MANPOWER REQUIREMENT PLANNING: A FRAMEWORK AND CASE STUDIES

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MANPOWER REQUIREMENT PLANNING

-A Framework and Case studies

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Determining manpower requirements for any operating facility - whether a manufacturing unit or a service facility, is generally a very complex task. It is complicated by the fact that manpower requirements are influenced by several factors both technological as well as sociological. Nature of technical processes, manufacturing hardware, types of raw materials and outputs, working conditions, work practices, systems and procedures, etc. all affect requirements of manpower.

Although physical workload has for long been considered as prime determinant of manpower, the same is not the only factor creating need for manpower. Indeed rapid changes taking place in processes and techniques of production and work are increasingly placing lower and lower emphasis on purely physical aspects of the work. Even in situations where latter circumstance prevails, there is always considerable variation both in the nature and volume of physical work. Under such conditions, earlier manpower assessment methods which relied mainly on output/efficiency norms or manpower expenditure ratios are quite inadequate. In approaching this exercise, therefore, there are many important issues which merit careful consideration. In this study, we make an attempt to dwelve upon such issues. A framework is then presented to enable comprehensive analysis of manpower requirements. Specific case studies drawn from diverse situations are provided to illustrate the application of the proposed framework under different conditions, involving varying degrees of complexity. The proposed framework will be termed as Manpower Requirement Planning.

1. Components of manpower requirements and indicators

What constitutes manpower requirement in an operating unit? Admittedly the answer to the manpower requirement problem depends critically on the

analysis of this question. It can therefore be regarded rightly as the central issue in manpower problem. Manpower norms must inevitably bear relationship to the i) nature, ii) volume, iii) methods, iv) efficiency with which activities are performed during operations. Clear determination of this relationship is however intriguing. One possible way is to classify manpower into two types: direct and indirect. In this classification, direct manpower is the component that varies directly with the levels of the given activity, or its surrogate indicator. The rest of the manpower will be treated as indirect manpower. This method has several shortcomings, principal amongst which is that the question of indirect manpower requirement is still unresolved. Secondly, it presupposes that activity level can in fact be measured. Another way is to identify a set of one or more activity related factors and attempt to relate the manpower to these factors through appropriate techniques like regression, for instance. This is often useful for a quick projection of aggregate manpower requirement, for purposes of corporate planning, resource analysis, etc., particularly at macro level. It however does not lend itself to a disaggregative analysis of constituents of manpower requirements in various individual skill categories across different activity units of the organization. This is, however, extremely essential.+ What is therefore needed is a way of classifying the requirement such that it is possible to simultaneously relate it to the most appropriate constituents which generate need for manpower. Furthermore, this needs to be done across each of the various activity units of the organization, and for each skill category.

In majority of work situations, the bulk of the manpower can be said to be constituted by the following:

i) manpower related to the outputs of technical/manufacturing processes,
ii) manpower related purely to the physical workload arising out of manual operations.
iii) manpower related to the specific positions to be manned.
iv) manpower related to the administrative systems and procedures in existence,
v) manpower needs arising out of specific policy considerations, contingencies, working conditions, negotiated work practices, etc.

+ from the point of manpower management.

vi) manpower related to two or more of the above constituents.

It is easy to cite numerous illustrations to support the above classification. For instance, in assembly departments of engineering product manufacturing units, the assembly manpower depends upon the output desired from the assembly lines. In continuous process type manufacturing units like steelmills, significant amount of manpower is determined by the specific equipment/supervisory positions to be manned. Similarly, much of the manpower engaged in activities like material handling, house keeping, etc. arises out of the physical workload involved in such operations. Bulk of the manpower required for office work activities depends heavily on the systems and procedures in existence. Further, it is not uncommon for the management and unions to arrive at certain negotiated work practices. Fixation of crew sizes in group activities like maintenance of heavy machinery, is an example in point. Quite often, manpower requirement is determined by the nature of interaction amongst its different constituents. For instance, in bagging and filling operations of a chemical process plant, manpower needed depends upon the output of the processes as well as physical workload involved.

It should be obvious that the above constituents are sufficient to determine manpower requirement given any work situation. These, therefore, can be safely adopted as <u>indicators</u> of manpower requirement.

2. <u>Details of departmental work activities</u>

To use manpower indicators meaningfully, they should, as stated earlier, relate the manpower strength to the nature/volume of departmental activities. Consequently, it is necessary to obtain an intimate understanding of the technological processes, their inputs and outputs, types of equipments in use, the positions to be manned, methods and practices of work, as well as details of manual work activities, being carried out. Relevant information and data base needs to be developed with respect to these factors, so as to be useful for manpower assessment.

3. Systems and Procedures

Administrative systems and procedures play a very crucial role in determining the nature and volume of manpower in departments where work is primarily office type. Changes in systems and procedures entail corresponding changes of workload and by consequence, of manpower. It is also noteworthy that in administrative type of work, a given size of manpower can be expected to cater to a range of workload, rather than a unique level. Notwithstanding this, streamlining and simplification of systems and procedures is necessary to control proliferation of non-productive work as well as manpower.

4. Efficiency levels

Needless to state, departmental efficiencies influence manpower requirement, often quite heavily. Human efficiencies are, in turn, a major, though not the sole determinant of departmental efficiencies. Manpower plan of department must recognise this aspect. Wherever departmental outputs and inputs are measurable and quantifiable, departmental efficiencies are also easy to measure. Human efficiencies however can only be measured with reference to a standard. Such standards can be established wherever human work is measurable. Where departmental operations are predominantly process controlled, human efficiencies are less likely to impact on the outputs and efficiencies of the department. Reverse is the case where operations are primarily human controlled. In the latter case, manpower is a direct function of human efficiency. Continuous efforts are doubtless necessary to improve and maintain efficiencies at high levels. Similarly, factors which influence departmental efficiencies need to be thoroughly analysed. Uncertainty in the availability and quality of key input resources, fluctuation in demand for outputs, conditions of process hardware, etc. are known to affect departmental efficiencies. Similarly, performance payment/reward schemes, creating stimulating work structures, etc. have been used as a means to raise the level of human contributions. Nonetheless, marked

changes in efficiencies will of necessity impinge on the outputs as well as requirements of manpower.

5. Work environment

It has been established that the nature of work environment has, at times, decisive influence on manpower needs. Firstly, there is the statutory legal requirements within which work has to be carried out. This decides the net available working hours during a given time period, after consideration of various categories of leave entitlement, shift cycle allowances, etc. Secondly, environmental conditions such as of noise, fumes, dust, temperature, humidity, smell, presence of naked flames, work at height/depth, work during regular hours, work at various places, etc. generate need for intermittent or continuous spells to be provided to the workmen. At times, the spells may even amount to 100 - 200% of the time actually spent on work. It is also necessary to provide for certain allowances such as fatigue/relaxation/personal effects, etc. to recuperate from the effects of work. Finally, creation of work structures which help provide a stimulating and motivating environment for work has a direct bearing on the effective utilisation of manpower and by consequence, its requirement.

6. Other Considerations

Certain provisioning of manpower may be required to take into consideration- work of contingent/seasonal nature. Persistent occurence of too many contingencies is however a clear symptom of ineffective work organization and should be curtailed. Certain amount of manpower such as contractual labour, casual labour is generated out of specific management policies. Such requirements however must be integrated with the overall manpower needs and should not be determined in isolation.

7. Methods of work measurement

When manpower is related to physical workload, work measurement provides a direct means to estimate manpower needs. Several methods are available for this purpose such as:

i) Time study

ii) Work sampling

iii) Analytical estimating

iv) Output analysis

All these methods aim at setting up certain standards or norms for performance of work. Using these, manpower needs for a given quantum of work can be estimated. The estimates can be further modified to take into account prevailing efficiency levels and other conditions. Time study is probably the most accurate of all these methods. It has however severe limitations. First it is particularly suitable for repetitive, short cycle work, comprising of highly defined set of task elements. Except for some assembly and machine shop work, industrial/office work is seldom as well defined or of as short cycle nature that could render it suitable for time study. Limitations of time study mainly arise because of i) variable nature of work, ii) generally long work cycles, iii) considerable intra and inter-departmental work-flow. Moreover, revising time standards and keeping them upto date with changing conditions of machinery, materials, energy sources, etc. has been a major problem even in the most highly organised manufacturing plants. Even the technical characteristics of the method are such that are not always easy to fulfill in practice. Finally union disputes over the accuracy of the standards have made the method quite difficult to apply in practice. Work sampling technique involves determination of time standard through random sampling of a given work situation. Its major advantage over time study is that it is much more flexible and can be designed to accomodate the variable nature of work, long work cycles and the pattern of work flow. Thus, it is proving to be much more convenient to apply in a variety of work situations, endowed with the above work characteristics. The limitations of the work sampling arise due to i) longer time to accomplish the study, ii) sensitivity to changes in work mix and procedures, iii) limitations on accuracy levels. Similarly, highly variable or seasonal work measurement is beyond the scope of work sampling technique. The method of analytical estimating

relies on the experience and mature judgement of manpower determination team. Often, it is possible to develop a suitable guide to aid analytical estimating of various activities. Being judgemental estimates, the accuracy of such estimates is always in question. However, the method has some major advantages like i) speed of measurement, ii) adaptive nature of technique, iii) suitability in complex and uncertain work situations involving long variable work cycles, intricate work flow, considerable fluctuations in workload, etc. Used in isolation, the major criticisms of the method are i) possibility of biases, ii) potential reduction in accuracy levels. The problems are to a large extent overcome by involving multiple teams for manpower assessment ensuring appropriate composition of such teams and output analysis. Coupled with output analysis, the method of estimation can provide quite accurate and quick results. In summary, it is important to note that not all work lends itself to accurate measurement by time study. Perhaps, only a limited fraction of the work is so amenable. The rest of the work needs to be estimated and in large complex plants/organizations, this is unavoidable on account of complex technologies, intermecine work flows, multitude of procedures, etc.

8. Framework for manpower assessment

Based on the discussions in the foregoing sections, we now elucidate a proposed framework for manpower assessment. The framework applies to manufacturing, service as well as administrative work systems.

a) Study the work organization and obtain details of the work structure down to the lowest level (i.e. department, section, etc.)
   - manpower related to outputs of technical/manufacturing processes,
   - manpower related to equipment/supervisory positions to be manned,
   - manpower related to the nature and volume of physical workload, arising out of manual operations, etc.
   - manpower related to the administrative systems and procedures, in existence

b) any other, arising out of policy considerations, contingencies, negotiated work practices,

- manpower related to two or more of the above constituents,

c) Develop suitable indicators of manpower, for each level of work structure.

d) Analyse and prepare details of the technological processes, their inputs and outputs, types of equipment in use, the positions to be manned, physical and other works activities/responsibilities, jobs and task assignments, prevailing distribution of manpower, methods and practices of work.

e) Determine the types of manpower allowances to be used, i.e. work relief allowances like spells, shift cycles, contingency and policy allowances, leave entitlement and miscellaneous work. This enables calculation of net available hours.

f) Use preferably combination method of analytical estimating with output analysis for work and manpower assessment in each component mentioned in (b). Wherever time study/work sampling can be readily used, the same should be adopted.

g) As far as possible, the assessment should be based on scientific rationale. It should take into account current/expected efficiency levels and be simple enough for ready applicability and ease of implementation.

h) In case of work for which indicators are difficult to establish, manpower norms may be based on an assessment of total workload of this type during a given period (say, a year). If even this is impractical, allowance may be made for unmeasured work.

i) While the estimates would lead to an overall assessment of manpower, the most appropriate manpower skill-mix should also depend upon considerations like job requirements, etc.

j) The manpower assessment should reflect the systems, procedures and practices in operation. Substantive changes in the same should involve reassessment of the manpower requirement.

Figure 1 shows the schematic diagram of the above framework.

9. Mathematical formulation

We now attempt a mathematical formulation of the manpower assessment problem. Consider a simple operating unit, as shown in fig. 2 below.

