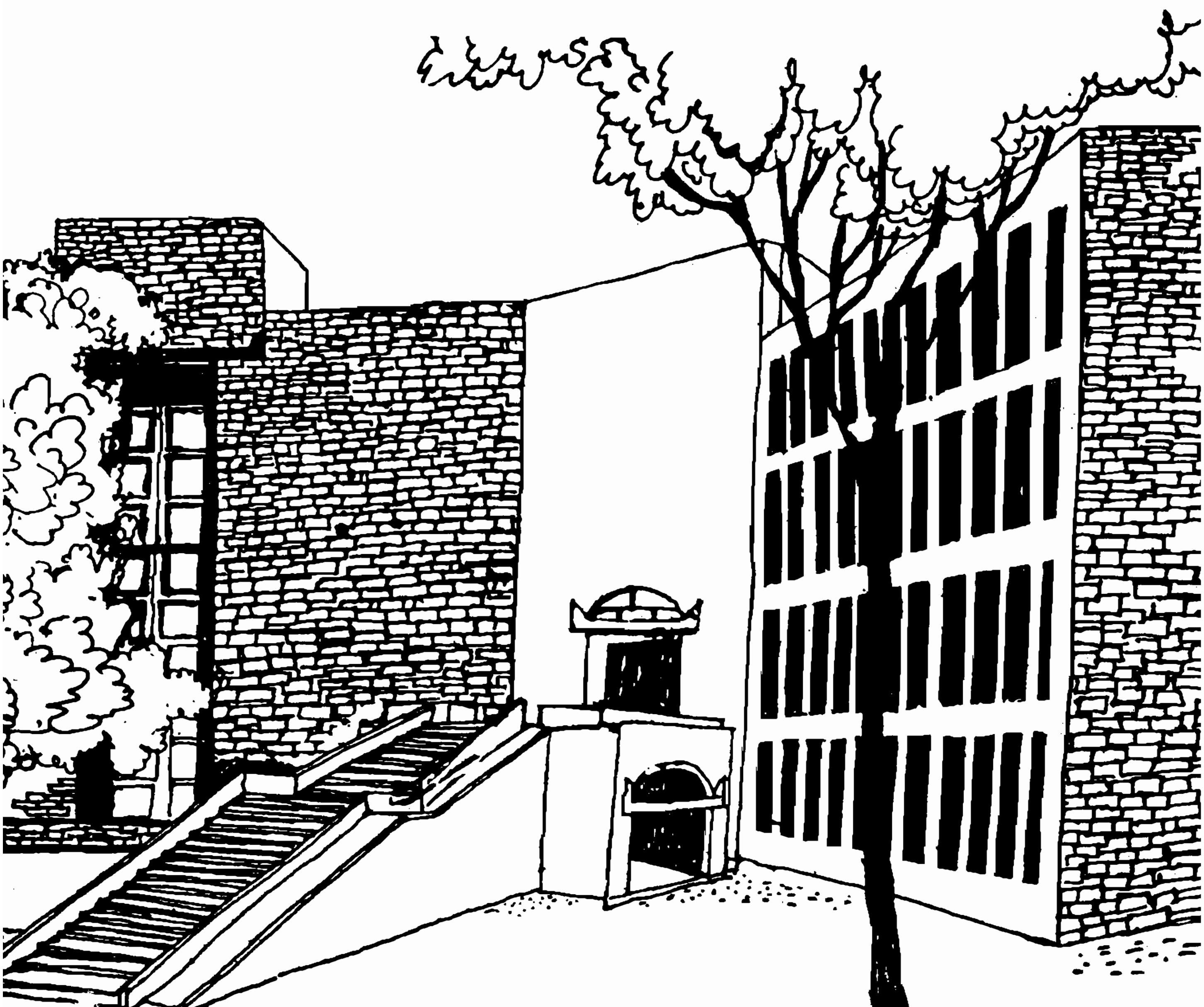
विद्याविनियोगाद्विकासः

IIM AHMEDABAD

Working Paper



DISPATCH PLANNING OF FINISHED STEEL: A CASE STUDY IN MODELING AND DATA ANALYSIS

By

A. H. Kalro
G. Raghuram
P. R. Shukla
&
A. Tripathy

W P No. 996
December 1991

The main objective of the working paper series of the IIMA is to help faculty members to test out their research findings at the pre-publication stage.

INDIAN INSTITUTE OF MANAGEMENT
AHMEDABAD-380 015
INDIA

DISPATCH PLANNING OF FINISHED STEEL: A CASE STUDY IN MODELING AND DATA ANALYSIS

A.H.KALRO, G.RAGHURAM, P.R.SHUKLA, and A.TRIPATHY
Indian Institute of Management, Ahmedabad - 380 015
INDIA

ABSTRACT

A steel plant has to dispatch products to forty four stockyards from a range of over hundred stock keeping units. The railways, who transport the steel, would like the steel plant to move the steel in a rake load since it is operationally beneficial. On the other hand, the steel plant prefers to move the steel with a shipment size as small as a wagon load. This paper attempts an analysis for the desirable shipment size between the rake load and the wagon load. This is done by first evaluating the requirements of the average finished goods inventory as a function of the percentage of dispatch by rake load, using a simulation model. A national perspective is then used for this decision since the railways are a crucial national resource. Having concluded that the rake load is the desirable shipment size, a decision support system is developed for the dispatch decision which must consider the product wise demand requirements, steel availability based on stocks available for loading and production expected in the short term, rake load (shipment size) requirements for various destinations, the rake formation constraints at the loading points etc. The paper also proposes longer term strategies to help increase the rake load dispatches.

