DETAILED PROJECT REPORT
ON
VARIABLE FREQUENCY DRIVE
FOR JET MACHINE PUMP
(SURAT TEXTILE CLUSTER)

ENERGY IS LIFE
BEE
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Bureau of Energy Efficiency

Prepared By

ZenithEnergy
Horizons Beyond Energy

Reviewed By

ISTSL

VFD FOR JET MACHINE PUMP
(10 HP)

SURAT TEXTILE CLUSTER

BEE, 2010

Detailed Project Report on VFD for Jet Machine Pump (10 HP)

Textile SME Cluster, Surat, Gujrat (India)

New Delhi: Bureau of Energy Efficiency;

Detail Project Report No.: ***SRT/TXT/VFD/13***

For more information

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Zenith Energy Services Pvt. Ltd. is also thankful to "Shri Mahesh Malpani, Chairman, PEPL and Surat Textile Manufacturers Association" for their valuable inputs, co-operation, support and identification of the units for energy use and technology audit studies and facilitating the implementation of BEE SME program in Surat Textile Cluster.

We take this opportunity to express our appreciation for the excellent support provided by Textile Unit Owners, Local Service Providers, and Equipment Suppliers for their active involvement and their valuable inputs in making the program successful and in completion of the Detailed Project Report (DPR).

ZESPL is also thankful to all the SME owners, plant in charges and all workers of the SME units for their support during the energy use and technology audit studies and in implementation of the project objectives.

Zenith Energy Services Pvt. Ltd.

Hyderabad

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LIST OF ABBREVATIONS

BEE	Bureau of Energy Efficiency
DPR	Detailed Project Report
DSCR	Debt Service Coverage Ratio
FD	Forced Draft
GHG	Green House Gases
HP	Horse Power
IBR	Indian Boiler Regulation
IRR	Internal Rate of Return
ID	Induced Draft
MoP	Ministry of Power
NPV	Net Present Value
ROI	Return on Investment
SME	Small and Medium Enterprises
VFD	Variable Frequency Drive
NG	Natural Gas
MoMSME	Ministry of Micro Small and Medium Enterprises

EXECUTIVE SUMMARY

Zenith Energy Services Pvt. Ltd is executing BEE - SME program in Surat textile cluster, supported by Bureau of Energy Efficiency with an overall objective of improving the energy efficiency in cluster units.

Surat is renowned for the synthetic Sarees and dress materials and there are about 450 above industries in the cluster. The major fuels used in the cluster units are Imported Coal, Lignite, Natural gas and Biomass (Groundnut husk briquettes and Wood). Lignite and imported coal are used in boilers for steam generation. Natural gas is used in Stenter NG based generators. The cost of energy as a percentage of manufacturing cost varies anywhere between 12 to 15%, which includes electrical as well as thermal energy cost.

Pumps are major electricity consuming equipments in Surat Textile industries and installed for Jet machine circulation pumps, drum machines, water pumps etc. As per the detailed energy audits conducted about 40% of the pumps installed are throttled or more flow is circulated, though not required and hence leading to wasteful of energy.

This DPR is prepared on installation of variable frequency drives for Jet machine pumps (10 hp) which will reduces electricity consumption by 34,860 kWh per annum for a set of 5 jet machines.

This bankable DPR also found eligible for subsidy scheme of MoMSME for “Technology and Quality Upgradation Support to Micro, Small and Medium Enterprises” under “National Manufacturing and Competitiveness Programme”. The key indicators of the DPR including the Project cost, debt equity ratio, monetary benefit and other necessary parameters are given in table:

S.No	*Parameter*	*Unit*	*Value*
1	Project cost	₹ in lakh	1.62
2	Electricity saving	kWh	34860
3	Debit equity ratio	ratio	3:1
4	Monetary benefit	₹ in lakh	1.95
5	Simple payback period	years	0.84
6	NPV	₹ in lakh	5.58
7	IRR	%age	92.93
8	ROI	%age	29.44
9	DSCR	ratio	4.84
10	Process down time during implementation	days	1

The projected profitability and financial indicators shows that the project will be able to earn profit from installation of VFD on Jet machine pump.

ABOUT BEE SME PROGRAMME

Bureau of Energy Efficiency (BEE) is implementing a BEE-SME Programme to improve the energy performance in 25 selected SMEs clusters. Surat Textile Cluster is one of them. The BEE's SME Programme intends to enhance the energy efficiency awareness by funding/subsidizing need based studies in SME clusters and giving energy conservation recommendations. For addressing the specific problems of these SMEs and enhancing energy efficiency in the clusters, BEE will be focusing on energy efficiency, energy conservation and technology up gradation through studies and pilot projects in these SMEs clusters.

Major activities in the BEE -SME program are furnished below:

Energy use and technology studies

The energy use technology studies would provide information on technology status, best operating practices, gaps in skills and knowledge on energy conservation opportunities, energy saving potential and new energy efficient technologies, etc for each of the sub sector in SMEs.

Capacity building of stake holders in cluster on energy efficiency

In most of the cases SME entrepreneurs are dependent on the locally available technologies, service providers for various reasons. To address this issue BEE has also undertaken capacity building of local service providers and entrepreneurs/ managers of SMEs on energy efficiency improvement in their units as well as clusters. The local service providers will be trained in order to be able to provide the local services in setting of energy efficiency projects in the clusters

Implementation of energy efficiency measures

To implement the technology up gradation projects in clusters, BEE has proposed to prepare the technology based detailed project reports (DPRs) for a minimum of five technologies in three capacities for each technology.

Facilitation of innovative financing mechanisms for implementation of energy efficiency projects

The objective of this activity is to facilitate the uptake of energy efficiency measures through innovative financing mechanisms without creating market distortion.

1 INTRODUCTION

1.1 Brief about the SME cluster

The products manufactured in Surat Textile Cluster are synthetic sarees and dress materials which are renowned in the country as well as abroad and have good domestic market. The main raw material used for the cluster units is grey cloth which is procured by local weaving units and agents. The cost of energy (electrical and thermal energy) varies between 12 and 15% of total manufacturing cost.

Majority of the cluster units are of integrated type, where the raw material "grey cloth" is processed in-house to the final product like sarees and dress materials. Most of the units of the cluster are working on Job basis, where the textile agents will provide design and grey cloth and the grey cloth is processed as per design provided by the clients. The energy cost is next to the raw materials cost**.**

Production process

The main process operation for dyeing and printing process of synthetic sarees and dress materials adopted in cluster units are as follows:

Fabric pre-treatment

The main purpose of the fabric pre-treatment process is to remove oil, grease and other materials and to whiten the grey cloth though bleaching. The various process adopted in pre-treatment are scouring, bleaching and shrinking process.

Dyeing

Dyeing is the process of imparting colors to the material through a dye (color). In which a dye is applied to the substrate in a uniform manner to obtain an even shade with a performance and fastness appropriate to its final use. This process is mainly performed in Jet Dyeing Machines and Jigger machines.

Dyeing of fabric is carried out in jet dyeing machines. The temperature of the solution is raised to 50℃. Concentrated dyestuff solution is prepared separately and is added to the liquor. After the addition of dyes, the temperature is raised to 130℃ and maintained for about 60 minutes.

After whitening/dyeing, the fabric is unloaded from the machine and taken to the folding and rolling machines for improving the width of cloth, which gets shrunk during the washing and dyeing process.