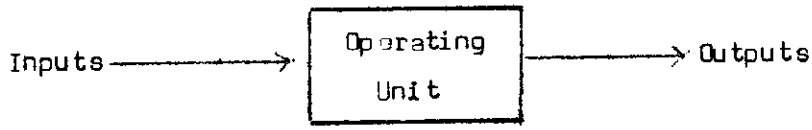


Fig. 2: A Simple Operating Unit

Let the operating unit have the following features in a given period:

N = Number of positions to be manned

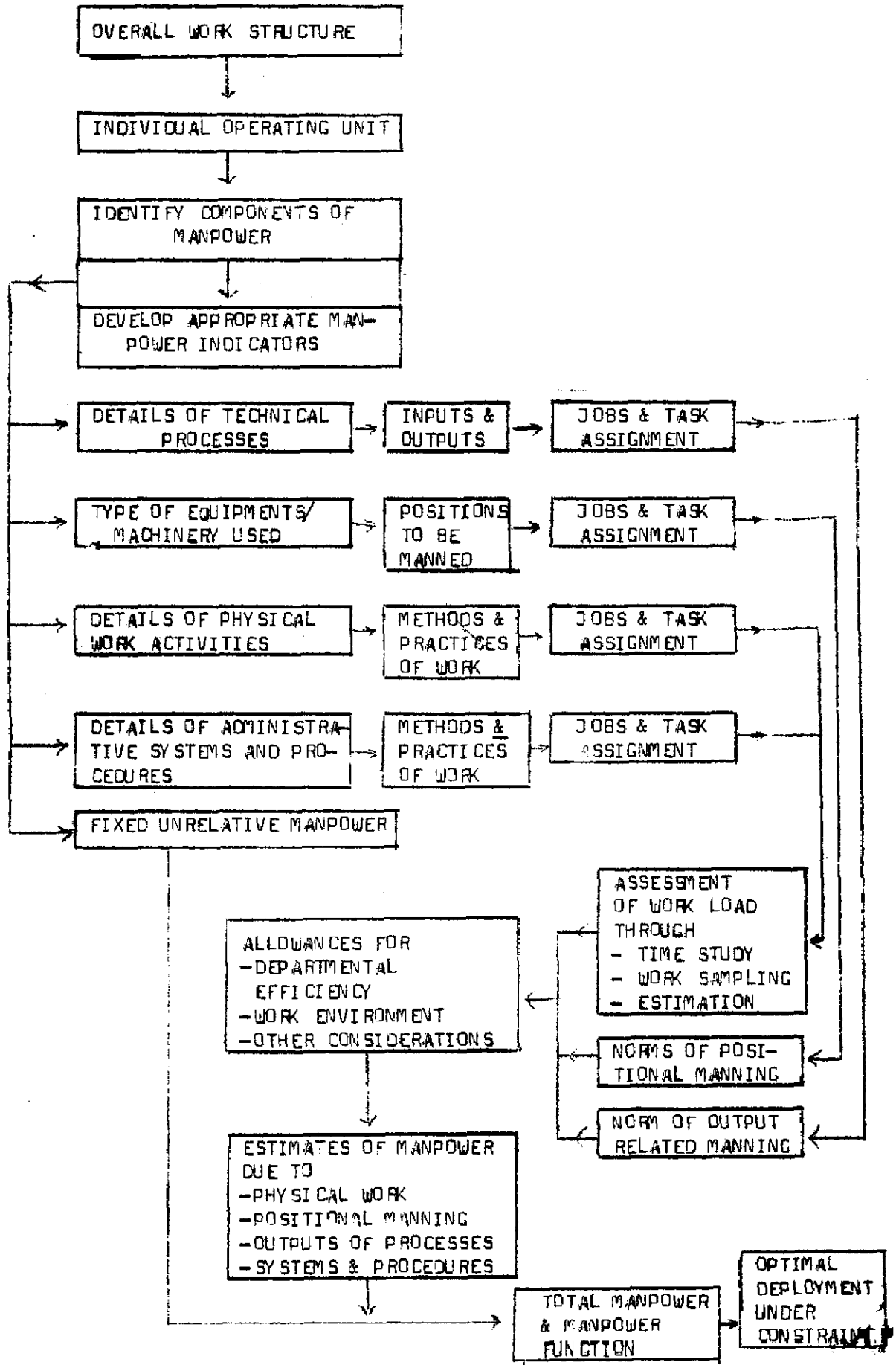
M = Volume/quantity of output

P = Amount of physical workload to be handled

Q = Amount of workload associated with administrative systems and procedures

R = Allowance for unmeasured work

Fig 1: Framework of Manpower Requirement Planning



For the operating unit under consideration, the manpower assessment problem can be defined as one that involves determination of the function.

$$X = f(N, M, P, Q, R)$$

Where X = total manpower required during the period under consideration. The true nature of this function is presently unknown and likely to vary with the nature of operating unit. It is however likely that the function is of concave nature representing a situation of diminishing returns to scale. It is not the aim of this study to explore this aspect in further detail. For the present exposition, we assume a linear function, as stated below:

$$X = L + L_1N + L_2M + L_3P + L_4Q + L_5R$$

The manpower assessment problem thus involves determination of the coefficients L, L_1, L_2, L_3, L_4, L_5. This allows determination of X, for given values of N, M, P, Q and R.

Nevertheless it is often possible and eminently desirable to aggregate the work and manpower for a given operating unit in terms of certain predetermined indicators, which best reflect the manpower need. For instance, in the traffic department of a state road transport corporation, it is possible to use the number of schedules operated by the Corporation as a key indicator of manpower requirement. In a branch of a land development bank, number of loan cases processed and number of recoveries effected are good indicators of manpower needs. When such indicators are available, the manpower assessment problem for the operating unit may be conveniently restated as follows:

Determine $X = F(y_1, y_2, \ldots\ldots, y_n)$

Where y_i is the ith element in a set of n indicators. Here again, the true nature of the function is unknown presently, although it is easy to see why it is likely to be generally concave. We however assume a linear function stated as follows:

$$X = K + K_1 y_1 + K_2 y_2 + K_n y_n = K + \sum_{i=1}^{n} K_i y_i$$

where y_1, y_2, y_n are the n indicators of manpower. The manpower assessment problem then involves determination of coefficients K_1, K_2, ..., K_n and the Constant K. It is noeworthy that determination of the manpower function also enables projection of manpower requirement for expected activity levels in the future. In this formulation, K represents a fixed requirement which does not vary with the levels of manpower indicators.

Now, in the simple case where no fraction of manpower is commonly shared amongst more than one operating unit , the total manpower required for the organization is determined as follows:

Let m = total number of operating units in the organization

X_j = manpower required in operating unit j.

X = total manpower required for the organization.

Then $X = \sum_{j=1}^{m} x_j$ $\quad i=1,2, \ldots\ldots,n$ $\quad j=1,2, \ldots\ldots,m$

$= \sum_{j=1}^{m} [k_j + \sum_{i=1}^{n} k_{ij} y_{ij}]$

A cost based formulation of the manpower assessment problem is also possible. For the sake of simplicity, we will assume average unit manpower cost for each operating unit.

Let C_j = average cost per unit of manpower in operating unit j

Then totalmanpower cost = $\sum_{j=1}^{m} C_j x_j$

Of course, it is possible to formulate the cost function more accurately by taking into account the average cost for each category in each operating unit.

Now because of the budgetary restrictions, resource constraints etc., suppose the amount that can be spent on manpower in a given period is restricted. Let this amount be **D**. If this does not allow full deployment of manpower as required, then there is a constraint. Let y_j be the manpower that can **actually** be deployed in unit j. Then the total cost of

deployment can be written as:

$$\sum_{j=1}^{m} C_j Y_j = D$$

Likewise we can also write:

$$Y_j \leq X_j \qquad j = 1, \ldots, m.$$

This means that actual deployment could be upto the required manpower. It is also important to note that every operating unit will need a minimum complement of manpower. For operating unit j, let this be equal to Z_j. We then have:

$$Z_j \leq Y_j \leq X_j. \qquad j = 1, \ldots, m$$

The manpower assessment problem can then be stated as:

$$\text{Min.} \quad \sum_{j=1}^{m} (X_j - Y_j)$$

$$\text{Subject to} \quad Z_j \leq Y_j \leq X_j \quad j = 1, \ldots, m$$

$$\sum C_j Y_j \leq D$$

The statement of the problem can ofcourse be modified to accomodate other constraints which might arise in a specific situation, from time to time. The problem can also be restated as follows:

$$\text{Min} \quad \sum_{j=1}^{m} \left[\left(\sum_{i=1}^{n} K_j + K_{ij} Y_{ij} \right) - Y_j \right]$$

$$\text{Subject to} \quad Z_j \leq Y_j \leq \left(\sum_{i=1}^{n} K_j \cdot K_{ij} Y_{ij} \right) + k_j$$

$$\sum_{j=1}^{m} C_j Y_j \leq D$$

All Y_i's are non-negative integers

10. CASE STUDIES

We shall illustrate the proposed framework with several Case Studies ranging from simple to the complex and drawn from diverse work situations. In the simplest case, manpower requirement calculations will be made for a specific work activity. In the most complex case, the application of the framework for the operation of a Power Generating Station will be broadly overviewed. It is important to note that the case studies amply

demonstrate the usefulness of the MRP framework for all types of work situations.

CASE STUDY 1

MANPOWER REQUIREMENT FOR RECOVERIES ACTIVITY IN THE BRANCH OFFICE OF A STATE LAND DEVELOPMENT BANK

This illustration is drawn from a Land Development Bank operating at the State level. Here, the aim is to determine for a specific work activity, manpower requirement in the branch office of the bank. The bank had two head offices, seventeen district offices and about 180 branch offices. The branch offices are geographically spread talukwise. The main purpose of the bank is to advance long term loans to farmers for land development purposes. The branch office of the bank can be appropriately regarded as its main operations unit. It is through this unit that the main activities of the bank, namely advancing loans and effecting recoveries of dues and overdues are carried out. The control over the branch offices is exercised by the corresponding district office. The staffing in the branches is presently such that results in an average of little over five persons per branch. The following are the main components of overall work in the branch office.

1. Processing Loans
2. Effecting recoveries
3. Shares, transfer, allotment, refund, dividends
4. Audit and Inspection
5. General accounts and Administration.

We shall illustrate the determination of manpower requirement for the recoveries component of work.

Table 1 gives time estimates developed for individual task elements involved in effecting recoveries.

Aggregation of much of the workload of recoveries is possible using member with a live account as an indicator. This is because, major

portion of the variable part of the workload can be broadly grouped under the following activities:

i) Computation and issue of demand notices,

ii) effecting recoveries in the branch office, itself, henceforth termed as Table recoveries,

iii) Effecting recoveries in the field, by personal contact, henceforth termed as field recoveries,

iv) Book keeping load in the office.

In each of the above cases workload aggregation is possible using recovery load for member with a live account as work aggregate indicator. The remaining direct work refers to certain cases of default. In this instance, a case processed can be selected as the work indicator. The rest of the workload is of fixed, indirect type and assessment of annual workload is made for this purpose. Using the work norms developed in Table 1, the following estimates shown in Table 2 were developed for assessment of work in recoveries component.

Table 2

Work Estimates in a Nutshell for Recoveries

Sr. No.	Work Indicator	Estimate
1.	Variable workload for Table recoveries	40 mins/member
2.	Variable workload for field recoveries	70 mins/member
3.	Cases processed under section 139/summary recoveries	30 mins/case
4.	Preparation of annual overdues statement	1 man hr/120
5.	Other fixed load	110 man hrs.

We shall now proceed to calculate the manpower requirement.

The net total available working hours per person per year, after making allowances for various leave entitlements, holidays, etc. and taking into account prevailing working time per day, amounted to 1400 hrs/year.

