing device shall have on – off control of intermediate carrier and shall have sequence inter lock.

### iv) Rake type Intermediate Carriers: 3 Nos.

Rake type intermediate carrier, between the mills whose centre distance shall not be less than 14000 mm shall be provided. The width of the carrier trough shall be suitable to

accommodate 2040 mm rake width and its cross section suitable for handling bagasse of ultimate crushing rate with imbibition upto 300% on fibre.

The rake carriers shall have runners of angle iron / channel with 8 mm spring steel wear flat and 8 mm mild steel bottom trough plate with stiffeners and be supported on steel channel column provided with rigid base plate. The columns shall be adequately braced wherever necessary.

Each rake carrier drive shall consist of the TEFC motor of 50 BHP, 1440 RPM with enclosed helical speed reducer, with open gearing, fluid coupling, common bed frame. The linear speed shall not be more than 25 m/minute.

The rake carrier chain shall be 300 mm pitch block type forged chain having breaking strength of minimum 80,000 kgs. driven over two cast steel sprockets having 16 No. machine cut teeth mounted on 225 mm central dia. head shaft of 40 C8 quality conforming to IS:1570 or equivalent and running in 160 mm size split gun metal lined cast steel bearings secured to head shaft columns. The tail shaft of 170 mm central dia. and of 40C8 quality or equivalent shall have two cast steel sprockets or drums to guide the chain and shall run in 140 mm size gun metal bush lined cast steel or mild steel fabricated plummer blocks attached to the elevator boot. Its bearing shall be outside the elevator trough. The tightening arrangement shall be provided near the centre of carrier in vertical direction by providing idler sprockets. The angle of the rake carrier shall not be more than 50 deg. The rake carrier shall be designed for head end discharge of bagasse to the Donnelly type chute.

## Mill Drive:

### Four Nos. Thyristor Controlled Variable speed D.C. Drives

Each mill shall be driven by continuously rated 850 HP D.C. electric motor. D.C. motors shall be SPDP, IP 23 with class V overload duty S1 continuous. The motor base speed shall be 1000 RPM and shall have constant torque characteristic between 20% to 100% base speed and constant power characteristic between 100 to 110% at base speed.

Detail specifications of motor shall be as below :

Rating (continuous)	-	850 HP 1000 rpm Class V, Duty S1
Overload Class	-	V
Armature voltage	-	660 V, DC
Field voltage	-	220 V
Protection	-	IP 23



(SPDP) force cooled with air filter

Class of Insulation	-	F Temp. rise limited to class B at continuous rating and class of application.
Speed (RPM) Base	-	1000
Mounting	-	Horizontal foot mounted
Ambient Temp.	-	45 degree C

The motors shall be designed for variable speed operations, controlled by the thyristor converter station, and shall have constant torque characteristics down to continuous operating speed of 20% of the rated speed.

ETD for temperature detection of motor winding shall be provided.

Thermesters shall be provided for thermal protection of the DC Motors. RTD shall be provided for bearings. Necessary thermister relays and RTD scanner with tripping facility shall be provided in the thyrestor panel.

#### **FOUR Thyristor Converter Station (Digital type)**

For operation and control of the four D.C. motors,

Convertor cubicals fabricated from 12/14 SWG cold rolled steel sheets, free standing, passivated, and painted with anti-corrosive paints.

The cubicle will house all protective switch gear, thyristor modules, regulation circuit, interlocking relays, mounted on passivated plates, the cubicle will conform to IP-30 protection.

All necessary indications, annunciations, controls will be neatly arranged on cubicle front door with neoprene gaskets on all edges of panel. Ventilation openings shall be provided at the top of panel and on side covers by louvres suitably covered by fine wire mesh.

The thyristor drive panel shall be as per following specifications:

- a) Armature converter
  - Rating of DC motor controlled – 850 HP
  - Rated DC voltage - 660V, DC

## Sugar Mill Calculations

Free resource for Sugar Mill Calculations .....

- |                               |  |
|-------------------------------|--|
| - Incoming AC supply          | - 11 KV , 3 phase, 50 Hz<br>( thro. 11 KV / 600 V converter trafo.)                          |
| - Torque rating               | - 100% cont. 150% for 2 hours and 200%<br>for 1 min class V constant of rated full<br>speed. |
| - Type of Thyristor bridge    | - 3 ph, 6 pulse fully controlled non<br>regenerative   |
| - Voltage grade of thyristors | - 1500 V PIV (approx)  |

Panel complete with field converters, regulators, tacho feedback, safety protection, indication meters, push buttons, switch gears and controls.

Drive bi - directional in operation with field reversal in the speed range of 50% to 100% of speed at constant torque.

Speed regulation will be  $\pm 1\%$  of base speed at base speed by tacho feedback. The panel will have facility to accept 4 to 20 mA signal for speed setting in auto mode. Speed regulation with armature voltage feed back shall operate in case failure of tacho feed back.

Auto visual window annunciators will be provided.

The pressure ventilation system with electric motor driven blower with filter will be provided for panels.

One common control desk with controls shall be provided for each motor to be controlled from this common desk.

The thyristor panels to be installed in AC room to be provided by the Purchaser.

**NOTE: Alternatively** – Suitable capacity hydraulic drives can also be considered.

### (ii) Mill Gearings :

Each mill drive shall be coupled through flexible gear coupling to enclosed reduction gear and single stage low speed reduction gearing unit capable of transmitting 850 HP continuously under shock load conditions at base speed of the motor. The total reduction ratio of the gearing unit should be such so as to run the mill roller at a surface speed of 12 m / min. When motor is run at its base speed. The enclosed reduction gear boxes shall have hardened and ground internals and shall have minimum service factor 2.0 with forced feed lubrication system with 2 nos. coolers, 2 no. pumps, reservoir, piping etc. with provision for auto starting of spare pump. The pinion should be of EN-24 and gears of cast steel confirming

to IS-2708 Gr.III and hardness of pinion and gear should be minimum 250BHN and 220BHN respectively. The open spur gearing shall be designed to transmit 1000 HP continuously at mill roller surface speed of 12 m / min under shock load conditions and shall conform to IS: 4460. The low speed reduction gearing unit shall have machine cut teeth by gear generating process in both cases. The module of the open gearing should not be less than 30.

Suitable bed plates made in sections, mild steel guards for completely enclosing the gears and pinions (low speed), shall be provided. Shafts of these gears shall be of 40C8 quality conforming to IS:1570 or equivalent having minimum tensile strength of 58 Kg/mm<sup>2</sup> and supported on cast steel plummer blocks with gun metal bearings provided with self / mechanical lubrication arrangement with needle valves, stand by pump reservoir and return pipe line etc. with automatic starting of standby pump. The gearing unit shall be complete in all respect.

The mill top roller shall be connected to transmission gear shaft by means of forged steel tail bar of 40C8 quality conforming to IS:1570 or equivalent and coupling. The length of the tail bar shall not be less than 2000 mm and its size not less than 425 mm square. Two cast steel couplings, one of lesser cross section so as to act as a fuse to safeguard reduction gearing units and drive with provision of greasing shall be provided.

**(h) Imbibition Equipment and Mixed Juice Pump**

**(i) TWO - Rotary Screen for Juice Screening ( 1 no. As stand by)**

For separating the cush – cush / fine bagacillo from the mixed juice, generally to the following specifications:

- |    |   |  |
|----|---|--|
| 1. | Juice handling capacity                   | 250 m <sup>3</sup> /hr.  |
| 2. | Juice loading per sq.m. screen open area. | 105 m <sup>3</sup> /hr. max  |
| 3. | Drum speed                                | 1 to 1.5 m/sec   |
| 4. | Drive arrangement                         | Positive through transmission chain and chain wheels or directly coupled, minimum 7.5 HP |
| 5. | Material of construction :                |  |
| a. | Screen drum                               | Wedge wire screen of SS 304 welded type having slot width 0.35 mm/0.5 mm                 |
| b. | Support and thrust rollers                | Of METALON / Polyuvethene/<br>Carbon steel case hardened                                 |

- supported on antifriction bearings
- c. All juice wetted parts like juice tray, splash guards, inlet feed box, drum shell at inlet and outlet, cush-cush, discharge chute. SS 409 M
6. Water sparging system For cleaning and sanitation, to spray hot water through jet nozzles during Operation with provision of auto on/off Pressure at nozzle header min 4 kg/cm<sup>2</sup>.

The Rotary Screen shall be mounted on suitable steel staging, having platforms around the drum at right angles to the mills so as to directly discharge the cush-cush in to the rake elevator.

## CONTROL PHILOSOPHY FOR OPERATION OF ROTARY SCREEN

### A) Hot Water Sparging

The screen drum should be cleaned at regular intervals by spraying weighed hot water (80 to 85 °C) at adequate pressure (min.4kg/cm<sup>2</sup> at nozzle header) through spray nozzles. The hot water should be pumped by a separate high pressure Sparging pump. The starter panel of the pump should be provided with control circuit having timers to 'START' the pump at pre-set time intervals of every 5 to 10 minutes. The pump remains 'ON ' for about 30 to 60 seconds.

#### Alternatively

#### Screened Juice Sparging

The screen drum should be cleaned at regular intervals by spraying screened juice at adequate pressure (min. 0.5 kg/cm<sup>2</sup> at nozzle header) through spray nozzles. The juice is tapped from screened juice pump delivery line and provided with a solenoid control valve, with control circuit to spray the juice at a pre-set interval for a set time period.

In this case, a separate pipe header is required for sanitizing the screen with either hot water (80 to 85 °C at 1.0 bar pressure from imbibition water system or with exhaust steam (125° C at 0.5 to 1.0 bar pressure) at least once in a shift for a period of one to two minutes

## B) Caustic Soda Solution Cleaning

1. In order to clean accumulated scum of gummy, waxy matter, a spray of dilute caustic soda solution (about 20 %), approx. 300 to 500 liters, is applied on to the screen drum once in a week. Caustic soda solution pumped with the help of the same water-Sparging pump. It is necessary to stop the feed juice going to the screen, at this time. Dilute caustic soda solution should be allowed to react on the scum of gummy, waxy matter and later, hot water / screened juice should be sprayed to wash away the loosened scum as well as traces of caustic soda solution. The caustic soda solution is to be re circulated by installing a separate tank by installing a diverter and valve , so that this caustic soda solution does not add alkalinity to the juice.
- 2 As an additional precaution, screen drum should be inspected and bagacillo, gummy, waxy matter accumulated & hardened in the screen slots over the period of time, should be thoroughly cleaned with brush & caustic soda dilute solution during the regular cleaning shut – down.

### (ii) Juice Tanks and Pumps :

The juice from mill No.3 and 4 shall be collected in individual cylindrical whirler tank with conical bottom of 1500 mm dia and 1200 mm height and made of 8 mm thick aluminium sheet or 4 mm thick S S 409 M connected to mill juice trough through 8 mm thick . Aluminium or 4 mm thk. SS 409 M gutter.

The juice from mill No.2 and 1 shall be collected from individual mill juice trough to Aluminum / SS 409 M gutters outside the mills and then connected to individual cylindrical whirler tank with conical bottom of 1500 mm dia height 450mm more than the mill bed height. All whirler tanks shall be interconnected with gutter and flap at top level.

The juice from whirler tanks of mill number 3 and 4 shall be pumped through individual chokeless pump capable of pumping 120 m<sup>3</sup> per hour of juice having minimum 50% solids at 10 metres head to imbibition juice distribution trough through a suitable surplus feed back device installed above the level of gangway at the mills to ensure steady and uniform rate of imbibition. The juice from Mill No.1and 2 shall be pumped through two No. chokeless pump with full bore discharge and each capable of pumping 300 m<sup>3</sup> per hour of juice having minimum 50% solids at 12 meters head to rotary screen. All the above pumps shall be designed to operate at about 960 rpm.

The screened juice shall be collected in a 8mm thick Aluminium / 5 thk SS 409 M cylindrical tank / column of 200HL capacity. Two strained juice pumps (one as stand by) each of 300m<sup>3</sup>/hr capacity and 55mtr head shall be provided for pumping the screened juice to juice heaters through juice flow meter.

All juice pumps Viz. Imbibition, unscreened and screened juice pumps to have SS bodies and with / SS impellers and SS shafts.

All the juice pumps should have delivery lines not less than 250 mm.

## AUTOMATIC IMBIBITION WATER FLOW AND TEMPERATURE CONTROL SYSTEM

The system shall include two separate automatic control loops having various control system components as specified.

### a) Imbibition water flow control system

Imbibition water flow will be controlled to maintain a fixed ratio of imbibition water to cane. The desired ratio will be fed through the keyboard and the load on the penultimate mill or brix of LMJ will be measured. The flow of imbibition water will be regulated to maintain the ratio at various loads. If load of penultimate mill or brix of LMJ is below the minimum running level, imbibition water flow will stop.

**Sensor** : On-line brix measurement of LMJ with Coriolis density sensor with dual U tube design or single full bore straight tube design having following specifications.

Accuracy	:	+ or - 0.0005 gm/cc
Ambient	:	0.001 % of nominal flow
Temperature effect	:	rate per °C
Power supply	:	85-230 VAC
Housing	:	NEMA 4X

OR

Load of penultimate mill with two wire electronic analogue pressure transmitter with capacitance sensing technology having 4 – 20 mA DC out put or current transformer out put for recorder and controller.

**Controller** : Microprocessor based multi loop PID controller.

**Control Valve** : Suitable for controlling the flow of imbibition water continuously with proportional control.

OR

**A.C. variable drive** : Suitable for controlling the speed of the electric motor employed for imbibition water pump.

**b) Imbibition water temperature control system**

- i) Sensor** : Suitable RTD PT 100
- ii) Transmitter** : Two wire electronic analogue type with 4-20 mA DC output
- iii) Controller** : Microprocessor based single loop indicating type
- iv) Control Valve** : Suitable for controlling the flow of water in well designed and fabricated condensate - water Mixing Arrangement

**iii) ONLINE MAAGNETIC FLOWMETER**

For the accurate weighment of imbibition water online magnetic flow-meter of 220 T/hr at 100°C capacity shall be provided.

On line calibration facility for check weighment with prover tank of suitable capacity shall be provided for random checking of imbibition water delivered by mass flow meter without stopping the crushing.

**(iv) Hot water imbibition pumps:**

2 Nos.(1 as standby) Hot water imbibition pumps of 120m<sup>3</sup>/hr Capacity and 50m Head shall be provided.

**j) Bagasse Conveying System**

**(i) Rubber belt conveyer** – One no. suitable to carry 130 TCH bagasse to elevater when boilers are located right angle to mills.

**(ii) Bagasse Elevator**

One steel slat or rake type bagasse elevator of all steel construction of 2000mm effective width and suitable length (inclination not to exceed 45 deg. with the horizontal) to carry about 135 tonnes of bagasse per hour and driven by TEFC electric motor of 75 BHP through helical speed reducer with open gearing to give a linear speed of 25 metres/minute shall be provided. It shall have two strands of chains of 200 mm pitch. The breaking strength of

chains shall be minimum 60,000 kgs. The elevator shall have on line arrangement for bagasse weighment.

The elevator chain shall be driven over two cast steel of 40C8 sprockets with machine cut teeth only mounted on 200 mm dia. , head shaft running in 160 mm size gun metal bearings and secured in cast steel housings.

The tail shaft shall have two cast steel sprockets having machine cut teeth mounted on 180 mm central dia. shaft running in 140 mm size gun metal bearings secured in cast steel housing with side rails and tension bolts for tightening the chain. The head and tail shaft shall be of 40 C8 quality. The bagasse scrapers would rise on the bottom side of the elevator and discharge by means of mild steel chute bolted to head columns into the bagasse carrier. The trough side and bottom plate shall be of 6 mm thick mild steel. The elevator shall be provided with horizontal section of suitable strength which shall be removed at a later stage to install 5<sup>th</sup> mill in case of in line arrangement of boiler.

Easy sliding screens shall be provided on the elevator for screening the bagacillo. The screening area shall be 15m<sup>2</sup>. Each screen shall have a blind portion for sliding it in the elevator portion for cleaning or changing the screens while working. Width of each screen shall not be more than 600 mm. The screen shall have punched conical holes having 6/8 mm dia. size on the surface facing the bagasse elevator. Platform and staircase shall be provided for approaching on both sides of the elevator.

### iii) Bagasse carrier

One main Bagasse carrier of double trough design and all steel construction of 2000 mm effective width and of 70 m minimum length to suit the additional boiler for ultimate capacity of 7500 T.C.D. It should be able to carry about 135 tonnes bagasse per hour, driven by T.E.F.C electric motor of 100 BHP at 1440rpm through helical speed reducer with open gearing to give a linear speed of 25 meters/minute. It shall have two strands of chains of 200 mm pitch. The breaking strength of chains shall be minimum 60, 000Kgs.

The main bagasse carrier shall have construction similar to bagasse elevator and to be supported on steel channel columns, provided with rigid base plate. The columns should be adequately braced. The conveyor shall be complete with all structure and feeding chute to boilers etc. and will have arrangement to feed bagasse to the boilers from return bagasse carrier. The individual chutes to each boiler should have slide operated diagonally cut doors operable from the working platform of the boilers having double pinion and rake type arrangements and stair case from boiler platform.

### iv) Return Bagasse Carrier

One return type self discharge bagasse conveyor of 2000 mm effective width inside sprockets and of 20 Mtrs. Horizontal length similar in construction as elevator shall be provided.



The conveyor shall be complete with all its structure and be driven by TEFC electric motor of 75 BHP coupled to helical reduction gear unit with open gearing to have linear speed of the conveyor not more than 25 metres/minute. Idler sprockets having machine cut teeth shall be provided wherever there is change in direction. Approach from the ground shall be provided to attend to drive of this conveyor. Horizontal loading portion of this carrier shall be 14m long & not more than 300 mm below the ground level. Mild steel guards shall be provided over the horizontal portion to ensure safety of workman.

The return bagasse carrier shall have arrangements so that it can deliver the bagasse to the main bagasse carrier as well as it receives bagasse from the main bagasse carrier. A gangway with hand railing shall be provided along whole length of the return bagasse carrier with access staircase from the ground at the drive end.

### **k) Mill House Crane and Gantry**

One three motion electrically operated overhead mill house travelling crane conforming to class II IS specifications having Two trolleys each of 20 Tonnes SWL complete with crane gantry shall be provided. The crane rail centre distance shall be to suit the mill house building span and roller storage space in mill house. The specifications for mill house crane shall be as under :

Height of lift	-	10 metres
Main hoist speed	-	2 metres/minute
Long travel speed	-	10 metres/minute
Cross travel speed	-	10 metres/minute
Main hoist motor	-	25 HP, sq. cage.
Long travel motor	-	10 HP slipring TEFC
Cross travel motor	-	7.5 HP slipring TEFC

All the above motors shall be of crane duty.

The supplier shall provide the loading data and span detail to enable the purchaser to arrange suitable design columns to support the mill house truss and crane gantry. There should be 2 Nos. drives for long travels with suitable reduction gear box at each end of bridge. The length of travel for mill house crane shall cover, fibrizer to bagasse elevator.

### **LIST OF ADDITIONAL EQUIPMENT FOR EXPANSION TO 7500 TCD ( FOR CANE MILLING PLANT)**

**(a) Cane Handling & Feeding Arrangement**

**(i) ALT - I**

1 No: Bridge with 2 No: Trolleys of 7.5 tonnes SWL with supporting structure.

**ALT - II**

1 No: Bridges with one trolley of three motion with sling or grab system.

1 Lot Extension of gantry by one bay of 10 mtrs.

**(ii)** 1 Nos: Feeder Tables of identical specification size 6 M width x 7 M length with 15 HP variable speed drive.

**(b) Donnelly chute for rake type inter carrier for mill at zero mill position**

1 No: Donnelly type chute in place of ordinary bypass chute shall be provided. Height of chute shall not be less than 3 mtrs. And it shall be similar in construction as described under Donnelly chute item 3(iii)

**(d) Cane Preparation : (Suitable for Fibrizer installation )**

**(i) Cane Chopper :**

1 No: 200 HP / 600 RPM identical motor with gearbox and coupling to be coupled from other side.

A suitable starter with load balancer for proper operation of twin electric drive shall also be supplied.

**(ii) Cane Leveller**

1 No: 500 HP/600 RPM identical motor with gear type coupling to be coupled from other side.

A suitable starter with load balancer for proper operation of twin electric drive shall also be supplied.

- (iii) Swing Hammer Fibrizer : Existing turbine to be unblanked for developing 3000KW at factory site.

### (g) Milling Plant

#### (i) Mill :

One mill having roller dia 1070mm x length 2140mm as zero mill and GRPF on zero and last mill of 1020 dia x 2040mm long.

Each mill roller shall be minimum nominal dia of 1070 mm x 2140 mm length length and journals of minimum 550 mm dia x 700 mm length and journal centre distance of minimum 3200. The rollers shall be of coarse grain cast iron having hardness 180 -210 BHN. The composition of the shell material shall conform to IS : 11201-1985 and shall be :

Total carbon	-	3.20 to 3.6 percent.
Manganese	-	2.2 to 3.2 percent
Silicon	-	1.2 to 2.2 percent
Phosphorus	-	0.5 per cent Max.
Sulphur	-	0.15 percent Max.

The cast iron shell shall be hot shrunk on forged steel shaft of 40C8 quality conforming to IS: 1570 or equivalent having a minimum tensile strength of 58 kg/mm<sup>2</sup>. All the shaft shall have square ends, not less than 450 mm square. Top roller shall be fitted with stationary flanges and juice rings in two halves. The bottom roller shall be provided with juice rings and removable guards to prevent entry of juice into the bearings. The cast steel crown pinions shall have minimum 600 mm face width and conform to IS :2708 Grade III 17 nos. machine cut teeth, keyed to roller shaft and suitable mild steel guards and troughs.

The headstocks shall be of cast steel as per IS:1030 grade 280/520w These will be of king boltless type. Removable hard steel/cast steel/gun metal/fibre wearing plates on feed side as well as discharge side and with lubricating arrangement between top roller bearings and wearing plates shall be provided. The top and side caps shall be of cast steel as per IS:1030-1974 grade 280/520W and shall be securely locked in position for quick assembly. Stainless steel strip of 8 mm thick shall be provided in the side roller bearing face of the head stock. The eccentricity between top roller bearing centre and hydraulic cap centre shall be kept suitably towards the feed side of the headstock,except in case of inclined headstock .

All rollers shall be coated with surface roughening electrode material and its bearings shall be of cast steel with gun metal lined / white metal lined , Gr. 6 as per IS – 25, 1979 with

water cooling arrangement. The side roller bearing shall be of cast steel housing with renewable gun metal liner as per IS:318. Bearing housing shall have water cooling arrangement. All top roller bearings shall be interchangeable. Similarly all feed side and discharge roller bearings shall be interchangeable by their respective bearings.

The mill shall be provided with cast steel trash beam as per IS:1030 grade 280 / 520W and supported on heavy steel brackets with pivoted journals fitted in the head stocks and adjustable by means of tie rods and fitted with removable cast steel trash plate as per IS:1030 grade 280/520 w , bolted by high tensile bolts and nuts. Top roller scrapers shall be of floating type. Scrapers for top and discharge rollers shall have renewable cast iron tips. Messchaert groove scrapers shall be of spring steel secured on square shaft and supported on cast steel blocks and provided with lever or other suitable adjusting device. All mechanical parts shall be designed for 7500 TCD crushing capacity.

Each mill shall be provided with hydraulic loading system, consisting of hydro-neumatic accumulator, one for each of the journal of the top roller, one extra as spare and accessories such as pumping set, receiver tank, gauges, remote control panel and roller movement indicator electronic type . The dia. of the hydraulic ram for top cap shall be minimum 420 mm .The hydraulic system shall be designed for a oil pressure of 280 kg/cm<sup>2</sup> g.

One forced feed oil lubricator for each mill having 24 number of points shall be provided so as to have two points for each bearing - one being as standby .