Printing

In Surat cluster three types printing methods are used. Most of the units are following the flat bed printing, rotary printing and some units follows hand printing. Hand printing is the old method to print the fabric. The flat bed printing has provision for printing 10 to 14 colors simultaneously. The color print paste prepared is fed onto the screens from which it is transferred to the fabric fed in. The fabric after print paste transfer is passed through a drying chamber at 145℃. The dried and printed fabric is taken for further processing.

Drying and Error! Hyperlink reference not valid.Finishing

After printing, the drying process is performed in loop machine, where the temperature is maintained between 130℃ to 170℃ for better color setting. After passing through the loop machines, the printed fabric is washed in a series of normal water and hot water washing in the presence of chemicals for color setting. After completion of the washing process, the printed and washed fabric is subjected to heat setting process in Stenter and then pressing and finishing treatments.

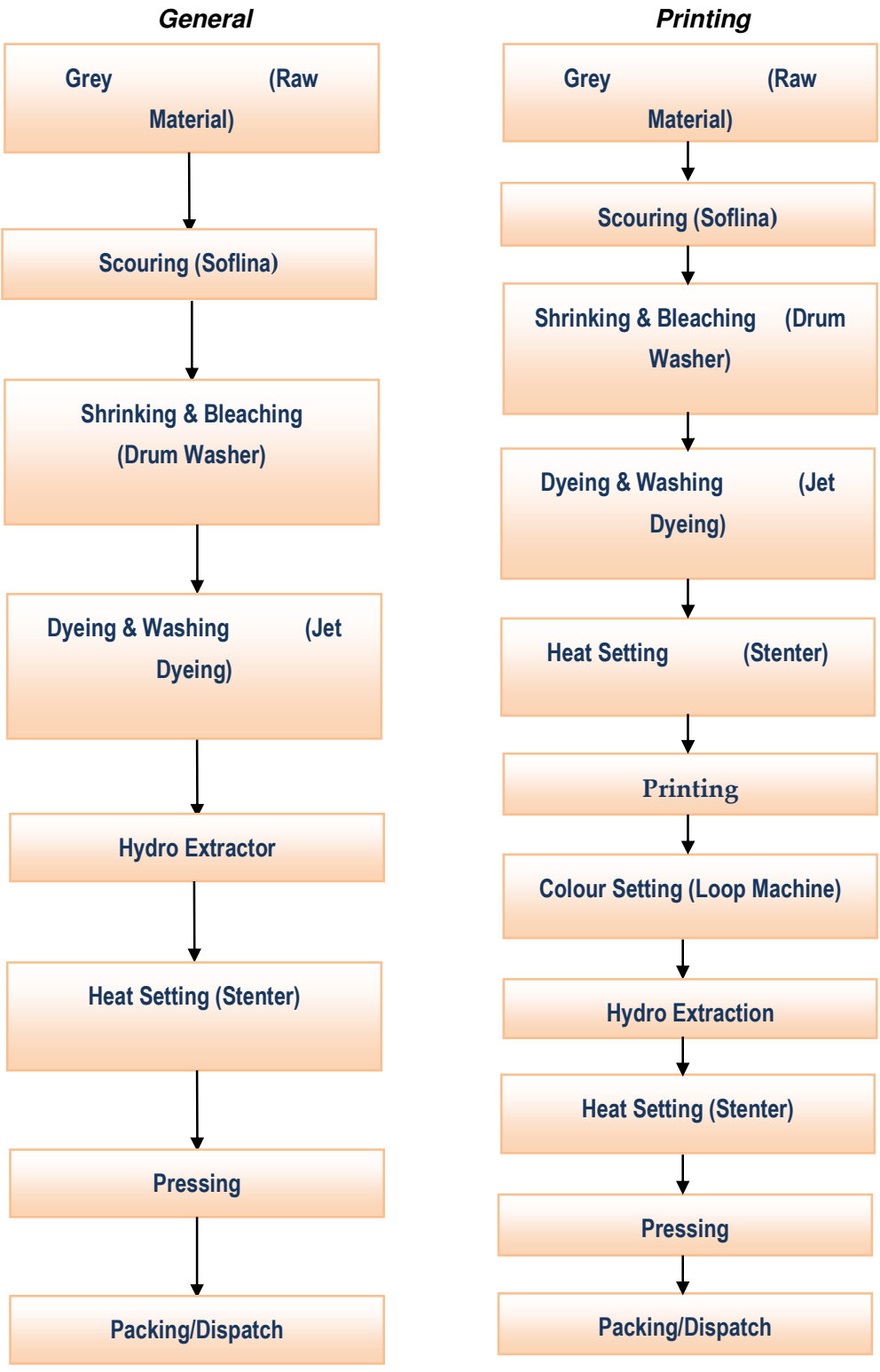


Figure 1: General process flowchart of a typical textile unit

1.2 Energy performance in existing situation

1.2.1 Fuel and electricity consumption of a typical unit

The main energy forms used in a typical unit in the cluster are electricity, coal/lignite and natural gas. Electricity is used for driving the prime movers of pumps, fans, stenter fans, ID and FD fans, conveyers, loop machines drives, lighting etc. Imported coal and lignite are used as fuel in boilers for steam generation whereas natural gas is used as fuel in electricity generation for stenter, printing and loop machines. The energy consumption of a typical unit in the cluster does not have VFD's and pumps are throttled and having about 10 Jet machines is furnished in Table 1.1 below:

Table 1.1 Energy consumption in a typical unit (Tulsi Syntex Pvt Ltd)

S.No	Details	Unit	Value
1	Coal/lignite consumption	tonne/year	4320
2	Grid electricity consumption	MWh/annum	1299
3	Production (quantity processed)	mts(In lakh)/year	70

1.2.2 Average production by a typical unit in the cluster

The average production in a typical unit is 70 lakh meter of final product per year.

1.3 Identification of technology/equipment to be upgraded / changed

1.3.1 Description of current technologies used

There are about 10 circulation pumps are connected to the Jet machine in a typical unit in the cluster and are operated by throttling of the valves operated at rated though it is not required leading to wasteful of energy. Technical details of existing Jet machine pump are furnished in Table 1.2 below:

Table 1.2 Technical details of existing Jet machine pump

S.No.	Particular	Unit	Value
1	No. of Pumps	Nos.	5
2	Temperature in jet dyeing machine	^{0}C	130
3	No. of Hours of Operation	hours	24
4	Capacity of the pump	kW	7.5
S.No.	Particular	Unit	Value

5	Discharge	cum/hr	50
6	Head of the pump	meters	25
7	Method of flow control	-	Throttling of valves

1.3.2 Its role in the whole process

The project activity is installation of VFD for Jet machine pumps and is additional equipment and is used for controlling the flow and avoiding throttling operation and operating at full load when not required.

1.4 Establishing the baseline

1.4.1 Design and operating parameters/fuel consumption

The present power consumption in a Jet machine water circulation pump is 5.5 kWh installed for 150 kg capacity Jet machine and connected with 10 HP motor. This Jet machine is operated for 24 hours in a day.

