# DETAILED PROJECT REPORT
# ON
# WASTE HEAT RECOVERY SYSTEM -50 TONS CAPACITY KILN
# (EAST & WEST GODAVARI REFRACTORIES CLUSTER)

ENERGY IS LIFE
BEE
CONSERVE IT

**Bureau of Energy Efficiency**

***Prepared By***

APITCO LIMITED
Engineering Growth

***Reviewed By***

ISTSL

# WASTE HEAT RECOVERY SYSTEM FOR PREHEATING OF REFRACTORIES 50 TONS CAPACITY DD KILN

## EAST AND WEST GODAVARI REFRACTORIES CLUSTER

BEE, 2010

Detailed Project Report on Waste Heat Recovery for pre-heating of refractories -Up to 50 Tons/Batch

Refractories SME Cluster, Rajahmundry, Andhra Pradesh (India)

New Delhi: Bureau of Energy Efficiency

Detail Project Report No.: **E&W /BMG/01**

**For more information**

Bureau of Energy Efficiency (BEE)

(Ministry of Power, Government of India)

4th Floor, Sewa Bhawan

R. K. Puram, New Delhi – 110066

**Telephone** +91-11-26179699

**Fax**+91-11-26178352

**Websites**: www.bee-india.nic.in

**Email:** jsood@beenet.in/

pktiwari@beenet.in

## *Acknowledgement*

We are sincerely thankful to the Bureau of Energy Efficiency, Ministry of Power, for giving us the opportunity to implement the BEE SME project in “Refractory Cluster, East & West Godavari District of Andhra Pradesh”. We express our sincere gratitude to all concerned officials for their support and guidance during the conduct of this exercise.

Dr. Ajay Mathur, Director General, BEE

Smt. Abha Shukla, Secretary, BEE

Shri Jitendra Sood, Energy Economist, BEE

Shri Pawan Kumar Tiwari, Advisor (SME), BEE

Shri Rajeev Yadav, Project Economist, BEE

Andhra Pradesh Industrial & Technical Consultancy Organization Ltd. (APITCO) is also thankful to “*The Ceramic Manufacturing Welfare Association, Rajamundry at East & west Godavari Districts*” 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.

We take this opportunity to express our appreciation for the excellent support provided by 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).

APITCO 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.

**APITCO Limited**

**Hyderabad**

**Contents**

**List of Annexurer**



**List of Tables**

## List of Figures



## LISTS OF ABBREVATIONS

- BEE - Bureau of Energy Efficiency
- DPR - Detailed Project Report
- DSCR - Debt Service Coverage Ratio
- DD - Down Draft Kiln
- FD - Forced Draft
- GHG - Green House Gases
- HP - Horse Power
- IRR - Internal Rate of Return
- ID - Induced Draft
- MoP - Ministry of Power
- MoSME - Micro Small and Medium Enterprises
- NPV - Net Present Value
- ROI - Return On Investment
- SIDBI - Small Industries Development of India
- SME - Small and Medium Enterprises

## *EXECUTIVE SUMMARY*

APITCO Ltd is executing BEE-SME program in East and West Godavari (Refractories) Cluster, supported by Bureau of Energy Efficiency (BEE) with an overall objective of improving the energy efficiency in cluster units. Rajahmundry is one of the oldest clusters of state of Andhra Pradesh producing refractories and potteries. These industries were in operation since last four to five decades. Earlier, these industries were used to produce potteries for domestic market, which are commonly used for storing pickles for longer time. The products called 'Jars' are the most commonly used container in Southern India specifically in the state of Andhra Pradesh for storing various food items. During the course of time, the demand for potteries (Jars) was considerably reduced due to change in economy and food habits. These pottery making units were diversified to produce refractories which are used in industries as insulation.

Majority of the industries are producing refractories and very few units are producing potteries. These industries have been in operation for the last 25 to 30 years. The main raw materials are clay, refractory grog, other chemicals etc.

The major Energy used in cluster is Coal and Wood as a fuel and Electricity. Coal and wood are used as fuel in down draft kilns for heat treatment of refractory bricks. Electricity is used for drive the prime movers used in Brick Press, grinding machines, clay mixers, crushers etc. The total energy cost in refractory industries varies from 40% to 50 % of production cost. The down draft kilns requires higher thermal energy, which is major share of total energy consumed.

The Down Draft kiln is a common type of kiln used in all cluster units for curing/heat treatment of refractory bricks. Coal is used as fuel and the capacity of the down draft kiln is 50 tons/batch. Wood is also used in small quantities for enhancing the burning of the coal in the kiln. These kilns are very old design and are constructed with the local masonries and the thermal efficiency of the kilns is found to be low. The design of the down draft kilns is more or less identical in all cluster units.

The temperature required for the down draft kiln is 1050 $^oC$ to 1100 $^oC$ and is raised slowly from ambient temperature. During energy audit studies, it is observed that, the waste flue gases from the kiln is found to be 600 $^oC$ to 650 $^oC$ and is vented to the atmosphere without any heat recovery..

The DPR highlights the details of the study conducted for assessing the potential for implementation WHR for preheating of refractories, potential of energy saving, possible monetary benefit, availability of the technologies/design, local service providers, technical features and proposed equipment specifications, various barriers in implementation, environmental aspects, estimated GHG reductions, capital cost, financial analysis, and schedule of Project Implementation.

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 below

| S.No | Particular | Unit | Value |
|---|---|---|---|
| 1 | Project cost | ` (in Lakh) | 9.00 |
| 2 | Coal saving | Tons/annum | 370.67 |
| 3 | Cost of electricity consumption | ` /annum | 0.99 |
| 4 | Monetary benefit | ` (in Lakh) | 15.69 |
| 5 | Simple payback period | Year | 0.57 |
| 6 | NPV | ` (in Lakh) | 50.35 |
| 7 | IRR | %age | 149.04 |
| 8 | ROI | %age | 29.21 |
| 9 | Average DSCR | Ratio | 7.27 |
| 10 | Process down time | Week | Nil |
| 11 | $CO_2$ emission reduction | Tons/annum | 379 |

***The projected profitability and cash flow statements indicate that the project implementation i.e. installation of WHR System will be financially viable and technically feasible.***

## *ABOUT BEE'S SME PROGRAM*

Bureau of Energy Efficiency (BEE) is implementing a BEE-SME Program to improve the energy performance in 29 selected SME's clusters. East and West Godavari Refractories Cluster is one of them. The BEE' s SME Program 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 SME' s 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 SME' s clusters.