**OR**

One centralised mill lubrication system having positive displacement pump at about 400 bar pressure having dual delivery lines made of SS 304 x 2mm thick (DIN standard) of 16mm dia for main line on both sides of the mills with changeover valves, relief valves and distributors with delivery adjustment arrangement with feed line of 8mm dia SS x 2mm thick provided to the bearings, complete with control panel pressure gauges and audio/vedio alarm with suitable timer arrangement for controlling pump operations.

Juice trough under the mills shall be made of 8 mm thick aluminium plate or 6 thick SS 409 M. The trough shall be bolted to the headstocks with stainless steel bolts and copper washers. Joint shall be suitably sealed to prevent any juice leakage.

The Mill shall be high set so that no part of the juice tank , pumps are situated below floor level. The mill shall have common gangway on both sides having width not less than 1000mm with chequered plates or gratings, and shall be suitably connected to existing gangways.

Access from mill platform to rake elevator drive platform with suitable cat ladders shall be provided. All gangways and staircase shall have hand railings.

### **(ii) One GRPF – For New Mill**

Pressure feeder system for 3 roller conventional mill shall be supplied.

The rollers shall be of nominal dia. 1070 mm x 2140 mm length, running in heavy duty G.M. liner bearings fitted in cast steel housing. The journal size shall be 550mm dia. x 700 mm long. The under feed roller shall be of minimum 100 % of GRPF roller dia. driven through pinions from top roller.

The GRPF roller speed shall be about 30% higher than the mill roller speed.  
The scope of supply shall include heavy fabricated base frame, pair of cast steel / fabricated headstocks, pair of rollers, bearings, a pair of crown pinion and UFR complete with bearings, drive pinions, a set of open gearing, gearing shaft with bearings, base frame, gear guard, a tail bar and square couplings.

The cast steel head stocks shall be supported on M.S. fabricated pedestals. The pressure feeder roller shafts shall be of forged steel of 40C8 quality conforming to IS:1570-1979 or equivalent having a minimum tensile strength of 58 kg/mm<sup>2</sup>. In case of circumferential 'V' groove pressure feeder, the pressure feeder rollers shall be interchangeable with mill rollers and shall be provided with 100% dia under feed roller, with gear drive etc. One force feed lubricator shall be provided for each pressure feeder. One pressure chute shall be provided for each mill. This shall be fabricated out of 25mm thick M.S. plate suitably reinforced and lined with 8mm thick AISI-316 quality stainless steel plate. The chute shall have hard facing at finger tips. Pressure chute shall be designed to withstand a maximum pressure of 7 Kg/cm<sup>2</sup>. Arrangement shall be provided for adjusting this pressure chute setting.

A suitable 400 HP DC drive to be provided.

### **(iii) One GRPF for Last Mill**

GRPF system for 3 roller conventional mill shall be supplied.

The rollers shall be of nominal dia. 1020 mm x 2040 mm length, running in heavy duty G.M. liner bearings fitted in cast steel housing. The journal size shall be 500 mm dia x 650 mm long. The under feed roller shall be of minimum 100 % of GRPF roller dia. driven through pinions from top roller.

The GRPF roller speed shall be about 30% higher than the mill roller speed.  
The scope of supply shall include heavy fabricated base frame, pair of cast steel / fabricated headstocks, pair of rollers same as mill and bearings, a pair of crown pinion and UFR complete with bearings, drive pinions, a set of open gearing, gearing shaft with bearings, base frame, gear guard, a tail bar and square couplings.

A suitable 400 HP DC drive to be provided.  
Other specifications as mentioned above at g(i)

### **(iv) Mill & Pressure Feeder Drive:**

**ALT I – One No. Thyristor Controlled Variable Speed D.C. Drive**

The mill shall be driven by continuously rated 1000 HP D.C. electric motor. D.C. motor shall be SPDP IP 23 ,with class V overload duty S1 continuous. The motor base speed shall be 1000 RPM and shall have constant torque characteristic between 20% to 100% base speed and constant power characteristic between 100 to 110% at base speed.

Detail specifications of motor shall be as below :

Rating (continuous) -1000 HP 1000 rpm Class V, Duty S1(for Mill) 400HP, 1000rpm, class V duty S1 (for pressure feeder)

Overload Class	-	V
Armature voltage	-	660 V DC
Field voltage	-	220 V
Protection	-	IP 23 SPDP(forced air, separate blower ventilated)
Class of Insulation	-	F Temp. rise limited to class B at continuous rating and the same limited to class F at overload class V
Speed (RPM) Base	-	1000
Mounting	-	Horizontal foot mounted
Ambient Temp.	-	50 degree C

The motors shall be designed for variable speed operations, controlled by the thyristor convertor station, and shall have constant torque characteristics down to continuous operating speed of 20% of the rated speed.

ETD for temperature detection of motor winding shall be provided.

Thermesters shall be provided for thermal protection of the DC Motors. RTD shall be provided for bearings. Necessary thermister relays & RTD scanner with tripping facility shall be provided in the thyristor panel.

## Thyristor Converter Station (Digital Type)

For operation and control of the four D.C. motors,

Each converter cubicals shall be fabricated from 12/14 SWG cold rolled steel sheets, free standing, passivated, and painted with anti-corrosive paints.

The cubicle will house all protective switch gear, thyristor modules, regulation circuit, interlocking relays, mounted on passivated plates, the cubicle will conform to IP-30 protection.

All necessary indications, annunciations, controls will be neatly arranged on cubicle front door with neoprene gaskets on all edges of panel. Ventilation openings shall be provided at the top of panel and on side covers by louvres suitably covered by fine wire mesh.

The thyristor drive panel shall be as per following specifications:

- a) Armature convertor
- Rating of DC motor controlled – 1000 HP (for Mill) and 400HP for GRPF
  - Rated DC voltage - 660 V
  - Incoming AC supply - 11 KV , 3 phase, 50 Hz  
(11KV / 600 V or 750 V thro converter trafo )
  - Torque rating - 100% cont. 150% for 2 hours and 200%  
for 1 min class V constant of rated full  
speed.
  - Type of Thyristor bridge - 3 ph, 6 pulse fully controlled non  
regenerative
  - Voltage grade of thyristors - 1000 V PIV (approx)

Panel complete with field convertors, regulators, tacho feedback, safety protection, indication meters, push buttons, switch gears and controls.

Drive bi - directional in operation with field reversal in the speed range of 50% to 100% of speed at constant torque.

Speed regulation will be  $\pm 1\%$  of base speed at base speed by tacho feedback.

The panel will have facility to accept 4 to 20 mA signal for speed setting in auto mode.

Speed regulation with armature voltage feed back shall operate in case failure of tacho feed back.

Auto visual window annunciators will be provided.

The pressure ventilation system with electric motor driven blower with filter will be provided for panels.

One common control desk with controls shall be provided for each motor to be controlled from this common desk.

The thyristor panels to be installed in AC room to be provided by the Purchaser.

**(v)** One no. Donnelly chute for zero mill of size 1070 x 2140mm and motor rake carrier for 1<sup>st</sup> mill of 1020 x 2040mm mill to suit the capacity and sizes as per layout having other specifications of construction similar as mentioned at g(iii) and g(iv) and rake elevator between zero mill and 1<sup>st</sup> mill shall be provided along with drive.

**(vi) Mill Gearings :**

The mill drive shall be coupled through flexible gear coupling to enclosed reduction gear and single stage low speed reduction gearing for mills capable of transmitting 1000 HP continuously under shock load conditions at base speed of the motor. The total reduction ratio of the gearing unit should be such so as to run the mill roller at a surface speed of speed of 12 m / min, when motor run at its base speed. The enclosed reduction gear boxes shall have hardened and ground internals and shall have minimum service factor 2.0 with forced lubricating system having 2 nos. coolers, 2 no. pumps, reservoir pumps etc. with provision for auto starting of the spare pump. The open spur gearing shall be designed to transmit 1000 HP continuously at mill roller surface speed of 12 m / min under shock load conditions and shall conform to IS:4460. The low speed reduction gearing unit shall have pinions of EN-24 and gear of cast steel conforming to IS-2708 Gr.III, hardness of gear and pinion should be minimum 220 and 250BHN respectively with machine cut teeth by gear generating process in both cases. The module of the open gearing should not be less than 36.

Suitable bed plates made in sections, mild steel guards for completely enclosing the gears and pinions (low speed), shall be provided. Shafts of these gears shall be of 40C8 quality conforming to IS: 1570 or equivalent having minimum tensile strength of 58 Kg/mm<sup>2</sup> and supported on cast steel plummer blocks with gun metal bearings provided with self / mechanical lubrication arrangement with needle valve standby pump, reservoir and return pipe line etc. with automatic starting of spare pump. The gearing unit shall be complete in all respect.

The mill top roller shall be connected to transmission gear shaft by means of forged steel tail bars of 40C8 quality conforming to IS:1570 or equivalent and coupling. The length of the tail bar shall not be less than 2500 mm and its size not less than 450 mm square. Two cast steel couplings, one of lesser cross section so as to act as a fuse to safeguard reduction gearing units and drive with provision of greasing shall be provided.



**(h) Imbibition Equipment and Mixed Juice Pump**

**(i) Rotary Screen for Juice Screening**

Existing 2 nos. rotary juice screens of 250 m<sup>3</sup> / hr capacity each, shall be suitably modified by adding necessary segments to suite the capacity of 375 m<sup>3</sup> / hr each.

**(ii) Juice Tanks and Pumps :**

The juice from mill No. 2, 3 and 4 shall be collected in individual cylindrical whirler tank with conical bottom of 1500 mm dia & 1200mm height made of 6 mm thick aluminum sheet or 4 mm thick S S 409 M connected to mill juice trough through 6 mm thick . Aluminium or 4 thk. SS 409 M gutter.

The juice from mill No.zero and 1 shall be collected from individual mill juice trough to Aluminum / SS 409 M gutters outside the mills and then connected to a individual cylindrical whirler tank with conical bottom of 1500 mm dia, height 450mm more than the mill bed height. All whirler tanks shall be interconnected with gutter and flap at top level.

The juice from whirler tanks of Mill No: 2, 3 and 4 shall be pumped through individual chokeless pump capable of pumping 240 m<sup>3</sup> per hour of juice having minimum 50% solids at 12 metres head to imbibition juice distribution trough through a suitable surplus feed back device installed above the level of gangway at the mills to ensure steady and uniform rate of imbibition. The juice from Mill No..zero and 1 shall be pumped through one no. each with full bore discharge and capable of pumping 300 m<sup>3</sup> per hour of juice having minimum 50% solids at 12 metres head . So that two pumps will be in operation and one no. pump of 300 m<sup>3</sup> / hr capacity will be used as common stand by. All the above pumps shall be designed to operate at about 960 rpm.

The screened juice shall be collected in a 6 mm thick Aluminium / 5 thk SS 409 M cylindrical tank / column. One strained juice pumps of 350 m<sup>3</sup>/hr capacity and 55 mtr. head shall be provided for pumping the screened juice to juice heaters.

All juice pumps Viz. Imbibition, screened, unscreened to have SS bodies and with/ SS impellers and SS shaft.

All juice pumps should have delivery lines not less than 250.

**(iii) Hot Water Imbibition Pump:**

1 No. pump of 60 M<sup>3</sup>/Hr. capacity and 50M head, so that two pumps (of 120 Cub.M and 60 Cub.M./hr) shall be in operation and existing one no. of 120 m<sup>3</sup>/hr capacity will be used as common standby.

## II) CLARIFICATION PLANT (DOUBLE SULPHITATION PROCESS)

### a) JUICE WEIGHMENT

For 5000 TCD:

Mass flow meter suitable for ultimate capacity, 400 T/hr

For 7500 TCD:

Juice flow measuring system shall have computerised, instantaneous and integrated system, to be installed in screened juice line with check weighment arrangement. Beam scale of suitable capacity to be provided for random verification with suitable capacity MS tank to be kept at a height for gravity flow of juice to recovery tank.

The filtrate from filter station shall be pumped to Juice Sulphitor.

Specification for mass flow meter is as under:

### ONLINE MASS FLOWMETER

For the accurate weighment of juice online mass flow-meter having following specifications shall be considered.

<b>Type</b>	:	Coriolis Dual U Tube design or single full bore straight tube design.
<b>Wetted Parts and Connection</b>	:	Tube, Manifold, and Process flanges in 316 SS welded design, enclosure in SS 304 and should fullfill NACE standard.
<b>Accuracy</b>	:	± 0.10% of mass flow rate
<b>Ambient Temp. Effect</b>	:	0.001 % of Nominal flow rate per °C
<b>Repeatability</b>	:	± 0.05% of rate
<b>Inaccuracy in current output</b>	:	None
<b>Core processor</b>	:	It should be microprocessor based with digital communication having meter diagnostic capabilities and multivariable measurement with 4 wire system between the sensor and transmitter.

<b>Outputs</b>	:	<ul style="list-style-type: none"> <li>i) 4-20 mA for mass flow rate</li> <li>ii) 0-1000 Hz frequency for mass flow rate</li> <li>iii) Digital HART for remote configuration</li> </ul>
<b>Power Supply</b>	:	85-250 VAC / 24 VDC
<b>Electrical Connection</b>	:	¾ inch NPT
<b>Electrical Housing</b>	:	NEMA 4X
<b>Temperature Limits</b>	:	0 to 204°C
<b>Indication facilities</b>	:	<ul style="list-style-type: none"> <li>i) Flow rate in TPH</li> <li>ii) Current hour flow in tonnes</li> <li>iii) Last hour flow in tonnes</li> <li>iv) Separate display for measured liquid during check weighment.</li> </ul>
<b>Communication Ports</b>	:	<ul style="list-style-type: none"> <li>a) RS 232/RS 485 for PC communication</li> <li>b) Centronic parallel port for printer</li> </ul>

On line calibration facility for check weighment with prover tank of suitable capacity shall be provided for random checking of juice delivered by the mass flow meter without stopping the crushing.

Suitable arrangement for preparation, storage and pumping of phosphoric acid solution shall be provided. The tank of stainless steel with stirrer, rubber lined, piping of PVC, dosing pump of suitable capacity shall be provided.

### b) JUICE HEATERS

For 5000 TCD - 3 Nos. of 460 m<sup>2</sup> heating surface and two Nos. 690Sq.M. additional for 7500 TCD.

#### Distribution:

One for raw juice heating - 690 M<sup>2</sup>

Two for sulphited juice heating. - 460 M<sup>2</sup>

One for clear juice heating - 690 M<sup>2</sup>

One as common stand for sulphited juice and raw juice heating – 460.

All juice heaters to be modified to reduce pressure drop for ultimate capacity.

All vertical tubular juice heater shall be multiple circulation type, designed to have juice velocity of 1.50 m/sec. The body shall be constructed from 16mm shell , cover plate and tube plate of 40 mm.

Multiple passes vertical tubular juice heaters with easy opening device for cover plates, two sets of double beat valves for RJ / SJ heaters and one set for clear juice heater, having a common housing necessary for inter changeable connections of heating raw juice and sulphited juice, heating by exhaust and vapour bleeding connections with valves and top and bottom venting control by separate valve to atmosphere and vacuum arrangement and safety valve to calandria. The pipeline for vapour bleeding from the first body and second body of the evaporator set shall run separately to the juice heaters.

Arrangements shall be provided to drain of all juice heaters, drained juice to go to separate collection tank along with suitable pump to deliver the drained material to juice sulphitor. The platform shall be provided below the juice heaters for opening the covers, draining and repairs etc. Each juice heater shall have mercury filled 150 mm dial type thermometer in inlet and outlet branch of juice and for the steam chest. One compound gauge shall also be provided in the steam chest. Tightening bolt T type or eye type shall have individual fixing pin and pitch shall less than 120mm. The partition plate and header shall be not less than 16mm thick M.S. plate and flexible cord fixing arrangement be made of 30mm<sup>2</sup> with dove tail arrangement.

Annealed stainless steel tubes as per AISI-304 of 45 mm outside dia. and 1.2 mm thick shall be used. Ligament of the tubes shall be minimum 12 mm. The length of tubes shall be about 6100 mm.

Juice heater shall be provided with individual condensate receiver for exhaust and vapour condensate alongwith a pump of 25 m<sup>3</sup>/hr capacity, 30 m head.

### c) JUICE SULPHITER

For 5000 TCD - One unit of 300 H.L. capacity.

For 7500 TCD - Replacement of existing by one unit of 450 H.L. capacity .

One continuous juice sulphitation unit of 300 HL capacity designed for a crushing rate of 230 TCH with 115% juice, retention time not less than 7 minutes and working height of juice column above the gas distribution not less than 2 m. It shall consist of a reaction tank, stack gas recovery tower, one cylindrical receiving tank of 300 HL capacity two centrifugal pumps each of 300 m<sup>3</sup> / hour capacity (one as standby) at 60 m. head capable of pumping juice through two juice heaters in series, to the flash tank of the clarifier. The speed of stirrer used shall be around 16 RPM. Design of the unit shall have arrangement for pre sulphitation, pre

liming, shock liming and sulphitation. Telescopic valve to regulate the juice level in the sulphiter shall be provided.

The continuous juice sulphitation unit shall be made from 12 mm thick mild steel plate and be complete with milk of lime proportioning arrangement, SO<sub>2</sub> gas pipe shall be of CI conforming to IS-210-1978. line and sparger shall be of SS 316 grade.

For ultimate capacity of 7500 TCD one number pump of identical capacity shall be added so that two pumps shall be in operation and one will remain as standby.

**pH. automation for juice sulphiter** shall be provided.

Specification for pH Automation System is as under:

## **AUTOMATIC pH CONTROL SYSTEM FOR JUICE SULPHITATION**

The microprocessor based two loop pH control system shall be considered. Lime dosing into juice sulphitor shall be automatically controlled based on pre-set ratio to juice flow. Lime flow will be measured to give feed back signal to the lime dosing control loop. pH of treated juice will be measured and signal given to control speed of sulphur dosing pump in case of thin film type sulphur burner option. Combustion temperature of thin film type sulphur burner will be measured and air vent valve will be adjusted to control operation of sulphur burner. The system shall have following specifications.

**Sensor** : (a) Ruggedised industrial grade combined pH electrode with automatic temperature compensation. It shall be field repairable type.  
: (b) Suitable magnetic flow meter for the measurement of MJ (mixed with filtrate) and MOL

**pH Analyser** : Microprocessor based design with LCD display for pH and temperature value with following facilities:

Output : 4-20 mA dc for recorder/controller

Power : 230 V AC

Supply

Mounting : Panel/Field

Alarm : High/Low

Housing : NEMA 4X

Diagnostic : Following Diagnostic features feature shall be provided

i) Electronic failure

ii) Electrode coating

iii) Electrode breakage

- Controller** : Microprocessor based multi loop controller with following main facilities :
- i) Cascade control and self tuning
  - ii) Communication port
    - a. RS 232 or RS 485 for PC communication
    - b. Centronic Parallel port for printer
- Control Valve`** : Suitable for controlling the flow of lime and SO<sub>2</sub> continuously with proportional control.
- Recorder** : Suitable recorder shall be provided.

### (d) SULPHUR FURNACE

For 5000 TCD - 3 Nos. ( one as standby ) – 140Kg/hr.

For 7500 TCD - Addition of 1 No: of 140 kg/hr. capacity

Each sulphur furnace shall be of continuous type, suitable for burning 140 kgs of standard quality sulphur per hour. Each burner shall have a minimum 1.2 m<sup>2</sup> burning area capacity. All sulphur feeding valve spindles and seat shall be of stainless steel. The melting chamber for sulphur burner shall be made out of 12 mm thick mild steel plate. The combustion chamber shall be 16 mm thick mild steel with refractory lining.

The furnace shall be complete with, water jacketed counter current cooling arrangement for the vertical gas pipe( material for cooler pipe shall be of schedule 80), mild steel water jacketed scrubbers of 16 mm thick, etc.

Sulphur pipeline from all the furnaces shall be so designed that both juice and syrup could be sulphited from any of the furnaces either singly or jointly. Sulphur pipeline and crosses shall be of Cast Iron conforming to IS 210-1978. Suitable glass lined rubber diaphragm valves shall also be provided. Temperature indicators for indicating temperature of molten sulphur and SO<sub>2</sub> gas shall be provided and automatic control for sulphur furnace shall be provided.

### ALTERNATIVELY FILM TYPE SULPHUR BURNER

Two Nos. thin film type sulphur furnace suitable for burning 200 kgs of standard quality sulphur per hour shall be provided as per following specifications.

- A. Sulphur melter with overflow and underflow dirt separation – One No.

The size of sulphur melter should be minimum 2 m x 1.5 m x 1.5 m

The melter should be made of 8 mm thick M.S. Plate and should be complete with steam coils, valves and traps etc.

## B. Sulphur Burner

The sulphur burner should be complete with refractory lining, and chequered bricks arrangement with oil burner for pre heating

1. Material for construction - M.S.
2. Size - 1.75 m dia x 4.0 m ht
3. Thickness of bottom plate - 12 mm
4. Thickness of shell plate - 10 mm
5. Sulphur line - steam jacketed, M.S.
6. Variable speed, plunger type positive displacement pumps - 2 nos. (one as standby )
7. Staging and inter connecting piping shall be provided.

### Instrumentation and Automation System for Thin Film Type Sulphur Burner

Electronic controlled system with digital display shall be provided for the following :

- 1) Variable speed drive for sulphur pump to control the burning rate. The variable speed drive should be compatible to take output from a controller for feed back control of juice flow/pH as and when installed in future.
- 2) To control the supply of primary air to sulphur burner by controlling air vent valve with feed back of temperature.
- 3) Mechanical temp. recorder for SO<sub>2</sub> gas outlet range 0 – 200 deg. C.
- 4) Digital temperature indicator for temperature indication of molten sulphur, burner and final SO<sub>2</sub> gas.

### Performance Parameters

Performance of the sulphur burner will be judged on the following parameters:

1. Rate of sulphur burning - 200kg/hr
2. No sublimation & minimum SO<sub>3</sub> formation with 100% burning.
3. Temperature of final SO<sub>2</sub> gas - 70°C
4. Concentration of SO<sub>2</sub> not less than 7% at 70°C @ 200kg/hr burning of sulphur.
5. Turn down capacity upto 50%.

### e) AIR COMPRESSORS

For 5000 TCD - 2 Nos: 1200 m<sup>3</sup>/hr. free air delivery pressure of 1 kg/cm<sup>2</sup> .  
For 7500 TCD - Additional one air compressor of 1200 m<sup>3</sup>/hr. capacity.

Each Air compressor shall be provided with necessary pipe line, gauges, valves etc. arrangement to supply moisture free air (with air refrigeration system) with suitable filter of adequate capacity air receiver with suitable relief valve. All furnaces shall be connected in such a way that any furnace could be worked with either compressor.

### f) MILK OF LIME PREPARATION

For 5000 TCD

One lime slaker capable of slacking about 1200 kgs of quick lime per hour. A Koran flash tank type lime classifier with grit remover or rake type lime classifier or hydrocyclone type classifier. Two milk of lime storage tanks of about 300 HL capacity each and two pumps (one as standby) either rubber lined rotary or plunger type each capable of delivering 12.0 m<sup>3</sup>/hr per hour of milk of lime at 20 mtrs head and two grit catchers common for both pumps.

The slaker shall be of continuous type, driven by electric motor, through suitable reduction gearing arrangement to give 6 to 8 rpm. The storage tanks shall be made of 8 mm thick mild steel plates and shall be complete with stirrers with independent drive for each tank and connected through grit catchers to milk of lime pumps. Separate gutters shall be provided over the milk of lime storage tanks for the milk of lime coming from the slaker and return milk of lime.

For 7500 TCD - 1 Nos: M.O.L. Tanks of 300 HL capacity each, shall be provided with additional pump.