1.4.2 Electricity Consumption

The power consumption of various Jet machines of three cluster units and is operating parameters without VFD is furnished in Table 1.3 below:

Table 1.3 Electricity consumption in different unit

S. No	*Name of the unit*	*No. of Jet Machine pumps*	*Capacity (10 hp)*	*Power consumption (kWh/day)*
1	Tulsi Syntex Pvt. Ltd.	5	10	664
2	Rashmi Dyeing Mills Pvt. Ltd.	6	10	855
3	Shanti Praksh Dye & Ptg. Mills Pvt. Ltd.	5	10	635

1.5 Barriers for adoption of new and energy efficient technology/equipment

1.5.1 Technological Barriers

The major technical barriers that prevented the implementation of the energy efficient pump in the cluster are:

- Lack of awareness about VFD and its benefit
- Lack of awareness of the losses and monetary benefit of energy efficient pumps
- Dependence on local equipment suppliers, who doesn't have technical knowledge about VFD and its proper installation

1.5.2 Financial Barrier

- The lack of awareness of the losses and monetary benefit of energy efficient pumps
- Lack of financial strengths to invest for VFD's

1.5.3 Skilled manpower

In Surat Textile cluster, the availability of skilled manpower is one of the problems due to more number of units. One local technical persons available at Surat takes care of about 5-10 textile units. Maintenance or repair work of major equipments of textile units like stenter, Jet Dyeing machine, Jigger machine etc, are generally taken care by the equipment suppliers itself.

1.5.4 Other barrier(s)

Information on the energy efficient technologies not available among cluster unit owners, though the suppliers are available locally, the information was not disseminated among cluster units.

2. Technology/equipment for energy efficiency improvements

2.1 Detailed description of equipment selected

2.1.1 Description of equipment

More than 50% of the total electrical energy consumption in Indian industries is used by rotating equipment. Out of which about 65% is consumed by centrifugal or flow related applications such as fans, blowers, compressors, and pumps. With using Variable Speed Drive technology the advantage gained in both productivity improvements and reduced energy consumption has been widely documented in the past few years. For example, by lowering fan or pump speed by 15% to 20%, shaft power can be reduced by as much as 30%. The main reason behind use of VFD is to reduce energy costs and prolong the life of equipment by adjusting motor speed to meet load requirements.

Variable Frequency Drive

A variable frequency drive is an electronic controller that adjusts the speed of an electric motor by regulating the power being delivered. Variable-frequency drives provide continuous control, matching motor speed to the specific demands of the work being performed. Variable-frequency drives are an excellent choice for adjustable-speed drive users because they allow operators to fine-tune processes while reducing costs for energy and equipment maintenance.

Figure 2.1 Variable Frequency Drives

Working Principle

Single-speed drives start motors abruptly, subjecting the motor to high torque and current surges up to 10 times the full-load current. VFD offers a soft start, gradually ramping up a motor to operating speed. VFD lessens mechanical and electrical stress on the motors and reduces maintenance and repair costs and extends the motor life. Energy savings from VFD can be significant. For example with centrifugal fan even a small reduction in motor speed can reduce a fans energy use by as much as 50%. For a 25 horse power motor running 23 hours per day (2 hours at 100% speed; 8 hours at 75%: 8 hours at 67%; and 5 hours at 50%) a variable frequency drives can reduce energy use by 45%. Because benefits varies depending on system variables hence, it is important to calculate benefits for each application before specifying a VFD saving.

In Surat Textile Cluster units, the pumps fitted to jet machine circulation pumps and the pumps are throttled or the pumps are operated at full capacity even though not required leading to wasteful of energy. If the flow can be controlled by reducing the speed of the pump motor this would offer a more efficient means of achieving flow control. In fact the saving is greater than that might initially be expected. As the speed of the pump is reduced, the flow will reduce partially, while the power required by the pump reduces with the cube of the speed.

The mechanical constriction of the flow may reduce the load on the motor/fan/pump motor. But the constriction itself is an energy loss, which is obviously an inefficient operation. If the flow or speed can be controlled by reducing the speed of motor, this would offer a more efficient means of achieving flow control. In fact the saving is greater than that might initially be expected. As the speed of the motor is reduced, the required speed/flow will reduce partially, while the power required by the motor reduce with cube of speed, for instance, if the speed is reduced by 10%, the flow reduces by 10% and power consumption reduces by 25%.

In Surat Textile Cluster units, the pumps fitted to jet machine circulation pumps and the pumps are throttled or the pumps are operated at full capacity even though not required leading to wasteful of energy. If the flow can be controlled by reducing the speed of the pump motor this would offer a more efficient means of achieving flow control. In fact the saving is greater than that might initially be expected. As the speed of the pump is reduced, the flow will reduce partially, while the power required by the pump reduces with the cube of the speed.

2.1.2 Technology/equipment specifications

Technical specifications for VFD's for Jet machine pump are provided in Annexure 4 for all the capacities of VFD's.

2.1.3 Justification & Suitability/integration with existing process

As discussed above, controlling the flow of pumps by throttling valve is inefficient and consumes more power. If the flow is controlled by reducing the speed of the pump motor this would offer a more efficient means of achieving flow control. In fact the saving is greater than that might initially be expected. As the speed of the pump is reduced, the flow will reduce partially; while the power required by the pump reduces with the cube of the speed while the power required by the motor reduces with the cube of the speed.

2.1.4 Superiority over existing technology/equipment

The installation of VFD's for fans has the following advantages:

The benefits of installing the drives are multifold as furnished below:

- Reduction in breakdowns and smooth start
- Reduction in breakages and motor burn's
- Improved life of the motor and increased production
- Reduction in production cost and maintenance cost due to frequent failures of belts, bearings, yarn breakages
- Improved power factor (.98 across speed range)
- Maximize power distribution system
- Minimize Peak Demand Charges
- Soft Start/Soft Stop
- Eliminates Mechanical Shock and Stress on Power Train (couplings, belts, drive shafts, gear boxes, etc.)
- Reduce Utility (Operating) Costs
- Reduced Energy Consumption, Process Operates at Most Efficient Point
- Allows Load Shedding
- May Qualify for Utility Rebates
- Controlled Acceleration and Deceleration

2.1.5 Availability of the proposed equipment

VFD suppliers are available in local and in vadodara, which is 150 KM's from Surat city. Details of equipment suppliers are provided in Annexure 7.

2.1.6 Source of technology/equipment

The technology is locally available.

2.1.7 Service/technology providers

Details of service providers are in Annexure 7.

2.1.8 Terms and condition in sales

Terms of payment

50% Advance with purchase order, and remaining 50% along with taxes and duties against Performa Invoice before dispatch.

Excise duty, sales tax & other levies

The quoted prices are exclusive of all taxes, duties, levies such as excise duty, central/local sales tax, octroi, etc. as are applicable at the time of dispatch or imposed by any statutory authorities subsequently or paid by us, shall be paid by you extra at actuals. However CVD is charged at 8% + 4% on the unit price plus 3% Education cess and VAT is charged at 5%.

Warranty

The supplier shall repair or replace at free of cost, on ex – works basis the whole or any portion of material which under normal and proper use and maintenance proves defective in material and/or workmanship within 12 months from the date of commissioning or 18 months from the date of shipment of equipment whichever is earlier, provided prompt notice is given of such defects.

2.1.9 Process down time during implementation

No process down time is envisaged as installation of VFD is additional and will take 2 to 3 hours.

2.2 Life cycle assessment and risks analysis

The operational life of the energy efficient boiler is considered to be 15 years.