1. INTRODUCTION

The problem considered here is in the context of dispatch planning of finished steel products at Bhilai Steel Plant (BSP). BSP is one of the five integrated steel plants of the Steel Authority of India Limited (SAIL), with a capacity of two million tons per annum (at the time of this study). It is located in the central part of India, in the state of Madhya Pradesh.

BSP has to dispatch finished steel products to 44 stockyards spread all over the country, from a range of over hundred stock keeping units. The railways, who transport the steel, would like BSP to move the steel in train loads (also called rake loads) since it is operationally beneficial. On the other hand, BSP would like to move the steel with a shipment size as small as a wagon load (also called piecemeal), especially since their loading infrastructure is setup for loading a few wagons only at a time. Section 2 describes the various issues and constraints in the context of dispatch planning. Section 3 attempts an analysis for the desirable shipment size between the rake load and the wagon load. This is done by first evaluating the requirements of the average finished goods inventory as a function of the percentage of dispatch by rake load, using a simulation model. A national perspective is then used for this decision since the railways are a crucial national resource. This analysis concludes that the rake load is the desirable shipment size. Section 4 describes a decision support system developed for the dispatch decision which must consider the product-wise demand requirements, steel availability based on stocks available for loading and production expected in the short term, rake load (shipment size) requirements for various destinations, the rake formation constraints at the loading points etc. Section 5 proposes longer term strategies to help increase the rake load dispatches. The final conclusions are given in section 6.

2. THE PROBLEM CONTEXT FOR DISPATCH PLANNING

Dispatch Decision

The dispatch decision (also called as order processing in other industries) is the allocation of the quantity of the items on stock as well as production expected during the loading period (two to three days) to the stockyards, on a daily basis. This decision is subject to the constraints of supply, demand, wagon requirement and rake formation.

Supply

The total number of distinct products made at BSP is nearly 110 (without considering quality as a dimension of distinction). These products come out of six loading points (five mills and one for pig iron) in their finished form. The number of products that are available for loading on any given day generally ranges between 50-75. The average production at BSP per month is 175000 tons. Each mill makes (rolls) one product at a time, for a period lasting three to five days, called a rolling campaign. Campaigns for the same product may be repeated. Some products may have to be processed a little more after the rolling, to obtain different finished products. For example, 8 mm wire rods are processed further to obtain plain, ribbed or electrode quality wire rods.

Demand

Nearly 70% of the demand goes to the stockyards while the remaining 30%, called direct dispatch, is sent to major customers. The order for finished steel from the direct dispatch customer is usually a rake load consisting of one or two products and consequently does not pose to be a problem for loading and dispatching.

The BSP gives a higher priority to direct dispatches, since the customers pay on receipt of the material, as opposed to stockyard dispatches where collections take a much longer time, facilitating better working capital management. There are 44 stockyards spread all over the country through which the products of BSP are sold.

Exhibit 1 gives the stockyard locations with the average monthly aggregate demand and the rail distance to the stockyards from BSP.

A map showing the location of the various stockyards and the railway route from BSP is given in Exhibit 2.

Wagon Requirement

There are five types of wagons which are used for loading various types of steel products. Exhibit 3 gives the type of wagons that can be used for the various product categories, as well as the types of wagons that can be combined for forming rakes. Thus, while matching of wagons to products and rakes is an issue, wagon availability as such poses no problems since the steel sector has a high priority for wagon allotment.

Rake Formation

The rake combinations come in various sizes - 20, 30, 35 and 40 wagons depending upon the route for the rake movement. The load permissible per wagon is 55 tons. Since a rake would otherwise require a large amount (1100 to 2200 tons) of steel to be loaded for a single destination, the Railways have permitted certain combinations of destinations. Exhibit 4 gives the permitted combinations.

Since the layout of the BSP is expansive, it is desirable to form rakes from as few loading points as possible. Exhibit 5 gives a schematic layout of the loading points at BSP.

Dispatch Meeting

The daily dispatch meeting is the crucial decision-making body for the dispatch decision. It is chaired by the Deputy General Manager (Mills) and essentially conducted by a 'rake coordinator'. Representatives from the traffic department and all mills and loading points attend the meeting with the latest wagon availability, steel product inventory and production status. The demand to be satisfied is given to the mills by the marketing office. From this, depending on material availability, a list of destinations with the quantity that can be loaded is given to the rake coordinator. Sometimes, in spite of a standing demand and stock, materials (usually the one produced earlier) may not be available for loading due to submergence of products.

As soon as the dispatch decision is taken, the mills are required to load the products into wagons whose placement at the loading points is ensured through the traffic department. Sometimes, just to help complete rakes, the marketing department is asked to place indents for products which are available at the plant. At this meeting, decisions are also taken to place indents on wagons based on loading plans, both at a monthly aggregate level as well as on a daily basis with a lead time of 3-4 days.

Scientific Approach to Decision Making

Considering the above details, it becomes important to

1. Understand the relationship between the piecemeal requirements and the finished goods inventory.
2. Provide a mechanism for better dispatch planning.
3. Identify strategies to reduce piecemeal requirements.

A simulation model is developed to address (1) and a decision support system is developed for (2).

3. SIMULATION MODEL

A brief description of the model is as follows.

