ADMINISTRATION MANAGEMENT & DEVELOPMENT OF SAIL-A STUDY

MAINTENANCE MANAGEMENT & PROJECT MANAGEMENT:

Maintenance Management In sail.
Project Management Safety & Environment.
Human Resource Management In sail.
Maintenance Management in SAIL

Introduction

Maintenance management is one of the most important functions in the management of any industry. It has direct impact on the productivity as well as profitability of the plant. Productivity depends on the availability of equipment in healthy condition and then profitable usage. Downtime for equipment due to any reason is a costly luxury, which we can ill-afford. A 10% non-availability of assets of SAIL would mean idleness of assets worth Rs. 1500 crores. Downtime of equipment is therefore a matter of serious concern to the management. Further, unplanned downtime in the form of breakdown is to be more seriously viewed as it dislocates the process and sometimes even damages the assets. It is therefore, one of the important roles of the maintenance to see that unplanned downtime is minimize.

Equipment installed in the steel plants are subjected to hard-working conditions characterised by fluctuating loads, thermal stresses, shock loading, dirt, fumes and gases. The equipments also are operated on a continuous duty cycle. The wear and tear is thus very intensive. All this calls for an efficient maintenance organization, flexible enough to match the needs of the production process and also contribute to the achievement of production targets and goals in terms of quality, quantity and other parameters.

In an integrated steel plant, various production departments are inter dependent and any disruption in one unit is likely to cause repercussions in the other. Thus, stoppage of one unit means much more than the production loss in that unit alone. In a single line production unit like Rolling Mills, even one mechanism or equipment can bring the whole mill to a grinding halt.

The inter-relation between production units becomes important while planning shutdowns. Maintenance organization takes this into account and plans jobs in such a way that it does not disrupt mainstream of production.

It is also necessary for the maintenance organization to keep costs low by controlling spares consumption, restricting purchase of stores and spares and utilising men and material resources effectively. This calls for high degree of competence and discipline.

Objectives

The objectives of the maintenance organization are broadly as under:

- To ensure equipment availability for target production.
- To preserve health of equipment for long and sustained outputs.
- To ensure reliability of equipment for the uninterrupted production.
- To ensure safe environment for personnel.
- To ensure operational readiness of all stand-by equipments, rescue units etc.

Maintenance Practices

Different types of maintenance systems that can be practised are:

- Centralised System
• De-centralised System
• Mixed System

Centralised System - In a fully centralised system, the complete functional as well as administrative responsibility of maintenance rests with the Maintenance Chief of the plant. The shop production heads do not bear responsibility towards maintenance and they are not answerable for equipment performance or fulfilment of repair schedules. The system has advantage of flexibility in resource mobilisation, standardised approach for system management, better inventory control, etc, but suffers from the disadvantage of lack of co-ordination between maintenance and production head, particularly at the shop level. Under this system, there is compete dependence on central authority.

Decentralised System - In this system, the complete responsibility of maintenance rests with the production chiefs and there is no centralised control. In such systems, specialised jobs are undertaken by contractual agencies and local expertise is least developed.

Mixed System - This is the combination of the two systems. Such a system exists at Bhilai, Bokaro, Durgapur and Rourkela Steel Plants but the degree of centralisation varies from plant to plant. In this system the primary responsibility for owning and maintaining the assets of a particular production shop is with the chief of that shop. The overall functional responsibility of maintenance of the plant however rests on the chief of maintenance of plant who has also under his control centralised groups of maintenance of plant and facilities for manufacture of spares and other specialised services. This system ensures (i) better co-ordination between operation and maintenance wings and (ii) better utilisation of manpower. Sufficient back-up is given by the Chief of Maintenance for meeting peak loads and in the areas of specialised expertise. The chiefs of shops have complete control over assets and are fully equipped with routine maintenance groups for carrying out normal maintenance. This system, however, has comparatively limited scope of pooling of resource.

Organization

In SAIL, the maintenance has been given high priority. The Operations Directorate has a separate wing which monitors the performance of the plants with respect to equipment availability/utilisation, completion of scheduled repairs and so on. There are regular review meetings at SAIL level to assess the performance and also draw out action plans. The maintenance plans are approved along with production plans as a single package so that there is an integrated approach for achievement of the overall goals of the company.

At the Shop level also, equal importance is given to the maintenance and production functions. The shift maintenance incharge and the production incharge are at the same level reporting to their respective incharges at Manager/Superintendent Level.

Systems

The following methods are used in practice for carrying out maintenance -

• Breakdown maintenance
• Preventive maintenance
• Predictive maintenance

Breakdown maintenance is event based and is generally carried out after failure of the equipment. Preventive maintenance on the other hand is time-based and endeavours to forestall unplanned downtime of machines. Predictive maintenance is condition-based.

The basic activities in preventive maintenance are:
• Periodic inspection of the plant assets and equipments to uncover conditions leading to breakdowns.
• Upkeep of plant to avoid failures of equipment or adjust / repair them while they are still minor. Thus, preventive maintenance, if carried out in time qualitatively, shall result in less number of breakdowns and interruptions.
• Predictive maintenance uses inspection data to predict when equipment will fail so that timely corrective actions can be taken to prevent failure. Thus, predictive maintenance is condition based and parts are replaced only when their condition indicates that they are nearing the end of their useful life.

In our plants, we follow, by and large, planned preventive repairs. Breakdown maintenance is applicable to few isolated non-critical areas. Predictive maintenance is gaining ground and the plants are implementing Condition Based Maintenance.

Scheduling and Planning

SAIL plants have adopted the policy of arranging planned and scheduled stoppages as the philosophy for maintenance. The major shut down of the equipments are planned before the beginning of the year on calendar basis and repair schedules are drawn which fixes the quantum of jobs and agencies. The planning follows a regular pattern but is reviewed every year to make mid-course corrections as required. For most of the equipments, the frequency for preventive repairs are fixed depending upon severity of service conditions and operation.

While arranging capital repairs several preparatory jobs are undertaken and meticulous planning is done for spares 6 to 18 months in advance. Modifications/ Maintenance works are carried out during these repairs so that the assets after such repairs are better than before.

Essential Ingredients in Maintenance

The following sequence of activity completes the maintenance cycle:
1) Inspection
2) Planning & Execution
3) Reporting & Documentation
4) Feedback to the System and Technical Improvements

I. Inspection

A sound inspection system forms a strong base for a good maintenance system. By knowing the condition of the equipment, breakdowns can be averted and jobs rescheduled so as to give less hold-up of production. Such inspection can be done by following the manual or with the help of gadgets when the equipment is running or
when idle. The inspection is to be done by experienced hands so that timely corrective actions can be taken up. One should also look for statutory violations and unsafe working conditions. The frequencies of inspection can be finalised depending upon the severity of the working conditions and its importance in the production environment.

II. Planning and Execution

Proper planning and scheduling of work increases productivity and reduces downtime through proper utilisation of resources. Maintenance planning activity is essentially based on past experience and time of undertaking a job can vary depending on the methods adopted and the strategy used. There is always room for innovation in undertaking maintenance jobs. Maintenance is attempted as far as possible as an off-line activity i.e. by using stand-by units, without affecting production. For on-line equipments, attempts are made to reduce the downtime. The methods used thus will vary as the situation demands.

Planning and preparation for shutdown is another area, which is crucial for the successful execution of repair. Keeping right spares in hand, adopting safety measures, placing right men on the job are essential for any maintenance job.

III. Reporting and Documentation

Maintenance jobs done have to be properly recorded for future reference. Such references are necessary to improve planning and also actual performances. Similarly, in case of premature failures, the past records provide valuable analysis.

IV. Feedback

Maintenance activity is aimed at preserving the health of equipment for long periods by giving engineering inputs at right time. This is possible only if there is a systematic feedback to update the system. After a repair is over, therefore, all elements of individual activity are noted and analysed and essentials recorded. This serves as a feedback to the system, which is constantly recorded. This serves as a feedback to the system, which is constantly updated as a result of such feedback.

Sudden or gradual failures of equipment are investigated thoroughly to establish cause of failure and identify measures to prevent similar occurrences. This too is a powerful feedback and covers almost all the tribological aspects, technology of working and rules of operation.

Captive Resources for Making Hardware

The requirement of spare parts and assemblies is met from the following three sources:-

1. Captive Shops;
2. Purchases from indigenous sources;
3. Imports

The main source out of the three, is the captive shops which have been provided in each of the steel plants. Captive resources include Foundries, Machine Shops, Forge Shops, Fabrication Shops and Electrical Repair Shops. These Central Engineering Shops undertake manufacture of new spares, repair of old spares, equipment and
generate necessary assemblies for replacement.

So far, a 2-tier system has been operating in the plants for meeting these requirements. Each major department is provided with a small repair shop to take care of fast wearing parts and minor spares and fabrications. The central engineering shops mentioned earlier manufacture new parts, undertake major repairs and revamping of old equipments. Some of the plants have gone in for the 3rd tier in series in the form of Area Repair Shops & Zonal Repair Shops. These Shops are mainly having facilities for machining and assembling and are primarily meant to take care of preparation of assemblies and sub-assemblies for replacement and are suitably placed so that they are within easy reach of the production centres.

In addition to the above, a need has been felt for establishing manufacturing facilities for complete equipment and major revamping of equipment at SAIL level. A Growth Division has been established with manufacturing facilities at Kulti. This enables SAIL to have in-house facilities for manufacture of equipments from indigenous sources which will help imports reduce. Growth Division shops also provide an inherent facility to experiment and adopt new technologies at a fast rate.

Maintenance Cost

Maintenance cost for the plant consists of two major factors, they are -

1. Labour
2. Spares, consumable & equipment

Whereas labour constitutes the fixed cost in which direct saving is not possible, there is always need for improving the output of men by adopting mechanisation; in repairs and refining the organization techniques and using more productive tools and tackles. With the ageing of the plant, equipment tends to throw up more and more volume of work. Attempts are made to contain this trend by improving labour productivity as mentioned above and also increasing the life cycle of equipment by utilising the potential of tribological efforts. In fact, the concept of maintenance-free equipment / spares is coming on the surface in the recent years which reflects the climax in this direction. This is an area where constant efforts shall have to be made in future.

The stores & spares consumption control is another area where lot of attention is paid in our plants with a view to keep the maintenance costs low, various techniques like Standardisation, Value Engineering, Inventory Control etc. are used in these areas to achieve results.

Future Trends

Computer Managed Maintenance System - A computer can handle large volumes of repetitive and time consuming tasks accurately over long periods of time and can process several jobs at a time almost simultaneously. These capabilities have been utilised in evolving an effective Computer Managed Maintenance System (CMMS).

The advantages of the computerised system are -

1. Instant communication to all levels of management
2. Optimisation of available resources of men and materials
3. Improved planning and scheduling
4. Ready accessibility to job backlogs
5. Improved inventory control due to instant access to stock data
6. Overall improvement in system and time management for purposes of implementation, CMMS is divided into following sub-systems modules -

Equipment classification, Maintenance Planning, Execution, Monitoring, Evaluation and History, Captive Shops schedule and manufacture of spares for optimum utilization, Material Planning / Purchasing & Stores Control System

*Predictive Maintenance* - Predictive Maintenance is a technique of recent origin meant to time the maintenance activity only when it is really required on the basis of a scientific analysis and prediction over a possible equipment failure. The approach is to - Conduct on-stream inspection through specialised gadgets, Use permanent condition monitoring instruments, Statistical analysis of failures, frequency of interruption in production etc.

The techniques are –

I. **Vibration Monitoring Analysis**

Every equipment in motion causes a vibration and can be characterised by the frequency amplitude and the phase of the wave. When a machine is operating normally, the pattern of vibration is recorded as vibration signature. The deviations are registered on a vibration analyser and this lead to corrective action. This process is called vibration analysis.

II. **Shock Pulse Analysis**

Shock Pulse meters are the instruments to monitor shock pulses generated when rotating elements encounter surface discontinuities. Bearing damages are often indicated by the Shock Pulse meters.

III. **Ultrasonic**

The techniques is useful to survey wall thickness of vessels, pipings, etc, to detect cracks and to determine extent of corrosion / erosion at vulnerable areas.

IV. **Infrared Heat Detection**

Use of infrared pictures or thermography is used for heated spot detection. This is particularly useful when temperatures are high and conditions cannot be known of happenings inside the furnace etc.

V. **Eddy Current**

An Eddy Current Tester is useful in the inspection of defects of non-magnetic pipe tubes of heat exchangers or other units. The predictive maintenance technique is adopted selectively after studying behavioural pattern of the equipment and costs involved in the application. Such systems have been found very suitable in a large number of applications.

The concept of hands-off maintenance or design-out maintenance is an approach to provide total reliability of an operation for the complete life cycle of an equipment by taking care at the design stage itself. When applied to a total equipment such designs are necessary in case of space crafts, missiles and rockets etc. Costs are apparently high.
Mechanical Shops

All SAIL plants have been provided with Central Engineering Shops to facilitate repair / re-conditioning of components, sub assemblies and assemblies as well as a substantial part of their spare requirements. In addition, in Bhilai and Bokaro, are with Area Repair Shops to cater to the requirements of the departments.

Efficient operation of an integrated steel plant depends upon the proper upkeep of equipment with efficient maintenance systems and facilities. Any deficiency in this can result in costly and prolonged down time, postponement of scheduled maintenance and inefficient operation.

The demands placed on the Engineering Shops are indeed highly challenging and the shops have to strive hard to meet these demands.

The shops usually consists of -

*Machine Shop* - With light and heavy Machining Section equipped with lathes, planers, horizontal and vertical boring machines, slotting machines, grinders.

*Tool Room* - With necessary heat treatment facilities, milling and grinding machines.

*Forging Shop* - With steam hammers, pneumatic hammers.

*Structural Shop* - With profile cutters, plate benders, shears, welding machines of different types, hydraulic press etc.

*Fitting & Assembly* - With heavy lift, overhead cranes, hydraulic press, portable machines etc.

All the above shops are properly equipped with material handling facilities like overhead cranes, transfer cars etc. and bays for keeping the ready items as well as receipt of defective units for repairs.

Another important section of the Auxiliary Shop is the Foundry and Pattern Shop. Arc Furnaces and Cupolas, Core Shop, Casting bay, Fettling Shop, Auxiliary Furnaces are part of Foundry Shop.

Apart from producing Ingot Moulds and Bottom Plates vitally required for the Steel Melting Shop, the foundries also produce various iron castings, steel castings and non-ferrous castings to meet the regular spare parts requirements of the Steel Plant.
Project Management

Introduction
An industrial organisation begins to die once it ceases to grow. Growth may be inhibited by various factors including market constraints or geographical constraints of the organisation. Modern technology may overcome these obstacles by breaking in new areas of business both domestic and foreign.

The basic tool for industrial growth is through management of projects, well conceived with timely start and in-time completion. The basic input costs often escalate and threaten the profitability of high investment projects. Hence a constant vigil has to be kept to offset the incidence of higher input costs over profitability. An ideal project is short-lead, low value and high profitability project. Project cost seldom remains at low level. Hence the challenge of Project Management is to complete the project within shortest possible time and within the estimated cost.

In SAIL, the projects have been classified into the following heads:

- Expansion
- Modernisation
- Additions, Modifications and Replacements (AMR)
- Debottlenecking
- Special assignments
- Statutory Requirement
  - Environment
  - Safety

Classification of Major Projects in SAIL

Expansion Projects - Demand and supply gap of a product in the market initiates an expansion programme. Keeping in mind the shortage, a proper technology is to be selected which will give product of low cost and better quality and will involve minimum capital expenditure and shortest project duration.

Modernisation Projects - Our SAIL plants came into existence from end-fifties. Probably SAIL being first generation steel makers at that time, the futuristic technologies were not installed. Most of our plants are of energy intensive technology.

Modernising a plant sometimes involves complete replacement of major assets and technology. If the plant is very old, sometimes it is imperative that a scrap and rebuild philosophy is adopted. This would evidently require a massive capital investment. Such projects would not become viable unless during this modernisation plan, very up-to-date technology with moderate dose of automation is put in along with enhancement of capacity and design for high efficiency energy saving methods.

Addition, Modifications and Replacements Projects - In operating the existing plant over the years, it is sometimes seen that to sustain production at high levels and to increase productivity and to improve profitability, certain amount of technological addition or modifications in equipment and process are required. In SAIL, while replacement action is taken, latest equipment of higher efficiency is attempted to be chosen.
Identifying a Project and its Selection - A project is identified from the problems of existing installation, future threats to the industry etc. and various alternates of solutions are made. First attempt is to examine whether with existing assets, by proper rationalization of management systems could results be achieved; failing this, examination is made in the direction of capital investment to augment or modernise the production units.

When a project is identified, the source of financing and pattern of financing is to be first determined for investment decision. A close watch, on the technology to be employed, trends in the market and economic environment, is essential in identifying investment opportunity. The cost of investment and likely revenues in future is required to be assessed. Before taking an investment decision, the infrastructure to undertake the project from the organisational and human resources point of view is to be assured.

Sanction of Projects - Sanction is given on the basis of investment yield and economic benefits and after the authority examines the investment risk. National priorities and investment yield in financial and economic terms are examined by the Public Investment Board in sanctioning a project.

Importance of Time Factor & Boundary - The viability of the project through Internal Rate of Return is based on the following:

- Capital cost estimate of investment
- Phasing of expenditure (Cash outflow)
- Time for project construction and commissioning date
- Estimate of gestation period (learning curve)
- Realization of rated output and productivity
- Maintenance and health of equipment of plant in order that project life span originally envisaged do not get shortened

Capital cost estimate of project is the arithmetic sum of the annual cash outflows from start of project to the end of construction. Phasing of expenditure will determine the NPV of cash outflows. If time of construction increases, NPV of cash outflow increases. If gestation period is enlarged or project does not achieve rated output the stipulated NPV of cash inflow diminishes. Thus total NPV at the commissioning date reduces from the original value, adversely affecting the investment yield i.e. the IRR.

Reasons for Time and Cost Overrun - There are a number of problems which have been responsible for time and cost overrun of projects as under:

- Approval sought for the project on the basis of feasibility study. Feasibility study is seldom accurate in projecting the work volume and thus both cost and time estimates become invalid.

- Zero date of project starts from the approval, but the kick-off for construction work starts much later (Generally no interval is provided in the time estimate between the approval of the project and the commencement of construction work).
• Estimates are made on adhoc basis
• Time estimates are also made based on adhoc volume of work
• Technology selection and matching with existing services and Plant is done later thus mid-stream change in work volume in technological units takes place
• Project personnel work in isolated compartment de-linked from operating technology group
• Ownership of project rests with project department only. Shadow of existing practices looms over new technology thus inhibiting free acceptance of new equipment, resulting in delay start-up and takeover
• Training and placement of operating personnel not given importance in time thus long gestation period
• High degree of dependence of indigenous equipment manufactures, no proper technology base and infrastructure but only having large capacity works
• Employment of primitive construction methods

Project Management Challenges and Problems - Restricting ourselves in the area of brown field projects, challenges of the project management are given below:
• Finalisation of layout keeping in view of operations of the existing plant
• Various temporary diversions of utilities and facilities of the existing plant to clear the project site
• Determining the better limits of the project facilities with respect to the existing assets / service
• Selection of appropriate technology to match the existing one
• Overcoming physical and mental barriers to induct modernised concept
• Accurate determination of quantities of work and projection of realistic time frame of implementation
• Deciding the agencies for equipment supply and construction work who are capable to operate within construction time frame
• Realistic estimate of project cost
• Co-ordination within management (Project, Operation, Materials, Finance, Administration and Personnel) and outside between consultants, equipment suppliers, construction agencies and their sub-vendors and labour.
• Co-ordination with State Government and statutory authorities
• Dynamic decision making to combat probable daily follow-ups in interdisciplinary priorities arising out of schedule upsets, design changes and topographical problem.

Project Management in SAIL

Analysis of the project management history with its shortfalls are undertaken by the Project Directorate of Corporate Office in participation with the heads of projects of all the SAIL units.

An action plan to overcome the shortcomings has been made and following decisions have been taken.

Integrated Project Management - Integrated project management system has been introduced in Durgapur Steel Plant for the first time in SAIL. Responsibility and accountability hitherto resting on Project Development alone has been supported by the important functionaries like Finance, Materials, Personnel and Administration.
Each project unit had its own Finance, Materials and Personnel heads so that all the management functions in the project work was integrated for a common task. The administrative lead time had thus been minimised.

Creation of Centralised Data-base - This is for realistic estimates of cost and time. Vendor rating is another very important input to project management. In the large SAIL family if an introspection is made and a data base is created, decisions on vendor selection will be dramatic. Some of the other steps taken are enumerated below:

- Training from well organised projects
- Improvement in work culture
- Productivity
- Quality Control
- Technological discipline
- Cost reduction & elimination of wastes
- Communication workshops
- Cost control and time management through micro-level planning and monitoring
- Adoption of accountability in miles-stone completion. Commitments are given for completion of major miles-stones or project

Annual Implementation Plan - In every unit of SAIL, an Annual Implementation Plan is made for the various projects in hand.

Both physical and financial targets are monitored every month at corporate level and daily basis in unit levels. The MOU signed with the Ministry has given significant emphasis on this aspect.