2.3 Suitable unit/plant size in terms of capacity/production

The VFD proposed is suitable for 7.5 kW motor and is standard as per the capacity of the motor.

3. ECONOMIC BENEFITS OF NEW ENERGY EFFICIENT BOILER

3.1 Technical benefits

3.1.1 Fuel savings per year

No fuel savings is envisaged due to implementation of the project activity.

3.1.2 Electricity saving

The power savings due to installation of VFD for Jet machine pumps are 15% of present motor power consumption and is estimated as 34,860 kWh per annum (0.83 kWh/Jet machine, 24 hours/day and 350 days/year of operation & rounded off)) for a set of 5 Jet machine pumps. Details of electricity saving calculation are given in Annexure 3.

3.1.3 Improvement in product quality

There is no significant impact on product quality ***directly and indirectly.***

3.1.3 Increase in production

The proposed equipment does not contribute to any increase in production ***directly or indirectly.***

3.1.4 Reduction in raw material consumption

No significant impact on the reduction of raw materials consumption ***directly or indirectly.***

3.15 Reduction in other losses

There is no significant reduction in other losses ***directly or indirectly.***

3.2 Monetary benefits

The monetary benefit due to installation of VFD for Jet machine pump is estimated ₹ 1.95 lakh per annum due to reduction in electricity consumption.

3.3 Social benefits

3.3.1 Improvement in working environment in the plant

As installation of VFD eliminates Mechanical Shock and Stress on couplings, drive shafts, etc., this may lessen the breakdowns and working environment may improve

3.3.2 Improvement in skill set of workers

The technology selected for the implementation is new and energy efficient. The training provided by equipment suppliers will improve the technical skills of manpower for better operation and maintenance; hence the technology implemented will create awareness among the workforce and improve the skills.

3.4 Environmental benefits

3.4.1 Reduction in effluent generation

There is no significant impact in effluent generation due to implementation of the project.

3.4.2 Reduction in GHG emission such as CO_2, NO_x, etc

The major GHG emission reduction source is CO_2. The technology will reduce grid electricity consumption and emission reductions are estimated at 30 tonne of CO_2 per annum due to implementation of the project activity.

3.4.3 Reduction in other emissions like SO_x

No significant impact on SO_x emissions.

4 FINANCIAL ANALYSIS OF NEW ENERGY EFFICIENT EQUIPMENT

4.1 Cost of equipment implementation

4.1.1 Cost of equipments

Total cost for installation of VFD is estimated at ₹ 1.37 lakh(` 0.27 * 5 VFD), which includes VFD, Panel, switches and cabling.

4.1.2 Other costs

The total cost of implementation of VFD for jet dyeing machine is estimated at ₹ 1.62 lakh. The above cost includes cost of equipment / machinery, cost of fabrication (and/or) commissioning charges and the details are furnished below:

Table 4.1 Details of project cost

S. No.	Details	Cost (₹ in lakh)
1	Plant equipment and machinery and electrical works	1.37
2	Erection & Commissioning	0.25
3	Interest during implementation (preliminary & pre- operative expenses)	0.00
4	Total	1.62

4.2 Arrangement of funds

4.2.1 Entrepreneur's contribution

The entrepreneur's contribution is 25% of total project cost, which works out at ₹ 0.41 lakh.

4.2.2 Loan amount

The term loan is 75% of the total project, which is ₹ 1.22 lakh.

4.2.3 Terms & conditions of loan

The interest rate is considered at 10% which is SIDBI's rate of interest for energy efficient projects. The loan tenure is 5 years excluding initial moratorium period is 6 months from the date of first disbursement of loan.

4.3 Financial indicators

4.3.1 Cash flow analysis

Considering the above discussed assumptions, the net cash accruals starting with ₹ 1.55 lakh in the first year operation and increases to ₹ 8.91 lakh at the end of eighth year.

4.3.2 Simple payback period

The total project cost of the proposed technology is ₹ 1.62 lakh and monetary savings due to reduction in fuel consumption is ₹ 1.95 lakh and the simple payback period works out to be 0.84 years.

4.3.3 Net Present Value (NPV)

The Net present value of the investment at 10.00% interest rate works out to be ₹ 5.58 lakh

4.3.4 Internal rate of return (IRR)

The after tax Internal Rate of Return of the project works out to be 92.93%. Thus the project is financially viable.

4.3.5 Return on investment (ROI)

The average return on investment of the project activity works out at 29.44%.

4.4 Sensitivity analysis in realistic, pessimistic and optimistic scenarios

A sensitivity analysis has been worked out to ascertain how the project financials would behave in different situations like there is an increase in power savings or decrease. For the purpose of sensitive analysis, two scenarios are considered are.

- Increase in power savings by 5%
- Decrease in power savings by 5%

In each scenario, other inputs are assumed as constant. The financial indicators in each of the above situation are indicated along with standard indicators are shown in Table 4.2 below:

Table 4.2 Sensitivity analysis at different scenarios

Particulars	*IRR*	*NPV*	*ROI*	*DSCR*
Normal	92.93	5.58	29.44	4.84
5% decrease in electricity savings	88.54	5.24	29.22	4.61
5% increase in electricity savings	97.29	5.93	29.64	5.07

4.5 Procurement and implementation schedule

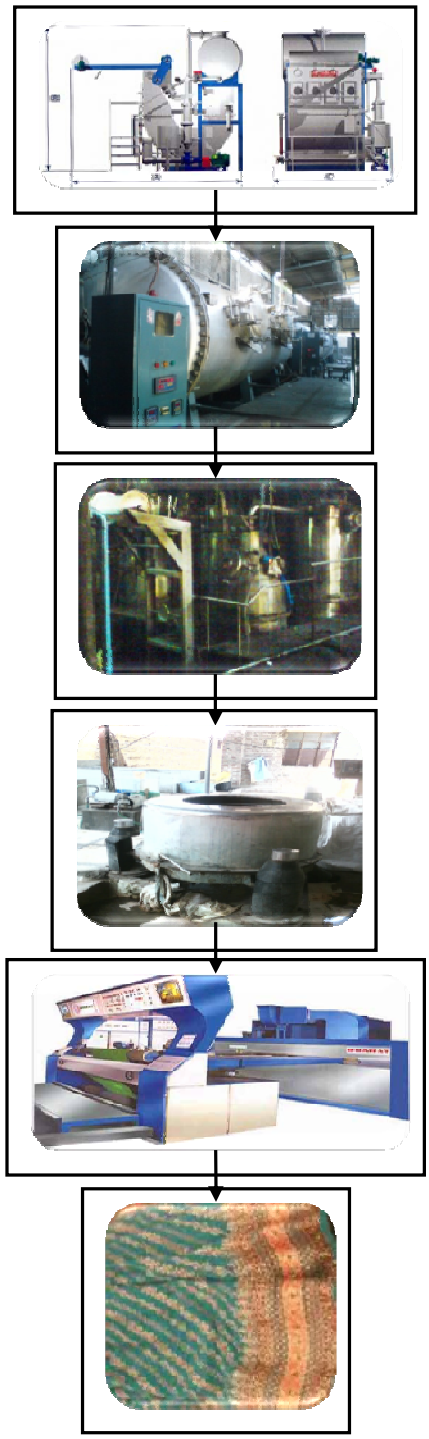
The project is expected to be completed in 1 week from the date of financial closure. The detailed schedule of project implementation is furnished in Annexure 6.