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

***Activity 1: Energy use and technology audit***

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 SME' s.

***Activity 2: 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 SME' s 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 up of energy efficiency projects in the clusters.

***Activity 3: Implementation of energy efficiency measures***

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

***Activity 4: 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 Introduction about cluster

Rajahmundry is one of the oldest Industrial clusters and located in state of Andhra Pradesh and manufacturing refractories products and potteries. These industries were in operation since last four to five decades. Earlier, these industries were used to manufacture potteries for domestic market, which are commonly used for storing pickles for longer time. The products called 'Jars' are the most commonly used container in Southern India specifically in the state of Andhra Pradesh for storing various food items. During the course of time, the demand for potteries (Jars) was considerably reduced due to change in economy and food habits. These pottery making units were diversified to refractory manufacturing due to demand.

Majority of the industries are manufacturing refractories and very few units are potteries. There are about 83 industries in the cluster. These industries have been in operation for the last 20 to 30 years. The main raw materials are clay, refractory grog, other chemicals etc. The major Energy used in refractory cluster is Electricity and Fuels like Coal and Wood. Electricity is used for drive the prime movers of brick making units, grinding machines, mixers etc. Coal and wood are used as fuel in down draft kilns for heat treatment of the bricks.

The cost of energy is varies from 30% to 50% of production cost which is depending up on the kilns and capacities. In refractory industries, major cost is contributed by energy cost followed by raw material cost and labor cost.

### 1.1.1 Production process

The main process operation for manufacturing refractory bricks adopted in cluster units are as follows:

The raw material i.e. Clay 60%, refractory Greg 40% and water is feed manually and sent to clay mister for uniform mixing . The refractory bricks are either prepared by manually (Hollow bricks) or in molding machines (Solid bricks) and the bricks are dried naturally/ using fans for 2 to 3 days and naturally dried bricks are loaded to the kiln.

The heating of the bricks is done under slow firing in kiln for 72 hours for removing the moisture content. In the slow firing, for every one hour, about one shovel of coal (3.5 kgs) in each grate is burnt. The temperature is maintained between 100 – 200$^{o}$C. During this period all the doors and damper existing in the kiln are kept open.

After slow firing firstly raw material charging door in kiln is closed. Out of 24 holes provided in kiln, 4 no's of top holes are closed every 8 hrs from the time of charging door closed. After closing the all the doors, rapid firing system started by adding 1 shovel of coal per hour in every coal feeding doors.

After 72 hours, the full firing period is carried out for 48 hours and the temperature of the kiln is increased from 200 $^{o}$C to 1050 $^{o}$C. The damper position in kiln is kept opened for about 25%. After completion of the rapid firing for 48 hours, all the coal feed points /grates and damper are closed and firing is stopped. Then the kiln is left for maintain the temperature (soaking) for 24 hours and then the kiln is taken for natural cooling and the bricks are unloaded after 24 hours of natural cooling.

