CENTRAL WATER AND POWER COMMISSION
MINISTRY OF IRRIGATION AND POWER

REPORT OF THE CONSTRUCTION PLANT & MACHINERY COMMITTEE

Report of the Construction Plant and Machinery Committee

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GOVERNMENT OF INDIA

Ministry of Irrigation and Power

Central Water & Power Commission

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PART I

INTRODUCTORY

INTRODUCTORY

1.01. Appointment of the Committee and its Terms of Reference

The Government of India in the Ministry of Irrigation and Power under their letter No. DW-II-29 (78) dated the 17th September, 1953 decided to appoint a Committee of engineers to visit some of the projects now under execution in India and to submit a report on the economic and efficient operation and maintenance of the plant and machinery used in the construction work of River Valley Projects in the country. The terms of reference to the Committee were as under :

(1) The makes, types and sizes of the plant best suited for various types of work with a view to standardisation ;

(2) combination and matching of plant where more than one unit of plant is involved ;

(3) correct apportionment of labour to plant ;

(4) mode of calculation of the working cost of each type of plant per hour ; the unit cost of the work performed by each type of plant on the various projects should be computed for the last working season and variations in cost should be explained ;

(5) suggestions for a unified scale of depreciation to be followed on all River Valley Projects ;

(6) standard forms for the history sheets and log books of each type of plant ;

(7) the various factors involved in efficient plant operation emphasising the adverse factors which have been responsible for low output and poor maintenance on the various projects visited ; and

(8) comparison of cost of work being carried out by machinery with that carried out by manual labour with recommendations as to the type of work which should be normally carried out with machinery.

The letter of the Government of India is included as Appendix 1.1.

1.02. Personnel of the Committee

The personnel of the Committee comprised four engineers as under :

Shri K. Gopal Iyengar, Retired Superintending Engineer, Madras Engineering Service (Chairman).

Mr. E. R. Harvey, Chief Mechanical Engineer, (Colombo Plan), attached to the Hirakud Dam Project (Member).

*Mr. R. F. Koken, American Specialist, attached to Bhakra Dam (Member).

Shri G. G. Dhanak, Bombay Service of Engineers (Member-Secretary).

The Committee's office work was assisted by one Technical Assistant, one Stenographer, one Clerk, one Typist and two Peons. Two posts of peons were not filled.

The Chairman assumed duty on the 12th October 1953, the Member-Secretary on the 19th October and the other two members on the 20th and 23rd October 1953.

1.03. Projects Visited

The Committee started functioning from the 23rd October, 1953. The first few days were spent setting up an office, acquiring staff, stationery, etc. In outline of the form in which information from various projects was to be collected was discussed and finalised, and questionnaires were sent out to various projects. The Committee started its tour on the 29th October, 1953 and ended it on the 30th November, 1953. The following projects were visited :

Lower Bhavani.—Under the Government of the Madras State.

Tungabhadra.—Under the Control Board representing Government of India, Mysore/Andhra and Hyderabad States.

Gangapur.—Under the Government of Bombay State.

Hirakud.—Under the Government of India and the Orissa State.

Damodar Valley.—Under the Damodar Valley Corporation (Maithon and Panchet Hill).

Bhakra-Nangal.—Under the Government of Punjab State.

*In their letter No. DW-II-29(78) dated the 17th September 1953, the Government of India, Ministry of Irrigation and Power had appointed Mr. B. H. Lundmark, the American Specialist, at the Bhakra Dam, but Mr. R. F. Koken was delegated to the Committee in his place *vide* Government of India, Ministry of Irrigation and Power letter No. DW-III-29(78) of the 15th January 1954.

The letter of the Government of India, Ministry of Irrigation and Power No. DW-II-29 (78), dated the 17th September 1953, included in addition the Sukhawa and the Vaitarna Projects. We did not visit these works because the former has not yet been started and the latter comprises a concrete dam executed through the agency of contracts. We considered that adequate data will be available from the projects visited, which were executed departmentally. Appendix 1.2 gives the information about the contacts made by the Committee.

1.04. Interim Report

The Committee prepared an Interim Report and participated in the Bhakra Seminar from the 5th to 7th January, 1954. The Report was discussed by the Sub-Committee No. 1 Earthwork and equipment, which included in its personnel the Chairman and the Member-Secretary of our Committee. The Committee now has the advantage of having had the views of various Engineers at the Seminar and had a free and frank discussion on all aspects covered in the Sub-Committee's Report. The Final Report incorporates or amplifies some of the points as a result of these contacts.

The Committee was required to submit its report by the 10th of December 1953, but in view of the fact that it did not start functioning until the fourth week of October and a month was required for the visits to the projects and that some data called for from the various projects was received late in December, it was forced to ask for extension until the 15th February 1954.

1.05. Additional Work

By their letter No. DW-II-29 (78) dated the 3rd December 1953, the Ministry of Irrigation and Power asked the Committee to go into the question of the scope of manufacturing the earth-moving equipment in India. A report on this subject is being made separately.

1.06. Record of the Committee

The record of the Committee's work is filed in the Central Water and Power Commission, Plant and Stores Branch.

The report is divided into four parts. The first is Introductory, the second embodies the report, the third gives a summary arranged in terms of reference and the fourth embodies the Appendices.

1.07. Foreword

The terms of reference to the Committee does not specify the type of construction plant for its study. Broadly, the plant can be divided into two parts; (i) earth-moving machinery including rock

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drilling and excavating equipment, and (ii) concreting plant. We are of the opinion that the concreting plant has to be specific for each job, depending on job conditions and that there can be little in common amongst various projects. Such factors, therefore, as standardisation, working cost per plant hour, ratio of labour to plant, etc., mentioned in the terms of reference, do not apply to the concreting plant. Therefore, we have limited our study to the earth-moving and allied equipment.

Moreover, the time at the disposal of the Committee was so short that it was considered advisable to concentrate on the earth-moving machinery alone. This in itself presents a very large field and there seems at present much variance on different projects.

The Committee had to face much difficulty in the collection of data concerning the performance and cost of upkeep of machinery. The visit of the Committee coincided with the beginning of the working season where the project staff was very busy. The statistics required to evaluate the performance of various machines had to be rather elaborate to allow studying from all aspects. The project staffs naturally felt it a difficult task to supply us with the information called for and to the last date of submission of this report some of the projects have not done so.

Another difficulty experienced was that no two projects maintained their data in the same manner. For a comparative assessment of the data, it was necessary to have the statistics of all the projects on a common basis. Every effort was made to collect the statistics in the form in which they were considered to be most easily available. All the same, voluminous work was involved in reducing the available records to the desired form. We are grateful to the project staff for supplying the information.

We noticed that all projects have struggled against nebulous conditions of earlier records and have gradually evolved individual patterns of record-keeping. On many projects the earlier data on cost and machinery performance have not been assembled in a readily available form that aligns with the later records. Well-assembled and continuous records were available for the Lower Bhavani and Gangapur Dams. This was probably due to the continuity of personnel and policy and relatively small size of the jobs.

The various forms and proforma recommended in this report are worked out to incorporate information as complete as possible for the most commonly used equipment on our projects. The statistics for special plant will need to be developed separately to suit the characteristics of each but they can follow the same general pattern.

We are aware that the secret of having reliable and up-to-date statistics on projects lies in expecting a minimum of written work without much computation. Execution of the work in hand is the primary thought of all project staff and they should not be bothered with avoidable table work. We have suggested various proforma trying to bear in mind the fact that these must be filled in at each stage, by a member of the staff as routine. No engineering computations should be involved.

The Committee has realised that it is easy to find fault but service can be rendered to the projects only by constructive criticism. It is our intention to avoid making adverse remarks about persons or projects. Where names have been mentioned in the report, they are used to substantiate the views expressed by the Committee as based on observations.

The mechanisation of projects is a new sphere in which the Indian Engineers are not yet fully oriented. It should be realised that we are attempting to adopt 1953 techniques in this country with a background which is 50 years behind the times in relation to countries that we try to follow. The entire approach is in a process of evolution. Until 1948 there was scarcely any heavy earth-moving equipment in India, whereas today there is approximately 40 crores of rupees worth of machinery on our projects. It will necessarily take time to train our administrative, technical and ministerial staff to obtain high efficiency in this new field. It is satisfying to record that all concerned have realised this aspect and are trying out various alternatives in an attempt to improve the situation. As a result of our visit to various projects and the study of their statistics we consider that although there is scope for improvement, the projects are in as satisfactory a position by now as they can be expected to be under existing circumstances. Efforts are being made in the right direction to achieve better and lasting results. Implementation of the recommendations in this report will further improve the situation.

The Government of India have taken a step in the right direction by wanting to consolidate the experience gained on various projects which have now been working for a few years. During this time, our projects have undergone a difficult pioneering struggle at the cost of considerable unproductive expenditure but have gained valuable experience. We have analysed the various fields of project activities and tried to consolidate the findings which, we hope, will better performance of mechanised construction. We feel, that a short visit and a single review will have only a limited result. We have recommended that the C. W. & P. C. should extend its activities to carry forward this work to the sphere of Machinery and Spare parts, Technical manpower and Cost Accounting.

We have avoided reiterating such aspects of the Construction Engineering as can be studied from the books and articles except in so far as we felt that some of them required to be high-lighted. We have added instead a bibliography in Appendix 1.3 listing the available literature on the subject.

1.08. ACKNOWLEDGEMENT

Our thanks are due to the various project organisations for their whole-hearted cooperation in our work.

Our thanks are also due to Shri Kanwar Sain, I.S.E., *Chairman*, and the personnel of the Central Water and Power Commission without whose help it would not have been possible for us to carry out our work.

Lastly, we wish to place on record, our indebtedness, to the assiduous and indefatigable services of Shri G. G. Dhanak, the Member-Secretary for the Committee, who, with his valuable theoretical and practical knowledge of Indian Civil Engineering and with his experience in mechanisation of the Gangapur Dam, contributed, in no small measure, towards the gathering and compilation of information from the River Valley Projects under execution and towards the writing of this Report, especially the portion dealing with the orientation of Indian practices and procedures in Civil Engineering with the requirements of the present-day accelerated progress of work by mechanisation, under specialised scientific and technical control. Without his valuable services, this report could not have been completed satisfactorily and in time.

The Committee was fortunate in having been allotted an industrious and intelligent team of workers, whose application to the work has earned our appreciation. The members of the team are:

1. Shri B. L. Gupta, B.E. (Mech.), Technical Assistant.
2. Shri H. L. Ohri, Stenographer.
3. Shri M. L. Varma, Clerk-Typist.
4. Shri Paras Ram, Typist.

Sd. Shri K. Gopal Iyengar, *Chairman*
" Mr. R. F. Koken, *Member*
" Mr. E. R. Harvey, *Member*
" Shri G. G. Dhanak, *Member-Secretary*

PART II

REPORT

PLANT PLANNING

2.01. PROJECT DESIGN

The importance of working out the details of a project properly has been stressed over and over again. An elaboration of this point is outside the scope of this report.

The design engineer must realise, the conditions under which the best performance of machines can be obtained and should evolve his design accordingly. For example, a few construction berms, on an earth dam, can cut down the cost of transport. The adoption of a material of construction which can be more easily handled by the available equipment, instead of specifying another material which may be more difficult to excavate or transport with the main bulk equipment can reduce the cost. The dimensions of the width of the cut off trenches and the tops of earth dams are often guided, amongst other factors, by that required for movement of transport. The slopes and gradients should be specified bearing in mind the type of machinery with which the earthwork will be done. The size, thickness and specifications of stone rip-rap will be guided by the method of construction and the equipment used.

(Often enough, the preliminary design has to be worked out before deciding upon the type of equipment. But there should be no hesitation to revise it as soon as construction plant is finalised. It may be stated as a general rule that well-planned working areas will give ultimate economy, although it may mean some extra cost; because the performance of machines will be much better.

2.02. STUDY OF MATERIALS

A more detailed study of the construction materials is necessary for mechanised construction, than has been customary on our earlier projects planned for construction by manual labour. Whereas manual labour is adaptable for working under varying conditions, machines are designed to operate best in particular type of material) This can be best explained by a few examples. If the excavation is in hard material, a small excavator will not suit. Similarly, in highly plastic clays with high moisture content ,scapers will give more trouble than bottom dumps. An elevating loader can be selected as suitable if the soil does not contain boulders. The natural moisture content in the borrow pits is often a decisive factor in the selection of the type of the equipment. The topographical and the sub-soil survey of the materials in the borrow pit have an important bearing on the selection of the type of excavating and transporting equipment. We are of the opinion that adequate attention is not paid to these aspects. This is partly due to inadequate acquaintance with the engineering properties of soils, and partly due to lack of knowledge of the design features of equipment.

2.03. Schedule of Quantities

Schedules of quantities are worked out on the projects, but they are often defined inadequately to work out plant planning. They must specify the leads and lifts for various categories of materials and the quantities involved for the different leads and lifts. It is not adequate to state "lead within 2 miles", which is often done in contract schedules. The selection of the equipment will depend upon the quantities of earthwork to be done within the various groups of leads and lifts. If it is a canal construction job, most of which is excavation within a lead of 100 to 200 ft. and a lift of 10 to 40 ft., the principal investment would be on draglines with a few transport units to take care of the relatively small quantities for embankments requiring short leads. Every borrow pit must be clearly defined, the position of dumping specified and sequence for items of work indicated before the plant requirement is determined. A lack of definite data in regard to this will lead to wasteful expenditure in plant planning.

The necessity of working out similar details for the foundation works cannot be over-emphasised. Many jobs are held up because suitable equipment for use in foundation work is not available. Deterioration of production from other equipment and consequent rise in the overall cost follow. It is wise to plan the equipment for the foundation work accurately and to provide for it slightly on the liberal side.

2.04. Selection of Equipment

Plant planning for a project, should be done with the same care and attention to details as the rest of the project. It should be done by an engineer who has specialised knowledge of the characteristics of the types and makes of equipment, with reference to their operation under the various working conditions existing on a project. The specialist should know how to interpret and modify the operational and performance data, furnished by the makers of equipment, for realistic application to the Indian conditions. Plant planning, especially for earth-moving, is a specialised subject on which a number of reference books are written. We have attended a bibliography in Appendix 1.3.

The main principles in plant planning for a particular project are the following:

(1) To have a minimum number of types of equipment and to select such types as will be suitable for the majority of the items of work.

(2) To have a minimum number of sizes in each type of equipment as will match satisfactorily with the other equipment in the group and be small enough so as to have an adequate number of them which will safeguard against risk of dislocation of work when some of the machines go sick —50% of sickness is not unusual on our projects.

(3) To have the same make of machines, and the same make of power units on the machines as far as practicable.

(4) To ensure about 70% life utilization of the equipment. One hundred per cent life utilization is impracticable as it does not afford adequate safeguard against dislocation of work due to large number of machines that will be sick towards the end of the project. Twenty-five per cent residual life should be considered as normal. This can be utilised along with some new equipment on other jobs.

(5) To avoid over-mechanisation of a project under Indian conditions. Certain items of work are best done by normal labour with the help of a few simple machines.

(6) To adopt realistic value for "pay load" per trip, in relation to the type of soil and the compaction standards.

(7) To recognise multi-shift working as essential to achieve satisfactory utilization of equipment per year.

(8) To provide adequate flood lighting to make efficient shift operation possible.

(9) To plan the haul roads for efficient working and easy maintenance.

(10) To provide adequately for ancillary equipment necessary for efficient working.

(11) To recognise the necessity for payment of an incentive wage based on outturn over a basic minimum.

(12) To adopt a realistic figure for "productive time" factor.

The '50-minute hour' is rarely realistic. *Shri Kanwar Sain quotes the following table from a study of the Joint Committee Report of Highway Research Board and Public Roads Administration of the U.S.A. It does not make a pleasant reading even for an advanced country like U.S.A. It is more realistic to assume somewhat lower figures for India, taking into account the inadequate resources of technical personnel and the long pipe line involved in getting spares.

Percentage of Total Available Time

	Crawler Tractor Towed Scraper		Wheel Tractor Scraper		Power Shovel		Euclid Loader	Avg. of all equipment
	Range	Avg.	Range	Avg.	Range	Avg.	Range	Avg.
Total working time . .	100	100	100	100	100	100	100	100
Major delays (over 15 min.) .	14—66	37	28—85	65	4—80	42	39	46
Net available work-time .	34—86	63	15—72	35	20—96	58	61	54
Minor delays (15 min.) .	3—12	4	3—12	7	5—42	21	15	12
Actual productive time . .	31—78	59	12—61	28	14—70	37	46	43

2.05. Alternative Plans

Before deciding upon the final plan, various alternative plant planning will have to be worked out in sufficient detail to study comparative cost, production and other features of each plan. A typical case is worked out by †F. Girsperger which we recommend for study.

2.06. Management Factor

The planning engineer will have to make some assumptions for the management factor affecting the job set-up to work the plant availability and operational efficiency, such as (a) the availability of adequate repairs facilities, (b) availability of spare parts as indicated by stock limits, (c) realistic wage scales of staff, (d) existence of housing and other amenities to the operators and technicians, (e) structure of executive and staff organisation, (f) prevalence of incentive wage scales, (g) grant of adequate powers to officers for local purchase of parts and engineering stores in emergencies, etc. These basic assumptions, should be clearly stated in the plan. It often happens that even when the plant planning is done carefully the underlying and implied assumptions are not adhered to during

*Hand-Book of Earth-moving Machinery, C. B. I., New Delhi.

†"General principles governing the selection of earth-handling and moving machinery" Hand-book of Earth-moving Machinery, C.B.I., New Delhi.

execution and the engineer's planning is blamed as unsuitable. It will be a step in the right direction to assess the value of the departures from the assumptions, such as those defined above, and to bring out the financial implications. The administrations dealing with the project should be cautioned, emphatically, that these are basic data for the plan and that they cannot be modified without affecting the entire plan. To quote a simple example, the strength of equipment, costs and production targets will need revision, if the administration does not accept the incentive wage system adopted in the plan for estimating the outturn.

2.07. Equipment Pool

Our study covered mostly the larger projects and concentrated organisations designed to take care of the equipment. We are aware of a large amount of costly construction equipment, diffused throughout the States, with no specialised organisation to maintain it. We recommend that States should make lists of all these machines and form organisations for care and maintenance of them, and for hiring them out on-jobs. The purchase of construction equipment for minor jobs is diffused. So the attention of the States is not yet drawn to the necessity for such organisations. Investment on equipment will be on an increase in the future and the earlier a positive planning in this direction is done the better will it be. The organisation can also hold the central pool of spare parts for all the commonly used equipment on the project. The Bombay State has established such an organisation for spares for their major Irrigation Projects. We recommend this idea to other States.

On completion of a Major Project, a number of items of equipment with residual life of 25 per cent. and over an overhauled and re-conditioned in a satisfactory manner will become available. Along with these, major and field repair and servicing equipment and trained and experienced personnel will also be available, as well as the residual stock of spare parts.

The States concerned, to some extent, may absorb these. But the bulk of these can only be utilised by transfer to other projects outside the States. Surveys and fixations of value for these items of equipment are preliminary to such transfers. These can be best done by the C. W. & P. C. through a suitable organisation, when such help is required by the States.

In para. 7.08 we have recommended the formation of a parts co-ordinating an scaling organisation under C. W. & P. C. Such an organisation, in our opinion, should be immediately formed. It should be supervised by an experienced man from the U.K. or U.S.A.

with adequate experience of parts scaling and construction equipment. Most of the equipment on our projects have now reached a stage of their life, when major repairs have to be carried out. Technical advice in this connection from the aspects of dis-proportionate cost, non-standards, obsolescence, unsuitability, etc., has to be made available to the projects. The services of the plant engineer can be utilised for this purpose and also for the survey and fixation of price for plant approved for transfer by the project.

As regards the scheme for creation of a central pool for construction machinery, it does not appear to be practicable for the centre to go beyond the work of co-ordination and channelising the movement of plant from one project to another. The equipment will have to be stored and looked after by owning project till its transfer or disposal by sale to the public.

2.08. Standardisation

We think that the importance of standardisation of a few well-tried items of construction equipment is well recognised, both from the technical and economical points of view. The absence of a master plan for plant planning is surpassed, on many of the projects, only by the indecisive mind as to the types, makes, and sizes of equipment to purchase. Piece-meal purchases are made of equipment, which often have not matched with the previously acquired plant. A summary of the plant population on the projects, studied by us, is given in the Appendix 3.1, which shows the very unsatisfactory position existing at present. With so much of indecisive planning, it is impossible to expect a high standard of performance.

2.09. Factors Contributing to Unsatisfactory State at Present

The factors that contributed to the present state of affairs on the projects appear to be:

(1) blind application of the principle of calling for tenders against vague, general and descriptive specifications and accepting the lowest tender;

(2) giving undue importance to sales literature and sale talk and succumbing to the speculative urge to try new makes of equipment, in the hope of finding better ones;

(3) restricted finance, necessitating piece-meal purchases and the risk of lapse of purchase allotment bringing on "panic" purchases.