Annual Capital Expenditure Budget - Each year in the month of September, budgets are prepared scheme wise at unit level for next financial year. Network based fund requirement is examined and approved by Project Directorate / Steel Ministry / Planning commission. After in depth discussion and justifications the budget is approved.

Conclusion

Thus, Project management encompasses a wide spectrum of work, starting with conception and formulation of project, its approval and execution, upto the state of commercial operation. The aim at each stage is to ensure fulfillment of project objective on scheduled time and at the estimated cost and also to meet desired performance. This requires down to earth thinking, realistic vision and the strictest control. The variables are too many and their effects on the industry and the national economy are far too great. The project management is therefore a challenging assignment.
Safety and Environment Management

Introduction

Safety
SAIL gives adequate emphasis on safety of human resources and assets of the Company along with production and productivity, cost reduction and quality. SAIL has Safety Departments in all the Plants, Subsidiary Units and Mines to look after safety management of the respective Plants and Units. In 1988, a Corporate Safety Unit named SAIL Safety Organisation (SSO) was set up to coordinate and monitor the safety activities and to provide appropriate corporate thrust on safety management in Company.

SAIL has a Safety Policy. In consonance with the Safety Policy of the Company, safety programmes and safety activities are organized in SAIL Plants/Units. Substantial improvements in safety performance was possible through formulation of action plans covering safety and fire services and close follow-up for time bound implementation, spread of ‘Risk Control Grading System’ from Bokaro Steel Plant to major hazards units of SAIL and conducting statutory safety audits.

The major areas of function are:

1. To coordinate, monitor, promote and enhance the safety, fire services standards of Plants/Mines.
2. Formulation of corporate safety action plan.
3. Development of policies of systems and procedures for workplace improvement.
4. Advice to Plants/Units/Mines in matters relating to safety.
5. Competence through training that includes the development and empowerment of employees.
6. Encouraging awareness and responsibility among employees.
7. Tracking of performance – specifically by organizing meetings and discussions.
8. Maintaining Incident/Accident Management Information System.
10. Carrying out secretarial functions of JeSSI.

The major Accident prevention measures by SSO are:

Preventive measures for avoiding accidents at work sites receive topmost priority in the safety management programme by SSO like:

1. Conducting Hazard Operatability studies, Job Safety analysis and Hazard analysis to identify hazards and suggest preventive measures.
2. Investigation of fatal accidents, to find out causes and suggest remedial measures to avoid recurrence.
3. Organising safety training programmes for Sr. Line Managers, Line Managers, Safety Officers and Inspectors and opinion makers.
4. Introducing system of internal benchmarking in safety (intra and inter plant).
5. Inclusion of safety as a factor in PAR of executives.
7. Computing of cost of accidents for all injury on works cases.

Awareness generation efforts through celebrating National Safety Day and organizing competitions through JCSSI like safety essay, poster, calendar and rewarding to best performers. A unique feature of safety management in steel industry is that a bipartite forum named Joint Committee on Safety, Health and Environment in Steel Industry (JCSSI) was formed in 1973 at national level having representatives from Steel Plants of SAIL as well as TISCO, RINL, Dastur Co. and HSCL. All the Central Trade Unions are represented on this Committee. With a view to inculcate safety consciousness, JCSSI organizes seminars, workshops, training programme, safety competition like poster designs, calendar designs and essays for the employees of its member organizations. It has also brought education materials like manuals, booklets, DO's and DON'T's, safety codes and practices etc. from time to time. JCSSI with the co-operation and support of Trade Union representatives formulates policies and guidelines for its member plants. Implementation of these guidelines is monitored through two sub-committees on Plant Safety and Construction Safety. SAIL and JCSSI put together conduct interplant competitions on safety issues and give awards like Steel Minister’s trophy, Chairman’s SAIL Silver Plaque for ‘No fatal accidents’ and ‘Ispat Suraksha Purashkar’ for Plants and Mines to the winning plants, mines and individuals.

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<th>Safety Policy</th>
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<td><strong>Steel Authority of India Limited (SAIL)</strong> is committed to:</td>
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<td>• The safety of its employees and the people associated with it including those living in the neighbourhood of its Plants, Mines and Units.</td>
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<td>• Pursue the safety efforts in a sustained and consistent way by establishing safety goals, demanding accountability for safety performance and providing the resource to make safety programme work.</td>
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<th>Guiding Principles</th>
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<td>• We firmly believe that all accidents are preventable.</td>
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<td>• All employees are responsible and accountable for maintaining laid down safety standards.</td>
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<td>• Safety standards shall be incorporated in all our work procedures.</td>
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<td>• Imparting training to create safety consciousness and to work safely shall form key elements of our safety programme.</td>
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<td>• We shall make collective efforts to enhance safety through participative safety committees and fora.</td>
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<td>• We shall perform all works in consonance with the Local, State and Central Acts, Rules and Regulations on Safety.</td>
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<td>• Comprehensive audits of the safety performance shall form an essential part of our safety programme.</td>
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<td>• Continuous improvement in safety performance is necessary for our success.</td>
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Environment
The industrialisation in India for its economic growth, apart from its advantages, has brought pollution problems in the environment. Awareness about control of this pollution in industries has increased today, both in public sectors as well as in Government. SAIL, one of the major public sectors in India, has adopted pollution control as one of the thrust areas to give better working environment, in and outside its units thereby achieving increase in production. SAIL has set up a multi level organisation “Environment Management Division” at Calcutta. This division started functioning from 28th June, 1988. This division functions under the Directorate of Corporate Planning and is headed by a senior executive, and is coordinating the Environment Control Departments (ECDs) at Plants with well trained executives. Some of them are experienced executives drawn from the Plants while others are specialised in Environmental Engineering.

Objectives of EMD
To develop data bank and expertise:
- On existing legislation and information on environmental protection stressing on pollution control in the plants, for coordinating with statutory Authorities.
- On latest trends and developments in the pollution control and waste management technology and techniques.
- To assist Steel Plants in implementation and transfer of latest technology and details of the special equipment in the relevant areas.

Monitoring and control of pollution
- Continuous monitoring of the environmental impact due to plant’s operation and bringing it within the acceptable limits.
- Identifying action plans for both short term and long term monitoring facilities and controlling measures of pollution for different units.

An environment policy in SAIL has been made and it is given in the following table.

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<td>Environmental Policy</td>
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We, the Steel Authority of India Limited (SAIL), manufacture various products of iron and steel. We have four integrated Steel Plants and two special Steels Plants along with captive mines for iron ore, lime-stone and dolomite. We also have an extensive marketing spread across the length and breadth of the country.

We believe that contributing towards a clean and sustainable environment is one of our prime responsibilities. We also believe that resource optimisation and environmental protection are fundamental for sustaining all our business activities.

We, therefore, commit to:
- introduce sound environmental management practices in all our activities
- conduct our operations in an environmentally responsible manner to comply with relevant regulations
- progressively replace the pollution prone processes by cleaner, energy efficient technologies
• minimise waste generation and promote recovery, recycle and reuse
• increase greenery in and around our plants and mines
• strive for continuous improvement in our environmental performance by setting challenging targets
• conduct necessary programmes to enhance environmental awareness amongst our employees and the general populace around the plants and mines
• encourage our subsidiaries and business associates to adopt similar approach for environmental protection
• review the policy periodically and update the same

Pollution contributed by various departments of Steel Plant

Bye-Product & Coke Oven:
Particle emission of different size ranges, visible smoke, hydrocarbons, carbon monoxide, sulphur dioxide, Hydrogen sulphide and other originate from the following by-product and coking operations:
a) Material handling operations, like unloading, storing, crushing, and loading of cokes.
b) Oven charging, coke pushing, and quenching.
c) Leakages around poorly sealed coke-oven doors and lids.
d) Drawing gaseous emissions to a collecting main for separation of Ammonia, Coke-oven gas, Tar, Phenol, Light Oil which causes gaseous pollution.

Sinter Plant
The sintering process fuses some collected dust, fine ore, coke fines and scales into a stable mass called Sinter which is suitable for a Blast Furnace charge, emissions from sintering plant take place from the material handling dust control system. Particles customarily pass through dust collection system before being discharged to the atmosphere.

Calcining Plant
Atmospheric emission from calcining units of any iron and steel plant includes particulates matters from the handling, crushing, screening, conveying, transfer points, calcining of limestone and combustion products from the kiln. The vertical kilns because of the large particle size of charge matter, lower air velocities and less agitation during calcination have considerably less particulate emissions. The rotary kilns create more air pollution problem because of the smaller particle size of charge with more agitation, higher rate of fuel consumption and greater air velocities through the rotary chamber.

Blast Furnace
Blast Furnace emission consists of 35-50% Fe, 4 to 14% carbon, 8 to 13% SiO₂ and in small amount of the oxides of aluminium, manganese, calcium and other materials. The carbon monoxide content of the Blast Furnace gas is quite high. Gases like sulphur dioxide and carbon monoxide are also found in the monkey hole and tepehole area around the platform and the stoves.
Steel Melting Shop

There are several processes for steel making but the most common ones in practice in any modern steel plant are; O.H. Faces, L.D. Converters and Electric Arc Furnace.

Each of the different processes is a potential source of air pollution. The nature of pollution is indicated below:

Open Hearth
i. Particulate matter emission contain 45% to 50% Iron Oxide.
ii. Some amount of Flouride (if Flouride is used in the charge) may be emitted.

LD Process
i. Particulate emission chiefly consisting of Iron Oxide, although some amount of Flouride may be present.
ii. 7.0 Kg/ton carbon monoxide is generated.

Electric Arc Process
i. Particulate emission consists mainly of Iron and SiO₂.
ii. 7.5-10 Kg/ton carbon monoxide is generally emitted.

Foundry
Potential sources of particulate emissions of foundries are the cleaning of sand and the casting operations. Generally cupola's reverberatory and electric induction furnaces are used to produce gray iron casting. Emission from Cupola include gases, dust, fume, smoke and solid vapours, emission from electric induction furnaces consist of metallurgical fumes.

Conclusion

With the enactment of comprehensive Anti-Pollution Act by the Central Govt. and the laying down of tolerance limits for various discharges by the Central as well as State Pollution Control Boards, SAIL – as the sole custodian of Public Sector Steel Plants identified environment managements as one of the key thrust areas.

The setting up of Environmental Management department in different Steel Plants with well defined tasks and responsibilities, Central Environmental Management Division at Calcutta and Environmental Waste Management Laboratory at RDCIS, Ranchi are steps in that direction.

SAIL has also entered into MOU with different worker’s Union for ensuring a clean safe and decent ‘Steel Environment’ for the steel collective in order to improve quality of life, work culture of productivity. SAIL is becoming a pioneer and a trend setter in the field of Environmental Control amongst the public sector undertakings in this country. The ensuing modernisation programme of different steel plants will bring about ecological modernisation with massive investments for pollution control technology.

Environmental pollution control with the participation, education and training has become a mass movement in SAIL.
Marketing Management

Marketing
The Marketing function of SAIL represents an important interface of the company with its customers. This function has assumed critical significance in the past few years. In 1991 the business environment underwent a radical change in the Indian Steel Industry and particularly so for SAIL. It moved from a controlled era to a free market when the competitiveness of marketing activities necessitated SAIL to respond to the needs of the market immediately. Initially starting with selling of 55,700 tonnes of Pig Iron and 70,000 tonnes of steel in 1959-60, SAIL has reached to the level of 10.07 MT of saleable steel in 2002-2003. This has been made possible through a highly effective marketing efforts of SAIL.

The Central Marketing Organisation (CMO) earlier known as Central Sales Organization (CSO) of the then Hindustan Steel Limited was formed in 1963 to facilitate the marketing of different products of all the Steel Plants in a coordinated manner. Since then, CMO has grown into a vast organisation with a network of 35 branches all over the country. The CMO Headquarter is situated in Kolkata.

The Organization Structure of CMO is as follows:

CMO is now certified to ISO 9001:2000 Standard.
Role and Functions

The role and functions of Marketing in SAIL are as follows:

Commercial Directorate - It formulates corporate policies and strategies on commercial matters and gives directions to Central marketing Organisation. It also oversees the achievement of annual sales targets and plans, export / import policies etc.

Central Marketing Organisation - This is the marketing wing of SAIL. All saleable products of SAIL are marketed through this Unit. A network of 35 branches are grouped under 4 regions.

Major functions are -

Sales and after Sales Service Market Research, Demand Assessment, Segment prioritisation, Product Planning, Logistics Distribution etc. CMO has a network of sales offices and stockyards within the country for purposes of sales of materials from these outlets. The other aspects controlled by CMO’s work are Planning, Customer Service, Transport and Shipping, Data & Information Systems etc.

The sale of Iron and Steel products is done by the CMO through its branches and stockyards located in all important steel consuming centres in the country. For administration purposes, the branches are grouped under 4 regions. The sales through the stockyard are now of the order of 55% and through direct despatches by the plant 45%. They see that the movement of the products is fast and the customers are satisfied.

Plant Level Marketing

Plant marketing departments / production planning control departments / sales coordination departments liaise between the production shops and CMO to ensure the fulfilment of APP. In addition, plant marketing departments are also engaged in selling of scrap, arising and defectives, directly from the plant.

Customer Orientation

Earlier, the steel plants were in a sellers market and not much attention was paid towards satisfying individual customer needs. Today without a satisfied customer, no organisation can survive. SAIL has regular interactions / meetings with customers to ensure total satisfaction for customers, which requires supply at the right time, at the right place for the right application at the right price.

The marketing policy of SAIL envisages a sustained relationship with the customers
through long-term contracts, annual contracts and quarterly contracts for sale of various products. In the last 2/3 years, the concept of key customers and MOU booking are in vogue with a view to satisfy the needs of the customer and also develop and retain clientele on long-term basis. Details of consuming industries of major products are-

<table>
<thead>
<tr>
<th>Products</th>
<th>Consuming Industries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pig iron</td>
<td>Foundries / Spun Pipe Manufactures</td>
</tr>
<tr>
<td>Plain Rounds</td>
<td>Bright Bar / Fastener Manufacturers</td>
</tr>
<tr>
<td>TMT Bars</td>
<td>Construction</td>
</tr>
<tr>
<td>Wire Rods</td>
<td>Wire Drawing Units</td>
</tr>
<tr>
<td></td>
<td>Reinforced Concrete Pipe Manufacturers</td>
</tr>
<tr>
<td></td>
<td>Electrode Manufacturers</td>
</tr>
<tr>
<td></td>
<td>Fastener Manufacturers / Bright Bar Manufacturers</td>
</tr>
<tr>
<td>HR Coils / Skelp</td>
<td>Tube Makers</td>
</tr>
<tr>
<td></td>
<td>Cold Rolled formed Section Manufacturers</td>
</tr>
<tr>
<td></td>
<td>Hamilton Pope manufacturers sponsored by P&amp;T Department</td>
</tr>
<tr>
<td></td>
<td>Wheel Manufacturers</td>
</tr>
<tr>
<td></td>
<td>CR Coils / Sheets / Strips Manufacturers</td>
</tr>
<tr>
<td>HR Sheets in LPG Quality</td>
<td>LPG Cylinder / Pressure Vessel manufacturers</td>
</tr>
<tr>
<td>CR Coils</td>
<td>Galvanised/ Coated Sheets Manufacturers, Drums and Barrel Manufacturers, Automobile Industry Precision Tube Manufacturers etc.</td>
</tr>
<tr>
<td></td>
<td>Furniture manufacturers, Refrigeration Industry</td>
</tr>
<tr>
<td>Billets/ Bloom/ Slabs/ Ingots</td>
<td>Re-rolling and forging Industry etc.</td>
</tr>
<tr>
<td>Wheels/ Axles/ Rolls/ Other</td>
<td>Railways</td>
</tr>
<tr>
<td>Structural / Plates</td>
<td>Fabrication, TL towers etc.</td>
</tr>
</tbody>
</table>

**Key Accounts Management**

SAIL has also started a comprehensive ‘Key Account Management’ (KAM) programme for its customers. Currently, only 2% of our customers (around 165) account for more than 50% of our sales. To protect these large customers from competition, we need to correct anomalies in the existing accounts management process. For example, at present, large customers who buy multiple products from us have to approach separate salespersons. In addition, salespersons spend far too much time with small customers. In some branches, only one or two salespersons handle most of the large accounts yielding up to 80% of sales.

The proposed KAM process will be implemented with involvement of both CMO as well as Plant personnel. The team would be responsible for ensuring reliability on quality and delivery of products to the key customers. As a consequence, we should be able to improve our share with them, as well as NSR due to better service. We
plan to accomplish increased sales of 5 - 10% to the top 165 customers by the end of the financial year.

**Various Divisions of Central Marketing Organisation**

The following are the major divisions of the Central Marketing Organisation:

*Product Management Group* - The main function of this department is to bring about coordination between the market demand and production of the steel plants. This department also supervises the product management function ensuring competitiveness of our products and monitors segment-wise and region-wise despatches of materials based on market demand. The four Sales Resident Managers of the Central Marketing Organisation located in four Integrated Steel Plants located at Bokaro, Bhilai, Durgapur and Rourkela also report to this division. The Sales Resident Managers interface with the steel plants in respect of matters relating to marketing and bring about day-to-day coordination in movement, despatches etc.

*Pipes, Electrical Steel Sheets and Tin Plates Division* - Headquarter of this set-up is located at Calcutta. These materials have to be marketed under highly competitive conditions. This division works out marketing strategies and looks after sales of these products. This division has a field set-up at each of the Regional Headquarters as well as at major centres of consumption.

*Marketing Services Division (MSD)* - This division looks after the Management Information System (MIS) functions at Calcutta. The operation of this division is supported by a Computer Centre where data on marketing operations throughout the country are processed on a regular basis to bring out periodical MIS reports. The responsibility for working out details and informing policy / procedures for Road Movement, Handling Contract systems etc. are also with them.

*Commercial Division* - This division deals with formulation of policies and also with pricing. This division also deals with Parliament Questions on behalf of Central Marketing Organisation.

*Application Engineering Group (A.E.)* - This division deals with application engineering function which includes advising customers about selection of most suitable steel materials, development of new products required by the market etc. It also undertakes technical inspection on behalf of the Central Marketing Organisation wherever needed. The Application Engineering Group personnel are posted at each regional headquarters.

*Fertilisers and Chemicals Division* - This division is headquartered at Calcutta and looks after the distribution of Calcium Ammonium Nitrate (CAN) produced by Rourkela Steel Plant and Ammonium Sulphate produced by all the steel plants. This division has got offices at field locations where the demand for fertilisers is substantial.

*Market Research Group (MRG)* - This division undertakes assessment of demand for pig iron and steel products, for long-term perspective and advises management about the market. This division brings out periodic reports covering various aspects of consumption, market condition, competitor activities etc. They have field representatives for collecting and forwarding market intelligence to the headquarters.

*Transport and Shipping Department* - This department is headquartered at Calcutta.
and has branch offices at major port areas. This division is responsible for handling imports and exports on behalf of SAIL. This division clears the coal imported for Steel Authority of India Ltd., at the port and forwards the same to various steel plants. This division also clears and forwards general cargoes and plants and machinaries, spare parts etc. for the steel plants. It arranges for shipment of export cargoes on behalf of SAIL.

*Finance & Accounts Department* - This department renders financial advice to the Line Managers as well as CMO headquarters and maintains the accounts of the organisation covering Home Sales, Transport & shipping, Exports, Residual imports, Internal Audit etc.

*Computerisation Division (EDP)* - This division is headquartered at Delhi and reports to General Manager (EDP). This division is in charge of the ongoing project for total computerisation of CMO at headquarters, field offices and SRM in the plant locations. At present, this division is responsible for hardware and software maintenance also. Software Development Centre at Hyderabad is engaged in developing and updating software required for CMO marketing.

*Legal Cell* - This Cell deals with all legal matters of CMO like court cases, arbitration, examination of different documents for giving loans to employees for house building and renders legal advice on various transactions.

*International Trade* - This department is headquartered at Delhi in Commercial Directorate and is in charge of the export and import operations of SAIL.

*Special Projects Division* - This division is headquartered at Delhi and reports to Director (Commercial). This division deals with modernisation of stockyards, giving technical help and assistance to the stockyards in maintenance of handling equipment etc. This department also deals with construction of office building of Central Marketing Organisation and acquisition/construction of residential accommodation etc.

*Regions and branches* - As mentioned about there are 35 branches under four regions which are located at Northern (Delhi), Western (Mumbai), Eastern (Calcutta) & Southern (Chennai), In every important city in India you can find a CMO branch or a Stockyard.

*Conclusion*

With the objectives of maximising the sales, increasing the net sales realisations and also providing customer satisfaction with quality marketing of steel is a difficult task and all the branches of SAIL work towards these objectives.
Materials Management

Objectives
The approach to the materials management in various units of SAIL is that of integrated one where the philosophy is to have all the activities connected with the materials management under one umbrella. The functions and techniques adopted vis-à-vis the experience and the progress made thereof for achieving desired results are discussed below.

Materials management has two basic and very important objectives to serve. Firstly, the production system is supplied with the requisite quantity of materials in time and of requisite quality. This can be termed as a “Service Objective” of the function. Secondly its objective is “Financial Control” which means optimum utilisation of the funds available to provide the above service. Any higher proportion of capital employed to provide the service objective will have adverse effect on capital productivity.