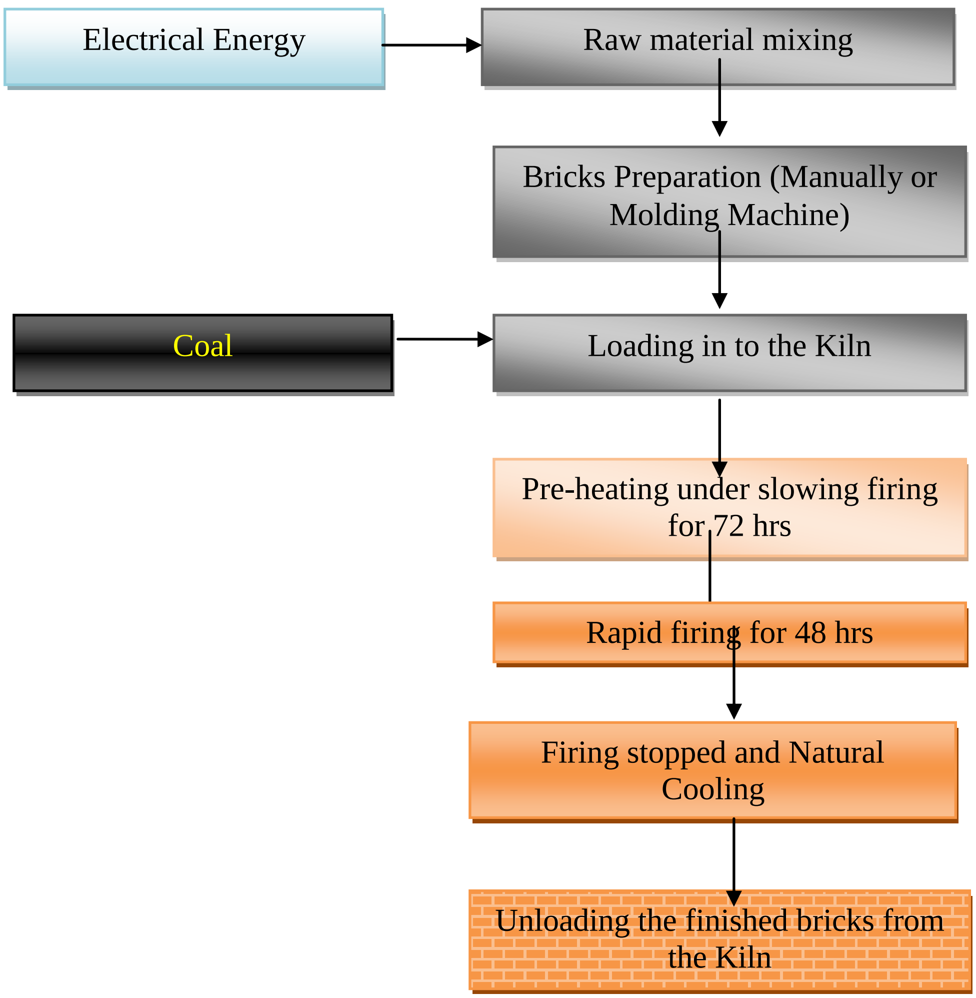



**Figure 1: General Process Flowchart of a Typical Refractory Manufacturing Unit**

## 1.2 Energy performance in existing situation

### 1.2.1 Fuel and electricity consumption of a typical unit in the cluster

The main energy forms used in a typical unit in the cluster are electricity, coal, and wood. Electricity is used for drive the prime mover of brick making unit, mixers, grinding machine, etc. Coal and wood is used as fuel in the down draft kiln. The energy consumption of a typical unit in cluster is furnished in Table 1.1 below:

**Table 1.1: Energy consumption of a typical unit**

| S.No | Name of Unit | Yearly Consumption | | |
|---|---|---|---|---|
| | | Coal (Tons) | Electricity (kWh) | Wood (Tons) |
| 1 | M/s. Dwaraka Refractories | 914 | 25371 | 110 |

### 1.2.2 Average production by a typical unit in the cluster

The average production in a year in a typical unit is 800 tons.

### 1.2.3 Specific Energy Consumption

The main energy forms used in the refractories production are electricity, coal, and wood. The Specific energy consumption for electrical and thermal energy per ton of Production for a typical unit is furnished in Table 1.2 below:

**Table 1.2: Specific energy consumption for a typical unit**

| S. No. | Type of Fuel | Units | Sp. Energy Consumption |
|---|---|---|---|
| 1 | Coal Consumption | kg of coal / kg of Product | 1.14 |
| 2 | Grid Electricity consumption | kWh/ kg of Product | 31.75 |
| 3 | Wood consumption | kg of Wood/ kg of Product | 4.00 |

## 1.3 Existing technology/equipment

### 1.3.1 Description of existing technology

The down draft kiln is a common type of kiln used in all cluster units for curing/heat treatment of refractory bricks. Coal is used as fuel and the capacity of the down draft kiln is 30 tons/batch. Wood is also used in small quantities for enhancing the burning of the coal in the kiln. About 2 to 3 batches are produced in a month. The DD kiln is operated on continuous basis for 6 days for each batch as per the requirement.

The temperature required for the down draft kiln is 1050 $^{o}$C to 1100 $^{o}$C and is raised slowly from ambient temperature. During energy audit studies, it is observed that, the waste flue gases from the kiln is found to be 600 $^{o}$C to 650 $^{o}$C and is vented to the atmosphere without any heat recovery.

### 1.3.2 Its role in the whole process

The down draft kiln is used for curing and heat treatment of the refractories.

## 1.4 Establishing the baseline for the equipment to be changed

### 1.4.1 Design and operating parameters

The main energy forms used for DD kiln are coal and wood. Electricity is also used in small quantities for operation of clay mixing, crushers, ball mills, brick press and lighting etc.

The down draft kiln is one of the old design kiln and constructed locally and doesn't have any name plate details. The life of the DD kiln is considered at 25 to 30 years. The production capacity of the DD kiln is 35 tons/ batch. The coal consumption depends on quantity of Refractories and types, grade of coal and calorific value, temperature required. The operating parameters of the DD kiln collected for a typical unit during the field visit is furnished below:

- Duration of the batch : 8 days
- Products : hollow refractory bricks
- Designed capacity :50Tons
- Production : 35 tons
- Coal consumption : 15 tons
- Calorific value of coal : 4200 kcal/kg
- Excess air measured : 30%
- Slow firing : 2 days
- Rapid firing : 4 days
- Heat maintained : 1 day
- Normal cooling : 1 day

### 1.4.2 Coal consumption & Operating Efficiency

The operating efficiency of the DD Kilns in various units had been evaluated during energy use and technology audits using coal as fuel. The efficiencies of the DD kilns are found to be in the range of 10 % to 15 % in various units of the cluster. The details of coal consumption, electricity consumption and efficiencies of DD kilns are furnished below in table 1.3 below:

**Table 1.3 Energy Consumption & Efficiency of units in the cluster**

| S.No | Name of the unit | Coal Consumption (Tons/annum) | Electricity Consumption (kWh/annum) | DD Kiln Efficiency (%) |
|---|---|---|---|---|
| 1 | Dwarka Refractories | 914 | 25371 | 10.2 |

## 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 waste heat recovery system for DD kiln in the cluster are:

- Lack of awareness of the technology and there was no considerable research by the consultants or Local service providers
- Most of the operators/supervisors are non technical and doesn't have knowledge on the design and technical aspects.

### 1.5.2 Financial Barrier

The lack of awareness of the losses and monetary benefit of the new technology.

Energy Efficiency Financing Schemes such as SIDBI' s, if taken up in the cluster, many SME owners will come forward to up taken up the technology due to financial attractiveness of the technology.

### 1.5.3 Skilled manpower

Lack of skilled manpower was also one of the major barriers in the cluster.

### 1.5.4 Other barrier(s)

No major other barriers were identified

# 2. TECHNOLOGY OPTION FOR ENERGY EFFICIENCY IMPROVEMENTS

## 2.1 Detailed description of technology/equipment selected

### 2.1.1 Description of technology

The waste heat recovery system is identified which can be used for pre-heating Refractories. The entire heat cycle takes about 8 days. Out of 8 days, 2 days will be slow firing, 4 days will be rapid firing, and 1 day is soaking period. Considerable quantities of coal are consumed during rapid firing and flue gas temperatures are around 300 to 1050 $^{o}$C during rapid firing. At present, the high temperature flue gases are vented off to the atmosphere through chimney. The company has a old kiln, which is not in use. The hot air generated can be used for preheating the refractories of the next batch for reducing fuel consumption and to reduce batch time. So, during the present batch process, the refractories to be processed in the next batch are placed in the old kiln and hot air is blown onto the refractories to be heated.