The first two conditions should be controlled by a careful selection of equipment from rigid standardisation, and the last one by suitable modifications to the procedure of yearly finanical allotments to the project. We understand that the question of non-lapsable grant for River Valley Projects is under active consideration of the Government.)

There was yet another factor, the conditions of scarcity and non-availability of equipment which followed the World War II and the Government stock piling in the States. This factor affected the projects that were started during the years 1948-50, but it no longer exists.

The arguments in support of non-standardised purchases appear to be:

(1) standardisation introduces conditions of monopoly; and

(2) prevents a wider distribution of the benefits of Government patronage to commerce.

Of these arguments, the first is academic and not real. To the foreign manufacturer, the Indian demands from a tiny proporeion of the global demands. As regards the Indian Distributors, there is scope for examination of their price structure by the Central Purchasing Organisation, which should afford adequate safeguard against monopolistic prices. As regards the second, it is out-weighed by the considerable loss of efficiency and economy that is being caused by the absence of standardisation with reference to the operation and maintenance of equipment on the projects.

2.10. Effects of Non-Standardisation

The purchase decisions on capital equipment are not coordinated with the plans of the project engineer with the result that he is loaded with equipment which does not fit his organisation or job requirements. The policy of purchasing on the lowest tenders can be sound if the specifications of the commodity can be written down in exact terms, still making them general enough to invite competition. This is almost impossible in the earth-moving field where the design of the various assemblies, their mettalurgy, and intricate processing details are of paramount importance. To the best of our judgement, there is only one sound way of specifying a satisfactory piece of equipment for purchase, and that is to mention makes, size and type of equipment required. To retain the element of competition, more than one make can be mentioned but it is impossible at present to limit the tenders to the desired makes and sizes by noting general specifications on the purchase enquiry.

Then again the initial purchase is weighed separately from the after-sales-service. It is not adequately realised that the purchase of a piece of equipment is only the beginning of trade relations with the firm selling the equipment and that its performance will depend not only on the quality of the machine but on the capacity of the firm to service it throughout its life. It is not appreciated that the purchase of equipment implies an unsigned contract for over half the value of the equipment in spare parts which will be required during the life of the machine. A purchase contract based on a partial picture as shown by the initial cost alone without evaluation of the future commitments is evidently a faulty approach. When a project buys equipment it also buys the after-sales-service and the spare parts facilities available in India. The two cannot be severed from each other. It is unsound, therefore, to buy equipment from firms who have "an agency and nothing more".

It is impossible to expect firms to have efficient after-sales-service and an adequately stocked spare parts depot when they represent equipment of small population in India. It is further impossible at our infant-stage of industrialisation to find technicians who are well qualified to take care of the large variety of highly intricate modern machines. If the range can be limited, the firms as well as the technicians will have a better opportunity to look after the machines.

The want of standardisation on few satisfactory makes of equipment serviced by capable firms in India, has to our mind, contributed largely to the unsatisfactory position obtaining at present on most of our projects. This fact found unanimous support by the engineers at the Bhakra Seminar. We cannot do better than reiterate that if one project buys most of its equipment in one make and standardises on sizes the Indian technicians can give a far more satisfactory standard of performance.

2.11. Standardisation of Power Units

We further consider that the standardisation of the power units should be given adequate weight in plant planning. Advantage of option in power units should be taken and equipment should be purchased to have, as far as possible, the same makes of engine. The makes of engines on many of the static units, *e.g.*, power generators, crushers, pumps, etc., should also align, as far as possible, with the bulk of engine makes even at a slightly increased initial cost.

2.12. *Omitted*

2.13. Standardisation on Sizes

We further suggest that, in plant planning for mechanised projects, it is not desirable to go into the range of small equipment because large equipment is sturdier and the jobs that suit small equipment can better be done by manual labour. We suggest that under the category of Crawler Tractors sizes not less than 80 drawbar H.P. should be used. Under excavators, we recommend 1½, 2½ and 3½ yard sizes. Still larger sizes may be required on special jobs. The Bottom and Rear Dumpers should not be smaller than 6 cu. yds. struck capacity. The Scrapers should be 12 cu. yds. struck minimum, the Graders 70 B.H.P. minimum and the Compressor 215 cfm. minimum.)

ADMINISTRATION

3.01. Factors Controlling Project Efficiency

There are two sets of factors which control the efficiency of any project, namely the *job factor* and the *management factor*. The job factor is beyond our control having to do with topography, weather conditions and job specifications which sometimes make it necessary to handle the work in an otherwise than economical manner The second or *management factor* consists of:

(1) planning and administering the job ;

(2) selection, training and direction of personnel ; and

(3) selection, care and repair of equipment.

Point (1) will be considered here, (2) is considered in Chapter Four, and (3) is to be covered in Chapters Two, Five and Six.

3.02. Planning and Administration

Planning for a particular job can only be done in the light of actual information about the job concerned. However, all projects have certain facets which must be considered and more or less standard concept of administration can be suggested. The principal variable will be the size.

3.03. Delegation of Authority

It is very difficult for any one man to handle the detail necessary to the administration of large endeavour. To do so adequately *it becomes necessary for him to delegate his authority.* One of the greatest difficulties with administration in India today is that executives are reluctant to delegate authority in the proper manner. They are reluctant for three reasons :

(a) their subordinates are improperly trained or qualified ;

(b) they do not trust their subordinates ; and

(c) government regulations do not allow for enough delegation of authority.

In the first instance, the executives should train their subordinates; in the second, subordinates who cannot be trusted should be replaced ; in the third, regulations must be reformed to allow this proper delegation of authority where it is necessary. The method of doing this in use by all large armies and industrial organisations in the world today is known as a *line and staff organisation.*)

3.04. Line and Staff Organisation

This type of organisation will be better understood if we think in terms of army organisation. The Infantry are a line organisation and are backed up by such staff organisations as Quartermaster Corps, etc. On construction the same concept is true. The people who do the actual work are the line organisation and are backed up by such staff sections as finance, cost accounting, personnel, supply, etc.

3.05. Co-operation in Administration

The total efficiency of such an organisation depends on proper co-operation between sections and proper integration of functions of sections. Frequent staff conferences at the different levels must be held to keep the personnel informed and to integrate the work of different sections. Friction and lack of co-operation between sections do great damage and cannot be allowed.

3.06. Suggested Organisation

A suggested organisation for large multi-purpose projects is outlined in Chart I and the accompanying analysis. This is for a very large project. The organisation for smaller projects would be similar with some sections or units left out and with the functions of some combined.

3.07. Chart I as a Concept of Organisation

It must be understood that this chart is not offered as an actual chart for a project. It is not. It is offered as an attempt to indicate proper lines of thinking about efficient organisation and administration. The particular idea, we are most interested in conveying, is the line and staff concept. Before analysing Chart I, certain factors should be noted which may make the analysis simpler for the reader.

3.08. Variation in Project Organisation

The present administration of the various projects visited on the recent tour of this Committee differed a great deal in their organisation. When this was discussed and an attempt was made to find reasons for the difference, the conclusion was reached that the administrations were the result of trying to apply the Indian P.W.D. system and grades of service to the projects.

3.09. Existing P.W.D. Organisation

The present Indian P.W.D. system as listed is as follows :

P.W.D. Grades of Services

1. Secretary	Civil Service Man.
2. Chief Engineer I. S.E., or Class I	Pay 1,700 to 2,000. One for each or a group of subjects in one State.
3. Superintending Engineer . .	1,300 to 1,700 Zonal or subjectwise. About 4 to 6 of these would make a Chief's charge. Two Chiefs may have overlapping jurisdiction on one S. E.
4. Executive Engineers, Class I or I. S. E.	500 to 1,000 Zonal or projectwise. About 4 to 6 of these make an S. E.'s charge. One Zonal E. E. may be responsible to more than one S. E.

Assisted by Personal Assistant 250 to 600 usually Class II or Junior Class, one man.

Divisional Accountant. A. G.'s representative 150 to 300 is equivalent in rank to Sub-Divisional Officer.

5. Sub-Divisional Officer. . .	250 to 600
Class II Service . . .	4 to 6 of these make a Divisional charge.

Assisted by (a) Senior Accounts and Office Clerk.
(b) One Overseer.

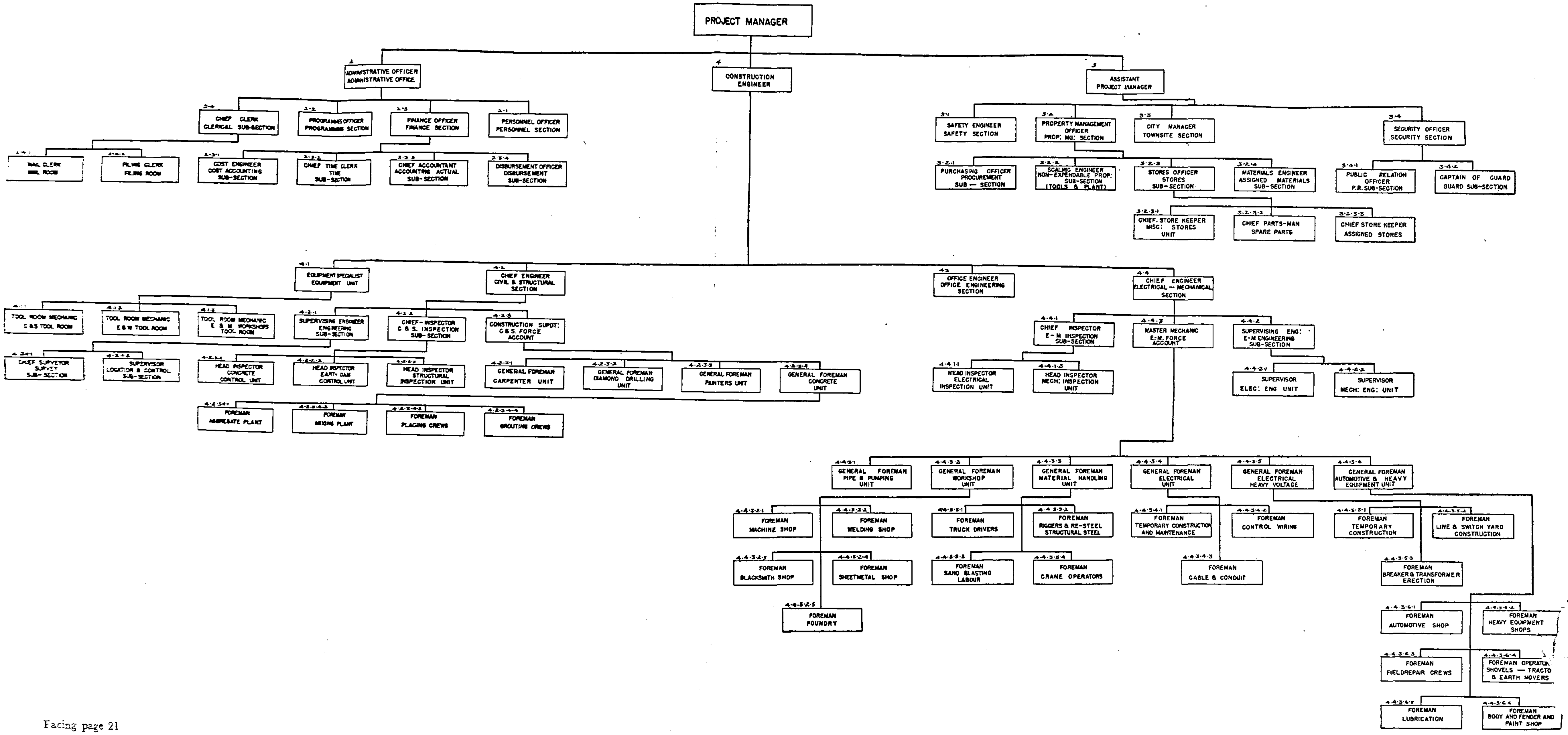
6. Overseer and Supervisor Class III Subordinate Service (Non-gazetted).	70 to 200 Clerks, Mistries, Technicians.

3.10. P.W.D. System's Original Purpose

The above system is excellent for the purpose for which it was developed, *i.e.*, the building and maintenance of public works such as public buildings, roads, water system, etc. However, it was developed chiefly for use with contract manual labour and it is not applicable to large multi-purpose projects to be built by Government forces using large amount of machinery.

Note.—Item 6 usually a diploma holder in Engineering (short course of three years). Rest have to be Graduate of Engineering.

LARGE MULTI-PURPOSE PROJECT



Facing page 21

3.11. Designation used in Chart I

You will find on inspection of Chart I that very few of the titles used are in use in India. It will also be found that more grades of service are necessary to set up such an organisation. The titles used and positions described are the result of experience with the Bureau of Reclamation in the U.S.A. The organisation shown is somewhat similar to the one in use at Grand Coulee Dam at the time when the U.S.B.R. was doing all the work with Government forces

3.12. Organisation and the Financial Adviser

Please note that no place is shown on this chart for a Financial Adviser. It is our feeling that Financial Advisers are unnecessary on these projects. Funds are alloted to the projects for use in construction; the only people qualified to pass on the use of these funds are the engineers responsible for the construction. Dr. Sudhir Sen* writes "a financial expert advises on proper spending, his function is positive. He checks, but does not checkmate; he vests, but does not veto, for he knows that jobs are done by wise expenditure, not by withholding it". If the Financial Advisers would operate on the lines set in the above quotation, there would be no difficulty. Unfortunately they generally do not, and since few of them have any mechanical background or construction experience, they are more often hinderances than aids.

This is not to be misunderstood ; the executives responsible for funds on a project must stand behind and be responsible for the correct handling of the allotments. Periodic audits are necessary and must be conducted to ensure honesty and efficiency.

3.13. Limitations of Chart I

It is necessary to note that staff is suggested only as to type and placement in the organisation. The number of personnel employed is determined by the size of the project and must be held to a minimum as far as possible. The numbers above the upper left-hand corners of the boxes on the chart refer to paragraphs in the analysis.

3.14. Chart of Organisation

(*See opposite.*)

3.15. Analysis of Chart I

1. Project Manager

This is a fully qualified engineer responsible for the management and construction of the project as a whole. He is the final authority on policy and construction as far as the project is concerned. His

*"The Future of Public Corporation" by Dr. Sudhir Sen. This is recommended reading for persons interested in the matters concerned in Chapters Three and Four of this Report.

headquarters are at the project. His selection will be a matter for the State Government or the Control Board involved in a construction project. On the very large projects, he should be a man of recognised reputation. Staff—Personal Secretary and Stenographer.

2 Administrative Officer

This position is the top position in the administration of the project. The Administrative Officer is in charge of personnel, programmes, finance and accounting. As such, he must have adequate background in the handling of large amounts of money and large groups of personnel. He is not necessarily an engineer. He is a businessman. All important correspondence on matters of policy will go through his hand. Staff—Personal Secretary and Stenographer.

2.1. Personnel Officer

This officer is head of the Personnel Section and works directly under the A.O. and is responsible for recruiting, training and maintaining constructive work relationship *viz.*, project personnel. A good Personnel Officer is familiar with the project work and qualifications of people necessary to fill all positions on the project. In connection with the maintaining constructive work relationship with personnel, it is necessary that he disseminates information to the Supervisory personnel on the project regarding correct supervisory conduct and project policy in general. In the Personnel Section, complete records are kept of all personnel employed, promoted and released, Staff consists of Jab Analysts, evaluation, personnel clerks, filing clerks and typists. *See* Chapter Four.

2.2. Programmes Officer

This officer is head of the Programmes Section and works under the direction of the A.O. The responsibilities of the Programmes Section are to prepare the budget for the projected programme as determined by conferences of the following projects officers:—

(i) Project Manager.

(ii) Administrative Officer.

(iii) Assistant Project Manager.

(iv) Construction Engineer.

(v) Programmes Officer.

The Programmes Officer budgets money as per the programme determined. If his budget is sanctioned, the programme is carried forth against this line. If his budget is increased, the programme is expanded and if his budget is decreased, the programme is curtailed. During the conduct of the programme the Programmes

Officer collects actual figures of expenditures for labour and material and is responsible for holding the work of the project within the limits of the budget allotted. He must also make sure that special allotments of money are used for the purpose for which they have been sanctioned. Staff consists of statisticians, accountants, engineers, and suitable office personnel.

2.3. Finance Officer

This Officer is in charge of the Finance Section and is responsible to the Administrative Officer. He is primarily a Chartered Accountant and is responsible for sub-sections as follows:—

2.3.1. *Cost Accounting*—This is an engineering function headed by a costing engineer. His function is to set up accounting system for the project and to determine how accounts and specifications shall be sub-divided in order that control of cost shall be attained. *See* Chapter Eight.

2.3.2. *Time-keeping*—This section is under the charge of Chief Time-keeper. The duties of the sub-section are to make pay bills, muster-rolls for each month for all personnel on the project. Must collect all labour costs including supervisory labour against various accounts and furnish this record to the Programmes Officer for his information periodically.

2.3.3. *Accounting (Actuals)*—The duties are to collect costs of labour, materials and miscellaneous.

2.3.4. *Disbursement*—This officer is a cashier in charge of paying pay bills and muster-rolls and pays for all materials and services received by the Project.

2.4. Chief Clerk (Sub-Section)—Correspondence and Filing

This man is head of the correspondence and filing section. This is primarily an office function. The main duties of the Chief Clerk are to see that records and correspondence are properly filed and all mail received on the project is promptly delivered to the proper addressees.

2.4.1. *Mail Room*—All correspondence of the project is delivered to this place and from here is delivered, by project messengers, to the proper office or personnel.

2.4.2. *Filing Sub-Section*—All records and correspondence are kept properly filed to be immediately available, when necessary.

3. Assistant Project Manager

This officer is directly responsible to the Project Manager and acts in his stead when the Project Manager is not available. This man should be fully qualified as construction engineer. The following sub-sections and personnel of the project are responsible to him:

3.1. *Safety Engineer*

This officer is responsible for safe practices throughout the project including the training of personnel as regards safe practices, providing of adequate first aid stations and if necessary hospital facilities. He is responsible for giving personnel physical tests to determine their fitness for their projected employment.

3.2. *Property Management Officer*

He is the head of the Property Management Section and is directly responsible to the Assistant Project Manager. The title is descriptive of the function which is the management of the project property. He should be a man with manifold experience in operation and handling of equipment. An engineering degree is not necessary for this position. He is responsible for procurement and storage of all materials used on the project and is responsible for the purchase, maintenance and utilisation of all equipment and spare parts used on the project. The following sub-sections work under him:

3.2.1. *Procurement Officer*—He is in charge of the procurement sub-section and takes action on all purchase and procurement orders and requisitions for the whole project, getting quotations, issuing purchase orders and expediting procurement.

3.2.2. *Scaling Engineer*—This man works under the direction of the Property Management Officer and his duty is to originate and review purchase requisitions for materials, stores and spare parts. The facts he has to consider in reviewing are (a) adequacy of the requisitions as regards quantity, (b) adequacy of the requisition considering the requirements of the project and (c) he must make sure that stores and spare parts are adequately stocked without being overstocked. See Chapter Seven and Appendix 7.

3.2.3. *Stores Officer.*—This Officer is head of the stores sub-section and is responsible to the Property Management Officer. He is in charge of all stock-keeping on the project and of all office records for materials intended for the project works. He will have a staff of approximately 20 clerks for recording and receiving reports, pricing indents and taking care of disposa. records. The following stores are under his charge :

3.2.3.1. Miscellaneous Stores including all general hardware, paints, etc.

3.2.3.2. Spare Parts Store including all parts for equipment and tyres etc.

3.2.3.3. Assigned Stores including all stores purchased against the particular specifications for use in the construction of some phase of the project work. Under this come, cement, fabricated sections for gates, turbines parts etc.

3.2.4. *Materials Engineer*—Assigned materials sub-section. This is a parallel position to the Scaling Engineer but where the Scaling Engineer is concerned with spare parts and general hardware, the Materials Engineer is concerned with bills of material for particular work as determined from design specifications furnished by the Office Engineer.

3.3. City Manager

This officer is responsible for the management and facilities of the construction town. If rents are to be collected or any fees are charged for amenities the billing is done through his office although payments are made to the Cashier who works for the Finance Officer.

3.4. Security Officer

Security Section. He is the head of the Security Section and as such is responsible for the security of the project including public relation functions and physical security as regards theft or pilferage.

3.4.1. *Public Relations Officer.*—He is the head of the Public Relations Section. He is responsible to see that articles for publication stemming from the personnel of the project are suitable. If radio broadcasts or movie pictures are to be made concerning the project he will guide the making of the broadcast or the film.

3.4.2. *Captain of the Guards*—He is in charge of and responsible for the guide and guard force.

4. Construction Engineer

This man is in complete charge of construction on the project and is responsible directly to the Project Manager. He should be a well qualified engineer with manifold experience of project construction.

4.1. Equipment Specialist

This man is the head of the equipment unit and is responsible for all tools and plant used on construction from the standpoint of accountability. All requisitions for general hardware and spare parts, that originate from the Construction Directorate, are reviewed in his office before going to the Scaling Engineer, Material Engineer or the Procurement Officer. He is to inspect and insist on proper maintenance of all equipment, tools and plant in the Construction Directorate. The following sub-units are responsible to him:

4.1.1. *Civil and Structural Tool Room*—All tools and plant are kept, maintained and issued for daily use and are returned at the end of the period used.