Now, manpower required for 'Recoveries' can be given as:

$$X = K + K_1Y_1 + K_2Y_2 + K_3Y_3 + K_4Y_4$$

where Y_1 = Members for table recoveries

Y_2 = Members contacted for field recoveries

Y_3 = Cases processed under section/39/summary recovery

Y_4 = Total number of members having live accounts

K = fixed workload $= \frac{110}{1400}$

K_1, K_2, K_3, K_4 are coefficients whose values are as follows:

$$K_1 = \frac{1}{2100}$$

$$K_2 = \frac{1}{1200}$$

$$K_3 = \frac{1}{2800}$$

$$K_4 = \frac{1}{16800}$$

Hence $$X = \frac{110}{1400} + \frac{Y_1}{2100} + \frac{Y_2}{1200} + \frac{Y_3}{2800} + \frac{Y_4}{16800}$$

$$= \frac{1}{16800}\left[1320 + 8Y_1 + 14Y_2 + 6Y_3 + Y_4\right]$$

To illustrate the formula, assume that in a branch office, the following data is available:

1. Number of Table recoveries/year = 500
2. Number of members contacted for field recoveries/year = 1000
3. Cases processed under sections 139/year = 50
4. Number of members with live accounts = 1500

Then

$$X = \frac{1}{16800}\left[1320 + 8\times500 + 14\times1000 + 6\times50 \div 1500 = \frac{21120}{10800}\right]$$

$$= 1.26$$

$$= \bullet$$

Thus the required manpower is a little over 1 person. Before deciding on the total manpower similar assessments will have to be made for all other work components and then accumulated.

Often, a quick estimate of manpower is required for purposes like short term deployment of manpower, budgeting, etc. For this purpose, we may use the members with live account as the sole manpower indicator.. Thus the manpower requirement will now be given as:

$$X = PY$$

where Y = number of members with live account

P = Coefficient indicating manpower/live account

In the present case a rought estimate of P is

$$P = \frac{21120}{16800\times1500} = 0.838 \times 10^{-3}$$

and $X = 0.838 \times 10^{-3} Y$

Table 1

Work Norms on Branch Operations of LDB Activity

Recoveries

Sr.No.	Details of Activity (in sequence)	Time(man mine)per unit of work	Unit of work measurement
1.	Preparation of demand register - kaccha register	5	entry in register
	- villagewise register	3	entry in register
2.	Demand notices issued (forms no.27,28,29)	6	notice issued (issued thrice)
3.	Effecting Table recoveries	15	Table recovery
4.	Effecting field recoveries with a group size of 2 persons	40	members contacted per day per village
5.	Posting to credit day book - register No.2	2	entries in register No.2
6.	Posting to day book - register No.4 (including copy sent to HO, Rajkot)	6	entries in register No.4
7.	Posting to general ledger - register No.5	2	entries in register
8.	Posting to register No.11 - Individual loan ledger	5	entry in register No.11 under old accounts
9.	Preparing daily MT returns to DO (printed form, without number)	2	MT returns sent
10.	Preparing weekly MT returns to HO and to DO	5	MT returns sent
11.	Preparing form No.768, relating to recoveries to be sent to HO & DO.	120	forms sent
12.	Preparing weekly post card of recoveries (printed without number) to HO and DO	60	Post cards sent
13.	Processing in the branch, cases under section 139	30	cases processed
14.	Preparation of monthly statement to SRO (Summary Recovery Officer) regarding cases to be treated under Section 139	60	Statements prepared
15.	Processing cases for summary recovery(follow up of rainspection)	30	cases processed
16.	Processing criminal cases (wherever & whenever required)	390	cases processed

Sr.No.	Details of Activity (in sequences)	Time (man mins) per unit of work	Unit of work measurement
17.	Issue of notices under Section 134 (SRO form No.5)	3	notices issued
18.	Posting to register No.17, in case of advance recoveries (including computation time)	10	entries posted
19.	Preparation of statement to SRO concerning certificate of surcharge issued	30	statements prepared
20.	Preparation of annual overdues statement (printed, without number)	500 mis/ 1000 accts.	Accounts.

CASE STUDY NO.2

MANPOWER ASSESSMENT FOR THE AUTO RECEIPT SECTION OF THE CENTRAL STORES OF A ROAD TRANSPORT CORPORATION (SRTC)

The previous study focussed on the work situation where work was primarily of administrative type, with certain amount of field work involved. The manpower requirement was calculated for a specific component of work, occuring within an operating unit namely, branch office of a Land Development Bank.

We now consider a more complex case which involves manpower assessment in a section of a department. The case selected for illustration is that of the receipts section of the central stores of a State level Road Transport Corporation (SRTC). The main feature of this example is that it involves manpower due to both administrative system and processing as well as due to physical workload.

The stores department of the SRTC is responsible for the following main activities:

i) Indenting, follow up, receipt, and inspection of stores materials
ii) Processing suppliers' bills for payment
iii) disposal of scrap and obsolete surplus items
iv) Storage and issue of revenue stores and capital items
v) Inventory control of central stores and divisions
vi) Codification, record keeping, stock taking, stores accounting and physical material handling.

The Department is headed by the Controller of Stores who is overall in charge of the department, and reports to Dy. General Manager (General) of the Corporation. The Corporation also has divisional stores located in respective divisions. For administrative purposes, the Central Stores is under the charge of Dy. Controller of Stores, reporting to Stores Controller.

The various activities of the Central Stores are organized into the following sections:

i) Auto receipts
ii) Auto issue
iii) General receipts
iv) Aluminium/mild steel section
v) Property
vi) Consumables
vii) Machinery and Tools
viii) Slow moving parts
ix) Inventory control
x) Provisioning
xi) Central Kardex
xii) Packing
xiii) Inspection

Many of the above sections are grouped under two categories of stores, i.e. i) General Stores, ii) Auto Stores. The General Stores covers the following sections: General receipts, aluminium/mild steel, property and consumables. The Auto Stores covers the following sections: Auto receipts, Auto issue, Packing, Machinery & Tools. Of interest is the Auto receipts section for which manpower calculations are to be made. The activities of this section can be detailed under two main categories: i) clerical/administrative type, ii) physical handling type.

The important clerical/administrative activities of the receipts section are as under:

i) Processing railway receipts, documents received through the banks,
ii) Processing carting agent's bills
iii) Preparation of receipt vouchers, clearance certificates, claims,
iv) Processing cases of write off, rejections, surplus materials from divisions, penalty for late supply of items,
v) Preparation of office notes and statements
vi) Correspondence, maintenance of files, posting and maintenance of registers, contacts with other sections.

The principal physical work handling activities in the Receipts section are as follows:

i) Unloading the consignments. Their segregation itemwise,

ii) Opening the consignment in the presence of security representative,

iii) Counting, against details in challan, in the presence of security representative,

iv) Arrangement of the material at appropriate location in the recovery yard.

In some cases, weighment of the truck loads at the weigh bridge is also involved. The workload pattern depends on two major factors: i) arrival pattern of the consignments, ii) size, type and weight of consignments. Irregular pattern of arrival of consignments implies a corresponding irregular pattern of physical workload, thus causing irregular fluctuations in the same. Similarly, the crewsize required depends upon the size, type and weight of consignments. These circumstances make it difficult to evolve accurate indicators for physical workload of receipts, on the basis of which workload could be aggregated. However, a broad indicator of this workload is the number of consignments received.

Table 3 gives the workload estimation for the administrative/clerical type of work in the Auto receipts section. The estimated annual workload due to administrative/clerical type work amounts to 15131.12 hours. The auto receipts section handles the various autoparts such as radiators, crankshafts, engines, cylinder heads, other assemblies, bearings, spare parts, etc.

The main physical handling activities are: i) unloading the wooden case from trucks, hand carts, etc., ii) opening the cases in presence of security representative, iii) Counting the items in cases, iv) Arranging the items in proper location.

Generally the consignments are quite heavy. Hence teams of helpers are required for handling them. The crew size may vary from 2 to 4,

depending upon the nature of items, size of cases and quantity received. For instance, in case of heavy parts such as radiators, crankshafts, engines, etc. crew size of 3 - 4 helpers is required. For other parts such as bearings, spare parts etc. crew of 2.3 helpers is necessary. Finally, for light cases of items like springs, nuts and bolts, etc. crew of 2 helpers is used. Normally, around 2400 receipts are to be handled in a year, giving an average of about 8 receipts/day. Approximately 15% of receipts are of heavy parts. Another 40-45% receipts are medium weight parts. The remaining receipts are light weights. Table 4 gives estimates of workload for physical handling of autopart receipts. The estimated annual workload due to physical handling in auto receipts section is equal to 10920 man hours.

The manpower requirement may now be assessed as follows:-

$$X = K + K_1 Y + K_2 Y$$

here X = Manpower required/yr.

K = Constant, reflecting fixed manpower (supervisory)

Y = Number of receipts handled/yr.

K_1 = Coefficient, showing clerical manpower/receipt

K_2 = Coefficient, showing material handled/receipt.

We let $K = 1$ i.e. section supervisor

From our assessment of the workload, K_1 and K_2 may be estimated as follows:

$$K_1 = \frac{15131.2}{2468 \times 2000} = 0.003065$$

and $$K_2 = \frac{10920}{2468 \times 2000} = 0.002212$$

This assumes the working time available per man per year in the stores section is 2000 hours, after allowances

$$X = 1 + 0.003065Y + 0.002212Y$$

Here clerical manpower = $0.003065Y$

material handlers = $0.002212Y$

Assuming that number of receipts handled/yr = 5000

Then clerical manpower = 0.003065Y = 15.325 = 16

material handlers = 0.002212Y = 11.06 = 11

and total manpower required will be X = 1 + 16 + 11 = 28

Table 3

Estimation of workload - Administrative type work

Auto Receipts Section - Central Stores (FRTC)

r.No.		Description of work indicator	Representative units of work-load/year	Estimates of man mins.units	Estimated annual wo load man hrs.
	a	Processing railway receipts	569	22.5	213.37
	b	Processing challans (including receipting time)	0.1 x 2468 0.25x 2468 0.25x2468 0.4 x 2468	30.0 60.0 105.0 240.0	123.40 617.00 1079.75 3948.78
	c	Processing carting agents' bills (including statement in annex c)	0.75 x 569 0.25 x 569	30.0 45.0	213.37 106.69
	d	Processing suppliers' bills (including entries in RC register)	1209	30.0	605.00
	e	Processing receipts vouchers	4000	30.0	2000.00
	f	Processing rejection letters	0.125x2468	15.0	77.12
	g	Processing clearance certificate	229	60.0	229.0
	h	Processing claims	62	40.0	41.33
	i	Processing import receipts	25	480.0	200.00
2.	a	Workload due to entries in RC Register (including scrutiny)	2468	10.0	411.33
	b	Preparation of notes in annex H and revised annex H	2468	30.0	1234.0
	c	Preparation of statements in Annex D	0.25 x 569	30.0	71.12
	d	Preparation of statements in Annex K	300	15.0	75.0
	e	Preparation of statement in Annex L	300	15.0	75.0
	f	Preparation of statements in Annex M	100	15.0	25.0
	g	Correspondance - Normal - Import receipts	8250 125 x 0.25 125 x 0.5 125 x 0.25	12.5 30.0 60.0 120.0	1718.0 15.62 62.5 62.5
	h	Filing	1800	30.0	900.0
	i	Contacts	4500	10.0	750.0
	j	Preparation of office notes (annex. B)	551	30.0	275.5(

Table 4

Estimates of Workload - Physical handling

Auto Receipts Section

Type of receipts	Receipts that can be handled per day	Crew Size
Heavy	av. 2	3 - 4
Medium	av. 4	2 - 3
Light	av. 6	2

The average daily workload involved in handling receipts is estimated as follows:

Approx. workload for heavy receipts/day = 0.15x8x3.5x3.5 = 13.72 man hrs

Approx. workload for medium " " = 0.425x8x1.75x2.5 =14.88 man hrs.

Approx. workload for light " " = 0.435x8x1.12x2 =7.80 man hrs.

Total approx. workload/day = 36.40 man hrs.

" " workload/yr. = 36.40 x 300 = 10920 man hrs.

13. CASE STUDY NO.3

MANPOWER REQUIREMENTS AT THE ORE HANDLING PLANT OF THE BLAST FURNACE DEPARTMENT OF AN INTEGRATED STEEL MILL:

In this study we consider the problem of determining manpower requirements at the ore handling plant of the blast furnace department of an integrated steel mill. The main feature of the manpower situation is that it is characterised by the existence of substancial amount of positional manpower. We shall first briefly describe the overall operations, before considering the specific manpower problem.