Inputs

1. Opening stock for all products.
2. Daily net production (net production = total production - direct dispatch for all mills) for all the products.
3. Monthly demand from all the stockyards.
4. Permitted minimum and maximum rake sizes for all the stockyards and permitted stockyard combinations [Exhibit 4].

The original product list, being large, is modified to bring it to a manageable size. Products are removed from the original list if they have either a zero stockyard demand or negligible demand and are not listed in the production data for the year.

Outputs

1. Quantities of stock supplied in rakes and in piecemeal daily, and cumulatively per month.

2.Inventory held at the end of each month.

Assumptions

1. The model treats one calender month as a rigid demand period for forming rakes. (In actual practice, towards the end of the month, some allocations are made against the following month's tentative demand, often based on experience, to obtain more flexibility in rake formation.)

2. The simulation is carried out employing three different values for the number of days after which, if the material is not allocated, it has to necessarily go as piecemeal. The values are 7, 10 and 15. (in actual practice, this is done based on actual congestion in the loading area and likely submergence.)

3. Products are considered from combinations of up to three mills to satisfy the "maximum three loading points" constraint.

4. Classification and prioritisation of stockyards: For the purpose of the simulation, the stockyards are divided into four categories, based on the permitted rake combinations given in Exhibit 4.

(a) Stockyards that have a demand of at least one full rake load, not falling into any of the permitted rake combinations.

(b) Stockyards falling into any of the permitted rake combinations, and offering a full rake load along with other stockyards of the combination.

(c) Stockyards which do not offer a rake load either individually or as part of a permitted rake combination.

(d) Bhilai local supply.

For rake load allocation, categories (a) and (b) are considered in that order and further in the decreasing order of total demand.

For piecemeal allocation, categories (c) and (d), which are always sent as piecemeal, are considered in that order. If the stockyards in these categories get exhausted, the piecemeal supplies are made to the stockyards in the other categories, which have a residual demand less than a rake load. If there are competing stockyards in the same category, then allocations are made in the decreasing order of total demand.

Results

The following table presents the summary of the results obtained by the simulation exercise, which was carried out for the period April 1988 to March 1989.

Number of days before going as piecemeal	% of piecemeal generated	Average inventory at the end of the month (tons)
7	53.70	26600
10	47.34	43336
15	34.45	48519

The piecemeal generation is different than what is actually observed. This can be attributed to the rigidity behind the monthly demand horizon and the number of days before being assigned as piecemeal. However, the more important outcome of the simulation model is how the changes in inventory levels and changes in percentage of piecemeal generated are related, under the existing scenario of production planning.

SAIL and Railways

To determine the most economical way to move iron and steel to the required consumption centres from the joint perspectives of SAIL, Railways and the customer, the key decision variable is the shipment size. Though, theoretically, a whole range of alternatives right from a wagon load to a load limited by rail technology are available, the effective alternatives are a piecemeal wagon load (about 55 tons) and a rake load (between 1100 to 2200 tons). The rake load quantity is expected to increase to 4500 tons or even 9000 tons.

A qualitative analysis between the piecemeal and rake options would be as follows:

	Piecemeal	Rake
Total Transportation Cost	High	Low
Inventory Cost: Plant	Low	High
Inventory Cost: Pipeline	High	Low
Inventory Cost: Stockyards	Low	High
Operational Problems for SAIL	Low	High
Operational Problems for Railways	High	Low

The customer is not explicitly considered in this analysis since it is assumed that under either option, a desired service level has to be maintained for the customer. It is the distribution system that has to be designed for the desired service level, increasing whatever costs for transportation, inventory and operations. This analysis is presented quantitatively in Exhibit 6. Based on the three cost categories, rake movement is clearly justified under the joint perspectives of SAIL, railways and the customer.

With this in view, a decision support system to facilitate operational decision making, and other strategies to facilitate rake movement are described in the following two sections, respectively.

4. DECISION SUPPORT SYSTEM

The decision support system developed on a Personal Computer (PC) is to facilitate planning and operationalising dispatch of finished steel to various destinations (primarily stockyards). The support is provided for dispatches on a daily basis. Relevant data are maintained on database files. The required data sets are transferred to a spreadsheet for providing support in decision making. A flowchart of the DSS is given in Exhibit 7.

Database

Three sets of data are being maintained in the database files.
Product Data: Product code, production centre (mill(s) where these could be produced/loaded) and wagon type(s) in which these could be loaded.

Master Demand Data: Destination wise, product wise demand for one quarter.

Stock Data: Product wise, production centre wise stock on a particular date.

Exhibit 8 gives a sample structure of the Master Demand Data file. While product data are less subject to modifications, the master demand data are modified as and when new demands become known or some dispatches are being made. The stock data are updated on a daily basis based on production and dispatches.

In addition, the following data are needed on a daily basis for the use of the DSS model.

1. Product wise stock at different production centres at the commencement of the day
2. Stock available for loading at the commencement of the day (considering the submergence)
3. Expected production in next 24, 24-48 and 48-72 hours
4. Wagon availability at the commencement of the day including likely availability of wagons for loading in next 24 hours

Decision Support

A spreadsheet model is used for providing support for operational planning of dispatches in the next 24 hours and tentative planning for dispatches between 24-48 hours and between 48-72 hours (i.e. next two days on a daily basis). The required data from the Product Data and the Master Demand Data files are transferred to the spreadsheet. A sample screen format of the spreadsheet is shown in Exhibit 9.