4.1.2. *E. & M. Tool Room*—All tools and plant for the E. & M. Section are kept, maintained and issued for daily use and returned at the end of the period used.

4.1.3. *E. & M. Workshops Tool Room*—All tools and plant for the Workshops are kept, maintained and issued for daily use.

4.2. Chief Engineer, Civil and Structural Section

This man is a qualified Civil Engineer and is directly responsible to the Construction Engineer for all civil engineering and inspection done locally on the project. The following sections are responsible to him:

4.2.1. *Civil and Structural Field Engineer*—This man is a qualified Civil Engineer and is responsible directly to the Chief Engineer, C. & S. Section. The following units are responsible to him:

4.2.1.1. SURVEY UNIT—As the name implies, this unit is to make all local surveys in connection with the temporary construction facilities.

4.2.1.2. LOCATION AND CONTROL UNIT—This is a survey section which makes all surveys in connection with the basic design for the project including embankment measurements etc.

4.2.2. *Civil Structural Field Inspection*—The head of this subsection is a qualified Civil Engineer and is responsible to the Chief Engineer, C. & S. He is in charge of all C. & S. inspections. The following units are directed by him:

4.2.2.1. Concrete Control including Concrete Laboratory Unit.

4.2.2.2. Earthwork Control Unit including Earthwork involved in the Dam Construction.

NOTE.—The above two units are generally headquartered together and the same laboratory facilities are available to both.

4.2.2.3. STRUCTURAL INSPECTION UNIT—As the name implies, this man is responsible for the inspection of all structures, *i.e.*, reinforcement of steel, painting, etc.

4.2.3. *Construction Superintendent and C. & S. Force*—This man is not necessarily a qualified engineer but a man with large practical experience in concrete structural works on the projects. He is in charge of all C. & S. labour force and is directly responsible to the Chief Engineer, C. & S. Section. The following units fall under his control :

4.2.3.1. General Foreman, Carpenters.

4.2.3.2. General Foreman, Diamond Drilling.

4 2.3.3. General Foreman, Painters.

4.2.3.4. General Foreman, Concrete, including.

4.2.3.4.1. Aggregate plant and quarries ;

4.2.3.4.2. Mixing Plant ;

4.2.3.4.3. Placing of concrete ; and

4.2.3.4.4. Grouting.

4.3. Officer Engineer

This man is directly responsible to the Construction Engineer. He has mixed staff of engineers including Civil, Electrical and Mechanical and a number of draftsmen. It is his responsibility to take the basic design furnished for the project and furnish detail blueprints to the C. & S. Section and E. & M. Section. All local designs are done in this office. Lists for materials necessary to complete structures and/or any operations of project work are made up in this office and sent to the Materials Engineer for his action.

4.4. Chief Engineer, E. & M. Section

This man is a qualified E. & M. Engineer and is responsible directly to the Construction Engineer. He is in charge of ali field E. & M. engineering and inspections. The following sub-sections and units are under his control :

4.4.1. *E. & M. Field Inspection*—This is headed by the Chief Inspector, E. & M. He is a qualified E. & M. Engineer and is in charge of all field engineering and inspection so far as E. & M. installations are concerned.

4.4.1.1. ELECTRICAL INSPECTION—The personnel of this unit do the inspection of all the electrical installations and make the progress reports. It is their responsibility to see that all electrical installations are in accordance with the basic designs furnished by the Office Engineer.

4.4.1.2. MECHANICAL INSPECTION--The personnel of this unit do the inspection of all the mechanical installations and make the progress reports. It is their responsibility to see that all the mechanical installations are in accordance with the basic designs furnished by the Office Engineer.

4.4.2.1. ELECTRICAL ENGINEERING—This unit is headed by a qualified Electrical Engineer. His duties are to check the electrical installations and re-design, when necessary.

4.4.2.2. MECHANICAL ENGINEERING—This unit is headed by a qualified Mechanical Engineer and his duties are to check the mechanical installations and re-design, when necessary.

4.4.3. *Master Mechanic*—This man is in charge of all E. & M. installations, Force Account and labour and is not necessarily a qualified engineer but is a man of manifold experience in handling labour for E. & M. construction work. He is directly responsible to the Chief Engineer, E. & M. Section. The following sub-sections fall under his control.

4.4.3.1. General Foreman, Pipe and Pumping.

4.4.3.2. General Foreman, Workshops.

The following five workshops are under him:

4.4.3.2.1. Mechanical Workshop.

4.4.3.2.2. Welding Workshop.

4.4.3.2.3. Blacksmith Workshop.

4.4.3.2.4. Sheetmetal Workshop.

4.4.3.2.5. Foundry Workshop.

4.4.3.3. GENERAL FOREMAN, MATERIALS HANDLING.—This man is responsible to the Master Mechanic and the following units fall under his direction:

4.4.3.3.1. Truck Drivers.

4.4.3.3.2. Riggers-reinforcing steel—structural steel.

4.4.3.3.3. Sandblasting-labour.

4.4.3.3.4. Crane Operators.

4.4.3.4. GENERAL FOREMAN ELECTRICAL—The following units fall under his direction :

4.4.3.4.1. Temporary construction and maintenance.

4.4.3.4.2. Control Wiring.

4.4.3.4.3. Cable and conduit.

4.4.3.5. GENERAL FOREMAN, ELECTRICAL, HIGH VOLTAGE—This man is responsible to the Master Mechanic and the following units are under him:

4.4.3.5.1. Temporary construction.

4.4.3.5.2. Line and Switchyard construction.

4.4.3.5.3. Breaker and transformer erection.

4.4.3.6. GENERAL FORMAN, AUTOMOTIVE AND HEAVY EQUIPMENT—This man is directly under the Master Mechanic and the following units work under him:

4.4.3.6.1. Automotive shop.

4.4.3.6.2. Heavy-equipment shop.

4.4.3.6.3. Field repair crews.

4.4.3.6.4. Operators-shovels, tractors and earth-movers.

4.4.3.6.5. Lubrications.

4.4.3.6.6. Body and Fender shop.

3.16. Codifying of Functions

As mentioned before, the organisation is similar one used by the Bureau of Reclamation in the U.S.A. It should be understood that all routine procedures and forms to be used by the different sections are codified in the Bureau of Reclamation Manual. All decisions are made in compliance with the Manual, but they are made by the officer concerned on the project. In other words, the Manual is given as guide, but project officers are responsible to the Project Manager who in turn is responsible to the Government for adherence to the Manual.

3.17. Codification Necessary in India

The lack of codification of procedures and forms is the greatest difficulty in project organisation and administration in India. The three Directorates recommended by this Committee (Equipment and Parts Planning, Personnel and Training and Cost-accounting), if established, should have as their primary function the codification of procedures, forms and records. This would ultimately bring about the assembly of a manual of procedures.

3.18. Financial Limit of Mechanised P.W.D. Charges

We feel that although a normal Divisional charge in P.W.D. should be able to handle project works through contracts to the extent of about Rs. 40 lakhs per year mechanised departmental work should be limited to about 25 lakhs. If more is attempted it will result in inadequate control and higher costs, causing in overall uneconomical performance. We further think that the strength of such a Division should be about 1·5 times the normally accepted standards for Divisions.

3.19. Proper Placement of Authority

Regarding the mechanised organisations, we felt that inadequate attention is paid to a proper set-up in most of our projects and that the importance of a high standard of control on machines is not appreciated. Over half the expenditure on even a modestly mechanised project is through machines. The machines and their supervising staff are placed as tools in the hands of Civil Engineering Officers who do not have adequate knowledge of the technique and performance of equipment. We do not advocate independent charge to mechanical engineer, since that would create divided responsibility but we do believe that the sphere of responsibility of the entire mechanised field should be set at as high a level as possible in the administration of a project. We feel that the Nangal and Hirakud Organisations have scope of improvement in this direction. Even on small projects such as Lower Bhavani or Gangapur, the bifurcation of the mechanical engineering is done starwise—in that many officers are independently operating under the Executive Engineer. An integration of all of them under a Plant Engineer with unitary control would be an improvement.

3.20. Direct Control

Fundamentally, no person should be invested with powers of authority unless he is responsible for production. This leads to direct control and reduction of routine. which is very essential for rapid progress and low costs. Organisations developed for maintenance do not do well on construction work. Unnecessary routine in the handling of correspondence must be avoided.

3.21. Decentralisation of Powers

It is necessary on the projects that powers should be vested at each level so that too much centralisation does not occur. Speed in handling project matters is more readily achieved, if decisions are made at lower levels. If cases have to be sent to higher officers the knowledge of details may be lacking. Every officer must be vested with authority commensurate with the responsibilities entrusted to him. The principle has been accepted in the normal P.W.D. accounts, where large powers are vested at various stages in the service personnel. It is surprising that in the matter of supply most of the projects have adopted different yardsticks that cause too much centralisation. Often routine matters are referred to persons who have no responsibility for the conduct of the project. A review of the position in this respect is overdue.

3.22. Necessity for Rapid Decisions

The work on mechanised construction is so fast that unless decisions are made quickly, either the work has to be stopped or carried on wastefully. The importance of making decisions rapidly enough not to impede the progress of the project, cannot be overemphasised. All important project matters should be dealt with under a system of 'priority' which should be properly planned.

3.23. Modern Facilities

Speed is the essence of mechanised construction and hence it is not adequate to buy the equipment if the ancillary services do not keep pace with it. Liberal use of telephone between officers down to the level of S.D.O.'s and field stations should be 'a must'. Additional facilities such as calculating machines, Roneo, typewriters and card indexing system should be utilised freely.

3.24 Phasing of Work

Rigid adherence to the time phased schedule of work is a great necessity on all works but it is more so on jobs executed departmentally through machinery. If delay occurs in one phase, it throws other phases of construction out of the gear ; the production falls down and the costs mount up. The organisation should, therefore, be very alert in planning phases and executing it in such a way that the production of all units are synchronised in conjunction.

3.25. Modification of Designs

With contract jobs there is usually a tendency to stick to the official design and expect the contractor to solve the difficulties that arise in meeting the requirements of the design. When a job is executed departmentally, such an approach may result in great waste of money. There should be no hesitation to change the design as soon as it is realised that with the means available at the project, the work cannot be carried out as rapidly and economically as required. So long as the main engineering requirements are fulfilled, there should be no objection in changing design during the execution of the work.

3.26. Separation of Design and Construction

Most of the States, we visited, have separate arrangement for design. The construction staff should not be taxed with designs or the State is liable to lose in quality of both. We recommend that with the large amount of projects in the State, it should establish a separate Design Directorate.

3.27 Decision as to Means of Executing Projects

When a project is designed and estimated it must be decided whether it will be executed departmentally or through contracts. There is still a common belief that this consideration should not make any difference in the execution of a project. This is not correct. The details worked out for executing a project through contracts are entirely inadequate for doing it departmentally. A lot of arguments have been forwarded for and against departmental execution not only in India but even in more mechanised countries like U.K. and U.S.A. This report is no place to discuss this matter except in as far as it effects mechanisation on projects.

PERSONNEL

4.01. Need for Personnel Policy

The need for an enlightened personnel policy of the type in effect in large modern commercial enterprises made itself evident during our visits to various projects.

The development and advancement of a modern mechanised society depends on the co-ordination of three basic types of personnel, *i.e.*, pure scientists, engineers and technicians. The lack of any one of these will cripple the development of mechanisation.

The general functions of the three types are as follows :

The pure scientists do research and develop theories working from the general to the particular or from the particular to the general. When a theory is developed, the engineers give it a practical application by designing something in which the use of the theory is incorporated. The technicians build, operate, and maintain the machines that engineers design.

It must not be thought that these three fields are strictly separate. Sometimes an engineer does practical research, hence the term "research engineer"; at times a scientist does some engineering as when an inventor constructs a machine incorporating a theory he has developed.

In the U.S.A. it is quite common for technicians to do engineering as they often suggest changes in design of machines in order to make machines better in some way, *i.e.*, more powerful, more readily maintained, more durable, or easier to control.

4.02. Present Status in India

India has enough scientists and enough graduate engineers, although the engineers do not have the experience necessary for the construction of the very large projects that are planned. There is a very outstanding lack of technicians and this is at present a critical factor, which holds back the mechanisation of projects and makes them unduly costly.

4.03. Facets of a Modern Personnel Policy

The establishment of an enlightened personnel policy will do much towards alleviating the present difficulties in the mechanization of projects. The proper recruitment, training and the maintenance of constructive work relationships with personnel are essential to the economical conduct of the projects.

4.04. Personnel Evaluation by Tests and Testing

Personnel evaluation by means of tests and testing is a new and wide field considered here because of its value in selection and training of personnel. There are several types of tests and methods of testing available and they are applicable at all levels from the executive down to the craftsman.

Two kinds of tests are used in selection of personnel for employment and for training. The first type tests intelligence and basic aptitude or abilities and is particularly valuable in the selection of people for training as it saves a large amount of the money wasted on training of unfit candidates. The second tests also for intelligence; but lays more stress on proficiency and acquired information. A third type of test is used in the selection of candidates to train for executive positions. This type evaluates personality, which is more important in an executive than either intelligence or proficiency as long as the candidate has average or better intelligence and efficiency. Proper selection of tests to use and methods of using them are matters for trained psychologists. It is the opinion of this Committee that this matter needs investigation. We suggest that this matter should be pursued by the Directorate of Technical Personnel recommended to be opened under C. W. & P. C. A bibliography of material applicable is attached (Appendix No. 2.1.).

4.05. Recruiting of Personnel

The first step in considering recruitment of personnel for a large project is to determine the number and qualifications of personnel needed.

The number of personnel and their necessary qualifications can be determined from the specifications of the project under consideration and the type of organisation to be set up, *see* under Chapter Three.

When the specifications of positions to be filled are known, a specific procedure for recruitment can be set up and the personnel can be recruited. It should be noted here that influence is often exercised to fill these and other positions on projects. This is wrong.

The policy in effect on T.V.A. projects in U.S.A. is set out in the T.V.A. Act which says "No political test or qualification shall be permitted or given consideration, but such appointments and promotions shall be given and made on a basis of merit and efficiency."

4.06. Corruption in Personnel Selection

The corruption involved in filling positions with people, who are not the best available, is just as indefensible as the taking of bribes, The restrictions imposed by the Civil Service Regulations as to ratings and seniority often work a hardship in obtaining and retaining properly qualified people ; these regulations should be reviewed and reformed, where necessary.

4.07. Retention of Trained Personnel

Men who have been trained at considerable cost in both time and money are sometimes transferred to other work because they are due for promotion. From an economic stand-point, this is wasteful. Most projects are completed in two to ten years. It would be a far more sensible procedure to retain men who are familiar with the problems and organisation of a project even though it be necessary to give them higher rates and salaries as "next below rule".

4.08. Criteria for Selection

The correct criteria for selection of personnel for positions are academic qualifications, experience and merit as determined from previous work or school records, and by adequate testing where possible.

Although high level positions on major projects are generally filled in by the State Governments or Control Boards concerned the necessary qualifications for these positions should be carefully worked out, suitable position descriptions developed and scrupulously adhered to and the selection made by giving more weight to practical experience than academic qualifications and seniority.

The same procedure should be followed in employing personnel for other positions on a project. When a project is planned, the organisation chart should show the number and levels of positions necessary. The functions of the positions should be determined and from this the necessary qualifications will be apparent. Knowing the functions and duties of a position ; the position can be classified as to qualifications.

The next step is to post notifications stating that the described positions are open for application. When applications are received by the personnel officer, they must be carefully evaluated and the best candidates employed as per the criteria mentioned.

4.09. Application Forms

A standard application form should be worked out. Copy of a Union Public Service Commission blank used in India for Gazetted Officers and copies of forms 57 and 58 as used by the United States Civil Service Commission are *attached. *See* Appendix Nos. 2.2. and 2.3.

In referring to these forms a contrast is immediately noted. In the Indian form about 40 per cent of the space is used for academic qualifications and testimonials to be furnished by the candidate and 10 per cent for the experience records. In the U.S. form 57 about 35 per cent of the space is used for the experience record and about 10 per cent for academic qualifications. The Indian form requires an application fee, which is not desirable in a form to be used by the level of applicant, we have in mind. Consideration of the U.S. forms will show that while questions are asked about physique, salary desired, education and experience ; no question is asked about family, political affiliation, or religion except questions 27, 28 and 29 asking about membership in Communist or Fascist Organisations.

4.10. Applications of Non-Literate Candidates

On the large projects in India, it will be necessary to establish employment offices, under the control of the personnel officer, to interview candidates for employment since the level of literacy is such that many of the people who must be employed are not able to make out an adequate application although they may be entirely satisfactory for the work they apply for.

4.11. Evaluation of Applications

As mentioned above, the applications when received must be carefully evaluated. For some standard classified positions, tests and standards for acceptance can be developed and applied. An example of a position is the Stenographer. Tests in typing and shorthand are readily available and it is not necessary to depend on references to determine a candidate's fitness for employment. In the same manner, tests and standards for acceptance can be evolved for many of the positions below the executive or administrative level.

4.12. Training

Under this heading, while training personnel at several levels and by several methods will be considered, it is more important from the standpoint of the Construction Plant and Machinery Committee to stress training at the levels of the operation and maintenance forces and their supervisors. The lack of trained personnel is evident and from the papers presented at the Engineers' Seminar at

*Not printed.

Bhakra, January 5—7, 1954, we are glad to notice that the subject is now under active consideration by the Centre and the various administrations.

4.13. Foreign Training

Training for personnel of various levels is available through the Technical Cooperation Mission and through the United Nations Organisation. A copy of the T.C.M. programme is *enclosed, Appendix No. 2.4. It should be noted that this training is available to technicians as well as engineers.

4.14. Seminars

The proposed series of Seminars for engineers which started with one at Bhakra, is an excellent step in the right direction. This is a programme, which will contribute to the training of executives and to the exchange of information between projects and as such is very valuable.

4.15. Lack of Co-ordinated Programme

The projects have made all efforts to train operation and mechanical forces and supervisors. The results are at present very disappointing. There are several reasons for this, the chief one is the lack of any planned co-ordination programme for training and the lack of any set standards for training.

4.16. Training of Operators and Mechanics in U.S.A. & U.K.

In both the United Kingdom and the United States the training of operators and mechanics is largely an "on-the-job" set-up. This is necessary since the only place an operator of earth-moving equipment can be trained is, where the earth is being moved, preferably in large quantities. The first step in training an operator in the States is to put him on the machine as an oiler (Greaser) with an operator. As such he is totally responsible for the lubrication of the machine and becomes familiar with its working parts. The theory behind this is that the operator is responsible for the care of his machine and in order to be responsible, he must be thoroughly familiar with its working parts. This necessary familiarity can never be acquired as an operator trainee who merely watches in order to learn which lever or pedal to push. In India the projects depend too much on the equipment distributors to furnish operators. These distributors are not interested enough in training operators properly. As mentioned above, they merelv teach what lever or pedal to activate to make the machine move.

*Not printed.

The training of mechanics in both the U.K. and U.S.A. is accomplished through apprentice programmes. This programme generally involves four years of both practical and theoretical training before an apprentice becomes a journeyman. The apprentice attends school for at least two hours a day to learn the theory behind the work he is learning in his practical training. This school is in connection with and sometimes a part of the workshops and is conducted by workshops personnel. A planned programme incorporating these ideas with standards for training could be applied both in the case of operators and mechanics and would be of far more value than the present haphazard system.

4.17. Indian Army Standards

The Indian army has worked out a set of standards for operators, excavators, and earth-movers which set up four classes of operators. The army gives their recruits considerable training in the operation and maintenace of these machines and it is felt that since these are the only standards available worked out for Indian conditions, they are the best to apply at present. See Appendix 2.5.

4.18. Testing Candidates for Training

It has been mentioned above that in connection with training of any kind it would be wise to apply tests to the candidates in order to make sure that they can absorb the training. As regards both operators and mechanics, it would be wise to insist that they be either diploma holders or graduates with a good knowledge of English in order that they can read the parts books and service manuals for the machines. The translation of service manuals into Hindi or local dialects has been considered but we do not recommend the attempt at present, since neither Hindi nor the dialects have terms adequate to the description or discussion of machinery and adequate understanding of instructions would be difficult to obtain.

4.19. Adequate Supervision of Operators and Mechanics

As regards supervisors and mechanics, neither in the U.K. nor in the U.S.A. is a person ever allowed to supervise operators or mechanics if he is not a good craftsman himself. It has been found that it does not work since it is impossible for a supervisor to check adequately on work which he cannot do himself.

4.20. Standard of Operation in India

The standard of operation in the country has to be improved from two aspects (i) care in operation of the machine and (ii) getting the best production. The average operator lacks the necessary background of training to operate his machine to have a minimum of wear and tear. To remedy this defect we suggest that one or two Training Centres should be opened in the country. There are over 4,000 operators of heavy equipment on the River Valley Projects. If half of them take advantage of the Training Centre there will be a substantial improvement on the projects. States cannot afford high-grade training schools and hence the Central Government should take over this work. The necessity of having trained and certified operators has long been recognised by Railways. Even for minor equipment such as lorries, a driver's licence is necessary. It should be more necessary to require a certificate for a costly piece of equipment which in some cases costs as much as a locomotive.