13.1 Overall process flow chart.

The overall flow chart for the steel making process at the plant studied is given in Figure 3. As seen in the chart, iron ore, coal and limestone are the three major raw materials used. Coal is converted into coke through further processing in coal handling plant, coke oven batteries and coke handling plant. Iron ore passes through an ore handling plant. Coke, limestone and iron ore are fed to the blast furnaces which produce the molten pig iron. The latter passes through the bessemer converters and then fed into open hearth furnaces which produce steel of the right composition. This is cast into ingots which after being soaked in soaking pits are fed to the blooming mill. The blooms are then rolled into heavy structurals and sheets, billets and bars in two separate rolling mills. Part of the billets are further rolled into bars, rods and other merchant products in a merchant mill; part of them are rolled into medium and light structurals in a medium and light structural mill. The rest are sold. The sheet bars pass through a sheet mill which produces plain, galvanised and corrigated sheets.

13.2 Processes in the blast furnace department

The basic function of a blast furnace is to make molten iron from iron ore(chemical formula Fe_2O_3 called Haematite) Carbon in the form of coke is used both as fuel and chemical agent. The basic reaction is:

$$Fe_2O_3 + C \longrightarrow Fe + CO$$

This reaction occures in a complex manner. Naturally occuring iron ore is contaminated with silica (SiO_2) and Alumina (Al_2O_3) called gangue. These are highly melting compounds not easily reduced in blast furnace. Hence limestone and dolomite fluxes are added to blast furnace- Fluxes and gangue react to form a low melting fluid compound called slag. Slag is lighter than iron and is removed by gravitational method. Coke is burnt with air to form carbon dioxide and carbon monoxide. These along with nitrogen (from air) escape from blast furnace top as blast furnace gas. The inputs to blast furnace are : iron ore, coke, limestone, dolomite, manganese ore, and air. The blast furnace outputs are: molten iron (hot metal), slag, blast furnace gas and flue dust. The steel mill presently has 4 blast furnaces. Of these two have a capacity of 1200 tonnes/day.

The department comprises of the following sections:

i) Raw material handling section - (ore handling plant)
ii) Stock house
iii) Furnaces (proper)
iv) Stoves
v) Gas cleaning plant
vi) Pig casting machine
vii) Slag bank
viii) Ladle house
ix) Refractory
x) Surkhi mill
xi) Traffic

Of interest to the present illustration is the Raw material handling section, i.e. Ore handling plant.

13.3 Ore handling plant

The main function of this section is to handle iron ore, limestone, dolomite and manganese ore and part of the coke. Bulk of the coke is fed directly by conveyor belts from coke ovens. The ore handling plant maintains uniterrupted supply of raw materials to the blast furnace. Iron ore

and limestone are generally received in BOBS/KO wagons. These are unloaded in 9 transit bunkers, seven for iron ore and two for limestone. Lime stone is directly conveyed to high line bunkers. Iron ore delivery system may follow one of the following four cycles:

i) Transit bunker to high line

ii) Transit bunker to reclamation pile

iii) Reclamation pile to high line

iv) Material to be conveyed by combination of (i) and (ii) mentioned above.

Other raw materials are unloaded on ground and as per requirement, these are loaded back in internal KO wagons and then transferred and unloaded in the bunkers of blast furnace high lines. In case these are received in hopper type wagons, they are directly taken to high line for unloading into bunkers. Table 5 gives details of the equipment and their capacities in the raw material section.

Table 5

Equipments used in the Ore handling plant

Sl.No.	Activity	Equipment used	Nos.	Age	Capacity	Capacity utilisation
1.	Supply of raw materials to Blast furnace 1) Iron ore 2) Limestone 3) Dolomite 4) Manganese Ore 5) Coke	1) Transit bunkers	9		500T	
		2) Apron feeders	18		200T/Hr	75%
		3) Belts	12	24 yrs.	800T/Hr	
		4) Reclaiming bunker	1		90000T	
		5) Apron feecers	12		200T/Hr.	

Figure 4 gives the flow diagram in the ore handling plant. The detailed sequence of activities in the ore handling plant is given below:

13.9 Detailed sequence of activities in the ore handling plant

i) To contact yard master of nearby railway station . Arrange to get wagons from yard to high lines for unloading them in appropriate bunkers i.e, unload into the bunkers on high line and transit bunkers.

ii) Reclaim iron ore from stock in case transit bunkers are empty and supply to high lines.

iii) Position the shuttle over the correct bunker and fill the bunker by operating the shuttle one by one.

iv) Operate the sequence selector depending upon material to be conveyed.

a) from transit bunkers to high line bunkers
b) from transit bunkers to reclaimer bunkers
c) from reclaimer bunker to high line bunker
d) Combination of (a) and (b) mentioned above

v) Start appropriate belts by operating push button controls

vi) Keep a watch over the running belt for any lumpy ore. If such ore is found, signal for stopping the belt

vii) Poke chutes to clear jams

viii) Clean high line and transit bunkers

The ore handling plant handles on an average, the following quantum of ore per month:

Iron ore - 100 000 T/month
Lime stone- 26 600 T/month
Dolomite - 7 000 T/month
Manganese Ore - 3 200 T/month
Coke - 4 800 T/month

*Table 6 gives details of the jobs and their primary functions in the Ore handling plant. It will be observed that excepting the job of raw material foreman all the remaining jobs are shift jobs. The plant itself has continuous three shift operations. Furthermore, most of the manpower required is due to positional manning and therefore determined by the positions to be manned rather than by outputs or physical workload.

Table 7 gives the calculations for the manpower requirement. The total manpower required, inclusive of shift cycle allowances, is worked out to be 103. Thus, once the positions to be manned are known, fairly accurate assessment of manpower is possible. However, requirement of labour gang khalasi depends upon the tonnage handled . For a quick projection, we may wish to relate the manpower to the positions to be manned and the tonnage handled. We can then write:

$$X = K + K_1 P + K_2 M$$

Here we let K = supervisory positions = 8

and K_1 = Coefficient, denoting average manpower/position

K_2 = " , denoting average manpower/tonne

P = Number of positions

X = Manpower required

M = Tonnage handled per month

the total number of positions P = 9

Tonnage handled/month M = (100000 + 26600 + 7000 + 3200 + 4800)

= 141600 T

$$K_1 = \frac{67}{9} = 7.445$$

$$K_2 = \frac{28}{141600} = 1.977 \times 10^{-4}$$

$$X = 8 + 7.445 P + 1.977 \times 10^{-4} M$$

Table 7

Determination of Manpower for Ore Handling Plant

Sr.No.	Designation	Estimate of manpower					
		Shifts	G.shift	Spell	Total duty posts	Shift Cy.etc.	Total
1.	Raw material foreman S - 4	-	1	-	1	-	1
2.	Shift raw material foreman S-4 x 5	1x3=3	-	-	3	-	3
3.	Asst. Raw material foreman S-3 x 4	1x3=3	-	-	3	1	4
4.	Shuttle Belt Attendant S-2						
	a) Reclaimer Bunker	2x3=6	-	-	6	1	7
	b) High Line Bunker	2x3=6	-	-	6	1	7
5.	Belt Attendant B-7 +						
	a) Junction Tower	2x3=6	-	-	6	1	7
	b) Transit Bunker	2x3=6	-	-	6	1	7
	c) Reclaimer Bunker	1x3=3	-	-	3	1	4
6.	Belt Khalasi * B-4x5	9x3=27 1x3=3	-	-	30	5	35
7.	Labour Gang khalasi x B-2						
	a) Transit bunker	4x3=12	-	-	12	2	14
	b) High line bunker	4x3=12	-	-	12	2	14
		87	1	-	88	15	103

+ Generally 2 positions/belt are to be manned except reclaimer bunker

* Belt Khalasi operates mainly as belt attendant's helpers and a team of 1 attendant & 1 khalasi is required. For the remaining work, 1 khalasi/ shift is required.

x Gang jobs and a gang of 4 khalasis is required for the unloading operation

Sr.No.	Designation	Grade	Shift	Primary functions	Working Conditions
1.	Raw Material Foreman	S 5	G	To maintain adequate supply of raw- material to the blast furnaces.	Occassional outdoor, all weather condition, dusty atmosphere, crosses railway tracks occasionally.
2.	Shift Raw Material Foreman	S- 4 &5	A,B,C,		"
3.	Asst.Raw Material Foreman (Transit Bunker)	S- 3&4	A,B,C	To ensure timely unloading of rawmaterial into transit bunkers and to supply to BF high lines as per requirement.	"
4.	Asst. Raw Material Foreman (High Lines)	S- 3 &4	A,B,C,	To ensure that all lines of blast furnaces are full with appropriate raw materials.	
5.	Shuttle belt attendant (High line Bunker, Reclaimer bunker)	S-2	A,B,C,	To operate shuttle belts to unload iron ore and lime stone either in bins or high lines or on reclaimer bunkers.	Very dusty
6.	Belt Attendant (Junction Tower Transit bunker, Reclaimer bunker)	B-7	A,B,C	To operate the belts and feeders under his charge according to the raw material position in transit bunkers.	"
7.	Belt Khalasi	B-4&5	A,B,C	To attend to chutes and belts	Dusty all weather condition.
8.	Labour Gang Khalasi (Transit bunkers & High line bunkers	B-2	A,B,C	To unload raw material wagons into the respective bunkers and to carry out general cleaning jobs.	"

Table 6. Details of jobs and their primary functions

14. CASE STUDY NO.4
DETERMINING MANPOWER REQUIREMENTS IN THE 'WARD' DEPARTMENT OF A MEDICAL HOSPITAL

In this study we illustrate the application of the framework for Manpower Requirement Planning (MRP) for the case of a medical hospital. For illustrative purposes, only the 'WARD' department of the hospital will be considered. The main feature of this case is the application of the methodology for the case of a purely service facility.

The medical hospital studied comprises of the following departments:

1. Laboratory
2. Wards
3. Sanitation
4. X-ray and physiotherapy
5. Pharmacy
6. Kitchen
7. Vehicle Section
8. Cardiology, ENT, Eye, Dental, Operation theatre and Miscellaneous
9. Malaria Control
10. Family Welfare and Public Health
11. Stores

The present study pertains to the 'Ward' department of the hospital. The principal activities of the wards are summarised as under:

1. Patients are admitted to the wards for indoor treatment
2. Each Ward maintains -

   i) Admission and discharge register giving details such as name, address, department, age, sex, time of admission/ discharge from the ward, disease, etc.

ii) Direction book for nursing staff giving details such as bed number, patients' name, medicine, details, treatment details, time of administration of dosages and their quantity, diet, etc.

iii) Records of pathological and other test reports

iv) Case sheet for each patient

v) Temperature chart

vi) Indenting and maintaining inventory of medicine, linen, hardware and other articles. There are in all 16 wards and the details about the beds in each are provided in Table 8A.

The job title currently prevailing in the ward department are the following:

1. Sr. Nursing Sister
2. Home Sister
3. Staff Nurse
4. Sr. Nurse
5. Sr. Nursing Assistant (Male)
6. Nursing Assistant (Male)
7. Junior Nurse
8. Sr. Ward Master
9. Hospital Attendant (Male)
10. Hospital Attendant (Female)
11. Auxiliary Nurse cum Midwife

Table 8 gives the main functions of each of the above job titles.

The manpower requirement depends upon i) type and number of wards ii) number of beds in the wards. Table 9 gives the detailed calculation for the manpower requirements of the staff in the wards. The total assessed manpower for the ward department is 239.

For quick projection of manpower requirement, it is possible to relate the bulk of the manpower to the number of beds provided in the various wards. Only the Home Sister and Sr. Nursing requirement depends upon the number of wards (in a way positional requirement).

Thus we may write

$X = K + K_1 B$

Where K = Constant = Number of wards (& other units)
= 19 (including leave reserves)

K_1 = Coefficient, denoting required manpower per bed

B = Number of beds in various wards

K_1 can be determined as follows:

$$K_1 = \frac{239 - 19}{493} = 0.446$$

$X = 19 + 0.446\ B$

Knowing the number of units and the beds in the various wards of the department, it is possible to obtain a quick estimate of the total manpower in the department. For instance, if the number of wards goes upto 25 and the bed strength goes upto 800, our estimate of total manpower required will be as follows:

$K = 25 + 0.1 \times 25 = 28$

$X = 28 + 0.446 \times 800 = 385$

In this illustration, the number of beds was identified as the main indication of manpower requirement.