The destinations to which rake loads could be dispatched are arrived at through the spreadsheet using the data provided on a daily basis and the data transferred from the database files. The constraints of wagon compatibility (indicated in Exhibit 3) and other constraints like not more than three loading points for a rake etc., are kept in view while arriving at the destinations for rake dispatches.

In case the number of destinations for rake dispatches are more than the available wagons/rakes, the most desirable ones are selected by the decision maker (as he is the best judge of this). However, more often than not, the number of destinations for rake dispatches are less than the number of rake dispatches desired on the particular day. At this stage, the decision maker uses the flexibility available with him for deciding the rake load dispatch destinations. Some of the flexibility is related to rake dispatches with multipoint combinations (as per the permitted rake combinations in Exhibit 4), dispatch of fast moving materials (though firm demand may not exist) to form rake loads etc. The spreadsheet model provides enough support to take care of such concerns of the decision maker. Once a rake dispatch plan for the next 24 hours is finalised, actions are initiated to implement the same. The stock positions of materials are updated on a daily basis based on the actual production and dispatches.

In addition to a firm plan for the next 24 hours, tentative plans are also arrived at for 24 hours to 48 hours period and 48 hours to 72 hours period on similar lines. The tentative plans are primarily used for wagon indents.

In addition to rake point dispatches, decisions in respect of piecemeal dispatches are also finalised on the basis of the decision rules formed from time to time. The DSS also allows incorporation of alternative decision rules for arriving at rake load dispatch destinations.

5. STRATEGIES TO REDUCE PIECEMEAL REQUIREMENTS

The PC-based decision support system described above facilitates operational decision making towards the objective of rake formation. There are other strategies available to reduce piecemeal requirements. some short term, others medium and long term. Detailed analysis of dispatch and demand data provided the following strategies.

Short Term

(a) Combining direct dispatch with stockyard dispatch. (This is not done currently since these two dispatches are treated separate administratively and financially.)

(b) Combining pig iron dispatch with other products. (This is not done currently since a discount is available for a full pig iron rake.)

(c) Having a quarterly dispatch programme.

(d) Moving to smaller stockyards from larger stockyards by road, rather than directly by rail.

(e) Direct road dispatch from BSP through the plant based stockyard to stockyards within a radius of 500 kms. (Jabalpur, Nagpur, Vizag, Rourkela and Bhubaneshwar).

The combined short term strategies could reduce the piecemeal requirement by 5%.

Medium Term

(a) Improved MIS and coordination through a computer based decision support system.

(b) Multipoint rakes, scientifically arrived at, and in consultation with Railways.

(c) Production planning - modifying the duration of and coordinating rolling campaigns to enable proper order processing and dispatching.

Long Term

(a) Mixing yards: Along with the short term strategies, a mixing yard with the requisite capacity can bring down the piecemeal requirement to nearly nil.

(b) Mother yards/Nodal points: About 25 among the existing stockyard locations should be selected. (This would provide full coverage for the country with an individual stockyard coverage of 300 kms. by road and also account for nearly 90% of steel distribution by primary movement). Secondary movement is best done by road. With this strategy, the piecemeal requirements for primary transportation would come down to nearly nil.

(c) Shipping bays: Some of the piecemeal requirements due to operational problems of handling and loading would be reduced by modifications in the shipping bays.

6. CONCLUSIONS

It is felt that results towards the objective of smoothing the dispatch process (by reducing piecemeal requirements) can be achieved through better MIS, managerial coordination and production planning rather than the long term investments in infrastructure. Once this is exploited, then infrastructure investments can be considered.

ACKNOWLEDGEMENTS

The authors would like to thank the Steel Authority of India Limited for the opportunity to work on this problem. Acknowledgements are due to Mr.Padmanabhan, Ms.Minal, and Mr.N.K.Rao for assisting us with data collection and programming.

EXHIBIT - 1

STOCKYARD WISE DEMAND 1988-89

SL.NO.	STOCK YARDS	DISTANCE (In Kms.)	AV.MONTHLY DEMAND (Tons)	CUMULATIVE DEMAND (Percent)
1	BOMBAY	1100	10886	8.85
2	MADRAS	1300	7876	15.26
3	BHILAI	5	7222	21.14
4	CALCUTTA	900	7156	26.96
5	GHAZIABAD	1300	7025	32.67
6	AHMEDABAD	1250	5720	37.32
7	HOWRAH	900	5275	41.61
8	JALANDHAR	1750	4816	45.53
9	LUDHIANA	1650	4725	49.37
10	SECUNDRABAD	900	4512	53.04
11	COIMBATORE	1700	4175	56.44
12	MANDIGOVINDGARH	1550	4156	59.82
13	NEW DELHI	1300	3964	63.05
14	BANGALORE	1500	3956	66.26
15	NAGPUR	300	3691	69.27
16	KANPUR	1000	3561	72.16
17	JAIPUR	1300	2694	74.35
18	ALLAHABAD	1000	2692	76.54
19	BARODA	1150	2611	78.67
20	TRICHY	1700	2609	80.79
21	CHANDIGARH	1500	2516	82.84
22	BOKARO	800	2460	84.84
23	FARIDABAD	1300	2430	86.81
24	AGRA	1100	1922	88.38
25	VIZAG	500	1709	89.77
26	PUNE	1150	1549	91.03
27	DURGAPUR	900	1538	92.28
28	BHUBANESWAR	850	1359	93.38
29	GAUHATI	1900	1350	94.48
30	PATNA	1200	1074	95.36
31	COCHIN	2000	1030	96.19
32	JABALPUR	350	913	96.94
33	VIJAYAWADA	800	824	97.61
34	GWALIOR	1100	729	98.20
35	ROURKELA	400	477	98.59
36	JAMMU	2100	431	98.94
37	LUCKNOW	1000	383	99.25
38	SRINAGAR	2100	332	99.52
39	KOTA	1000	180	99.66
40	INDORE	700	141	99.78
41	GOA	2000	134	99.89
42	DHARAMNAGAR	2350	54	99.93
43	DIMAPUR	2150	46	99.97
44	BELGAUM	1600	38	100.00
	TOTAL		122940	100.00