Role and Functions
Management of materials has a significant role to play on the performance of an enterprise and on capital productivity. In a process industry such as Iron & Steel, the materials alone constitute about 60% of the cost of production. In an integrated materials management approach, functions of materials management are inter-related to other managerial functions such as finance, production, marketing etc. It is no more a supporting function in the overall management perspective. On the other hand, it has been recognized as a major function where the techniques adopted have yielded substantial gains in terms of cost savings and profit improvement of a company.

The materials management is entrusted with entire range of activities like planning procurement, storage and distribution of materials. The functions of the materials management department can be broadly classified as follows:

i. To establish targets, major category wise, for purchase commitment, receipts and average inventory on the basis of consumption budget, present inventory position etc.

ii. To review the actual figures of consumption, purchase commitment, receipts and inventory periodically.

iii. To review the progress of the materials management with particular reference to the following:
   - Non-moving item analysis
   - Slow-moving item analysis
   - Accounting of Project surplus items
   - Imported spare analysis resulting in use/ non-use/ disposal (if possible) of items and corresponding purchasing action.
   - Development of new/ alternative sources for critical and high value items.
   - Results of value analysis conducted by departments and other consumers
   - Development of price indices for A-Class, B-Class and critical items and their impact on indenting/ purchasing policies and decisions.
   - Number of items selected for norms study, fixing stock levels and developing indenting time table and automatic procurement.
Inventory Control and Role of Line Managers in Managing Inventory

Classification of Inventories – For monitoring and control, the materials are classified into following groups:

- Raw Materials
- Refractories
- Spares
- Consumables
- Rolls & Refractories
- Constructions/ Capital/ Project Spares
- Others

Materials classified as above are either imported or indigenously procured and to the extent facilities are available manufactured by the Captive Shops of the Steel Plants.

Reasons for Heavy Build up of Inventory

Inventories of the materials tend to pile up for reasons both internal and external. These are:

- Lack of proper market intelligence and alertness in adopting policies suiting to the environments.
- Non-adoption of Scientific Inventory Management Techniques
- Too many varieties of items for procurement.
- Absence of proper standardization of materials.
- Lack of effective implementation of systems for classification, coding, storing and accounting for material components.
- Non-availability of effective systems such as rate contracts with the standard manufactures resulting in multiple order and administrative lead time and running into risk of getting different qualities of the same product from different sources.
- Long lead time and standardisation of logistics in the case of suppliers located at distant places and also in respect of imports.

Measures for More Efficient Inventory Management

The process of inventory control and management is action-oriented. The objective is to initiate action and exercise control on the quantity of physical stock in order that the production and financial objectives are achieved within the overall frame work of policies governing them. The process is basically consists of comparing the actual status with the pre-determined norms and initiate action and follow up, to minimize variances.

Following are the steps or measures that are envisaged to control and manage for optimisation of inventories:

Task Force - Multi-disciplinary task forces are set up for different categories of items. Such task force is headed by a major user at the senior level. The purpose of forming a task force is to reduce the inventory holdings in terms of physical quantities and value and to ensure that slow moving and non moving items are utilised and declared as surplus for sale. Items such as refractories, wire ropes, cables and lubricants are covered under this.
**ABC Analysis** - This is carried out once in a year at the beginning of the financial year. This is an analysis of items in terms of value of annual consumption. Categories of items falling within a predetermined range of annual values of consumption, A1, A2, B and C are listed out. These are used for monitoring and planning vis-à-vis consumption norms fixed by the management so that the variances are kept at the minimum.

Similarly a list of slow-moving items whose stock at the end of the year exceeds 24 months requirements are prepared which helps phasing out supplies, cancelling purchase orders and assessing surplus for disposal. List of Non-moving items not moved for 3 years and above is also prepared shop-wise and stores-group wise. In consultation with the shop incharges, items that are not required in the plant for the next 5 years are identified and management approval taken for disposal.

**Norms of Inventory Holding** - Development of realistic norms for comparison and proper feedback at regular intervals forms basic necessities of any control system. SAIL norms of inventory holdings for the major categories by SAIL are as follows:

<table>
<thead>
<tr>
<th>Category</th>
<th>SAIL Norms for Inventory holdings</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Stores</td>
<td>4 months (Imported)</td>
</tr>
<tr>
<td></td>
<td>3 months (Indigenous)</td>
</tr>
<tr>
<td>Spare Parts</td>
<td>12 months (Imported)</td>
</tr>
<tr>
<td></td>
<td>6 months (Indigenous)</td>
</tr>
<tr>
<td>Refractories</td>
<td>5 months (Imported)</td>
</tr>
<tr>
<td></td>
<td>3 months (Indigenous)</td>
</tr>
<tr>
<td>Rolls</td>
<td>12 months (Imported)</td>
</tr>
<tr>
<td></td>
<td>6 months (Indigenous)</td>
</tr>
<tr>
<td>Overall Inventory</td>
<td>7 months</td>
</tr>
</tbody>
</table>

**Budgetary Control** - Introduction of strict budgetary control both for commitment and consumption simultaneously, with higher delegation of powers to regulate purchases/consumption corresponding to level of production. Also mid-course corrections are effected by having periodical reviews.

**Spare Parts Management** - Spare parts constitute a substantial percentage of the inventory of steel plants. It is essential to deal with spare parts inventory separately due to their peculiar nature unlike other categories of items such as consumables, raw materials etc.

The stock-out in critical spares leads to disruption in production processes. It provides an excuse for excessive build up to spares inventories. To avoid this, by and large, all the steel plants have various systems of control by ways of purchase indents screening at different levels before procurement action is initiated. Spare parts are identified according to ABC/VED analysis and list of items is prepared for ordering them on fixed / periodic intervals. Effective preventive maintenance and standardisation of spares with emphasis of import substitution and indigenisation helps in proper planning of spares, reduction in the lead time in procurement and hence lowering inventory levels.
**In-Company Standards** - One of the important tools for inventory management is the setting up company standards. Keeping this in view, an Inter Plant Standardisation Committee has been set up by SAIL. Each of the units of SAIL has been assigned with formation of standards under different sub-committees for a particular set of items. IPSS (Inter Plant Steel Standards) have been issued for number of items, spare parts, tools, consumable stores and conforms to national standards wherever applicable.

**Work in Progress and Finished Stock - Inventory Management** - The work in progress levels depend largely on the manufacturing processes and the technology involved and the variety of products being manufactured. In the materials management activity of the Steel Plants, the philosophy of work in progress is applied to those items, which are manufactured within the Plant with the available facilities from the engineering shops. The raw materials required for manufacture of items in these shops is held by stores organisation as inventory in the form of steel rolled products of sections. The volume of inventory holding for these plant-made items in terms of total inventory holdings is, however, less than 1%.

**Finished Goods** - The finished products of the steel plants are not under the control of materials management department. The control and management of inventories of these items is, however, with the Central Marketing Organisation headquarter based in Kolkata.

**Purchase Policies & Methodology Adopted** - Setting up of a strong and effective materials planning and purchase organisation with clear cut purchasing policies leads to better inventory management. Certain measures envisaged in SAIL units are enumerated below:

a) Vendor Development and Vendor Rating: Selection of vendors for calling of quotations and grading of vendors based on their performance of the critical sub-functions affecting the administrative lead time as also the receipt of goods of proper quality and quantity in time. Computerisation of vendor development and vendor rating procedures has been taken up recently. Re-examining the mailing list of parties and registration of the right type of vendors, removal of those whose performance have been found to be unsatisfactory. In case the firms diversify their activities, list of vendors is updated to enable the purchase organisation to select the vendors for issue of enquiries and placement of order more effectively.

b) Limited Tender Enquiries: Experiences of buying different materials have enabled selection of reputed suppliers for each group of items and the enquiries are issued on limited tender basis minimising the practice of going in for advertising tender for all the items.

c) Delegation of Powers: Proper delegation of powers with accountability leads to quick decision making. The delegation of powers should be such that decisions in the different areas of materials management are made quicker, meaningful and process independent.

d) Role of Tender Committees: Functions of the Tender Committees is to play a vital role in finalising the purchase action. While our objective will be to take advantage of multidisciplinary group in the form of a Tender Committee, the working of the Tender Committees should not delay taking purchase decision. In this connection, composition of the Tender Committees having members of appropriate level, fixing of time within which tender committee should finalise their recommendation and such other factors have to be planned meticulously to make the functioning effective and less time consuming.
e) Buying quality materials from reputed manufacturers: Buying at reasonable price is no doubt important but we should not discount the quality factors. Paying for quality may be cheaper considering the other loss for a cheaper variety. Buying from reputed manufacturers/traders may involve a little higher unit price but will lead to such benefits as assured quality, assured delivery and phased delivery etc.

f) Long Term / Rate Contracts: Long Term / Rate Contracts for some items of "A" category with proper escalation clause insulate from wide fluctuations in prices with an added advantage of cutting down number of order which otherwise would have been processed causing avoidable wastage of administrative lead time. Items falling under such categories are automobile parts, earth moving equipments and parts, electrical and mechanical spares of recurring nature, repetitive items, orders on small scale industries, lubricants and prime metals like aluminium copper etc.

g) MODVAT / Proforma Credit Facility: handling of taxes and duties keeping in view of advantage of MODVAT / Proforma Credit Facility available by systematically covering up each item under the scheme will reduce expenditure.

h) Computerisation - Computerisation of materials management activities in SAIL units has been taken up as early as 1980-81. All the Integrated Steel Plants have entire inventory data on the computers. The actual management of inventories by way of control and monitoring of the inventories systematically item by item, group by group, value by value is being done. The budgetary control reports have no doubt helped in exercising such control with the help of the computer outputs.

Disposal of Stores

Materials management department has also the responsibility of disposal of the secondary products, scrap materials, rejected and defective materials, other industrial scraps etc. including declared surpluses of non-moving and slow-moving items which are collected and arranged in lots for disposal to outside agencies through the system of either auction or fixed price sale. Auctions are normally conducted through appointment of auctioneers for sale. However, auctions conducted departmentally have proved that auctions can be successfully conducted departmentally deploying only internal resources and can also accept such challenges by giving proper publicity. This saves the Plant money which would have been paid as commission for the engagement of auctioneers.

Role of Line Managers

Any amount of control on inventory or use of the latest techniques will not yield results so long as strict discipline is not maintained by the user of the materials. The role of line managers, therefore, has great significance as they have to be vigilant not only in maintaining strict control over the quantum of materials used but also how & when the materials used are equally important. These decisions have direct bearing on the consumption and the volume of purchase of materials. In this context proper exposure and orientation of the line managers to the important aspect of materials management such cost, quality, lead time of procurement and advantages of minimum inventory vis-à-vis profit margin of the company will bring about the necessary transformation in the work culture itself.

Similarly, the materials managers are no more expected to be confined to purchase, stores or inspection department. They have to interact with the line managers so that they are aware of the problems and the needs on the shop floors. Also the understanding of needs / requirements of the User Department and the Manufacturer
will assist a materials manager in alleviating the feelings of suspicion and cautious approach existing perennially as psychological barrier for no specific reasons between the vendors and their products on one hand and the users on the other. The important functions of the materials management i.e. purchasing, storing and distribution are no more simple activities like calling of quotations, placing purchase orders and issuing the stores as and when required by the user department. The total integrated functions should have a broader horizon encompassing the specific actions of responsibility and accountability between the departments as well as the managers of both the line and the materials management.

Keeping in line with the above principles it is necessary that responsibility for holding inventory levels for all different purchase of items like electrical spares, mechanical spares, refractories etc. are fixed and individual indenting departments are made responsible to maintain inventories within prescribed norms to avoid over indenting. The role of line management in exercising budgetary control practice and periodical monitoring of the inventories will help in not only maintaining proper inventory levels fixed but also reducing them to the minimum.

**Interface Between Line and Materials Management**

The following point can be highlighted as the grey area of interaction and responsibility between the line and materials managements in achieving the desired goals:

i. The materials manager will have to ensure and develop confidence in the line manager by making available to right quantity of materials, in right time and in right quality. Adopting proper vendor rating, simplification of purchase procedures by adopting long term contracts for supplies from reputed manufacturers / traders etc. are some of the solutions.

ii. On the other hand, the line managers have to be careful and vigilant on usage of materials with emphasis on proper maintenance of equipment commitment to zero level technology violations will help in achieving the desired results.

iii. Proper awareness and strict vigilance both by the line as well materials managers in introducing budgetary control for commitment and consumption of material will also help in regulating volume of purchase and consumption corresponding to level of production.

iv. Exposure to the latest techniques developed within the country and abroad both by the line and materials managers and exchanges of views and information on such matters.

v. Training of both line and materials managers in implementing latest techniques not applied hitherto.

**Conclusion**

With the advent of new work culture, there is awareness among both the line and materials management personnel that every rupee saved on materials is a rupee gained. The responsibilities are becoming clearer and the departments are getting geared up to face the new challenges. The computerisation of the materials management functions and adoption of latest techniques such as zero inventory concept will definitely help in minimising the inventory level as well as reducing the volume of purchases to the minimum.
Human Resource Management

Introduction

Human Resource Management or Personnel Management, is a vital part of Management and cannot be viewed in isolation or in contradiction to the overall management goals and objectives. It is a profession in transition and in any organisation which looks forward to a positive and dynamic management philosophy, the role of personnel manager has gone beyond the traditional areas of establishment, welfare and industrial relations. Today it encompasses the entire area of reaching out to the people of the organisation. Communication, motivation, teambuilding, training and development are integral parts of personnel management. Personnel managers in SAIL have to function as change agents in the furtherance of the on going process of developing a positive work culture and outlook amongst all the people in the organisation. In this broad area of people management, the key factors are motivation, manpower planning, recruitment, training and development and employee relations and employee services.

The manpower position of SAIL as on 31st March 2005 is as follows:

<table>
<thead>
<tr>
<th>Plant/Unit</th>
<th>Total Exe</th>
<th>Total Non-Exe</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bhilai Steel Plant</td>
<td>3,234</td>
<td>33,208</td>
<td>36,442</td>
</tr>
<tr>
<td>Durgapur Steel Plant</td>
<td>1,582</td>
<td>14,629</td>
<td>16,211</td>
</tr>
<tr>
<td>Rourkela Steel Plant</td>
<td>2,085</td>
<td>2,0906</td>
<td>22,991</td>
</tr>
<tr>
<td>Bokaro Steel Plant</td>
<td>3,783</td>
<td>3,0291</td>
<td>34,074</td>
</tr>
<tr>
<td>Alloy Steels Plant</td>
<td>386</td>
<td>2,311</td>
<td>2,697</td>
</tr>
<tr>
<td>Salem Steel Plant</td>
<td>316</td>
<td>1,028</td>
<td>1,344</td>
</tr>
<tr>
<td>Visvesvaraya Iron &amp; Steel Plant</td>
<td>308</td>
<td>2,418</td>
<td>2,726</td>
</tr>
<tr>
<td>Raw Materials Division</td>
<td>504</td>
<td>4,737</td>
<td>5,241</td>
</tr>
<tr>
<td>Central Coal Supply Organisation</td>
<td>34</td>
<td>178</td>
<td>212</td>
</tr>
<tr>
<td>Central Marketing Organisation</td>
<td>830</td>
<td>2,036</td>
<td>2,866</td>
</tr>
<tr>
<td>R&amp;D Centre for Iron &amp; Steel</td>
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Motivation

People have many conscious, often complex and competing goals. We must understand why one employee works at less than 60% of standard and another works at over 150% of standard. Motivation thus helps in encouraging effective individual performance.

These individual behaviours that are crucial in determining the effectiveness of organisations are, almost without exception, voluntarily motivated behaviours. Other behaviours may be due to an external stimulus. Work organisations control much of what happens to employees for eight or more hours a day. So a work environment is highly conducive to motivational approaches. However, there are some common motivating factors:

- Does money always motivate? Money has an important role because organisation has to attract and retain people by paying them well. Money may not motivate always as there comes a level when a satisfied man looks for something more in his job. Money itself may not motivate but the lack of it may cause dissatisfaction.
- Hierarchy Levels: Extensive hierarchies have been developed to facilitate coordination in the organisation. The hierarchical structure also means that some people have more status and power than others. Because of this the possibility of promotion within the structure is often important to people and exerts influence on motivation.
- The job itself: Large organisations have thousands of different jobs which is mainly due to the principle of division of labour. However, the significance of person's job in the whole organisation is what ultimately motivates him. For instance, a person doing a part of the assembly line job in a routine manner is less motivated than the man who goes in to the market to sell the car.

At managerial levels, self actualization, i.e. the need for one to become what he is capable of becoming is the most prominent motivating factor. What will make people work is the pride they take in their company and in their work and clarity with which they understand the totality of their task.

Motivation is not the exclusive responsibility of one man or one department. It is the responsibility of all Managers. In case there is a problem not in a particular area or department but in the organisation as a whole, then it is to be addressed by personnel or HR department.

SAIL provides top of the line welfare facilities and commensurate salaries but specific motivational aspects have to be concentrated upon which is done through various motivational schemes which are monetary as well as non-monetary.

SAIL has many productivity linked incentive schemes and many more financial incentive schemes and rewards. However, what motivates workers depends more on the leadership styles of Managers & Supervisors and more can be attained through the enrichment of the job they are doing.

Manpower Planning, Recruitment

Many managers at some time or other have found themselves in the position of not having the right men available when needed. One indication of sound management is that it tries constantly to control events, rather than reacting to events as they
occur. Hence the attempts to plan manpower is essential requirement if they are to reach their goals. Thus if a way can be found to plan the use and the development of people, at least one of the many areas of uncertainty about the future will become more manageable.

The objectives of a sound manpower planning are -

i) Fair assessment of optimal manpower requirements

ii) Assessment of the training needs of employees in order that they cope with new technology / automation.

iii) Recognition of means of exploiting for efficient manpower utilisation

iv) Avoiding surpluses by redeployment

v) Estimate future needs

All planning involves analysis and this analysis should challenge, rather than accept existing practices. Manpower planning, career planning, training and development, productivity studies and organisation developments are all ultimately related. In considering how many and what type of people we require, we should also be asking whether we are using the ones we possess in the best way.

In SAIL, manpower planning aims at:

Having an adequate database, for the men with the complete profile in terms of age, qualification and skill levels of existing human resources.

Identifying surpluses which exist in construction / mines and making provisions for re-training / re-deploying them.

Recruitment at prescribed levels in order to keep the organisation young and continuously responsive to changing technologies.

In this preparation for future, the kind of people who will be needed is being emphasised and efforts are on to improve utilisation by multi-skill operation, to work in more than one job.

**Line Manager's Role**

A prominent role in manpower planning is played by the line managers. Line manager is in close touch with workers and the production function, the line manager's manpower assessment and requirement will be more rational. Keeping in the line with innovations in technologies, the future requirements are to be correctly estimated. In this the line managers would help in reducing the quantity of manpower at the same time assuring quality. The line managers would be able to appreciate the required skill and age mix and job specifications worked out by them would be more relevant.

Effective utilisation of manpower can best be ensured by line managers. The concept of multi-trade designations can be better explained to workers by the line manager and he can convince the former on the accruing advantages of such a system. The improving of the skill mix rests in the hands of line manager to a certain extent.

The basis for estimating requirements of manpower can be reviewed by line managers from time to time keeping in view the changes in the technology and the trend of the production.

It cannot but be emphasised that line managers should coordinate with the staff,
namely, personnel managers to ensure efficient enforcement of the later functions especially manpower planning and recruitment. The relationship between line and staff must be clearly defined.

Training and Development

The human resources are our greatest asset. Training and continuous development of this asset is an important management responsibility. SAIL has always placed the training of its employees on a high pedestal since inception. Starting from late fifties, when the Steel Plants under erstwhile Hindustan Steel Ltd. were built and commissioned. SAIL has been striving to reach new peaks in the spheres of technical management and other training activities including training for technology upgradation, modernisation automation and computerisation etc.

SAIL's training policy is based on the realisation that the development of human resources is crucial to the success of our organisation. The company is also aware of the changing environment with respect to continuously updating technologies, skills required, attitudinal changes, growth strategies and future plans.