Table 8A

Number of beds in the Wards - Medical Hospital Study

Sr.No.	Ward	General Ward	Side Room	Cabin	Misc.	Total
1.	Male Medical Ward I	36	4	2	-	42
2.	Male Medical Ward II	27	-	-	-	27
3.	Male Surgical Ward I	34	3	2	10*	49
4.	Male Surgical Ward II	46	-	-	-	46
5.	Intensive Care Unit	6	-	-	-	6
6.	Female Surgical Ward	52	2	-	6**	60
7.	Female Medical Ward	28	2	2	-	32
8.	Children Ward	26	-	-	-	26
9.	Maternity & Gynaec. Ward	35	3	3	11+	52
10.	Antenatal Labour Room	7	-	-	-	7
11.	Infectious diseases Ward	70	-	-	-	70
12.	New Medical Ward III & IV	34	-	-	-	34
13.	New Surgical Ward III & IV	32	-	-	-	32
14.	Nursing Home	-	-	5	-	5
15.	Casuality	3	-	-	-	3
16.	New Outdoor - traumatology unit	2	-	-	-	2
17.	Total	438	14	14	27	493

* Burn room and Traumatology Unit

** Burn ward - 4, Nurse's sick room - 2

\+ Sceptic room - 4, Eclamptis room - 2, Post Operative room - 5

The average occupancy is around 500.

Table 8

Primary Functions of Ward Staff

Sr.No.	Job	Functions	Remarks
1.	Sr. Nursing Sister	To admit and discharge patients from ward, to ensure proper ward administration and cleanliness, to coordinate work of nursing staff in shifts, to carry out doctor's instructions, to give prescribed medicines to patients in time and report any thing abnormal, to accompany medical staff and matron on rounds, to ensure proper diet for patients, to keep custody of linen, medicines, & other material, to raise indents as and when required, to prepare patients for operation, diagnostic examination, to administer injections as and when necessary and to coordinate with all concerned agencies for proper patient care.	Works in general shift. Indoor working.
2.	Staff Nurse	To take care of patients, bathing patients whenever necessary, bed making, feeding and other comforts of patients, to administer medicines/ injections to patients as per instructions, to take temperature, pulse, respiration etc. and recording, to follow technical procedures, pre and post operative care of patients, to assist doctors as and when necessary to ensure cleanliness of wards, timely writing of patients report, to fill lab requisition forms, send specimen after correct labelling and receive report, to assist Sr. Nursing Sister in her work.	Generally deployed in shifts. Indoo working.
3.	Senior Nurse	Same as for Staff Nurse	deployed in shifts. Indoo working
4.	Senior Nursing Asst.	-- do --	Mai, nursing staff deploye in shifts. In door working

Sr.No.	Job	Functions	Remarks
5.	Junior Nurse	Same as for Staff Nurse	deployed in shifts. Indoor working
6.	Nursing Asstt.	-- do --	Male nursing staff deployed in shifts. Indoor Working
7.	Sr. Ward Master	To supervise cleanliness of hospital premises, compound and sorroundings including wards, offices and various departments of the hospital; to submit daily bed statement admission reports and reports of the condition of patients; to maintain case records admission and discharge register, discharge boards, guiding patients to the respective places, conveying proper instructions and documents, etc. to discharged patients, to receive and issue hospital sanitary stores, etc.	
8.	Ward Master	To assist Sr. Ward Master in all his work	
9.	Auxiliary Nurse cum Midwife	To assist staff nurses in the labour room in all their work	deployed in shifts.
10.	Hospital Attendant (Male)	To assist the nursing work and patients care; to transport patients and holding of stretchers to carry patients or to carry on wheel chairs and wheel trolleys, to help nurses in the upkeep of the ward, cleaning ward furniture, doors, windows, to help in distribution of food, drinking water to patients, cleaning of plates, to give bed pans, urinals, spittoons etc. to patients; whenever necessary, to carry messages, call books, registers, requisition slips, to carry supply of medicines from OPD stores, etc, and other similar works.	deployed in shifts.
11.	Hospital attendant (female)	Same as above, except that stretchers are not carried by the Hospital attendants (female)	deployed in shifts.
12.	Home Sister	In charge of the Nurses' Hostel	

Table 9

Calculation of Manpower Requirement for Ward Department

Sr. Nursing Sister : The assessed requirements are: 1 each in - i) Medical Ward I, ii) Medical Ward II, iii) Male Surgical Ward I, iv) Male Surgical Ward II, v) Female Surgical, vi) Female Medical, vii) Children Ward, viii) Nursing Home, ix) Infectious diseases ward, x) New Medical and New Surgical Ward, xi) Burn Unit & Traumatology Unit, xii) Labour Room, xiii) Maternity & Gynaecology xiv) Intensive Care Unit, xv) Casuality, xvi) Night duty sister, xviii) 2 sisters to provide leave reserve. The total number required = 18

Home Sister : 1 Sister is required to be in charge of Nurses' Hostel

Nursing Staff (includes Staff Nurse, Sr. Nurse, Sr. Nursing Assistant(Male), Nursing Asstt. (Male, Junior Nurse) The calculations are shown below:

.No.	Ward	No. of beds	Shift requirement	General shift	Total
1.	Male Medical Ward I	42	2x3=6	1	7
2.	Male Medical Ward II	27	1x3=3	1	4
3.	Male Surgical Ward I	49	2x3=6	1	7
4.	Male Surgical Ward II	46	2x3=6	-	6
5.	Female Surgical Ward	60	3x3=9	1	10
6.	Children's Ward	26	2x3=6	-	6
7.	Nursing Home	5	1x3=3	-	3
8.	Infectious diseases Ward	70	3x3=9	-	9
9.	New. Med. & Surgical Ward	66	2x3=6	1	7
0.	Burn unit & Traumatology	2	1x3=3	-	3
11.	Maternity & Gynaecology	52	3x3=9	1	10
12.	Female medical ward	32	2x2=4	1	5
13.	Labour Room	7	1x3=3	1	4
14.	Casuality	3	1x3=3	1	4
15.	Intensive Care Unit	6	1x3=3	1	4
		81	81	10	91
16.	Leave reserve		81x0.25=20	10x0.1=1	21
17.	TOTAL		101	11	112

4. Sr. Ward Master : 1 Sr. Ward Master is required.

5. Ward Master : 1 Ward Master is required

6. Hospital attendant (Male) : The assessment is shown below

Sr.No.	Ward	No. of beds	Shift requirements	General shift	Total
1.	Male Medical Ward I	42	1x3 = 3	1	4
2.	Male Medical Ward II	27	1x3 = 3	1	4
3.	New Medical & Surgical Wards	66	2x3 = 6	-	6
4.	Male Surgical Ward I	49	1x3 = 3	1	4
5.	Male Surgical Ward II	46	1x3 = 3	1	4
6.	Casuality	3	2x3 = 6	-	6
7.	Nursing Home	5	1x3 = 3	-	3
8.	Intensive Care Unit	6	1x3 = 3	1	4
9.	Infectious diseases Ward	70	1x3 = 3	1	4
10.	Female Medical Ward	32	-	1	1
11.	Female Surgical Ward	60	-	2	2
12.	Maternity & Gynaecology	52	-	1	1
13.	Traumatology	2	-	1	1

Allowing for 25% L.R. on shift and 10% L.R. on General Shift, required manpower = 33 x 1.25 + 11 x 1.1 = 41 + 12 = 53

Hospital Attendant (female) : The assessment is shown below

Sr.No.	Ward	Beds	Shift requirement	General Shift	Total
1.	Maternity Ward	52 (including Gynac.)	2x3 = 6	-	6
2.	Labour Room	7	1x3 = 3	-	3
3.	Gynaecology	-(considered	2x3 = 6	-	6
4.	Infectious diseases	70	1x3 = 3	-	3
5.	Female medical	32	1x3 = 3	1	4
6.	Female surgical	60	2x3 = 6	-	6
7.	Children's Ward	26	1x3 = 3	-	3
		177	30	1	31
8.	Leave reserve		8	-	8
	Total		38	1	39

Auxiliary Nurse Cum Midwife : The required manpower = 4 (1x3 + 1) = 16

The total manpower required = 18 + 1 + 112 + 53 + 39 + 16 = 239

15. CASE STUDY NO:5

DETERMINING MANPOWER REQUIREMENTS FOR THE FINANCE & ACCOUNTS DEPARTMENT OF A CHEMICAL PLANTS COMPLEX

This company since its inception in 1971, has experienced rapid growth and continues to actively persue its expansion plans. At its manufacturing complex in an Industrial Estate, the company has been manufacturing for some time now sodium nitrite, sodium nitrate, nitric acid, a rubber blowing compound called DNPT. A plant to produce explosive grade ammonium nitrate was recently commissioned, and work was progressing in the plant to manufacture concentrated nitric acid. Another plant to manufacture formal dehyde mainly for captive consumption was also commissioned. In addition, plans were afoot to put up plants for the manufacture of hexamin (also for captive consumption) and explosives. The Company has also promoted another concern for manufacture of anhydrous liquid ammonia. This was the first collaborative venture of the company. Further collaborations were on the anvil for the second phase expansion of ammonium nitrate plant, the manufacture of explosives and for the manufacture of concentrated nitric acid. The company's sales turnover at the time of the study had crossed Rs. 6 crores.

At the time the study was undertaken, the company was organized into several departments, namely,: Process, Maintenance, Research and Development (including Quality Control), Materials, Finance & Accounts, Personnel and General Administration, Internal Audit, and Marketing. Each of these departments excepting internal audit was headed by a senior executive. The present study pertains to the finance and accounts department of the company. The major aim of the study was to determine the clerical manpower requirements for the department.

The following components of departmental work were identified for assessing the manpower requirement:

a) bills passing

b) writing journals/registers/ledgers

c) other indirect work activities

Corresponding to the above components of work, it was possible to evolve appropriate indicators of work. These are summarised below:

15.1 Bills Passing The work load in bills passing could be aggregated using the following indicators:
i) Suppliers' bills, ii) Medical bills, iii) Contractors' bills, iv) TA/DA bills, v) LTC bills, vi) Cash vouchers and daily cheque payment, vii) DEL payment, viii) Public Utility bills, ix) Salary bills.

15.2 Writing Journal/registers/ledgers: The work load is assessed on the basis of entries made in records stated below:
i) Purchase journal, ii) Expenses journal, iii) Creditors' ledger, iv) Raw materials ledger, v) Sales journal, vi) Debtors' ledger, vii) Fixed assets register, viii) Bank book, ix) Cash book, x) Bombay petty cash book, xi) Provident Fund, xii) Stores Ledger, xiii) Stamped receipts, xiv) 'C' forms register and reminders, xv) Consignment sales (Agents) ledger, xvi) Branch Stock transfer, xvii) Preferred customers ledger, xviii) Main journal, xix) General ledger, xx) Debit note register, xxi) Credit note register, xxii) Plant register.

15.3 Other Indirect Work Activities: The major indirect work activities were as under:

i) Payment of Sales Tax to Government once a month, ii) Income Tax (IT) working under Section 80-j, iii) IT returns of the company, iv) Insurance work, v) Liaison with banks, vi) dealing with Government and sister concern, vii) finalisation of accounts, viii) fixed deposits work, ix) Outstation visits for cash withdrawals, etc. x) Other miscellaneous work.

Output analysis coupled with departmental time estimates for various components of work were used to establish work norms for the department. The norms so developed under current efficiency levels and prevailing systems and procedures are summarised in Table 10.

For determining manpower workload function, the following procedure is adopted:

a) In case of bills passing, all the bills are converted into equivalent purchase bills, using work content as a basis. The work norm is then developed for equivalent purchase bills.

b) In case of writing journals/ledgers/registers, the work load is accumulated and the work norm is developed on the basis of entries in journal/ ledger/register.

c) For the rest of the work load, based on the annual assessment of the same, required manpower is specified. Conversion ratios, for converting the various types of bills into equivalent purchase bills are provided in Table 11.

The assessment of aggregate work norm for writing ledgers/journals/ registers was made by estimating the total workload of this type and the total number of entries/year.