The system consists of waste heat recovery system, blowers, ducting for supplying air to the kiln and the refractories to be cured, before charging for heat treatment, the refractories are pre heated.

### 2.1.2 Technology /Equipment specifications

The waste heat recovery system is typically a fabrication activity and doesn't contain specifications and is suitable for 2500 kgs/hr of flue gases. The materials used for the fabrication of the waste heat recovery system are stainless steel and Mild steel sheets of required thickness:

### 2.1.3 Justification of the technology selected

DD kiln are the most commonly used kiln in Refractory and pottery unit in the cluster. As per the studies carried out in various units, no single unit has waste heat recovery system. In many cases, the temperature of the flue gases at the exit of the DD kilns is found to be varying between 300 $^{o}$C to 1050 $^{o}$C.

Installing waste heat recovery system for pre-heating the refractories will reduce the fuel consumption by utilizing the heat in waste flue gases

### 2.1.4 Superiority over existing technology/equipment

The proposed technology enhances the efficiency of the DD kiln for the following reasons:

- The precious heat available in the waste flue gases is utilized and thus reduces coal consumption

- The pre heating of the refractories will considerably reduce the melting time
- Reduces thermal pollutants to the atmosphere due to reduction in temperature of waste flue gases

### 2.1.5 Availability of the proposed technology/equipment

The waste heat recovery system is available based on the waste heat generated by supplying the specifications to the manufacturers. It can be locally fabricated with the local service providers. The details of the local service provider are furnished in Annexure 5.

### 2.1.6 Source of technology/equipment for the project

The technology is Indigenous and locally available.

### 2.1.7 Service/technology providers

The service providers are available in Hyderabad.

### 2.1.8 Terms of sales

Details term and condition of sale of supplier is given at annexure 7.

### 2.1.9 Process down time during implementation

The waste heat recovery system is additional equipment and No process down time is considered, as the kiln is operated 15 days a month. The waste heat recovery system is installed during idle time of the kiln.

## 2.2 Life cycle assessment and risks analysis

The life of the WHR is considered more than 5 years.

## 2.3 Suitable unit/plant size

The proposed WHR capacity is suitable for up to 50 tons per batch and can be installed in all the units having similar capacity.

# 3. ECONOMIC BENEFITS OF NEW ENERGY EFFICIENT TECHNOLOGY

## 3.1 Technical benefits

### 3.1.1 Fuel savings per year

The project activity is installation of waste heat recovery system for pre heating combustion air in the DD kiln and reduces coal consumption. Based on the detailed studies undertaken, it is estimated that the coal consumption reduces by 370.67 tons per annum for a typical unit having DD kiln of 50 tons per batch designed kiln.

### 3.1.2 Electricity savings per year

No electrical savings is envisaged by WHR, further, the WHR consumes electricity consumption for operation of FD fan blower. Total electricity cost would be ` 0.99 lakh/year.

### 3.1.3 Improvement in product quality

The project activity is installation of waste heat recovery system and doesn’t have impact on the product quality.

### 3.1.4 Increase in production

The project activity is waste heat recovery system and heat in the flue gases is used for pre-heating the Refractories and hence reduces the time of the curing. Hence, the production may improve due to reduction in batch time.

### 3.1.5 Reduction in raw material consumption

No significant effect on the raw materials consumption.

### 3.1.6 Reduction in other losses

None

## 3.2 Monetary benefits

### 3.2.1 Monetary savings due to reduction in energy consumption

The installation of WHR reduces production cost and monetary savings is estimated at ` 15.69 lakhs per annum. Detailed energy and monetary benefits calculation is shown in annexure 2.

## 3.3 Social benefits

### 3.3.1 Improvement in working environment in the plant

The project activity is a waste heat recovery system; hence due to reduction of temperature of waste flue gases, the working environment will improve considerably.

### 3.3.2 Improvement in skill set of workers

The technology selected for the implementation is new. The technology implemented will create awareness and operation and maintenance of the new technology and hence improves skills of the workers.

## 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 activity.

### 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 coal consumption by 370.67 tons per annum and the emission reductions are estimated at 650 tons of $CO_2$ per annum due to implementation of the project activity.

### 3.4.3 Reduction in other emissions like $SO_x$

As the project activity reduces coal consumption, the SOx emissions also reduces to some extent.

# 4. INSTALLATION OF NEW ENERGY EFFICIENT TECHNOLOGY

## 4.1 Cost of technology/equipment implementation

### 4.1.1 Cost of technology/equipments

The total cost for installation of waste heat recovery system is estimated at ` 7.00 lakhs as per quotation at annexure 7.

### 4.1.2 Other costs

Other cost includes cost of the ducting, erection, and commissioning charges for the waste heat recovery system. The details of the item wise cost are furnished below:

**Table 4.1: Total project cost**

| S.No | Particular | Unit | Value |
|---|---|---|---|
| 1 | Waste heat recovery system | `in lakh | 7.0 |
| 2 | Blower, ducting, erection and commissioning | `in lakh | 1.0 |
| 3 | Misc. Costs | `in lakh | 1.0 |
| 4 | Total Investment | `in lakh | 9.0 |

## 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 ` 2.25 lakhs.

### 4.2.2 Loan amount

The term loan is 75% of the total project cost, which works out at ` 6.75 lakhs.

### 4.2.3 Terms & conditions of loan

The interest rate is considered at 10.00% which is prevailing interest rate for energy efficiency projects. The loan tenure is 5 years and the moratorium period is 6 months.