The company's policy is dynamic and flexible and allows for focusing of our approaches for training and development. For example, the major emphasis areas thus focused for training are as follows:

• Attitudinal changes
• Optimal utilisation of existing manpower i.e. by redeployment and multi-skill training etc.
• Continuously train human resources for higher level automation
• Enhancing efficiency
• Proper orientation / induction of all new entrants
• Thrust areas
• Safety and pollution control
• Training in TQP

Accordingly, the training plans are made and these training plans are implemented / coordinated by the following agencies:

• Management Training Institute at Ranchi
• The Plant/Unit Training Centres
• Corporate Human Resource Development Group

Training in SAIL

The various training schemes in vogue at the plant / unit Training Centres of SAIL are as given below:

a) Training of New Entrants - Management Trainees (Tech), Management Trainees (Admn), Junior Manager (Finance), Senior Operative Trainees, Junior Operative Trainees, Artisan Trainees, Trade Apprentices. The training periods of these categories vary between 3 months to 3 years.

b) Training of Executives - Need based general management, functional training programmes, Microplanning, Action Leadership Training for upgradation etc. are conducted at Plant Management Training Centres and Management Training
Institute at Ranchi. These programmes are of short duration of 1 to 4 weeks where eminent outside guest faculty and specialists are also invited to share their experiences.

c) Training of Non-executives - Supervisory development functional programmes, shop floor skill development programmes e.g. Unit Training, Refresher Training Schemes, Redeployment Training, Training in Basic Maintenance Skills are organised at Plant/Unit levels as per the organisational needs and developmental needs of employees.

d) Training within India - In order to keep abreast with the development in various specialities/functions a number of employees both executives and non-executives are deputed to reputed training establishments/professional agencies/institutes/supplier organisations for training within India. Under this, around 8-10% executives are deputed each year.

e) Training Abroad - For the transfer and absorption of advanced and new technologies, a good number of qualified technologists and specialists of SAIL plants are deputed every year for training abroad in countries like USA, Russia, West Germany, UK, Japan, Austria, Australia etc.

f) Manpower Development - Looking at the short term and long term developmental needs of man power, a number of in-house programmes are conducted in each Unit/Plant Training Institutes and at the Management Training Institute, Ranchi. It may also be mentioned here that the training plans drawn and implemented in different units of SAIL are tailor made to meet the needs of each Plant/Unit. Continuous efforts are being made to train the manpower through systematic approach to training.

Physical Facilities

The Training Institutes in Plants and MTI, Ranchi are well equipped with infrastructural facilities such as well equipped class rooms, workshop/laboratories, audio-visual aids and libraries, hostels for trainees, sports and recreation facilities, playgrounds etc.

Employee Relations and Employee Services

Employee relations and employee services go hand in hand. Personalised service to employees improve the employee relationships. This employee relations is deeper than industrial relation. The IR scenario in our organisation has been fairly satisfactory.

The concern for human beings transforms itself into the objective of providing these services, i.e. to look after the human beings in our dealings, which would bring about credibility and image in the organisation. The aspects being looked after are -

1) Proper recruitment
2) Efficient training
3) Looking after promotions, transfers and leave
4) Redressal of grievances
5) Housing and medical facilities
6) Recreation facilities
7) Other services

The need is to provide these personalised services with efficiency, speed and dedication. It is the responsibility of the organisation to ensure that individuals get a
proper induction to the organisation and are trained periodically to do their job. The
grievance handling should not be made procedure oriented and speedy redressal of
grievances by shop-floor personnel is essential.
The quality of employee service has to be improved. This would build credibility in
the organisation. The image thus created facilitates team building, motivation and
communication and improves employee relations. Further employee relations can
be improved by:

1) Adopting preventive rather than reactive strategies
2) Time bound implementation of unanimous recommendations of Bipartite Forums
3) Monitoring of unproductive work practices
4) Better administration of welfare facilities

These personalised employee service and improved employee relations will make
individuals feel cared for and respected. For instance, in case of any mistake
committed by a worker, counselling him provides the human touch unlike a warning
letter issued. A satisfied and well looked after worker involves himself more in the
job. His contribution to the organisation’s success increases many fold.
Finance Management

Introduction

The objective of all profit strategies should be to maximise generation of resources required to achieve our vision to be a global player. But the new economic policy initiated by the Government since July 1991 has brought about several structural changes in the business environment, which have direct implications on our performance. We had a protected market so far. But other steel manufactures have entered the market now with quality steel at competitive prices. Low international prices of steel combined with low import duties have led to increased availability of low cost imported steel in the past.

The year 2004-2005 witnessed a growth of around 31.52% in sales turnover which at Rs.31800 crore (previous year Rs.24170 crore) was the highest ever achieved by the company. This was possible due to higher sales volume, better product-mix and higher steel prices. The company made a pre-tax profit of Rs.9365 crore during the year as compared to Rs.2628 crore in the previous year. The net profit after tax at Rs.6817 crore (previous year Rs.2512 crore) recorded an improvement of Rs.4305 crore indicating an increase of over 171% over the previous year.

Cost Reduction Drive in SAIL

SAIL continued its thrust on intensive cost control and revenue maximization measures. Cost control measure focussed on reduction in using the coking coal / other raw materials, improvement in yields and techno-economic parameters, reduction in energy consumption and control on administrative expenses. Substantial savings were also achieved in the non-conventional areas like higher volume of waste utilization, control on arisings and maximizing in-house manufacturing of spares and refractories.

Financial Strategy

The Company’s thrust on reduction of borrowing continued during 2004-05 and there was a reduction of Rs.2920 crore during the year. This has been achieved by all round improvement in sales and cash management. Reduction in debt resulted in interest savings of Rs.296 crore. Debt equity ratio has improved to 0.58:1 (as on 31.3.2005) from 1.187:1 (as on 31.3.2004). Considering short-term deposits with Banks of surplus funds of Rs.5670 crore, SAIL is virtually debt free.

Cost Control

SAIL continued its thrust on cost control management. Cost control measures focused on reduction in usage of coke rate / other raw materials, improvement in yields and tech-economic parameters, reduction in energy consumption and control of administrative expenses. The Institute of Cost & Works Accountants of India (ICWA) recognized SAIL’s cost management efforts for the second year consecutively. The Company has taken major IT initiatives and is planning to implement ERP in phases starting from Bhilai Steel Plant.
**Project Management**

Projects worth over Rs.3,000 crore are at various stages of implementation and approval in the Company.

The major ongoing schemes are:

**Bhilai Steel Plant (BSP)**
- Rebuilding Coke Oven Battery – 5
- Upgradation of Blast Furnace – 7
- Revamping of B-Strand of Wire Rod Mill

**Durgapur Steel Plant (DSP)**
- Bloom Caster with associated facilities

**Rourkela Steel Plant (RSP)**
- Rebuilding of Coke Oven Battery – 1
- Capital Repair of Blast Furnace – 4
- Upgradation of ERW Pipe Plant

**Bokaro Steel Plant (BSL)**
- Rebuilding of Coke Oven Battery – 5
- Revamping / Modification of Mal West Block System and housing machining in Finishing Stands F 6 – F 12

The major schemes which have been accorded ‘in principle’ approval are:

**Bhilai Steel Plant (OSP)**
- Upgradation of Slab Caster, RH Degassing and Ladle Furnace
- Modernization of Sinter Plant – II
- Desulphurisation Unit in SMS – II

**Durgapur Steel Plant (DSP)**
- Local Dust Injection in Blast Furnace (3 & 4)

**Rourkela Steel Plant (RSP)**
- Installation of Hot Metal Desulphurisation Unit at SMS – II.

**Bokaro Steel Plant (BSL)**
- Upgradation of Tandem Mill & Pickling Line in Cold Rolling Mill (CRM)
- Installation of Coal Dust Injection in Blast Furnace (2 & 3)

**SAIL’s Strategy**

To ensure long term growth, with cost and quality competitiveness, SAIL has drawn Corporate Plan with perspective upto 2012. The plan envisages maintaining the markets leadership of SAIL and growing in identified growth segment. SAIL shall achieve a growth in production to about 20 MT of hot metal with commensurate
enhancement in the production of crude steel and salable steel in its product-mix by de-bottlenecking and selective investments. Further, to improve competitiveness the focus would be on cost competitiveness and quality enhancement. Further, functional strategies in the areas of Marketing, Operations, Human Resources, Finance and Information Technology have been evolved to support the key strategy of growth with cost and quality competitiveness.

### Performance Indicators
#### 10 Year Digest

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#### Production Statistics

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#### Shareholding Pattern

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### A. SOURCES OF FUNDS:

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### B. APPLICATION OF FUNDS:

#### Gross Fixed Assets:

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</table>

#### Less: Depreciation

| 13458.75 | 14558.66 | 15558.41 | 17198.33 | 3479.62 | 3668.16 | 3668.71 | 4051.52 |

#### Net Fixed Assets (c)

| 14035.86 | 13153.65 | 12485.07 | 12612.14 | 2372.42 | 2228.67 | 2294.05 | 2255.18 |

#### Capital Work-in-progress

| 305.75 | 362.20 | 366.46 | 797.94 | 54.26 | 229.69 | 34.98 | 218.35 |

#### (d) Sundry Cr. for gap WIP

| 192.92 | 179.58 | 213.47 | 316.13 | 55.49 | 48.97 | 55.29 | 54.96 |

#### (e) Net Capital WIP (d)

| 168.33 | 202.12 | 153.01 | 441.81 | -2.23 | 180.92 | -20.28 | 149.59 |

#### Others:

- Investments: 543.17 | 543.17 | 606.71 | 292.00
- Proceeds of GDR 8.30 | 171.05 | 148.20 | 0.05
- Loans & Adv. to Subsidiaries 1050.28 | 7674.36 | 11526.32 | 13845.57
- Other Current Assets 8030.28 | 1404.84 | 1223.60 | 1297.22 | 1795.09
- Loans & Advances to others 1724.44 | 1295.54 | 1783.99 | 3033.82 | 272.81 | 242.67 | 154.82 | 218.44

#### TOTAL INVENTORIES:

| 7282.40 | 8030.28 | 14187.43 | 17383.73 | 1404.84 | 1223.60 | 1297.22 | 1795.09 |

#### Less: CURRENT LIABILITIES:

- Sundry Creditors 1484.55 | 1600.83 | 1994.03 | 2111.23 | 493.98 | 530.72 | 581.26 | 518.08
- Security Deposits 191.92 | 218.53 | 209.97 | 232.30 | 32.44 | 34.69 | 44.47 | 42.13
- Other Liabilities 2623.02 | 2433.36 | 2617.75 | 2530.04 | 260.60 | 354.95 | 288.64 | 289.95
- Provisions 476.88 | 1741.21 | 2042.66 | 3222.54 | 85.84 | 416.54 | 93.83 | 29.36
- Total Current Liabilities (g) 4776.59 | 5997.23 | 6608.11 | 8106.11 | 939.38 | 1316.64 | 988.55 | 879.52

#### Working Capital (Cg - N) 17261.47 | 16133.34 | 20970.31 | 22171.57 | 7935.96 | 9997.71 | 14208.76 | 17186.81

#### CAPITAL EMPLOYED (c+e+h) 18451.87 | 15218.90 | 20064.39 | 21437.78

---

### FINANCIAL POSITION

**Page No 103**
### FINANCIAL POSITION OF SISTER UNITS

(Rs. In Crores)

<table>
<thead>
<tr>
<th>Particulars</th>
<th>BOKARO STEEL PLANT</th>
<th>DURGAPUR STEEL PLANT</th>
<th>KOURKELA STEEL PLANT</th>
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<td>(i) Deferred Revenue Exp.</td>
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<td>(ii) Working Capital from banks</td>
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<td>Gvt. of India</td>
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<td>1132.95</td>
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<td>i) Proceeds of GDR</td>
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<td>ii) Loans &amp; Adv. to subsidiaries</td>
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<td>IL&amp;UC Net</td>
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<td>Semi-Finished Goods</td>
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**CAPITAL EMPELOYED (c+h)**

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## COMPARATIVE PROFITABILITY STATEMENT FOR SAIL & BHP

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<tr>
<th>Particulars</th>
<th>SAIL (Rs. In Crores)</th>
<th>Bhilai Steel Plant (Rs. In Crores)</th>
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### Cost Ratios (Ratio of cost element to total cost)

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<td>Power &amp; Fuel</td>
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<td>12%</td>
<td>12%</td>
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<tr>
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<td>2%</td>
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<td>4%</td>
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<td>5%</td>
<td>4%</td>
<td>3%</td>
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158
### COMPARATIVE PROFITABILITY STATEMENT FOR SISTER PLANTS

Remove freight from 2005-06 figures  
(Rs. In Crores)

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<tr>
<th>Particulars</th>
<th>Bokaro Steel Plant</th>
<th>Durgapur Steel Plant</th>
<th>Rourkela Steel Plant</th>
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<tr>
<td>Net Sales including IPTs</td>
<td>8675.34</td>
<td>8335.41</td>
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<td>32.26</td>
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<td>Stock Accnt/ Deplin</td>
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### Cost Ratios (Ratio of cost element to total cost)

<table>
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<td>Interest &amp; Financing Charges</td>
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<tr>
<td>Depreciation</td>
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PROCESS FLOW AND EXISTING TECHNOLOGY OF SAIL PLANTS:

- Process Flow technology.
- Coal Making of by Products.
- Sinter, Iron and Steel Making.
Process Flow and Existing Technology of SAIL Plants

Introduction

Various metallurgical processes are employed for converting iron ore into steel and shaping it into different products as required by the consumer industries and the people. Steel plays a key role in the industrial development and economic growth of a country. Therefore, the selection of very efficient and effective metallurgical processes at the time of installation and their continuous up-gradation through research and development is very vital.

Process Flow of Materials

The process flow of materials and converting them into semi finished and finished products, is summarised below:

Metallurgical grade coals are received from Collieries & Washeries. Part of this coal is also imported. The coals are crushed, screened and blended and fed to Coke Ovens to make Coke suitable for use in the Blast Furnaces. The Coke Oven Gas which comes out as a by-product is sent to By-product plant to recover many valuable Coal Chemicals after which it is used as fuel.

The Coke from Coke-Ovens, Iron ore after beneficiation and agglomeration and Lime Stone as a flux along with hot blast of air, are main raw materials which are used to make molten pig iron in the blast furnaces. In the steel making convertors, molten iron is charged along with scrap and various alloying elements to make different grades of steels.

The liquid steel is cast into ingots and fed to soaking pits for primary rolling into blooms, slabs and billets. The liquid steel can also be fed to continuous casting machine to cast billets or slabs or even near finished shapes, where not only primary rolling is totally avoided but also a portion of secondary rolling may not be needed.

The steel plants under SAIL at the time of it's installation and subsequent expansion have been provided with the following technological process :-

- Beneficiation of coal & iron ore.
- Raw materials bedding and blending.
- Carbonization of coal in coke oven batteries.
- Agglomeration of iron ore fines through sintering.
- Reduction of iron ores into Hot Metal in Blast Furnaces.
- Twin Hearth process of steel making or Basic Oxygen steel making
- Ladle refining of steel.
- Continuous Casting of steel.
- Hot rolling.
- Cold rolling.
- Galvanising/Electrolytic Tinning.

For understanding the flow diagrams and brief description of Integrated Steel Plants may be referred to.
### Brief Description of Bhilai Steel Plant

#### Department | Under 2.5 MT Plant | Addition under 6th BF Complex | Addition under 4.0 MT Expansion | Product | Annual Capacities in 1000 T
---|---|---|---|---|---
1. Coke Ovens | 6 batteries of 65 ovens each with useful coke chamber volume of 21.6 cu.m & 4.3 m high | 2 batteries of 65 ovens each with useful coke chamber volume of 21.6 cu.m & 4.3 m high | 1 battery of 67 ovens with useful coke chamber volume of 41.6 cu.m & 7.0m high and another of same capacity as a replacement of three old batteries. | +25 mm coke (dry) | 2198 | 2511 | 3303

2. Sintering Plant

   a) Sintering Plant No.1 | 3 sintering machines each of 50 sq.m. hearth area | 1 Sintering machine each of 50 sq.m. hearth area | | Super fluxed sinter | 1520 | 2040 | 2040

   b) Sintering Plant No.2 | 2 sintering machines each of 75 sq.m hearth area. | 1 sintering machine of 75 sq.m. hearth area and other of 80 sq.m. hearth area. | - | - | 1500 | 3137

   c) Sintering Plant No. 3 | | 1 sintering machine of 312 sq.m hearth area. | | | 3200

3. Blast Furnace | 5 blast furnace, 3 of 1033 cu.m each with a hearth size of 7.2m and 1135 T/day 2 of 1719 cu.m each with a hearth size of 9.1 m and 1738 T/day | 1 Blast Furnace of 1719 cu.m with a hearth size of 9.1 m and 1738 T/day | 1 Blast Furnace of 2000 cu.m with a hearth size of 9.75 m & 2640 T/day | Hot Metal Saleable Pig Iron | 2361 | 2969 | 4080

4. Steel Melting Shops

   a) SMS-1 | | | 4 Twin Hearth Furnaces - each of 500T capacity | Ingot Steel | 2500
<table>
<thead>
<tr>
<th>Department</th>
<th>Under 2.5 MT Plant</th>
<th>Addition under 6th BF Complex</th>
<th>Addition under 4.0 MT Expansion</th>
<th>Product</th>
<th>Annual Capacities in 1000 T</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Under 2.5 BF Complex Under 6th BF Complex Under 4 MT</td>
</tr>
<tr>
<td>b) SMS-II</td>
<td></td>
<td></td>
<td></td>
<td>Liquid Steel</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Slabs</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Blooms</td>
<td>-</td>
</tr>
<tr>
<td>5. Rolling Mill</td>
<td>14 groups of recuperative soaking pits each of 125 T capacity &amp; 2 Hi Reversing Mill of 1150 mm. size</td>
<td>-</td>
<td>-</td>
<td>Bloom</td>
<td>2142</td>
</tr>
<tr>
<td>a) Blooming Mill</td>
<td>Continuous Mill with 12 stands two groups, the first group comprising two 2 Hi Horizontal stand of 1000 m.m size and two vertical and two Hi Horizontal stand of 700mm size and the 2nd group comprising of three vertical and three 2 Hi Horizontal stands of 500mm. size.</td>
<td>-</td>
<td>-</td>
<td>Billet (Total) Of which for sale</td>
<td>1263</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Rails &amp; Heavy Structural</td>
<td>750</td>
</tr>
</tbody>
</table>
### 6.2 Brief Description of Bhilai Steel Plant

<table>
<thead>
<tr>
<th>Department</th>
<th>Under 2.5 MT Plant</th>
<th>Addition under 6th BF Complex</th>
<th>Addition under 4.0 MT Expansion</th>
<th>Product</th>
<th>Annual Capacities in 1000 T</th>
</tr>
</thead>
<tbody>
<tr>
<td>d) Merchant Mill</td>
<td>3 Reheating furnaces of 60 T/hr capacity each Mill comprises of total 12 stands having 5 Roughing Stands (4,2 Hi Horizontal of 500m.m. size &amp; 1 vertical of 400m.m size) 4 Intermediate stands (3,2 Hi horizontal &amp; 1 vertical of 400m.m. size) 3 Finishing stands (2,2 Hi Horizontal of 400 &amp; 350m.m size &amp; 1 vertical of 350mm size)</td>
<td>-</td>
<td>-</td>
<td>Merchant Products, Bars &amp; Rods</td>
<td>500 500 500</td>
</tr>
<tr>
<td>e) Wire Rod Mill</td>
<td>1 reheating furnace of 120 T/hr capacity. Mill comprises of 37 stands (7 of 450mm size &amp; 2 of 350mm size) First Intermediate stand (Six of 300 mm size, rolling in four stand). Two second Intermediate stand (each rolling in 2 stand, four finishing group (each of two vertical and 2 horizontal of 250 mm size stand ) rolling in single stand. The entire mill is divided into A, B, C, D strands with modernisation of strands C&amp;D only to meet stringent quality specification</td>
<td>-</td>
<td>-</td>
<td>Wire Rods</td>
<td>400 400 400</td>
</tr>
<tr>
<td>f) Plate Mill</td>
<td>-</td>
<td>-</td>
<td>3 Reheating furnace of 120T/hr capacity Mill comprises of one descaler one vertical edger, one reversing 4 Hi, roughing stand and one reversing 4 Hi, Finishing stand, two leveler &amp; two shearing lines</td>
<td>Plate</td>
<td>- - 950</td>
</tr>
</tbody>
</table>
### Brief Description of Durgapur Steel Plant

<table>
<thead>
<tr>
<th>Department</th>
<th>Coke Ovens</th>
<th>Sinter Plant</th>
<th>Blast Furnaces</th>
<th>Basic Oxygen Furnaces</th>
<th>Continuous Casting Plant</th>
<th>Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>Under initial 1.0 MT capacity came up in late 50s</td>
<td>3 Batteries of 78 Ovens each with Chip-Breaking of 445 mm, B.C. Time 18 - 20 hrs</td>
<td>1 Battery of 78 Ovens &amp; a Half</td>
<td>1 BF of 1754 m³ Useful Volume &amp; Capacity of 1500 TPD</td>
<td>BF #1 - 1400 m³, 1600 TPD</td>
<td>CCP - Cast Billet, Slabs &amp; Sleeper Bars</td>
<td>BF - Basic Oxygen Furnace, CC - Continuous Casting Plant, MT - Million Tonnes</td>
</tr>
<tr>
<td>Under initial 0.6 MT Expansion in late 60s</td>
<td>1 Battery of 39 Ovens</td>
<td>2 x 142.7 m³ Hearth Area Sintering Machine with Capacity of 2500 TPD</td>
<td>BF #2 - 1400 m³, 1600 TPD</td>
<td>BF #3 - 1400 m³, 1800 TPD</td>
<td>BF #4 - 1600 m³, 1800 TPD</td>
<td>PCM - Pig Casting Machine</td>
</tr>
<tr>
<td>Addl. Under Modernisation in late 80s and early 90s</td>
<td>1 Battery of 78 Ovens and a Half</td>
<td>1 Slitting Machine of 198 m² Gross Sinter</td>
<td>BF #3 - 1400 m³, 1800 TPD</td>
<td>BF #4 - 1600 m³, 1800 TPD</td>
<td>BF #5 - 1800 m³, 2200 TPD</td>
<td>BF - Basic Oxygen Furnace, CC - Continuous Casting Plant, MT - Million Tonnes</td>
</tr>
</tbody>
</table>