4.21. C. W. & P. C. Training Scheme

C. W. & P. C. has worked out a scheme for training operators and we recommended its early implementation. We, however, suggest the following improvements:

(a) The basic standard of elementary education and initial practical training for recruitment should be fixed so that the operators can assimilate the higher training in operation and maintenance.

(b) The pay scales should be made more attractive and be more or less uniform in all the States to increase the chances of equal distribution of good operators on all projects.

(c) The recruitment to the Training Centre should be from two sources—(i) direct recruits (ii) from the operators working on the project for advance training.

(d) For grading the trainees, technical examinations should be held and certificates issued under the authority of the Government of India. The pay scales should be correlated to the grades.

(e) The Indian firms representing standardised equipment should be associated with the Training Centre and their resources should be utilised in a suitable manner.

(f) Facilities should be offered to the operators on far off projects, to appear for examination at the Project Headquarters, under the normal regulations of Departmental Examinations.

(g) Periodical physical examinations should be given to determine the physical fitness of the operator for his work.

Suitable minimum standards should be set.

The setting up of a school at the Centre for the training of operators and mechanics is a responsibility which must not be assumed lightly. This will take much time and cost a large amount of money

As has been pointed out, it takes at least three or four years to make a journeyman operator or mechanic. To waste money on a school with inadequate teaching personnel and facilities would be worse than useless.

4.22. Service Records of Operators

Projects should maintain service books of every operator which should record, amongst other essential data, information regarding his operational knowledge and experience. Supervisory staff of operation teams should also be trained on similar lines to achieve satisfactory standards of performance and use of machinery statistics. A central record of quality operators and technicians should be maintained by the Directorate of Technical Manpower suggested by us to be opened under C. W. & P. C.

4.23. Improvement of Maintenance

Maintenance standards on our projects are even poorer than the operational standards. More care and effort is necessary to create a team of technicians who are good at "trouble shooting" and who can overhaul machines satisfactorily. The Central Training Centre will not be able to do much in this respect as it cannot have access to all types of equipment at various stages of repair. This training can best be imparted by running special schools under the guidance of the technical staff of the standardised equipment. This should be a part of the obligation on their part. The location of the school will have to be decided with due regard to the proximity of the projects sending the candidates, the facilities as to the availability of the specialised tools, hostel and class room facilities and above all machines of different types at different stages of wear and repairs. Use of the workshops of the firms representing standardised equipment is one alternative; use of the facilities of the larger projects is another.

Some of our projects have developed certain aspects of maintenance and repairs to a good standard. Projects staff at and above the level of Mechanical Overseer should be encouraged to receive training at different project shops for one to three months.

4.24. Maintenance of Constructive Work Relationship

Maintenance of Constructive Work Relationship is a broad field which is receiving more and more attention in both the United Kingdom and the United States. The basic theory involved is that there are far better ways to motivate workers than fear or force. It is necessary for a worker to feel important, to feel that he holds an important place in the organisation, that the work he does is important. Wages are an important consideration but modern research as conducted by the American Management Association indicates that they are not the most important. The following ten points are taken from "The Supervisors Management Guide" published by the American Management Association.

The ten basic principles of sound Human Relations are :

(1) All of us resent domination—this is particularly important in collective bargaining.

(2) We all enjoy a good fight—obviously true and a very important point to consider in labour management relations

(3) We are more likely to agree with those we like personally —the better we know and understand people, the less chance of disagreement.

(4) We are inherent sentimentalists—our home is the most pleasant—our car is the best make. When it is possible to build this sentiment to where the worker says our job is the best job, something very real has been accomplished.

(5) We all want to feel important. Recognition and treatment are as important to an individual as financial advantage in most cases.

(6) We all want to be "in the know"—witness how rapidly rumours and gossip travel. This point goes hand in hand with number 5 and is very important.

(7) We like to win out over obstacles—everyone values the things he has to work hard for, things that are obtained easily have value only in proportion to the effort expended to get them.

(8) We are all different—no two people have exactly the same capacities or potential. It requires individual treatment to bring out the best in any one.

(9) We must recognise the inevitability of gradualness. It is difficult to get people to change. It was 600 years before men were willing to admit there was any other way to take off a shirt than by pulling it over one's head.

(10) We all want all we can get—this is a critical point. When working people do feel that they are not being paid a satisfactory wage they become unreasonable to deal with and uninterested in their work.

A sound modern programme based on the above ten points would be of inestimable value to India. This programme would require the training of supervisors at all levels in order to be effective

4.25. Motivation of Employees

Motivation of Employees is the most important problem confronting the projects at the present time. To this end incentive wage scales should be considered. Some interesting results were achieved at Gangapur Dam in Bombay State. At this project the operation and maintenance forces were paid a daily wage instead of monthly as is customary elsewhere in India. The workers receive no pay for days not worked. This solved the holiday problem. A committee was selected by the workers to decide what holidays to work. It was found that when the Committee decided not to work on a holiday they recommended working on the preceding or following Sunday to make up for the wage lost on holiday. Basic normal production and machine sickness were worked out and additional pay was given for exceeding these figures. It was found that 0.4% of additional expenditure brought a 20% increase in production.

4.26. Payment by the Holiday

Payment by the Holidays is suggested as an answer to the production loss caused by the numerous holidays in India. Where this is not permitted because of existing regulations, it is recommended that steps be taken to reform the regulations to allow the payment of hourly or daily wages. This need not affect leave, as appropriate leave schedules can be set up on the basis of the days worked, as is customary under the Factory Act.

4.27. Continuity of Work

Continuity of the services of technicians is a natural corollary to long range training plans. States should plan their mechanised construction programmes with a positive continuity from job to job in such a way that the next job is started by the time the first nears completion. Unless this is done, every project will have to start from scratch with the consequent wasteful expenditure inevitable in a new set-up.

4.28. Gratuity and Contributive Provident Fund

To create the requisite inducement for the staff to stick to the job, some scheme for gratuity and contributive provident fund should be worked out to even cover the work-charged establishment.

4.29. The Incentive Wage

The Incentive Wage should be accepted as a basis of wage structure. With the low sense of responsibility which prevails in the lower grades of service, a direct correlation must be attained between extra production and an incentive wage. The payment of incentive wage should be in addition to the basic salary. It should be based on individual performance for operators and collective performance for maintenance and service teams. It is suggested that basic production for operators should be fixed at 60% of the best performance calibrated by stop watch study; and the extra production should be priced in such a way that good operators can get up to 30% extra wage by increased care and efforts. The incentive wage for field maintenance and servicing teams of certain group of machines should be based on the minimum standards of sickness. Each project will have its own average percentage of sickness, depending upon the availability of particular spare parts, specialised workshop equipment and the standard of technical skill available on the project. The average number of sick machine varies at present from 25% to 50%. The percentage improvement in the number of sick machines to the total strength of machines on the project should be correlated to the extra wage for the Major Repair team

All staff below the rank of Gazetted Officers should be made equally eligible to earn the extra wage. This will help to develop the necessary morale.

4.30. Foreign Personnel

Some mention should be made here of the use of foreign technical personnel in India. Most of these people are used as advisers only, and theoretically at least, have no responsibility for the completion of work. This is a situation in which the heavy expenditure on their salaries is only partially utilised and they find it difficult to adjust themselves, since most of them are people used to authority and commensurate responsibility. At present they are working at approximately 30% efficiency due to lack of authority and a sort of general frustration brought about by trying to work in conditions with which they are not familiar. A recommended solution for this situation would be to clarify their exact responsibility; either make them responsible for the completion of items of work they are concerned with or responsible for training of people to do the work. In the latter case they would have to have enough authority to ensure that methods they recommend, be followed.

4.31. Pay Scales

Analysis of present scales on the projects reveals that, in comparison with responsibility which people are asked to assume, pay for their positions is too low. Even though scales are fixed for some of the cadres, suitable allowances and amenities should be given to the staff when they are asked to shoulder additional responsibilities such as cost control or multi-shift work. Operators, mechanics and their supervisors are poorly paid when the value of the equipment entrusted to them is considered. Appendix 2.6 gives a summary of the pay scales prevalent on our projects and those granted by the firms representing earth-moving equipment in India. Our recommendations are listed in the last column. We realise that these scales will be considered high by those who will judge them from the standard of technicians we now have on the projects, but we have borne in mind "what we want to have rather than what we have". Unless the scales are improved the projects will not draw technicians of adequate basic qualifications. The higher range in the scales need not be given except to the best technicians but they must be open to anybody who can work up to them.

OPERATION AND MAINTENANCE

5.01. Factors Affecting Operational Costs

The factors affecting operation and their costs are many and varied and require adjustment to meet each individual situation.

(1) *Equipment and Plant Planning*—

(*a*) Underpowered equipment not suited in capacity, giving rise to extended time cycles, lower capacity per haul, less production and larger amounts of repair occasioned by excessive breakdowns.

(*b*) Over-loaded equipment increases maintenance and premature overhauls are required.

The subject of proper plant planning is dealt with in Chapter Two.

(2) *Neglect of proper maintenance* resulting in early destruction of equipments.

(3) *Poor conduct of the job in hand.*

(4) *Incompletely trained, inadequately supervised* operators, who seriously damage equipment.

(5) *Inadequate parts and service.*

The importance of this aspect is dealt with in Chapter Seven in detail.

5.02. Operational Standards

Operation of earth-movers is a highly skilled job. An intensive training must be undertaken before an operator be allowed to operate in the field. The skill and correct practice of the operator is more important to maximum continuous output than any inanimate component of the machine, and this fact should influence the selection, training and allocation of the labour concerned. The value of earth-moving equipment in relation to operator's salary gives a guide as to how important this training should be.

No operator should be allowed to take over a machine until he has furnished evidence of his knowledge of:

(1) the purpose and capacities of the machine.

(2) the co-ordination of controls,

(3) the output/time factors and the different settings to achieve them,

(4) the ability to sense faults developing, and

(5) the machine service and maintenance.

Further it should be essential that the officer or supervisor in charge of any field section should be capable of operating each and every type of equipment under his control. If he cannot, it means that, he must rely on the operator's word with relation to mechanical faults and cannot verify for himself the position of his equipment. The skill of the operators and the rapid fault finding and rectifying by the maintenance team are the two greatest controlling factors on any field operation.

We have discussed training of operators and the supervisory staff *vide* Chapter Four.

5.03. Conditions Affecting Performance

The conditions affecting operation and output are as follows:

(1) Quality and distance of haul road governing haul speeds.

(2) Acceleration, breaking and gear shifting caused by unnecessary grades, corners etc., from borrow pit to dropping area.

(3) Altitude, season, time of day.

(4) Service availability.

(5) Type of loading.

(6) Material being hauled.

(7) Dropping areas.

5.04. Importance of Haul Roads

Main haul roads should be given constant attention for it is on these highways that maximum haul speeds are attained. The perfection would be a haul road without bends or grades from borrow pit to dropping area. Gradual curves and small grades only slightly decrease speed of hauling. Borrow pits should be planned with this idea in view. The haul roads must be of a sufficient width to allow free passing of vehicles without any decrease in speed or any danger of collision, if separate return roads are not incorporated. They should be cambered and ditched correctly, constantly bladed and damped to obviate dust menace. They must be well-lighted for night operation.

5.05. Loading from Borrow Areas

Borrow pits must be easily accessible and well graded out. Loader borrow pits should be of a large area. Increased output can be achieved from a circular borrow pit. Lighting facilities play a major part in night operations. "Tower lighting", mounted on skids for ease of positioning, is an advantage.

The loader should carry sufficient lights with an observation point, or crows nest, mounted on the elevator frame for night loading. By this means rated loads can be achieved without the loader operator's loss of concentration.

Shovel operation should be planned in such a way as to have easy access to borrow area and transporters with a minimum swing cycle. The borrow area must be constantly levelled by grader or bulldozer. The borrow face should be sufficiently high to give a full bucket load without a repeated digging.

Scraper operation can be speeded up by:

(1) Down hill loading.

(2) Straddle loading.

(3) Chain loading.

(4) Staggered or shuttle loading.

On large borrow areas for scrapers, chain loading is the more satisfactory, for it decreases the distance which the pusher tractor has to travel between each loading. A well drained borrow area is essential for scraper operation.)

5.06. Dropping and Compacting

Dropping areas should be sufficiently large and planned in such a way that the equipment can roll in and drop at speed. Bottom dumpers, hydraulically operated are able to windrow to a depth of one foot and levelling can be accomplished by a grader or bulldozer before compaction. Dropping areas worked on a grid system are a distinct advantage. Back fill operations present a different problem, but should be laid out in such a way that the equipment turning circle lends itself to a quick cycle. Campaction should be achieved by "gang" rolling, that is, by a large crawler tractor pulling multiple rollers. The benefits of this are:

(*i*) a large area compacted by one series of rollers, and

(*ii*) less number of compaction "turns" required for any one area.

Correct moisture content may be achieved by fixed standpoints with hose attachments, but this does not lend itself to speed. Water tankers with pressure sprinklers should be employed. Each operation should be planned in such a way that the "fill" rises uniformly in distinct but small lifts.

Equipment should not be forced to run over windrows to drop their loads, nor should it be forced to run over rough uncompacted material ; this decreases operational speeds and causes unnecessary breakdowns, besides giving uneven compaction.

5.07. Personal Requirements for Increasing Efficiency

The deciding factor in efficient operation is the human element. Operator comfort, ease of control, visibility, safety of operation, all have a direct bearing on the performance of a machine. The opertors of large earth-moving equipment, especially the "open-to-the-elements" type of equipment, should be given every aid by the project authorities to operate as comfortably as possible.

Constant dust menace causes many unnecessary accidents and much hardship to the operators. It seems only reasonable that goggles should be issued to the operators.

Clothing of proper type and design should be issued without charge to operators as a safeguard against accidents and protection against the elements.

During the summer months loader operators and their tractor drivers should be protected by a sun-blind. These aids have a direct bearing on increased efficiency.

Mention here must also be made of the advisability of issuing to the various field and workshop sections, detergents for use of personnel handling oils and fuels as a safeguard against dermatitis.

5.08. Importance of Maintenance

The importance of preventive maintenance cannot be stressed adequately. A complete and thorough system of preventive maintenance must be established and vigorously prosecuted. The purpose of this maintenance is two-fold, (a) as far as possible, to prevent mechanical breakdown, (b) in any case of breakdown, to put the machine back into service as quickly as possible.

Machine breakdowns are due usually to one or more of the following causes :

(*i*) Incorrect operation.

(*ii*) Irregular or inadequate service.

(*iii*) Lack of attention to adjustments.

(*iv*) Failure to effect minor repairs or replacement of parts when the need first arises.

(*v*) Lack of any regular mechanical inspection.

The effectiveness of any maintenance programme is dependent on the technical qualifications and ability of the supervision staff with particular reference to the type of equipment being maintained.

To this must be added the proper tools and special equipment available to the maintenance team.

We noticed that the standard of maintenance on the River Valley Projects in general is even poorer than the standard of operation. We have discussed training of maintenance personnel *vide* Chapter Four.

Every type of equipment has a maintenance schedule furnished by the manufacturer and this should be rigidly adhered to. The only deviation desirable, is that for equipment carrying dissimilar engines, the serving periods should be brought into line so that oil changes etc., are synchronised. The Log Books must incorporate detailed instructions for periodical maintenance.

5.09. Periodical Inspection

If machines are given periodical mechanical inspections, it is possible to avoid many of the initial causes of ultimate major break-down. The frequency of these inspections depends upon the class of operation and quality of the maintenance teams.

The inspection should cover :

(*a*) a thorough scrutiny for obvious defects,

(*b*) checking the amount of wear on common wearing parts and the amount of adjustment left on adjustable parts, with the object of ensuring the availability of replacements, before the machine efficiency suffers for the want of them,

(*c*) replacement of parts as in (*b*),

(*d*) checking for tightness of all securing devices which are difficult of access,

(*e*) effecting minor repairs,

(*f*) checking tyres, wire ropes, batteries, etc., and

(*g*) checking points peculiar to that type of equipment being worked on.

5.10. Methods of Maintenance

The two methods of field maintenance are:

(1) The equipment is taken to a Central Maintenance Depot.

(2) Maintenance is taken to the equipment by means of a mobile servicing unit.

The first method is employed successfully where relatively small distances are involved and on smaller projects. When borrow areas are widely dispersed, or where the fill is spread over a wide area, it is essential that maintenance be brought to the machine.

The first method is followed at Gangapur with but one difference ; all servicing and maintenance is carried out during the closed operational period, *i.e.*, from 10 P.M. to 5 A.M. This saves operational time. It must be pointed out that this method must be very strictly supervised to achieve daytime efficiency. The sevicing and maintenance teams are granted an additional 20% pay for working the midnight shift.

Hirakud have compromised the two methods by setting up a Service Station on the main haul road midway between borrow area and dam site. This method breaks down in efficiency when basic machines (*e.g.*, Euclid Loaders) are brought from the borrow area to the Service Station between shifts for maintenance. The time lost in returning to service and the inherent habit of the loader operators to finish a shift early may result in as great a loss as 15% of total available operating time.

It is essential that basic machines are serviced and maintained by servicing trailers on projects. They can be serviced during the recess hours, change shift hours or after working hours to avoid idle time of equipment.

The second method of servicing the equipments is considered the more efficient and more economical. Many hours of operation can be gained from a highly specialised maintenance team servicing the equipment on site, because the equipments are fed back directly to the work. The mobile servicing truck should not take more than 10 minutes to completely service an equipment. However, such standards are difficult to attain without adequate supervision and streamlining of servicing operations.

5.11. Plant Requirements for Servicing and Maintenance

The strentgh of the servicing team will depend on the type of servicing trailer being used and its capacity, *i.e.*, how many individual operations may be carried out from the trailer at the same time.

There are available today efficient mobile lubrication units at competitive prices suitable for all field servicing. The more familiar and better makes are Tecalemit and Alemite.

A mobile field workshop truck with a small lathe and a pillar drill, with gas and electric welding plant, heavy lifting tackle and carrying a full range of fitters' tools should be made available for field repairs. This leads to machine efficiency for it is obviously the quickest means of effecting repairs. The Calcutta Le Tourneau agents have developed a highly successful maintenance truck at a very attractive cost which is suitable for all field operations in India.

On an average, a provision of 5%—10% over the cost of fuels and lubricants should cover the cost of the servicing team and their vehicles. The range of percentage being dependant on the number of the equipments being serviced. The larger the project, the lower the percentage rate.

5.12. Field Repair Shop

The minimum requirements for a static field maintenance depot are:

(a) Covered workshop floor space preferably concrete with light and power;

(b) fittings shop equipment *i.e.*, benches, vices cupboards, racks, portable electric drills, grinders, jacks, crowbars and a comprehensive range of special tools for the types of equipment in use;

(c) lifting tackle, gantry type or mobile crane of large capacity;

(d) portable electric welding equipment;

(e) oxy-acetylene cutting, welding and brazing plant and forge;

(f) field stores which include satisfactory tool stores.

5.13. Fast Moving Supplies

Maintenance section should carry an adequate supply of all fast moving and expandable spare parts, if the stores issue procedure is such as may cause delay; no machine should normally wait for more than half an hour to get the spare part, if it is available in the project stores.

5.14. Servicing Times

In all matters of servicing it is better for equipment to have fixed days instead of fixed hours. Date and time can be painted on the equipment to avoid confusion.

5.15. Maintenance "Set-up"

The set-up of various maintenance teams required on a job will depend upon many factors. However, we suggest that it should incorporate an organisation to look after the following types of services:

- Central Wokshops
  - Preventive inspection
- Maintenance
  - Field Servicing
    - Fuels & Lubricants
    - Tyres
  - Field Repairs

5.16. Control of Inspection

The importance of preventive inspective maintenance has been stressed earlier and does not need a repetition. The team should carry out periodical inspections of each piece of equipment and either set right the defects, (if they are of small magnitude) or bring them to the notice of the Field Repairs Section for rectification as early as possible.

We have suggested that control of this team should be with the Central Workshop under the Inspection Branch, so that an independent and unbiased check is exercised on equipment.

The forms required for such periodical inspection will depend upon the type and make of the equipment and will thus be special to each sub-group of equipment. We have listed in Appendix 4, a few typical forms.

5.17. Control of Servicing Team

The field servicing and field repair teams should operate under the Chief Maintenance executive. The servicing teams should be split up in at least two parts; one for fuels and lubricants and the other for tyres, tubes and loader belts etc. The forms of various reports are given in Appendix 4.

5.18. Care of Tyres

Tyres should at all times be the subject of special attention. It is not sufficient to maintain the haul roads satisfactorily so that tyres do not get damaged by rock or in other ways. Tyres must be inflated to their correct pressure. They must never be "bled" during the heat of the day. They must be switched from free rolling to driving wheels periodically to give longer life. They must not contact grease or oil. If an equipment is standing for lengthy periods it should be "blocked up" and the tyres covered or it should be moved forward periodically to avoid "set" in the tyre. Further if "recapping" of the tyres is being undertaken on the project, or by tyre agents in India, a full inspection must be done periodically to ensure that the tyre does not wear past its reconditionable limits. The forms for maintaining tyre records are given in Appendix 4.5.