## 4.3 Financial indicators

### 4.3.1 Cash flow analysis

Considering the above discussed assumptions, the net cash accruals starting with ` 14.25 lakhs in first year operation and ` 77.67 lakhs at the end of eighth year.

### 4.3.2 Simple payback period

The total project cost of the proposed technology is ` 9.00 lakhs and monetary savings due to reduction in energy/production cost is ` 15.69 lakhs and payback period works out to be 0.57 years.

### 4.3.3 Net Present Value (NPV)

The Net present value of the investment at 10.0% interest rate works out to be ` 50.35 lakhs

### 4.3.4 Internal rate of return (IRR)

The after tax Internal Rate of Return of the project works out to be 149.04%. Thus the project is financially viable. The average DSCR works out at 7.27.

### 4.3.5 Return on investment (ROI)

The average return on investment of the project activity works out at 29.21%.

Details of all the financial parameters for the replacement of conventional furnace with energy efficient furnace are presented in Table 4.2 below:

**Table 4.2 Financial parameters**

| S. No | Parameter | Unit | Value |
|---|---|---|---|
| 1 | Simple payback period | Years | 0.57 |
| 2 | NPV | ` in lakh | 50.35 |
| 3 | IRR | %age | 149.40 |
| 4 | ROI | %age | 29.21 |
| 5 | DSCR | Ratio | 7.27 |

## 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 monetary savings and decrease. For the purpose of sensitive analysis, two scenarios are considered are.

- Increase in fuel saving savings by 5%
- Decrease in fuel savings by 5%

**Table 4.3 Sensitivity analysis**

| Particulars | IRR % | NPV `in lakh | ROI % | DSCR |
|---|---|---|---|---|
| Normal | 149.04 | 50.35 | 29.21 | 7.27 |
| 5% increase in fuel savings | 157.87 | 53.54 | 29.27 | 7.66 |
| 5% decrease in fuel savings | 140.24 | 47.16 | 29.15 | 6.88 |

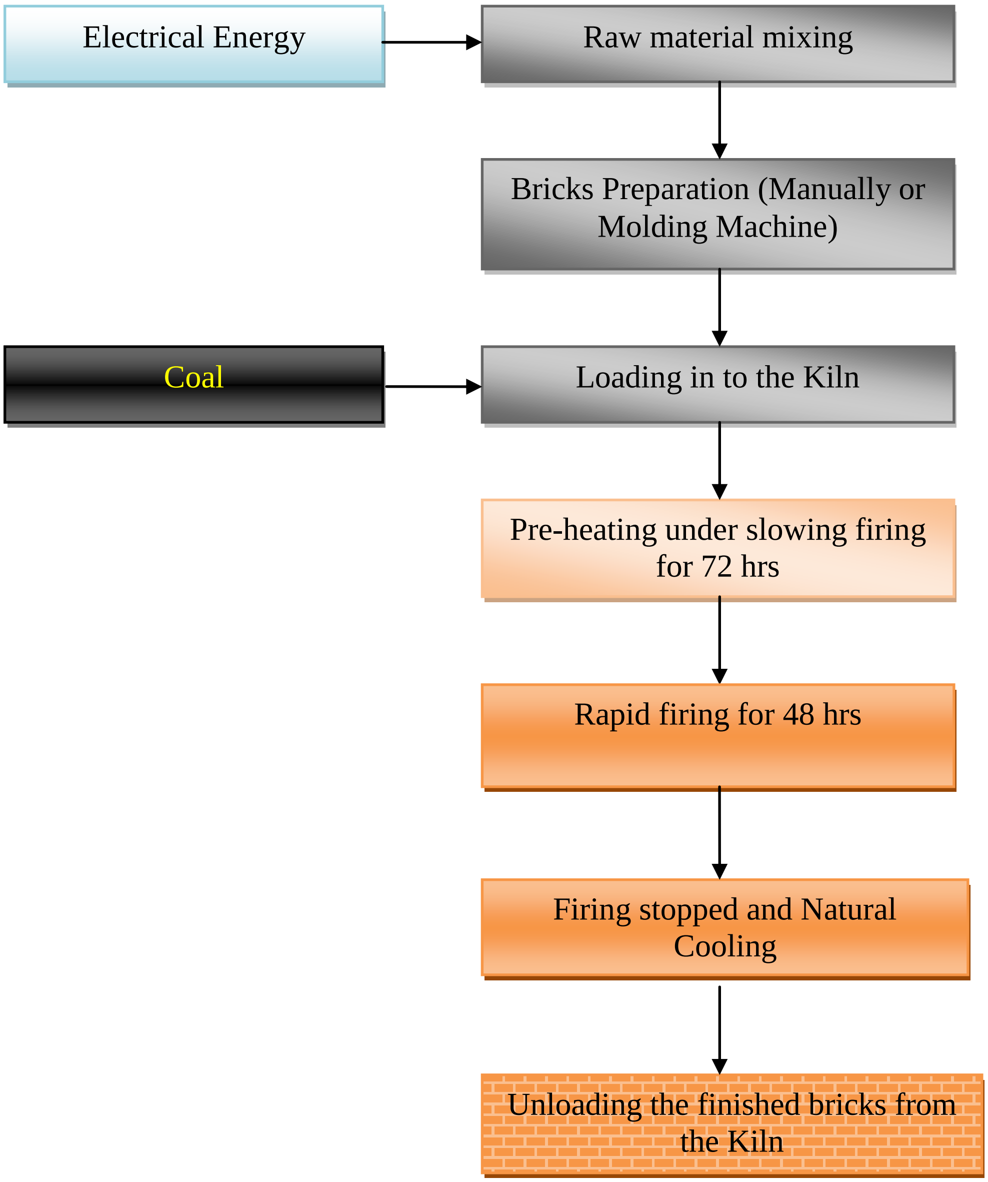
In each scenario, other inputs are assumed as constant.

### 4.5 Procurement and implementation schedule

The project is expected to be completed 8 weeks from the date of financial closure and release of work order to the supplier. The detailed schedule of project implementation is furnished in Annexure 5.