Milk of Lime pipe lines shall be provided up to juice sulphitation with return piping and to mud overflow tank and to condenser outlet.



## **g) CLARIFIER**

For 5000 TCD - 1 No. 12200 mm. diam .

For 7500 TCD - 1 No: 9144 mm dia. - Additional.

One no. 12200 mm dia. clarifier with four compartment, each compartment to have height of 1524 mm.

Clarifier shall have separate juice and mud outlet from each compartment.

The flocculating compartment complete with skimmer and feed well shall be installed separately.

The clarifier shall be made of mild steel plates having following minimum thickness :

Particulars	For 12200 mm dia.	For 9144 mm dia.
1. Bottom :	12 mm	10mm
2. Shell :	10 mm (with stiffeners)	8 mm (with stiffeners)
3. Tray (intermediate):	12 mm	10 mm
4. Tray (Top) :	10 mm	8 mm
5. Top Cover :	10 mm	8 mm
6. Flocculating ; Compartment	10 mm	8 mm

The continuous clarifier shall be complete with mild steel flash tank and withdrawal boxes, 2 nos. for clear juice and one no. for mud with sleeves, telescope pipes and O-rings, hinge type squeezers, driving mechanism with variable speed drive head with motor consisting of sprocket, chain and drive guards, all inside and outside clear juice piping and mud piping, all valves and pipe fittings etc, and complete with peripheral walkway, angle iron bracket supporting angles, piping for railing, rail support etc; 4 manholes one for each compartment, each manhole to have platform, railing and access ladder; pumps tank with support, insulation material etc. Mud liquidating pump of 80 m<sup>3</sup>/hr. and 20 m. head of C.I. construction with bronze fittings complete with drive motor shall be provided. Two clear juice centrifugal pumps each of 300 m<sup>3</sup> per hour and not less than 30m. head and C.I. construction with bronze fittings complete with drive motor and suitable column having sight and light glasses shall be provided for pumping juice through clear juice heater to 1st body of evaporator. Provision of recirculation of juice in the clarifier shall be also provided. Arrangement of preparation and dosing of flocculent to be provided.

For ultimate capacity of 7500 TCD, one no. pump having capacity of 150 m<sup>3</sup>/hr for clear juice shall be added so that two pumps (300 Cub.M and 150 Cub.M each) will be in operation and one no. of 300 m<sup>3</sup> / hr capacity will remain as common standby.

### (h) Vacuum Filter

For 5000 TCD - 2 No: 3.7 m dia. x 7.4 m long

For 7500 TCD - 1 No: 3.7 M dia. x 7.4 M long to be added.

Each rotary cane mud vacuum filter shall have nominal filtration area of 84 m<sup>2</sup> and installed at a height so as to have a operating level of min. 8 meters from factory floor level, shall be complete with 5 mm thick SS 304 grade drum, 8 mm thick SS heads with MS structural reinforcement, cast iron trunnions, SS 304 grade internal piping and decking, SS screens, MS trough, agitator, two numbers valves, one on each side consists of bronze / SS 303 grade valve body, bronze / polypropylene / ferro-bestos wear plate, SS pipe plate, washing assembly and scrapper, variable speed drum drive and constant speed agitator drive. The drum drive shall be of 3.7 KW TEFC motor having means to vary the drum speed from 30 RPH to 10 RPH. The agitator drive shall be of 2.2 KW TEFC motor. The rotary filter shall be complete with two numbers filtrate receivers fitted with gun metal vacuum release assemblies and copper floats, one number vacuum regulating valve, two nos, filtrate pumps each capable to extraction 50 m<sup>3</sup> / hr filtrate under vacuum of 500 mm (20") mercury and discharging at 20 meters head, one cascade condenser, one entrainment separator with sealing arrangement to discharge the entrained juice to mud receiving tank, feed mixture, one vacuum pump of 36 m<sup>3</sup>/minute capacity against 500 mm mercury, complete with motor and drive, one over flow tank of 60 HL capacity with steam coil and trap, one centrifugal blower 270M<sup>3</sup>/hr, one bagasse cyclone suitable for separating bagacillo with mild steel adusting fin, 550 mm inlet connection and out let two way valve fitted with manually operated flap door, one mud circulation non – clog centrifugal pump of 50 m<sup>3</sup>/hr capacity at 18 meter discharge head complete with motor drive, one injection water pump of 25 m<sup>3</sup>/hr capacity at 30 meter discharge head complete with motor drive, one cake wash water pump of 20 m<sup>3</sup>/hr capacity at 30 meter discharge head complete with motor drive etc. the bagacillo blower shall be complete with 550 mm dia. blowing pipe from mill house to bagacillo cyclone along with pipe fittings etc. one common belt conveyer for in line installation of vacuum filters or individual mud conveyers for parallel installation of vacuum filters, of 450 width and suitable length for discharging mud at least 4 meters out side the filter house complete with motor drive shall be provided.

The feed mixer, Air blower and cyclone separator shall be suitable for ultimate capacity.

## (III) EVAPORATION AND BOILING PLANT

### a) Evaporator :- For 5000 TCD

Vapour bleeding arrangement.

From 1<sup>st</sup> effect - for 'C' Vacuum Pans and second sulphited juice heating.

From 2<sup>nd</sup> (A) effect - for 'A' and 'B' vacuum pans.

From 2<sup>nd</sup> (B) effect – for first sulphited juice heating

From 3<sup>rd</sup>.effect - for raw juice heating

By pass arrangement for 2<sup>nd</sup> (B) body to be made for low crush rate.

#### Quadruple effect evaporator:

1<sup>st</sup> body        3700 m<sup>2</sup> (long tube evaporator )

2<sup>nd</sup>. body (A)  2100 m<sup>2</sup> (Robert type)

2<sup>nd</sup> . body (B) 1350 m<sup>2</sup>        “

3<sup>rd</sup> . body        900 m<sup>2</sup>                “

4<sup>th</sup> . body        450 m<sup>2</sup>                “

#### **For 7500 TCD:**

Vapour bleeding arrangement.

From 1<sup>st</sup> effect - for 'C' Vacuum Pans and sulphited juice heating.

From 2<sup>nd</sup> effect (A) - for 'A' and 'B' vacuum pans.

From 2<sup>nd</sup> effect (B) – for first sulphited juice heating

From 3<sup>rd</sup>.effect - for raw juice heating

By pass arrangement for 2<sup>nd</sup> (B) body to be made for low crush rate.

#### Quadruple effect evaporator:

1<sup>st</sup> body        6000 m<sup>2</sup> (long tube evaporator ) new

2<sup>nd</sup> body (A)  3700 m<sup>2</sup> (existing)

2<sup>nd</sup> body (B)  2100 m<sup>2</sup> (existing)

3<sup>rd</sup> body        1350m<sup>2</sup> (existing)

4 <sup>th</sup> body	900 m <sup>2</sup> (existing)
4 <sup>th</sup> spare	450m <sup>2</sup> (existing body)

Suitable relief valve spring loaded or dead weight lever type shall be provided to ensure that pressure in the vapour space of 2<sup>nd</sup> body of evaporator does not exceed 0.5 kg/cm<sup>2</sup> g. The bodies shall have a vapour space height (between the top tube pate and the bottom of the umbrella or cylindrical portion of the vapour space) shall not be less than 2 times the calendria height, in case of 3<sup>rd</sup> and 4<sup>th</sup> body and 2.5 times in case of last body. Suitable arrangement for light and heavy noxious gas removal shall be provided. Boxes shall be provided for easy removal of condensate from calendria. Manhole shall be provided in bottom saucer and vapour space . Suitable connection for soda washing and draining for juice shall be provided. Safety valves shall be provided on calendria of first body.

For Robert type bodies having heating surface for 300 m<sup>2</sup>, minimum thickness of mild steel plates for calandria and body shall be 12 mm, bottom saucer 16 mm and tube plates 25 mm and for body above 300 m<sup>2</sup> and up to 1350 m<sup>2</sup> minimum thickness of mild steel plate of calandria and body shall be of 16 mm, bottom saucer 22 mm and tube plate 32 mm and for body above 1350 m<sup>2</sup> and up to 2100 m<sup>2</sup> minimum thickness of mild steel plate of calandria and body shall be of 18 mm, bottom saucer 25 mm and tube plate 36 mm. The bottom saucer shall be welded to the calandria. The dooms of the bodies of Robert type evaporators shall have efficient save all of centrifugal type.. A suitable external saveall for fitting in the vapour pipe after the last body going to the condenser shall be provided. In case of long tube type evaporator, Polly baffle type of SS 304, 18 SWG save all shall be provided. Each body shall have three sight and light glasses, lowest side glass shall not be higher than 1.5 M from the working platform and 250 mm from top tube plate.

For LTE bodies having heating surface of 3700 m<sup>2</sup> and 6000 m<sup>2</sup>, minimum thickness of mild steel plates for calandria body shall be 20 mm, bottom saucer 28 mm and tube plate shall be of 50 mm.

In case of Robert type bodies, annealed stainless steel tubes confirming to I.S. 13316 of 45 mm outside dia. and 1.2 mm thick and 2500 mm length shall be used. The pitch of the tube shall be such that the ligament is not less than 10 mm. In case of semi kestner tube length shall be 6100mm and 1.6mm thick.

For falling film evaporator bodies S.S. tubes confirming to grade 304 shall be of 45mm O.D., 1.6mm thick, 10,000 mm length. For semi kestner bodies S.S. tubes confirming to grade 304 shall be 45mm O.D., 1.6mm thick x 5100mm long.

In case of falling film type evaporator, body shell be in two parts i.e. one heat exchanger and another separator.

The placement of the tubes shall provide effective steam distribution arrangement.

The falling film type evaporator shall be provided with 300M<sup>3</sup>/hr at 10 mt. head capacity two juice transfer pumps and two re circulation pumps each of suitable capacity at suitable head be provided.

The evaporator set shall be complete in every respect with fittings for satisfactory operation, 8 mm thick mild steel interconnecting vapour pipes. Syrup extraction system with suitable columns connected to two syrup extraction pumps (one as standby) of 70 m<sup>3</sup>/hr. capacity at 30 m. head through grit catchers of SS: 304 screen shall be provided. For ultimate capacity of 7500 TCD, one pump of 40M<sup>3</sup>/hr having 30mt. head shall be added, so that two pumps will be in operation and one will remain as common standby. Continuous syrup sampler and sampling arrangement from each body shall also be provided. Suitable individual condensate extraction pump with receiver bottles to be provided to all bodies. The rpm of condensate pumps should not be more than 1500.

Condensate outlet pipe from various units shall have sight glasses at eye level in addition to sight glasses in extraction columns. The cock shall be provided at all units individually for testing condensate for sugar traces of  $\Phi$  condensate pumps delivery lines shall have suitable connection with valve for draining as and when sugar traces are found in the condensate.

A working platform with staircase from ground level under the bodies for cleaning, repairs and maintenance shall be provided. Platform with stair case to be provided on the top of LTE bodies for operation and maintenance. Walk ways to be provided on top of evaporator bodies for opening valves and man holes.

For open soda boiling, reduced steam entry and vapour outlet to atmosphere at top shall be provided in each body.

Suitable arrangement for preparation of caustic soda solution and pumping the same to the evaporator bodies with recirculation arrangement shall also be provided. Capacity of the tank shall be 200 HL., pump capacity shall be 23 L/second against a head of 15 metres.

## ON-LINE CONDUCTIVITY MEASUREMENT OF CONDENSATE WATER

On line conductivity measurement system shall be provided for measurement of conductivity in condensate return lines from vapour cell, 1st / 2<sup>ND</sup> body of evaporator set. The system shall have following specifications.

**Sensor cum Analyser** : Based on conductivity principle with tefzel body SS 316 electrode and built in temperature element for automatic temperature compensation. Cell constant for conductivity sensor shall be 0.1 or suitable for low conductivity measurement.

Output : 4-20 mA DC for remote indication and recording

Alarm : High/Low contacts for Alarm annunciator.

### b) Syrup Sulphitation Units

For 5000 TCD - 1 No: of 120 H.L. capacity

For 7500 TCD - Replacement of existing sulphitor by 1 No: 180 H.L. capacity.

One continuous syrup sulphitation unit of 120 HL working capacity capable to process syrup of 65 deg. Bx., with working height of 1.5 m. of syrup column above the gas distribution, stack gas recovery unit constructed of 10 mm thick mild steel plate complete with SO<sub>2</sub> gas absorption arrangement and all necessary pipelines, valves etc, shall be provided.

SO<sub>2</sub> pipe and sparger shall be of SS 316 grade, Two syrup pumps each of 80m<sup>3</sup>/hr capacity at 30 m. head (one as standby), grit catchers and one sulphited syrup receiver of 450 mm dia. and 1800 mm height with sight and light glasses, inlet, outlet, and equalising connections shall be provided.

For ultimate capacity of 7500 TCD, one no. pump of 40 m<sup>3</sup>/hr capacity shall be added, so that two nos. will be in operation and one of 80 m<sup>3</sup>/hr capacity will remain as common standby.

### (c) Syrup and Molasses Storage Tanks

For 5000 TCD - 10 tanks each of 360 H.L.

For 7500 TCD - 3 tanks each of 360 H.L. (Additional)

Each tank shall be of 360 HL capacity to store syrup, molasses and melt etc. at the pan floor. These tanks shall be preferably rectangular.

Two or three tanks shall be arranged in one nest depending upon the material to be stored with the provision of separate nest for syrup, each molasses and melt. The tanks shall be made of 10 mm thick mild steel plate. Molasses storage tank shall be provided with steam heating coils with necessary valves and non-return valves, draining arrangement, pipes, gutters, valve etc. The wash out connection of each tanks shall be connected by a pipe to juice check weighment tank with proper dilution with water and pumped to juice sulphitation tower with suitable valves.

Necessary pipe lines with right angle valves from the tanks to the pans i.e. for syrup, melt, A-light molasses etc. for A-heavy molasses and B- light molasses, B heavy and for C-light molasses shall be provided, for respective A,B, and C massecuite pan.

Three Molasses conditioning unit complete with inter connecting pipes, valves and sampler shall be provided; one for A-heavy molasses, one for B-heavy and one for C-light

molasses. These molasses conditioners will be designed for a ultimate crushing capacity with following percentages of molasses:

- A-heavy - 9 percent on cane
- B-heavy - 7 percent on cane
- C-light - 4 percent on cane

**Automatic control of temperature and brix system** shall satisfy the following requirements:

- i) Temp. of conditioned molasses - 70 deg.C
- ii) Brix of conditioned molasses - 70 - 75 deg.C
- iii) Conditioned molasses shall contain no fine grains

## **AUTOMATIC BRIX AND TEMPERATURE CONTROL FOR MOLASSES CONDITIONER**

The automatic brix and temperature control system for molasses conditioner shall be provided. For each molasses conditioner the system shall include two control loops consisting of various control system components as specified.

### a. Brix Control System :

- i. Sensor - based on conductivity principle with tefzel body  
SS 316 electrode and built in temp. element for  
automatic temperature compensation
- ii. Transmitter - two wire electronic analogue type with 4-20  
mA DC output
- iii. Controller - microprocessor based single loop indicating type
- iv. Control valve - suitable for controlling the flow of water in  
molasses continuously with proportional control

### b. Temperature Control System :

- i. Sensor - suitable RTD PT 100
- ii. Transmitter - two wire electronic analogue type with 4-20 mA  
DC output
- iii. Controller - microprocessor based single loop indicating type
- iv. Control valve - suitable for controlling the flow of steam  
entering into the molasses conditioner  
Continuously with proportional control

Recorder : Suitable recorder for recording the controlled brix and temp. of the molasses.

### (c) Vacuum Pans

#### ALT – I: Batch pans for A – Masecuite and Continuous pans for B and C – Masecuite

For 5000 TCD - 3 Nos: Pans of 100 tonnes strike capacity for A masecuite.  
2 Nos., each of 60 tons strike capacity for B and C graining  
1 No. 35T/H capacity continuous pan for B masecuite  
1 No. 25T/H capacity continuous pan for C masecuite

For 7500 TCD - 1 No. of 100 tons strike capacity for A masecuite (additional)  
1 No., of 60 tons strike capacity for B graining (additional)  
1 No. 35T/Hr. capacity continuous pan for C masecuite (existing)  
Existing 25 T/H and one 25 T/H additional pans shall be used for B masecuite.

#### ALT – II: Batch pans for A, B and C - Masecuite

For 5000 TCD - 6 Nos: Pans of 100 tonnes strike capacity.

For 7500 TCD - 3 Nos. each of 100 tons strike capacity (Additional)

The vacuum pans shall be low head rapid boiling calandria type having normal strike capacity of 60 tonnes (420 HL) and 100 tonnes (700 H.L.) Graining volume in each pan shall preferably not exceed 45 % strike capacity. Down take diameter shall be 45 % of the calandria dia.

The heating surface of each pan shall be so designed so that the ratio of heating surface (m<sup>2</sup>) to volume (m<sup>3</sup>) is not less than 6.6. The length of the tube shall not exceed 750 mm.

The tubes shall be of Stainless steel confirming to I.S. 13316-92 having 102 mm outside dia, x 1.6 mm thickness. The pitch of the tubes shall be such that ligament is not less than 16 mm. Mild steel tube plates shall be 32 mm thick calandria and body 16 mm, bottom saucer 22 mm in case of 60 ton pan. In case of 100 ton pan tube plate shall be 36 mm thick, body of 18 mm and saucer of 25 mm thick. Vapour pipe 8 mm thick for 60 ton and 10 mm thick for 100 ton pan. Cone or W shape bottom saucer shall be welded to the calandria in which case suitable arrangement for expansion of tubes in the bottom tube plate shall be provided. Bottom saucer shall be of ring supported design.

A vapour space of 2.5 m shall be provided in the cylindrical portion above the strike level. The pan shall have internal saveall having centrifugal type catchall of efficient design.



The vapour pipe dia. going to the condenser shall be 1100 mm. In case of 60 ton pan and 1400 mm for 100 ton pan. Each pan shall have feed-check valve after the feed manifold. Pans shall have sight and light glasses, light and reflection to illuminate the whole tube plate and to have calibration scale, vacuum gauge and thermometer in vapour space and a compound gauge and thermometer in the calandria.

Pan shall be complete in every respect with necessary fittings for satisfactory operation including the discharge valve of ample capacity, various pipe lines (vapour, syrup, high and low grade molasses, movement water, inter connecting cut over pipe lines etc.) key sampler, vacuum and atmosphere venting. Hot water meter cum recorder capable of measuring 15 m<sup>3</sup>/hr. of hot water to be provided.

The condensate extraction system shall consist of two closed cylindrical receivers installed at the factory floor level. The capacity of exhaust condensate receiver shall be 200 HL and that for vapour condensate receiver 500 HL. These tanks shall be complete with level indicator outside the tank and necessary venting arrangement. The condensate piping shall be such that the condensate from low grade pans could go to either of these tanks whereas condensate from other two high grade pans could go to vapour condensate receiver. The condensate pipes in these receivers shall lead upto 1/4th height from the bottom of the receiver for sealing purpose. Two pumps (one as common standby) each of 100 m<sup>3</sup>/hour capacity and one pump of 40 m<sup>3</sup>/hour capacity against a head of 30 m. shall be provided for pumping the condensate from these tanks to boiler feed water tank/hot water tank. These pumps shall have minimum 25 percent leak off to the receivers for maintaining a constant level of the tanks.

## CONTINUOUS PANS :

Alternatively continuous vacuum pans for B and C Masecuite along with suitable graining pan may be considered for 5000 TCD and 7500 TCD.

25 tonnes/hr. Capacity for C masecuite } **for 5000 TCD**  
 35 tonnes/hr capacity for B masecuite }

Existing 25T/hr + 1 new 25T/hr for B masecuite } **for 7500 TCD**  
 Existing 35 T/hr for C masecuite }

### 1) Specifications:-

- |    |            |   |   |
|----|------------|---|---|
| 1. | Capacity   | - | 25 tonnes/hr for boiling C-masecuite and 35 T/hr. For B-masecuite |
| 2. | Type       | - | Horizontal type with vertical tubes.                              |
| 3. | Tube metal | - | S.S. 304 (as per ISS code) 102 mm OD x 1.5 mm thick               |

## Sugar Mill Calculations

*Free resource for Sugar Mill Calculations .....*

- |     |                       |   |   |
|-----|-----------------------|---|---|
| 4.  | Length of tube        | - | 1200 mm (max) which would promote circulation keeping in view as S/V ratio 9 to 10. |
| 5.  | ID/OD                 | - | ID – 99 mm, OD – 102  |
| 6.  | No. Of compartments   | - | 10 to 13 (preferably 12 compartments)   |
| 7.  | Working height above- |   | 200 mm in tightening zones, 400 mm in tube plate boiling zones.                     |
| 8.  | Vapour temp/pressure- |   | 105 deg. At 0.1 kg/cm sq.   |
| 9.  | Condenser             | - | Multijet of low water consumption   |
| 10. | S/V Ratio             | - | 10.5 : 1.0 (MSQ/M cube)   |
| 11. | Body thickness        | - | 16 mm   |
| 12. | Tube plate thickness  | - | 32 mm   |

2) In addition to the above, the supplier will ensure the following:

- |    |                           |   |   |
|----|---------------------------|---|---|
| 1. | Steam valve               | - | Butterfly type  |
| 2. | No. of manholes           | - | 3 nos. Minimum of 500 mm dia & 1 in vapour line.                            |
| 3. | Sight & Light glasses     | - | 2 nos. Minimum to each compartment  |
| 4. | Discharge connection size |   | 400 mm dia  |
| 5. | Sample proof keys         | - | Each compartment should have individual sample key.                         |
| 6. | Cutover valve size        | - | 250 mm dia  |
| 7. | Save all type             | - | Centrifugal type inbuilt.   |
| 8. | Pump for seed             | - | 6" size screw pump with variable speed drive and gear box capacity 15 T/hr. |

Steam connections in pipe lines with valves and NRV with vapour pipe support.

3. Instrumentation and Automation System for Continuous Pan.
  1. **Feed control loop** - A feed control loop has to be provided for each compartment each control loop should consist of conductivity electrodes (self cleaning type) conductivity monitor, micro processor based PID controllers, IP converters and pneumatic control valve. The number of loops will depend on the number of compartments in the pan. The conductivity monitor shall have to be calibrated for purity range of massecute during boiling such that ideal brix to be maintained in individual compartments is noted visa-a-vis the conductivity monitor to enable set the desired value of conductivity for each compartment on PID controller.
  2. **Seed Magma Feed Control** – A system for varying the RPM of the metering pump through the signals received from the pressure transmit the monitoring the vapour pressure in the calandria at pre set value should be available.
  3. **Absolute Pressure** – A facility to regulate condenser water quantities automatically should consist of one absolute pressure transmill PID controller and an electro pneumatic control valve. The control valve to be fitted on water inlet pipe of the spray nozzles. The water quantity is to be regulated corresponding to the vacuum in the pan.

All control valve sizing should be calculated to ensure an output of 25 T/hr of massecute on a continuous basis.

### General

The complete system consisting of the various above loops apart from field mounted components, should be provided with a main control panel fitted with all monitors, controllers, indicating lamps, alarm annunciator and hooters.

In addition to the above, the following will also be provided.

- 1) Condensate water flow indicator with integrator
- 2) Molasses quantity flow indicator with integrator
- 3) Level indicator in the seed magma storage crystallisers.
- 4) Level indicator in the molasses storage tank with low level annunciation.

### Performance Parameters

1. Capacity - 25 T/hr and 35 T/hr

- |    |                            |   |                                   |
|----|----------------------------|---|-----------------------------------|
| 2. | Crystal Growth             | - | Double of the footing grain size. |
| 3. | Exhaustability             | - | Purity drop 18 to 22 units        |
| 4. | Frequency of water boiling | - | 35 to 45 days.                    |

## AUTOMATION FOR CONTINUOUS PAN

The system shall include following control systems: -

1) Feed control system for each compartment: -

This system shall measure the brix of the massecuite of alternate compartment of boiling zone by use of conductivity sensors & transmitters.