#### Annual Capacity (000 T)

- BF Coke: 1140
- BF Hot Meta (Gross): 1700
- BF Basic O.H. Fee.: 1600
- BF Basic O.H. Fee.: 1900
- BF Basic O.H. Fee.: 1200
- BF Basic O.H. Fee.: 1500
- BF Basic O.H. Fee.: 1800
- BF Basic O.H. Fee.: 2000
- BF Basic O.H. Fee.: 2200

#### Coke Ovens

- BF #1: 1400 m³, 1600 TPD
- BF #2: 1400 m³, 1800 TPD
- BF #3: 1600 m³, 1800 TPD
- BF #4: 1800 m³, 2200 TPD

#### Sinter Plant

- BF #3: 1400 m³, 1800 TPD
- BF #4: 1600 m³, 1800 TPD
- BF #5: 1800 m³, 2200 TPD

#### Blast Furnaces

- BF #1: 1400 m³, 1600 TPD
- BF #2: 1400 m³, 1800 TPD
- BF #3: 1600 m³, 1800 TPD
- BF #4: 1800 m³, 2200 TPD

#### Basic Oxygen Furnaces

- BF #1: 1400 m³, 1600 TPD
- BF #2: 1400 m³, 1800 TPD
- BF #3: 1600 m³, 1800 TPD
- BF #4: 1800 m³, 2200 TPD

#### Continuous Casting Plant

- BF #5: 1800 m³, 2200 TPD
- BF #1: 1400 m³, 1600 TPD
- BF #2: 1400 m³, 1800 TPD
- BF #3: 1600 m³, 1800 TPD
- BF #4: 1800 m³, 2200 TPD

#### Pig Casting Machine

- BF #5: 1800 m³, 2200 TPD
- BF #1: 1400 m³, 1600 TPD
- BF #2: 1400 m³, 1800 TPD
- BF #3: 1600 m³, 1800 TPD
- BF #4: 1800 m³, 2200 TPD

#### BF - Basic Oxygen Furnace, CC - Continuous Casting Plant, MT - Million Tonnes
### 6.3 Brief Description of Durgapur Steel Plant (Contd…)

<table>
<thead>
<tr>
<th>Department</th>
<th>Under initial 1.0 MT capacity came up in late 50s</th>
<th>Addl. Under 0.6 MT Expansion in late 60s</th>
<th>Addl. After Modernisation in late 90s and early 90s</th>
<th>Products</th>
<th>Annual Capacity (000 T)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>1.0 MT</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>1.6 MT</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>Modn</strong></td>
</tr>
<tr>
<td><strong>Section Mill</strong></td>
<td>2 x 40 T / Hr. End Chg. &amp; End Discharging Re-heating Foe; One 26” 2-Hi Roughing Mill, Two 24” 3-Hi Int. Mill &amp; One 24” 2-Hi Finishing Mill</td>
<td></td>
<td></td>
<td>Joists, Channels, Angles</td>
<td>200 + 12.8 (FP)</td>
</tr>
<tr>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td><strong>Merchant Mill</strong></td>
<td>1x 70 T / Hr. Side Chg. &amp; Side Discharging R. Foe; 13 Horizontal Stands &amp; 4 Repeaters (Closed Top Type Morgan Design)</td>
<td>Silt Rolling with Crop cum Cobble Shear, Thermax Cooling, Automatic Bundling &amp; Bundling Machine</td>
<td>Plain Rounds &amp; TMT Bars</td>
<td></td>
<td>240 240 250</td>
</tr>
<tr>
<td><strong>Skelp Mill</strong></td>
<td>1 x 60 T / Hr. Side Chg. &amp; Side Discharging Reheating Foe; 11 Horizontal Stands &amp; 6 Edgers (Continuous Loewy Design)</td>
<td></td>
<td></td>
<td>Steel Strip/ Skelp Width 147-234mm Thk 1.78-4.8 mm</td>
<td>250 100*</td>
</tr>
<tr>
<td><strong>Sleepers</strong></td>
<td>One 229 T Hydraulic Press; One Continuous Walking Beam Foe.</td>
<td></td>
<td></td>
<td>BG Sleepers</td>
<td>75 75 75*</td>
</tr>
<tr>
<td><strong>Fish Plate</strong></td>
<td>3 Vertical Multi-Spindle Drilling Machine</td>
<td></td>
<td></td>
<td>52 Kg Fish Plate</td>
<td>11 11 5*</td>
</tr>
<tr>
<td><strong>Finishing Plant</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Wheel &amp; Axle</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>57</strong> 93 58</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>583 869 725</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>821 1239 1586</td>
</tr>
</tbody>
</table>

* Capacity of Skelp Mill considered in Post Modernisation is 100,000 T although the installed Mill Capacity is 250,000 T. Presently however it is taken as 180,000 T (adding to 100,000 T the capacities of the Fish Plate and Sleeper Plant which are not running due to lack of orders).
Process Flow Chart of DSP

LS, Dolo, Iron ore,
Ferro Mn, Ferro Si,
Silico Mn

Raw Material
Handling Plant

Coal Handling
Plant

Sinter Mix

Sinter Plant

Blast Furnace

Coke

Gas

Clean Gas

FeSi
FeMn
Dolo
I/Ore
Lump

Sinter

Coke

Slag

SGP

Granulated Slag

Scrap

Scrap Yard

Return & Process
Scrap

PCM

Pig Iron

Steel Melting Shop (BOF)

Liquid Steel

Oxygen
Plant

O₂, Ar, N₂

Teeming Stage

Wheel Ingots

8 Ton Ingots

Striped BT Ingots

Blooming Mill

Blooms for Sale

Billet Mill

Billets & Slabs for Sale

Merchant Mill

Plain Rounds & Ribbed Rounds (TMT Bars)

Skelp Mill

Steel Strip / Skelp

Angles, Channels, Joists

Special Casting Bay

Striped Wheel Ingots

Wheel & Axe Plant

Wheels & Axe for Railway Carriages

Legend:

AS - Ammonium Sulphate
BOF - Basic Oxygen Furnace
CC - Continuous Cast
CCP - Continuous Casting Plant
Dolo - Dolomite
I/Ore - Iron Ore
LS - Lime Stone
LSN - Light Solvent Naptha
NLCP - New Lime Calcination Plant
PCM - Pig Casting Machine
SGP - Slag Granulation Plant
TMT - Thermo Mechanically Treated

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### 6.4 Brief Description of Rourkela Steel Plant

<table>
<thead>
<tr>
<th>Department</th>
<th>Facilities</th>
<th>Capacities</th>
<th>Special Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Coke Oven</td>
<td>5 Batteries</td>
<td>Each oven's useful volume = 21.6 m³</td>
<td>[More details provided in the text]</td>
</tr>
<tr>
<td></td>
<td>-3 Batteries of 70 ovens each</td>
<td>Oven height = 4.5 m</td>
<td></td>
</tr>
<tr>
<td></td>
<td>-2 Batteries of 80 ovens each</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Partial briquetting of coal charge with two presses 80 t/hr</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>capacity each</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Ore Bedding and Blending Plant</td>
<td>Iron ore (Fines &amp; Lumps), Limestone &amp; Dolomite (Both BF &amp; SMS grade) and</td>
<td>5 MT/yr</td>
<td>Coke &amp; Flux crushing and Base mix preparation</td>
</tr>
<tr>
<td></td>
<td>Manganese Ore are handled. Base mix</td>
<td></td>
<td>facilities available for supply to Sinter Plant.</td>
</tr>
<tr>
<td></td>
<td>preparation for Sintering Plant-I and Sintering Plant-II</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Sintering Plant -I</td>
<td>2 machines, each has a sintering area of 125 M²</td>
<td>1.5 Mt/yr</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bed Ht. = 440 mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Sintering Plant -II</td>
<td>1 machine of sintering area of 162 M²</td>
<td>1.57 Mt/sinter/yr</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bed Ht. = 600 mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Blast Furnace</td>
<td>4 Blast Furnaces</td>
<td>2.0 MT/yr of Hot Metal</td>
<td>Furnace No. 2,3 &amp; 4 are provided with BLT system</td>
</tr>
<tr>
<td></td>
<td>* 3 BFs of 1200 TPD each, Hearth dia of 7.4 m and working volume</td>
<td>DNBA Cast house Slag</td>
<td>Hot metal desulphurisation done by Calcium</td>
</tr>
<tr>
<td></td>
<td>995 m³ each</td>
<td>Granulation Plant of 0.4 MT/yr at</td>
<td>Carbide injection</td>
</tr>
<tr>
<td></td>
<td>* 1 BF is of 1800 tonne per day working volume of 1448 m³,</td>
<td>BF #4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hearth size 9 m</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Blast Furnace productivity is 1.13 tonne/m³/day as per DPR</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Steel Melting Shop-I</td>
<td>2 LD Converter each of 60/66 T Capacity/blow</td>
<td>0.26 Mt/yr of liquid steel</td>
<td>Pioneer in L.D. technology in Asia. Also, equipped with vacuum are refining,</td>
</tr>
<tr>
<td></td>
<td>2 Mixer each of 1100 T capacity in active type</td>
<td>0.305 Mt/yr</td>
<td>vacuum oxygen refining and Ladle Furnace</td>
</tr>
<tr>
<td></td>
<td>1 single strand slab caster</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Steel Melting Shop-II</td>
<td>2 LDs each of 150 T capacity/blow</td>
<td>1.44 Mt/yr of liquid steel</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2 mixers each of 1300 T capacity</td>
<td>1.355 Mt/yr</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2 Single strand slab caster</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Hot Rolling Mills</td>
<td>i) Plate Mill</td>
<td>0.299 Mt/yr Plates</td>
<td>i) One Walking Beam Furnace having 100 Hr.</td>
</tr>
<tr>
<td></td>
<td>3.1 m wide, 4 High Reversing</td>
<td></td>
<td>- Normalising Furnace</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Flame cutting machine for cutting</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Plates &gt; 20mm thickness</td>
</tr>
<tr>
<td></td>
<td>ii) Semi Continuous Hot Strip Mill</td>
<td>1.44 Mt/yr</td>
<td></td>
</tr>
<tr>
<td></td>
<td>One 1.7 m 2-Hi Universal mill R₉V₉</td>
<td></td>
<td>Quick roll charging device,</td>
</tr>
<tr>
<td></td>
<td>One 1.7 m 4-Hi reversible roughing stand R₁</td>
<td></td>
<td>One coil box, New coil conveyor system</td>
</tr>
<tr>
<td></td>
<td>One 1.7 m 4-Hi non-reversible roughing stand R₂</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Finishing mill of 6 continuous 1.7m wide 4-Hi stand</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2 Hydraulic coilers of down type</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2 walking beam furnaces</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>225 T/Hr each of capacity</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Brief Description of Rourkela Steel Plant (Contd.)

<table>
<thead>
<tr>
<th>Department</th>
<th>Facilities</th>
<th>Capacities</th>
<th>Special Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>9. Cold Rolling Mill</td>
<td>2 Pickling line &lt;br&gt;One Cold Reversing Mill of 4 high stand. &lt;br&gt;Width range 630-1540mm &lt;br&gt;5 Stand Tandem Mill 1420mm, 4 high &lt;br&gt;2 Skin Pass Mill, 4 high &lt;br&gt;2 Hot Dip galvanizing lines 1220mm width &lt;br&gt;Electrolytic Tinning Line 560-1040mm</td>
<td>0.748 MT/Yr. of HR coil as input</td>
<td>Thyristorisation of Tandem Mill &lt;br&gt;Branding of Galvanised Sheets with brand name 'SAIL Jyoti'</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.428 MT/Yr.</td>
<td>Jet coating &amp; corrugation facility &lt;br&gt;Certified as per ISO 9002 QA System</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.16 MT/Yr.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.085 MT/Yr.</td>
<td></td>
</tr>
<tr>
<td>10. Silicon Steel Mill</td>
<td>4 high reversing mill &lt;br&gt;CRNO 900, 950 &amp; 1000mm width, 0.5-0 &amp; 0.65mm thick &lt;br&gt;Length 2000mm, 2500mm</td>
<td>0.0735 MT/Yr.</td>
<td>Synthesis gas plant of capacity 900 Nm³/hr &lt;br&gt;Hydraulics AGC Certified as per ISO 9002 QA System &lt;br&gt;Achieved ISO - 14001 Certificate</td>
</tr>
<tr>
<td>11. Pipe Plant</td>
<td>ERWPP - 3 hi, 1400 mm wide, &lt;br&gt;Pipe OD-8.5/8 to 18&quot; in specific dia's &lt;br&gt;Thickness 4.8-10 mm &lt;br&gt;SWPP - Pipe OD 18&quot; to 64&quot; &lt;br&gt;Thickness 5.56-10.3 mm</td>
<td>75000 T/Yr of ERW</td>
<td>API Grade Pipes and IS grade pipes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>50,000 T/Yr. of SW pipes</td>
<td></td>
</tr>
<tr>
<td>12. Special Plate Plant (SPP)</td>
<td>Bogie Hearth Heat Treatment Furnace &lt;br&gt;Roller Hearth Heat Treatment Furnace &lt;br&gt;Tempering Furnace &lt;br&gt;Machining Facilities</td>
<td></td>
<td>Quenched and tempered High Hardness producer of Defence Steel and space quality plates, e.g. spade armour plates, jacket steel plates, Maraging Steel, etc. equipment with a flame cutting machine.</td>
</tr>
<tr>
<td>13. Captive Power Plant-I</td>
<td>2 Nos FBC HB Boilers &lt;br&gt;2 Nos Gas fired HB Boilers &lt;br&gt;2 Nos Multiple fuel HB Boilers &lt;br&gt;5x25 MW TA &lt;br&gt;5 Nos Turbo Blowers &lt;br&gt;3 Nos MP Boilers (2 nos. stoker fired, 1 no. CFBC fired) &lt;br&gt;4 nos. of Furnace oil storage tank for 4000 Tonnes storing capacity &lt;br&gt;2 nos. of DM Water Plant for HP Boiler &lt;br&gt;2 Nos. of soft water plant &lt;br&gt;18 nos. of cooling Tower Cells</td>
<td>128 MW</td>
<td>Blower House for BF Supply process steam for all Plant/Unit</td>
</tr>
<tr>
<td>14. Captive Power Plant-II</td>
<td>2 units x 60 MW</td>
<td>120 MW</td>
<td>Operating under joint venture of SAIL/NTPC i.e. NSPCL</td>
</tr>
</tbody>
</table>
### Brief Description of Bokaro Steel Plant

<table>
<thead>
<tr>
<th>Plant/Shop</th>
<th>Principal Units (Description)</th>
<th>Numbers at 1.7 MT</th>
<th>Annual Capacities</th>
<th>Million Tonnes at 1.7 MT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coke Oven</td>
<td>Coke Oven Batteries</td>
<td>4 8</td>
<td>B.F.Coke (+25mm)</td>
<td>2.09 3.48 3.48</td>
</tr>
<tr>
<td></td>
<td>- 69 ovens each</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- 27.3 m³ capacity each</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- 4.7 m high each</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sinter Plant</td>
<td>Sintering Machine</td>
<td>2 3</td>
<td>Fluxed Skip Sinter</td>
<td>3.7 6.2 6.2</td>
</tr>
<tr>
<td></td>
<td>- 252 sq. m. area</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blast Furnace</td>
<td>2000 M³ Blast Furnace</td>
<td>3 5</td>
<td>Hot Metal</td>
<td>2.735 4.585 4.585</td>
</tr>
<tr>
<td></td>
<td>- 2640 T/day Capacity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Hearth size 9.75 m</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Steel Melting</td>
<td>I. LD Converter</td>
<td>4 5</td>
<td>Ingot Steel</td>
<td>1.7 2.5 2.20</td>
</tr>
<tr>
<td></td>
<td>- 100/130 T Capacity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2 (a). LD Converter</td>
<td>- 2</td>
<td>- Do -</td>
<td>- 1.5 -</td>
</tr>
<tr>
<td></td>
<td>- 300/350 T Capacity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2 (b). CCS Facility</td>
<td>- -</td>
<td>Concast Slabs</td>
<td>- - 2.16</td>
</tr>
<tr>
<td></td>
<td>(No. of continuous casting machines)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slabbing Mill</td>
<td>Universal Slabbing Mill with No. of soaking pits</td>
<td>6 12</td>
<td>Steel Slabs</td>
<td>1.465 3.449 1.90</td>
</tr>
<tr>
<td></td>
<td>- each having 4 holes of 160 T Capacity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- 1250 mm horizontal stand</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- 1000 mm vertical stand</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hot Strip Mill</td>
<td>Hot strip mill with No. of reheating furnaces indicated</td>
<td>2 3 4</td>
<td>HR Coil (Total)</td>
<td>1.43 2.263 3.955</td>
</tr>
<tr>
<td></td>
<td>- 2000 mm wide</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Charging rate 260 T/hr.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5 Roughing stands +7 finishing stand of tandem type</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>No. of coilers</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### 6.5 Brief Description of Bokaro Steel Plant

<table>
<thead>
<tr>
<th>Plant/Shop</th>
<th>Principal Units (Description)</th>
<th>Numbers at</th>
<th>Annual Capacities</th>
<th>Million Tonnes at</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1.7MT</td>
<td>4.0MT</td>
<td>Mod</td>
</tr>
<tr>
<td>Hot Rolled</td>
<td>Shearing line</td>
<td>2</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>Finishing</td>
<td>Slitting Line</td>
<td>1</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Cold Rolling</td>
<td>-2000 mm Pickling line (on H₂SO₄)</td>
<td>1</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>-1420 mm Pickling line (on HCl)</td>
<td>-</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>-Four Stand 2000 mm Tandem Mill</td>
<td>1</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>-Five Stand 1420 mm Tandem Mill</td>
<td>-</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>-Bell type Annealing line</td>
<td>1</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>-Tower type continuous Annealing line</td>
<td>-</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>-2000 mm Single stand skin Pass Mill</td>
<td>-</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>-1420 mm twin stand temper DCR mill</td>
<td>-</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>-Shearing and slitting line</td>
<td>(2+1)</td>
<td>(5+3)</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>-Hot Dip Galvanising line</td>
<td>-</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

- HR Sheets/Plate
- HR Slit Coil
- Pickled Coil
- Cold Rolled Coil
- Annealed Coil
- Skin Passed Coil
- Black Plate
- CR sheet, CR coil & CR Slit Coil
- Galvanized Plain & Corrugated sheets
### Brief Description of IISCO Plant, Burnpur

<table>
<thead>
<tr>
<th>Department/shops</th>
<th>Facilities (Description of Principal Departments/shops)</th>
<th>Principal Product</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coke Oven</td>
<td>No. of battery - 3&lt;br&gt;Each battery contains 78 ovens</td>
<td>Coke</td>
</tr>
<tr>
<td>Blast Furnace</td>
<td>No. of Blast Furnace - 4&lt;br&gt;2 B.F. of useful volume- 530 M³ each&lt;br&gt;Hearth size - 5.1 meter&lt;br&gt;Capacity - 600 T/day&lt;br&gt;2 B.F. of useful volume - 1170 M³ each&lt;br&gt;Hearth size - 7.162 meter&lt;br&gt;Capacity - 1200 T/day&lt;br&gt;No. of pig casting machine - 6&lt;br&gt;Weight of Pig Iron Lump- (20-25 Kg)</td>
<td>Pig Iron</td>
</tr>
<tr>
<td>Steel Melting Shop</td>
<td>Total No. of Twin Hearth Furnace - 2&lt;br&gt;Furnace capacity - 450 T/Heat&lt;br&gt;Oxygen Plant - 50T/Day</td>
<td>Steel Ingot (Weight of steel Ingot 5 Tonnes)</td>
</tr>
<tr>
<td>Rolling Mills</td>
<td>Soaking Pits - 32&lt;br&gt;Each soaking pit capacity - 40 Tonnes&lt;br&gt;Fuel used - Mixed Gas (B.F. &amp; C.O. gas)&lt;br&gt;Blomming Mill (40&quot; Mill)&lt;br&gt;One 2 Hi Reversing Mill&lt;br&gt;Roll Size- 42&quot; dia; Capacity - 1 M T/Year&lt;br&gt;Input - 5 Tonnes &amp; 8 Tonnes Ingot (IPT)&lt;br&gt;Heavy Structural Mill (34&quot; Mill)&lt;br&gt;No. of Rolling Stands - 3&lt;br&gt;One 2 Hi Reversing Roughing Stand&lt;br&gt;One 2 Hi Reversing Intermediate Stand&lt;br&gt;One 2 Hi Reversing Finishing Stand&lt;br&gt;Light Structural Mill (18&quot;)&lt;br&gt;No. of Rolling Stand - 4&lt;br&gt;3 Hi Non reversing stand - 2 (Roughing)&lt;br&gt;3 Hi Non reversing stand - 1 (Intermediate)&lt;br&gt;2 Hi Non reversing stand - 1 (Finishing)&lt;br&gt;Billet Mill&lt;br&gt;No. of Stands - 10&lt;br&gt;Continuous type Mill&lt;br&gt;Merchant Mill (Bar &amp; Rod Mill)&lt;br&gt;‘2’ Horizontal Roughing Stands&lt;br&gt;2 Hi Horizontal Stands - 17 Nos.&lt;br&gt;Edgers - 4 Nos.</td>
<td>Bloom &amp; Slab</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Heavy structural sections:&lt;br&gt; Joist, Angle Channel, Rail, Z Bar, Z Piling &amp; Special Sections&lt;br&gt;Light structural channel, Joists, equal &amp; unequal angles, 30 lbs Rail, rounds.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Billet and Sleeper Bars</td>
</tr>
</tbody>
</table>
### 6.7. Product Mix of SAIL Plants