**ANNEXURES**

**Annexure 1: Process Flow Diagram**



## Annexure 2: Technology Assessment Report- WHR

| S.No | Parameter | Unit | Value |
|---|---|---|---|
| 1 | Quantity of Coal Consumption | kgs/batch | 45000 |
| 2 | Excess air measured | % | 30 |
| 3 | Theoretical Air required | kg/kg | 8.50 |
| 4 | Actual air quantity supplied | kg/kg | 11.05 |
| 5 | Total Quantity of flue gases | kgs/batch | 542250 |
| 6 | Average temperature of flue gases | oC | 650 |
| 7 | Temperature of flue Gas after WHR | oC | 210 |
| 8 | Specific heat of flue gases | kcal/kg oC | 0.29 |
| 9 | Waste heat recovery potential | kcal/batch | 69191100 |
| 10 | Efficiency of Heat Exchanger | % | 75 |
| 11 | Total heat can be recovered considering the Eff. of HE | kcal/batch | 51893325 |
| 12 | Equivalent coal savings | kgs/batch | 12355.6 |
| 13 | No. of batches per annum | No. | 30 |
| 14 | Coal savings per annum | kgs/annum | 370667 |
| 15 | Coal savings per annum | Tons/annum | 370.67 |
| 16 | Coal cost | `/ton | 4500 |
| 17 | Monetary savings | `in lakhs/annum | 16.68 |
| 18 | Investment required for WHR | ` in lakhs | 9.00 |
| 19 | Electricity consumption of the blower | kWh/Year | 26319 |
| 20 | Electricity bill | `.(in lakh)/year | 0.99 |
| 21 | Net monetary savings | `(in lakh)/year | 15.69 |
| 22 | Payback period | Year | 0.57 |

## Annexure 3: Technical Drawings of Waste Heat Recovery

Not available

## Annexure 4: Financial calculation

| ***Name of the Technology*** | ***Waste Heat Recovery*** | | |
|---|---|---|---|
| ***Rated Capacity*** | ***50 TPD*** | | |
| ***Details*** | ***Unit*** | ***Value*** | ***Basis*** |
| Installed Capacity | TPD | 50 | |
| No of batch | No. | 30 | Feasibility Study |
| ***Proposed Investment*** | | | |
| Cost of plant & Machinery | `(in lakh) | 7.00 | Feasibility Study |
| Erection & Commissioning | `(in lakh) | 1.00 | Feasibility Study |
| Applicable taxes | `(in lakh) | 1.00 | |
| Total Investment | `(in lakh) | 9.00 | Feasibility Study |
| ***Financing pattern*** | | | |
| Own Funds ( Internal Accruals) | `(in lakh) | 2.25 | Feasibility Study |
| Loan Funds (Term Loan) | `(in lakh) | 6.75 | Feasibility Study |
| Loan Tenure | Years | 5 | Assumed |
| Moratorium Period | Months | 6 | Assumed |
| Repayment Period | Months | 66 | Assumed |
| Interest Rate | % | 10.00 | |
| ***Estimation of Costs*** | | | |
| O& M Costs | %( on Plant & Equip) | 4.00 | Feasibility Study |
| Annual Escalation | % | 5.00 | Feasibility Study |
| ***Estimation of Revenue*** | | | |
| Coal Saving per batch | tons/year | 370.67 | - |
| Cost of coal | `./tons | 4500 | - |
| Electricity consumption | kWh/annum | 26319 | |
| Cost of electricity | `/kWh | 3.75 | |
| St. line Depreciation | % | 5.28 | Indian Companies Act |
| IT Depreciation | % | 80.00 | Income Tax Rules |
| Income Tax | % | 33.99 | Income Tax Act 2008-09 |

***Estimation of Interest on term loan*** ***`(in lakh)***

| **Years** | **Opening Balance** | **Repayment** | **Closing Balance** | **Interest** |
|---|---|---|---|---|
| 1 | 6.75 | 0.30 | 6.45 | 0.78 |
| 2 | 6.45 | 0.96 | 5.49 | 0.60 |
| 3 | 5.49 | 1.32 | 4.17 | 0.49 |
| 4 | 4.17 | 1.52 | 2.65 | 0.35 |
| 5 | 2.65 | 1.72 | 0.93 | 0.19 |
| 6 | 0.93 | 0.93 | 0.00 | 0.03 |
| | | 6.75 | | |

**WDV Depreciation** `(in lakh)

| Particulars / years | 1 | 2 |
|---|---|---|
| **Plant and Machinery** | | |
| Cost | 9.00 | 1.80 |
| Depreciation | 7.20 | 1.44 |
| WDV | 1.80 | 0.36 |

**Projected Profitability** `(in lakh)

| Particulars / Years | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | Total |
|---|---|---|---|---|---|---|---|---|---|
| **Revenue through Savings** | | | | | | | | | |
| Fuel savings | 15.69 | 15.69 | 15.69 | 15.69 | 15.69 | 15.69 | 15.69 | 15.69 | 125.54 |
| Total Revenue (A) | 15.69 | 15.69 | 15.69 | 15.69 | 15.69 | 15.69 | 15.69 | 15.69 | 125.54 |
| **Expenses** | | | | | | | | | |
| O & M Expenses | 0.36 | 0.38 | 0.40 | 0.42 | 0.44 | 0.46 | 0.48 | 0.51 | 3.44 |
| Total Expenses (B) | 0.36 | 0.38 | 0.40 | 0.42 | 0.44 | 0.46 | 0.48 | 0.51 | 3.44 |
| PBDIT (A)-(B) | 15.33 | 15.32 | 15.30 | 15.28 | 15.26 | 15.23 | 15.21 | 15.19 | 122.11 |
| Interest | 0.78 | 0.60 | 0.49 | 0.35 | 0.19 | 0.03 | - | - | 2.44 |
| PBDT | 14.55 | 14.71 | 14.81 | 14.93 | 15.07 | 15.21 | 15.21 | 15.19 | 119.67 |
| Depreciation | 0.48 | 0.48 | 0.48 | 0.48 | 0.48 | 0.48 | 0.48 | 0.48 | 3.80 |
| PBT | 14.07 | 14.24 | 14.33 | 14.45 | 14.59 | 14.73 | 14.74 | 14.71 | 115.87 |
| Income tax | - | 4.51 | 5.03 | 5.07 | 5.12 | 5.17 | 5.17 | 5.16 | 35.24 |
| Profit after tax (PAT) | 14.07 | 9.73 | 9.30 | 9.38 | 9.47 | 9.56 | 9.57 | 9.55 | 80.63 |