AVERAGE LEAD = 1137.33 Kms.

EXHIBIT - 2

MAP SHOWING RAILWAY ROUTES TO STOCKYARDS

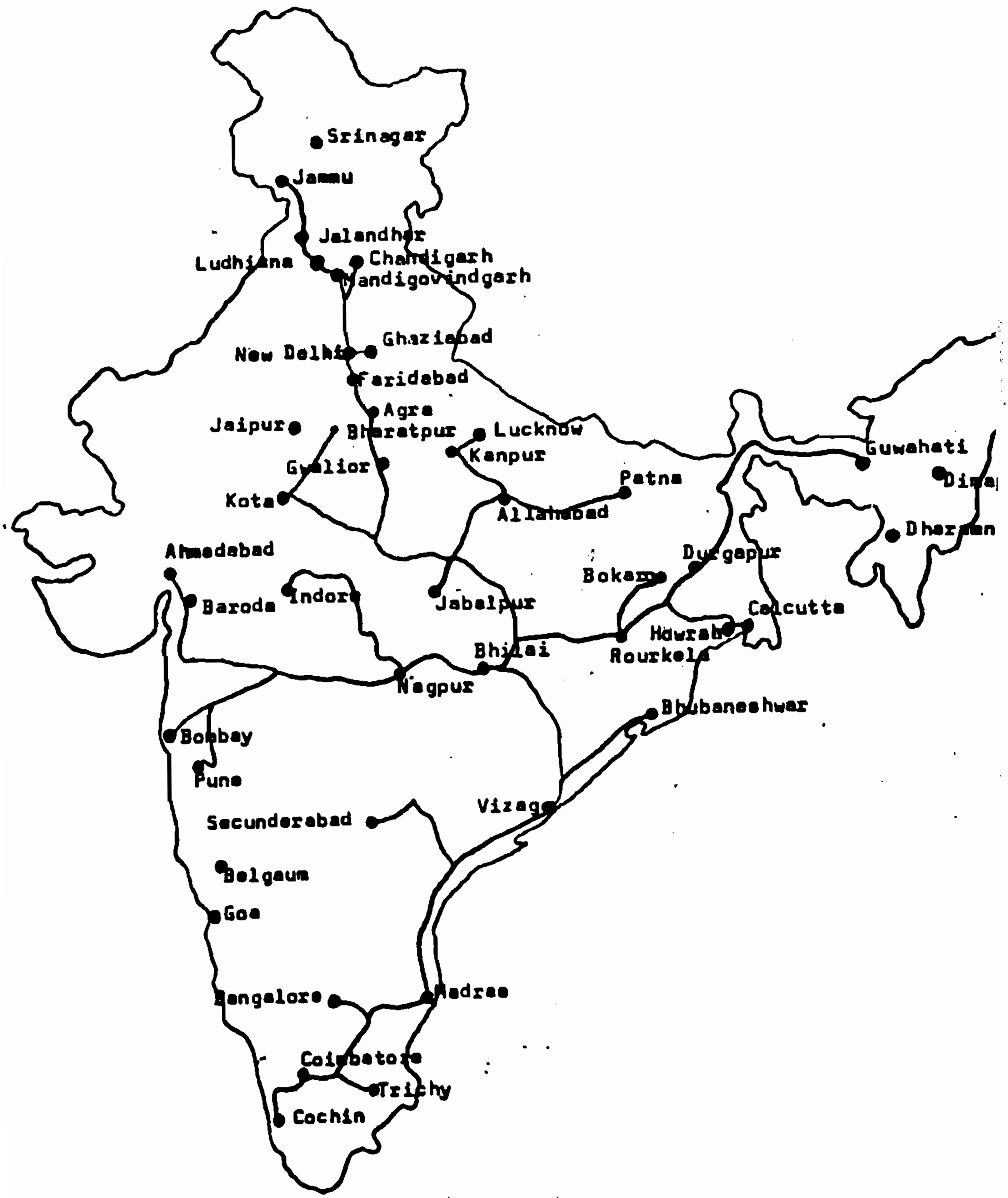


EXHIBIT - 3

TYPE OF WAGONS FOR VARIOUS PRODUCTS

Product	Type of Wagon
Pig Iron	BOX (Rakes) BKC/KC (Piecemeal)
Billets and Blooms	BOX/BRH/BFR
Rails	BRH (Rakes) BFR (Piecemeal)
Structurals	BOX/BRH (Rakes) BFR/KC (Piecemeal)
Merchant Mill	BOX/BRH (Rakes) BFR/BKC/KC (Piecemeal)
Wire Rod Mill	BOX (Rakes) BKC/KC (Piecemeal)
Plate Mill	BOX (Rakes) BFR/BRH (Piecemeal)