The specifications of the systems components shall be as specified below: -

- |      |                          |   |   |
|------|--------------------------|---|---|
| i)   | Conductivity sensor      | : | Tefzel body, SS 316<br>Electrode & built in temperature element for automatic temp. Compensation. |
| ii)  | Conductivity transmitter | : | Two wire electronic analog type with 4 - 20 mADC output.  |
| iii) | Conductivity controller  | : | Microprocessor based single loop indicating controller  |
| iv)  | Control Valve            | : | Suitable for controlling the flow of molasses in the compartments.                                |

2) Grain feed flow control to the 1<sup>st</sup> compartment: -

The system shall measure the brix of molasses in the 1<sup>st</sup> loop and in the vacuum crystallizer by use of conductivity sensors and transmitters depending upon the required ratio of these brixes the flow of grain shall be regulated by varying the speed of the metering pump through dyno drive. The specification of the system components shall be as as below:

- |     |                          |   |   |
|-----|--------------------------|---|---|
| i)  | Conductivity sensors     | : | Tefzel body, SS 316<br>Electrode & built in temperature element for automatic temp. Compensation. |
| ii) | Conductivity transmittor | : | Two wire electronic analog type with 4 - 20 mADC  |

output.

- ii) Controller : Microprocessor based dual loop controller to control the speed of the motor through dyno drive employed for metering pump speed variation.

### 3) Steam flow control system: -

The system shall measure the vapour pressure of the pan & control the flow of steam through the steam control valve.

The system shall consist of following parts: -

- i) Pressure transmitter : 2 wire electronic analogue pressure transmitter with capacitance sensing technology & 4-20 mADC output for controller.
- ii) Controller : Microprocessor based single loop PID controller
- vi) Control valve : Suitable control valve for controlling the steam flow continuously.

### 4) Vacuum control system

The system shall measure the temperature of tail pipe water and vacuum line to control the injection water requirement by suitable control valve. The specification of the system component shall be as given below:

- i) Pressure transmitter : 2 wire electronic analogue pressure transmitter with capacitance sensing technology & 4-20 mADC output for controller.
- ii) Temperature sensor : Suitable RTD PT 100
- iii) Temperature transmitter : Two wire electronic analogue type with 4 – 20 mA DC out put for controller.
- iv) controller : Micro processor based dual loop indicating type
- vi) Control valve : Suitable control valve for controlling the flow of injection water continuously.

### 5) Condensate measurement:

Magnetic flow meter with indicating, integrating and recording facilitates as per the following specification:

Suitable sized meter with SS 316 electrodes with tefzel lining.	
Accuracy	: 0.50 % of flow rate.
Mounting position effect	: Nil
Vibration effect	: Nil as per IEC 770 standard
Flow tube material	: SS 303
Manual calibration	: Not required.
Integral mount	: Sensor and transmitter shall be integral mounted . Empty pipe detection facility shall be provided.

**Note:**

The scalable process control system for logic & sequential operations of the continuous pan, as described in above control loops, may be considered as an alternative keeping the field instrumentation as specified above.

**(e) Seed Crystalliser and Vacuum Crystallisers**

For 5000 TCD:

2 Nos. seed crystalliser of 85 tonnes net working capacity and three vacuum crystalliser of 70 tonnes capacity. All the crystallisers shall be fitted with stirrer, coupled to 15 HP, TEFC motor and reduction gear unit and necessary fittings. The speed of the stirrer shall be about 60 RPH. These crystallisers shall be installed on pan floor. Necessary interconnecting pipelines between these crystallisers and pans shall be provided.

The shell of the vacuum crystallisers shall be made of minimum 12 mm thick M.S. plate with necessary stiffeners and the end plates minimum 18 mm thick M.S. plate with stiffeners. The seed crystalliser shell shall be 10 mm thick and end plate 12 mm thick with stiffeners.

Vacuum crystalliser shall have four sight glasses on the side and one sight glass with light and reflector at top. One manhole each of 500 mm dia. and arrangement for sight glass washing shall be provided. A ladder shall be provided for the approach of seed and vacuum crystalliser. Cut over valves of these crystallisers shall be operable from the pan floor .

Vacuum crystallizers should be near C – pans and seed crystallizers towards A – pans.

For 7500 TCD:

One no. seed crystalliser of 85 ton capacity and one no. vacuum crystalliser of 70 tons capacity shall be added.

**(f) Condensers :**

For Evaporator 1000 mm dia. (existing to be replaced with 1300 mm dia for 7500 TCD).

For Vacuum Pan 1100 mm dia. for 60 tonnes capacity  
1400 mm dia. for 100 tons capacity  
Suitable size for continuous pans

Type of condenser : **Single water entry type**

Each condenser shall be made of 6 mm thick up to 1100 mm size and 8 mm thick for 1400 mm size, SS 304 with M.S. hoop rings and tail pipe shall be of S.S. 304, 4 mm thick. Suitable platform with railings, access staircase for inspection, repair etc. of the condenser shall be provided. Jet and spray nozzles shall be of gun metal / S.S. 304. / PVC – Thermo engs. plastic. Condenser shall be so designed that the approach temp. should not be more than 5 deg. C. Injection water line be provided with online strainer.

### **(g) Injection / Spray Water Pumps :**

#### Injection Pumps :

For 5000 TCD -3000 m<sup>3</sup>/hr. - 22 m head - 3 Nos: ( 1 No: standby) for single entry

For 7500 TCD - Addition of 3000 m<sup>3</sup>/hr. – 22 m head – 1 No: for single entry

#### Spray Pumps :

For 5000 TCD - 3000 m<sup>3</sup>/hr. - 15 m head - 3 Nos: (1 no. stand by) for single entry

For 7500 TCD - Addition of 3000 m<sup>3</sup>/hr. – 15 m head - 1 No: for single entry

The above pumps shall be of centrifugal type, bronze impeller and fittings and directly coupled to SPDP slip ring induction motor with suitable starter (starting current not exceeding 300% of FLC) for continuous working. Priming pumps for injection and spray pumps shall be provided.

The injection water pipe connection to condenser should have separate valve for regulation purpose. A pressure gauge in water line is to be provided. A common header of suitable size shall be provided. Each pump shall have isolating and non-return valve in delivery line.

The Injection and Spray – pumps should have 950 rpm running speed.

### **(h) Spray Pond :**

For 5000 TCD - No: of nozzles 450

For 7500 TCD - Addition of No. of nozzles - 225

The main header of Spray Pond shall be M.S. construction of minimum 12 mm thickness. The branch piping shall be PVC/MS with support of RCC pillars the nozzles shall be of thermo Engg. Plastic with S.S. insert at throat of nozzle and arranged on branch piping with single nozzle arrangement.

The cooling system for the water shall be so designed that at least a drop of 13 deg. C or within 7 deg. C of wet bulb temperature, which ever is less should be achieved.

Note: (i) Provision of space in the layout for additional pumps for ultimate capacity to be kept.

(ii) Spray pond and Masonry water channels shall be suitably designed for Ultimate capacity and additional piping and nozzles to be provided at expansion stage.

**Alternatively**, cooling tower of suitable size shall be added.

### **(IV) COOLING, CURING AND GRADING PLANT**

#### **(a) Crystallisers**

For 5000 TCD

1) Air-cooled crystallisers

#### **ALT – I**

(i) Three Nos. each of 110 tonnes batch type horizontal crystallisers  
A massecuite.

(ii) One No: crystallisers each of 65 tonnes capacity as receiver for  
'B' Massecuite for continuous pan.

(iii) One No: crystallisers each of 65 tonnes capacity as receiver for  
'C' Massecuite for continuous pan.

#### **ALT – II**

(i) Three Nos. each of 110 tonnes batch type horizontal crystallisers  
A massecuite.

(ii) Two No: crystallisers each of 110 tonnes capacity as receiver for  
'B' Massecuite.

(iii) Two No: crystallisers each of 110 tonnes capacity as receiver for  
'C' Massecuite .

1) Water cooled crystalliser

(ii) One No: vertical type crystalliser of 300 T holding capacity for



'B' massecuite.

- (i) One No: vertical type crystalliser of 500 T holding capacity for 'C' massecuite.

For 7500 TCD:

- 1) Air-cooled crystallisers:

**ALT – I :**

- (i) One No. of 110 tonnes to be added for 'A' massecuite

**ALT – II :**

- (j) Two Nos. of 110 tonnes to be added for 'A' massecuite

- 2) Water-cooled crystalliser:

- (i) One No. of 150 ton capacity vertical crystalliser for 'B' massecuite to be added
- (ii) One No. of 250 ton capacity vertical crystalliser for 'C' massecuite to be added

The batch crystallizers for 'A' massecuite shall be complete with efficient stirring arrangement of sturdy construction. Air cooled crystallisers shall be driven by electric motor of 15 BHP, for 65 T and 20 BHP for 110 T capacity suitable for continuous working and complete with suitable reduction gear unit designed to give a stirrer speed of not more than 60 RPH.

Necessary cooling surface to be provided in case of "B" massecuite cooling, so that the massecuite temperature is cooled from 65 deg C to 50 deg C when supplied with cooling water at 30 deg C. in 8 hours. Vertical type water cooled crystalliser for 'B' massecuite shall be driven by electric motor of 20 BHP for 300 T capacity and 15 BHP for 150 T capacity, suitable for continuous working, complete with suitable reduction gear unit, suitable design to give a stirrer speed of not more than 20 RPH, all worm and worm wheel shall be machined cut and interchangeable duty wise

In case of C massecuite necessary cooling surface shall be provided so that the temperature of the massecuite is cooled from 65 deg. C to 40 deg. C in 15 hours, when supplied with cooling water at 30 deg. C. Provision in the design shall also be made for a maturing period of 4-5 hours in case of low-grade continuous crystallisers. The cooling surface (m<sup>2</sup>) to volume (m<sup>3</sup>) ratio shall be minimum 2. The heat exchange elements shall be tested at pressure of 6-kg/cm<sup>2</sup> g. suitable for continuous working, complete with suitable reduction gear unit designed to give a stirrer speed of not more than 20 RPH all worm and worm wheel should be machined

cut and inter changeable duty wise. For , vertical crystallizer of 500 T the motor shall be of 30 BHP and 20 BHP for 250 T capacity.

The heat exchange elements of water cooled vertical crystallizers should be of boiler quality or heavy duty (C – Class) MS pipes as per IS 1239.

The shell of the horizontal crystallisers shall be made of minimum 10 mm thick mild steel plate and end plates 16 mm thick mild steel plate for 65 T capacity and 16 mm thick MS plate and end plate of 20 mm thick MS plate for 110 T capacity.

For pumping B & C massecuite from receiving crystalliser, 3 no. pumps ( one as common standby) and 2 no. pumps for liquidation for vertical crystallizer each having capacity of 45 T/hr and 30 m head shall be provided.

For ultimate capacity, existing 3 no. pumps for pumping B & C massecuite shall be replaced with 3 nos. pumps of 70 T/hr capacity and 30 m head for pumping B & C massecuite. The existing 2 no. pumps for B & C massecuite shall be used for liquidation of B & C massecuite vertical crystallizers, newly installed. Alternatively, all the crystallizer should be driven by shaft mounted high efficiency suitable helical planetary drive system.

## **(b) Centrifugal Machines: -**

### **I. Fully automatic plough discharge machines**

- (i) For 5000TCD: 4 Nos. fully automatic flat bottom plough discharge machines each of 1750 kg / charge capacity, ( one as stand by ).
- (ii) For 7500 TCD: 2 Nos: additional 1750 kg/charge capacity

For 1750kg/charge capacity , D.C. thyristor controlled drive shall be provided with with 18 to 20 cycle /hr.

### **II. Continuous Machines:**

- (i) For 5000 TCD 4 Nos. Continuous centrifugal machines for 'C' Foreworker dia 1500 mm shall be capable to cure 'C' massecuite of minimum 100 brix and 52 purity at a rate of 8-10 T/hour and shall have a Minimum gravity factor of 2200.

4 Nos. Continuous centrifugal machines for 'B' curing and 'C' afterworker dia 1500 mm. capable to cure 16-18 T/hour & shall have

minimum gravity factor of 2000, One machine common for B & C afterworker.

- (ii) For 7500 TCD Additional 4 machines of dia 1500 mm shall be provided.

'C' massecuite shall be double cured.

**Alternatively**, continuous centrifugal machines having inbuilt melting / mixing arrangement shall be considered.

All operations of the automatic recycling type machines including charging and discharging, changing the speed, switching of motor polarity if any, application of superheated wash water, molasses separation, operation, bottom valve closing etc. shall be automatic. Manually operated brakes shall also be provided with process logical control programme shall be provided such that the plough should not be operated at higher basket speed than ploughing speed of 60 RPM.

Each machine shall have individual switch fuse isolator of suitable rating, an ammeter, and thyristorised/ air break-contactor for operating the machine in manual and fully automatic recycling with a separate selector switch. All operations such as charging, bringing the machine at different speeds, retardation, water wash, pugmill gate opening and closing, syrup separation, cycle over etc. shall be given on control box and indicated by different lamps. All these applications shall also be possible to be applied by push button/rotary switch in manual or automatic position of the selector switch from the control box except bringing the machines at different speeds, retardation and cycle over. Necessary arrangement in the panel shall be provided for tripping of the machine in case of high temperature on sensing through ETDs of the motors.

The continuous centrifugal machine shall be complete with mild steel monitor casing designed to provide a sturdy support for all machine elements, separate compartment for sugar and molasses, hinged doors for access to the sugar chamber, sugar sampler and water/steam washing arrangement, stainless steel basket construction, stainless steel inner supporting screen, pure nickel chromium plated working screen, stainless steel accelerating cone, receiving cup, hot water/steam washing arrangement with metering device to measure the wash water, drive arrangement having motor, pulley, V-belts/direct drive and bearings, massecuite feeding device etc.

The angle of basket shall be 30 deg. for 'B' & 'C' massecuite. Screen for 'C' foreworker machines shall have perforations of 0.06 mm and not less than 7% open area. Screen for B and C afterworker machines shall have perforations of 0.09 mm and 9% open area. The bearing lubrication system shall have built in protecting arrangement to trip the machine incase of failure of lubrication system and or bearing temperature rise.

Operator's push button panel shall have provision for operating motor, an ammeter and 'ON' indication.

Incoming panels for both batch and continuous type centrifugal shall be designed for a symmetrical fault level of 35 KA (rms) of one second and suitable for ultimate capacity of 7500 TCD. at unit load factor. All incoming panels shall consist of an ACB, an ammeter, and voltmeter with fuse and selector switch and 'ON' indication. Suitable interlocking arrangement shall also be provided in each self-discharging machine panels such that not more than two machines are started at a time.

Monorail with 5 tonnes capacity chain pulley block over the centrifugal machines shall be provided.

Suitable pugmill made out of 6 mm thick mild steel plate and mounted over the machines shall be provided having stirring arrangement, driven by electric motors, coupled to reduction gear unit. The pugmill feed valve for batch machines shall be operated pneumatically. For low-grade massecuite separate header with transient heater for individual C/F machine shall be provided. Pugmill with drive will be provided for 'C' after and 'B' machines. All the foreworkers and low grade massecuite afterworker machines to discharge directly into the corresponding magma mixer of suitable capacity and design. The shell of the magma mixers shall be of 6 mm thick mild steel plates having double beater paddles, coupled to electric drive through suitable reduction gear.

All transient heaters should have 16 SWG wall thick AISI 304 grade SS tubes.

The centrifugal station shall be complete in all respects and shall have necessary accessories namely Air compressor 7 kg/cm<sup>2</sup> with receiver and refrigeration dryer to supply moisture free air for pneumatic control, mild steel molasses tanks, two of 6 m<sup>3</sup> capacity for A-heavy and A-light molasses and remaining tanks of 4 m<sup>3</sup> capacity each, two molasses pumps of 60m<sup>3</sup>/hour capacity at 30 meters head for A heavy and light molasses, four molasses pumps of 20 m<sup>3</sup>/hour capacity at 30 meters head for B-heavy, C-light and final molasses with a standby for final molasses.

Three magma pumps of 30 m<sup>3</sup>/hour capacity at 30 meters head for B foreworker, C-foreworker and C afterworker magma. Magma pumps shall be of rotary type with cast iron rotor having replaceable gun metal or bronze strips and have by-pass arrangements. All magma and molasses pumps shall have steam connections with non-return valves and suitable size return pipes with valves from their delivery pipes to the respective tank. The speed of the magma pumps not to exceed 36 RPM.

All machines shall be suitably connected to respective molasses tanks for flow of molasses.

### **(d) Sugar Melter**

For 5000 TCD

One vertical continuous sugar melter of 30 tonnes/hour capacity for melting sugar lumps and magma sugars and one melt pump of 40 m<sup>3</sup>/hour at 22 meters head shall be provided.

A magma mixer and magma pump of 20 tons/hr at 22-meter head shall be provided near the grader for taking dry seed for A massecuite. Necessary water, steam and other usual connections shall be provided Melter will be for ultimate capacity.

For 7500 TCD : Addition of 15 t/hr melter with suitable pumps.

## **AUTOMATIC BRIX AND TEMPERATURE CONTROL FOR MELTER**

The automatic brix and temperature control system for melter shall be provided. The system shall include two control loops consisting of various control system components as specified below:

### Brix Control System :

- i. Sensor - based on conductivity principle with tefzel body  
SS 316 electrode and built in temp. element for  
automatic temperature compensation
- ii. Transmitter - two wire electronic analogue type with 4-20  
mA DC output
- iii. Controller - Microprocessor based single loop indicating type.
- iv. Control valve - Suitable for controlling the flow of water in  
melter continuously with proportional control

### Temperature Control System :

- i. Sensor - suitable RTD PT 100
- ii. Transmitter - two wire electronic analogue type with 4-20 mA  
DC output
- iii. Controller - Microprocessor based single loop indicating type.
- iv. Control valve - Suitable for controlling the flow of steam  
entering into the melter continuously with  
proportional control

Recorder: Suitable recorder for recording the controlled brix and temp. of the melt.

### **(e) Grass Hopper ( suitable for 7500 TCD )**

Two sets of parallel system of grass hoppers:

Each set comprising of one single tray grass hopper conveyor of 2 M width and 12 M. length shall be installed under the " A " machines to convey the sugar discharged from the machines to the first multitray grass hopper.

Two sets of multi-tray grasshoppers, each of 2 m. width and length not less than 12 m. shall be driven by 15 BHP TEFC electric motor with hot air blowing arrangement on the first multi-tray unit (after conveyor hopper), cold air blowing in the second shall be provided. The hopper eccentricity shall not be less than 16 mm and its driving shaft speed shall be 250 to 300 RPM. Portion of the hopper where connecting rod is fixed shall be strengthened by 10mm plate, 1 meter wide. The hopper shall not be welded on longitudinal seams. Each hopper shall have two connecting rods. Sugar lump separating unit shall be provided on second hopper. The drying arrangement should be in such a way that the bagging temperature of sugar should not be more than 40 deg. C when ambient temperature is not more than 36°C.

All drive slats etc. shall be similar and interchangeable.

**(e) Sugar Elevator**

For 5000 TCD : 25 ton /hr 2 Nos.

For 7500 TCD : Addition of 1 No. of 25 ton / hr.

Each Steel cased elevator to deliver 25 T sugar per hour from the hopper to the grader fitted with two strand of chain (or belt bucket elevators) and GI / S.S. buckets and driven by a TEFC electric motor coupled to enclosed worm reduction gear unit shall be provided. Approximate height of the elevator shall be 11 meters. The speed of elevator not to exceed 30 m/minute.

**(f) Sugar Grader**

**For 5000 TCD 25 T /Hr. two Nos.**

**For 7500 TCD Addition of one No. of 25 tons/hr.**

Each sugar grader shall be of 25 T per hour capacity having four decks and each deck capable to sieve minimum 8 tonnes of sugar of any grade and shall be mechanically/electrically vibrator type capable of screening any grade of sugar according to IS specifications. The grader shall be driven by TEFC electric motor. Magnetic iron separator shall be provided for each chute. One sugar distributor for distributing the sugar over full width of grader screen shall be provided. The screens shall be of SS-304 quality. Arrangement for handling 50Kg bags be provided.

Suitable dust catching arrangement shall be provided.

**(g) Sugar Weighing Machine**

### **For 5000 TCD:**

Four Nos. pre-determined balance weight type weighing machines each having capacity to handle 50Kg HBPE/PP bags @ 200 bags/hr..

Alternatively two sets of microprocessor based electronic load cells type fully automatic net weighing bagging machine for packing sugar having weighing range of 25 to 100 Kg., with pneumatic controlled charging and discharging and bag clamps, facility to generate various packing reports viz., hourly, shift wise or daily packing, overweight or underweight bags, having LCD display, facility for printer attachment and transferring data to the computer and operator friendly controller having membrane type key board. Weighing accuracy +/- 30 gms, capacity 300 to 350 bags per hour.

The above arrangement should be provided with sugar elevator at the discharge of each graders and suitable small buffer hopper of approx. 25 bags capacity.

**For 7500 TCD** : Addition of two similar units.

### **(h) Bag Stitching Machine**

#### **For 5000 TCD:**

4 Nos. electrically operated double row stitch bag stitching machines with one spare head, of conveyor type, each suitable for handling about 200 bags of 50 kg each per hour shall be provided. The length of conveyor shall be 4 meters.

Alternatively, arrangement for 50Kg bags filling/weighing/stitching to be provided.

**For 7500 TCD** : Addition of two similar units.

Suitable bin (MS quality only) storage and automatic bag weighing and filling system with continuous sugar bag stackers shall be adopted.

### **(i) Molasses Weighing Scale**

#### **For 7500 TCD :**

One automatic molasses weighing scale of 3.5 tonnes per tip capacity, complete with registering counter and other accessories, weighed molasses receiving tank of 60 HL capacity and two pump sets (one as standby) each of 25 m<sup>3</sup>/hour for pumping the final molasses to the storage tank at a distance of about 80 m from factory shall be provided. The delivery pipe line shall be raised vertically and the subsequent horizontal portion to have

suitable gradient. Provision of check weighing with a suitable tank mounted on platform type scale of 5 Ton shall be provided.

**(j) Final Molasses Storage Tank**

For 5000 TCD . 3 Nos. tanks each of 6000 M<sup>3</sup> capacity

For 7500 TCD . 1 No. additional of 6000 M<sup>3</sup> capacity.

Final molasses storage tanks shall be as per IS specifications. A pump for recirculation of molasses 20m<sup>3</sup>/hr. and 20 mtr. head shall be provided. An overhead tank of 20 m<sup>3</sup> capacity shall be installed on staging at a height of 5 meters from ground floor with a 300 mm discharge line and valve to supply molasses to the tanker directly by gravity. A molasses pump of 20 m<sup>3</sup>/hr. capacity at 30 mtr. head shall be supplied for recirculation and for loading the molasses.

Arrangement for spraying water on all sides of the tank shall be provided

**(k) Hot and Cold Water Service Tanks ( suitable for 7500 TCD )**

Three rectangular overhead tanks of 8 mm thick mild steel plates with stiffeners and angle frame each having a capacity of 600 H.L. complete with valves, fittings, pipes shall be provided. Bottom of the tanks shall be atleast 5 meters above Pan floor. Tanks shall be covered. Level indicators to be provided.

Two electric driven centrifugal pumps, each having a capacity of 450 m<sup>3</sup>/hour at 30 meters head complete with pipes and valves from the pump to the service tanks shall be provided at suitable place.

Two parallel strainers with isolating valves shall be provided in each of cooling water lines to mill bearings, oil coolers, air compressors, vacuum pumps, etc, so that one will be stand by for periodical cleaning.

All bearings and oil cooling water to be collected in a Masonry tank to be provided by purchasers, which should not be more than 10 m away from mill house factory building.