The resulting norm is:

Number of entries/man/year = 10000

15.4 Application of manpower norms

An example is provided to illustrate the application of norms for Finance & Accounts department:

No. of purchase bills/year	: 5000
Medical bills	: 1750
Contractors' bills	: 250
TA/DA bills	: 75
LTC bills	: 200
Cash vouchers and daily cheque payments	: 7300
DEL Payment	: 600
Payment to Public Utility	: 1200
Salary bills	: 5400

Number of entries in various journals/ledger/register per year are as follows:

Purchase journal, expense journal	: 5000 entries
Creditors' ledger	: 650 accounts
RM Ledger	: 2500 entries
Preferred customers' ledger	: 75 (no. of customers)
Main Journal	: 3000 entries
General ledger	: 300 accounts
Debit Note register	: 200 entries
Credit Note register	: 50 entries
Plant register	: 2500 entries
Sales Journal	: 5000 (no. of invoices)
Debtors' Ledger	: 1000 no. of accounts
Fixed assets register	: 300 entries
Bank book	:10000 entries
Cash Book	: 5500 entries
Bombay Petty cash book	: 2500 entries
Provident fund	: 450 accounts
Stores Ledger	: 6000 entries
Stamped receipts	: 5000 entries
Number of 'C' forms & reminders	:11000 entries
Consignment sales	: 8000(invoices)
Branch Stock transfer	: 75 (transfer)

Table 12 gives the equivalent purchase bills passed per year. Table 13 gives the estimates of manpower requirement. The total clerical manpower was assessed to be 14.

The manpower workload relationship can be developed as follows:

$$X = K + K_1 Y_1 + K_2 Y_2$$

Where K = Constant = fixed manpower requirement

$$= \frac{4500}{217 \times 7} = 2.962$$

K_1 = coefficient, denoting manpower required per unit equivalent purchase bill

K_2 = Coefficient, denoting manpower

Y_1 = Number of equivalent purchase bills processed per year

Y_2 = Number of entries in Journals/registers/ledgers per year (in multiples of 10000)

We know that $K_2 = 1$

$$K_1 = \frac{30}{60 \times 217 \times 7} = \frac{1}{3038} = 0.000329$$

$$= 3.29 \times 10^{-4}$$

$$X = 2.962 + 3.29 \times 10^{-4} Y_1 + Y_2$$

Thus, knowing the equivalent purchase bills to be processed and the number of entries to be made in the journals/register/ ledgers, the total clerical manpower required is readily determined.

Table 10

Work norms for various activities in the Finance & Accounts Department

Sr.No.	Compartment of Work	Work Indocator	Work norm(rounded off) (man mins/unit)
1.	Bills passing	Purchase bills	30/bill
		Medical bills	12/bill
		Contractors' bills	170/bill
		TA/DA bills	30/bill
		LTC bills	30/bill
		Cash Voucher and daily cheque payment	4/payment
		DEL payment	8/employee
		Public Utility bills	12/bill
		Salary bills	12/employee
2.	Writing Journals/ Registers/Ledgers	Purchase Journal ‖ Expense Journal ‖	8/entry
		Creditors' Ledger	50/account
		RM ledger	6/entry
		Sales Journal	6/invoice
		Debtors' Ledger	50/account
		Fixed assets Register	4/entry
		Bank Book	8/entry
		Cash Book	6/entry
		Bombay Petty Cash Book	8/entry
		Provident Fund	120/account/year
		Stores ledger	15/entry
		Stamped receipts	11/receipt
		'C' forms register & reminder	5/form
		Consignment Sales	3/invoice
		Branch Stock Register	40/transfer

Sr. No.	Component of Work	Word Indicator	Work norm (rounded off) (man mins/unit)
		Preferred Customers Ledger	240/customer/year
		Main Journal	5/entry
		General Ledger	8/entry
		Debit Note register	6/entry
		Credit note register	6/entry
		Plant register	4/entry
3.	Other indirect activities	-	4500 man hrs./year

Table 11

Conversion ratios for various types of bills

Sr.No.	Type of bills	Conversion ratio (rounded off)
1.	Purchase bill	1.0
2.	Medical bill	0.4
3.	Contractors' bill	6.0
4.	TA/DA bill	1.0
5.	LTC bill	1.0
6.	Cash voucher & daily cheque payment	0.15
7.	DEL Payment	0.3
8.	Salary bill	0.4
9.	Public Utility bill	0.4

Time/equivalent purchase bill = 30 man mins/bill

Table 12

Equivalent purchase bills passed

Sr.No.	Type of bill	Conversion Ratio	Equivalent purchase Bills
1.	Purchase bill	1.0	5000 x 1 = 5000
2.	Medical bill	0.4	1750 x 0.4 = 700
3.	Contractors' bill	6.0	250 x 6 = 1500
4.	TA/DA bill	1.0	75 x 1 = 75
5.	LTC bill	1.0	200 x 1 = 200
6.	Cash voucher & daily cheque payment	0.15	7300 x 0.15 = 1095
7.	DEL payment	3.3	600 x 0.3 = 180
8.	Salary bill	0.4	1200 x 0.4 = 480
9.	Public Utility bill	0.4	5400 x 0.4 = 2160
	TOTAL		11390

The total number of entries in ledgers/journals/registers = 69100

Table 13

Estimation of Manpower Requirement

Sr.No.	Component of work	Work Indicator	Work norm	No.of units of work/Yr.	Estimated Workload	Estimated manpower
1.	Bills passing	Equivalent purchase bill	30 man mins/ bill	11390	5695 manhrs	5695 / 217x7 =3.749
2.	Writing ledgers/ Journals/registers	Entry in Journal/ledger/ register	10000 entries/ man yr.	69100	6.91 man yrs.	6.91
3.	Other indirect work load	-	4500 man hrs/yr.	-	4500 manhrs	4500 / 217x7 =2.96

Total manpower required $= \frac{10195}{217 \times 7} + 6.91$

$= 14$

Here, number of working days per year per employee after deducting all leave entitlements, etc. is taken as 217 days and working hours per day are taken as 7.

16. CASE STUDY NO.6

DETERMINING MAN POWER REQUIREMENTS FOR THE OPERATIONAL STAFF OF A POWER GENERATING STATION :

We shall now consider a more comprehensive and complex case of a power generating station. The power station comprises of a set of 4 turboalternators with a total installed generating capacity of 60 MW. Figure 5 gives the various operating units in the Power Station.

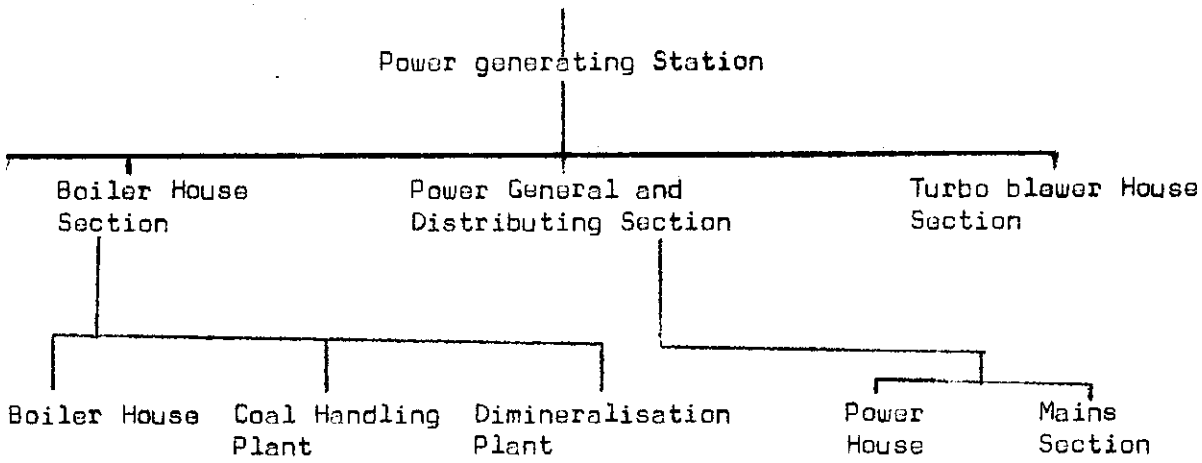


FIG. 5 : OPERATING UNITS OF THE POWER GENERATING STATION

Figure 6 gives the thermal diagram and Figure 7 gives the line diagram of the solid fuel handling system for the boiler plants. The activities of each of the sections of the Power Station are briefly described below:

16.1 Coal Handling Plant

Coal is received from outside sources by wagons/trucks. It is unloaded by End rock tippler or manually. Out of the total coal receipt per day 30% is coming by wagons and 70% by road transport. Coal received by 4 wheeler covered wagons is unloaded in End Rock Tippler (100 T/hr) and sent to coal crusher via No.1 and 3 belts (100 T/hr). Coal which is manually unloaded is bulldozed to reclaiming hopper (80T Capacity) and sent to coal crusher for crushing and seeing through Nos. 2 and 3 belts.

After crushing to ($\frac{3}{4}$" - 1") size, coal is sent to old boilers or Coal stock yard (6000T) via belts Nos. 5, 7, 8, 9, 10, 11. From stockyard coal is bulldozed to reclaiming hopper for feeding coal to old boilers. Adjacent to wagon tippler, there are 5 track hoppers of 40T capacity each where coal is unloaded both by wagons and trucks. Coal from track hoppers is sent to new crushers via 5 nos. of feeders and M_1 & M_2 belts. From new crusher (100T/hr) coal is sent either to new boilers (A & B) or old boilers through different belt systems. From coke ovens, coke breeze is also sent to boilers through new belts CB_1, CB_2, CB_3, CB_4 as and when required. Furnace oil is also sent to new Boilers at the rate of 1.2 Tonnes/hr. to boost up steam production to 30% MCR. Table 14 gives the equipment details of the coal handling plant.

Table 14

Equipment used in Coal Handling Plant

Sr.No.	Equipment used	nos.	Year of installation	Capacity
1.	End Rock tippler	1	1953	100T/Hr.
2.	Reclaiming Hopper	1	1953	80T/Hr.
3.	New Crusher	1	1980	200T/Hr.
4.	Track Hopper	5	1980	40T each
5.	Old Crusher	1	1953	100T/Hr.
6.	Feaders	5	1980	
7.	Screen	2	1953	6" square
8.	Conveyor belts (old CHP)	11	1953	100T/Hr.
9.	Conveyor belts (new CHP)	5	1980	100T/Hr.
10.	Tripper (new CHP)	1	1980	100T/Hr.
11.	Tripper (old CHP)	2	1953	100T/Hr.
12.	Coke Conveyor belts	2	1980	100T/Hr.
13.	Bunkers (old boilers)	4	1953	295T(together)
14.	Furnace Oil Tank	2	1982	

16.2 Boiler Section

Altogether there are 14 stocker fired water tube boilers for generating superheated steam. Out of them, 12 are old and 2 new boilers (A & B). 7 of the old boilers are single stocker fired and the remaining are twin stocker fired. The new boilers are also twin stocker fired.

Dimeneralised water from demineralisation plant and softening plant is passed through heat exchanger (50 ^{o}C) and sent to Hot well tank. Hot water is then sent to deaerators for removal of dissolved oxygen from feed water by heating steam. (0.5 kg/cm.^{2}) Water is pumped by feedwater pumps to economisers of respective boilers, where feed water is heated by outgoing flue gases of the boiler. Water from economiser (139 ^{o}C) is sent to boiler drum where it is heated by burning of coal/coke breeze/BF gas/CO gas in the grate. Steam from boiler drum is superheated in superheater by exchanging heat with outgoing flue gases. Air is supplied by FD fan to stockers and gas burners for cumbustion. Air is preheated in recuperative hollow plate type air heaters before entering stockers/gas burners by flue gases. Superheated steam from the 14 boilers is passed to 6 receivers from where steam is distributed to a) power house, b) Turboblower house. In the old boiler, the entire operation is manually controlled. In new boilers, stocker control is manual. LD and FD fan controls are pneumatic auto controlled. Ash from the stockers falls in the open channel filled with CI lines and is carried away by continuous flow of water under closed system to the ashpits. Table 15 gives the equipments used in the boiler house.