<table>
<thead>
<tr>
<th>Facilities/Product</th>
<th>Bhilai (000 Tonnes)</th>
<th>Bokaro (000 Tonnes)</th>
<th>Durgapur (000 Tonnes)</th>
<th>Rourkela (000 Tonnes)</th>
<th>HISCO (000 Tonnes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Hot Metal</td>
<td>4080.0</td>
<td>4585.0</td>
<td>2088.0</td>
<td>2000.0</td>
<td>670.0</td>
</tr>
<tr>
<td>2. Crude/Liquid Steel</td>
<td>4000.0</td>
<td>4500.0</td>
<td>1876.0</td>
<td>1900.0</td>
<td>380.0</td>
</tr>
<tr>
<td>3. Saleable Steel</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a) Semi for sale</td>
<td>553.0</td>
<td>861.0</td>
<td>12.0</td>
<td>12.0</td>
<td></td>
</tr>
<tr>
<td>b) Finished Steel</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>i) Flat Product</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Wide Heavy Plates</td>
<td>950.0</td>
<td>299.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• HR Sheets, Coil &amp; Plates</td>
<td>2120.0</td>
<td>490.4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Skelp</td>
<td>180.0</td>
<td>180.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• CRCoils/Strip/Sheets</td>
<td>1390.0</td>
<td>433.1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• TMBP</td>
<td>100.0</td>
<td>100.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Electrolytic Tin Plates</td>
<td>85.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Galvanised Sheets/coils</td>
<td>170.0</td>
<td>160.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Silicon Steel</td>
<td>73.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• ERW Pipes</td>
<td>75.0</td>
<td>75.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Spiral Welded Pipes</td>
<td>55.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sub Total (i)</td>
<td>950.0</td>
<td>3780.0</td>
<td>180.0</td>
<td>1671.0</td>
<td></td>
</tr>
<tr>
<td>ii) Non Flat product</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Structural</td>
<td>250.0</td>
<td>207.0</td>
<td>166.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Merchant Products</td>
<td>500.0</td>
<td>280.0</td>
<td>111.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Wire Rods</td>
<td>400.0</td>
<td>400.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Rails</td>
<td>500.0</td>
<td>500.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Wheels &amp; Axles</td>
<td>58.0</td>
<td></td>
<td></td>
<td>16.0</td>
<td></td>
</tr>
<tr>
<td>• Special Sections</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sub Total (ii)</td>
<td>1650.0</td>
<td>545.0</td>
<td>293.0</td>
<td>293.0</td>
<td></td>
</tr>
<tr>
<td>Total Saleable Steel</td>
<td>3150.0</td>
<td>3780.0</td>
<td>1586.0</td>
<td>1671.0</td>
<td>305.0</td>
</tr>
</tbody>
</table>
Metallurgical Process under Consideration for Implementation in Future.

- KR process of reduction smelting using non coking coals.
- Solid/Gas based direct reduction of iron.
- Palletizing of iron ore concentrates.
- Formed coke making
- DR-EAF route of steel making
- Combined blowing in LD converters.
- Ladle refining of steel
- Thin strip casting
- Production clean steel
- Net shape casting

Future Technological Plans

SAIL’s Integrated Steel Plants (ISPs) were installed in the late fifties (BSP, DSP & RSP) and in the early seventies (BSL). Driven by the forces of market, capacity enhancement, cost reduction and environmental issues these plants have been upgraded from time to time. In this context, SAIL has completed a massive modernisation programme in three of its ISPs, viz., DSP, RSP & BSL. The modernisation at DSP & RSP mainly comprised the following:

Upgradation of raw material handling facilities and installation of new sinter plants to improve the burden quality and increase the percentage of sinter in the Blast Furnaces’ burden (One new sinter plant each at DSP & RSP and a new Ore Bedding and Blending plant at RSP)

Upgradation of Blast Furnaces for improving productivity and reducing coke rates.

New Basic Oxygen Furnace (BOF) shops (one each at DSP & RSP) to completely do away with the outdated and unviable Open Hearth Furnace steel making.

Introduction of continuous casting to eliminate/reduce ingot casting – roughing mill route (Billet casters at DSP and Slab casters at RSP). Ingot casting has been completely eliminated at RSP.

Selective upgradation of finishing facilities (Section mill and Wheel & Axle plant at DSP and Hot Strip mill at RSP) primarily to improve product qualities.

The modernisation programme at BSL focussed on the liquid steel casting aspect and hot rolling. A slab caster shop has been installed with SMS-2 and the Hot Strip mill has been upgraded.

Apart from the above modernisation programmes, a new sinter plant with a machine hearth area of 312 m2 (largest sinter machine in SAIL) along with its associated raw material handling facility has been commissioned at BSP. This sinter plant is ensuring availability of high percentage of excellent quality sinter for the blast furnaces and is also envisaged to facilitate closure of the older Sinter Plant – I. The new plant is of state of the art design, and incorporates a host of modern features including latest pollution abatement features.

With the culmination of the massive modernisation programme in the near future, focus will be on consolidation for improving performances and selective upgradations. The broad area wise technological upgradation and replacement schemes, which are likely to be taken up in the next three to five years, are as follows.
Raw Materials:
SAIL has captive iron ore mines. The deposits in the present mining areas get depleted and the mines need periodic developments for maintaining the production and quality. The schemes envisaged in the iron ore mines areas are as under:

Modernisation & Expansion of Bolani Iron Ore mines. This mine supplies iron ore primarily to DSP.

Developmental work for new iron ore mines for BSP at Rowghat.

Coke Ovens
Rebuilding of coke ovens is a continuous process with old batteries (after they have served for 25 years or so) being rebuild into newer ones. The batteries that are likely to be rebuilt will incorporate pollution control features for keeping the emissions from the batteries within the stipulated limits. Certain process control automation schemes are also likely to be introduced while rebuilding the old batteries.

Blast Furnaces
In the area of blast furnaces the focus will be on introducing alternate fuel injection systems (for reducing coke rate and reduce the number of operating coke oven batteries) and upgradation of existing furnaces. The schemes envisaged are:

Introduction of Coal Dust Injection in more furnaces, both at BSP and BSL (CDI has already been introduced in BF-6 of BSP and BF-4 at BSL)

Upgradation of BF - 3 at DSP and BF-7 at BSP with introduction of closed loop cooling systems and other features. BF-4 at RSP is envisaged to be fitted with new gas cleaning plants for facilitating high top pressure operation (for improving productivity and reducing coke rate). BF-1 at RSP is provided with a cast house slag granulation system.

Steel Melting & Casting
In this area the focus will be on cast steel quality improvement and introduction/upgradation of continuous casting facilities. The major schemes envisaged to be undertaken are:

• Upgradation of slab caster and bloom caster at BSP
• Introduction of process control automation, desulphurisation and vacuum degassing facilities at SMS-2, BSL
• Billet Caster & Secondary Refining facility for SMS-1, BSP
• Introduction of combined blowing technology at SMS-2, BSL is already under progress and this technology may be introduced also at SMS-2, RSP.

Rolling & Finishing
The product of these mills directly go to the customer. With increasing competition (both at domestic and global level) and stress on ever improving product quality, SAIL is focussing on product quality improvement schemes in its rolling and finishing mills. The schemes likely to be undertaken in this area are as follows:

Upgradation of Cold Rolling Mill complex at BSL with introduction of features like Hydraulic Automatic Gauge Control (HAGC), Shape control, computer and automation systems, Electro discharge texturing machines, Hydrogen Annealing, etc. These schemes are envisaged to improve the product quality with respect to gauge variations, shape, mechanical properties and surface quality. In conjunction the existing pickling lines, emulsion systems are also planned to be upgraded.
HAGC & on-line thickness gauge in Plate Mill of BSP

Roughing stand and Vertical Scale Breaker modification in Hot Strip Mill of BSL for improving the width tolerances and surface quality of the hot rolled coils

Technical upgradation of Electric Resistance welded Pipe Plant + (ERW) at RSP is under implementation. After this, RSP will able to meet specific requirements of high grade API Pipelines for carrying Petroleum products and gases.

On-line gauge measuring system and straightening Machine for TMT (Thermo Mechanically treated) wire rods for improving their quality at Wire Rod Mill, BSP.

A finishing mill at DSP is also being planned for enriching its product mix. The Rail & Structural Mill at BSP is under expansion for meeting the demands of longer rails from Indian Railways (the present rail length supplied is 13m. In future longer rail lengths may be supplied).

**Conclusion**

SAIL, as the largest Iron & Steel producer in the country, has played a leading role in industrial development of the country in the last 45 years. It has taken a position in the top 15 steel producers of the world. A considerable improvement is being observed in Operation, Marketing and Financial parameters. Challenging targets have been fixed for future. After the introduction of new technologies with modernisation, the productivity, quality and specific energy consumption have improved significantly. Besides achievement of set goals, our endeavor in future should be to earn and establish excellence in some of the technological areas.
Raw Materials

Raw Materials Division of SAIL

Raw Materials Division (RMD) of SAIL is the second largest mining organisation in the country after Coal India Ltd. It has the obligations and responsibility of supply of consistent quality and quantity of raw materials to steel plants. Specific mission of the division is to achieve rapid expansion and optimisation of its production capacity, improvement in technology quality and profitability with better service to steel plants. The composite picture of demand of raw materials is given in Table No. 1

<table>
<thead>
<tr>
<th>Table - I</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demand of Raw Materials (other than Coal)</td>
</tr>
<tr>
<td>(in million tonnes)</td>
</tr>
<tr>
<td>Iron Ore:</td>
</tr>
<tr>
<td>Lump</td>
</tr>
<tr>
<td>Fines</td>
</tr>
<tr>
<td>Limestone:</td>
</tr>
<tr>
<td>BF grade</td>
</tr>
<tr>
<td>SMS grade</td>
</tr>
<tr>
<td>Dolomite:</td>
</tr>
<tr>
<td>BF grade</td>
</tr>
<tr>
<td>SMS grade</td>
</tr>
<tr>
<td>Manganese</td>
</tr>
</tbody>
</table>

Raw materials like iron ore, limestone, dolomite, manganese ore and coke are used for iron making which are all received in steel plants from mines to charge the furnace. It is preferable to have low ash content in the coke, low gangue material in the iron ore and fluxes to increase furnace productivity. In order to ensure consistency in quality and quantity of major raw materials SAIL has a number of captive mines. The mines were in the beginning captive to respective steel plants. As our demands grew stringent in terms of quality, it was felt necessary that the mines be brought under one umbrella. All the mines belonging to RSP, DSP and BSL were brought under one function called Raw Materials Division, It was formed during 1989-90. It was formed with the following goals in mind:

- Proper development of mines and optimum utilisation of assets.
- Create synergy in mining operations.
- Reduction in dependence on non-captive sources by increasing asset utilisation/productivity and inter-plant transfers.
- Perspective planning and development of new sources.
Major Advantages

- Centralised responsibility to organise supply of raw materials to plants of desired quality and quantity.
- Proper emphasis on mine planning and long term development of the mines.
- Integrated approach for development of new mines and scouting for new mineral areas.

The Raw Materials Division of SAIL

Raw Materials Division of SAIL has five iron ore mines (excluding BSP mines), four limestone mines, and two dolomite quarries. Various mines under RMD and their capacities are indicated in Table No. 2 (i) & (ii).

Table - 2 (i)
Mines under RMD and their capacities Iron Ore (in Million tonnes)

<table>
<thead>
<tr>
<th>Mine</th>
<th>Capacity</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kiriburu</td>
<td>4.250</td>
<td>Jharkhand</td>
</tr>
<tr>
<td>Meghabatuburu</td>
<td>4.300</td>
<td>Jharkhand</td>
</tr>
<tr>
<td>Bolani</td>
<td>3.010</td>
<td>Orissa</td>
</tr>
<tr>
<td>Barsua</td>
<td>2.010</td>
<td>Orissa</td>
</tr>
<tr>
<td>Kalta (Manual)</td>
<td>0.800</td>
<td>Orissa</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>14.37</strong></td>
<td></td>
</tr>
</tbody>
</table>

Table - 2 (ii)

<table>
<thead>
<tr>
<th>Mine</th>
<th>Capacity (MT)</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bhawnathpur</td>
<td>1.45</td>
<td>Bihar</td>
</tr>
<tr>
<td>Purnapani</td>
<td>0.880</td>
<td>Orissa</td>
</tr>
<tr>
<td>Kuteshwar</td>
<td>0.800</td>
<td>M.P</td>
</tr>
<tr>
<td>Satna</td>
<td>0.240</td>
<td>M.P</td>
</tr>
<tr>
<td>Tulsidamar</td>
<td>0.400</td>
<td>Bihar</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>5.150</strong></td>
<td></td>
</tr>
</tbody>
</table>

The Method of Mining

The method of mining in all the captive mines other than coal is opencast. All the iron ore deposits of SAIL are in the hilly terrain. Due to this kind of topographical advantage mining or iron ore is somewhat easier than the pit mining of other minerals.

At first the highest point of the deposit is approached by developing suitable roads. Benches are developed in the form of steps. Keeping in view the depth and disposition
of the ore body (as ascertained by exploration) suitable site for erection of the primary crusher is selected outside the limit of ore body so that the cost and time of hauling of ore remains optimum throughout the life of the mine. Primary/Secondary crusher material is carried by the down-hill conveyors to the foot of the hill where beneficiation and loading plants are located. In certain cases beneficiation plants are in continuation with the crushing plant.

On the other hand, limestone and dolomite deposits are occurring in flat terrain almost near the surface. When sufficient area of the ore body has been exposed by the removal of overburden a trench is generally cut across for the formation of benches. Benches recede on both the sides till the ore limit is reached. Similarly, the lower benches are also developed. Since the limestone and dolomite deposits are subterranean, water accumulation in the pits is a very common phenomenon.

Most of the iron ore mines of SAIL are highly mechanized, whereas in limestone and dolomite the trend is reverse except, Nandini, Bhawanathpurt and Purnapanni where both mechanized and manual mining sections coexist. In mechanized mines, mining is done by shovel - dumper combination.

**Ore Processing (Handling) Plant**

In ore processing (handling) plant, the ore is crushed and screened to the desired size as stipulated by the customer requirement. In most of the plants crushing is done in two stages-primary and secondary. At Bolani and Kiriburu tertiary crushing is done for further reduction in the size of the ore. Crushed ore is fed on the screens for separating the lumps (generally +10 to -40 mm). The oversize from the screen is carried by the conveyor to the lumps stockpile and undersize to the fines stockpile near loading plant.

In case of iron ore at Kiriburu, Meghhatuburu and Dalli, the run-of mine (ROM) and at Bolani only iron ore fine is being washed to reduce the gangue content (i.e. alumina and silica) and thereby it increases the "Fe" content in the ore. Washing also improves the handling characteristics of iron ore fines.

The washing process involves scrubbing, wet screening and classification. The material is scrubbed in the scrubber, then fed to vibrating screen (single or double deck) where water is sprayed for good washing and screening. In wet screening, lump is separated from the fines and is carried to the washed lump stockpile by conveyors. The undersize (10 mm mixed with water) is fed to the classifier.

Microfine (-65 mesh) gets separated into classifier and the same is allowed to overflow having 18-20% of solid waste material. Products from rakes (+65 mesh) with 14% to 17% moisture are fed to the dewateriser screen to reduce the moisture content by 4 to 5%. The aperture size of screen cloth of the dewateriser ranges from 0.2 mm to 0.5 mm. Washed fines with 10-11% moisture from the dewateriser is carried to the washed fines stockpile by conveyors. In the stockpile the water percolates to the bottom of the pile bringing down the moisture content to around 6.9% in the washed fines. The collected moisture at the bottom is drained out from the stockpile.

For indigenous coking coal, SAIL plants have to depend largely on Coal India Limited, who are the major producers of coal in the country. A small quantity is supplied from
SAIL’s captive mines and washeries and the rest is imported. For non-coking coal SAIL depends almost entirely on CIL.

The trend of coking coal supplies from CIL indicates that coal supplies are more or less stagnating at 10 MT per annum level. The production of metallurgical coking coal from CIL has also stagnated at around 20MT per annum. SAIL is increasing its hot metal production by about 0.6 to 0.7 MTPA, thus increasing the requirement of coking coal and subsequent widening of gap between the availability from indigenous sources and requirement. Also the indigenous sources are not able to meet the quality stipulations. Therefore coal imports have become inevitable for quite some time to come to maintain the quality of charge coal at desired ash level of 17%. Moreover, substantial deterioration in the quality of raw coal fed to the washeries has taken place. The washeries, commissioned during the sixties, were designed to wash raw coal of 22-25% ash. Over the period, the raw coal ash has gone up as high as 30-35%. Thus, the existing washeries need modernisation to beneficiate the available raw coal with higher ash content at optimum yield to meet the quality need of SAIL.

Coking coal requirements will go up at a rate of 3.0 lakh tones for every 1% ash increase in the charge coal. The technology of PBCC (Partial Briquetting of Charge Coal) facilitates higher usage of semi-coking coal in the blend without affecting the coke strength.

Coal Carbonisation in taller battery is yet another technique for coke strength improvement. Coke production through Stamp Charged battery is one of the techniques for improvement of coke quality. The coke quality improvement is due to improved inter-particle cohesion during Carbonisation.

In selective crushing of charge coal, coal is crushed and its pneumatic classification done. Ash bearing particles being denser get segregated and are separated, thus making coal blends which help in improving coke strength.

In addition to the above, SAIL has envisaged reduction of specific consumption of coking coal through technological innovation in the area of raw materials other than coal. In order to be self-sufficient in coking coal reduce dependence on imports, SAIL has decided to acquire and exploit virgin blocks of Prime and Medium Coking Coal. SAIL is looking for large areas where integrated mining and processing can be undertaken.
Coke Making and By-Products

Introduction

In an integrated Steel Plant, Coke Ovens & By-Product Plant plays a vital role. It supplies coke, one of the two principal raw materials to Blast Furnace. In addition, the coke oven gas produced during coke manufacturing is used as major energy source within the integrated steel plant along with B.F. Gas produced during combustion of coke in Blast Furnace.

C.O. & BPP Consists of the following units :-
I. Coal Preparation Plant
II. C.O. Batteries & Coke Sorting
III. Gas condensation, and tar plant
IV. Benzol recovery plant
V. Sulphuric acid plant
VI. Ammonium Sulphate plant

Process of Coke Making
The process of coke making starts with coal blend preparation as the quality of Coke & Gas produced primarily & largely depends upon the petrographic constituents of the coal charge prepared in coal preparation plant.

Coal Preparation Plant
The prime objective of Coal Preparation Plant is to feed C.O. Batteries with a consistent quality of coal charge. A typical blend composition, coal charge analysis and the blend composition of coal is given below:

<table>
<thead>
<tr>
<th>Blend composition coal %</th>
<th>Proximate analysis of coal charge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prime Coking</td>
<td>Moisture 7.3-8%</td>
</tr>
<tr>
<td>17.5-18.5%</td>
<td></td>
</tr>
<tr>
<td>Medium Coking</td>
<td>Ash 13.5-15.5%</td>
</tr>
<tr>
<td>27.5-28.5%</td>
<td></td>
</tr>
<tr>
<td>Blendable</td>
<td>V.M 24.5-25.5%</td>
</tr>
<tr>
<td>0-0.2%</td>
<td></td>
</tr>
<tr>
<td>Imported</td>
<td>F.C 58.30-59.40%</td>
</tr>
<tr>
<td>52.5-53.5%</td>
<td>B.D 818-837 Kg/M3</td>
</tr>
</tbody>
</table>

Coal preparation plant prepares variety of coals viz Prime Coking, Medium Coking, Poor Coking or blendable. Imported prime coking coals having very low ash content of 8-10% as compared to Indian Coking Coal with ash content varying from 16 to 26%. Coal preparation plant prepares required quantity of consistent quality of coal charge as per the requirement of Blast Furnace.
The following processes are involved in coal preparation:-

Unloading of coal, Primary crushing, Storing and averaging, Reclaiming & pile cleaning, Blending in Silos, crushing & Mixing of Coal

a) Unloading of coal

Unloading of wagons is done by wagon tipplers. Wagon tippler is provided with "Beetle" type shunting carriage, which can pull a number of wagons at a time & can place the wagons one by one on the wagon tippler as the unloading goes on.