Annexure

Annexure 1: Base line for saving calculation of Jet machine pump VFD

Particulars	*Unit*	*Value*
Total Jet machine pumps	Nos.	5
Total hours of Operation	hour	24
Total pumps	Nos.	5
Rated Power (Each)	kW	7.5
Power Consumption (Each)	kWh	5.5
Daily Electricity consumption	kWh	660

Annexure 2: Process flow diagram



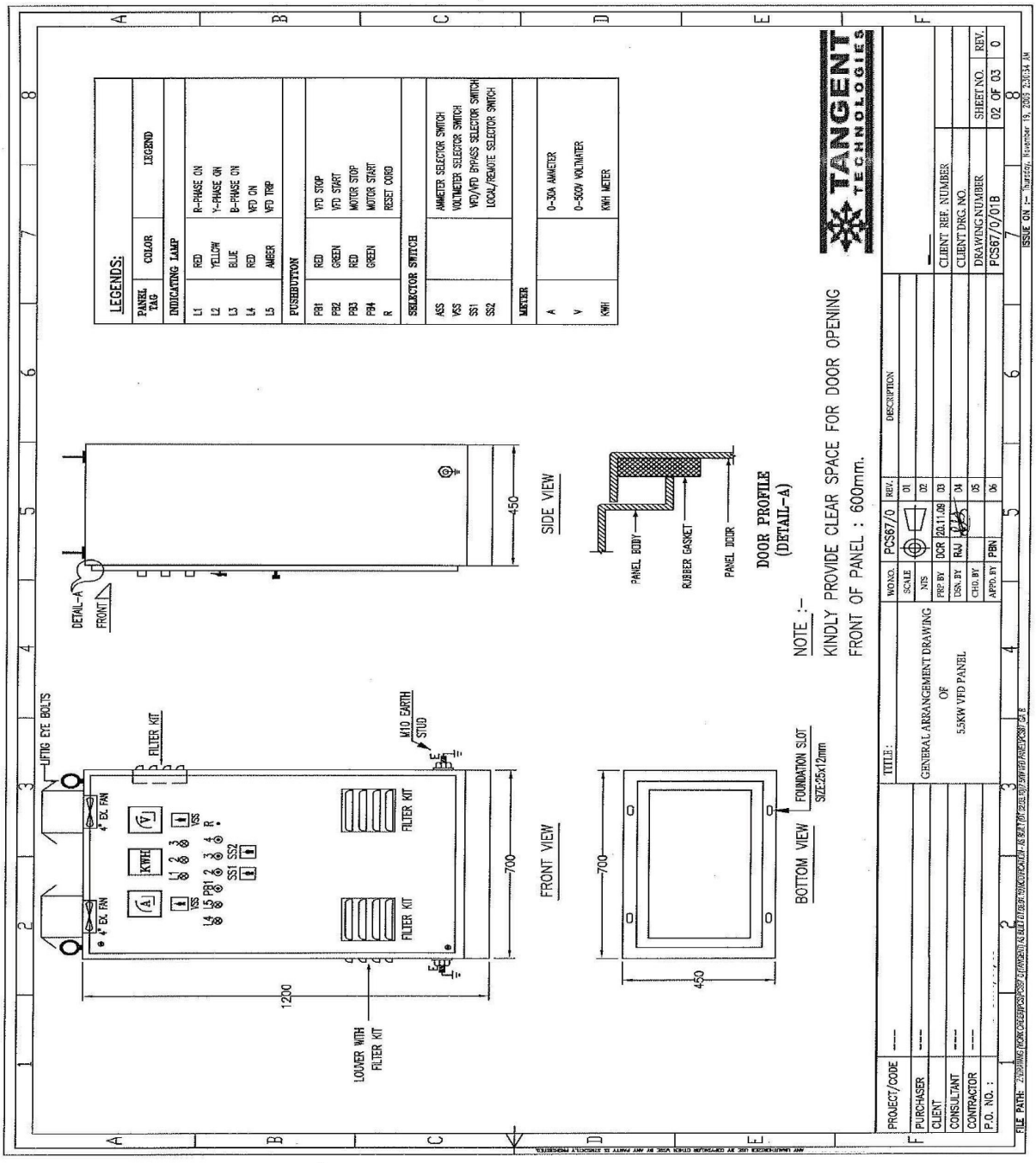
Annexure 3: Detail Technical Assessment Report

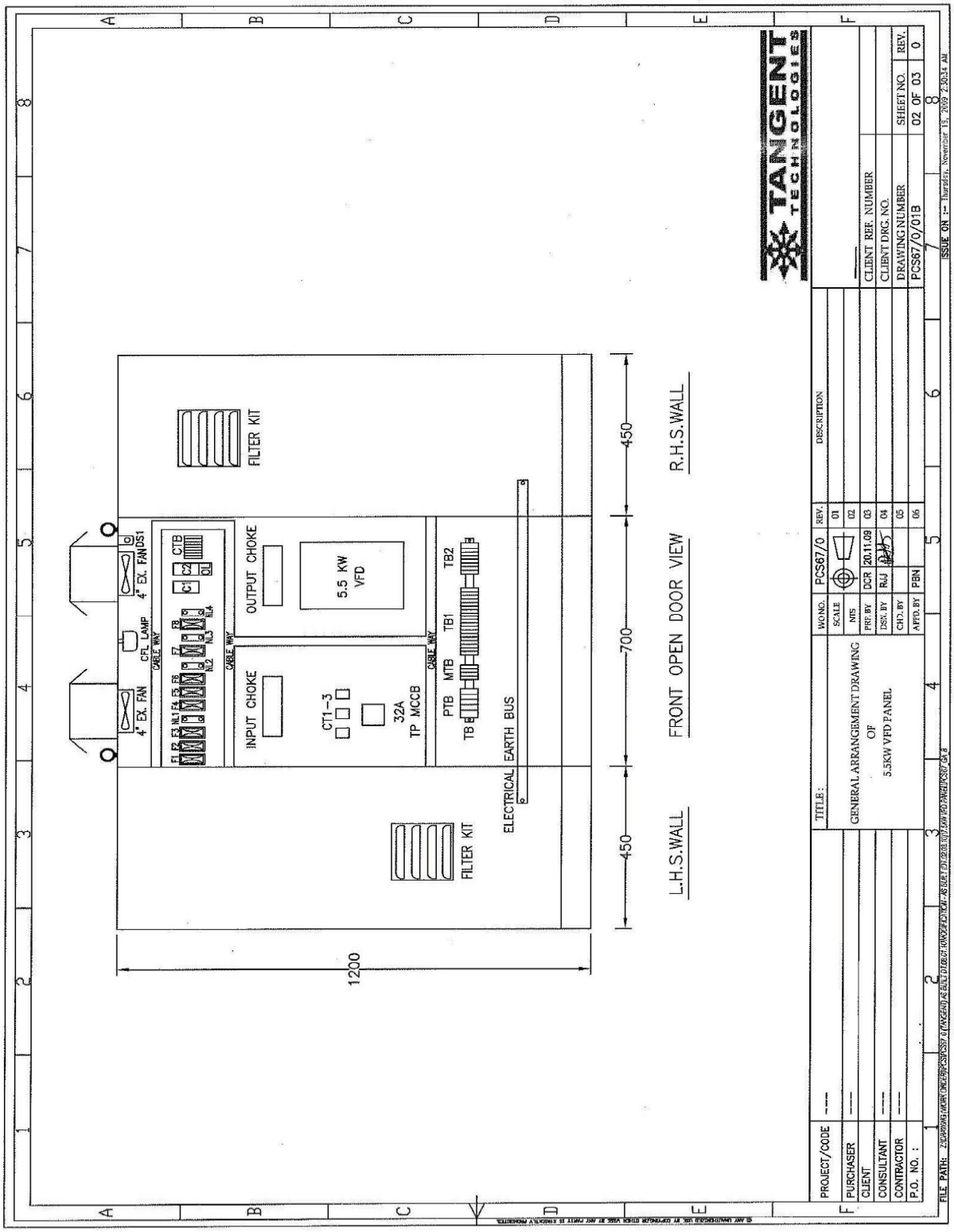
Variable Frequency Drive for Jet machine pump