5.19. Cleanliness, an Aid to Efficiency...

One important item in efficient maintenance and field repairs is cleanliness. Equipments, fueling points, maintenance and mobile lubricating trailers should be kept as clean as possible. Tidiness and cleanliness always lead to efficiency. Nowhere does cleanliness afford a greater saving than in dispensing, storing and handling fuels and lubricants

5.20. Storage and Dispensing

Storage should be affected in two or more large capacity fuel tanks. While dispensing takes place from one, sedimentation takes place in the others. (These tanks should always be used in rotation so that the fuel can settle for at least 96 hours. From the large tanks the fuel should pass through a battery of filters to a smaller tank, from the smaller tank through a large capacity Vokes filter to the metering pump (which also has a filter) and from thence to the equipment tank by overhead fuel lines. This ensures a completely clean and accurately recorded fuel supply

5.21. Misuse of Oils and Lubricants

Too much confusion exists on the majority of projects with regard to the manufacturers' grades of oils which correspond. The practice of procuring oils and greases from a number of manufacturers leads to mistakes.) On one project visited it was observed that including all types, 57 different grades of oil were in use. Series II oils recommended by certain equipment manufacturers had been displaced in some instances by straight mineral oils, and in other cases by a mixture of various brands. This points out the obvious ; that project should only have one supplier, at the most two and that all times the equipment manufacturers recommendations should be rigidly adhered to.

The avoidance of servicing erros may be achieved by the very simple solution of painting the grease nipples and the oil caps to correspond with the colour scheme on the various oil barrels.

Reference must also be made to the practice of utilising inferior grades of oil in hydraulic systems. If a manufacturer's recommendation falls in a certain range of oils, for example, a Shell Tellus 27 falling in the S.A.E. 10 range, it does not follow that any S.A.E. 10 oil can be used. Hydraulic oil should contain anti-foam and anti-oxidisation additives.

Manufacturers recommend oils which are guaranteed to do the job required. It must be assumed that they know best and their advice should be followed.

5.22. Division of Maintenance Personnel

The strength required for the field repairs will depend upon the population of the equipment and the efficiency of operation. It is a good plan to sub-divide the work into various teams each attending to one type of duty. Due to the low standard of individual efficiency in India at present all round skill cannot be expected from the low paid Techincal staff.

The maintenance personnel may, for example, be sub-divided into the following teams:

(*i*) Electrical.
(*ii*) Wire Ropes and Blades.
(*iii*) P.C.U.
(*iv*) Crawler Tracks.
(*v*) Clutch Adjustment and Repairs.
(*vi*) Engine and Transmission.

The number of such teams will depend upon the organisation, but it is desirable to have as few items as possible under one team, since specialisation is the target.

On jobs having more than 12 machines in a type we recommend the follownig teams:

Equipment	Maintenance Teams								
	El.	Wire Ropes	P.C.U.	Tracks	Tyres or Belt	Clutches	Engine	Transmission	Hydraulic & other work
TRACTORS . .	YES	YES	YES	YES	..	YES	YES	YES	YES
SCRAPERS . .	YES	YES	..	..	YES	YES	YES	YES	YES
DUMPERS . .	YES	YES	..	..	YES	YES	YES	YES	YES
EXCAVATORS . .	YES	YES	..	YES	..	YES	YES	YES	YES
LOADERS . .	YES	..	..	YES	YES	YES	YES	YES	YES
COMPRESSORS . .	YES	..	..	..	YES	YES	YES	YES	YES

The forms required for their daily reports and for operational reports are indicated in Appendix 4.

5.23. Control of Maintenance Teams

The maintenance teams should be directly controlled by a Technical Foreman with long experience on earth-moving equipment. Each section of the team should have one or more qualified fitters. Should two or more maintenance teams be required on any project, a qualified mechanical Engineer, whose sole charge is maintenance, should be given control. The importance of placing the best men available on maintenance cannot be over-stressed.

5.24. Major Field Repairs

These are undertaken by a workshop team directly controlled by the Workshop Engineer. This ensures that priority is given to major field repairs over normal shop work. This subject is dealt with in Chapter Six. Finally we would like to stress the fact that suggestions from anyone at any level which bear on efficiency should always be carefully considered. Good ideas can originate at any level and may lead to large savings in time and money.

WORKSHOP OVERHAUL AND REPAIR

6.01. Importance of Economic Deployment of Labour in Plant Overhaul

A well-planned workshop, efficient as to quality of repair with the minimum delay in placing the equipment back into service, is the keynote to success in earth-moving fields. It should be clearly understood that sick plant in workshops can cost more in loss of time, as represented by losses of revenue than the value of overhaul to be carried out. Therefore, workshop facilities should be as complete as possible to achieve efficient and quick repairs.

The economic deployment of labour in plant overhaul stands high in importance. A highly skilled staff is essential in any workshop but is more so on job carrying out major overhauls and repairs to project equipment. This staff should be familiar with the equipment, as it leads to quickness of overhaul and rapid fault finding. A constant training of staff is required and this can be undertaken by individual projects. We have given an outline of the training scheme for mechanics in Chapter Four.

6.02. Group Operations

Equipment should be broken down into as many operations or group operations as is consistent with the labour in each section. Therefore, in modern workshops, a semi-skilled man doing repetitive work achieves a high degree of skill in quality and speed as he becomes expert in one operation. The highly skilled all round staff should be used as progress inspectors, or in other spheres where their technical knowledge can be utilised for better benefits.

6.03. Over Employment of Assistant Labour

Assistant labour for each skilled man should be unnecessary. Most of the time either the assistant watches the skilled man work or the quality of the work degenerates to the level of the assistants, without adequate contribution from the skilled hand.

The sub-sections of a workshop should carry sufficient technical assistants to enable all jobs in the section to be carried out quickly and easily. Workshop labour should not be engaged solely on the principle that each man must be kept fully employed. A certain amount of even inadequately utilised expert staff will pay in the long run.

6.04. Use of Operators in Workshops

The operators of plant under overhaul and reserve operators should be used extensively as productive labour. This will help them at least to know their machines.

6.05. Inspection of Work

Supervision and inspection must be such in any workshop, that a 'Line' inspection be carried out. At all stages of overhaul, no finished detail work should be finally enclosed until it has been checked by a suitably qualified member of an inspection team.

The workshop is a means to obtaining maximum return on capital invested and major repairs costs must be kept at a minimum to achieve its purpose.

6.06. Importance of Quick Field Repairs

Field repairs should take precedence over all other work. No matter how busy a workshop may be internally, assistance should always be rendered, both in labour and materials, to the working site as a top priority. A mobile workshop like the one mentioned in Chapter Five is essential on any large project. This workshop should be operated by highly skilled general fitters, familiar with all types of equipment in use.

6.07. Planning of Overhauls

Planned overhaul is much easier with plant which has been correctly operated, regularly and adequately serviced, and efficiently maintained from the time it was new, than with machines which have been neglected, abused or acquired in poor condition. On most projects the machines are taken out of service seasonally and the full weight of overhauls are felt in a very short spell. All workshop resources are strained to the limit and the quality of work often suffers. Phasing out the overhauls will enable a large fraction of the work to be done during the working season. This will not impair unduly the operational efficiency and will insure quality of overhauls.

6.08. Principal Internal Purpose of Workshops

The principal "internal purpose" of workshops is preventive overhaul inasmuch as they ensure, that given efficient usage in the field, no preventable major mechanical trouble is evidenced from one overhaul to the next. In normal circumstances workshops should not be required to reproduce new machines from worn out plant. Abnormal workshop overhauls to any equipment, plus high maintenance costs and time losses due to unreliability show that it is better to "write off" a machine than try to utilise it beyond its economic working life.

6.09. Continuity of Work and Breakdown into Sections

Workshops should be laid out in such a way that continuity of operation can be achieved without any congestion leading to breakdown of production schedules. Therefore, a large floor space to allow for manoeuvrability and expansion is always desirable.

A typical workshop is split into the following sections and each section should have individual instructions issued and strictly enforced. An example of the type of instructions that should be posted in each section is given in Appendix 4.7.

Workshop Sections

Code No.	
(1) MF	Machine and Fitting Shop.
(2) EL	Electrical-Shop.
(3) BWS	Blacksmith, Welders and Structural Shop.
(4) FS	Foundry Shop.
(5) PS	Paint Shop.
(6) CUS	Carpenters, Sheet Metal & Upholstery Shop.
(7) ES	Engine Shop.
(8) EAT	Erection, Assembly and Track Shop.
(9) ID	Inspection Department.
(10) IS	Internal Stores.
(11) P	Progress Department.
(12) R&I	Receipts and Issue.
(13) CR	Costing and Records.
(14) L	Internal Administration and Labour Office.

6.10. Functions of Progress and Inspection Department

The functions of the Progress Department and the Inspection Department may need be explained in detail, the functions of the other departments are self evident.

Progress Department

(1) All requests for work to be undertaken should originate from Progress Department.

(2) Classification of work.

(3) Issuance of job cards.

(4) Answering of queries in relation to jobs undertaken.

(5) Estimation of time and job factor in relation to the work in hand.

(6) Checking of completed job cards before passing to works accounts.

(7) Setting up of a provisional production programme in conjunction with production or Workshop Engnieer.

(8) The recording of all information relating to equipment being worked on.

(9) Completing of equipment records.

(10) Liaison between workshop departments with particular reference to overhaul or manufacturing hold-ups.

(11) The issuance of weekly lists detailing manufacture of items to departments concerned.

All the above are functions of the Progress Department.

Inspection Department

(1) Inspection on receipt of equipment for overhaul, for classification of overhaul or detail work involved.

(2) Inspection and examination of all component parts on breakdown.

(3) Recording on job cards the parts required for replacement and limit and tolerances reached.

(4) The testing of all suspect parts before passing to sub-assembly sections.

(5) Detailing special information on equipment for fitting staff use and laying down of overhaul standards.

(6) The extent to which salvage or reclamation may be taken.

(7) The examination of all work done on "build up" of equipment.

(8) The final engine tests record and inspection.

(9) Check Inspection before equipment proceeds to work.

(10) Field Inspection of equipment at definite periods.

All the above are functions of the Inspection Department.

6.11. Standards of Overhaul

From the receipt of a machine until its issue, the inspection department should have technical control as to the standards to be maintained in its overhaul. Before commencing to strip, this inspection department should obtain as much information on the equipment as possible, from the records of the operation, field service and maintenance. On stripping the inspectorate should examine each and every part before sending out to sub-assembly bays, and should record all information necessary for the equipments overhaul such as the necessity of replacement with new parts, reconditioning the old ones, etc.

As the machine gets built up, the inspection team should examine and certify on a *proforma* at all stages. An example of *proforma* is given in Appendix 4.8.

6.12. Cleanliness in Overhaul

Before work of any description is done on an equipment, it should be thoroughly cleaned. A high pressure washing plant or a high pressure steam chemical cleaning plant is essential. Further to the above, major sub-sections, such as engine shop and section for final drives, should have pressure fed paraffin washing tanks or de-greasing tanks. The preliminary cleaning should be set up on a direct route from the receipt section to the dismantling bay. All work carried out in repair shops should be above ground level whenever possible, arranged at convenient working heights, so that cleanliness and better production can be achieved.

6.13. Mechanical Handling in Workshops

A first class workshop must at all times be able to handle overhauls quickly and efficiently. Mechanical handling should, wherever possible, be incorporated. The most efficient form of lifting gear is an overhead electric travelling crane. If, however, the job cannot afford it, a mobile self powered crane should be used. Each sub-section fitting bay should also have swing arms with travelling blocks and tackle to handle the lighter loads. For inter-departmental use a fork lift truck for lighter loads is ideal. There should always be readily available in workshop sub-sections, sufficient lifting slings of all sizes and capacities, complete with sling spreaders for engine shop use. The slings should be periodically checked and tested.

6.14. Equipment used in Fitting Bays and Fitting Shops

Fitting bays should be equipped with work benches each fitted with a vice, with adequate number of locked cupboards for ordinary and specialised tools. Racks should be used to store impending or completed work, or work that has been cleaned prior to assembly.

The workshop should also have compressed air available to all section. They should be well lit and have adequate ventilation.

Fitting shop equipment should include the following, in individual bays dependent on the work being carried out in that section ;

(1) Hydraulic or screw jacks.

(2) Special spanners and tools, with pullers and extractors for the specific type of work being undertaken.

(3) Adjustable stands or blocks.

(4) Special stands to suit sub-assemblies.

(5) Boxes for storage of minor parts.

(6) Floor trays.

(7) Valve refacing tools.

(8) Special tools for individual types of engines, valve spring lifters, piston ring compressors, etc.

6.15. Fuel Pump Overhaul and Injector Testing

A special section under a trained technician should be provided for fuel pump calibrating and pump and injector testing. Special precautions must be taken to ensure the cleanliness of the testing room, by dust exclusion. Extractor fans should be installed.

It must be pointed out that the installation of such a testing section should be weighed against amount of work to be done and the charges levied by the firm that can carry out the job. If a manufacturer's Agent has the necessary testing equipment and operates at competitive prices it would be better to sub-contract the work to him, provided that the work is taken up fast enough. An efficient installation gives better results in time, accuracy and cost. This also applies to crankshaft grinding. If the manufacturer's Agents have grinding facilities, advantage should be taken of them, provided that competitive prices are given.

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Parts for reclamation should be strictly inspected and their reclamation subjected to exacting limits. Even then their issues should be controlled to see that the part matches with the rest of the equipment.

6.19. Importance of Recording Component Part Changes

All workshop records should be comprehensive. It is highly important that any deviation from standard dimensions of any component parts should be recorded in the History Books. One reason for this is that a standard part may be sent out to a field site on urgent repair when a non-standard is required. Such records will also be helpful in satisfactory scaling of spares for the future indents.

A sample engine shop layout and inspector's log sheet for engine overhaul are given in Appendices 4.9 and 4.10. The workshop accounts should operate through job cards, which will incorporate the necessary technical data for transfer to the History Books. A sample of job cards is given in Appendix 4.11.

CHAPTER SEVEN

SUPPLIES AND SPARE PARTS

7.01. Overstocking of Spares Without Attendant Efficiency

On all the projects that we visited, there were machines on the sick line waiting for spare parts. The projects stores carried large stocks of spare parts, but many of the parts in regular and frequent demand were out of stock. The demand for spare parts was increasing as the machines grew older. All this caused production to lag behind schedules and cost to mount. A serious view must be taken of this situation. It can be remedied to a great extent by the following line of action.

7.02. Standardisation in Relation to Supplies of Spare Parts

All future projects should learn by past experience and not buy equipment of too many makes and sizes. The existing projects should be encouraged to exchange their equipment and spares with other projects to reduce the number of makes held by each project. In some cases it would pay to concentrate on standardised groups of equipment and ignore odd makes and sizes, instead of inflating the stores with greater assortments of spares and dissipating the available repair facilities by trying to keep these non-standard, odd pieces of equipment in repair.

Normally projects should not be required to carry their own spares beyond the minimum required for "first line of safeguard". It is the business of the firm, selling the equipment to stock enough parts to meet project demands. We believe that this can be done easily when standardisation of equipment is effected. The firms should be encouraged and required to stock enough spare parts, so that they can meet approximately 80% of the immediate demands ex-stock.

7.03. Factors Affecting Requirements of Spares

The quantity of spares which a project should hold depends on :

(a) value of the equipment :

(b) its yearly utilisation ; and

(c) the time-lag between the demand and supply.

The average annual requirement of spare parts is of the order of 15* to 20% of the cost of the capital equipment. If there is one year's time-lag between the demand and supply of spare parts, the project must carry one year's requirements for spare parts in its stores. In addition, it is impossible to foresee accurately which parts will be required in the next period of one year so some overstocking of slow-moving and moderately slow-moving parts becomes inevitable. The parts not utilised remain in stores and continue to accumulate as new types and sizes of equipment are added. The projects are thus loaded with large amounts of spares for which demands are few and far between.

7.04. Reasons Leading to Overstocking

We think that the reasons causing this unsatisfactory situation are :

(a) want of standardisation of equipment, and

(b) the policy of enforcing unnecessarily lengthy and complicated procedures for obtaining spare parts.

We recommend that the powers to purchase spare parts within certain limitations mentioned below, should be given to project executives themselves. Rarely, if ever can spare parts requirements of various projects be integrated in the purchase branch of the D. G. S. & D. to gain the advantage of bulk supply. If the purchase orders are to be handled as they arise (as they should be for quick procurement) they can be dealt with more expeditiously by the project organisation. The normal procedures of inviting tenders and the powers of accepting them afford adequate financial control on the P.W.D. officers. There is no necessity for imposing more restrictions, or transferring the authority without the responsibility. Even with the best of the arrangements the D. G. S. & D. take about 10† weeks before an order reaches the firm. That is too long for the supply of spare parts.

7.05 D. G. S. & D. Price Agreements and Rate Contract

On the other hand, the D. G. S. & D. should concentrate on the price agreements and rate contracts for the supply of spare parts with the firms dealing in the equipment used on the projects. These

*If p is the cost of the plant and 10,000 hours its life, hourly depreciation is $p/10{,}000$. If the average rate to defray cost of major repairs is 80% of depreciation, the cost of spares will be about 64%. If a project works the equipment for 2,000 hours per year the provision to meet the cost of spares will be $\frac{p \times 64 \times 2{,}000}{10{,}000}$ =about 13%. To this must be added the cost of minor parts for field repairs, say 5% making a total of 18%.

†Time-table agreed in a meeting on 27-6-1951.

contracts should be based on the printed price lists of the spare parts indicating the discount allowed for bulk purchase and for forward delivery. The project officers should then be allowed to operate on these contracts as Direct Demanding Officers. The inspection by the D. G. S. & D. should be dispensed with, as it can be carried out more expeditiously by the project staff. They should be authorised to make 90% payment against proof of despatch, subject to adjustment after receipt and checking of the consignment. The firms should be permitted to insure the consignment at Government cost.

7.06. Stores Purchase Committee

A Stores Purchase Committee is appointed by the Government of India and is investigating these spheres. Some points which this Committee should consider are as under:

(1) Spare parts are speciality products. They have to be purchased from the authorised dealers on single tender system. Open market competition is not possible nor often desirable (to avoid spurious parts being purchased).

(2) Accurate forecast of the requirements of spare parts, long in advance, is not possible with the present state of our technical resources. Where such attempts have been made, they have resulted on large amounts of waste by way of dead spares in the stores.

(3) The purchase procedure should make adequate provisions for rushing through "panic demands". A week is the utmost time-limit to supply the part, if available, to the machine.

(4) The Scaling Organisation, if it materialises, will take a long time before it becomes completely effective, though its results may be felt from the start. Until then it is risky to ask projects to place a majority of their demands long in advance. They should rather buy more specifically and urgently.

(5) A large portion of the supplies needed to keep the machines going comprises stores other than spare parts. A forecast and planned purchase for this class of materials should be possible for the bulk of the requirements. However, in attempting to safeguard against non-availability at any time, there is danger of overstocking. Adequate powers should be given to the projects to handle such demands on an urgent basis. The powers should be correlated to the total requirements and should not be arbitrary.

(6) The D. G. S. & D. should increase sphere rate contracts and price agreements. These are advocated by all the projects, provided there is adequate mechanism to reduce time-lag to a bare minimum.

(7) Large delay is occurring at present in clearing some consignments, mostly of spares, from the customs. Suitable measures should be recommended to remedy the situation. One source of this trouble appears to be lack of co-ordination between Customs and Import Trade Control and the other appears to be lack of requisite technical background in both the controls.

7.07. Estimating Purchase of Spare Parts

The next question is to consider the amounts of spare parts that should be allowed to be purchased. We have dealt with the estimated requirements for spare parts in Chapter Ten. We have recommended later in this chapter the value of the stock that should be built up in the project stores. With these two guiding factors, modified suitably for each project's conditions and the plant hourly utilisation estimated during the year, the value of the spare parts required for each sub-group of equipment can be worked out for the year. These figures should then be regarded as the financial limits of the purchases. The demands for spare parts will then arise under two categories, (i) panic demands due to unforeseen breakdowns, and (ii) forward demands for planned overhauls. If a demand is certified as "panic" (when a machine is lying sick for lack of a particular spare part not available in the project stores), short-circuited procedures should be taken to obtain the spares. If no price agreements for the category of parts required exist, the purchase should be based on expeditious or telegraphic enquiries. We believe that it would be possible to extend the scope of price agreements to cover all the types of equipment on a project so that it will not be necessary to ask any firm to tender a quotation before placing a purchase order. We think that if a well-planned store is maintained and if forward demands are carefully computed, the value of the "panic" orders should not exceed about 25% of the total requirements for spare parts.

7.08. Forward Stocking

Difficulty is generally felt in making out lists of parts against anticipated forward demands for :

(*a*) Contingency stocking; and

(*b*) for planned major overhauls.