**Water Conservation Recirculation System** - Necessary arrangement be provided for recirculation of cooling water from power turbine, Mill bearing, enclosed mill drive gear boxes, crystallizers, air compressor and sulphur burner etc. All equipments like M.S. fabricated collection tank of suitable capacity, 2 nos pumping sets (one as standby) piping, valves etc. be installed at suitable location. This water shall be pumped to raw water reservoir through spray nozzles installed on the reservoir itself to achieve the atmospheric cooling.



## (V) STEAM GENERATING PLANT

### TECHNICAL SPECIFICATIONS FOR BOILER

MCR (Max.Continuous rating)

Evaporation : Two nos. 80 tonnes per hour for 5000 TCD plant.  
( One no. to be added for 7500 TCD plant)

Peak generation : 110% of MCR for half an hour.

Pressure at superheater outlet : 67 kg/cm<sup>2</sup> g

Temperature of steam at superheater outlet at 60% to 110%MCR : 485 ± 5 deg.C

Feed water temp. at Inlet of feed water tank : 85 deg. C

Excess air % theoretical air : Not exceeding 35 %

Temp. flue gases at outlet : 160 deg. C.

Efficiency : 70% minimum on GCV of bagasse having 50% - 52% moisture with bagasse as fuel determined as per IS Code 13980-1995/ ASME PTC-4 Code.

Fuel : Bagasse with 50-52% moisture.

Installation : Indoor & Elevated height of 4.0 Mt. Above FFL

Each boiler shall be provided with minimum one steam drum and lower drum both of fusion welded construction. The drum shall be provided with suitable dished ends, manhole, doors, fitted with cross-bars, studs and nuts at each end. The steam drum of the boiler shall be provided with primary separators of S.S. construction and secondary separators of stainless steel construction to promote circulation and ensure high steam purity.

#### **Boiler Headers :**

Boiler headers shall be constructed in accordance with IBR specifications with flanged ends to promote cleaning and inspection.

### Super Heater:

The boiler shall be provided with super heater capable of superheating total steam generated by the boiler to a final steam temp of 485+/- 5 deg.C at 60 to 110% MCR and complete with inter-connected pipelines between the boiler and superheater, mountings such as safety valves, drain/air vent valves, pressure gauges etc. as per IBR.

The tube elements of the superheater shall be expanded into the steam drum at one end and butt welded/expanded to the manifold at the other end. The superheater manifold shall be fabricated from solid drawn seamless pipes. The manifold shall be supplied complete with branches for main steam take off safety valve, air release connection etc. A thermowell in the outlet manifold shall be provided to measure the temperature of superheated steam. The superheater design should be such that the temperature of steam at superheater outlet shall not exceed 500 deg.C in any case.

A spray type attemperator or heat exchanger attemperator in between primary and secondary coils of superheater to be provided to maintain automatically the temperature of steam at superheater outlet 485+/-5 deg.C for steam flow rate between 60 to 110 % of MCR and tube elements of the superheater shall be constructed from seamless alloy steel tubes of SA 213 T 11 specification or equivalent for primary coils(1<sup>st</sup> stage) and SA 213 T 22 specification or equivalent for secondary coils(2<sup>nd</sup> stage).

### Furnace:

Suitable furnace(s) to burn bagasse with 50-52 percent moisture with preheated air shall be provided for each boiler. Furnace shall be designed to give maximum continuous rating with bagasse firing only even when furnace chamber(s) are being cleaned. One of the following type furnaces with all accessories shall be provided.

Spreader stoker with dumping grate.

Or

Pulsating grate.

Or

Travelling Grate

Ash hoppers shall be provided below each furnace and boiler height shall be adjusted such that manually operated trolleys can be placed below the ash hoppers. The boiler furnace shall be placed at elevated height of about 4 m level from ground. Steel staging to start from floor level onwards. M.S. chequered plate operating platform at 4 m level, M.S. beams and columns upto 4 m level shall also to be provided by the Seller.

Alternating furnace to be designed for burning bagasse and coal individually or simultaneously if designed by purchaser in which case boiler performance is to be finalised between purchaser and seller.

### **Rotary Feeders:**

Minimum six no. of rotary feeders coupled to variable speed drive for of positive infinitely variable regulating the quantity of bagasse to furnaces shall be provided. The feeders shall have speed variation and maximum speed not to exceed 25 RPM.

Suitable bagasse storage bunker(bagasse silo) of ten minutes storage capacity for each feeder shall be provided.

### **Induced draft fans (Two nos. per boiler) :**

Each fan shall be designed for a minimum discharge capacity of 50 m<sup>3</sup>/sec. The shaft of the fan shall conform to 40 C 8 of IS:1570-1978. Renewable hard faced wear pads on the blades shall be incorporated in the impeller. The Fan rated speed shall not be more than 750 RPM. The impeller of the fan shall be fabricated out of minimum 5 mm thick nickel chrome alloy steel. Each fan shall be provided with dampers at the inlet as well as at the outlet to control the flue gas quantity. The fan construction should be identical so as to have single spare impeller.

### **Drive for Induced draft fans (Two nos. per boiler) :**

The ID fans shall be directly coupled to variable speed electrical drive(Thyristor controlled D.C motor with IP-54 enclosure or variable frequency A.C motor) complete with control equipment , speedometer, operators control cubicle etc.

### **Forced draft fans (One no. per boiler) :**

Primary air for combustion shall be supplied by one no. forced draft fan having capacity of 50 m<sup>3</sup> /sec through air heater and shall be supplied to the furnace underneath the grate. Variable inlet vane control damper in the suction of the FD fan shall be provided. The blades of fan rotor shall be fabricated out of minimum 5 mm thick mild steel plates. The rotors of the ID & FD Fans shall be dynamically balanced. RPM of the fan shall be 1440. Fans are to be interlocked so that FD runs only when ID fan is running.

### **Drive for forced draft fans(Two nos. per boiler) :**

The FD fans shall be directly coupled to variable speed electrical drive(Thyristor controlled D.C motor with IP-54 enclosure or variable frequency A.C motor) complete with control equipment , speedometer, operators control cubicle etc.

Direction of rotation in case of both ID fans, & FD fans shall be same. Inter locking between ID & FD.

### **Secondary air fans ( Two Nos. for each boiler) (one as standby) :**

Each secondary air fan 20m<sup>3</sup>/sec at 600 mm water gauge along with TEFC squirrel cage motor shall be supplied. This will supply air into the furnace as a secondary air at high pressure through heat resisting nozzles for ensuring combustion completeness. The secondary air nozzles shall be installed in the furnace walls. From the same fan air shall be supplied to the pneumatic distributors to distribute the bagasse on to the grate uniformly. The isolating/ controlling damper shall be provided at the fan suction and in the duct at a branching point. The suction of fan shall have provision for cold air as well as hot air from airheater with two separate dampers for hot air and cold air. The deliveries of both fans to be interconnected. Each fan to be coupled to the motor. The rpm of secondary fans shall not be more than 1440.

### **Blow down arrangement :**

Continuous blow down equipment as per IBR complete with all piping connected to the M.S. blow down tank within 10 meters outside the boiler house. Suitable vapour recovery system of blow down water shall be provided.

### **Soot Blowing equipment :**

Steam operated motorised soot blowing equipment having minimum four nos. boiler soot blowers (each to cover half the width of tube bank) per boiler at appropriate places to cover bank of boiler tubes and two nos. motorised automatic retractable soot blower for superheater elements each covering half of the furnace width shall be provided. Additional two nos.(minimum) steam operated motorised soot blower(s) shall also be provided for the Economiser. All the sootblowers shall be connected to the sequential control panel.

### **Economiser : (One for each boiler)**

An integral economiser with adequate heating surface shall be provided. Economiser shall be complete with coils, supports, thermowells for measuring inlet and outlet water temperature, casing and ducting, soot blower, lagging etc. The economiser shall be designed in accordance with the requirement of IBR. The system should have bypass arrangement for flue gas and water circuit. The rise in temp. of feed water in economiser shall be 60° less than saturated temperature of drum water.

### **Air pre-heater : (each for individual boiler)**

Air heater with adequate heating surface to heat the air by flue gases required for combustion shall be provided. Air heater shall be complete in all respects with 10 SWG thick ERW tubes, tube plates, support, dampers, casing and ducting etc. and the tube plate

thickness of 30 mm. Entry of cold air shall be distributed properly over the length of air heater to avoid condensation of moisture.

The air heater and economiser shall be designed so as to give final flue gas temp. within 160 deg.C. The air outlet temperature shall not be less than 220 deg C.

**Fly Ash Arrestor :**

**Electrostatic Precipitator (ESP)**

The ESP should be designed on the following basic parameters :

Gas Flow Rate	=	Corresponding to MCR of boiler
Temperature of gasses at ESP inlet	=	160°C
Inlet Dust concentration	=	5.0g/cu.m
Outlet Emission (concentration) at ESP exit	=	<150mg/Nm <sup>3</sup>
Pressure Drop across ESP for condition gas side	=	<25mm Wc

The electrostatic precipitator of suitable capacity shall be designed so that the dust emission at the outlet of the chimney should be limited to 150mg/NM<sup>3</sup> or as prescribed by State Pollution Control Board. The ESP shall be installed on the suction side of ID fan and shall be complete with rotary air lock valve with drive provided with local and remote push button control and a side manual gate. The minimum elevation of the discharge flange of the rotary air lock valve shall be at +2500mm suitable platform, MS steel staging, ladders, staircases, railing, inspection and packing holes shall be included in the scope of supply. The ESP should be properly insulated with aluminium cladding ESP be provided with indication for ash level, low and high temperature alarm, water washing arrangement ESP Switchgear Control Panels, rectifier control panels complete in all respects. It should be provided with suitable ash handling system.

The general arrangement showing major dimension and clearances for ESP system, ESP foundation drawing for load data, electric single line diagram alongwith detailed drawings should be furnished for approval from the Purchaser.

**Boiler feed water tank (Suitable for 7500 TCD) :**

One cylindrical closed mild steel tank shall be of 900 HL capacity with inlet connections for condensate, treated water, chemical dosing arrangements, outlets connections, for transfer pumps, overflow connection, air vent connection etc. Feed water tank shall be supported on steel supporting structure. Bottom of the tank shall not be 8 metre heigh from the transfer pump suction. Access ladder and platform around the tank shall be provided. High and low water level alarm shall be provided in the feed tank along with gauge glasses .

Three nos. transfer pumps (one as standby) each of 100 m<sup>3</sup>/hr capacity and of 60m head to pump water from boiler feed water tank to Deaerator to maintain 4 kg/cm<sup>2</sup> g pressure at the nozzles of Deaerator shall be provided.

One no. transfer pump of 100 m<sup>3</sup>/hr shall be added for 7500 TCD.

### **CHEMICAL DOSING EQUIPMENTS (Suitable for 7500 TCD)**

The boiler shall be supplied with chemical dosing systems one for high pressure dosing and other for low pressure dosing. Each system shall consist of chemical proportioning tanks, two nos. positive displacement type dosing pumps, valves and measuring instruments. Each mixing tank shall have rubber linings from inside and shall be fitted with motorised stirrer and complete with piping and fittings. The capacity of each tank shall be of 400litres. The chemical dosing system equipment shall be located near feed water station on the ground floor.

### **Deaerator (Suitable for 7500 TCD) :**

Deaerator mounted on de-aerated water tank of 1200 HL capacity and suitable for maximum flow rate of 300 m<sup>3</sup> per hour shall be provided to obtain a temperature rise of feed water from 85 deg.C to 105 deg.C by using exhaust steam at 0.5 - 1.5 kg/cm<sup>2</sup> gauge. The maximum dissolved oxygen in the deaerator water shall not be more than 0.007 ppm. at 105 deg.C. temp. The deaerator tank shall be installed at a height of 8 metres from the feed pump suction, platform around the tank shall be provided, cat ladder from G.L. and approach from boiler platform.

### **Boiler feed water pumps :**

#### **Electrical driven feed pumps :-**

Three nos. each of 100 m<sup>3</sup> per hour capacity (one as standby) and suitable head and one no. start-up pump of capacity 20 m<sup>3</sup> per hour against suitable head shall be provided.

For 7500 TCD additional two nos. pump of 100 m<sup>3</sup> per hour capacity against suitable head shall be provided.

Each multistage electrical driven pump shall be suitable for pumping hot water at 105 deg.C. from deaerator to boiler. 2% leak-off connection shall be provided for each pump. Electric motor of TEFC sq. cage type with soft start ( starting current not exceeding 300% FLC) shall be provided.

Turbo Feed Pump – One no. turbo feed pump having a capacity of 200m<sup>3</sup> /hr capacity and suitable head suitable for emergency operation. Specific steam consumption should not be more than 7.0 Kg/HP/Hr working at 67 kg/cm<sup>2</sup> and 485°C.

### **R.C.C Chimney (Purchaser Scope) :**

One R.C.C chimney per boiler, of 4.5 meters inside diameter at top and of 40Mtheight as per pollution board norms along with refractory lining, ladder with guard, lightening arrestor etc with suitable connection at the bottom shall be provided by the purchaser ( for 2 Nos. 80 T/hr capacity).

For 7500 TCD one additional for R.C.C chimney of 3.0 meters inside diameter at top and of 40Mt. height as per pollution board norms along with refractory lining, ladder with guard, lightening arrestor etc with suitable connection at the bottom shall be provided by the purchaser for one no. 80T/hr boiler.

### **Boiler Feed Water Treatment Plant (Suitable for 7500 TCD) (Purchaser Scope) :**

A D.M plant with mixed bed of 45 m<sup>3</sup>/hr capacity shall be installed by the Purchaser to suit the water requirement of the boiler.

Two nos. storage tanks of 2500 H.L capacity, shall be included to store the treated water from the treatment plant. Two pumps of 160 m<sup>3</sup>/hr capacity and of 25 meters head shall be provided by the purchaser to pump the water from treated water storage tank to feed water tank. Existing water analysis shall be provided by Purchaser.

### **Following shall be included.**

1. All safety valves shall be provided with silencers to maintain noise level below 85 db from 1 meter distance.
2. Steam drum air-vent and Superheater outlet header air vent valves shall be provided with silencers.
3. Feed water pumps shall be provided with auto-recirculation valves.
4. Steam stop valves at superheater outlet shall be motorised.
5. Steam drum air-vent valve and Superheater outlet header air- vent valve shall be motorised.
6. Feed water control bypass Globe valve shall be of gear operated.

### **High pressure Steam Distribution header (Suitable for 7500 TCD):**

One no. steam distribution header of 500mm I.D. with same sized flanged ends on either side and provided with the following flanged tapings for collecting the steam and distribution it to various units to be provided.

- i) Two nos. 250mm inlet openings with gate valves for two nos. boiler.
- ii) 250mm inlet opening with dummy flange for future boiler.
- iii) Two nos.200mm outlet opening with Gate Valve for T.G.Set.
- iv) 200mm outlet opening with dummy flange for future T.G.Set.

- v) 200mm outlet opening with Gate valve for PRD.
- vi) 100mm outlet opening with Gate Valve for Turbo feed pump.
- vii) 125mm opening with Gate Valve for fiberizer turbine.
- viii) Two spare openings of 250mm size with dummy flange.
- ix) Socket for pressure and temperature gauge.

All high pressure piping shall conform to IBR.

### Instrumentation and controls :

The instrument control panel to be totally enclosed in a cubicle for dust free conditions by providing an exhaust fan on the panel. The control panel shall be properly wired, tubed and connected to all field transmitters and instruments as per standard instrumentation practice. It should be housed in A.C. room suitably sized designed and constructed by Purchaser.

- A) The following instrumentation system are to be provided for measuring the various parameters.
- (i) Steam flow meter of integrating, indicating and recording (in data logger) type
  - (ii) Feed water flow meter of indicating, integrating and recording ( in data logger) type.
  - (iii) Drum water level indicating and recording ( in data logger) type.
  - (iv) Superheater pressure indicating and recording (in data logger) type.
  - (v) Multipoint temperature scanner interface with ' K/J ' type thermocouple and universal temperature transmitters with linear output for each of the following points. All these points to be connected to data logger for recording.
    - a) superheater steam at final superheater outlet and primary superheater outlet.
    - b) Feed water economiser inlet.
    - c) Feed water at economiser outlet.
    - d) Feed water at deaerator inlet.
    - e) Flue gas temperature at boiler outlet.
    - f) Flue gas temperature at economiser outlet.
    - g) Flue gas temperature at airheater outlet.
    - h) Flue gas temperature at I.D fan inlet.
    - i) Air temperature at airheater inlet.
    - j) Air temperature at airheater outlet.
    - k) Furnace temperature.
  - (vi) Draft gauges for –
    - a) F.D fan discharge.
    - b) I.D fan suction.



- c) Furnace.
  - d) Flue gas at boiler outlet.
  - e) Flue gas at economiser outlet.
  - f) Flue gas at airheater outlet.
  - g) Flue gas at fly ash arrestor outlet.
  - h) Air at airheater outlet.
- (vii) O<sub>2</sub> analyser with signal connection to datalogger.
- (viii) Pressure gauges of size 250 mm diameter with S.S. syphon and isolation valve to be provided at boiler drum, superheater outlet steam and at fire door level for superheater outlet steam.

Pressure gauges of size 150 mm diameter with S.S. syphon and isolation valve to be provided at economiser inlet, economiser outlet, at each feed water pump outlet and feed water pumps common header.

- (ix) Microprocessor based 24 channel data logger programmable to any type of inputs like current, mv, T/C and digital for recording the following parameters with 80 column dot matrix printer and relay output for 8 channels for annunciation.

- (a) Steam flow.
- (b) Feed water flow.
- (c) Superheater steam temperature at primary superheater outlet.
- (d) Superheater steam temperature at secondary superheater outlet.
- (e) Superheater steam pressure at secondary(final) superheater outlet.
- (f) Drum level.
- (g) Deaerator level.
- (h) Deaerator pressure.
- (i) Furnace pressure.
- (j) Air flow.
- (k) Feed water at economiser inlet.
- (l) Feed water at economiser outlet.
- (m) Feed water at deaerator inlet.
- (n) Flue gas temperature at boiler outlet.
- (o) Flue gas temperature at economiser outlet.
- (p) Flue gas temperature at airheater outlet.
- (q) Flue gas temperature at ID fan inlet.
- (r) Air temperature at airheater inlet.
- (s) Air temperature at airheater outlet.
- (t) Furnace temperature.
- (u) O<sub>2</sub>.

- B) Microprocessor based annunciator with electronic hooter to be provided for the following.
- (a) Feed water tank level low.

- (b) Deaerator tank level low.
  - (c) Deaerator tank level high.
  - (d) Drum water level low.
  - (e) Drum water level high.
  - (f) Superheater steam temperature high.
  - (g) I.D fan trip.
  - (h) F.D fan trip.
  - (i) S.A fan trip.
  - (j) Feed water pump trip.
  - (k) Bagasse feeder trip.
  - (l) Feed water transfer pump.
- C) The following auto controllers are to be provided with the boiler.
- i) **Three element drum level control system:** Drum level shall be automatically controlled using the three element control philosophy to ensure quick response of the system. In case of drum level falls below minimum level, the feed water control valve will open fully. In case drum level rises above maximum level, the feed water control valve will close fully.
  - ii) **Deaerator pressure and level control system:** Deaerator pressure shall be maintained by regulating the steam flow to the deaerator so that temperature of boiler feed water is maintained at the desired set value. Deaerator level shall be controlled so as to balance the inflow and out- flow of feed water.
  - iii) Cascaded superheater steam temperature control system based on measuring temperature at outlet of primary superheater header and final superheater header.
  - iv) **Combustion control system:** This will be an integrated control loop for maintaining the steam pressure. According to the steam pressure the master controller will adjust speed of dynodrives to feed more or less fuel to the boiler and FD fan to control amount of primary air sent to the furnace respectively. To ensure that this adjustment is correct, the signal of O<sub>2</sub> % in flue gases will be taken in the loop to make the final correction in the speed of FD fan.
  - v) **Furnace pressure control system:** ID fan speed shall be controlled to maintain draft in side the furnace to – 5mm WC.
- D) Two air compressors (one as standby) shall be provided to supply oil and moisture free air through refrigeration dryer for pneumatically controlled instruments.

OR

### COMPUTERIZED BOILER AUTOMATION :-

The computerized scalable process control system shall be provided to achieve the above referred measurements, control & audio- visual alarms for the safe and smooth operation of the boiler. The system shall have the following features and facilities.

- a) Data acquisition and monitoring.
- b) Data logging.
- c) Alarm and event logging.
- d) Dynamic trend for 32 channels.
- e) Three dimensional graphic display.
- f) Free format report generation for customized reports.
- g) Online mathematical computation for any physical and virtual channels.
- h) Printer hard copy.
- i) Loop wise scan time selection.
- j) Card replacement without power shutdown.
- k) Latest communication standards like HART/Foundation field bus.

### Material of construction and general instructions:

The boiler shall be manufactured in accordance with the requirements of Indian Boiler Rules and Regulations.

The boiler shall be provided with a steel supporting structure from rolled steel sections and designed with adequate strength for the loads imposed by the boiler and associated equipments.

The boiler shall be complete with necessary tubes, manifolds, integral pipe works, mountings and fittings with valves, gauges, high and low water alarm, maintenance tools consisting of expander, mandrills, ratchets two grease guns and a set of spanners, water gauges, chemical injection valves etc. The integral pipe work shall consist of blow-off bends, high and low pressure drains, water gauge piping, water and steam connections to the feed water regulator, piping from feed control valve to economiser inlet manifold, feed piping from economiser outlet manifold to the boiler steam drum, pressure gauge piping, soot blower steam supply pipe works, safety valves escape pipe work etc. The boiler shall be provided with a three element type automatic feed water regulator of the electric/pneumatic controller type, which shall respond to momentary fluctuations in steam demand upto +/- 5% of the rated MCR of the boiler. One hand operated control valve of cast steel (located such that its operator can see water level in gauge glass) capable of passing the required amount of water shall also be provided. The boiler shall have two water gauge glasses at the top drum independently connected.

Necessary mild steel ducting of 5 mm thick plate in case of air duct and 6 mm thick in case of gas duct with stiffeners shall be provided for the boiler, comprising of cold air ducting extending between the forced draft fan discharge and air inlet of air heater, hot air ducting

from the air heater outlet to the furnace , flue gas ducting from fly ash arrestor to the chimney. All ducts of mild steel shall be above the ground.

Necessary regulating and isolating dampers at suitable points shall be provided for the efficient operation and maintenance of boiler. All dampers will have an effective area not less than the specified for the ducts they control.

Suitable galleries and ladders with grating or open steel flooring for affording access to the essential levels of the boiler plant complete with hand railings, curb angles and supports shall be provided.

All supporting steel work, hangers, thrust brackets and castings for the furnace shall be provided for boiler. All refractory tiles and bricks, adequate quantity of high grade refractory cement, special shaped refractory tiles castable refractory bricks for furnace and high temperature zones shall be as per IS-8 quality. All necessary high grade insulating materials for the exposed portion of the boiler, steam and water drums, integral pipe work from the feed pumps to the boiler, steam piping, gas and hot air ducting shall also be supplied. Reinforcement with wire mesh and supercoated with a hard setting material so as to protect the high grade lagging materials against damage shall also be provided .

### **(VI) POWER GENERATING PLANT**

#### **(a) Turbo Alternator Set:**

**For 5000 TCD –2 nos. 11 KV, 8 MW AT 0.8 PF bleed cum back pressure type  
Or  
Suitable extraction cum condensing TG set**

**For 7500 TCD – Suitable configuration may be worked out.**

The turbine shall be horizontal bladed rotor type, double pedestal, multistage, nozzle governed, uncontrolled bleed cum back pressure type. The rotor and disc shall be machined from a single piece forging.

Two turbo alternator sets of 10000 KVA (8000 KW at 0.8 power factor) with synchronizing and control equipment for synchronizing with grid.