Particulars	*Unit*	*Value*
Total hours of Operation	hour	24
Total pumps	Nos.	5
Rated Power	kW	7.5
Power Consumption	kWh	5.5
savings	%age	15
Average power savings (Each pump)	kWh	0.83
Total Power savings for 5 pumps	kWh	4.15
Power saving per annum for 5 VFD	kWh/annum	34860
Monetary saving per annum for 5 VFD	₹ in lakh	1.95
Investment for 5 VFD	₹ in lakh	1.62
Simple payback period	year	0.82

Annexure 4: Detail technical assessment report

The electrical line diagrams are enclosed

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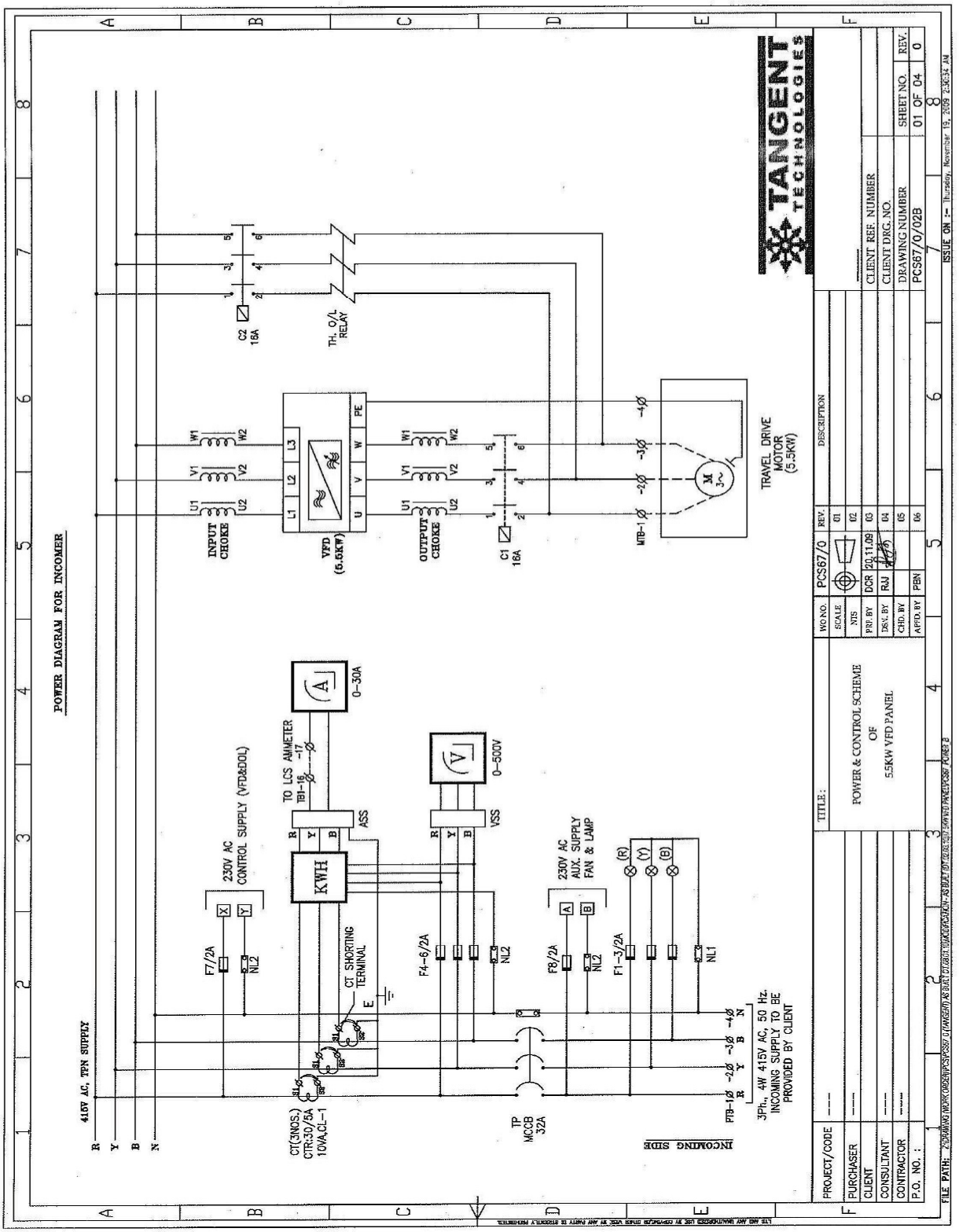
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F4-6/2A
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OF
5.5KW VFD PANEL
WO NO. PCS67/0
SCALE NTS
DRN. BY DGR 20.11.09
CHD. BY RAJ
APPD. BY PBN
DESCRIPTION
CLIENT REF. NUMBER
CLIENT DRG. NO.
DRAWING NUMBER PCS67/0/02B
SHEET NO. 01 OF 04
REV. 0
PROJECT/CODE ---
PURCHASER ----
CLIENT ----
CONSULTANT ----
CONTRACTOR ----
P.O. NO. : ----
ISSUE ON :- Thursday, November 19, 2009 2:36:34 AM

The technical specifications for VFD's for Jet machine pump are provided for all the capacities of VFD have and are furnished below:

	Voltage Class		3 Phase 400 Volts Class																								
	Model VSCP-□□□T4		0R7	01R5	02R2	3R7	05R5	07R5	011	015	018	022	030	037	045	055	075	090	110	132	160	200	220	250	280	315	355	400
	Constant Torque kW Max Motor Output HP		0.75 1.0	1.5 2.0	2.2 3.0	4.0 5.0	5.5 7.5	7.5 10	11 15	15 20	18.5 25	22 30	30 40	37 50	45 60	55 75	75 100	90 120	110 150	132 180	160 220	200 270	220 300	250 335	280 375	315 425	355 475	400 535
OUTPUT	Rated Current Amps.		2.3	3.8	5.1	9	13	17	25	32	37	45	60	75	90	110	152	176	210	253	304	380	426	470	530	600	660	750
	Max. Voltage		3Phase 380/400/415/440/480Volts proportional upto input line voltage																								
	Max. Frequency		400Hz																								
INPUT SUPPLY	Rated Input Voltage & Frequency		3-Phase, 380-480Volts, 50/60Hz.																								
	Allowable Voltage Fluctuation		-10% to +10%																								
	Allowable Frequency Range		47-63Hz.																								
CONTROL CHARACTERISTICS	Control Method		V/F Control, Sensorless Vector Control Mode1 & Mode2																								
	Starting Torque		Not less than 180% at 0.3Hz. in SVC Mode2 and 150% at 0.5Hz. in SVC Mode1																								
	Speed Control Range		1:50V/F mode, 1:100 SVC Mode1, 1:200 SVC Mode2																								
	Carrier Frequency		1kHz - 16kHz; Model dependant																								
	Over Loading Capacity		150% for 120Secs., 180% for 10Secs.																								
	Frequency Accuracy		Digital Setting : Max Frequency X +/- 0.1% Analog Setting: Max Frequency X +/- 0.2%																								
	Frequency Resolution	Analog	0.1% of Max Frequency																								
		Digital	0.01Hz.																								
		Pulse	0.5% of Max. Frequency																								
	Voltage / Frequency Characteristics		Base Frequency adjustable from 0-400Hz. Selection Between Constant Torque, Variable Torque with user defined curve																								
	Torque Boost		Automatic Torque Boost or Manual Setting between 0.1-30%																								
	Acc. / Decl. Time & Characteristics		0.01-3600secs, Linear or S-Curve selection.																								
	Multi-Speed		Realised thru In-built PLC function or Control Terminal																								
	Brake	Dynamic Braking	Internal upto 30% External upto 125% with Braking Resistor																								
		DC Injection	Optional at Start-Up or Stopping: Current: 0-150%, Time: 0-60sec																								
	JOG		Frequency 0.1-50Hz, and time 0.1-60secs selectable																								
	Process Control		Inbuilt Process functions for closed loop control																								
	Automatic Energy Save		Optimize V/F curve automatically based on load for power saving during running																								
	Automatic Voltage Regulator		Keeps constant output voltage during input voltage variation																								
	Automatic Current Limiting		Limits the current under the preset value automatically during operation																								
			Digital Input (10)					Digital Outputs (4)				Analog Input (2)				Analog Output (2)				Serial Comm. (1)							
	Control Terminals		2- Fixed 8 - Multifunction programmable (2 - Programmable for Pulse I/P)					2 - Open Collector 1 - Relay Output 1 - 24VDC Pulse Output				2 - Configurable 0-10VDC or 4-20mA				2 - Configurable 0-10VDC or 4-20mA				RS485 Modbus RTU							
	Running Frequency Channel		Keypad Operation / Control Terminal / Pulse Input / Serial Comm. with combined provision and can be switched between 2 Control.																								
	Protection Function		Over Voltage, Under Voltage, Over Current, Over Load, Over heat, Stall prevention, input/output Phase loss, output short circuit, External fault, analog input loss, etc.																								
ENVIORMENT	Ambient Temperature		-10 to 50°C (derated @2% for each degree above 50°C upto 60°C)																								
	Humidity		Less than 95% (non condensing)																								
	Vibration		Less than 5.9m/s² (0.6g)																								
	Location		Indoors (Free form corrosive gases and dust) and within 1000m altitude																								
	Protection		IP20																								
	Cooling Mode		Fan with automatic temperature control																								

- **Above specifications are for Standard 4-Pole Induction Motor. Select drive with motor rated current within drive rating.**
- **Maximum output voltage shall not exceed the input supply voltage.**
- **Braking transistor built-in upto 60HP rating. Available as an option for higher ratings.**
- **For current rating specification of drives above 400KW consult us.**
- **Consult us for 1Ph. 230V input drive 0.25-3HP rating and specifications.**

Annexure 5: Detailed financial calculations & analysis for financial indicators –

Assumption

Name of the Technology	Variable Frequency Drive		
Rated Capacity	7.5 kW		
Details	*Unit*	*Value*	*Basis*
No of working days	Days	350	
Proposed Investment			
Plant & Machinery	₹ (in lakh)	1.37	
Erection & Commissioning	₹ (in lakh)	0.25	
Total Investment	₹ (in lakh)	1.62	
Financing pattern			
Own Funds (Equity)	₹ (in lakh)	0.41	Feasibility Study
Loan Funds (Term Loan)	₹ (in lakh)	1.22	Feasibility Study
Loan Tenure	years	5	Assumed
Moratorium Period	Months	6	Assumed
Repayment Period	Months	66	Assumed
Interest Rate	%	10.00%	SIDBI Lending rate
Estimation of Costs			
O & M Cost	% on Plant & Equip	4	Feasibility Study
Annual Escalation	%	5	Feasibility Study
Estimation of Revenue			
Power Saving	KWh	34860	
Cost	₹/KWh	5.6	
St. line Depn.	%age	5.28	Indian Companies Act
IT Depreciation	%age	80.00	Income Tax Rules
Income Tax	%age	33.99	Income Tax

Estimation of Interest on Term Loan ***(₹ in lakh)***

Years	*Opening Balance*	*Repayment*	*Closing Balance*	*Interest*
1	1.22	0.06	1.16	0.11
2	1.16	0.12	1.04	0.11
3	1.04	0.16	0.88	0.10
4	0.88	0.24	0.64	0.08
5	0.64	0.32	0.32	0.05
6	0.32	0.32	0.00	0.01
		1.22		

WDV Depreciation

Particulars / years	*1*	*2*
Plant and Machinery		
Cost	1.62	0.32
Depreciation	1.30	0.26
WDV	0.32	0.06

Projected Profitability

₹ in lakh

Particulars / Years	1	2	3	4	5	6	7	8
Revenue through Savings								
Power savings	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95
Total Revenue (A)	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95
Expenses								
O & M Expenses	0.06	0.07	0.07	0.08	0.08	0.08	0.09	0.09
Total Expenses (B)	0.06	0.07	0.07	0.08	0.08	0.08	0.09	0.09
PBDIT (A)-(B)	1.89	1.88	1.88	1.88	1.87	1.87	1.87	1.86
Interest	0.11	0.11	0.10	0.08	0.05	0.01	0.00	0.00
PBDT	1.78	1.77	1.78	1.80	1.82	1.86	1.87	1.86
Depreciation	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
PBT	1.69	1.69	1.70	1.71	1.74	1.77	1.78	1.78
Income tax	0.16	0.51	0.61	0.61	0.62	0.63	0.63	0.63
Profit after tax (PAT)	1.53	1.17	1.09	1.10	1.12	1.14	1.15	1.14

Computation of Tax

₹ (in lakh)

Particulars / Years	1	2	3	4	5	6	7	8
Profit before tax	1.69	1.69	1.70	1.71	1.74	1.77	1.78	1.78
Add: Book depreciation	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
Less: WDV depreciation	1.30	0.26	-	-	-	-	-	-
Taxable profit	0.48	1.51	1.78	1.80	1.82	1.86	1.87	1.86
Income Tax	0.16	0.51	0.61	0.61	0.62	0.63	0.63	0.63

Projected Balance Sheet

₹ (in lakh)