**Computation of Tax** ` (in lakh)

| Particulars / Years | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Profit before tax | 14.07 | 14.24 | 14.33 | 14.45 | 14.59 | 14.73 | 14.74 | 14.71 |
| Add: Book depreciation | 0.48 | 0.48 | 0.48 | 0.48 | 0.48 | 0.48 | 0.48 | 0.48 |
| Less: WDV depreciation | 7.20 | 1.44 | - | - | - | - | - | - |
| Taxable profit | 7.35 | 13.27 | 14.81 | 14.93 | 15.07 | 15.21 | 15.21 | 15.19 |
| Income Tax | - | 4.51 | 5.03 | 5.07 | 5.12 | 5.17 | 5.17 | 5.16 |

**Projected Balance Sheet**

| Particulars / Years | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| **Liabilities** | | | | | | | | |
| Share Capital (D) | 2.25 | 2.25 | 2.25 | 2.25 | 2.25 | 2.25 | 2.25 | 2.25 |
| Reserves & Surplus (E) | 14.07 | 23.80 | 33.10 | 42.48 | 51.95 | 61.51 | 71.08 | 80.63 |
| Term Loans (F) | 6.45 | 5.49 | 4.17 | 2.65 | 0.93 | 0.00 | 0.00 | 0.00 |
| TOTAL LIABILITIES (D)+(E)+(F) | 22.77 | 31.54 | 39.52 | 47.38 | 55.13 | 63.76 | 73.32 | 82.87 |
| Assets | | | | | | | | |
| Gross Fixed Assets | 9.00 | 9.00 | 9.00 | 9.00 | 9.00 | 9.00 | 9.00 | 9.00 |
| Less Accm. depreciation | 0.48 | 0.95 | 1.43 | 1.90 | 2.38 | 2.85 | 3.33 | 3.80 |
| Net Fixed Assets | 8.52 | 8.05 | 7.57 | 7.10 | 6.62 | 6.15 | 5.67 | 5.20 |
| Cash & Bank Balance | 14.25 | 23.49 | 31.95 | 40.28 | 48.51 | 57.61 | 67.65 | 77.67 |
| TOTAL ASSETS | 22.77 | 31.54 | 39.52 | 47.38 | 55.13 | 63.76 | 73.32 | 82.87 |
| Net Worth | 16.32 | 26.05 | 35.35 | 44.73 | 54.20 | 63.76 | 73.33 | 82.88 |
| Debt Equity Ratio | 2.87 | 2.44 | 1.85 | 1.18 | 0.41 | 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 | 2.25 | - | - | - | - | - | - | - | - |
| Term Loan | 6.75 | | | | | | | | |
| Profit After tax | | 14.07 | 9.73 | 9.30 | 9.38 | 9.47 | 9.56 | 9.57 | 9.55 |
| Depreciation | | 0.48 | 0.48 | 0.48 | 0.48 | 0.48 | 0.48 | 0.48 | 0.48 |
| Total Sources | 9.00 | 14.55 | 10.20 | 9.77 | 9.85 | 9.95 | 10.04 | 10.04 | 10.02 |
| Application | | | | | | | | | |
| Capital Expenditure | 9.00 | | | | | | | | |
| Repayment Of Loan | - | 0.30 | 0.96 | 1.32 | 1.52 | 1.72 | 0.93 | - | - |
| Total Application | 9.00 | 0.30 | 0.96 | 1.32 | 1.52 | 1.72 | 0.93 | - | - |
| Net Surplus | - | 14.25 | 9.24 | 8.45 | 8.33 | 8.23 | 9.10 | 10.04 | 10.02 |
| Add: Opening Balance | - | - | 14.25 | 23.49 | 31.95 | 40.28 | 48.51 | 57.61 | 67.65 |
| Closing Balance | - | 14.25 | 23.49 | 31.95 | 40.28 | 48.51 | 57.61 | 67.65 | 77.67 |

***IRR*** **` (in lakh)**

| *Particulars / months* | *0* | *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* |
|---|---|---|---|---|---|---|---|---|---|
| Profit after Tax | | 14.07 | 9.73 | 9.30 | 9.38 | 9.47 | 9.56 | 9.57 | 9.55 |
| Depreciation | | 0.48 | 0.48 | 0.48 | 0.48 | 0.48 | 0.48 | 0.48 | 0.48 |
| Interest on Term Loan | | 0.78 | 0.60 | 0.49 | 0.35 | 0.19 | 0.03 | - | - |
| Cash outflow | (9.00) | - | - | - | - | - | - | - | - |
| Net Cash flow | (9.00) | 15.33 | 10.80 | 10.26 | 10.20 | 10.13 | 10.07 | 10.04 | 10.02 |
| *IRR* | 149.04% | | | | | | | | |