At present projects do not have adequate experience to forecast their forward demands accurately. This has resulted in over-stocking of slow-moving parts and a shortage of parts in regular demand. The manufacturer's agents in India are often consulted to give lists of parts to be ordered with the equipment. But such lists

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are seldom realistic, because they are often made out by persons with little local experience and are influenced by their own business considerations (to retain in their hands the profitable business of fast-moving parts). An accurate forecast of the parts' requirements should be based on :

(*a*) the estimate of work hour ;

(*b*) classification of work to be done ;

(*c*) standards of operation and maintenance ;

(*d*) facilities available for major repairs ;

(*e*) age of machines ; and

(*f*) the number of spare units available for replacement.

Hence, no two projects can have the same list of spare parts for forward supply. In view of the large expenditure necessary to keep the machines supplied with spare parts and to reduce wasteful expenditure due to overstocking, we suggest that a "Parts Scaling Organisation" should be set up under a Machinery and Spares Directorate of C.W. & P. C. to be discussed later in this report.

7.09. Project Interchange of Spares

After all this care is taken to plan the forward demands, the repairs to some of the equipment will at times be held up for lack of spare parts not available either on the project or with the suppliers in India. An agreement should, therefore, exist to enable a project to obtain the parts from another project that can conveniently spare them. An all project-wise organisation to index the available spare parts is, therefore, essential. The new Directorate suggested by us should take over this function. An outline of the organisation is given in Appendix 7.3.

7.10. Disposal of Surplus Spares

From a study of the project stores, we feel that there is a risk at present of Government facing a total loss over Rs. 2 crores in the deterioration and obsolescence of spare parts. It is desirable to take a business view and sell the surplus for which a market can be found. The new Directorate suggested by us will be helpful in this direction but we think the situation requires special urgent treatment as indicated. We suggest that business firms be invited to find customers for them as far as possible. Projects should agree to lose a little in rates to save the total loss. The firms handling the matter may be given a reasonable commission based on the sales affected.

7.11. Spares Necessary in Terms of Depreciation

The next question is how to effect a check to prevent over-ordering of spare parts. It will be necessary to lay down two standards:

(*i*) the average requirements of spare parts during the life period of various types of equipment expressed as a percentage of depreciation ; and

(*ii*) the yearly average requirements of spare parts for each type of equipment.

We have suggested standards for cost of major repairs in Appendix 3.3. When a good balance is obtained between field repairs, workshops and salvage of assemblies, we think that 80% of the provisions indicated would represent spare parts and the remaining 20% labour.

7.12. Scheduling Spares Over the Life of Equipment

We further suggest that the total provision of spare parts should be spread over the life time of the equipment in the following proportion :

Life	1st 1/5th	2nd 1/5th	3rd 1/5th	4th 1/5th	5th 1/5th	Total
Ratio of expenditure on spare parts	10	15	25	30	20	100

Spare parts do not include items such as tyres, blades, wire ropes, etc., which are normally steady requirements and for which action similar to that for consumables should be taken.

7.13. Stock to be Held in Project Stores

We further suggest that stock limits in stores should be stipulated per sub-group of equipment. The following table expresses our ideas about the basic principles of such a stipulation. Non-standardised equipment requires a larger stock of spares than standardised equipment. If all the equipment in a particular sub-group is purchased in one make and the range of sizes is restricted to a minimum, the stock of necessary spares in the project stores can be reduced.

Percentage of the Value of Stock of Spares to Equipment

Stage in life of equipment	Standardised Equipment			Non-Standardised Equipment		
	Population			Population		
	Above 20	10 to 20	Below 10	Above 20	10 to 20	Below 10
1st 1/5th	7½	10	15	15	20	30
2nd 1/5th	10	15	22	20	30	45
3rd 1/5th	15	20	30	30	40	60
4th 1/5th	10	15	22	20	30	45
5th 1/5th	6	8	12	12	15	24

The exact percentage mentioned above have to be fixed finally when required data becomes available, but we consider that the underlying principle is sound and may be followed until better standards are available. We noticed in our study of project stores, that the absence of a proper system of the classification of the items held by stores has resulted in a lag of information concerning the value of the stock held in relation to the value of a particular type of equipment on the project. We recommend that a numerical system of store classification, down to bin card numbering should be adopted. An example of such a classification is given in Appendix 4.14. The co-ordination of spare parts requirements by a central agency necessitates standardisation in store classification.

7.14. Residual Spare Parts

It will be apparent that a certain amount of residual spare parts at the end of the life of the equipment is inevitable. It can be minimised by judicious planning, but cannot be avoided. It should be taken into account as residual liability and figured in the unit cost. The total value of the work done by a machine during its life span is roughly equal to 3 to 4 times its purchase price. The residual value of the spares will thus be 1½% to 8% of the cost of the capital equipment. A 4% increase in the unit costs of civil items may be considered acceptable on this account. Adequate statistics are not available from our projects to study this aspect but we consider that this study should be carried forward by the Machinery and Spares Directorate of the C.W. & P.C. The projects should scrutinize their stores from this aspect and take suitable action.

7.15. Other Materials Necessary for Operation

The machines require other stores in addition to proprietary spare parts, *e.g.*, wire ropes, fuels, lubricants, tools, cotton waste, welding rods metals, etc. On an average 75% of the working expenditure of machinery is materials including spare parts. The annual expenditure on such materials will be about 1/3rd to 1/2 of the cost of the capital equipment on an active project. Efforts should be made to cover as many of the items of general requirements as possible by rate contracts. The remaining purchases should be made in bulk and the project offices should be empowered to purchase about 20% of the total value of materials as "local purchase".

7.16. Delay in Issue of Spares and Supplies

The delay obtaining on projects in compliance with approved indents by stores is discouraging. On some projects it was observed that restrictions were placed on the drawing of stores, inasmuch as the old part had to be returned before a new one could be issued. This was evolved for safeguard against non-genuine and unreasonable demands for spares, but this practice has only led to confusion. The Storekeeper blames the mechanic for not producing the old part quickly enough, whilst the mechanic blames the Storekeeper for not producing the goods quickly enough. In actual fact the fault lies in the lack of confidence displayed in the demanding persons' ability and the security arrangements safeguarding the welfare of the project.

7.17. Worn-out Parts—Disposal and Reclamation

Worn-out parts removed from a machine not intended to be refitted, should not be discarded haphazardly. They should be checked to see if they can be reconditioned for further use. This work should be done by the Inspection Wing of the base workshop. Parts that can be salvaged or repaired should be sent to the salvage section. Reclamation of worn out parts is dealt with more fully in Chapter Six.

7.18. Packing and Handling of Spares

The type of packing of spares adopted by some agents of equipment in India is still sub-standard. The high humidity conditions obtaining at places of storage calls for very sound anti-corrosive treatment of spares and stores which is lacking at present. This applies to project stores as well. Many expensive items are left lying on the floor of the project stores without treatment or protection against damage.

Every spare part liable to deterioration by moisture should, after receipt and checking, be subjected to the correct anti-corrosive treatment and be stocked above ground level. The cost of correct storing is very little but the benefits are very high.

7.19. Storage of Tyres and Tubes

The storage of tyres and tubes is a matter of the gravest concern. The rate of reduction of life in tyres under storage, is very rapid unless satisfactory provisions are made for their storage. The ideal condition is a temperature controlled warehouse. However, if conditions are improved by restricted admission of sunlight and by adoption of individual storage in racks with adequate free air space, the rate of deterioration of tyres will be retarded.

Expert advice on this subject can readily be obtained from the tyre distributors.

7.20. Dangers of Over-stocking

It is necessary to sound a word of caution against overstocking of supplies and spare parts. There is over six crores of rupees invested on spares by various projects in India. Unless care is taken to maintain them properly, they will deteriorate and become useless in a short time.

There are several types of stores which, for various reasons, are comparatively shortlived. Some examples are :

Greases—Soda base greases which are extensively used with heavy equipment have a maximum life of 9 months as per manufacturers' specifications. After the expiration of this period, they have an adverse effect on the surfaces to be lubricated due to precipitation.

Batteries—If batteries have been filled or charged, they deteriorate rapidly.

Seals—Felt seals absorb moisture and spoil the surface they work against. Natural rubber seals tend to become brittle, and break. After a long period of storage, leather seals become dry and brittle.

Condensers—Coils and voltage regulators deteriorate largely due to the absorption of moisture.

Gaskets—Cork and paper gaskets are subject to insect damage and shrinkage unless properly protected.

This is a partial list only. The proper storage of supplies, spares and general stores is very difficult in India due to climatic conditions.

From experience it may be estimated that in the end, approximately 60% of the stores now on hand will have very small residual value. The dangers of overstocking and inadequate care on storage are evident.

7.21. Genuine Spares

Non-genuine parts are generally cheaper. In stock items such as the bearings, seals, bolts and nuts, there should be no objection against buying from alternative sources, provided that the specifications are known and adhered to. For other items, it is desirable not to buy the non-genuine "will-fit" spares unless the purchaser knows exactly what he is buying and is acquainted with the quality. A large percentage of inferior spares find their way to the projects and cause untold trouble and heavy cost by the necessity for frequent replacement. Even though manufacturers who produce the parts for the end product, are manufacturing the spares, it does not follow that the specifications demanded by that end product are incorporated in those surplus manufactured parts, sold through agencies other than the recognised dealers.

In emergency, any spare that can keep the machine going must be purchased if genuine supply is not available, but care should be exercised to assess the risk involved of causing further damage to the machine by such use. Any non-genuine spare without repute must always be held suspect.

7.22. Manufacture of Spares in India

A large amount of foreign exchange is required at present for the purchase of spare parts and machinery. We consider that the country has not yet reached the stage of mechanisation required to manufacture most of the spare parts for heavy equipment. However, a beginning must be made and we suggest that the manufacture of a few commonly required parts should be attempted by our industries. Individual attempts to get specific requirements manufactured in a workshop are costly and slow. Bulk manufacture will have to be established for certain simple products, *viz.*, filters, seals, friction linings, etc. Even partial processing from imported materials will be a step in the right direction. Rigid controls on specifications and certified tests must be enforced by the appropriate Ministry of the Government of India, to ensure that parts of a calibrated standard are sponsored.

The workshops at the projects should be strengthened to enable them to take up the manufacture of some of the spares which are simple and within their scope. Project workshops should establish better contact with each other to make the facilities at one project available to other projects for their common benefit.

7.23. Import of Spare Parts

During our visit to the River Valley Projects, we were informed of the increasingly unsatisfactory stock position with distributors, of certain essential spare parts in frequent demand for the maintenance and servicing of earth-moving and construction plant, which is now in use. These are:

(1) Ball bearings of various sizes and types.

(2) Bolts, nuts, studs and screws in a variety of sizes and types.

(3) Precision oil seals of a variety of types and sizes.

An enquiry at the distributor firms elicited the information that such a state of affairs was consequent to the granting of restricted import licences for the categories of spare listed above.

A study of the current Import Control Red Book, discloses that the restrictions against free import of items under (2) and (3) have been cancelled. [*Vide* remark (iv) against item No. 36(5) Part II.]

As regards the Ball Bearings, the existing restrictions, evidently designed for protection of the indigenous manufacturers, *i.e.*, "The National Ball Bearing Co." are considered unnecessarily complicated for achieving the purpose. The variety of types and sizes of ball bearings in use on these equipment is great. There are about 26 types and 1,500 sizes for the manufacturers to choose from. The protection to the indigenous industry, has to be based on such sizes and types of this great variety of ball bearings as are being manufactured by the indigenous firm together with such additional sizes and types which the firm proposes to manufacture against their expansion programme in the near future. A ban on the import of the types and sizes actually been manufactured is all that should be done at present to avoid paralysing the costly equipment which we have purchased.

7.24. Manufacturing Difficulties

In the manufacture of ball bearings, the following aspects require consideration :

(1) It is a highly specialised industry, requiring the use of Automatics with their complicated tooling and rigid specifications for raw materials.

(2) With the off-take limited to the demand within the country, the range of sizes manufactured in India will be limited to those for which there is a regular and large demand, capable of economical production.

A study of the lists of types and sizes of ball bearings manufactured by the National Bearings Company, as enumerated in appendix 'C' of the Red Book, discloses the fact that these bearings are suitable for the equipment manufactured in the country, such as fans, electric motors, pumps, machine tools, textile machinery, etc. Under the circumstances, the possibility of the firm manufacturing the great variety of types and sizes of ball bearings used on earth-moving and construction machinery is very remote.

7.25. Restrictions on Import of Ball Bearings

The restrictions, now in operation against the free imports of ball bearings by distributors of plant and equipment, against item 36(5) Part II further specified in remark III against the item is as follows:

> "Not more than two per cent of the face value of licences granted for import of component parts can be utilised for import of Ball Bearings not specified in Appendix 'C'."

It is not clear, what stands in the way of the distributors being allowed to import the required quantities of spare bearings for machinery in use, so long as they are not the ones listed in Appendix 'C'. Further, it is not clear on what basis the restriction was fixed at *two per cent* of the face value of licence for spare parts. Any such fixation of limits for import of bearings has to be based on the spare parts required by the distributors with reference to the information available with them regarding the plant population in the country, their age and the estimate of the hours of the work during the year. The spare parts dealers automatically safeguard themselves against a too liberal an import of a particular bearing or spare part.

7.26. User Licences to Projects

The Committee is aware that some of the River Valley Projects have been furnished with special "User Licences" to import ball bearings and spare parts. This is a relief of a palliative nature which cannot be helpful unless a large assortment of parts are stocked in the project stores with little certainty of what exactly will be used. The satisfactory method is for the distributors to import and hold adequate stocks based on scientific method of parts scaling. Further the Committee feels that the grant of import Licences for spare parts to distributors, should be controlled by the Industrial Adviser. This would ensure the scrutiny of the applications under adequate technical information and background. This is absolutely necessary to control imports, to fostering the growth of indigenous industries and to prevent, at the same time, dislocation of work for want of spare parts for the equipment in use.

COST ACCOUNTING

8.01. Importance of Cost Accounting

Economical execution of works is one of the fundamental requirements of engineering skill. For the engineer to exercise control of costs, he must keep in touch with the actuals of cost and production in adequate detail to judge if there is wasteful expenditure in any field. Every job must have its own set of control statistics to enable the line and staff organisation, from the management down to the level of foreman, to judge from day to day the actual performance and cost with reference to standards prescribed. These figures should be supplied to them as quickly and often as necessary.

It is necessary to emphasise cost control at the present time for two reasons : (i) large scale departmental execution of works has started only recently, and (ii) execution of works by machinery is a new field to us.

8.02. Cost Accounting in Relation to Contract Work

Fairly large projects have been completed by our engineers using standard P.W.D. accounting. Some of them were executed through comprehensive contracts on the basis of firm rates. The Vaitarna Dam is a current example, where the control on the actual rates is the contractor's responsibility; the department pays the contractor at a fixed rate per unit of work done. On such works, the contractor takes care of "Cost Accounting". Before the advent of mechanisation, the contractors usually sub-divided his works into various minor rate contracts. His cost accounting was rarely required to go beyond the integration of various piece work rates, plus his overheads. These rates could be compared with the rates at which he was being paid.

8.03. Cost Accounting in Relation to Departmental Work

Most of the big works executed "departmentally" by the Public Works Department were managed through various minor piece workers. Each of these carried out a single type of work at a fixed rate, such as the supply of stores or the grinding of mortar for a masonry dam. Such works, employing a number of piece workers, throw more responsibility on the engineer, compared to a single all in contract. The engineer sometimes provides an intermediate service departmentally, such as transport, through the project organisation. On such works he has to watch that the integrated rates of all piece workers together with his own costs remain with his estimates. He has to phase and programme his work in such a way as to integrate the activities of all the piece workers to synchronise performances and give the desired progress. However, the essence of fundamental cost control remains with the piece workers. Success in achieving low rates depends on overall planning and offering suitable working conditions to the piece workers. His knowledge of actual costs involves few computations.

There is another system of departmental execution of works, *i.e.*, entirely through the control on the labour rate for unit work. The rate control on such works depends upon the daily output of each labour unit and on careful supervision. Detailed up-to-date statistics are essential to control the rates, otherwise the cost will spiral upward without commensurated out-turn.

In the departmental execution of mechanised construction, the risk of cost spiral is real and of large magnitude. When an unskilled labourer does not do his share of work, it may cost a project a wasteful expenditure not exceeding Rs. 1-12-0 per day; a machine may mean Rs. 250. Corrective retrospective action can be taken against a labourer, but the cost of operation of a machine cannot be recovered. Therefore, it is more necessary that a system of rapid and detailed costing is maintained on mechanised jobs. Executives must be kept informed of the financial implications involved in their way of working and they have to be provided with control statistics. The accounting organisation and procedures that have been used before in the country need to be amplified to cover new fields.

8.04. Lack of Cost Account System on Projects

During our visits to the projects and our study of their statistics, we noticed that the absence of a suitable system of accounts has resulted in (a) a lack of statistics that are necessary for executing cost control and (b) the absence of scientifically developed standards for evaluation of the statistics.

A statistical evaluation of jobs from the point of view of production and cost is a proven modern approach to effective control in industries, and should hold good equally on construction.

8.05. Limitations of Present System of Accounting

One of the reasons why most of the projects have not appreciated this important aspect of accounting, is that accounting has rarely risen beyond compilation of actuals and "pointing out irregularities". The "constructive criticism", which a study of such figures can offer, is not appreciated for the simple reason that they are not designed to render such assistance. An engineering approach to a properly designed cost accounting system is essential. The D.V.C. has done well in giving this organisation the importance it deserves.

8.06. Cost Accounting Organisation

The proper position of the cost accounting section in a large project in U.S.A. is indicated in the organisation charts given in Chapter Three. Its duties are :

(a) to design, co-ordinate and maintain a system of cost accounting suitable to the job for cost and production control at all levels of management down to the smallest field of activity where such controls can be utilised ;

(b) to measure the performances against approved standards and to communicate the results of operations to all levels of line organisation down to foremen with suggestions for improvement ;

(c) to devise ways and means to lay down scientific lines, standards of operations with which performances can be compared.

A good back-ground of project engineering plus adequate experience of cost accounting is essential to man this section properly. We believe that a properly trained engineer should be placed in charge of the section. This is justified since he can contribute substantially by effecting large savings on a project. When a cost accounting organisation is established on a project, the regular accounts branch under P.W.D. system will have two duties to perform :

(i) to compile the actuals required by the Accountant General for control of appropriation : and

(ii) to make available the actuals to the Cost Accounting Section for an engineering analysis.

To avoid duplication of work in the actuals, it is necessary that figures required by the A.G. be made available from the same records as cost accounting statistics after simple integration.

8.07. Duties of the Organisation

The Section should establish set routines, so that the executive staff concerned will receive daily, weekly, monthly, seasonal and yearly statistics to help them to get a picture of the rates and production at a glance. The Section should issue periodical bulletins which should be widely circulated to the staff to make them cost-conscious. These bulletins should be discussed in periodical conferences of the executives concerned. Such conferences should be a regular feature on mechanised construction jobs.

An important difference in viewpoint between the present system of compiling actuals and the concept of cost accounting is that the former lays more stress on accuracy and less on speed while the latter admits of less accurate figures in order to make them immediately available to the management. These figures may be reconciled with actuals periodically. The entire system is designed to operate with speed.