Permitted combinations of wagons for forming Rakes:

1. BFR and BRH
2. BOX and BRH

EXHIBIT - 4

PERMITTED RAKE COMBINATIONS

Stockyard	Rake Size	Permitted Combination
Eastern Region		
Calcutta	40/20	
Howrah	40/20	
Durgapur	40/20	
Bhubaneswar	30	
Rourkela	40/20	
Patna	30	
Bokaro	40/20	
Gauhati	40/35	
Northern Region		
New Delhi	30	Can be combined with Ghaziabad or Faridabad
Ghaziabad	30	
Faridabad	30	
Kanpur	30	Can be combined with Allahabad or Lucknow
Allahabad	30	
Lucknow	30	
Agra	30	These two destinations can be combined
Gwalior	30	
Chandigarh	30	Any two destinations can be combined
Mandi Govindgarh	30	
Ludhiana	30	
Jalandhar	30	
Jammu	30	
Western Region		
Bombay	35/30	
Pune	35/30	
Nagpur	35/30	
Bhilai	35/30	
Ahmedabad	35/30	These two destinations can be combined
Baroda	35/30	
Jaipur(Bharatpur)	30	These two destinations can be combined
Kota	30	
Southern Region		
Madras	40/30	For rakes of 30, following combinations are permitted i) Madras and Trichy ii) Coimbatore and Cochin For rakes of 40, any two destinations can b combined with 20 wagons each
Trichy	40/30	
Coimbatore	40/30	
Cochin	40/30	
Bangalore	40/30	
Secunderabad	40/30	10 wagons for Vizag or Vijayawada can be combined with a rake of 30 to Secunderabad or any other destination in South.
Vizag	40/30	
Vijayawada	40/30	

BHILAI STEEL PLANT

SCHEMATIC LAYOUT OF MILL LOADING POINTS

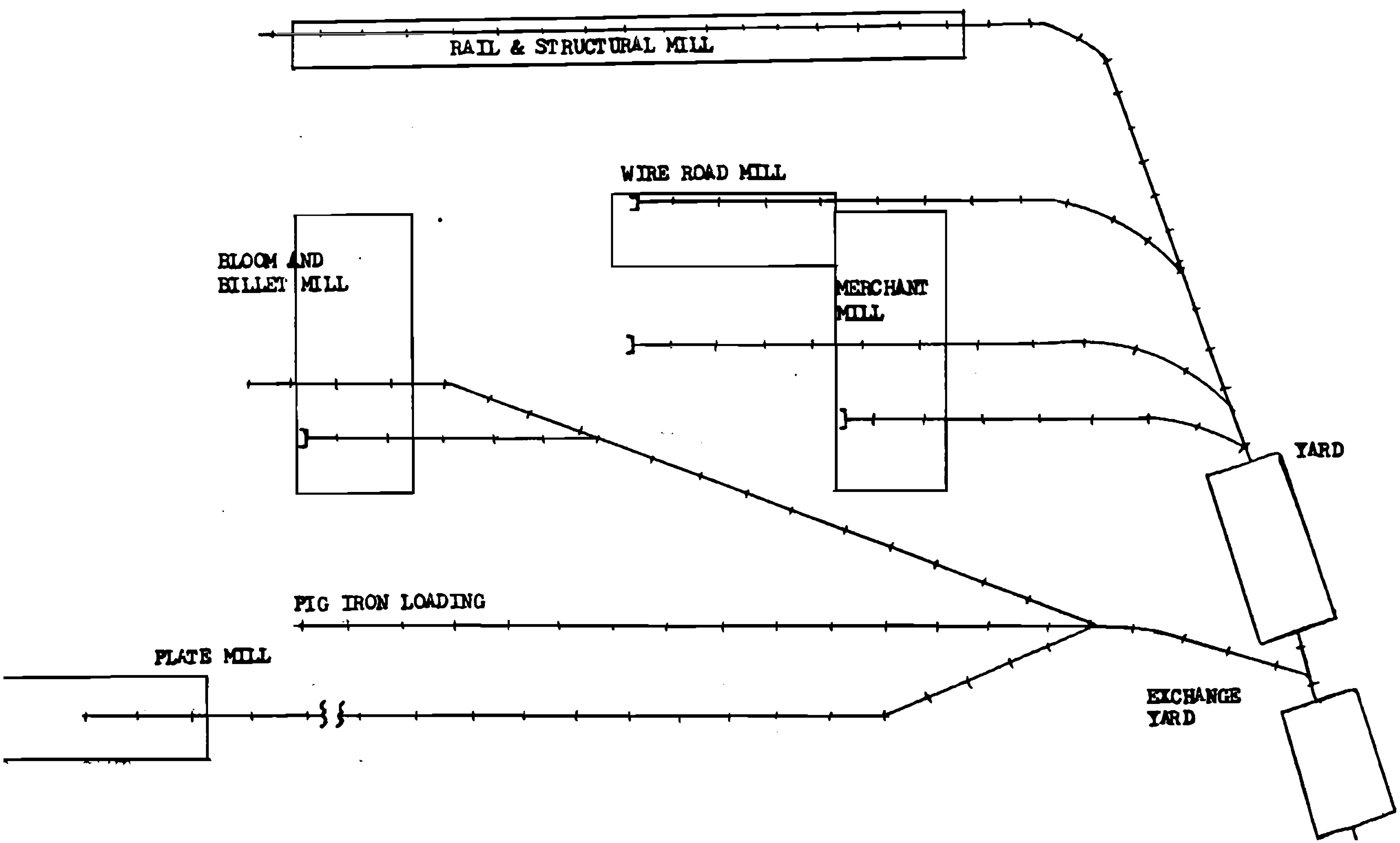


EXHIBIT - 6

COST TRADE-OFF BETWEEN SAIL AND INDIAN RAILWAYS (IR)