Particulars / Years	1	2	3	4	5	6	7	8
Liabilities								
Share Capital (D)	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41
Reserves & Surplus (E)	1.53	2.70	3.79	4.89	6.01	7.15	8.30	9.44
Term Loans (F)	1.16	1.04	0.88	0.64	0.32	0.00	0.00	0.00
Total Liabilities D)+(E)+(F)	3.09	4.14	5.07	5.93	6.73	7.55	8.70	9.84
Assets								
Gross Fixed Assets	1.62	1.62	1.62	1.62	1.62	1.62	1.62	1.62
Less: Accm. Depreciation	0.09	0.17	0.26	0.34	0.43	0.51	0.60	0.68
Net Fixed Assets	1.53	1.45	1.36	1.28	1.19	1.11	1.02	0.94
Cash & Bank Balance	1.55	2.69	3.71	4.66	5.54	6.45	7.68	8.91
Total Assets	3.09	4.14	5.07	5.93	6.73	7.55	8.70	9.84
Net Worth	1.93	3.11	4.20	5.30	6.42	7.56	8.70	9.85
Dept equity ratio	0.60	0.33	0.21	0.12	0.05	0.00	0.00	0.00

Projected Cash Flow:

₹(in lakh)

Particulars / Years	0	1	2	3	4	5	6	7	8
Sources									
Share Capital	0.41	-	-	-	-	-	-	-	-
Term Loan	1.22								
Profit After tax		1.53	1.17	1.09	1.10	1.12	1.14	1.15	1.14
Depreciation		0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
Total Sources	1.62	1.61	1.26	1.18	1.19	1.20	1.23	1.23	1.23
Application									
Capital Expenditure	1.62								
Repayment of Loan	-	0.06	0.12	0.16	0.24	0.32	0.32	-	-
Total Application	1.62	0.06	0.12	0.16	0.24	0.32	0.32	-	-
Net Surplus	-	1.55	1.14	1.02	0.95	0.88	0.91	1.23	1.23
Add: Opening Balance	-	-	1.55	2.69	3.71	4.66	5.54	6.45	7.68
losing Balance	-	1.55	2.69	3.71	4.66	5.54	6.45	7.68	8.91

Calculation of Internal Rate of Return

₹(in lakh)

Particulars / months	0	1	2	3	4	5	6	7	8
Profit after Tax		1.53	1.17	1.09	1.10	1.12	1.14	1.15	1.14
Depreciation		0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
Interest on Term Loan		0.11	0.11	0.10	0.08	0.05	0.01	-	-
Salvage/Realizable value									
Cash outflow	(1.62)	-	-	-	-	-	-	-	-
Net Cash flow	(1.62)	1.72	1.37	1.28	1.27	1.25	1.24	1.23	1.23
IRR	92.93								

NPV	5.58

Break Even Point

₹(in lakh)

Particulars / Years	1	2	3	4	5	6	7	8
Variable Expenses								
Oper. & Maintenance Exp (75%)	0.05	0.05	0.05	0.06	0.06	0.06	0.07	0.07
Sub Total (G)	0.05	0.05	0.05	0.06	0.06	0.06	0.07	0.07
Fixed Expenses								
Oper. & Maintenance Exp (25%)	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Interest on Term Loan	0.11	0.11	0.10	0.08	0.05	0.01	0.00	0.00
Depreciation *(H)*	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
Sub Total (I)	0.21	0.21	0.20	0.18	0.16	0.12	0.11	0.11
Sales (J)	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95
Contribution (K)	1.90	1.90	1.90	1.90	1.89	1.89	1.89	1.88
Break Even Point (L= G/I)	11.14%	11.18%	10.67%	9.61%	8.33%	6.13%	5.68%	5.75%
Cash Break Even {(I)-(H)}	6.64%	6.68%	6.16%	5.10%	3.81%	1.60%	1.15%	1.21%
Break Even Sales (J)*(L)	0.22	0.22	0.21	0.19	0.16	0.12	0.11	0.11

Return on Investment ***₹(in lakh)***

Particulars / Years	1	2	3	4	5	6	7	8	Total
Net Profit Before Taxes	1.69	1.69	1.70	1.71	1.74	1.77	1.78	1.78	13.85
Net Worth	1.93	3.11	4.20	5.30	6.42	7.56	8.70	9.85	47.06
									29.44%

Debt Service Coverage Ratio ***₹(in lakh)***

Particulars / Years	1	2	3	4	5	6	7	8	Total
Cash Inflow									
Profit after Tax	1.53	1.17	1.09	1.10	1.12	1.14	1.15	1.14	7.15
Depreciation	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.51
Interest on Term Loan	0.11	0.11	0.10	0.08	0.05	0.01	0.00	0.00	0.46
Total (M)	1.72	1.37	1.28	1.27	1.25	1.24	1.23	1.23	8.13

Debt

Interest on Term Loan	0.11	0.11	0.10	0.08	0.05	0.01	0.00	0.00	0.46
Repayment of Term Loan	0.06	0.12	0.16	0.24	0.32	0.32	0.00	0.00	1.22
Total (N)	0.17	0.23	0.26	0.32	0.37	0.33	0.00	0.00	1.68
	10.12	5.95	4.92	3.98	3.37	3.75	0.00	0.00	4.84
Average DSCR (M/N)	4.84								

Annexure 6: Details of procurement and implementation plan with schedule/timelines

Project Implementation Schedule – VFD's

S. No.	Activities	Days							
		1	2	3	4	5	6	7	8
1	Supply of the VFD's								
2	Panels and cabling								
3	Providing connections to the motor terminals								
4	Commissioning and trial runs								

The process down time is considered for Jet Machine

S. No.	Activities	Days							
		1	2	3	4	5	6	7	8
1	Panels and Cabling								
2	Commissioning and trial runs								

The process down time is considered for only one day, as panels installation and cabling will not affect the machine operation, when all the equipments are kept ready, then connections are provided and hence process down time is considered only for one day

Annexure 7: Details of technology/equipment and service providers

Equipment details	*Source of technology*	*Service/technology providers*
Variable Frequency Drive		**TANGENT TECHNOLOGIES** 105, 131 Ambica Complex, Gorwa Refinery Road, Vadodara India- 390016 E-mail: info@tangent.in Mobile:+91 9825500449 Telefax:+91 265 2291264 Website: www.tangent.in

Annexure 8: Quotations or Techno-commercial bids for new technology/equipment

TANGENT TECHNOLOGIES

Tangent VSCPlus Variable Speed Drive Price List

Model	Brake Chopper	Input (V)	Phase	Match Motor (KW)	Unit Price (Rs)
VSCP-0R7T4	Inbuilt	400	Three	0.75	11121
VSCP-1R5T4	Inbuilt	400	Three	1.5	13127
VSCP-2R2T4	Inbuilt	400	Three	2.2	15606
VSCP-3R7T4	Inbuilt	400	Three	3.7	18596
VSCP-5R5T4	Inbuilt	400	Three	5.5	22243
VSCP-7R5T4	Inbuilt	400	Three	7.5	27421
VSCP-011T4	Inbuilt	400	Three	11	35735
VSCP-015T4	Inbuilt	400	Three	15	41752
VSCP-018T4	Inbuilt	400	Three	18.5	50018
VSCP-022T4	Inbuilt	400	Three	22	64290
VSCP-030T4	Inbuilt	400	Three	30	74960
VSCP-037T4	Inbuilt	400	Three	37	100306
VSCP-045T4	Inbuilt	400	Three	45	120839

Terms and Conditions:

Prices: Ex Works Vadodara basis

Excise: 10.34% extra at actuals

CST: 2% against form C

Freight: Extra at actuals

Delivery: 2 weeks

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