Unloading is planned in such a way that the wagons are detained as less as possible to avoid demurrage. During unloading care is taken to see that there is no mixing between coals of different grades. Prime, medium, blendable & imported coals are separately unloaded & piled in stock-yard or silos earmarked for these coals.

b) Primary crushing of coal

About 20% of the coal which is received directly from mines as unwashed coal is subjected to primary crushing. As the coal received from washeries is already crushed below 80 mm size for washing, primary crushing is not required. Before the crusher the coal passes over a rotating type magnetic separator to arrest magnetic particles, if any. Coal is primarily crushed to 80 mm size by two diamond toothed roller crushers

Primary crushing has the following advantages:
1. Facilitate proper blending,
2. Enable balanced crushing in the final crusher,
3. Normal transportation

c) Storing & Averaging

Coal is received from a number of sources. Most of the mines and washeries supplying coal are located in Damodar Valley area in Bengal Bihar border. To maintain uninterrupted supply of coal charge to coke oven batteries, a stock yard having a capacity of about 20 days is provided. Methodical storing & reclamation is done with the help of gantry cranes or stacker cum reclaimer which receive and reclaim coals.

d) Averaging

Coal is heterogeneous in nature. Even at the same mine, coal of one seam is different in analysis from coal of nearby seam.

Averaging is the process of making each grade of coal homogeneous or uniform in analysis within certain limits. Averaging takes care of the variation of ash content, moisture content, V.M. content and Coking properties of coal received from different sources. Averaging is done in mechanized stock yard by receiving the coal on the ground in thin layers, one above the other and thus building up a pile. This pile is reclaimed by cutting across and coal from different layers gets mixed up in a uniform mass. In the same way averaging takes place in silos also. After the blending in
silos final crushing and mixing is done keeping the moisture under control then it is transported.

**Plan & Development in Coal Preparation Plant**

1) More competent blending system. [use of imported coal upto 30%]
2) Group-wise crushing of coal to be adopted.
3) Electronic weighing scale for computation of receipt & consumption of coal
4) On line ash & moisture control by electronic indicators & recorders for blend composition.
5) Use of additive like coke breeze & petroleum coke without sacrificing quality.
6) Study on selective crushing to take care of over crushing of coke components & under crushing of hard constituents [non-fusing].
7) Lining of silos & coal towers with Stainless Steel to avoid hanging of coal.
8) Partial briquetting of coal charge to accommodate non-coking coal to the extent of 20% with increased productivity due to increase in B.D.

**Coke Oven Batteries & Coke Sorting Plant**

A coke oven battery is monolithic structure of different refractories & oven fittings. About 12,000 to 14,000 tonnes of refractory of nearly 550 shapes are used in battery construction depending on the size of the battery.

Coke Ovens are constructed either with side feed or indirect system. P.V.R. stands for pair vertical flues with recirculation. It means that in heating walls if odd number vertical flues are burning, the even number vertical flues of each pair will discharge the waste gases to chimney through regenerators provided below the heating walls & oven chambers. A part of the waste gases is recirculated to the burning flues through a bottom window to increase the length of the flame by dilution. Thus, each pair of vertical flues has got a cross-over window at the gap & a recirculation window at the bottom. The system is reversed every 20 to 30 minutes.

**Coke Sorting Plant**

Blast furnace requires hard coke of a particular size. So the coke pushed out of oven is quenched and sorted, according to the size requirement or blast, in coke sorting plant. Coke sorting plant consists of wharf, series of belt conveyors, grizzly, crusher and vibrating screen. Quenched coke is sized, crushed and screened to three fraction -

25-100 mm size - Metallurgical coke, sent to B.F. bunker for iron making.
10-25 mm size - Nut/Pearl coke, partly for internal use and the rest sold out.
0-10 mm size - Coke breeze, used mostly for making Sinter.

Ash and strength of coke determine the quality of metallurgical coke. Coke rate per tone of hot metal mainly depends on these two factors. Coke strength is measured by a test in the coke sorting plant cooled MICUM test. Impact strength and resistance to abrasion are also measured by this test.

A typical proximate analysis of coke carbonized from a coal blend indicated earlier is as follows :-

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Moisture -3.5-3.9%, Ash-19-20.6%, V.M.-0.8-1.0%, Fixed Carbon- 78.1-80.0%, Mₐₗ 80% Min, Mₐₙ 8.9% Max

By-product Plant

In the by-product plant, tar, ammonia and crude benzol are recovered from the coke oven gas evolved during carbonization. The output of the chemical products and their composition depend upon the composition & properties (specially petrographic composition) of the coal blend used for coking, the temperature conditions and the operation conditions of the battery.

The output of tar and crude depends upon the volatile matter content of the coal, temperature of carbonisation and operating conditions of coke oven batteries and that of ammonia depends upon the nitrogen content of coal as well as the nature of nitrogenous compounds in which form nitrogen is present in coal.

By-product plant consist of the following units:-

I. Gas condensation section, Sulphate Plant, Benzol recovery plant.
II. Benzol rectification plant.
III. Tar distillation plant.
IV. Sulphuric acid plant

Gas Condensation Section

The gas-main coming from Coke Ovens to primary gas coolers have got a slope and because for this, Tar, Ammonia water & Sludge flow through the gas main. The gas, tar & liquor get separated in a separator before the primary coolers. The coke oven gas is cooled in the primary gas coolers from 80°-85°C to 30-35°C during which process almost all the tar, remaining in the gas after gas collector and the major part of the water vapour in the gas, condenses.

The tar & condensates from collectors, exhausters & tar precipitators collect in the condensate tank where tar separates from Ammonia water, tar flows into tar storage and Ammonia water flows into Ammonia water tank. Excess ammonia water is treated in Ammonia Column.

The gas is then passed through the electrostatic precipitators for removal of traces of tar which is harmful for ammonium sulphate to be used as fertilizer.

Ammonium Sulphate Plant

After ensuring that all the tar content is removed, the gas is sent to Ammonium Sulphate Plant for recovery of Ammonia as ammonium sulphate as a fertilizer in agriculture. The ammonia output is varying from 0.25-0.28% of dry coal charge and in terms of Ammonium Sulphate 0.90-1.1% of the dry coal charge. Ammonium sulphate produced in coke oven is mostly through semi-direct process.

Sulphuric Acid Plant

In order to meet the sulphuric acid requirement of Ammonium sulphate plant, sulphuric acid by Contact Process by burning imported sulphur is produced.
Benzol Recovery Plant and Benzol Rectification

The recovery of crude benzol from the gas is done after the recovery of ammonia. In the final cooler, washing of naphthalene present in the gas in the form of vapour & small crystals takes place; the naphthalene is removed from the water by mixing the water with tar, when naphthalene dissolves in the tar.

After the removal of naphthalene, the gas is scrubbed with wash oil in benzol scrubbers. The process of recovery of crude benzol from gas is by absorption.

Crude benzol content in the gas before the scrubber is about 30-33 gm/ Nm³, after the scrubber 1.5-1.8gm/Nm³ and output varies from 0.65-0.68% of the dry coal charges. Crude benzol & wash oil are separated by distillation as wash oil has higher boiling point. The technological scheme in Bhilai makes it possible to obtain two fractions of crude benzol-light crude benzol (B.P. up to 150°C) & heavy benzol (B.P. limit 150°-220°C).

Light crude benzol consists of light boiling fractions - benzene, toluene, xylene and heavy benzol consists of high boiling unsaturated components - solvent naphtha & some parts of xylo. Heavy benzol contains naphthalene which has been absorbed from gas by oil.

The output of crude benzol depends on the V.M. content in the blend & temperature of coking. The contents of various component in light crude benzol may vary in the following limit :-

N.G Benzene - 68.70%
N.G. Toluene - 10-12.5%
Xylene - 1.2-1.4%
Solvent Oil - 0.8-1.1%
Still Bottom - 2.8-2.9%
Sulphur components - 0.9-1.1%

Light crude benzol is rectified in benzol rectification plant and the benzol products obtained are benzene, toluene, xylene, solvent oil, etc. Yield of benzol products varies from 86-88% of the crude benzol processed.

Tar Distillation Plant

Tar separated out of coke oven gas in the gas collectors of Coke ovens & in the primary coolers of By-Product Plant, is a mixture of large quantities of chemical compounds. Out of these more than three hundred chemicals have been separated till recent times.

Out of tar, only a few number of compounds are separated in the tar distillation plant which have market demand. The output of tar and its composition depends mainly upon the V.M. content of the coal blend, the temperature conditions of coking and operating conditions of the battery. The more the V.M. Content in the blend, the more the output of tar. The quality of tar is characterized by specific gravity, naphthalene and phenol content in it, output of different fractions & the free carbon. The output of tar varies from 2.8-3.0% of the dry coal charge.
Amongst the tar products naphthalene is the costliest item & its yield at present is 50-55% of the tar distilled. Scope of increasing the yield is being explored.

**Techno-Economy & Cost Control in Coke Making**

a) Contribution of major energy inputs and Consumption for a Steel Plant:-

<table>
<thead>
<tr>
<th>Energy inputs from</th>
<th>Area wise energy input provided</th>
<th>Energy consumption</th>
<th>Area wise Energy consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coking coal</td>
<td>75-78%</td>
<td>Coke making</td>
<td>18-19%</td>
</tr>
<tr>
<td>Non-coking Coal</td>
<td>12-13%</td>
<td>Iron making &amp;</td>
<td>49-50%</td>
</tr>
<tr>
<td>Petroleum fuels</td>
<td>0.8-1%</td>
<td>Sinter making</td>
<td>8-9%</td>
</tr>
<tr>
<td>Power</td>
<td>9-10%</td>
<td>Steel making</td>
<td>9.10%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Steel Rolling</td>
<td>14-15%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Auxiliary</td>
<td></td>
</tr>
</tbody>
</table>

b) Impact of Coke ash in Blast Furnace Operation:-

Reduction of average ash content in Coke by 1.5% results in lowering the coke rate in B.F. by 3% with corresponding increase in productivity.

In other words, 1% reduction in coke ash reduces the coke rate by 12-15 Kg/THM reduction of coke rate gives an overall saving of 0.5% of the total energy consumption of Steel Plant.

c) 1% Change in Volatile matter content in coal brings about a change in Gas make by more than 2%.

Considering the role of coking coal and coke making, it is needless to say that all [coal preparation, coke making in battery & by product plant] have to perform equally good to achieve control over the techno-economy. Strict adherence to the blend composition, blend charge analysis by controlling receipt and analysis of the incoming coal, full utilisation of equipments, maximum averaging and blending, high and consistent degree of fines of crushing [80% below 3 mm] deliver a good and consistent blend charge which is the primary need of the battery.

**Future Plan**

Special feature in tar distillation plant and other B.P.P. Units are as follows:

1. Manufacture of extra hard pitch by aeration.
2. Dynamic scheduling of crystallisers to improve the productivity of naphthalene and maintenance effectiveness of crystallisers.
3. Production of I-C resin - investment proposal for setting up I-C resin plants are being processed.
4. Production of Technical quinoline. Market is being explored for final decision. Studies of low sulphur benzene by acid washing treatment are in progress.
5. Studies on extraction of Germanium from ammonical liquor is in progress.
Maintenance of C.O. & B.P.P. Coal Chemicals

Maintenance is the backbone of production in a modern industry. Steady production, productivity & quality of the products can not be attained without smooth & continuous running of the equipments.

The machines & equipments used in coke ovens are highly mechanized, and all of them are electrically operated. All these machines are exposed to head, dust, gas, smoke & corrosive chemicals.

Special Features in Maintenance Group

1. Ultrasonic ray testing to assess the thickness of pipe line conditions and reverted condition of exhauster.
2. Number of modifications to improve productivity in all sections.

For example -

a) Wrong pushing which is a common feature in any coke oven in India has been reduced by electrical modification.

b) +80 mm fraction in coke screening which is a very important technological factor influencing B.F. productivity and has been reduced to 10% or below from above 30% by modification of coke cutter in coke sorting plant.
Sinter Making

Introduction

Sintering is the process of agglomeration of fines (Steel Plant waste) by incipient fusion caused by heat available from the fuel contained in the charge. The lumpy porous mass thus available / obtained is known as “Sinter” and comprises an effective blast furnace feed.

For sinter to be good quality, the input raw materials to the sinter plant viz. iron ore fines, limestone, dolomite, coke breeze, etc. should be good. Regarding iron ore fines, improved washing techniques to reduce gangue content have to be resorted to. This will also help to increase Fe content in the fines. Regarding the fluxes, both limestone and dolomite are used in the sintering plant. Normally, iron ore sizes 0 to 10 mm are used in sintering plant. In future, it is envisaged to go in for 0 to 8 mm size in order to improve quality of sinter. Simultaneously, the blast furnace iron ore size will also be in the range of 8 to 30 mm.

As our metallurgical coal is high in ash content, and iron ores contribute high alumina, slag volume in blast furnaces is high resulting in lower productivity of the blast furnaces. Therefore, to increase productivity of the blast furnace and the quality of hot metal, control should invariably be aimed at reducing the coke rate. For this, it becomes imperative that we go in for production of highly fluxed sinters with MgO. Increase in the basicity of sinter will enable reduction and elimination of raw fluxes in the blast furnaces thereby enabling reduction in coke rate.

Preparation of Fluxes

Experience of operation of sinter plants in India over the years has demonstrated that the fluxes namely, limestone and dolomite should be crushed to obtain 94 to 98% fines (-3 mm fraction). Such finely crushed fluxes result in the formation of strong sinter due to absence of free lime.

For crushing fluxes in the sinter plants, normally hammer crushers working in close circuit with screens are provided. In some sinter plants, in place of hammer crushers rod mills are in operation.

Preparation of Fuel

As in case of fluxes, careful preparation of coke breeze to the extent of 92-95% (-3 mm fractions) is an essential prerequisite for producing high quality sinter. Normally, in sinter plants for crushing coke breeze, four roll crushers are used. Four Roll Crushers ensure better and consistent crushing and are also preferred due to easy maintenance.

Preparation of Charge for Sintering

The scheme for preparation of charge first envisages blending of raw materials in raw materials yard to obtain consistency in the chemical composition and size fraction.
of raw materials. After this, raw materials are received in raw materials receiving bins. Preliminary proportion is done at the receiving bins and then the raw materials are transported to stock bins where final and accurate proportioning is done.

Normandy, constituents proportioned are - Iron ore fines, Flue dust, Mill scale, Limestone and limestone chip, Dolomite, dolomite chips and dust, Lime dust, Burnt dolomite dust, Settling tank dust, Coke breeze & LD Dust.

It can be seen that Sinter Plant can make adequate use of almost all the valuable metallurgical arising in an integrated steel plant, thus paving the way for valuable conservation of minerals, and techno-economic benefits.

Proportioning at Stock Bins

An accurate proportioning is envisaged to be done at the stock bins. Here the constituents proportioned may consist of -

a) Ore mixture comprising mixture of ore fines, mill scale, lime, burnt dolomite dust and flue dust.

b) Flux consisting of mixture of limestone and dolomite, say in the ratio of 3:1 to obtain optimum MgO content in the sinter.

c) Crushed coke powder.

d) Return powder.

There are two stages of screening sinter:

1. Hot screening
2. Cold screening

The amount of return sinter generated may be in the range of 30-40%. In modern sintering plant, sinter is also screened at the blast furnace skip. Hot screening done before cooling and cold screening is done after cooling the sinter and before despatch to the blast furnaces. 8 to 10 mm screens are used for sinter screening.

Sintering

The proportioned charge from the storage bunkers is transported to the surge bunkers in the sintering building. From these bunkers, the charge is delivered to the Pug Mills (Mixing drums). The charge is thoroughly mixed and moistened in the pug mill and loaded on the sintering machine pallets. At the sintering machine, the following parameters have to be controlled:

1. Moisture in the charge: normally 7 to 8%.
2. Bed depth: 250 to 450 mm
3. Temperature of ignition of charge: 1200 to 1300°C (or even more)
4. Maximum suction during process: 1000 to 1200 mm water gauge.
5. Ignition gas mixture: 85% BF gas and 15% CO Gas.
6. Gas to air ratio: 1: 1.4 to 1.6
7. Calorific value of gas: 1350 to 1500 Kcal/CuM.
8. Period of sintering: 8 to 10 minutes normally.

The sinter is discharged from the sintering machine to the sinter crushers where it is sized into pieces (-) 80 mm. Hot sinter then falls on the self-balancing screens (or hot screens) where the fines are separated out, the under sizes constituting the sinter return. The oversize lumpy sinter enters the rotary cooler or strand cooler at a
temperature of 600° to 800° C. In sinter coolers, cooling takes place by suction of air through the hot sinter.

**Quality of Sinter**

Bhilai Steel Plant has been the forerunner in the development of technology for production of fluxed sinter and super fluxed high magnesia sinter.

There have been systematic efforts to improve Fe Content in the sinter by improving quality of the iron ore fines. Mechanical strength of the sinter is gradually improving as indicated by drum index and the shatter index. With increase in sinter basicity, and improved methods of ignition of charge, FeO content of the sinter has gone down. This has helped in increasing reducibility of the sinter. Increase in sinter basicity along with increase in MgO content results in stabilising size grading of sinter. Presence of MgO has considerable effect on sinter in as much as it arrests the polymorphic transformation of $2\text{CaO} \cdot \text{SiO}_2$ from the Beta to Gamma modification.

**Present Status of Sinter Plants in India and Measures for Improvement**

It has been generally observed that proportion of sinter in Indian blast furnace is quite low. IISCO & VISP, Bhadravati do not have the facility to produce sinter and manages with 100% ore charge. Other steel plants are working with 40-75% sinter in their burden, with pre-skip screening.

Present condition in India Steel Plants is as follows:

- Poor strength of sinter results is generation of fines during transportation, charging and inside the blast furnace.
- High proportion of fines are being charged into blast furnaces.
- High fluctuation in chemical analysis.
- Raw limestone charge in blast furnaces is quite high increasing the calcination heat i.e. thermal requirement of furnace and presence of free lime after calcination in bosh region deteriorates the bosh permeability and destabilizes the furnace.
- Because of mixed charge large softening melting zone (ore softens between 700-1230°C, sinters softens in the range of 1100-1350°C is formed in the blast furnace which affects the aerodynamics in the lower region badly.

All these parameters result in poor stack and bosh permeability causing localised fluidisation and flooding, leading to furnace irregularities which is further aggravated due to high fluctuation. In order to improve the blast furnace operation, use of sinter should be maximized. Good quality sinter makes stable operations of blast furnace and result in low fuel rates, low Si iron and higher productivity.

Moreover, our plants do not have facilities for testing of many important characteristics of the burden. Suitable standardized test procedures should be adopted to exercise control over raw material characteristics specially strength, reactivity of coke, reducibility of ore and sinter, high temperature characteristics in simulated blast furnace conditions, softening, melting temperature etc.

**Maintenance**

Sinter machine capacity utilisation in our steel plants, at present, is in the range of 48-85% only, whereas in developed countries, the percentage utilisation is as high as 96%. This indicate the extent of reserve capacity that can be made available by
better maintenance and upkeep of the sinter plants. In this direction, there are a number of measures that have to be taken like.

- Better blending of raw materials for the sinter plant.
- Better preparation of fluxes and fuels.
- Improvement in flux and coke crushing facilities to meet the needs of increasing production.
- Proper facilities like introduction of lime into the sinter charge.
- Proper planning of repairs, inventory of stores and spares, and quality of spare parts.
- Better design of ignition hoods.

**Future Technologies**

In future some of the technologies that will be suitable to our conditions in India would be:

- High pressure sintering
- Cold bonded pelletisation
- Manganese ore fines in sinter
- Utilisation of slimes arising out of washing of iron ores
- Super basic sinter.
Iron Making

Iron Making

Blast furnace process is very efficient process of iron making. But a steel plant based on this process route would require huge infrastructure and extensive supporting facilities in the form of coal washery, bedding and blending yard for raw materials, coke ovens, sintering plants, which would require large investment for its efficient operation. Such a steel plant would necessarily have to be of larger scale to be economically viable. The larger the plant, the greater is the demand on organisational and technological discipline.

Developments in Iron Making Technology

The real growth of blast furnace technology came with the production of high strength coke which enabled the construction of large size blast furnaces.

Initially the sintering plants were installed for utilising the fines generated during the mechanised mining of iron ore but later became one of the important sections of iron making as sinter was found to be a very good burden material and in fact was preferred over lump ore. Another process of agglomeration that came after the Second World War was pelletisation. In view of its strength and other metallurgical property, pellets also found a permanent place among the burden materials charged into blast furnaces. Its use was however reduced due to its high cost when oil price was increased.

Direct Reduction (DR) process of iron making got a big boost in the 80's. Directly reduced iron (DR) was found to be a very good substitute for steel scrap for electric arc furnaces for steel making. At present about 22.5 million tonnes of DRI is being produced in the world.

Meanwhile many new ways have been developed to intensify the blast furnace process which has resulted in increase in productivity, reduction in coke rate and production of hot metal with consistent quality.

Status of Iron Making Technology in India

In India steel is being produced largely through the Blast Furnace/ Open hearth or Blast Furnace/ B.O.F. route. Iron ore, sinter and coke are the major raw materials for blast furnace smelting.

Iron Ore - Indian iron ores are generally rich in iron content varying from 60% to 66% associated often with naturally occurring fines to the extent of 20%. Although relatively free from impurities like phosphorus, sulphur and copper, they have high alumina content, high alumina/silica ratio of about 2 or more. The high alumina content makes the slag highly viscous and creates problems for stable furnace operation.
Coke - The Indian coke is characterised by high ash (25-30%) and still worse, a wide fluctuation in ash content, poor coke strength leading to excessive generation of fines, rapid fluctuation in moisture content etc. The problem of poor quality coke has been partially tackled by adding upto 50% imported coal in the indigenous coal blend.