Table 15

Equipments in the Boiler House

Sr. No.	Equipment	Nos.	Year of installation	Capacity
1.	Twin Stocker fired water tube boilers (overfed tridrum)	3	1957	54.446T/Hr.
2.	- do -	1	1959	54.446T/Hr.
3.	- do -	1	1959	27.223T/Hr.
4.	Twin Stocker fired bidrum radiant type water tube boilers	2	1980	90.75T/Hr.
5.	Air heater	14	same as boiler	-
6.	Hot well tank	4	1939/1955	24' x10' x12'
7.	Deaerators (old boilers)	5	same as boiler	2 nos-54.44T/Hr 3 -158.8THr.
8.	Deaerators (new boiler)	1	1980	
9.	Induced draft fan(old boiler)	12	same as boiler	7 Nos-2073 m^3/ 5 Nos-3426 m^3/mi
10.	Induced draft fan (new boiler)	4	1980	3113 m^3/min.
11.	Forced draft fan (new boiler)	4	1980	1783 m^3/min.
12.	Forced draft fan (old boiler)	17	same as boiler	7-1105m^3/min. 10-1195m^3/min.
13.	Secondary Air fan (New boiler)	4	1980	382 m^3/min.
14.	Gas circulating fan (new boiler)	4	1980	339 m^3/min.
15.	Boiler feed pump (electric)	4	same as boiler	53.3 m^3/Hr.
16.	Turbo fuel pump	4	"	116.73 m^3/hr.
17.	Boiler feed pump (electric)	4	1980	117 m^3/hr.
18.	Booster pump	4		273 m^3/hr.
19.	Extraction pump (old boiler)	5	same as boiler	
20.	Service water pump(new boiler)	2	1980	
21.	Ash pump (old boiler)	4	same as boiler	387 m^3/hr.
22.	Ash pump (new boiler)	2	1980	500 m^3/Hr.
23.	Ash bunker (old boiler)	3	same as boiler	75 T each
24.	Ash bunker (new boiler)	3	1980	75 T each
25.	Telpher Crane (old boiler)	2	1950	3.1/4T
26.	Telpher Crane (new boiler)	2	1980	3.2 T
27.	Compressor (new boiler)	2	1979	6 m^3/min.
28.	Sump pump	2	-	-
29.	Leaf pump (old boiler)	5	-	-

16.3 Demineralisation Plant

A two stream demineralisation plant of exchange with normal treatment rate of 152 m^3/hr. per stream has been commissioned for demineralisation of raw water to be used in boiler plant. Raw water at a pressure of 2.72 kg/cm^2, 26 °C is passed through cation unit where sulphuric acid (3.8%) is used for ion exchange and then through anion unit where caustic soda (5%) is used for ion exchange so as to get demineralised water. The latter at a pressure of 6.8 kg/cm^2, 26 °C is consumed at the rate of 150T/hr in the boiler. Table 16 gives the equipments used in the plant.

Table 16

Equipments used in the Demineralisation Plant

Sr.No.	Equipment	Nos.	Year of Installation	Capacity
1.	Dilution Tank	1	1977	
2.	Acid pump	2	"	
3.	Alkali pump	2	"	
4.	Booster pump	3	"	
5.	Transfer pump	4	"	
6.	Effluent discharge pump	2	"	
7.	Storage tank	1	"	1000 m^3

16.4 Power House

There are 4 Turbo alternators with total installed capacity of 60 M.W. Superheated steam at a pressure of 22.85 kg/cm^2 and temperature of 398.85 °C is fed to the steam turbine of the alternator. Out of 4 alternators two are 10 MW each and the rest are 20 MW each. Steam, after work done in the steam turbine for generating electricity, is cooled by surface condensers For 20 MW sets, hyperbolic cooling tower is used whereas for 10 MW set, open hyperbolic cooling system is used for condensing steam. Condensate from surface condenser is extracted by condensate extraction pump and sent to hot well tank. Table 17 gives the equipments used in the power house.

Table 17

Equipments used in the Power House

Sr. No.	Equipment	No.	Year of installation	Capacity
1.	Turbo alternator	2	1939	10 MW
2.	Turbo alternator	1	1948	20 MW
3.	Turbo alternator	1	1959	20 MW
4.	Reaction, radial flow 34-stage Turbine	2	1939	suitable for 10 MW
5.	Reaction, radial flow, 28 stage Turbine	1	1948	suitable for 20 MW
6.	Reaction, axial flow, 42-stage Turbine	1	1959	
7.	Surface condenser (single pass, open channel type)	2	1939	90% vaccum
8.	Surface condenser (single pass, open channel type)	1	1948/1959	90% vaccum
9.	Condensate extraction pump	2	1939	16 litres/sec.
10.	Condensate Extraction pump	4	1948)(2 nos) 1959 (2 nos)	27.5 liters/sec.
11.	Cranes	2	1950	10T9(fast year) 30T(slow gear)

16.5 Turbo Blower House

At present there are 7 multistage centrifugal tube blowers driven by condensing steam from the turbine steam superheated at a pressure of 22.5 kg/em^2, 387.8 ^{o}C superheat is passed through multistage centrifugal blowers, so as to supply air to 4 blast furnaces and duplex plant. Table 18 gives the equipment used in the Turbo blower house.

Table 18
Equipments used in Turbo Blower House

Sr. No.	Equipment	No.	Year of installation	Capacity
1.	Multistage Centrifugal, twin inlet, cooled between stages, turbo blower	2	1928/29	1696 m^3/min.
2.	Multistage, single unit, centrifugal uncooled turboblower	2	1947/58	848 m^3/min.
3.	Multistage centrifugal twin inlet uncooled turboblower	3	1958	2685 m^3/min.
4.	Single inlet, single outlet, surface type 2 pass condenser	2	1928/29	86% vaccum
5.	Single inlet, single outlet, surface type, 2 pass	2	1947/58	85% vaccum
6.	Twin inlet, twin outlet surface type 3 pass condenser	3	1958	87% vaccum
7.	Manual chain driven spin gear type crane	1	1920	15T
8.	Manual chain driven spur gear type crane	1	1956	25T

16,6 Mains Section

Supply of raw and filtered water to the Station township. Raw water is pumped from river by pumps and sent to new pumphouse where it is chemically treated by alum,etc. From pumphouse semi-filtered water is pumped to township. Table 19 gives the equipments used in the Section.

Table 19

Equipments used in the Mains Section

Sr. No.	Equipment	No.	Year of installation	Capacity
1.	Centrifugal Electric pump	3	-	5 lakh gallons/Hr.
2.	Centrifugal electric pump	1	-	3 lakh gallons/Hr.
3.	Electric pump No.5	1	-	4 lakh gallons/Hr.
4.	Electric pump No.6x7	2	-	3 lakh gallons/Hr.
5.	Electric pump No.8x9	2	-	2.5 lakh gallons/Hr.

16.7 Manpower assessment

Table 20 gives brief description of the job titles and their respective activities for the various sections of the power station. The detailed manpower assessment in each job in the power station is made in Table 21. The total manpower required is assessed at 422. It will be clear from the detailed analysis that the manpower is almost wholly due to positional manning, arising out of i) Supervision, ii) manning equipment positions. We may therefore write the manpower function as:

$$X = K_1 P_1 + K_2 P_2$$

Here K_1 = Coefficient, denoting manpower per supervisory positions

K_2 = Coefficient, denoting manpower per equipment position to be manned

P_1 = Number of Supervisory positions

P_2 = Number of equipment positions

here $K_1 = \frac{50}{10} = 5$ $K_2 = \frac{422-50}{49-10} = \frac{372}{39} = 9.538$

$$X = 5 P_1 + 9.538 P_2$$

After knowing the number of supervisory and equipment positions to be manned, the total manpower required can be readily determined.

17. CONCLUSION

The six case studies reported in this study amply demonstrate the suitability of the proposed framework of 'Manpower Requirement Planning' (MRP) to assess manpower requirements in any type of work situation - manufacturing type, service type, administrative type or a combination of these. Furthermore, the framework readily accomodates any type of technological processes, regardless of whether they are machine controlled or manual. Apart from enabling to determine manpower for the given level of operation, suitable manpower requirement functions can be developed which help to project manpower requirement, for expected future levels of operation. Such functions were developed in all the illustrations cited. A further advantage of the proposed MRP is that it is possible to pinpoint the effect on manpower of any changes which take place in the work situation and this facilitates selective reassessment.

In situations where available resources represent a constraint on manpower deployment, MRP enables to find out the best possible deployment of manpower amongst various units after the requirements are assessed. The MRP framework proposed in this study is thus thought to be a step in the direction of solving the 'Manpower' problem in a work organization. The problem has however many other dimensions such as supply, utilisation, development, etc. which make it a complex one to resolve. These are not the subject of this study. The present study has concentrated on the requirement, (i.e. demand) dimension of the manpower problem, for which MRP may be expected to provide a comprehensive solution.

Table 20

Brief description of job titles and their activities

Sr.No.	Description
	COAL HANDLING PLANT (CHP)
1.	Shift foreman : Supervise the activities of coal handling plant, receipt, crushing and supply of crushed coal to boilers. Record consumption of stock of solid fuel.
2.	Control room Operator : To ensure supply of solid fuels to boilers by operating the different belts of CHP in sequence from Control Panel To keep vigil for smooth operation of CHP conveyor system.
3.	Coal Inspector : To check incoming coal. Record number of wagons/ trucks received daily. Visually check quantity of coal.
4.	CHP Operator : To operate wagon tippler, coal crusher, belt conveyors. To operate the sequence in the control room. To get greasing done in CHP.
5.	Bunker Attendant: To operate tripper car. To maintain and fill up coal, coke bunkers upto proper level. To keep the bunker float clean.
6.	Feedman : To feed and control coal/coke breeze through reclaiming feed hoppers and middling feed hoppers feeding both 1 and 2 conveyors.
7.	Belt attendant khalasi : Ensure smooth running of belt check chutes, idlers, motor gear box, etc. and inform any abnormality. In case of jam, stop the belt and clean. Do shifting of belt as necessary.
8.	Wagon Khalasi/General labour : Same as above

Sr.No.	Description
	BOILER PLANT (OPERATION) (BP)
9.	Shift foreman : Supervises activities of a battery of boilers including all the ancillaries, ash handling plant, water treatment plant, deaerators, ID & FD fans, etc. Check steaming of boilers and take steps to control abnormality.
10.	Chargehand (BP) : Assist shift foreman in all his activities, giving special attention to water treatment plant, feed pumps and ash handlin plant.
11.	Boiler Operator : Assist shift foreman in all his activities, check fire on the grate and draft. Control draft. Control speed of the stocker to control fire. Check deaerators. Supervise running of auxiliaries.
12.	Boiler Attendant : Assist chargehand in all his activities. Check all the running auxiliaries ashpit, steam and feed flow, temperature recorder, gas position and all the fans with bearings. Maintain fuel flow, feed flow, steam pressure, ash sluice drum, disposal of boiler ash.
13.	Fireman : Maintain water and fuel flow, fire and steam pressure. Control draught and clean clinker formation from front and middle riddling hopper.
14.	Ash handling crane driver : To operate the ash handling cranes so as to dispose ash from ash pit to ash bunker.
15.	Feed pump and softner plant Attendant : Operate feed pump, chemical pum deneratrs and lift pump. Regenerate softners. Back wash the sand filter. Maintain water in the hot well tank.
16.	Greasing and fan attendant : To attend to induced draught and forced draught fans. Check oil in the bearings and flow of cooling water through bearings. Top up with oil.
17.	Deaerator attendant : To attend to deaerators of new boiler units A & B.
18.	Pump attendant : Operate feed pump, service pump and fire pump. Check all the running pumps bearings cooling water supply. Clean the pump.