Key Parameters

1. At Bhilai 2 million tons of steel are loaded over 300 days in a year. Thus, daily loading is 6667 tons.
2. Average lead from Bhilai is 1137 kms (Exhibit 1).
3. Average speed for rake movement is 22 kmph.
4. Average speed for piecemeal movement is 4.5 kmph (due to long stays at yards).
5. Average earnings for IR per 50-ton wagon km is Rs.6.67.
6. Average rake-piecemeal split on IR is 80-20.
7. Average load per wagon is 50 tons and per rake is 1667 tons.
8. Cost of steel is Rs.4000/ton. Transport cost of steel is Rs.400/ton. Inventory holding cost is 20% per annum.

Transportation Cost

Piecemeal For 6667 tons/day at 50 tons/wagon, about 133 wagons have to be loaded per day. At an average speed of 4.5 kmph for an average lead of 1137 kms, the wagons will be in the pipeline for 10.5 days. Assuming an extra day for loading and half a day for unloading, number of wagons blocked for piecemeal movement will be 12 x 133 i.e. about 1600 wagons.
Opportunity cost of these wagons for IR is
1600 x 6.67 Rs./wagon km x [.8 x 22 x 24 + .2 x 4.5 x 24] km/day
= 10667 x [422.4 + 21.6]
= Rs.4.74 million/day = Rs. 1730 million/year.

Rake For 6667 tons/day at 50 tons/wagon, about 133 wagons have to be loaded per day. At an average speed of 22 kmph for an average lead of 1137 km, the wagons will be in the pipeline for 2.15 days. Assuming an extra 3 days for loading and 0.85 day for unloading, number of wagons blocked for rake movement will be 6 x 133 i.e. about 800 wagons.
Opportunity cost of these wagons for IR is
= Rs. 865 million/year.

Total savings in transportation cost possible due to rake movement is Rs.865 million/year.

Inventory Cost

Piecemeal At the bare minimum, about 15 days' stock is needed in the distribution system (most of it for pipeline).

Rake From the simulation exercise, about 10 days' stock (66,000 tons) is needed for facilitating rake movement. A similar amount of inventory would be present at the stock yards. The requirements in the pipeline is about 6 days. The total thus amounts to about 30 days' stock. From actual data, the total inventory held in the distribution system is nearly 60 days' stock, when the average rake-piecemeal proportion has been 80-20 for SAIL.

If we assume that the additional stock level were to go up even by 2 months entirely because of rake movement, then the additional inventory value is
(2 million/12) x 2 months x Rs.4000 = Rs.1333 million.

The holding cost due to this will be Rs.267 million/year.

Thus, the increase in inventory costs to SAIL would not compensate the oppurtunity cost incurred by IR.

Other Costs

Due to rake movement, operational problems like submergence, secondary road movement etc. increase for SAIL. Additional infrastructure at the plant and stockyards would be required for increasing rake dispatches.
The operational savings due to rake movement for IR (apart from just wagon time already accounted for in the transportation cost) should also be kept in mind, since yard operations would be minimised.

Based on the three cost categories above, rake movement is clearly justified, under the joint perspective of SAIL, IR and the consumer.

EXHIBIT - 7

SIMPLIFIED FLOW CHART OF D.S.S MODEL FOR DISPATCH DECISION

INPUT

1. STOCK AVAILABLE FOR LOADING
2. PRODUCTION LIKELY TO BE AVAILABLE FOR LOADING IN THE NEXT 24, 48 AND 72 HOURS
3. WAGONS AVAILABLE AND LIKELY TO BE AVAILABLE FOR LOADING IN THE NEXT 24 HOURS
4. QUANTITY ACTUALLY DISPATCHED IN THE LAST 24 HOURS
5. ANY NEW DEMAND DATA, IF AVAILABLE

UPDATE

1. DEMAND FILE BASED ON 4 & 5 ABOVE
2. QUANTITY OF STOCK AVAILABLE FOR LOADING BASED ON 1 & 2 ABOVE AND STOCK ALREADY NOMINATED FOR INCOMPLETE LOADS
3. WAGON AVAILABILITY BASED ON 3 ABOVE AND WHAT IS ALREADY NOMINATED

TRANSFER

1. DEMAND DATA OF STOCK KEEPING UNITS WHICH ARE AVAILABLE FOR LOADING AND LIKELY TO BE AVAILABLE FOR LOADING IN THE NEXT 24, 48 AND 72 HOURS
2. COMPATIBILITY DATA OF WAGON TYPES & STOCK KEEPING UNITS

FROM DATABASE TO SPREADSHEET

DISPATCH DECISION

1. AGGREGATE DESTINATION WISE DEMAND OF STOCK KEEPING UNITS AVAILABLE FOR LOADING
2. SORT THE DESTINATIONS ON THE AGGREGATE DEMAND
3. SELECT THE DISPATCH DESTINATIONS FOR THE NEXT 24 HOURS