The 8000 KW turbo set should be suitable of developing momentarily 9000 KW at 0.9 power factor even when both the over load valves of the turbine are closed.

The steam turbine shall be designed for operation for the following ranges of steam parameters:

### Inlet steam parameters

Maximum	:	67 kg/sq.cm <sup>2</sup> .g
Normal	:	65kg/sq.cm <sup>2</sup> . g
Minimum	:	60kg/sq.cm <sup>2</sup> .g

### Inlet steam temperature

Maximum	:	495degree C
Normal	:	480 degree C
Minimum	:	450 degree C

### Exhaust steam pressure

Maximum	:	1.5 kg/sq.cm.g
Normal	:	1.0 kg/sq.cm.g
Minimum	:	0.5 kg/sq.cm. g

The turbine shall be so designed that it suffers no damage if exhaust pressure occasionally goes down to atmospheric pressure and/or live steam temperature goes up to 500 degree C and pressure 67kg/cm<sup>2</sup>g

The turbine shall be horizontal rotor, double pedestal, multi stage, nozzle governed, uncontrolled bleed-cum- back pressure design. The turbine shall also be capable of developing 8000 KW when steam pressure at inlet stop valve is 60 kg/sq.cm.g. and temperature is 450 degree C and both over load valves open. The turbine shall have un-controlled bleed at a pre-set pressure of 7-8 kg/sq.cm. g. and quantity of steam vary from 0-5 tons/hr, depending upon process steam requirements. Turbine should have hydraulically operated servo motor control valves to minimise manual operation and quick re-alignment to varying load and input operating conditions to improve efficiency even at part load. The turbine shall have minimum six stages.

The specific steam consumption of the turbo generating set at its rated speed and on normal steam operating parameters of 67 kg/sq.cm<sup>2</sup>.g. shall not be more than 6.25 kg/kw/hr.

The turbine shall be coupled to a suitable enclosed reduction gear box of hardened and ground gears and pinions designed to transmit 8000 KW continuously at turbine rated speed and ambient temperature of 45 °C with a service factor not less than 1.5. The gear box shall be coupled to the alternator through suitable design flexible

coupling capable of transmitting 8000 KW continuously. The gear box shall be designed as per relevant DIN/IS/BS/AGMA standards. Necessary cooling arrangement for the gear box shall be provided. The turbine and the gear box shall be mounted on a common base plate which shall also serve as oil reservoir.

The turbine shall be provided with electronic type governor of woodward 505 E make programmable micro-processor based digital control with TG 13 actuator to actuate a set of inlet governing valves and should be capable of operating in parallel with State Electricity grid. The speed regulation of the turbine (droop characteristics) shall not exceed 6% at 8000 KW full load of the alternator. The turbine shall be complete with high pressure stop and emergency valve, steam strainer, steam traps, sentinel valve, main oil pump, auxiliary electric motor driven oil pump, one DC motor driven stand by oil pump, oil cooling system consisting of two no.s oil coolers with necessary pipes and valves so that one of the two coolers can be cleaned when the turbine is working on load, steam and oil temperature and pressure gauges, gauge type spot mounted bearing temperature indicators for turbine and gear box local/direct mounted speedometers and one remote reading tachometer, oil pockets with stem type thermometers in the live steam inlet and exhaust steam outlet lines, steam flow meter for measuring steam consumption of the turbine. Necessary oil reservoir, duplex micronic felt/self cleaning type oil filters, oil strainer, interconnecting oil, water and steam pipe work with valves and non-return valves, etc., and arrangements for automatic starting of auxiliary oil pump in case of low oil pressure shall be provided. The following safety devices shall be provided for the turbine.

- a) Over speed trip with audio visual alarm.
- b) Low oil pressure trip with audio visual alarm.
- c) The turbine should trip when the alternator ACB trips due to differential Protection.
- d) Remote operated manual trip with audio visual alarm.
- e) Manual trip handle on turbine.
- f) Axial movement trip.
- g) High back pressure trip.
- h) High oil pressure trip.
- i) Electronic over speed trip with sensing from speedometer.

### **TURBINE SUPERVISORY SYSTEM**

The system shall observe all critical process parameters of the turbine continuously with following provisions:-

- Monitoring of winding & bearing temperatures, vibrations continuously.
- Audio/visual ALARM & TRIP signals.
- Setpoints adjustable separately for winding & bearing.

- Immune to noise signals, radiations & electromagnetic interference.
- Ultra sensitive & accurate sensors.
- Built-in safety fuse & failsafe logic.
- Changeover relay contact outputs to activate buzzer or trip the turbine/motor.

The specifications of the system components shall be as specified below:-

- (1) **Sensor** : PT100/Thermocouple & vibration.
- (2) **Accuracy** :  $\pm 0.25\%$  of FS
- (3) **Display** :  $3\frac{1}{2}$  digits, 7 segments for temperature & vibration.
- (4) **Scan Time** : 3 to 30 seconds adjustable.
- (5) **Auto/Manual selection** : Front panel switch
- (6) **Setpoints** : Adjustable with front trimpots.
- (7) **Power supply** : 230/110 VAC; 50 Hz.

Special maintenance tools for the turbine shall be supplied along with the turbine. The turbine shall be completed with a set of foundation bolts and levelling pads, isolating valve at steam inlet, isolating valve at extraction, extraction non-return valve, exhaust isolation valve, exhaust non-return valve and exhaust flow relief valve.

The alternator shall be suitable for developing continuously 10000 KVA (8000 KW at 0.8 power factor), 3 phase, 3 wire, 50 cycles/sec. at a normal voltage range of 11 KV and shall conform to IS specifications. The alternator shall be suitable for developing continuously 10000 KVA even when the power factor is 0.9. The alternator shall be fitted with two RTDS in each phase for thermo protection of the alternator windings, space heaters, winding air space temperature indicator, dial type spot mounted temperature gauge for alternator bearings, etc. The alternator shall be designed for an ambient temperature of 45 degree C and shall be of cylindrical rotor, revolving field design suitable for grid paralleling.

The alternator shall be complete with brushless excitor, base frame, couplings, water cooled radiator with inter connecting cables, etc. The alternator shall be provided with two pedestals (one at each end). The alternator shall be suitable for taking thyristor load (DC mode) of upto 40% of its rated full load. The efficiency of the generator shall not be less than 96% at full load.

### ii) 11 KV Vacuum circuit breaker incoming panel.

VCB panel shall be single front drawout execution floor mounting free standing suitable for 11 KV,  $\pm 10\%$  variation, 50 Hz frequency  $\pm 5\%$  variation, 3 phases 3 wire type supply system suitable for fault level 25 KA for 3 seconds. Panel earthing should be through NGR, suitable for 50° ambient temperature and relative humidity of 95%. Panel shall be indoor type. VCB shall be electrically operated type with spring charging voltage 240 V AC and closing and tripping coils suitable for 110 V DC. Panel bus bar shall be of electric grade aluminium EC – 91 E suitable for fault level 25 KA for 3 seconds. Panel shall have all necessary CTS, PTS, indicating lamps and other required equipments suitable for grid paralleling and operation of sugar factory. The breaker shall have suitable no. of auxiliary contact for electrical interlocking with auxiliary power supply breaker etc..

The alternator shall have neutral breaker mounted on front side of breaker panel/bus coupler band. The neutral bus bar shall be half of phase bus bars and EC-91E grade.

Bus bars shall be located in air insulated enclosure and segregated from all other compartments of the cubicles. All bus bar joints and bus tap joints shall be silver faced. Panel shall have full proof earthing necessary safety interlock features etc.

Panel shall have interior illuminating lamp, space heater with thermostat suitable for 220 V AC, contactor for anti pumping, trip circuit supervision relay, spring charging handle. Earthing trolley shall be provided to short incomer of breaker when breaker is taken out for maintenance. Panel shall be suitable for bottom cable/bus duct entry. Panel shall be suitable for extension on both sides to connect distribution panel.

Suitable interlocking with castel lock shall be provided for interlocking of the main breaker with emergency power supply breaker of grid/DG set supply and bus coupler can be switched 'ON' only when one supply breaker is ON in addition to electrical interlocking. The scheme for interlocking shall be approved by purchasers.

### iii) Metering-cum-Synchronising Panel

Panel shall be metal enclosed free standing floor mounting type shall be dust moisture and vermin proof simplex type with IP 52 degree of protection. Panel shall have all necessary metering, indication in annunciation, synchronising equipments.

Metering – Minimum following metering shall be provided:

Ammeters & Volt meter with selector switch, KW meter, power factor meter, frequency meter, KVA meter, KVAR meter, Tri Vector meter, KWH meter and KVAH + MDI meter. Meter should be digital type of suitable ranges and ratings.



All meters shall be of 3 phase four wire type and shall be suitable for balance as well as unbalanced loads. Meter size shall be 144 mm sq., meter type moving iron type, accuracy class 0.5 FSR meters scale shall be 240 degree.

Synchronising - It shall have minimum following equipments: Check synchronising relay, guard relay, synchronising auxiliary relay, inter posing voltage transformer, double volt meter, double frequency meter, synchro scope, discrepancy control switch with all necessary indicating lamps selector switches and automanual selector switch.

Synchronising system should be such that 11 KV turbo set should be suitable for paralleling with other 11 KV turboset , grid or with similar turbo set installed in future.

Annunciation - Minimum following annunciation shall be provided:

Under voltage relay operated, Over voltage relay operated, Reverse active power relay operated, Reverse reactive power relay operated, IDMT over current relay operated, Earth fault relay operated, Generator lock out relay operated, Turbine lock out relay operated, Loss of excitation relay with under voltage relay operated, Loss of excitation relay without under voltage relay operated, Negative phase sequence relay alarm, Negative phase sequence relay operated, Under frequency relay operated, Very under frequency relay operated, Over frequency relay operated, Df/Dt operated, Relay panel DC fail, Instantaneous over current relay operated, Metering and AVR PT fuse fail, Protection PT fuse fail, Excitation PT fuse fail, Winding temp. high, Over load relay operated, Generator bearing temp. high, Emergency trip push button operated, First rotor earth fault, Second rotor earth fault trip.

Annunciator shall have RS-485 communication port to communicate through Modbus communicate protocol.

Panel shall have 16 channels temperature scanner suitable for PT 100 RTDS for generator winding and bearing, cold and hot air temperature.  
Scanner shall have RS-485 communication port to communicate through Modbus communicate protocol.

Codes and Standards: Panel shall generally comply with relevant Indian Standard Specification and relevant codes and practices.

#### iv) AVR & Excitation Panel

Field excitation system shall be fitted with suitable switching device with brushless generator for field excitation system such that field current is automatically cut off from circuit in the event of turbine/generator trip. Excitation system panel shall have DC ammeter, DC V meter, shunt field regulator for manual operation of excitor with automanual selector switch, suitable transformer indication lamps, fuses and field discharge resistance with necessary isolation facilities shall be provided.

One CT panel complete with 3 core current transformers for meters, protection, differential protection at phase and neutral side, compounding etc.

One set SCADA (supervisory control & data acquisition system) complete with PLC, computer with key board. SCADA package (software), distributed I/o control system, colour printer, etc. for monitoring and control various operating parameters of the TG set.

There shall be 2 no. AVR panels (one operating and one standby) with automanual selector switch with independent primary and secondary modes complete with all accessories, over voltage relay, suitable volt meter and fine voltage adjustment device, automatic power factor regulation facility suitable for grid paralleling.

AVR shall have motorised auto potential meter, facility for enabling remote raise/lower of voltage, AVR priming, short circuit maintenance features, compounding features, auto PF controlling features, followup features, diode failure detector for excitor rotating diodes, over and under excitation limiter. Panel shall have following meter, alternator volt meter, excitor volt meter, excitor ammeter, null meter and power factor meter etc.

### v) Protection relay panel

Protection relay panel shall be same in construction and other features for metering panel. Relay panel shall have minimum following protective relays:

Under voltage relay, over voltage relay with timer, reverse active power relay, reverse reactive power relay, voltage control 3 element type over current relay, earth fault relay, differential relay, generator lockout relay, turbine lockout relay, loss of excitation relay, auxiliary relay for loss of excitation relay, under voltage relay, negative phase sequence relay, four stage frequency relay with one  $df/dt$ , DC supply supervision relay, instantaneous over current relay, voltage balance relays for metering and protection PTS, instantaneous over voltage relay for excitation PT fuse fail sensing, overload relay, first rotor earth fault, second rotor earth fault relay, voltage surge relay, trip coil supervision relay, unit lockout relay.

Relay panel shall have necessary meters, switches, potentiometers etc. Differential relay shall be supplied with 3 nos. stabilising registers and 3 nos. metrosil surge diverters.

Relay shall be preferably electro mechanical type or solid state electronic type numeric relays also can be considered.

### vi) NGR with control panel

NGR shall be suitable for 11 KV, 3 phase, 50 Hz supply system with fault level of 25 KA for 3 seconds. Panel shall be metal enclosed free standing floor mounting type and shall be dust moisture and vermin proof. Neutral grounding equipment shall be completely assembled, wired and connected to neutral bus tap through seal off bushings.

Resistor unit mounted on the grid rods shall be fixed and assembled in tires and fitted into sheet steel enclosure. Resistor shall be able to carry specified current for the period of time as specified with temperature rise not exceeding 375°C over maximum ambient temperature. The resistor shall also be able to carry at least 10% of its rated current continuously.

An isolator shall be provided on incoming side to isolate the resistor from the main equipment. Isolator shall be provided on front of the panel. Isolating switch shall be single pole, knife type having rating of 125 times the rated current of resistor. Switch shall have adequate sets of potential free auxiliary contacts for remote indication/alarm/trip signals. An external handle suitably insulated and lockable both in ON & OFF positions shall be provided for isolating switch.

NGR panel shall have all necessary metering protections and indications and ammeter for earth leakage current.

### **vii) LAPT panel (Lightning Arrestor and Search Protection)**

LAPT panel shall be complete and shall house 11 KV search capacitors and class III discharge gapeless lightning arrestors in sheet steel cubicles.

LAPT panel shall have all necessary metering CTS, PTS and meters for protection metering and AVR sensing. Panel shall be suitable to connect 11 KV HT cable from at the top of the panel for incoming and at the bottom for outgoing cable of the panel.

PTS in the panel shall be cast resin, non draw out type suitable for nominal operation connected from line to ground and for 1.73 times rated line to ground voltage under sustain emergency condition. The lightning arrestor and surge capacitors shall be located in separate compartments and shall be single pole connected between line and ground terminals. The arrestor shall be station class, hermetically sealed type and shall be suitable for generator protection.

### **viii) Turbine control panel (control desk type)**

Turbine control panel shall be indoor type, desk profile type metal enclosed free standing floor mounting and shall be dust moisture and vermin proof. The control desk shall have ON/OFF push buttons (illuminating type), trip indicating lamp, ammeter, local/remote selector switch for air blower motor, vapour extractor motor, actuator motor, ALOP motor, barring gear motor, ACOP motor, emergency oil pump motor.

Panel shall have all necessary metering protections annunciations. Panel shall have temperature scanner for turbine and gear box bearings.

Annunciator shall have minimum following annunciation for:

Lube oil pressure low, lube oil pressure very low, control oil pressure low, differential pressure across filter high, control oil pressure very low, turbine speed high, high axial movement, condenser low vacuum, turbine lock out relay operated, solenoid trip, turbine bearing temperature high, turbine bearing temperature very high, emergency trip,

Annunciator shall be solid state microprocessor base type with taste, acknowledgment and reset push buttons.

Power supply to the annunciator shall be 110 V DC.

### ix) Turbine auxiliaries MCC

415 V LT MCC/switch board for T.G. Set auxiliaries and condenser shall be non drawout type single front compartmentalised suitable for three phase, four wire, 415 V, 50 Hz supply system. MCC shall have switch fuse contactor, over load relay starters for various motors required for turbine lube systems and condenser etc.

MCC shall be nondraw type ,free standing floor mounting type suitable for indoor operation, cable entry shall be from bottom and shall have adequately rated incoming switch fuse unit and starters for outgoing feeders.

MCC shall be constructed as per following IS codes:

IS-375 for bus bar clearances.

IS-2405 for current transformers

IS-4064 for switch fuse units

IS-9224 for fuses

IS-2959 for contactors

IS-3231 and 5544 for bimetalic over load relays with single phase preventer

IS-1248 for meters

IS-6875 for control switches & push buttons

### x) ACDB (AC Distribution Board for Power House Auxiliaries)

Panel shall be metal enclosed, wall mounting type, dust and moisture and vermin proof suitable for 230 V AC single phase 50 Hz supply system. Panel shall be indoor type having 1 no. switch fuse incomer feeder and 15 nos. two pole MCB outgoing feeders for supply to various control panels.

### xi) DC batteries & battery charger

DC batteries shall be lead acid type conforming to Indian Standard Specification and Codes of practice. Each battery cell shall be 2 V connected in row and double tire formation for getting 110 V DC supply. Batteries shall be mounted teak wood rake complete with cell no. plates fixing nails and battery interconnectors. Batteries shall be suitable for ambient temperature 50°C for satisfactory operation. Total 55 number cells are required for getting 110 V DC supply to various panels.

Battery charger shall be rated for 110 V DC and suitable for maintenance free batteries. Battery charger panel shall have all necessary meters and lamps for indication purpose. Panel shall consist of two chargers, a float charger and float-cum-boost charger for trickle and boost charging of battery of specified rating. Charger shall have automanual operation mode and suitable for 415 V, 3 phase, 4 wire system. Battery charger rectifier shall be Silicon control bridge full wave type. Output voltage regulation shall be +/- 1% maximum from no load to full load. Ripple voltage shall be 3% of RMS voltage. Battery charger shall have following indications AC supply on FC, AC supply on FCBC, charger on FC, charger on FCBC, FCBC on float charging, FCBC on boost charging, Phase fail and battery reverse polarity.

Following meters shall be provided. AC input V meter, DC V meter with selector switch, DC V meter and DC ammeter on load side, DC ammeter FC, DC ammeter battery.

Following annunciation shall be provided, FC fail, FCBC fail, DC voltage low, DC voltage high, overload FC, overload FCBC, mains failure, battery earth fault and rectifier failure.

Battery charger shall have following features and interlocks:

- a) Float charger cannot be switched on when the boost charger is on under float mode.
- b) Charger-1 is on and if charger-2 is made on in Float mode, charger-1 shall be tripped off automatically.
- c) In case of ac main failure, battery shall supply the load on an automatic basis.
- d) Rated output voltage shall be maintained during from charger to battery.
- e) Interlock shall be provided such that when charger-2 is selected in boost mode, it will be disconnected from DC load
- f) Normally the charger will work in float charging mode of FC.
- g) In case any problem in float charger, automatically changeover will occur to float charging mode of FCBC.
- h) After rectification of float charge of FC, manually it can be transferred to float charge of FC, from float mode of FCBC
- i) In case of low Battery voltage, Battery should be connected to boost mode automatically and float charger of FC should feed the load.
- j) After boost charging is over, battery tank shall be automatically connected to float charger of FC for trickle charging.

DC distribution panel shall be integral part of battery charger with following feeders:  
One number incoming feeder of adequate rating and 12 numbers outgoing feeders for supply of 110 V DC to various control panels.

**xii) DC motor starter panel**

Panel shall be metal enclosed, wall mounting type, dust and vermin proof, panel shall consist of 2 step resistant starter suitable for 110 V DC supply,  $\pm 10\%$  variation. Suitable for continuous duty. Starter shall be so design to limit the starting current two times full load current of DC motor. Panel shall have all necessary meters, contactor, indications and relays.

**B) 11 KV & 415 V Power Distribution System**

**i) 11 KV distribution panel**

11 KV distribution panel shall have VCBS (Vacuum Circuit Breakers) for each outgoing feeders feeding to plant transformers, convertor transformers, 11 KV motors if any and export power transformer. All other features of the panel for metering protection, relays and constructional features shall be same as 11 KV VCB incoming panel.

**ii) 11 KV/433 V distribution transformers for plant load**

Transformer shall be outdoor type, ground/platform mounting, oil immersed naturally cooled type (ONAN). Core type (Copper), double wound as per IS 2026 of suitable KVA rating. Suitable for 11 KV/433 V, 3 phases, HV delta connection and LV star connection with copper windings with vector group Dyn11. Transformer shall have HV terminal box suitable for terminating XLPE cables and LV terminal box suitable for bus bar ducting connection. Additional neutral will be brought out for earthing purpose for cable box/bus ducting arrangement. On HV side tapplings on HV winding  $\pm 5\%$  @  $2\%$  shall be provided to maintain rated voltage on LV for constant KVA for HV variation. Tabs can be changed ON-OFF circuit with an external handle. Tab position indicators with locking arrangement on each step shall be provided. Transformer shall have following standard fittings:

Monogram plate, Conservator with sump & drain plug, Oil filling hole with flange & bolted cover, Prismatic Oil Level Gauge, Dehydrating Silica get Breather with oil seal, Thermometer pocket, Air Release plug, Inspection Cover, Lifting Lugs, Cover lifting Lugs, Jacking Lugs, Top Filter valve 32 mm, Drain cum Filter valve 32 mm, Earthing Boss, Off circuit switch, Storage & instruction plate, Skid type under base & Bi-directional plain Rollers.

Transformer shall have following accessories:

Top oil temperature indicator (Vapour pressure type) – Capillary tubing type with MRP/RSD and alarm and trip contacts, Double float Buchholz relay with alarm and trip contracts, Magnetic oil level gauge with low oil level alarm, winding temperature indicator with current transformer and heater coil, and alarm and trip

contacts, marshalling box duly wired up from accessories to the box, Radiator shut off valves, pressure relief device.

### iii) 11 KV/600 V convertor duty transformers for Mill drives

Convertor duty transformers shall be dual winding type 11 KV/600 V/600 V. Each secondary winding shall be feeding to DC motor thyristor panel. Transformer shall be specially designed for convertor duty application. Balance transformer specification shall be similar to distribution transformer.

### iv) 415 V Bus Ducts (transformer to main distribution board)

Bus bar trunking : The bus bar shall be made of electric grade (EC-91E) aluminium. The busbar trunking enclosure shall be fabricated out of 50 x 50 x 6 mm angle and folded covers of 2 mm thick aluminium sheets shall be provided on all four sides. The louvers shall be provided on side covers. The flexible copper connections as alternator ends and fixed connections at the breaker panel end shall be provided. The bus bar trunking shall be designed for 3750 KVA continuous capacity at 0.8 power factor at an ambient temperature of 50 deg.C. and the maximum temperature of the bus bar shall not exceed 85 deg.C. It shall be designed to withstand a symmetrical short circuit current of 50 KA (RMS) for one second. The bus trunking shall also have a neutral bus bar of half the size of the phase bus

### v) 415 V Main Distribution Panel/Board

Main distribution panel: This shall be designed for capacity of 5000 TCD at unity load factor. The panel shall be fabricated from 14 SWG cold rolled sheet steel and shall be totally enclosed floor mounting type, dust, damp and vermin proof. Louvers shall be provided in the panel for air circulation. The panel shall be designed for an ambient temperature of 50 deg.C. and the maximum operating temperature of the bus bar shall not exceed 85 deg.C. The panel shall be designed to withstand symmetrical short circuit current of 50 KA (RMS) for one second. The operating heights of the panels shall not exceed 2000 mm. The panel doors compartment shall be interlocked in such a way that it shall not be possible to open them when the switch/circuit breaker is in closed on position. The bus bars provided in the panel shall be of aluminum EC-91E grade. The size of the neutral bus bar shall be half of that of phase bus bar. The earth bus bar shall be located at the bottom and shall be continuous throughout the length of the panel. Removable sheet steel gland plates shall be provided at the bottom of the panels for cable entry. The panel shall have individual air circuit breaker or switch fuse unit for outgoing feeders for motor control centres installed for boilers and centrifugal. The panel shall also have individual

switch fuse unit for outgoing feeders for all other motor control centres. The panel shall also have individual switch fuse unit for feeders for auxiliary panel, and electric oil pump for turbo set. The panel shall also have one bus section coupler consisting of 2000 amp. four pole air circuit breaker connected in such a way that some of the load can be transferred from the turboset supply and be fed from the emergency power supply. Coupler and emergency supply incomer breaker shall have four pole, 3 phase, and neutral circuit breaker.