8.08. Accounts Classification

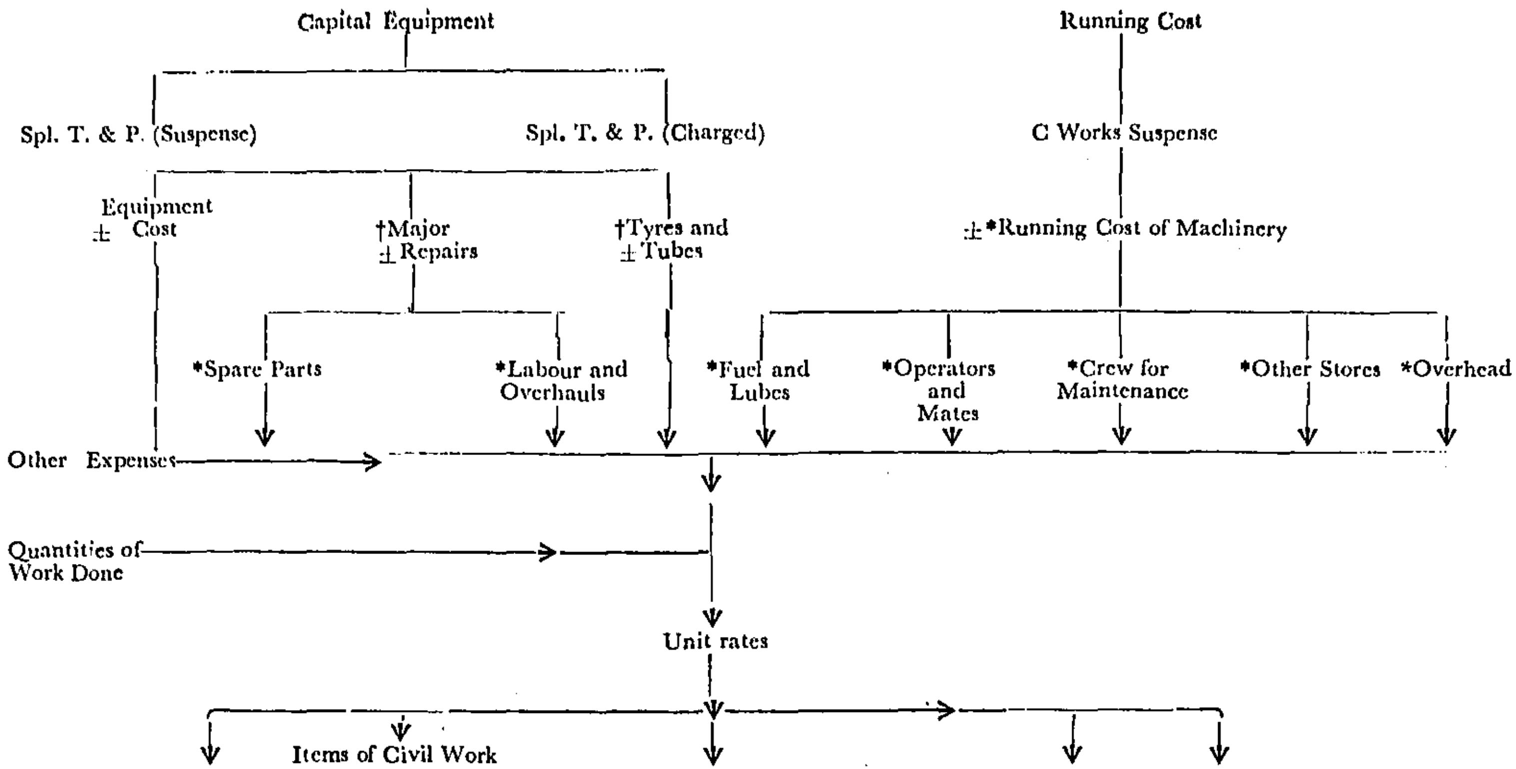
The present system of accounts is not designed to give adequate detail which can be useful for control of a small portion of work, *i.e.*, the work handled by a single foreman. It can state months after execution, that the cost of, for instance, rock-excavation has exceeded the estimated rates; but it cannot indicate that "this is due to waste of compressed air used for drilling". The project engineer is interested more in the cost at the level of individual teams, whom he can hold responsible for efficiency rather than in the integrated totals where the responsibility is diffused. Such a control requires detailed analysis of a job with a breakdown into unit-performances giving cost and production. A few examples of the detailed sub-heads required are indicated in Appendix 4.13. A proper system of numerical classification, giving the main account heads and sub-heads which it is necessary to compare with standards, must be devised and enforced. This concept is not new in accounts (e.g., '68' is understood as "Construction of Irrigation, Navigation Works—Capital Expenditure") but it is to be utilised to cover a wider field.

When a large number of sub-heads are incorporated in the accounts system, the decimal classification lends itself to brevity and exactitude. It has worked successfully at T.V.A., U.S.B.R. and some of our projects. It is desirable to evolve a comprehensive standard pattern which will leave adequate scope for amplification and is suitable for use on all projects. Until this can be done, each project will have to plan out its own system for its essential needs. Typical examples of numerical classification are given in Appendix 4.13.

8.09. Organisation

The organisation should pervade the entire sphere of management from the Chief Executive to the foreman. A chart showing the duties and activities of such an organisation in a typical industrial concern is given in the "Cost Accounting* and Productivity" which is reproduced on the next page.

*A Report by a group of European experts published by the Organisation for European Economic Cooperation Plan: Paris 1952.



NOTE:—†Sub-group-wise accounts in work register and Machine-wise in History Books.

±Debit and credit heads to be maintained.

*Only sub-group-wise account in Works Registers.

Cost Accounting & Producti[illegible]
from
Report by a Group of
European Experts.

To Follow Para 8·09

COMPOSITE TABLE OF REPORTS

COST ACCOUNTING

Level		Flow of data	Daily Reports	Weekly Reports	Monthly Reports	Other
Operating levels	Workers	Labour hours, Units produced Facilities used, Materials handled X X (1) (2)				
	Foreman (Figures for section)	Budget proposals X X X (3)	Labour hours, Units produced, Yield, Materials used	Labour hours and payroll, Units produced, Yield, Materials used, Scrap, Waste, Spoilage Variances from labour standard or budget	Labour hours and costs, Units produced, Yield, Materials used, Scrap, Waste, Spoilage, Costs per responsibility centre, Variances from standards or budgets Partial production costs (by processes)	
	Supervisor (figures for department)	X X	Labour hours, Number of employees, Units produced, Yield, Materials used, Materials intake, Scrap, Waste	Labour hours and payroll, Units produced Scrap, waste	Labour hours and costs, Units produced, Yield, Materials used, Materials intake, Scrap, Waste, Cost per department, Variances from standards or budgets Partial production costs (by processes)	
	Plant Manager (Figures for plant)		Labour hours totals, Number of employees, Units produced, Scrap and Waste, Yield, Costs. Sales, Shipments	Labour hours and payroll, Labour budget, Units produced Sales, Shipments	Labour hours and costs, Units produced, Scrap and waste, Total costs – preliminary and final, Sales, Shipments, Production costs, Profit and Loss statement Inventories	Break-even point
		Controller (4)				
Top management levels	Divisional Manager (Figures for division)		Units produced, Yield	Payroll	Costs per division, Variances from standards or budgets, Sales, Shipments, Production costs, Profit and Loss statements – preliminary and final, Inventories	Cost budget Capital expenditure Break-even point
	Senior Executives of staff departments (Figures for Company)		Units produced, Yield	Payroll	Total costs, Variances from standards or budgets, Sales, Production costs, Profit and Loss statements – preliminary and final, Profit by division, plant, department, product, Financial statement, Inventories, Capital expenditures Movement of personnel	Cost budget Sales budget Financial budget Break-even point Budget of capital expenditure
	Board of Directors (Figures for Company)				Profit and Loss statements – preliminary and final, Financial statements, Sales, Costs, Production costs, Profit by division, plant, department, product	Budgets Capital expenditure Estimates Break-even point Comparisons

NOTE; Data originating at workers' level are passed in detail to the foreman for his own section and thereafter aggregated for his executive superiors. In addition, data for each section are passed directly to the Controller's office. Lines (1) and (3) show at each X the point of aggregation and Line (2) the direct flow to the Controller. Line (4) shows the flow both up and down of appreciations from the Controller's office.

Facing page 80.

ACCOUNTING FOR CAPITAL EQUIPMENT

9.01. Introduction

A clear conception of the accounting procedure for the cost of owning and operating equipment is lacking at present since this is a new field in Indian Engineering.

The procedure is dealt with in the following sections:

(a) Capital cost and depreciation.

(b) Cost of Major Repairs.

(c) Running costs.

(d) Unit rates of civil items of work from machinery accounts.

The correlation of the various costs is shown in the chart attached.

Capital cost and depreciation are dealt with in this chapter and the rest in subsequent chapters.

9.02. Tools and Plant on Projects

The types of Tools and Plant required on a project are:

(a) Special T. & P. (Suspense);

(b) Special T. & P. (Charged):

(c) Minor T. & P. charged directly; and

(d) T. & P. ordinary (Overheads).

9.03. Special T. & P. (Suspense)

This should include all construction equipment for which a detailed depreciation account can be maintained. Examples of this equipment are: Tractors, Excavators, Scrapers, etc. The expenditure on the purchase of such equipment is progressively written off by depreciation proportionate to the hours of work the equipment has been used. At the end of the project the balance is credited as anticipated salvage value of equipment. Detailed capital accounts of each machine should be maintained through Works Registers and

History Books. The running charges are watched through sub-group suspense, each sub-group comprising equipment of one make, size and type.

9.04. SPECIAL T. & P. (CHARGED)

Minor equipment costing about Rs. 50,000 or less each and Special T. & P. of general utility for which detailed suspense accounts need not be maintained are grouped under this heading. Examples of this category of equipment are workshop tools, utility vehicles, unloading rigs, minor power units, etc. The capital cost is charged off progressively according to the overall progress made on the project and the Major Repairs and running charges are debited directly to the works concerned. When a project is completed, the entire expenditure on Special T. & P. (suspense as well as charged) should be transferred to works.

9.05. MINOR T. & P. (CHARGED)

Minor plant required for specific works for which no capital or Running Suspense accounts need be maintained, fall under this category, *e.g.*, Jackhammers, pumps, exploders, etc. Their cost may be directly debited to the work concerned.

9.06. ORDINARY T. & P. (OVERHEADS)

Workers tools, scientific, mathematical and survey instruments and equipment fall under this category. The charges are generally watched as overheads.

On one project we noticed that these charges are debited *pro rata* on the basis of the ratio of expenditure on T. & P. to works for the entire State. This leads to inaccurate accounting in the actual cost of the project. We recommend that these charges should be levied as actuals.

9.07. ACCOUNTING PROCEDURE FOR SPECIAL T. & P. (SUSPENSE)

The purchase cost of equipment should be watched by sub-heads in Works Registers maintained by sub-groups. This will include the expense of taxes, incidental cost of transport, and cost of erection and trial runs. Each of the sub-heads will have two parts, one for expenses cited above and the other for "Deduct depreciation" for use on works. The credits for depreciations will be compiled from the Log Books, by giving a corresponding debit to the items of work on which the machines are used. The individual capital account of equipment should be maintained in the History Books as detailed in Chapter Thirteen.

9.08. Depreciation

Depreciation is defined as the rate of charging the capital cost of equipment, in relation to use, by a progressive transfer of expenditure from Special T. & P. (Suspense) to works.

9.09. Methods of Calculating Depreciation

Two methods are commonly in use: (*a*) a decreasing rate of depreciation, and (*b*) straight line rate. In both of them the scrap value of the equipment at the end of the assumed life is taken as nil.

9.10. Decreasing Rate of Depreciation

The decreasing rate is adopted by the U. P. for their Jhansi dams as under:

Equipment	*Life*	*Dep. % per 2,000 hours of intervals*						
Tractors .	8000	35	30	20	15			
Tournapulls .	10000	30	25	20	15	10		
Excavators .	14000	20	20	15	15	10	10	10

This system represents the resale value of equipment in open market more accurately, but it is more difficult to work with than the straight line method. All the equipment, even in a sub-group, does not reach the same life at the same time. The result is that different rates will apply to different machines which makes the accounts procedure complicated.

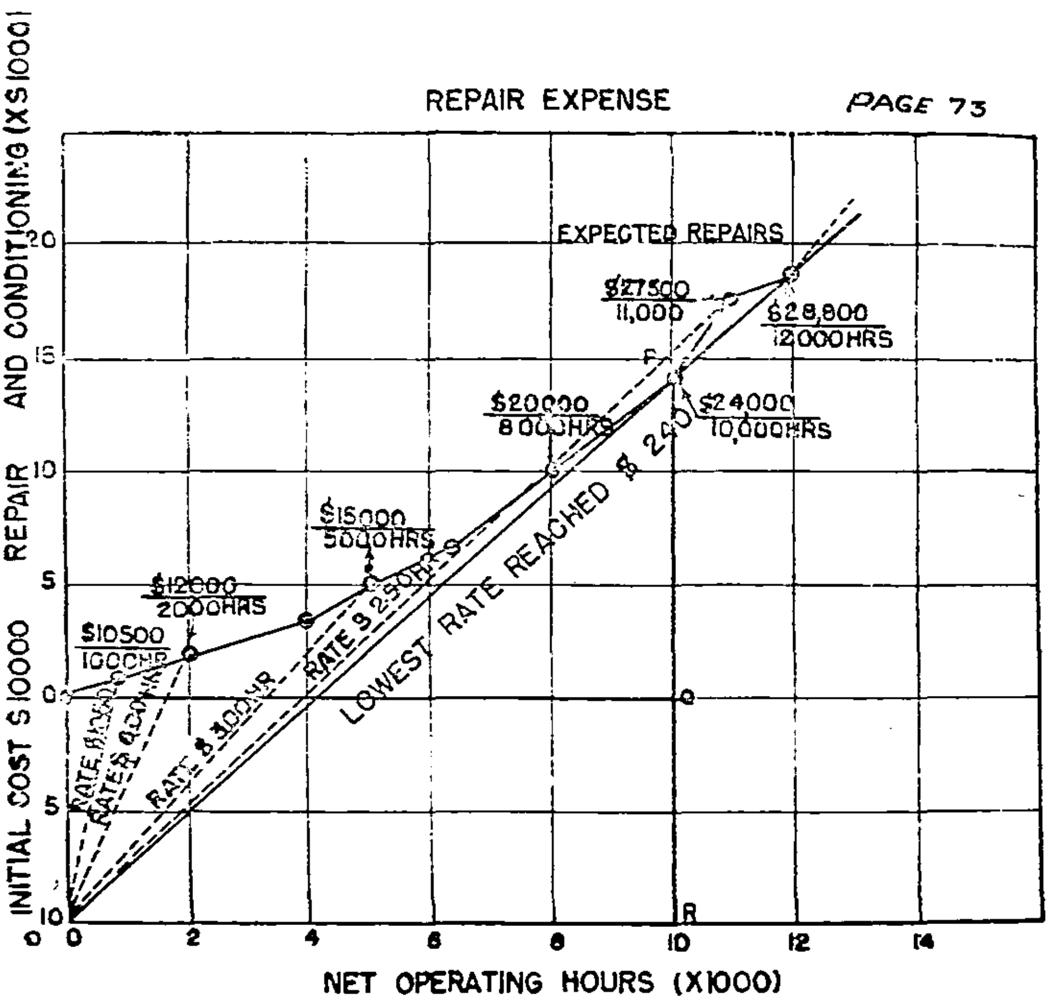
When this method is adopted actuals are taken as the cost of Major Repairs. The high cost of depreciation in the initial years coupled with the low cost of Major Repairs tend to even out the effect of the machinery charges on unit rates. Such levelling out can also be achieved by the system of levying Major Repair charges at a uniform rate as described below:

9.11. Straight Line Depreciation

This method is easy for computations and lends itself to quick cost control. When utilised in conjunction with a Reserve Fund for Major Repairs, it gives uniform distribution on unit rates. The depreciation is calculated as C/N where C is the capital cost of an equipment and N is the "plant hours" used.

9.12. Fixing the Life

There is no physical evidence which determines when a machine has reached the end of its efficient life. It can be kept going indefinitely by incurring progressively heavier expenditure on repairs until a point is reached when it will be cheaper to buy a new machine. The optimum life is an economic function, and is reached when the combined hourly cost of purchase and repairs reaches a minimum. This is explained in the Norris Dam Project from which the following graph is quoted :



Equipment Investment Studies

$$\text{MIN. TANG} \quad \frac{PQ+QR}{CR} = \frac{PQ}{CR} + \frac{QR}{CR}$$

= Avg. hourly cost of maj. repairs + Hourly rate of depreciation.

This theoretical analysis is still incomplete because it does not take into account the financial effect of the dislocation of work due to long hours spent on repairs. It is enough to visualise that the optimum life will be lower than that worked out by any such study.

We tried to collect information on these lines from the projects but the statistics were not helpful in obtaining a unique solution. The cost data are not compiled on uniform lines, are often not correlated with the time of repairs and do not cover the life spans of the equipment. Actually different definitions of the "plant hour" have lead to very wide variations. This can be seen from Appendix 3.5.

This lack of usable data caused us to study the standards laid down by various authorities. These are compiled in the Appendix 3.2. The standards adopted by various projects we studied are shown therein. The standards current in U.S.B.R.[1] those recommended by the Power Crane and Shovel Association U.S.A.[2], and the Associated General Contractors of America Inc.[3] are shown in the Appendix.

It is argued that the labour employed on repairs is cheaper in India and hence the optimum life could be longer than those adopted in U.S.A. The cost of Major Repairs is made up of the cost of spares and labour. The former is about 80 per cent costlier in India than in U.S.A. and the latter costs us about 1/10th. The ratio of the values of the spares to labour in U.S.A. is about 40:60. The cost of Major Repairs in India will approximately be 78 per cent. Because of lower standards of repair plus inefficient maintenance and operation, our cost is more, almost the same as that in the U.S.A. We are inclined to agree with the standards laid down in U.S.A. and do not recommend a longer life on this score.

A comprehensive list of life for equipment is given in Appendix 3.3.

A study of the sickness of equipment on projects shows that we are utilising only 52 per cent of the available plant hours on our projects (*vide* Appendix 3.4). This figure is so low that it leads us to believe that longer utilisation of old equipment is not commendable. Until the technical skill of operation, maintenance and repairs improves, it is uneconomical to prolong the life.

9.13. Salvage Value

As a project approaches completion, items of equipment will be released for disposal. If the plant planning was satisfactory, most of the equipment released should have worked for almost the life period fixed for them. This will have a residual life of about 25 per

[1] Schedule of Equipment: Ownership Expenses, U.S.B.R., 1949.

[2] Operating Cost Guide: Power Crane and Shovel Association, 74, Trinity Place New York 6, N. Y.

[3] Contractor's Equipment: Ownership Expenses, issued by A.G.C. 1227 Munesey Building, Washington, 4 D.C.

cent. The residual value after accounting for the credits due to the depreciation on work will be approximately 25 per cent of the procurement prices.

The equipment would have been overhauled and reconditioned when required by debit to the Major Repairs Fund mentioned in Chapter Ten.

When there is opportunity to transfer the equipment from one project to another, it should be satisfactorily overhauled and reconditioned, using funds available for Major Repairs. If the rate of levy for credit to these funds was adequate, funds will be available for such overhauls. To ensure such a condition a review of the adequacy of the rates, after say every 2,000 plant hours, will be necessary.

The sale value for such transfers should be based on consideration of the following:

1. The estimated residual plant hours.
2. The residual value at the end of the stipulated life.
3. The current price of a similar model of the machine.
4. Whether the model is still under production and if not, when it was discontinued.
5. The difficulty of getting spare parts.
6. General condition of the machine, with reference to the estimated residual life of the machine.

When items of equipment are transferred, a proportionate quantity of the residual stock of spare parts commensurate with the remaining life of the equipment, should also be transferred.

It will be a good plan to transfer the operators and service personnel working on the machines along with them, as far as practicable.

When there is no possibility of transfer of equipment, disposal by sale along with the related spares and accessories, etc., should be promptly accomplished. In view of the rapid deterioration under storage and the progressive approach of obsolescence it is unwise to carry items of used equipment in storage when there is no definite plan of re-use. This applies to all the spares and attachments for the equipment.

The suspense sub-heads opened for operation of the equipment on a project, *i.e.*,

(1) purchase of Special T. & P.,

(2) Major Rapairs Fund,

should be closed as soon as possible after the completion of the project, by taking prompt action for the transfer or disposal of the equipment. The residual amounts under the suspense heads, should be arrived at and adjusted and the modifications in the rates of levy for depreciation, Major Repairs, Tyres, etc., should be calculated and recorded.

The final machinery rates per plant hour and the unit rates of the civil items can be determined only after such adjustment is carried out. The project which receives the used and reconditioned units on transfer, should adopt the rates of levy for depreciation, Major Repairs, etc., as determined by the previous project and should continue the History Book of the plant where it was left off by the completed project. The relevant facts and figures should be extracted from the old books and recorded in the new books as opening entries.

A pronounced disinclination on the part of projects against accepting used equipment from other projects will have to be faced. Where the two projects are under the jurisdiction of the same Government, there should be no great difficulty. Where such is not the case, the services of a Neutral Surveyor and Arbitrator may be necessary to complete the transfer of equipment. The Machiney and Spare Parts Directorate of the C. W. & P. C. can be helpful for such transactions as mentioned in Chapter Seven of the Report.

When plant planning on a project has been done on an unnecessarily liberal scale, the project will be in a disadvantageous position, in the disposal of equipment. It is very important that plant planning is done by an engineer, who has the requisite specialised knowledge.

9.14. Interest on Capital

It is customary in foreign countries to figure interest on the Capital Cost and taxes as a part of Ownership Cost. This element is not included in the Ownership Cost on our projects because inter-divisional relations on a project do not require the raising of such debits. This introduces an unfair ground for comparison with the unit rates obtained by contracts.

Normally the A.G. raises the debit as an indirect charge based on the Capital Expenditure to date on the work. In fact when a piece of equipment is given on hire to a contractor, the element of interest on capital is included and the contractor is made responsible for other risks and taxes if any.

It is our contention, that the interest is a realistic charge on the project as a whole and that the correct place to figure it is in the unit rates. The method of accounting is given in Chapter Fourteen.

There are probably no taxes imposed on the types of the machinery dealt with in this report and it is not necessary to deal with them.

The insurance charge is a realistic expenditure. The system of insuring such equipment is not yet common in our country. The Government does not insure its property against loss or accident but many contractors do it.

On departmental work this item can be disregarded but it must be taken into account for comparison of rates of contractors.