| | |
|---|---|
| *NPV* | 50.35 |

***Break Even Point***

| *Particulars / Years* | *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* |
|---|---|---|---|---|---|---|---|---|
| ***Variable Expenses*** | | | | | | | | |
| Oper. & Maintenance Exp (75%) | 0.27 | 0.28 | 0.30 | 0.31 | 0.33 | 0.34 | 0.36 | 0.38 |
| Sub Total*(G)* | 0.27 | 0.28 | 0.30 | 0.31 | 0.33 | 0.34 | 0.36 | 0.38 |
| ***Fixed Expenses*** | | | | | | | | |
| Oper. & Maintenance Exp (25%) | 0.09 | 0.09 | 0.10 | 0.10 | 0.11 | 0.11 | 0.12 | 0.13 |
| Interest on Term Loan | 0.78 | 0.60 | 0.49 | 0.35 | 0.19 | 0.03 | 0.00 | 0.00 |
| Depreciation *(H)* | 0.48 | 0.48 | 0.48 | 0.48 | 0.48 | 0.48 | 0.48 | 0.48 |
| Sub Total (I) | 1.35 | 1.17 | 1.06 | 0.93 | 0.77 | 0.62 | 0.60 | 0.60 |
| Sales (J) | 15.69 | 15.69 | 15.69 | 15.69 | 15.69 | 15.69 | 15.69 | 15.69 |
| Contribution (K) | 15.42 | 15.41 | 15.40 | 15.38 | 15.36 | 15.35 | 15.33 | 15.31 |
| Break Even Point (L= G/I) | 8.74% | 7.60% | 6.91% | 6.04% | 5.03% | 4.03% | 3.89% | 3.93% |
| Cash Break Even {(I)-(H)} | 5.66% | 4.52% | 3.82% | 2.95% | 1.94% | 0.93% | 0.79% | 0.83% |
| Break Even Sales (J)*(L) | 1.37 | 1.19 | 1.08 | 0.95 | 0.79 | 0.63 | 0.61 | 0.62 |

**Return on Investment** **` (in lakh)**

| **Particulars / Years** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **Total** |
|---|---|---|---|---|---|---|---|---|---|
| Net Profit Before Taxes | 14.07 | 14.24 | 14.33 | 14.45 | 14.59 | 14.73 | 14.74 | 14.71 | 115.87 |
| Net Worth | 16.32 | 26.05 | 35.35 | 44.73 | 54.20 | 63.76 | 73.33 | 82.88 | 396.62 |
| | | | | | | | | | 29.21% |

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

| **Particulars / Years** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **Total** |
|---|---|---|---|---|---|---|---|---|---|
| ***Cash Inflow*** | | | | | | | | | |
| Profit after Tax | 14.07 | 9.73 | 9.30 | 9.38 | 9.47 | 9.56 | 9.57 | 9.55 | 61.51 |
| Depreciation | 0.48 | 0.48 | 0.48 | 0.48 | 0.48 | 0.48 | 0.48 | 0.48 | 2.85 |
| Interest on Term Loan | 0.78 | 0.60 | 0.49 | 0.35 | 0.19 | 0.03 | 0.00 | 0.00 | 2.44 |
| Total (M) | 15.33 | 10.80 | 10.26 | 10.20 | 10.13 | 10.07 | 10.04 | 10.02 | 66.80 |

***DEBT***

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Interest on Term Loan | 0.78 | 0.60 | 0.49 | 0.35 | 0.19 | 0.03 | 0.00 | 0.00 | 2.44 |
| Repayment of Term Loan | 0.30 | 0.96 | 1.32 | 1.52 | 1.72 | 0.93 | 0.00 | 0.00 | 6.75 |
| Total (N) | 1.08 | 1.56 | 1.81 | 1.87 | 1.91 | 0.96 | 0.00 | 0.00 | 9.19 |
| DSCR | 14.15 | 6.92 | 5.67 | 5.46 | 5.31 | 10.47 | 0.00 | 0.00 | 7.27 |
| Average DSCR (M/N) | 7.27 | | | | | | | | |

**Annexure 5: Procurement and Implementation Plan with Schedule**

| S. No. | Activities | Weeks | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 1 | Procurement of Materials | | | | | | | | |
| 2 | Fabrications | | | | | | | | |
| 3 | Trial Runs | | | | | | | | |

**Annexure 6: Technology/Equipment and Service Providers**

| Equipment details | Source of technology | Service/technology providers |
|---|---|---|
| Waste Heat Recovery System | Local suppliers are available | S.R.ENTERPRISES<br>(INSTRUMENTATION DIVISION)<br>G-4, Global Enclave, Bhagyanagar colony,<br>Opp: KPHB, Hyderabad-500 072<br>Tele / Fax: 040-2306 1973 Mobile: 94404 93650/ 9866771315<br>E-mail: srenterprise1999@rediffmail.com |

## Annexure 7: Techno-Commercial Bids

**S.R.ENTERPRISES**

**G-4, Global Enclave, Bhagyanagar colony, Opp: KPHB, Hyderabad-500 072**
**Tele / Fax: 040-2306 1973 Mobile: 94404 93650/ 9866771315**
E-mail: srenterprise1999@rediffmail.com

**QUOTATION : SRE/09-10/399**
**Customer Ref : Telecon**

March 22, 2011

**To**
**Vamsi Krishna**
**APITCO Ltd**
**Hyderabad**

**QUOTATION FOR WASTE HEAT RECOVERY SYSTEM**

| | |
|---|---|
| Supply of heat exchangers (3 nos), Air to air | Rs.7, 00, 000 |
| Total | Rs.7,00, 000 |

**Bureau of Energy Efficiency (BEE)**
(Ministry of Power, Government of India)
4th Floor, Sewa Bhawan, R. K. Puram, New Delhi – 110066
Ph.: +91 – 11 – 26179699 (5 Lines), Fax: +91 – 11 – 26178352
Websites: www.bee-india.nic.in, www.energymanagertraining.com

**APITCO Limited**
8th floor, Parisrama Bhavan
Basheerbagh, Hyderabad -500004
Phones: +91- 040-23237333, 23237981,
Fax: +91-40-23298945
E-mail: hyd1_apitco@bsnl.in
Website: www.apitco.org

**India SME Technology Services Ltd**
DFC Building, Plot No.37-38,
D-Block, Pankha Road,
Institutional Area, Janakpuri, New Delhi-110058
Tel: +91-11-28525534, Fax: +91-11-28525535
Website: www.techsmall.com