One four pole air circuit breaker of 2000 amp. rating shall also be installed in the main distribution panel for feeding the emergency power supply from diesel set/state electricity grid. All these Air circuit breakers shall be interlocked with the alternator breaker panel such that only one source of power supply is fed to the bus bar at a time. The main distribution panel shall be fitted with spare switch fuse unit, one of each size subject to a maximum of three nos. and 2 nos. plugs and sockets, each of 63 amps. control supply of 230 VAC shall be obtained only through Phase & Neutral. Automatic Power factor correction panel with capacitors shall be installed near the main distribution panel for automatic improvement of power factor to a minimum of 0.90. Air break contractors with back up switch fuse with ammeter and 'ON' Indicating lamps unit shall be fitted in the main panel for connection of about 800 KVAR capacitors. Capacitors shall be APP double layer type suitable for sustaining for D.C. harmonics generated by thyristor drives.

The balance number of capacitors shall be installed at individual MCC's and across all motors rated above 125 KW. The main distribution panel shall have ammeter and ON and OFF indicating lamps for each outgoing feeder. Ammeter, voltmeter and 3 nos indicating lamps shall be provided for incoming emergency supply breaker. All switches and air circuit breakers in the outgoing feeders in the main distribution board shall be designed for a rating of 1.2 times the connected load to each feeder. Each outgoing feeder shall be housed in individual separate cubicle with door interlock and shall be provided with energy meter etc. Suitable no. of bus coupler panel shall be provided as per layout and operation of co-generation system similar to VCB panel with necessary protections.

### vi) Motor control centres

Motor Control Centres (MCC) : Complete plant load shall be divided into 15 to 18 zones, 15 to 18 Nos. MCC's ( including 3 to 4 Nos. of MCC's for centrifugal machines) shall be supplied, each zone connected to a separate MCC. Boiler and injection pumps shall have minimum 2 Nos. MCC's each.

Also the main centrifugal machine motors shall be provided with minimum 4 Nos; MCC's. A separate MCC shall be provided for the crystallisers and massecuite pumps. Each MCC shall be provided with 1 No: incoming switch of 1.2 times the connected load excluding the standby equipment, an ammeter, a voltmeter with selector switch, 3 phase energy meter and OFF and ON indicating lamps. Each MCC will have individual outgoing feeder for each motor connected to that MCC. For squirrel cage motors, each



feeder shall have switch fuse unit, starter with overcurrent protection, an ammeter and on indicating lamp. For slipping motors, each feeder shall have switch fuse unit, starter, an ammeter and on indicating lamp. In case of slipping motors rotor starters shall be provided and installed near individual motors. The MCC's shall also have feeders for connection of low loss power capacitors APP doublelayer type, each feeder having air break contractor with back up switch fuse unit, on indicating lamps, ammeter, ON-OFF push buttons. Suitable number of similar zones will be added to distribute the additional load coming at the expansion stage of 7500 TCD.

Each feeder in the MCC's shall be housed in separate individual compartments with door interlock.

Each MCC shall be 14 SWG cold rolled sheet steel fabricated cubicle type/cast iron cubicle industrial type, floor mounted, dust, damp and vermin proof. Each MCC shall be expandable at both ends for additions of switches and starter for the motors if required at any stage. The bus bars shall be made of Electric Grade (EC-91E) aluminium. The earth bus bar shall be located at the bottom and shall be continuous throughout the length of each MCC. The operating height of each MCC shall be 1800 mm & maximum height shall be 2300 mm. Control supply of 230 VAC shall be obtained only through Phase & neutral. In centrifugal panels/ MCC 230 V A.C control supply shall be through control transformer.

Each MCC shall be designed to withstand symmetrical short circuit current of 35 KA (RMS) for one second. Each MCC shall be designed for an ambient temperature of 45 deg.C, the bus bar operating temperature shall not at the ultimate capacity of 5000 TCD shall not exceed 85 deg. C Removable sheet steel gland plates shall be provided in each MCC for cable entry.

Each MCC shall be provided with spare switches, one of each size subject to a maximum of three nos. and a plug with socket of 63 amps. All squirrel cage motors upto an including of 40 HP rating shall be controlled with D.O.L. starters. All other squirrel cage motors shall be controlled with air break automatic star delta starters.

Incomers for all MCC s shall be SFU / ACB with 1.2 times capacity of operating load.

Each slipping motor shall be controlled with rotor starter installed near motor.

Electrical inter-locking of the following electric motor (With arrangement for de-interlocking) shall be provided.

- (a) Cane cutter, cane leveller, fibriizer/ shredder, cane carrier motors so that if any of the cane preparatory device trips, the cane carrier drive shall also trip.
- (b) Bagasse elevator, baggase carrier and return bagasse carrier motors.

(c) Sugar elevator with grass hopper.

(d) All self discharging batch type centrifugal machines to be interlocked such that not more than 2 machines accelerate simultaneously.

In addition to these MCC's, one pedestal mounted push button operating station (with ON-OFF push buttons) shall be provided near each squirrel cage motor. Also stop push buttons at the ground floor shall also be provided for bagasse elevator, and return bagasse carrier.

### vii) Auxiliary panels

Auxiliary Panel : The auxiliary panel shall be provided with following outgoing feeders.

- 1 No: 160 amp switch fuse unit for tube well No: 1
- 1 No: 160 amp switch fuse unit for tube well No: 2
- 1 No: 200 amp SF unit for colony supply
- 1 No: 200 amp SF unit for workshop supply
- 1 No: 160 amp SF unit for factory lighting
- 1 No: 160 amp SF unit for street lighting
- 1 No: 63 amp plug and socket
- 1 No: 200 amp switch fuse unit for lighting auxiliary buildings
- 2 Nos: 160 amp switch fuse units as spare

The auxiliary panel shall be with one incoming 1000 amps switch fuse unit. One 1000 amps. 4 pole changeover switch shall also be provided for auxiliary panel so that it can be fed either from the turbo set supply or from the State Electricity grid supply. Neutral bus bar shall also be provided in the auxiliary panel. Other construction details and fault level etc. of the auxiliary panel shall be the same as the main distribution panel. The auxiliary panel shall be located in the power house. One ammeter with selector switch, one voltmeter and 'ON' indicating lamps shall be provided in the incomer. Each outgoing feeder shall have an ammeter and 'ON' indication.

### viii) Electric motors

Electric Motors : All the electric motors up to 100 HP except ID Fan motors shall be squirrel cage TEFC enclosure induction motors. All motors above 100 HP shall be slipring SPDP enclosure induction motors. Motors for batch type centrifugal machines and Mill drives shall be D.C. and as per duty conditions specified.

All the electric motors shall be suitable for operation at 3 phase, 50 Hz, 415 volts, AC supply and shall conform to IS-325-1978 and IS-4722 specifications.

Motors for batch type centrifugal machines shall be suitable for S8 duty as per IS-4722 specifications and shall be designed for an ambient temperature of 50 deg.C and shall be fitted with ETDs in each phase for thermo-protection of motor windings.

Electric motors for cross travel and long travel of cane unloader and mill house cranes shall be slipring TEFC enclosure suitable for S4 duty as per IS-4722 specifications. The electric motors for hoisting/de-hoisting of cane unloader and mill house crane shall be squirrel cage TEFC enclosure suitable for S4 duty as per IS-4722 specifications.

### ix) **Electric cables (11 KV, 1.1 KV grade)**

Electric cables : All power, control and lighting electric cables for the entire electrical distribution system shall be supplied.

The power electric cables from the main distribution panel to each MCC and to auxiliary panel shall be suitable for the connected load at unity load factor excluding standby equipments. Suitable derating factor for the cables shall be considered as per the recommendations of cable manufacturers.

All power and lighting cables shall be PVC insulated, armoured, suitable for use at 1100 V and shall conform to IS-1554(part I) specifications. All the control cables shall be of copper conductor. The minimum cross sectional area per core shall be 4 mm<sup>2</sup> for aluminum conductor and 2.5 mm<sup>2</sup> for copper conductor for power cables and 1.5 sq.mm. copper conductors for control cables.

All the power & lighting cables shall be 3. 1/2 core. All other cables from MCC to motors shall be 3 core .

All the cables on the ground shall be laid in trenches on proper racks, suitably spaced and clamped to the racks.

All cable terminations shall be through crimping type cable lugs. Cable glands shall be provided at panels. Starters, motors, push button etc.

### x) **Power factor correcting capacitors**

Power Factor Correcting Capacitors : Suitable number and rating low loss power capacitors APP double layer type shall be supplied to improve the plant power factor to 0.90, at 2500 TCD crushing capacity. The power capacitors shall conform to IS-2834 specifications. About 800 KVAR capacitors shall be connected to main distribution panel thro APFC panel and the balance capacitors shall be connected to the motor control centres and across motors of rating 125 KW and above

800 KVARs (8X100KVAR) capacitors shall be connected to main distribution panel through auto power factor correction relay and capacitor switching shall be by contactors / thyristered switching. If thyristered switching is used capacitors shall be MPP type

### **xi) Main lighting distribution board & sub lighting distribution board**

One main lighting distribution board and about 12 numbers sub lighting distribution boards for the lighting system fitted with miniature circuit breakers for each circuit shall be provided. The main DB shall be located in the power house The sub-distribution boards shall be evenly spread in the factory area to be illuminated. Each sub-distribution board shall also be fitted with 3 nos. three-pin plug points. The main DB shall have SFU, ammeter with selector switch and voltmeter on incoming feeder, SFU/MCB , an ammeter for 14 nos. outgoing feeders. The wiring for complete lighting system shall be done with the help of PVC insulated and armored aluminum conductor cables run on walls, ceilings or underground trenches as required The lighting boards shall be sheet steel fabricated.

### **xii) Factory lighting**

Factory Lighting : The scope of work under this section shall be to provide illumination in main factory building, cane yard, spray pump house / cooling tower with additional two flood lights for illuminating spray pond only, injection water pump house, condenser house, cane preparation house and I.D.fan house. The average illumination levels shall be 50 lux in cane yard, 200 lux in power house and 150 lux in other areas. The lighting system shall be designed for use of fluorescent tubes in combination with HPSV ( sodium vapour ) / HPMV ( mercury vapour ) light fixtures.

However, GLS lamps shall be provided on each light glass for various equipments and at each centrifugal machine. All light fixtures and fittings ( except tubelight, bulb and sodium/mercury lamps ) shall be provided.

### **xiii) Plant earthing**

Earthing : Earthing of all electrical installations shall be done as per IS-3043 specifications and the Indian Electricity Act and its rules and approved by the Electricity Authority of the Government.

### **xiv) Diesel generating set for emergency power**

1 No.: 500 KW and 1 no. of 250 KW rating diesel sets with 0.8 power factor .

The diesel generating set shall be continuously rated comprising multiple cylinder diesel engine having necessary protections such as low lube oil pressure trip, high engine temperature trip, over speed trip etc. and shall be fitted with speed control

knob speedometer, hour meter battery charging meter, oil pressure and temperature gauges, radiator etc. The diesel engine shall be coupled with suitable alternator capable of developing continuously the rated power at 3 phase, 4 wire, 50 Hz at normal voltage of 420 VAC (Alternator to be suitable for voltage range of 400-440 VAC) and conforming to IS-4722 specifications. The alternator shall be fitted with minimum one ETD in each phase for thermo protection of the alternator windings. The alternator shall be designed for an ambient temperature of 45 deg. C. The alternator shall be self excited and self regulated.

The diesel set shall be complete with base frame, couplings, one M.S. fabricated, diesel service tank of 10 HL capacity, inter-connecting piping, D.C. storage battery and self starting mechanism for starting of engine.

One 2 mm thick for the back side and 1.6 mm thick for the other sides cold rolled sheet steel fabricated floor mounted, dust and vermin proof panel for the diesel set shall be provided. The panel shall be fitted with air circuit breakers overcurrent relay, earthfault relay, reverse power relay, over voltage relay, reed type frequency meter, neutral isolating switch, three phase 4 wire unbalanced energy meters, KW meter, 3 phase power factor meter, 3 nos. ampere meters, one no. voltmeter with selector switch, ON-OFF indicating lamps. The panel shall have neutral and phase bus bars of electric grade (EC-91E) aluminum and shall be designed to withstand symmetrical short circuit current of 35 KA (RMS) for one second. The panel shall be designed for an ambient temperature of 45 deg.C, the operating temperature of the bus bars shall not exceed 85 deg.C. All the meters shall be class 1.5 per cent accuracy and shall conform to IS-1248 specifications. All the meters shall be square type of 100 mm sq. with 90 per cent deflection Interconnecting electrical cables from the diesel set to the main distribution panel and to the auxiliary panel changeover switch shall be provided.

Necessary synchronising panel with double voltmeter, double frequency meter, selector switch, lamps & synchroscope etc. shall be provided.

**C) Export Power Equipments (export power to Grid)**

**i) 11 KV VCB panel with necessary metering and protections**

Specification same as VCB panel given above in 11 KV distribution system.

**ii) 11 KV/33, 66, 132 KV OLTC ONAN type transformer for power export**

Export power transformer shall be on load type changer type complete with AVR and automatic tap changer control with all necessaries metering and protection. Transformer general specification shall be same as above given for Distribution Transformer. Transformer shall have cable connection boxes on primary and secondary side.

- iii) **33, 66, 132 KV SF6 type outdoor breaker with necessary metering and protections**
- iv) Complete switchyard sub-station equipment comprising of outdoor type isolators with and without earth switch, lightning arrestors, CTS & PTS, Post insulators, miscellaneous items i.e. aluminium tubes, clamps, convector, marshelling box, control cables, transformer relay/metering panels on HV side (33, 66 or 132 KV side)

**Note: During the installation of export power equipment i.e. export power transformer and sub-station equipments local electrical authorities shall be consulted for finalisation of detailed specifications for matching the grid system.**

Critical equipments for Grid Paralleling and Power Distribution (for co-generation)

Two nos. step down transformers of 11 KV/420 V, adequate MVA capacity, ONAN cooled conforming to IS 2026, complete with accessories, vacuum circuit breaker, ACB , etc.

Interconnecting power and control cables between TG set, its vacuum circuit breaker panel and above transformers.

C) Power House Crane

One no. electrical operated over head travelling crane of 25 tons SWL capacity conforming to Class II of IS specifications complete with rails, gantry, etc., shall be supplied. The crane rail centers shall be to suit the powerhouse span.

**Note: Suitable number of bus coupler of rating equivalent to VCB panel and specification with the trunking shall be incorporated for satisfactory operation of sugar factory as well as for export of power.**

**(VII) MISCELLANEOUS**

**(a) Cane weighment**

Purchaser Scope

**(b) Reducing Valves** - Suitable for ultimate capacity.

The following shall be supplied along with the machinery items: -

(i) Two automatic steam reducing valve each to reduce pressure of 50000 kgs of steam per hour from 64-67 kg/cm<sup>2</sup> g. to 7-8 kg/cm<sup>2</sup> g. pressure with suitable automatic desuper-heating arrangement and regulating system to maintain a steady temperature of 175 deg. plus-minus 5 deg.C. of the reduced pressure steam. There shall be provision for adjusting the down steam pressure at any pre-set valve between 7 to 8 kg/cm<sup>2</sup> g the reduced de-superheated steam shall be connected to a receiver with two branches to supply 15,000 kgs.of steam per hour to centrifugals, sulphur burners, mills, clarification equipment and boiling house etc.

(ii) The second branch shall be provided with two automatic steam reducing valve to maintain a steady pressure of 1.0 - 1.5 kg/cm<sup>2</sup> g. in the receiver for exhaust steam from the prime movers by injecting steam upto 40000 kgs per hour, in each, after reducing pressure from 7-8 kg/cm<sup>2</sup> g. Suitable automatic de-superheating arrangement and relating system to be provided to maintain a steady temperature of 130 deg. C. plus-minus 5 deg.C. in the exhaust steam receiver by automatic de-superheating of the entire exhaust and make-up steam The de-superheated steam coming out of the exhaust steam receiver shall be dry.

There shall be provision for adjusting the pressure in exhaust steam receiver at any pre-set valve between 1.0 to 1.5 kg/cm<sup>2</sup> g.

(iii) Two pressure pumps with electric drive of suitable capacity (one standby) for injecting water in the specified reduced pressure steam lines through pneumatically operated control valves shall be provided for de-superheating.

(iv) All the reducing valves shall be provided with pneumatically operated pressure controllers designed to maintain steady pressure with down steam flow rate variation from 10% to 100% of the rated capacity. With overriding control system. One electric driven air compressor with receiver and piping shall be provided for operation of the reducing valves and de-superheaters.

One steam flow meter shall be provided in the high pressure side of the reducing valve system at (b)(i) above .

(vi) One steam pressure recorder capable of recording pressure upto 2.0 kg/cm<sup>2</sup> g. shall be provided in the exhaust steam line near the Evaporator station. A dial thermometer of 150 mm dia and 0-300 deg.C range shall also be provided in the exhaust line. One temperature recorder to record the temperature upto 300 deg.C shall be provided in the exhaust line near the Evaporator station.

(vii) Suitable bypass arrangements as per IBR for each automatic reducing valve to be provided for manual operation. Isolating valves shall be provided to isolate the automatic valve for repairs while working. Steam strainers at upstream side of each reducing valve shall also be provided.

**(c) Bagasse Handling Equipment**

Four bagasse bailing press each to handle 2.5 tonnes per hour of bagasse having 50% moisture and complete with 30 HP slipring induction motor etc. shall be provided.

**(d) Pipelines and Fittings**

All hot and cold water,, juice, syrup, magma, molasses, massecuite and bled vapours, live steam, reduced pressure and exhaust steam pipe lines shall be suitable for 5000 TCD and all headers shall be designed for ultimate capacity. Various pipelines shall be designed so that velocities given below are not exceeded at 5000 TCD.

- (i) Water and juice : Suction 1.0 m/second  
Delivery 1.2 m/second.
- (ii) Condensate : Suction 1.0 m/second  
Delivery 1.20 m/second
- (iii) Syrup : Suction 0.5 m/second  
Delivery 1.0 m/second.
- (iv) Molasses : Suction 0.3 m/second  
Delivery 0.5 m/second.
- (v) Massecuite/ Magma : Suction 0.1 m/second  
Delivery 0.15 m/second
- (vi) Superheated/ Saturated steam : 30 m/second  
Exhaust steam : 30 m/second  
Bled vapours : 30 m/second
- (vii) Compressed air/ SO2 : 20 m/second
- (viii) A maximum pressure drop of 2.0 kg/cm<sup>2</sup> g. shall be allowed from boiler outlet to the inlet of power turbine.
- (ix) All pipelines, valves etc. shall be designed for 5000 TCD and not for ultimate capacity.

Safety valves to be provided in the steam pipe lines wherever necessary. Blow off pipes shall extend beyond the roof/factory buildings safety valves in the exhaust and reduced pressure lines shall be lever operated. Suitable drains, valves, steam traps etc. shall be provided in all steam lines, where necessary. High pressure steam manifold of 500 mm shall be provided for ultimate capacity

The pipes shall conform to specifications given below :



(i) Cast Iron Pipes and Fittings :

The pipes shall be class 'B' and shall conform to IS:1537-1976 specifications and integrally cast flanged joints or spun pipes with screwed ends on flanges as per IS:1536-1976 shall be used.

The pipe fittings shall be class 'B' and shall conform to IS:1538 (part I to XXIII) - 1976 specifications. Only flanged joints shall be used. One side of the flanges shall be machined in case all pipe fittings.

(ii) Mild Steel Pipes

All mild steel pipes and pipe fittings used for conveying of air, cold water, to water (except boiler feed water) oil (except oil for hydraulic accumulators), molasses, massecuite, juice, lime, syrup, noxious gases etc. shall conform to IS:1239(part I)-1976 and IS:1239 (part II)-1982 specifications. All juice and syrup piping including imbibition juice piping shall be class 'C' (heavy) and rest of the piping shall be class 'B' (medium). The thickness of mild steel pipes having diameter more than 200 mm shall be 8 mm.

In case of all piping above 25 mm NB only flanged joints shall be used. All flanges to be as per IS:6392-1971.

(iii) Live steam, exhaust steam and boiler feed water piping:

These shall conform to I.B.R. wherever applicable. The thickness of exhaust and vapour steam piping shall be minimum 8 mm in case of 300 mm dia. and above.

The distance between two flanges in straight portion of pipes shall not exceed 6 metres except steam, vapour feed water pipe. In case of bends, flanges shall be provided atleast at one end. All steam expansion bellows shall be of stainless steel tested at 1.5 times the exhaust steam pressure.

Valves shall be provided in each branch line of juice heater,, reduced pressure steam lines, water separator, drain, steam trap etc.

All delivery lines of juice, water and syrup of centrifugal pumps shall have non-return valves except in case of unstrained imbibition juice pump,lime and Mud pumps, Water connections to be provided at each station for cleaning.

All exhaust steam valves for evaporator and pans shall be rightangle valves.

All bearing and oil cooling water to be collected in a masonry tank which shall not be more than 10 metres away from the factory building.

## (e) Supporting steel structure

(i) Factory shall be gravity flow type.

(ii) Necessary staging for all the machinery including supporting columns, integral floor structure, staircases, railings etc. shall be provided. Mills, mill drive, turbo generator, clarifier and lime slaker shall be on R.C.C. staging. Sulphur furnaces shall be on steel staging with R.C.C. flooring. Other machinery except those on floor level shall have its own supporting steel staging.

Pipelines, mill and power house cranes, condensers, flash tanks, cyclone separators can be supported on building columns. No weight of other machinery or platform shall be transmitted to building columns. Mills to have mild steel chequered or perforated or grating flooring. Centrifugals to have chequered plate floor. In the boiling house chequered plate flooring shall be provided. All gangways, passages, staircases, working platform and railings shall be convenient. Chequered thickness shall be minimum 5mm.

Staging for additional evaporators to be installed for 7500 TCD shall be provided in the expansion stage. However, space is to be left at the initial stage with inter connecting platform. End columns of pan staging to be similar to intermediate columns to take load of pans to be added.

A clear working platform of atleast 2.0 m. width shall be provided in working front of pans and evaporator bodies. Moving space between pans shall be 1000 mm and in evaporator bodies a distance of 750 mm shall be provided. In case of other units a clear working platform of atleast 1.2 m. width to be provided.

All statutory requirement regarding staging platform staircases, safety devices etc. shall be observed at the design stage.

## (f) General Material Specifications

i) Gun metal used for bushes and bearings shall conform to IS : 318-1965.

ii) White metal used for lining of bearings shall conform to IS : 25-1966.

iii) Phosphor bronze castings shall conform to IS: 28-1975.

iv) The mill drive pinions shall be made of cast steel as per IS:2708-1973 B Grade III and gear wheels as per IS:2708-1973 Grade II.

v) Cast iron flexible couplings shall conform to IS:2693-1964.

vi) Glass wool for vessels and piping shall conform to IS:3690-1974 type 2. Mineral wool shall conform to IS:5696-1970. The thickness shall be to suit the temperature and diameter of pipe.

vii) Sheet rubber shall conform to type 8 of IS:638-1965. Grades to suit the nature of work.