THIS PART IS INTERACTIVE

EXHIBIT - 8

SAMPLE STRUCTUTRE OF THE MASTER DEMAND DATA

PRODUCT CODE	DEMAND_A	S_YARDCODE	WAGON_TYPE	YARD
340050050061001	11.30	57	BOX,BFR,BRH	NEW_DELHI
340050050061001	228.00	87	BOX,BFR,BRH	GHAZIABAD
340050050061001	114.00	71	BOX,BFR,BRH	FARIDABAD
340050050061001	57.00	81	BOX,BFR,BRH	AGRA
340050050061001	42.80	88	BOX,BFR,BRH	GWALIOR
340050050061001	171.00	59	BOX,BFR,BRH	JALANDHAR
340050050061001	57.00	93	BOX,BFR,BRH	JAMMU
340050050061001	76.65	92	BOX,BFR,BRH	CHANDIGARH
340050050061001	62.90	52	BOX,BFR,BRH	BOMBAY
340050050061001	34.20	72	BOX,BFR,BRH	PUNE
340050050061001	57.00	69	BOX,BFR,BRH	BHILAI
340050050061001	228.00	58	BOX,BFR,BRH	INDORE
340050050061001	57.00	74	BOX,BFR,BRH	JABALPUR
340050050061001	59.90	78	BOX,BFR,BRH	BARODA
340050050061001	9.60	79	BOX,BFR,BRH	JAIPUR
340050050061001	6.05	53	BOX,BFR,BRH	CALCUTTA
340050050061001	114.00	91	BOX,BFR,BRH	HOWRAH
340050050061001	57.00	89	BOX,BFR,BRH	DURGAPUR
340050050061001	17.10	54	BOX,BFR,BRH	BHUBANESHWAR
340050050061001	171.00	70	BOX,BFR,BRH	ROURKELA
340050050061001	114.00	76	BOX,BFR,BRH	PATNA
340050050061001	19.95	65	BOX,BFR,BRH	ALLAHABAD
340050050061001	285.00	63	BOX,BFR,BRH	GAUHATI
340050050061001	3.90	61	BOX,BFR,BRH	MADRAS
340050050061001	340.60	73	BOX,BFR,BRH	TRICHY
340050050061001	30.20	67	BOX,BFR,BRH	COIMBATORE
340050050061001	10.70	55	BOX,BFR,BRH	COCHIN
340050050061001	57.00	51	BOX,BFR,BRH	BALGALORE
340050050061001	399.00	62	BOX,BFR,BRH	SECUNDRABAD
340050050061001	228.00	68	BOX,BFR,BRH	VIZAG
340050050061001	57.00	57	BOX,BFR,BRH	NEW_DELHI
340050050061001	35.30	81	BOX,BFR,BRH	AGRA
340050050061001	57.00	59	BOX,BFR,BRH	JALANDHAR
340050050061001	24.00	72	BOX,BFR,BRH	PUNE
340050050061001	114.00	77	BOX,BFR,BRH	NAGPUR
340050050061001	114.00	50	BOX,BFR,BRH	AHMEDABAD
340050050061001	57.00	53	BOX,BFR,BRH	CALCUTTA
340050050061001	57.00	91	BOX,BFR,BRH	HOWRAH
340050050061001	57.00	76	BOX,BFR,BRH	PATNA
340050050061001	10.80	65	BOX,BFR,BRH	ALLAHABAD
340050050061001	57.00	63	BOX,BFR,BRH	GAUHATI
340050050061001	54.70	61	BOX,BFR,BRH	MADRAS
340050050061001	114.00	62	BOX,BFR,BRH	SECUNDRABAD
340065065061001	114.00	57	BOX,BFR,BRH	NEW_DELHI
340065065061001	171.00	87	BOX,BFR,BRH	GHAZIABAD
340065065061001	171.00	71	BOX,BFR,BRH	FARIDABAD
340065065061001	57.00	81	BOX,BFR,BRH	AGRA

EXHIBIT - 9

SCREEN FORMAT OF THE SPREADSHEET DECISION SUPPORT

B1: 1.0125000E+14 MENU

Import Save Print Check Quit Exit

Import the demand file

	A	B	C	D
1	Prod.code—>	101250000000001	340050050061001	410063000001001
2	Tot.stock	200	260	0
3	Avl.stock	6959.00	260.00	590.00
4	PROD.(24 Hr.)	266.00	0.00	200.00
5	PROD.(48 Hr.)	366.00	0.00	390.00
6	PROD.(72 Hr.)	400.00	0.00	0.00
7	Wag.type	BOX,BFR,BRH	BOX,BFR,BRH	BOX,BKC,KC
8	JALANDHAR	0.00	57.00	0.00
9	CALCUTTA	342.00	57.00	0.00
10	TRICHY	0.00	340.60	0.00
11	INDORE	0.00	228.00	0.00
12	GHAZIABAD	0.00	228.00	0.00
13	VIZAG	0.00	228.00	0.00
14	ROURKELA	0.00	171.00	0.00
15	SECUNDRABAD	0.00	114.00	0.00
16	NAGPUR	0.00	114.00	0.00
17	FARIDABAD	0.00	114.00	0.00
18	AHMEDABAD	0.00	114.00	0.00
19	CHANDIGARH	0.00	76.65	0.00
20	BOMBAY	0.00	62.90	0.00

12-Nov-91 11:10 AM