Sinter - The problem and the solutions associated with sinter have already been given in the previous chapter.

Description and Working of Blast Furnace

Blast furnace is basically a counter current apparatus, composed of two truncated cones placed base to base and having the following parts:

Bosh, Hearth, Belt, Shaft & Throat

The entire furnace is lined with suitable refractory and in addition to refractory lining, there are water coolers, designed to enhance the life of the furnaces. In the hearth, there is a taphole of suitable dimension and length for the purpose of tapping the hot metal. Bulk raw materials like Iron Ore, Lime Stone, Sinter will form the ‘O’ part of the charge and coke forms the ‘C’ part of the charging programme and a charging programme may be ‘OCC’ or ‘COC’ or ‘COOCC’ or ‘OOCCC’ depending upon the furnace condition. The raw material at the top will be charged either through ‘double bell system’ or ‘bell less system’ for furnace smelting.

Since blast furnace is basically a counter current apparatus the descending stream of raw materials extract heat from the ascending stream of gas generated from the burning of coke at the tuyere level. The ascending stream of gas contains CO (Carbon Monoxide) Nitrogen and Water Vapours and in the events of its coming in contact with the Iron Ore, reduction (this reduction is called Indirect Reduction) of Iron ore takes place at the upper part of the stack. Coke in the form of ‘C’ also takes part in the reduction. In the hearth there are slag notches (usually two in number) at about 1.1-1.2 Metre away from the hearth bottom for flushing out slag at regular intervals before tapping, the notches are also extensively water cooled by ‘monkeys’. The number of taphole, slag notches, their positioning and dimension will depend upon the capacity of the furnace. Many modern furnace’s are having 2-4 tapholes.

The furnace are equipped with tuyeres (water cooled copper construction for admission of hot blast of air) through which preheated air blast at a temperature of about 850°C - 950°C is introduced for burning of coke. Before preheating, the blast of cold air supplied by power and blowing station is introduced into Hot blast stoves at about 3.2-3.5 Kg/Cm² (gauge pressure) wherein the air is preheated regeneratively and sent to the furnace through hot blast main and bustle pipe. The air blast then passes from the bustle pipe through gooseneck and blow pipes into tuyeres. The pressure of the blast and its flow rate is dependent upon the capacity of the furnaces.

Raw materials including coke are collected into high line bunker, from where it flows down as per sequence into skip car after weightment. Weighing is done either by scale car or by load cell or by any suitable arrangement. As the stream of the material descends down through different temperature zones, ultimately we get two products:-
• Metal in the liquid condition gravitating in the bottom.
• Slag, having less density floats at the top.

Besides, we get one more important gaseous product out from the top of the furnace known as BF Gas. It generally comprises of 21-22\% CO\textsubscript{2}, 19-19.5\% CO, 54\% of N\textsubscript{2}, H\textsubscript{2} 4.4\%, O\textsubscript{2} 0.1\%.

After cleaning, BF gas as fuel is used in Blast Furnace stove heating, Coke Oven heating, and as a mixture with CO gas it is used in Refractory Materials Plant. Sintering Plant, Steel Making Shop, Reheating furnace of Rolling Mills as a fuel.

Liquid iron collected in the hearth is taken out by opening the taphole with power driven drill and oxygen lancing after regular interval into a train of ladles kept below the runner of the cast house. Slag that comes along with the metal is skimmed off with the help of skimmer plate towards slag runner and collected in slag thimbles. Slag thimbles are then sent to the slag granulation plant. Metal ladles are either sent to SMS or Pig Casting Machine of Foundry depending upon the composition of the metal being tapped. In modern plant, slag instead of being collected in slag thimble is directed to cast house granulation unit for on line Slag Granulation.

**Future Technological Options**

Some of the future technological options for our plants are discussed below:

**Beneficiation** - To upgrade the quality of Iron ore, special emphasis is required to develop a beneficiation scheme for preferential removal of alumina from the gangue.

**Bedding, Blending, Sizing and Screening of Burden** - Physical and chemical characteristic of iron ore, coal and limestone vary from deposit to deposit and also from one mine to another. For trouble-free operation of blast furnaces, it is essential to ensure supply of raw materials of consistent and uniform quality. Since the variation in raw material quality from different mines/deposits cannot be avoided, the bedding and blending of the incoming raw materials must be adopted before processing them.

**Use of 70-80\% Sinter in the Burden** - It has been proved that with the use of sinter in the burden the productivity of Blast Furnace increases. The capacity of sintering plant should be increased so as to provide about 75\% sinter in the burden.

**Conveyor Charging** - All burden materials should be delivered to the furnace top by conveyor. This is economical for bigger blast furnaces. The blast furnaces at Visakhapatnam Steel Plant have this provision.

**Bell Less Top** - In place of conventional two bell charging system, two charging hoppers with rotating chute are installed. The rotating chute distributes the material in the desired manner. The system is easy to maintain. The system has been adopted in BF - 4, 5, 6, 7, of BSP, BF-2, BF-3 and BF-4 of RSP and all the Blast Furnaces of BSL.

**Movable Throat Armour** - This is installed along with two bell system. The distribution of material is controlled by positioning the throat armour at proper location. The system improves the burden distribution. BF-4 of IISCO, and BF-3 of DSP have been provided with this system.

**Thermovision Camera** - The device is fitted at the top of the furnace. It emits a beam of infrared rays over the material surface of the stock and takes the photograph.
**Furnace probes** - Probes are fitted above the stock level/below the stock level in order to monitor temperature distribution and collect samples of burden material and gas.

**Improved Tuyere Stock** - Leakage of blast and noise pollution can be eliminated by going for improved tuyere stocks which have flexible joints. Flexible joints are provided by incorporating compensators. This has been adopted in BF-4,5,6,7 of BSP and in BF-2, 3 & 4 Blast Furnaces of RSP.

**Free Standing furnace Structure with a 4 Column Top Structure** - In this design the BF top structure are supported by four columns instead of the furnace shells as in the older design. This design also provides adequate working place in the tuyere area to facilitate mechanisation of tuyere handling arrangements.

**Exhaust Ventilation for Cast House Runners** - In this design, the cast house runners, tap-holes and spouts are provided with covers for sucking the fumes and dust during casting. This would improve the working condition of the cast house.

**Cast House Slag Granulation** - In this design the liquid slag from cast house runner is led to the granulating unit located very near to the cast house. This would eliminate the need for maintenance of large fleet of slag ladles, reduce the cost of production, avoid delays and increase the yield of granulated slag. BF No. 4,5,6,7 of BSP is having cast house slag granulation. This facility is installed in BF-5 of BSL. This facility is already existing in BF No. 4 of RSP. There is plan for installing SGP in BF-1 and re-building of BF No.4 with 2000 Cu.M volume and productivity of 1.5.

**Coal Dust Injection** - Non-coking coal in injected through tuyere using nitrogen as carrier. This reduces the coke rate and thus saves the valuable coking coal, which is also not abundantly available in India. Coal dust injection is normally associated with high blast temperature and oxygen enrichment, BF-6 of BSP has been provided with a coal dust injection system.

**External Desulphurisation of Hot Metal** - With the introduction of continuous casting technology and increased demand for high quality steel, requirement of low sulphur (less than 0.025%) hot metal has increased. For this purpose hot metal from BF is desulphurised by injecting desulphurising agents such as calcium carbide, lime soda ash, magnesium in the hot metal ladle. One desulphurising unit has been installed at RSP.

**Cast House Destiliconisation** - Silicon from hot metal is partially removed by adding mill-scale, iron ore, along with lime in the hot metal runner. Such installations are working in Japan.

**Dephosphorisation of Hot Metal** - Dephosphorising agents like soda ash and lime based flux are added in hot metal in transport vessel to reduce phosphorous content of hot metal.

**Energy Recovery Turbine** - There are installations in advanced countries where the pressure of top gas is converted to electrical energy by passing the same through a turbine.

**Hydro Fuel Injection** - To reduce coke rate and to intensify furnace operation, the
hydrocarbons like fuel oil, natural gas, pulverised coal, coal/oil slurry are injected through tuyeres.

*Lime Dust Injection* - As most of the ash in coke gets released at tuyer level, the basicity of bosh slag should remain high compared to that of final slag. This problem gets further aggravated with high ash coke. In order to overcome this problem part of the lime required is injected, in the form of lime dust through the tuyers.

*Automation & Computer Control* - In case of fully automatic operation, the computer receives signals from various sensors which determine the optimum point values and commands the equipments to operate automatically. Automatic control of charging & stoves are provided in BF No. 4, 5, 6, 7 of BSP. Semi-Automatic control of charging system and stoves are provided at Bokaro. In RSP also the stove operation is semi-automatic.

*Technological Discipline* - Discipline and healthy work ethos are motivators for higher productivity. The blast furnace operations require a willing work force to follow the accepted norms of work.

The golden rules of blast furnace operation is that the furnace conditions should not be disturbed. If for one reason or the other, the quality of charging materials fluctuate, the furnace will be affected. The moisture of coke should be continuously measured and corrective action taken. Once the tapping is opened and liquid level begins to fall, the blast pressures drops correspondingly. During the tapping itself, burden descent is fast and irregular. The rise and fall of blast pressure will cause raceway distortions. Similarly, the bosh gas distribution is affected when the burden descent rate increased or decreased. As stock line is not maintained many a time unprepared burden enters the melting zone and increases the thermal requirements. The effect of all these is the disruption of the configuration of the cohesive zone, increase in coke rate and decrease in productivity.

The planned expansion, modernisation, revamping and debottlenecking scheme must be undertaking immediately so that cost escalations do not make them unprofitable and quality iron is produced in furnaces.
400-500 m³/min. Generally two lances are provided for each converter so that there is always a lance in reserve. Process is either open combustion or suppressed combustion. All the heats for the Process are obtained from the oxidation of different metalloids present in hot metal supplied from Blast furnaces.

Before starting a heat the Converter lining is inspected & then scrap is charged followed by hot metal pouring into the converter. All the bulk materials, except ferro-alloys are fed through the hood from the overhead bunkers, by operating from the blowers’ pulpit. The charging of bulk materials is done at different times during the blow as per requirement and according to the computer advice. The position of the lance and the flow rate are two important variables to regulate the process of decarbonisation and dephosphorisation. Then end point is detected by the amount of oxygen consumed and temperature is measured by thermocouple. As soon as the desired temperature is obtained, steel is tapped into a steel ladle placed beneath the converter. Deoxidation is done in the ladle during tapping. Decarbonisers, and other alloying elements are also added into the ladle during tapping.

**Continuous Casting Shop**

At present, continuous casting facility is available at BSP, RSP, BSL, DSP and ASP. The shop at Bhilai consists of four single strand radial Slab Casters and one four strand radial Bloom caster. At ASP, continuous casting shop has two machines of 6 strand each to cast 100 sq. mm. billets. Slab caster at BSL, RSP and billet caster at DSP have been installed during modernisation and are working well now.

After tapping of liquid steel from converter into the steel teeming ladle, the ladle is moved to Argon Rinsing bay. Here steel is rinsed for 3-5 minutes. If the temperature of the steel is more than the required temperature, further rinsing is done and scrap may also be added as coolant. Temperature is measured again after rinsing.

After this the ladle is transferred to the casting bay and lifted up and placed on the lift & turn stand by means of casting crane. Casting is done with the help of ladle fitted with the slide gate. The hydraulic cylinder is fixed to the ladle, tundish heating is put off, tundish is brought to the casting position and the submerged nozzle is aligned with the mould. The ladle is turned to casting position. After this, ladle stopper is opened and after sufficient metal level in the tundish, tundish stopper is opened. From the tundish steel is poured into an internally cooled curved copper mould of one meter length. The temperature difference of outgoing & incoming water should never exceed 10°C. When steel in the mould reaches about 150 mm from the top of the mould, the machine is started with 0.1 M/min. speed. The mould oscillation is also started. Speed is increased slowly up to the working speed of 0.8-1.08 M/min.

When the dummy bar reaches the withdrawal rolls strands, it is separated from the strand (slab or bloom). The strand is cut at the gas-cutting machine into desired lengths and cut slabs/blooms are transported to the respective yards.

Ten minutes before the end of casting from a ladle, another ladle must be placed on the lift & turn stand. When casting from the ladle is over, the second ladle is positioned above the tundish and casting is started. This way on an average 8 to 10 heats may be cast in a sequence, depending on various operational conditions. During the sequence
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casting tundish is changed after every 4 to 6 heats depending on the grade of steel being cast. In a sequence only one grade and section of steel can be cast. During casting, samples are taken from every heat for analysis.

At the end of sequence, tail end of strand is quickly removed from the machine and machine is checked and prepared for further casting.

**New Technologies**

The basic philosophy of steel production for improving the techno-economic performance of our SMS would consist of introducing new technologies in the area of BOF steel making, ladle metallurgy and continuous casting. Among the major technologies which need mention, area wise are as follows:

A) **BOF Steelmaking**
   i) Introduction of Combined Blowing Steelmaking process
   ii) Dynamic control of BOF operation
   iii) Flame gunniting in BOF
   iv) Slag free tapping of BOF
   v) Use of low silica limestone
   vi) Suppressed gas combustion system
   vii) Use of DRI to meet the scrap shortage.

B) **Ladle Metallurgy**
   i) Inert gas rinsing of steel
   ii) Aluminium wire injection in ladle and calcium wire injection tundish
   iii) Powder Injection in ladle
   iv) Vacuum Arc Degassing for Hydrogen sensitive grades of steel
   v) Introduction of ladle furnace for temperature control
   vi) Measurement of oxygen & temperature in the ladle.
   vii) Automatic weighing and addition system of ferro-alloys and deoxidisers

C) **Casting**
   a) Ingot
      i) Introduction of recessed bottom plates for improved yield
      ii) Optimisation of hot topping practices for higher yield of killed steels.
      iii) Improvement in deoxidation and teeming technologies for semiskilled and rimming steels
      iv) Design and material improvement in ingot moulds

D) **Continuous Casting**
   i) Introduction of computerised control of continuous casting process.
   ii) Introduction of electro-magnetic stirring
   iii) Introduction of air mist cooling system
   iv) Introduction of cold tundish lining
   v) Introduction of direct strip casting
   vi) Introduction of continuous casting direct rolling
   vii) Introduction of a system for quick change of mould dimensions
   viii) On-line auto inspection of slabs, blooms/billets.
Steel Rolling

Introduction

The finishing zone of an integrated steel plant consists of one or two primary mills and different finishing mills. In primary mills cast ingots are reduced to primary products such as blooms, slabs or billets. These are further rolled in the finishing mills to various products.

In Bhilai & Durgapur Steel Plants and IISCO, Blooming and Billet mills have been provided to roll ingots into blooms & billets. Whereas in Rourkela and Bokaro Steel Plants a slabbing mill is provided to roll slabs. Rourkela Steel Plant is the first SAIL Plant of having 100% Continuous Casting facility for producing Slabs.

The Alloy Steels Plant at Durgapur produces special alloy steel products. Its primary mill is a Blooming and Billet Mill.

Primary Mills

The ingots received from steel melting shop are heated and soaked to above recrystallisation temperature in the soaking pits for easier deformation into Slabs, Blooms, Billets etc. Soaking pits are recuperative type and heated by mixed gas or electric power. The soaking temperature varies with the grade of steel, size of ingots & the characteristics of rolling mill. A removable cover closes the pit top. The charging and withdrawal of ingots into & from the pits is done by soaker / tong cranes. The hot ingots are transferred to the mill approach table by the ingot buggy.

The Blooming and Slabbing Mill is 2-Hi-reversing Mill driven by D C Motors. Top roll & spindles are balanced hydraulically. A set of manipulator & tilter are provided infront & one behind the mill. A number of passes are given before the ingot is reduced and cropped by shears of different capacities. The blooms, as per requirement, are further rolled in the Billet Mill to produce billets, shape billets, sleeper bar & skelp flats. These primary products are sent for further heating and rolling in the secondary mills.

The characteristics for Primary Mills of different steel plants are given on the next page.

Future of Primary Mills

The rolling mills of SAIL plants had been set up in the early sixties and early seventies. Since then, there has been considerable developments in steel making, steel casting and rolling technologies. Now converter - concast route of steel making has become the most adapted technology by modern steel plants, because of its advantages, viz, saving of energy and less cost of production. High capital and working costs of a primary mill are fully eliminated in this new route.

To make the old primary mills of SAIL plants up-to-date, the modernisation programme was carried out. Following are the main technological improvements:
Microprocessor control of heating and combustion regimes in soaking pits.
Yield optimisation at shear, including bite and back method for rolling slabs.
Automation of main stand working.
Replacement of main drive motors.
On line measurements of section dimensions.
Finally, phased replacement of ingot route by concast

Secondary Rolling

SAIL Plants produce hot rolled coils, cold rolled coils and sheets. Hot Rolling Steckel Mill is capable of producing high quality hot rolled stainless steel coils as well as value added mild steel coils like carton steel, EDD. The cold rolling mill produces all stainless steel varieties in the 300 and 400 series in the thickness range of .2 mm to 6 mm at Salem. Every finished product requires specified quality of steel, such as rimming steel for flat products. Aluminium killed for special formable steels, high silicon steel for electrical applications, killed and semi-killed steels in low and medium carbon for plates and structural and API quality high tensile steels for pipes.

At the slab or billet stage, the secondary rolling takes over and covers the entire range of heating, rolling in various stages, surface treatment, heat treatment and coating. Based on the end product requirement, hot or cold rolling processes are applied. Consequently, equipment design also varies. Thus we have 2-Hi, 3-Hi, and 4-Hi mills. Salem Steel Plant which rolls out cold rolled stainless steel has two Sendzimir Mills.

Various furnaces are used in the reheating and annealing stage which are process requirements in the secondary and finishing rolling routes.

These are the
- Pusher type reheating furnace
- Walking beam furnace
- Roller hearth furnace
- Bogie-hearth furnace
- Rotary hearth furnace
- Furnaces for continuous strip annealing
- Hood and box furnaces for batch annealing

These furnaces are normally fired by gas, which is a by-product of the plants, or oil. There are electrically heated furnaces also. Provisions exist for normalizing, sub-critical annealing, special controlled annealing for electrical sheets and quenching and tempering for hardened alloy steels.

Bhilai Steel Plant - Besides merchant products, beams and channels, Bhilai also produces rails for cranes and the Railways, and heavy plates. The rolling mills at Bhilai consist of Blooming Mill, Billet Mill, Rail & Structural Mill, Wire rod Mill, Merchant Mill & Plate Mill.

Rourkela Steel Plant - Rourkela Steel Plant produces the widest range of products catering to the automobile, space, defence, packaging, air-conditioning, oil and gas supply and the electrical manufacturing industries. The plant produces sheared and unsheared heavy plates of boiler quality and ship building quality, chequered plates,
hot rolled sheets and cold rolled sheets and coils, coated products like tin plate and
galvanized plain and corrugated sheets, electric resistance welded pipes for water and
oil transportation, spiral welded pipes for oil and gas transportation.

**Durgapur Steel Plant** - Durgapur Steel Plant is the major producer of railway track
materials like wheels, axles, fish plates and sleepers. The plant also produces billets,
light and medium sections, merchant products and skelp. The rolling mills at Durgapur
consist of Blooming Mill, Billet Mill, Section Mill, Merchant Mill, Wheel & Axle
Plant, Skelp Mill, Sleeper & Fish Plate finishing plant. Under modernisation, the
Merchant Mill was provided with controlled cooling facility known as “Thermax
System”, slit rolling and automatic bundling and binding.

**Bokaro Steel Plant** - The main product of Bokaro are hot rolled coils and sheets,
plates and cold rolled coils and sheets, plates, GP/GC sheets, and TMBP. Bokaro
caters to requirements of the LPG cylinder manufacturers, barrel and drum makers,
tube makers, automobile industries etc. The rolling mills at Bokaro Steel Plant consists
of hot strip mill, hot rolled coil finishing and cold rolling mill complex.

**Alloy Steels Plant** - Alloy Steels Plant produces a whole range of steels for special
and strategic needs of the country. Armour plate grade, cold and hot work tools steel
and shock resisting steel in billets, rounds, sheet and plate form the product range of
this plant. The plant also produces forged products.

Rourkela steel plant is the only unit under SAIL having Silicon Steel Mill to produce
cold rolled non-oriented and grain oriented sheets catering to the electrical stamping
and transformer Industry.

**Indian Iron & Steel Company Limited** - The Plant produces Joists, Channels, Rails,
Angles of various sizes in its Heavy Structural Mill. This mill also produces unique
special sections, Z bar, Z piling & colliery arch. Light Structural Mill has also capacity
to produce smaller sections of Joists, Channels, Rails, equal and unequal angles,
Rounds, Squares, Tees, Flats. Merchant and Rod mill products are Rounds, Flats,
Angles and Ribbed bars of various sizes.

Rolling Mills at Burnpur (IISCO) consist of Blooming Mill, Heavy Structural Mill,
Billet Mill, Light Structural Mill and Merchant Mill.