- viii) Compressed asbestos fibre shall conform to IS:2712-1971.
- ix) Cast iron sluice valves shall conform to IS:780-1969.
- x) Gun metal valves (not used for live steam) shall be heavy duty and shall conform to IS:778-1971.
- xi) Plummer blocks used for roller bearings shall conform to IS:4773-1968.
- xii) The slide rails for electric motors, if of grey cast iron conform to grade 15 of IS:210-1962. The slide rails shall be as per IS:2968-1964.
- xiii) Stirrer shaft for crystallizers, pugmills, magma mixer, lime tanks, sugar melter, juice sulphiter, molasses dilution tank etc. shall conform to 30 C8 of IS:1570-1979 or equivalent, except when mild steel fabricated pipes are used.
- xiv) Mild steel plates shall conform to IS:2062-1969 in case of fabricated headstocks, side caps, mill bearings, gear beds, for mill drive and all fabricated parts subjected to steam pressure higher than 1.5 kg/cm<sup>2</sup>.
- xv) Structural steel and mild steel plates conforming to IS:226-1975 or equivalent shall be used for the fabrication of rest of the machinery and equipment.
- xvi) All brass tubes shall be of 70 : 30 alloy conforming to alloy Number 1 of IS:407-1966.

### **(g) General**

The Plant and Machinery is to be according to the guide line specifications for 5000 TCD Plant expandable to 7500 TCD finalized by the Government of India and should incorporate the following:

- 1) In designing factory building and engineering layout criterion should be attached to local wind direction to ensure the following. General layout of plant and machinery shall show equipment for ultimate capacity.
  - 1) Effective natural ventilation of Power House.
  - 2) Non contamination of circulating waters by acidic agents.
  - 3) Statutory requirements of pollution preventions.
- 2) The factory floor levels as well as injection channels and spray pond levels shall be decided to suit the topography at the Sugar Plant site.
- 3) Eves height of bagging house to be 18 m to facilitate Sugar bins installation in future.
- 4) Plant and machinery to confirm to all State and Central laws.

- 5) All the cranes in the Sugar Plant (including cane unloader) should have box type bridge girders (and not lattice type). All the gear boxes installed on the cranes should be helical type having hardened and ground teeth.
- 6) The O&M manuals, drawings, specifications etc. should be supplied by the Seller to the Purchaser 4 months before the scheduled date of commissioning of the Sugar Plant and should also include the following:
  - i) List of Ball/Roller bearings fitted in the Sugar Plant (equipmentwise stating bearing Nos.)
  - ii) List of all electric motors installed in the Sugar Plant (equipmentwise stating motor type, H.P., RPM etc.).
  - iii) List of all Reduction gear boxes installed in the Sugar Plant (equipmentwise stating gear box type, ratio, H.P., rating, service factor etc.)
  - iv) List of pumps installed in the Sugar Plant (pump type, duty, discharge, total head etc.)
  - v) List of all coupling bushes, oil seals etc. fitted in the Sugar Plant (stating sizewise qty and equipment name where the part is fitted).
- 7) The Sellers shall not make the use of building columns and trusses for lifting weights of machinery during erection. Factory building structure should not be used as stanchion for any items of machinery and equipment (except mill and power house cranes & piping).
- 8) All the Grit catchers in the Sugar Plant should be 800 mm dia x 1000 mm height – shell 8 mm thick, bottom 10 mm thick, cover plates 20 mm thick. Covers should be hinged and cover holding bolts should be 25 mm dia. The bucket screens should be made of 3 mm thick. AISI 304 quality S.S. and should have sturdy handles for lifting.
- 9) Condensate outlet pipes from various units to have sight glasses at eye level in addition to sight glasses in extracting columns. Test cocks should also be provided for taking out condensate samples.
- 10) Test cocks should be provided in condensate outlets of all units individually for testing water for sugar traces. All the condensate pumps delivery lines should have 50 mm NB connection with a valve to let out the water in the drain, as and when sugar traces are found in the condensate.
- 11) Size of Condensate Receivers for Juice heaters and Evaporators should be 400 mm dia x 1200 mm height – Shell 8 mm thick, bottom 10 mm thick.
- 12) The RPM of the motor of the condensate extraction pumps should not be more than 1500.

- 13) Heating surfaces of juice heaters evaporator bodies, pans and boilers shall be calculated on the basis of mean diam and effective tube length with contact of heating fluid.
- 14) All the pumps of juice, lime and syrup should be provided with suitable catchers in the suction side. Also, juice delivery lines should be provided with non-return valves.
- 15) All the centrifugal pumps should have stop and non-return valves in the delivery pipes.
- 16) Centrifugal pumps: The service water pumps, injection and spray water pumps, syrup pumps, melt pumps should be bronze fitted. Otherwise these and other (except at mill house) centrifugal pumps should conform to IS-5659 and IS-5120 specifications.
- 17) All the vapour line of the pans and 4<sup>th</sup> body of the evaporators should be provided with a manhole to enable accessibility inside the vapour lines for cleaning and painting purposes. One 100 mm dia x 150 mm long nipple should be welded in the vapour pipe along with a blind flange to enable water filling of the vapour line.
- 18) The diameter of the pipes for filling water into bodies and calandrias of evaporator and pans should not be less than 100 mm size.
- 19) All the valves for massecuite and magma lines should be of rising spindle type only.
- 20) All massecuite, magma and molasses lines at crystalliser and centrifugal stations should be provided with 20 mm size steaming arrangements along with non-return valves.
- 21) The sluice/right angle valves used in exhaust steam and vapour pipelines should have stainless steel internals and S.S. spindles.
- 22) Suitable capacity steam traps should be provided in the exhaust line for the outlet of the condensate.
- 23) Steam flow meter of indicating, integrating and recording type shall be provided for PRDS.
- 24) Temperature recorders for raw, sulphited juice, evaporator exhaust steam, injection outlet/inlet water and vacuum recorder for last body of evaporator shall be provided at appropriate place.
- 25) For lagging the equipments, pipes and fittings etc. of the sugar plant as per specifications the Sellers scope of supply should be as follows:

All the equipments and pipelines (including fittings as defined under Clause 6 of IS:7413 specifications), surfaces in the sugar plant above 55 deg. C. temperature should be effectively lagged (except where heat dissipation is desirable and the surfaces which become hot intermittently such as steam traps and relief valve outlet pipes, vents, blow-down pipes etc.)

Material to be used:

- i) For lagging: Factory made mattresses of Bonded Glass wool/Rock wool/Mineral wool as per IS:8183 – (latest issue) specifications. The bulk density of the material should be:
- 50 kg/m<sup>3</sup> for hot surface temperatures upto 250 deg. C.
- a) 120 kg/m<sup>3</sup> for hot surface temperatures above 250 deg. C. but upto 550 deg. C.
- (as per clause 3.2 of IS:8183 – (latest issue) specifications)
- The thickness of the lagging should be such that the difference between temperature measured (at any time during the maintenance warranty period as per clause 22 of the draft agreement) at any point on the outer surface of the lagging cladding (i.e. protective finish) and the ambient temperature at that time should not exceed 10 deg. C.
- ii) For protective finish:
- Material for cladding of all lagging in the sugar plant should be cotton canvas (as per IS:7413 standard specifications) (except as follows).
- a) The valves and flanges (including the flanges of the equipment) to be lagged shall be provided with openable lagging boxes for valves and fittings of the HP steam lines (including boiler plant) openable boxes shall be out of 18 SWG thick aluminium sheets as per IS:737 designation 31000 condition H3.
- b) All the turbines lagging should be provided with boxes of 3 mm thick Aluminium sheets. Lifting block should be provided for these boxes.
- iii) Balance materials (not specified above) should be as per IS:7413 specifications.
- Application and finishing of the lagging materials, protective coverings etc. should be carried out by the Seller as per IS:7413 (latest issue) specifications.
- 26) All maintenance tools, tube expanders etc. to be supplied by the Seller to the Purchaser as per scope of supply stipulated under this Agreement should be brand new and should not be those used by the Seller for erection and commissioning of the Sugar Plant.
- 27) All nuts and bolts and non-return valves should be as per ISI specifications.
- 28) In cases tensile strength or solidily has been mentioned the supplier shall submit a suitable certificate of the same from original manufacturer/Govt. approved testing laboratories/Govt. Engineering Colleges.

29) Suitable arrangements shall be provided for continuous sampling of following

Primary juice

- a) Last mill juice
- b) Mixed juice
- c) Clear juice
- d) Sulphited syrup

### OPTIONAL

**Four Nos. Variable voltage variable frequency inverter A.C. Drives through inverter. (applicable for 11KV TG set supply)**

Each mill shall be driven by continuously rated 750 KW A.C. squirrel cage, 3-phase induction motor having synchronous base speed of 1000 rpm. The motor shall be suitable for variable speed application through thyristor controlled variable frequency, variable voltage (v.v.v.F) drive.

Detail specifications of motor shall be as below :

Rating (continuous) -750 KW synch. speed 1000 rpm, 3-phasesquirrel cage induction motor equivalent of DC drive for class V duty.

Main supply	-	3-phase, 11 KV, 50Hz
Protection	-	IP 54
Ventilation	-	TEFC / CACA
Variable speed range	-	20% to 110% of base speed
Constant torque operation	-	between 20% to 100% of base speed
Max. speed	-	110% of base speed
Direction of rotation	-	bidirection
Mounting	-	horizontal foot mounting
Class of Insulation	-	F

Temp. rise limited to class B

Ambient Temp. - 50 degree C

### **Four variable voltage variable frequency (V V V F) drive unit (inverter)**

Inverter cubicles shall be fabricated from 14 SWG cold rolled steel sheets, free standing, passivated, and painted with anti-corrosive paints.

The cubicle shall house all switch gear protections, controls, thyristors, regulating modules, interlocking relays, filters etc.

All necessary meters indications, annunciations, controls etc. shall be neatly arranged on cubicle front door with neoprene gaskets on all edges of panel. Ventilation openings shall be provided at the top of panel and on side covers by louvres suitably covered by fine wire mesh.

Inverter shall be suitable to vary the speed of the 750 KW, sq. cage induction motor in the range of 20% to 110% of base speed by varying voltage and frequency. Inverter shall have provision to adjust v/f curve as per requirement i.e. linear, squared, programmable. Inverter shall be PWM type.

Drive shall provide bidirection operation.

Speed regulation will be  $\pm 1\%$  of base speed at base speed by tacho feedback. The panel will have facility to accept 4 to 20 mA signal for speed setting in auto mode.

The pressure ventilation system with electric motor driven blower with filter shall be provided for panels.

One common control desk with controls shall be provided for each motor to be controlled from this common desk.

The thyristor panels to be installed in AC room to be provided by the Purchaser.

**NOTE** : Alternatively, suitable Hy. drives can also be considered.

### **One No. Variable Speed inverter A.C. Drive**

The mill shall be driven by continuously rated 1000 KW A.C. squirrel cage, 3-phase induction motor having synchronous base speed of 1000 rpm. The motor shall be suitable for variable speed application through thyristor controlled variable voltage, variable frequency (V V V F) drive.



Detail specifications of motor shall be as below :

Rating (continuous)	-	1000 KW synch. speed 1000 rpm, 3-phase  squirrel cage induction motor
Main supply	-	3-phase, 415v, 50c/s
Protection	-	IP 54
Ventilation	-	TEFC / CACA
Variable speed range	-	20% to 110% of base speed
Constant torque operation	-	between 20% to 100% of base speed
Max. speed	-	110% of base speed
Direction of rotation	-	bidirectional
Mounting	-	horizontal foot mounting
Class of Insulation	-	F Temp. rise limited to class B
Ambient Temp.	-	45 degree C

**ONE inverter Controlled variable voltage variable frequency (V V V F) drive unit (inverter)**

Inverter cubicals shall be fabricated from 14 SWG cold rolled steel sheets, free standing, passivated, and painted with anti-corrosive paints.

The cubicle shall house all switch gear protections, controls, thyristors, regulating modules, interlocking relays, filters etc.

All necessary meter indications, annunciations, controls etc. shall be neatly arranged on cubicle front door with neoprene gaskets on all edges of panel. Ventilation openings shall be provided at the top of panel and on side covers by louvres suitably covered by fine wire mesh.

Inverter shall be suitable to vary the speed of the 1000 HP, sq. cage induction motor in the range of 20% to 110% of base speed by varying voltage and frequency. Inverter shall have provision to adjust v/f curve as per requirement i.e. linear, squared, programmable. Inverter shall be PWM type.

Drive shall provide bidirection operation.

Speed regulation will be  $\pm 1\%$  of base speed at base speed by tacho feedback.  
The panel will have facility to accept 4 to 20 mA signal for speed setting in auto mode.

The pressure ventilation system with electric motor driven blower with filter shall be provided for panels.

One common control desk with controls shall be provided for each motor to be controlled from this common desk.

The thyristor panels to be installed in AC room to be provided by the Purchaser.

## PERFORMANCE PARAMETERS OF SUGAR PLANTS FOR 5000TCD EXPANDABLE UPTO 7500TCD

### 1. MILLING PLANT

i) The preparation index of prepared cane shall be 85 plus. The preparation index shall be determined by Aldrich / Rayner CCR Australian method.

ii) Whole Reduced Extraction (Mittal) shall be 95% plus at 220% imbibition on fibre.

iii) The specific steam consumption of the turbo feed pump should be as mentioned in the specification.

### 2. CLARIFICATION PLANT

#### Juice heaters:

Following temperature should be obtained:

i) Raw juice shall be heated from 20 deg. C to 70 deg. C by vapours bled from 3<sup>rd</sup> body of quadruple effect evaporator.

ii) Sulphited juice shall be heated from 65 deg. C to 103 deg. C by vapours bled from 2<sup>nd</sup> (B) and 1<sup>st</sup> body of quadruple effect evaporator.

iii) Clear juice shall be heated to 115 deg. C by available exhaust steam.

iv) Milk of Lime preparation, Juice Sulphiter and Clarifier -The clear juice obtained from clarifier should be free from suspended mud particles and thick mud should be obtained. In a sample of one litre muddy juice drawn from the clarifier, minimum 50 grams of dry insoluble solid should be obtained.

v) Vacuum Filter – Vacuum filter efficiency (mud solids retention) should not be less than 75% based on the average of 6 samples taken under regular working conditions. The bagacillo should be available at the rate of 9Kgs per tonne of cane per hour, pol % filter cake should not be more than 1.5 at wash water of 100% on cake.

### 3. EVAPORATION AND BOILING PLANT

#### (a) Evaporator

- (i) Minimum vacuum at the last body of evaporator shall be 635 mm at mean sea level.
- (ii) The evaporator set should be able to give up to 80% evaporation.

**(b) Syrup Sulphiter**

The syrup sulphiter should be capable of sulphiting the syrup to 5.0 pH.

**(c) Vacuum Pan**

- (i) Minimum vacuum at the pan body shall be 635 mm at mean sea level.
- (ii) Total cycle time (full strike level) should not be more than the following:

A massecuite pan	-	2.5 hours
B massecuite pan	-	4.0 hours
C massecuite pan	-	8.0 hours after footing and C – massecuite brix 101 deg.

**(d) Condensers**

- (i) Minimum vacuum in the body of the condenser shall be 650 mm.
- (ii) The difference of temperature between vapours to be condensed and tail pipe water temperature shall be less than 10 deg. C.

**(e) Spray Ponds**

Minimum drop of 13 deg. C or within 7 deg. C of wet bulb temperature, whichever is less should be achieved for injection water cooling.

**(f) Cooling Tower**

Minimum drop of 20 deg. C or within 5 deg. C shall be achieved during season.

#### 4. COOLING, CURING, GRADING

**(a) Crystallisers**

- (i) Minimum purity drop in C – crystallisers should be 4 units reckoned from C – pan dropping massecuite to overflow of C – continuous crystallisers.

- (ii) B – massecuite should be cooled from 65 deg. C to 50 deg. C in 8 hours when supplied with cooling water at 30 deg. C.
- (iii) C – massecuite should be cooled from 65 deg. C to 40 deg. C in 15 hours when supplied with cooling water at 30 deg. C.

**(b) Rapid Reheating Equipment:**

The cooled C – massecuite shall be reheated rapidly from 40 deg. C to 50 deg. C and the final temperature should not exceed more than 52 deg. C.

**(c) Continuous Centrifugal Machines:**

The guaranteed capacity of continuous centrifugal machines shall be linked to the following:

- (i) B – massecuite brix 94-96, purity not exceeding 67.0
- (ii) C – massecuite brix 100-102, purity not exceeding 55.0

**Performance Parameters to be obtained from Centrifugal machine:**

- (i) Purity of single cured C – sugar shall not be less than 80.
- (ii) Purity of double cured C – sugar shall not be less than 92
- (iii) Purity increase between Nutsch molasses purity ( C – massecuite fed to C – fore workers) and final molasses purity from C – fore worker machines shall not be more than 1.5.
- (iv) Purity of B – single cured sugar shall not be less than 95.0.
- (v) Capacity of A batch machines shall be judged for average cycles during continuous four hours working and for continuous machines for four hours continuous working for successive 7 days respectively.
- (vi) Exhaustion of massecuite shall be minimum 60 per cent.

**(d) Sugar Melter**

The brix of the melt should not be less than 55 deg. And melt should be free from sugar crystals.

**(e) Grass Hopper**

The temperature of the sugar at the end of the last hopper should not be more than 42 deg. C and moisture should not be more than 0.03% when the ambient temperature is below 36°C.

**(f) Reduced Boiling House Recovery**

The reduced boiling house recovery shall not be less than 90% by Gundu Rao formula.

**5. STEAM GENERATION PLANT**

- i) CO<sub>2</sub> in the flue gas should not be less than 14.5% measured after waste heat recovery units (corresponding to 35% excess air) with unburnt gases not exceeding 0.1%.
- ii) The flue gas temperature shall not be more than 160 deg. C. Measured after waste heat recovery units.
- iii) Peak generation shall be 110% MCR FOR HALF AN HOUR.
- iv) Efficiency of the steam generation plant shall be minimum 70% on G.C.V. of bagasse having 50% moisture and determined as per IS 13980-1995 code. For every reduction in moisture% bagasse of 1% there shall be rise of 0.5% in boiler efficiency.

**6. POWER GENERATION PLANT**

- i) Specific steam consumption of the turbine shall not exceed 6.25 kg/KW/hr for the conditions given in specifications.
- ii) The power factor of the electrical system shall not be less than 0.9.
- iii) The performance of all electrical equipments shall be as per existing IS codes.

At the time of factory performance trials, the factory management should, besides giving assistance as per agreement, also arrange adequate supply of clean cane conforming to the following specifications so that the trial operations are completed smoothly:

- Fibre % cane : Not more than 16
- Pol % cane : Not less than 12
- Mixed Juice Purity : Not less than 80

NOTE: Performance trial to be carried during the period of January to March.

## ANNEXURE - II

### INSTRUMENTATION AND AUTOMATION

#### Statutory Requirements

##### 1. Online Mass Flow meters:

- i. Depending upon the plant conditions like size, flow rate, specific gravity, viscosity, vendor shall furnish detail sizing calculations showing mass flow rate accuracy, pressure drop, velocities at 10 operating steps.
- ii. Weights and measures certification and stamping from local Weights and Measures authority of India shall be provided.
- iii. Manufacturer shall have facility in India for wet calibration of mass flow meter in the flow laboratory as per NIST standards.

##### 2. Automatic pH Control for Juice/Syrup Sulphitation :

Well designed and fabricated sampling system for cooling the juice at 40°C for effective online pH measurement.

##### 3. Online Brix Indicators

- i) Brix measurement shall be independent of changes in the other process parameters like pressure, temperature additives etc.
- ii) Instrument shall be fully configured, operated and maintained using operators' interface. It shall have large backlit digital display, soft push buttons and easy to operate menu driven screen.

##### 4. Online Conductivity Measurement of condensate water

- i) To ensure the computability the sensor and transmitter shall be of same make.
- ii) Well-designed and fabricated sampling system for each line shall be provided.

##### 5. Instrumentation Panel

All the panel mounted instruments which are integral part of the following control and measurement systems shall be housed in a well designed, fabricated and wired instrumentation panel.

- i) Auto Cane Feed Control System
- ii) Automatic Imbibition Water Flow and Temperature Control System
- iii) Online Mass Flow Meter for juice and water
- iv) Automatic pH Control System for Juice Sulphitation
- v) Online Brix Indicators

- vi) Automatic pH Control System for Syrup Sulphitation
- vii) Automatic Brix and Temperature Control of Molasses Conditioner & melter
- viii) Online conductivity measurement of condensate water
- ix) Automatic massecuite level control in pug mill
- x) Boiler Instrumentation and Automation
- xi) Turbine supervisory system
- xii) Massecuite feed control for continuous centrifugal machine.

## 6. Microprocessor based Datalogger

For recording various process parameters like pressure, temperature, flow level etc. at various equipments in the boiling house two numbers  $\mu$ p based 32 channels data loggers specifications with 80 column dot matrix printer/132 column dot matrix printer/inkjet printer having following specifications shall be provided : one at evaporator floor and the other at pan floor.

<b>Specifications</b>	:	
1. Input	:	Universal
		a) Thermocouple as per DIN 43710 (other than standard on request) (J,K,E,R,S,T,N,B grounded or ungrounded) Input resistance $\geq 1\text{ M}\Omega$
		b) RTD PT - 100 as per DIN 43760 (Excitation current $\leq 2.5\text{ mA}$ )
		c) Electrical signal (0/4-20 mA, 0/1-5 V.DC) Input resistance $\leq 250\ \Omega$ for current input Input resistance $\geq 500\text{ K}\Omega$ for voltage i/p
2. Display & Internal Scan Time	:	a) 3 ½ digit, ½", 7 segment LED display for process variable. 2 digits, ½", 7 segment LED display for channel no.
		b) 16 x 2/20 x 2 backlit LCD
		c) 50 m sec. per channel
3. Range & Accuracy	:	Keyboard configurable for each channel separately with reading accuracy of $\pm 0.25\%$ of F.S.
4. Alarms Facilities	:	2 settings (HI & LO) per channel over entire range, alarm output (NC/NO), programmable alarm acknowledgement & alarm status (bicolor LEDs) for each channel shall be provided.
5. Broken Sensor	:	Indicated by displaying error message on display



- |     |                       |   |  |
|-----|-----------------------|---|--|
| 6.  | C.M.R.R.              | : | 120 db   |
| 7.  | Memory                | : | It shall be possible to retain the user interaction memory for more than six months in case of power failure   |
| 8.  | Operating Temperature | : | 0 to 50°C with maximum $\pm 0.015\%$ /°C drift   |
| 9.  | Mains supply          | : | a) 230 V AC, $\pm 10\%$ , 50 Hz, single phase (Standard)<br>b) 110 V AC, $\pm 10\%$ , 50 Hz, single phase (Optional)   |
| 10. | Communication: Port   |   | a) RS 232 or RS 485 with Modbus RTU protocol for PC communication<br>b) Centronic parallel port for printer (log & print interval shall be user configurable with different print options) |

### 7. Documentation

The following documents shall be sent to the Purchasers' Consultant for approval.

- i) Instrumentation hookup diagram.
- ii) P & I diagram.
- iii) Specification of instruments i.e. Range, make etc.
- iv) Orifice plate design calculation data sheet as per BS 1042 for flow meters.
- v) Control valve sizing and Cv calculations.
- vi) Instrument control panel cutout, foundation and panel wiring drawing.
- vii) List and specification of erection material.

\*Impulse tubing shall be of SS316/304 15 NB sch 40 pipewith SS isolating and drain valves.

\*Instrument cables from field transmitters to panel shall be 1.5 mm x 2 core Cu conductor armoured cable.

The following documents shall be submitted in triplicate along with instruments to the end user :

- i) Erection drawing and instrumentation calibration and test reports.
- ii) Operation and servicing manuals.

### 8. Central data acquisition system

It shall be possible to connect all the data loggers to the centralised PC based data acquisition system

## 9. Instrumentation Control Rooms

To achieve the desired working performance of various instrumentation measurement and control system even under extreme conditions like shock, vibrations, humidity, electrical interference installation of instrumentation panel shall be done in well designed and constructed rooms as per the standard instrumentation practices.