Sr. No.	Description
19.	Dosing pump & compressor attendant : Check and operate the chemical dosing pump, air compressor. Check chemical solution and chemical stock. Prepare chemical solution.
20.	Greaser : Grease and oil all the greasing plants and lubricating plants in the boilers and auxiliaries. Grease Telpher cranes, ropes, hold drum conveyor idlers, pulleys, wagon tippler and coal crusher.
21.	Asst. fireman : Ensure free flow of ask to the sluice to avoid jamming. Operate ash door levers of the boiler so as to remove ash from the boiler. Ensure free movement of stocker by raking clinkers from the boiler.
22.	Fitter : To do minor fitting jobs in boilers and auxilaries.
23.	Helper : To assist filter in all the jobs
24.	Boiler Khalasi : To look after ash sluice drain change screen. Change brine for regeneration. Clean jamming of ash sluice drain/riddle hopper, coal, coke chute. Carry and collect samples for laboratory. Bring chemicals for laboratory.
25.	General labour: All types of miscellaneous cleaning jobs.
	DEMINERALISATION PLANT
26.	Shift in charge : Carry out regeneration work with the help of attendant and khalasi. Take acid/alkali in measuring tank, back wash both cation and anion units, acid/alkali injection, carry out routine chemical tests of raw water. Record water flow, PH meters, etc. at various stages and log them.
27.	Demineralisation plant attendant : Take acid, prepare alkali solution for regenerations. Back wash, change acid/alkali, rinse the units. Check frequently the strength of acid and alkali during changing and rinsing. Start/stop all the pumps as and when required. Grease the greasing points of pumps and injections.
28.	Khalasi : To assist demineralisation plant attendant and material handling. Keep the plant clean. Assist the shift in charge in carrying out different chemical tests connected with demineralisation plant. Carry chemical reagents for analysis.

Sr.No.	Description

POWER HOUSE (GENERATION AND DISTRIBUTION)

29. Shift foreman : Maintain and optimise steam depending upon the station condition, i.e. steam pressure. Share loads between the running alternators and watch the load of all outgoing feeders. Maintain liaison with plant control and all major substations. In case of shortage of steam, maintain load shedding schedule. Check 3.3 Kv/440V system in power house.

30. Asst. Shift Foreman : Maintain and optimise generation depending on steam pressure. Share load between the alternators and watch load of all outgoing feeders. Check/inspect the 3.3 KV/440V O.C.B in power house.

31. Sr. Switch board attendant. Attend the switchboard and optimise generation by properly sharing the load between the running machines. Check voltage regulator. Regulate the generating voltage at 11 KV. Operate switch gear for isolating the equipment for maintenanace jobs.

32. Switch board attendant: Keep close watch on active and reactive loads between turbo alternators. Take hourly readings of different instruments for controlling parameters like power, voltage, current, etc.

33. Sr. Turbine attendant/Turbine attendant : Check the electrical load on alternators, vaccum of condenser pressure, temperature of steam and bearings. Keep watch on instrument panel and see that oil pressure in bearings, governors, ejector, pressure, vaccum, steam pressure at various points are within specified limits. Operate various valves and controls.

34. Electrician : To attend to all electrical faults of the running plant in the Power house, boiler plant complex, turbo blower house and demineralisation plant.

35. Helper : To assist the electrician in all the jobs

36. Pump attendant : Attend auxiliaries such as condensing equipment, extraction pumps, exhaust valves for Turbine ejector, emerging valves etc. Check circulating water pressure of running Turbo alternator. Check bearing temperature of condeser pump, oil cooling and air cooling pressure, etc.

Sr. No.	Description
37.	Battery attendant: Check all acid and alkali cells. Check up sp. gravity and voltage. Check up battery charger and its input/output voltages. Add distilled water.
38.	Khalasi : Clean turbo alternators, pumps, motors, panels, etc.
	TURBO BLOWER HOUSE (OPERATION) - (TBH)
39.	Shift foreman : Operate entire TBH independently for uninterrupted production in shift including necessary corrective action. Check oil level, bearing temperature, lub. oil pressure, cooling water flow, vaccum efficiency, steam and air pressure/corrective action whenever necessary.
40.	Shift chargehand: Assist shift foreman in the operation of 6 turbo blowers including temp/pressure guage reading, writing logsheets. Attend to telephone/signal/communication systems. Assist the foreman in operating steam pressure reducing plant. Check vaccum height, oil pressure of every unit. Inspect the working of basement auxiliaries.
41.	Turbine attendant: To attend to one Turbo blower unit and ensure smooth flow of air as per demand. Check the turbine unit oil level, bearing temp., steam pressure, vaccum condenser, etc. Check the blower unit demand of air volume/blast pressure, air suction flap/positions, blowing condition, temperature, etc. Check the auxiliaries working. Operate valves and controls to regulate air supply. Keep watch on instrument panel.
42.	Pump attendant : To assist turbine attendant and to attend to auxiliaries, i.e. condensing equipment, extraction pumps, recirculating and water level controlling devices of running turbo blower.
43.	Greaser : To do all types of miscellaneous manual jobs and checking jobs. Work as releiver.
	OLD RIVER SIDE PUMP HOUSE (OPERATION)
44.	Pump Tindal : Start and stop all high tension and low tension pumps and motors and check up bearings and ammeters' reading
45.	Greaser : Lubricate all pumps and motor bearings. Clean the pumps motors and also inside of the pump house.

Table 21

MANPOWER ASSESSMENT FOR POWER STATION (OPERATION)

Sr. No.	Assessment of manpower for jobs	G. Shift	A B C Shift	A B Shift	S/L off + L R	Total
	COAL HANDLING PLANT					
1.	Shift foreman : 1 duly post/shift to supervise activities of CHP	-	3	-	1	4
2.	Control room operative : 1 duty post/shift to operate different belts of coal handling plants sequence from control panel	-	3	-	1	4
3.	Coal Inspector : 2 duty posts for recording weighment of coal trucks and number and also receive challans for delivery of coal, bull dozing operation for even distribution of stock	2	-	2	-	4
4.	CHP Operator : 2 duty posts/shift - 1 for maintenance of coal receipts, bull dozing of coal, levelling of coal at siding line, etc., 1 for operation of belt conveyors for feeding coal bunkers	-	6	-	1	7
5.	Bunker Attendant : 3 duty posts/shift for operating. 3 tripper cars to maintain and fill up coal/coke bunkers of 3 boiler houses	-	9	-	2	11
6.	Feedman : 3 duty posts/shift; 1 for feed and control of coal through reclaiming feed hopper, 1 for middling feed hopper and 1 for relief for A, B, C shift. In AB Shift, 2 duty posts for coke feeding from domestic coke bunker.	-	9	2	2	13
7.	Belt Attendant Khalasi : Old CHP (A,B,C) shift 5 duty posts/shift for long belts 3,5,7,8,9. For belt Nos. 10,11 - 1 duty post/shift. For old crusher M/C - 1 duty post/shift. New CHP - (ABC shifts). For belts M_1, M_2, SF_1, SF_2, SF_3 - 4 duty posts/shift. For new crusher M/C - 1 duty post/shift. Coke Handling (AB Shift) For belts CB_1, CB_2, CB_3, CB_4 - 3 duty posts/shift	-	36	6	6	48
8.	Wagon Khalasi : Since coal is rarely coming by wagons, no manpower is required.	-	-	-	-	-
9.	General labour : To cover leave/sick/absenteesm	-	-	-	3	3
	BOILER PLANT OPERATION					
10.	Shift foreman : 3 duty posts/shift. 1 - suspension of boiler (operation (No.1 to 6, & 12), 1-suspension of boiler Nos. 7 to 11 and 1 for new boiler units A & B	-	9	-	2	11
		-		-		105

Sr. No.	Manpower assessment for jobs	G. Shift	ABC Shift	AB Shift	S/L off + L R	Total
						105
11.	Charge hand (Boilar plant): 1/shift to assist foreman in old boiler plant giving special attention to water treatment plant, feed pumps/auxiliaries	-	3	-	1	4
12.	Boiler operative: 2/shift to assist foreman of new boiler plant in 2 areas; 1 operative to operate boiler control panel/auxiliary controls, etc. 2nd is to check combustion, furnace operation,etc.	-	6	-	1	7
13.	Boiler Attendant: 2/shift, 1-boiler Nos. 1 to 6 & 12, 1-boiler Nos. 7 to 11 to assist foreman in BP operation. Keep vigil on ash disposal plant.	-	6	-	1	7
14.	Fireman: 17/shift.14/shift for 14 boilers. 3/shift for soot blowing of old 12 boilers	-	51	-	9	60
15.	Ash handling crane driver in charge: 1/shift- to operate AH crane regular inspection of crane, prepare defect lists, proper greasing etc.	-	3	-	-	3
16.	Ash handling crane driver : 3/shift - to operate old boiler cranes & new boiler crane	-	9	-	2	11
17.	Feed pump softner plant attendant: 2/shift 1-operate 2 electric feed pumps for boilers 1 to 6 & 12, 1 to operate 2 turbo feed pumps for boilers 7 to 11 including deaerators and water softening plant.	-	6	-	1	7
18.	Greasing and fan attendant : 3/shift, 1-to operate ID/FD fan of boiler No. 1 to 6 & 12, 1-to operate boiler No.7 to 11, 1 to operate ID/FD fans of new boilers	-	9	-	2	11
19.	Deaerator attendant : 1/shift, for attending deaeration of new boiler units A & B	-	3	-	1*	4
20.	Pump attendant : 1/shift to operate feed pumps of units A & B. In AB shift, 2 posts to operate service pumps, fire pumps of old boilers	-	3	2	1	6
21.	Dosing pump & compressor attendant : 1/shift, to operate compressors of units A & B. Shift cycle off common with (19)	-	3	-	*	3
22.	Greaser : 2/shift, 1-to grease old boiler complex, 1-to grease new boiler complex	-	6	-	1	7
23.	Asst. Fireman : 2/shift, to dispose off ash from 2 new boilers, by operating ash door	-	6	-	1	7

Sr. No.	Manpower assessment for jobs	G.shift	ABC Shift	AB Shift	S/C/LR	TOTAL
24.	Fitter : 1/shift, for running maintenance jobs in old boiler complex	-	3	-	1	4
25.	Helper : 1/shift to assist fitter	-	3	-	1	4
26.	Boiler Khalasi : 6/shift, 2-old boilers, 1,6 & 12, 2-old boilers 7 to 11; 2-new units A & B - 16 posts of LR/S/Absenteesm.	-	18	-	16	34
27.	General labour : To cover leave/sick/absenteesm	-	-	-	4	4
	DEMINERALISATION PLANT					
28.	Shift in charge: 1/shift, to supervise activities of the plant	-	3	-	1	4
29.	Demin. Plant Attendant : 1/shift, to attend to the plant	-	3	-	1	4
30.	Khalasi: 1/shift, to assist the plant attendant	-	3	-	1	4
	POWER HOUSE OPERATION					
31.	Shift foreman : 1/shift, to supervise the Power House in respect of generation and distribution	-	3	-	1	4
32.	Asst. Shift foreman: 2/shift, to assist the foreman in all his activities of Power House & New Boiler Substation	-	6	-	1	7
33.	Sr. SBA : 1/shift, to attend to power house board & new boiler station , adj. to power house board	-	3	-	1	4
34.	SBA : 2/shift, to attend to old power house board & new boiler substation	-	6	-	1	7
35.	Chargehand : 1/shift, for running mte. of all electrical equipments in Power House, TBH, new Boiler Complex	-	3	-	1	4
36.	Sr. Turbine Attendant : 1/shift, for overall attention to turbine side of 3 alternators in operation	-	3	-	1	4
37.	Turbine Attendant : 2/shift, for attending to 3 Turbines	-	6	-	1	7
38.	Electrician : 2/shift, 1-new BP complex; 1-power house & TBH old CHP & boiler, 3 posts in General shift for new boiler complex maintenance	3	6	-	2	11
39.	Helper : Same as electricians	3	6	-	1	10
40.	Pump Attendant : 1 in General shift,attending to and condensing equipments/ extraction pumps, etc.	-	3	-	1	4

Sr. No.	Manpower assessment for jobs	G. Shift	A B C shifts	AB Shift	S/C/off & L R	TOTAL
41.	Battery Attendant : 1 in G. Shift, to attend/check all acid & alkali cells in Power House & riverside	1	-	-	-	1
42.	Khalasi : 4 posts to cover LR/Sick/absenteesm . 1 in general shift for cleaning the machines	1	-	-	4	5
	TURBO BLOWER HOUSE OPERATION					
43.	Shift foreman : 1/shift, to supervise operation of 6 turbo blowers	-	3	-	1	4
44.	Shift chargehand : 1/shift, to assist the foreman and attend to communication facilities	-	3	-	1	4
45.	Turbine Attendant : 6/shift, for operating 6 turbo blowers	-	18	-	3	21
46.	Pump Attendant : 2/shift, to attend to condensing equipment, extraction pumps, etc.	-	6	-	1	7
47.	Greaser: 2/shift - all manual work. Also relief to turbine attendant	-	6	-	4	10
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