ACCOUNTING FOR MAJOR REPAIRS

10.01. Definition

Much controversy exists in definition of the term "Major Repairs", as distinguished from "Capital Expenditure" or "Running Repairs". Definitions are given by the United States Bureau of Reclamation, U.S.A., in their publication "Schedule of Equipment Onwership Expense" of 3rd January 1949 and are quoted below:

"*Major Repairs and Overhauls*—Replacement of major machine parts because of excessive wear through a long period of use, or which fail through breakage normally after long use and are so costly that they are normally considered as being properly chargeable to an overall or lifetime average cost rather than to operating of or daily cost, and which will prolong the life of the equipment, do not justify an increase in the ownership expense rates.

"*Minor or Field Repairs*—are regarded as job or operating costs that require special study for each individual job, and as such are entered as cost of the work on cost plus operations. Minor or Field repairs include the replacing of only minor parts, for example, spark plugs, fan belts, broken bolts, shackles, an occasional broken track tread or pin (does not include replacement of complete track) and other small parts comparable in cost. Also, minor repairs may include only the cost of labour and is sometimes confused with or, to some extent, included in the cost of servicing. Loss of operating time for minor repairs normally would vary from a few minutes to a maximum of 8 hours. Sometimes minor repairs accumulate to such an extent that the correcting of several or all such defects in a single repair operation results in a too high cost and a too long shutdown to allow of it being chargeable directly to operation. In such a case, the charge should be to Major Repairs and assumed by the lessor.

"*Major and Minor Repairs*—are frequently difficult to distinguish. Occasionally a major part may become unusable through rough or careless operating or overloading of the machine or accident for which the lessee is responsible. In such cases, the lessee should be charged the cost of repairs. In other cases, similar failure may be the result of long use, or because of damage suffered unnoticed on other work, or damage suffered for which the lessor is responsible, or for other reasons not chargeable to the current work. In these circumstances, the lessor should absorb the cost of repairs. Replacement costs of wire rope, types, and conveyor belts are considered as capital costs and are to be borne by the lessor. Responsibility in such instances should be determined at the time by agreement between lessor and lessee."

When a machine is not hired out to a contractor, a great refinement is scarcely justified, if the expenditure on either of the heads is ultimately cleared by debit to the work done. However, proper control on the hourly cost of Major Repairs is important to the project executives to keep down the earthwork rates. An exact and workable formula to class the expenditure under this head is essential. Any rules evolved by a Project Organisation, should be simple enough to be interpreted uniformly by the lowest staff who classify the expenditure. Thus in actual practice "Major Repairs" is defined in various ways such as (1) the cost incurred by Base Shop; (2) any repairs requiring more than 24 hours; or (3) jobs costing more than 1% of the value of the equipment, etc.

10.02. Wide Variations in Actual Costs of Major Repairs

The absence of uniformity in the classification of expenditure in this respect has resulted in a wide variation in the cost per "Plant Hour" on the projects we have studied. The want of a common definition of "Plant Hour" and absence of a classified cost account for equipment has given such a wide variation in project statistics that the data is not helpful to establish standards of plant hour cost. The project statistics are given in Appendix 6.00 and an abstract of comparable data can be seen in Appendix 3.5.

10.03. Cost Data Cover Short Period

Another difficulty in working out standards from the project statistics is that they do not cover the life span of the equipment. The cost of repairs in the initial stage is low and does not furnish information for working out an average rate.

10.04. Flat Rate Charge

The expenditure for Major Repairs to an equipment is heavy and comes at relatively long intervals of time, unless these costs are evened out, the unit rates fluctuate violently with the result that proper cost control becomes impossible. To meet this situation a flat rate levy per plant hour should be made and the amount thus collected should be pooled to meet periodical Major Repair charges. The rate should be such as will balance the expenditure over the life of the equipment. The position of such accounts in the structure of machinery accounting is shown in the chart under para 9.01.

The flat rate of Major Repairs recommended by us is shown in Appendix 3.3. It is based on the Associated General Contractor's standards and conforms with the life of equipment and the definition of Major Repairs and Minor Repairs mentioned earlier. The figures of A. G. C. are modified suitably to accord with the Indian level of the cost of spares and labour.

These figures are no doubt approximate but in the absence of better factual data we think it best to go by them. The A. G. C. mentions that :

> "The percentage rates are subject to adjustment to fit the experience of the individual contractor. It is intended that this schedule prove useful as a basis or guide but it is recognised that individual experience may vary from the average within fairly broad limits. Some of the factors justifying adjustment of the rate shown are: weather condition: exposure of equipment, *i.e.*, relative rigour of work at hand: care of equipment both in operation and maintenance. The rates are not determined by any precise method of account and should always be applied in the light of the personal experience. The schedule is intended to express average experience."

We wish to sound a note of warning that before it is decided to modify these standards to lower figures, a careful study should be made as to whether such modifications are proposed on the basis of definite cost accounts figures. If this is so, was the standard of overhauls satisfactory, did the figures cover the expenditure over the life of the equipment and was the sickness of the equipment within reasonable limits ? The average standard of overhauls on projects is poor resulting in large "down time" as can be seen from the Appendix 3.4. At present most of our equipment is in the earlier stage of its life with the result that a bulk of the expenditure for Major Repairs (often of accumulated nature) can be expected to occur in the later period of the life of equipment. The basic concept of major overhaul is that it should be thorough and complete. It should consist of stripping the equipment to pieces, having the worn out parts replaced or rebuilt and adjustments carried out to go back to normal working tolerances. The low cost achieved on Major overhauls, is often a result of inadequate attention to such details. This causes a high percentage of sickness.

On the other hand, if a project feels it necessary, to enhance these provisions, it would be wise to determine if (a) overhauls are being carried out in time to a satisfactory standard, (b) adequate arrangements are made for the salvage of old parts, (c) the equipment is being used beyond its useful life, and (d) the nature of the work is beyond the normal scope for which the machine is designed.

10.05. Adequacy of the Rate

An approximate rule to check whether the flat rate of levy is adequate is to see that there is sufficient amount in the Major Repair Reserve Fund at any time to carry out a complete major overhaul of the equipment.

It can be seen from the graph given with para 9.12 that optimum life of an equipment is reached, when the hourly cost of Major Repairs (Tangent of the curve at opt. life) equals the hourly rate of depreciation plus the average hourly cost of Major Repairs. This leads us to the following findings:

(a) An equipment is working within its optimum life when the hourly* rate of Major Repairs is less than the total of the hourly rate of depreciation, plus the average† hourly rate of Major Repairs.

(b) An equipment is working beyond its optimum life when the hourly rate of Major Repairs is more than the total of the hourly rate of depreciation plus the average hourly rate of Major Repairs.

10.06. Annual Expenditure on Major Repairs

For authorising yearly budgets of expenditure the flat rate mentioned above, will need to be broken up to annual percentages. We could not find any standards to guide us. We suggest that in the absence of any factual data, the following standards be adopted:

Life	First 1/5th life	Second 1/5th life	Third 1/5th life	Fourth 1/5th life	Last 1/5th life	Total for life
Percentage of the provision for Major Repairs.	10	15	25	30	20	100

*The rate obtained at the time.

†Average rate from the beginning up to the time.

10.07. Account Procedure

Annual estimates of Major Repairs for each sub-group of equipment should be made based on actual requirements for the year. A careful programme will have to be worked out for this purpose, comparing as many details as can be foreseen. The part scaling department mentioned in Chapter Seven should be very helpful. We do not advocate a separate estimate for each machine on each occasion as it arises (*e.g.*, at Nangal) because this would lead to too much estimating and account work and an accurate individual estimate will not be possible until the machine is tripped. Moreover, the chances are that such estimates will remain open over long periods when some spare parts are not available.

The debits to these estimates will come from job cards detailed in Chapter Six and Appendix 4.11. The Works Registers should record the expenditure by sub-groups and the History Books by individual equipment. The expenditure will be off-set against the Reserve Fund.

The credits for Major Repairs will be collected at a flat rate per plant hour and accounted for under the Reserve Fund which should be carried forward from year to year. The details of the plant hour worked will be taken from the Log Books. The debit corresponding to the flat rate levy will go to the item of civil work on which the machine worked. Further details of the Transfer Entry orders are given in Chapter. Twelve.

10.08. Personnel Required for Major Repairs

It is difficult to lay down definite standards of the strength of the team. Apart from the varying standards followed by various projects to make a through job of the overhauls, the technical standards in the cadre of mechanics and their wage scales vary so widely that it is not possible to state the number of technicians required per machine to look after the major repairs. We have indicated in the Appendix 3.3 the standards of the reasonable labour charges per plant hour. However, there can be no distinct demarcation between the cost of spare parts and of labour. A project doing a minimum of salvaging of their old assemblies may show a reduction in the labour charges but to increase in the cost of replacements. The provision of spares and labour should, therefore, be viewed on a whole.

10.09. Tyres, Tubes, ets.

Strictly speaking the expenditure on tyres and tubes is a running cost as distinguished from the capital cost. But the expenditure on renewals is so heavy and sudden that unless it is equalized through a Reserve Fund Account, the hourly rates of equipment and the unit rates of civil items will fluctuate violently. We recommend that the cost of replacement of tyres, tubes, belts of loaders, etc., be expressed at a flat rate in the hourly cost of equipment and that credits be pooled under a Reserve Fund from which replacements can be effected. For simplicity of accounts procedure, this account can be maintained with the Reserve Fund for Major Repairs as a separate sub-head for each sub-group of equipment.

The expenditure on tyres and tubes, etc., on the heavy earth-moving machinery may run to over half the cost of the equipment over its life period. Maintenance of an accurate record of tyre costs and performance is necessary. We have given in Appendix 4.5 the form for maintaining the record of tyres.

The replacement costs of tyres and tubes, etc., should be deducted from the purchase cost of the equipment for working out the rate of depreciation of the equipment. The hourly cost of renewing the tyres and tubes, etc., should then be added by estimating the life over which the tyre, etc., would give service. A 10% addition should be made to cover the cost of servicing and repairs.

The actual life of tyres will depend upon the following factors:

(*a*) Selection of the proper type and size of tyres ;

(*b*) abrasive quality of the material ;

(*c*) care with which the roads are maintained ;

(*d*) skill of the operators ; and

(*e*) provisions made to avoid accidents.

We recommend that the following standards be adopted for average conditions :

Equipment	Life expectancy hours	
	Average material	Abrasive material
Scrapers	3,000	2,500
Dumpers—Bottom	3,500	3,000
Dumpers—End	3,000	2,500
Tractors	2,500	2,000
Rubber belt for loaders	3,000	2,500
Drawn Scrapers	4,000	3,500

ACCOUNTING FOR OPERATION AND MAINTENANCE

11.01. General Outline

All the charges of fuels, lubricants, operation, servicing, field repairs and allied services for field operations should be booked under this head of accounts. These items form the 'running cost' of operation and maintenance of the machines and are different in nature from the items included in the previous chapter, *viz.*, Depreciation, Major Repairs and Renewals of the tyres and tubes.

11.02. Fuels and Lubes

The cost of the fuel oil, petrol, lubricants, grease, hydraulic oils, etc., actually issued to the machines should be incorporated under this sub-head separately for each sub-group of equipment. It should not include the labour cost of the servicing crews which are to be watched under a separate sub-head. The issue rate should be based on the stock issue for bulk at the Depot. Where mobile tank-trucks are maintained the charges of the use of such vehicles should be debited to this sub-head.

The normal standard of consumption can be estimated from the rated B.H.P. of the engine, consumption of fuel per H.P. hour and the average load factor at which a machine will work. To illustrate, a 130 H.P. tractor working as a pusher with Scrapers will be working at about 60 per cent load factor. The average effective performance will be 78 H.P. and the fuel consumption of H.S.D. oil per hour at the rate of 0·50 lbs./B.H.P. will be 39 lbs. or about 4·5 gallons per hour. The load factor will depend upon the type of duty under which the machine works. If it works continuously near about the full load, a load factor approaching 100 per cent can be reached, but under normal field working conditions it will be difficult to get more than 60 per cent load factor. If the engine is in good condition, the fuel consumption thus serves as an index of the load factor and to check up whether the "plant hour" is being properly recorded. This is illustrated in the fuel consumption for an Euclid Bottom

Dumper 13/17 cu. yds (*vide* Appendix 6·1) consuming only 1·3 gallons per hour. The figure expressed that the load factor is very low. In fact the utilisation was not intensive as the vehicles were being loaded by 3/4 and smaller cu. yd. shovels. For 50 per cent load factor the consumption should have been about 4·4 gallons per hour.

The lubricants required by a machine normally fall into five different groups:

(*a*) Engine Crankcase Oils,

(*b*) Air Filter Oils,

(*c*) Transmission Oils,

(*d*) Greases, and

(*e*) Oils for hydraulic operation system.

Every machine has its own recommended types of oils and greases. These should be taken into consideration while working out the estimates. The D. G. S. & D. has rate contracts for most of the types of oils and greases normally required by projects. Such rates are considerably cheaper than the market rates and hence it is advantageous to operate on them.

To work out an estimate of the value of the lubes required for a working period, the capacity of the oil chamber, the interval of oil change and the periodical topping requires to be worked out. The interval between oil change is usually expressed in terms of hours of work in the case of equipment and mileage covered in the case of trucks and will depend upon the type of oil used, the condition of the machine and the field conditions such as the dusty atmosphere etc. Makers of the machines and the oil companies prescribe standards for oil changes, which should be followed. Care should be taken to see that the "plant hour" for the change of oils is properly defined to mean an hour a full load capacity. Under normal conditions series II Crankcase oils require a change after 120 plant hours. The quantity required for topping will depend upon the wear of the piston and liners; but a rule of thumb is that the quantity of topping required will roughly equal the oil chamber capacity between two oil changes.

The cost of the lubricants for transmission will generally have to be estimated on the basis of the period of oil-change specified for the machine. If oil seals are in good condition, no topping should be required but under normal working conditions a 10 per cent allowance for topping will be adequate to take care of leakages.

11.03. Operating Personnel

This includes operators, their mates and supervisory establishment. Normally, mates should be required only for excavators. They are alternatively designated as oil-men or greasers but are virtually operators under training. It is desirable to have separate supervisory officers for controlling the work of operators on projects using more than about 12 earth-moving machines. It will then be possible to train the operators to better standards and to get more efficient operation from the machines. The pay of such officers should be charged to work and watched under this sub-head.

It is desirable to have the same operator working on the same machine as far as possible. This will develop an attachment to the machine in the mind of the operators and will result in better care of the machines. Where sickness of machine is appreciable, this method may appear to lead to higher cost of operational personnel, nonetheless it is desirable to have individual allocation of machines as it will result in better performance and overall economy. A 10 per cent leave reserve should be added to work out the total strength of the team. This will also allow scope for the training of new operators and to replace the none-too-good hands by more promising newcomers. The cost of the operators per plant hour will depend upon the plant hours performed by the equipment. Assuming about 55 per cent available plant hours and a 10 per cent reserve, two man-hours of operators will be required for every hour put in by a machine. At the most, the number of operators can be cut down to obtain a ratio of about one in place of two, representing an apparent saving of only about 2 per cent in the working cost of equipment, but the "one man—one machine" rule will pay more than this extra cost. An operator should be asked to help the mechanics whenever his machine is sick.

Where jobs are worked in two shifts, it is good plan to let the operators select their own colleagues for working the other shift. Perfect co-operation of the two operators is of great importance to keep the machine in a good state of repairs

The pay scales of operators and mates are discussed in Chapter Four.

11.04. Maintenance Crews

The auxiliary personnel required to look after the machines on a project fall into the following categories:

I. Engineer in chaer of Base workshop controolling

(*a*) *Preventions inspections, and*

(*b*) *Major Repairs in field (dealt with under Major Repairs.*

II. Maintenance Engineer controlling

(*a*) *Servicing of—*

(*i*) Fuels and lubes,
(*ii*) Tyres and Tubes,
(*iii*) Batteries and Electrical Equipment ; and

(*b*) *Fied Repairs with a large number of specialised teams for specific types of duty.*

The maintenance organisation is discussed under Chapter Five.

On small projects, servicing is sometimes required to be done by the operators, but where the size of work is big enough, it is desirable to have independent servicing teams. An operator is apt to overlook or avoid detailed lubrication procedure which is a fairly taxing job. Nevertheless he should be held responsible to check up, before starting a machine, that the maintenance teams have done their duties properly.

The strength of the maintenance teams will depend upon the plant population on the job, and the time available for servicing. It is not possible to lay down a rigid standard of the number of personnel required. We have discussed the different set-ups for maintenance routines in Chapter Five. We think that a provision in the estimate of 5 per cent for large projects and 10 per cent for small projects of the cost of fuels and lubes used should be adequate to cover the cost of the fuel and lube teams. The recommended standards of cost for other maintenance are given in Appendix 3.3.

We suggest that the entire maintenance should be in charge of the best available ment. If one cannot be found in the project staff, it will pay to hire a man even at a high rate of pay, to reduce the sickness and cut down the cost of repairs. Each of the teams under the engineer should be headed by a Foreman, or an Assistant Foreman depending upon the size of the job.

11.05. Spares and Other Stores

In addition to the fuel and lubes, operation requires a fairly large quantity of consumable and other stores and minor spare parts that have to be renewed at frequent intervals. Wire ropes, cutting blades, filter, elements, bolts and nuts, electrodes and minor spare parts are constantly demanded by the maintenance teams. We have suggested in Chapter Five, that the field maintenance organisation should keep a small store for such articles so that these can be made available immediately. Such stores should be as small as practicable so that the maintenance teams are not taxed with the custody and accounting of too much stores. The size of the store will depend upon the length of the time-lag involved in getting out the materials from the main stores. We have known instances of long delays to get minor spare parts from the stores resulting in too much waste of production hours. Normally, the store set up on project should be such that a spare part or other material should be made available to the machine within one hour, if it is available in stock.

The cost of such materials should be debited to the "Spares and Other Stores". Cost of other services for field maintenance should also be debited to this head.

We have explained in Chapter Ten that the distribution of cost between Major Repairs and Field Maintenance will depend upon the project set-up. It is, therefore, not possible to lay down definite standards separately for the cost of materials and spares for Field Repairs. The figures given in Appendix 3.3 should, therefore, be considered as a whole and utilised as such.

11.06. Overheads

Overheads or indirect charges are incurred for "Ownership" and unproductive labour which cannot be booked direct to the servicing of individual or group of equipment, such as the pay of chowkidars, uniforms to operators, supply of drinking water to the site, charges of electricity and air to the field shops, muster, tools, and store clerks, etc. A provision of 2 per cent for these services should be adequate for an average job.

ACCOUNTING FOR OWNERSHIP AND RUNNING CHARGES PER PLANT HOUR

12.01. Main Sub-Heads

The hourly cost of working equipment is made up of all the component charges stated in the previous Chapters. They are recapitulated below:

Capital Accounts—

(a) *Depreciation.*

(b) *Major Repairs.*

(c) *Renewals of tyres, tubes, etc.*

Running Account—

(a) *Operating personnel.*

(b) *Fuels and Lubes.*

(c) *Maintenance crews.*

(d) *Spares and stores.*

(e) *Overhead expenses.*

It is necessary to ensure that no part of the equipment cost is charged *directly* to the earthwork or the hourly cost of equipment will not be realistic.

12.02. Working Equipment Through Suspense Account

We have recommended watching the running cost of machinery under suspense accounts. Some projects (*e.g.*, D.V.C.) debit such charges directly to the earthwork. This is undesirable as it does not lend itself to adequate cost control of equipment expenditure by the mechanical staff. In a mechanised set-up there are two distinct stages of cost control, *viz.*, (i) working the equipment economically with plant hour cost controlled under specified limits and (ii) ensuring that it does an adequate quantity of work per hour. The former can be controlled better by the mechanical engineer in charge of the plant whereas the cost control on the latter is usually the responsibility of the civil engineers. By working out the cost per plant hour in the first instance, the responsibilities of the mechanical and the civil side can be fixed more effectively. Another advantage of this system is that when the Material account remains in arrears (which it often does), the unit costs of earthwork can be approximated quickly from the scheduled cost per plant hour output obtained and plant hours put in.

12.03. Estimates for Ownership and Running Costs

Estimates for sub-groups of equipment should be made separately, for the Ownership and the Running costs at the beginning of each financial year. The provisions for various component charges recommended in the previous Chapter should serve as a guide. These estimates should give complete details of all personnel required to form maintenance teams. The provision for spare parts and materials in the estimate can be made as 'lump-sum', because, exact details cannot be foreseen. Estimates for hourly rates for charging to works to clear suspense accounts should be based on previous experience and actuals. The Running cost can be cleared every month on the basis of these rates. Every three or six months adjustments can be carried out for residual amounts. In any case expenditure on Running cost suspense accounts should be completely cleared by the end of a financial year, by transfer to project works. No allotment should be required for these charges.

12.04. Sub-Dividing Charges of Maintenance Teams

It is not possible nor desirable to have separate maintenance teams for each sub-group of equipment. For example, there may be only one team to do electrical maintenance on all the types and sizes of excavators on a job. In such a case the cost of the complete team should be worked out and the charges prorated in suitable proportion to the sub-groups of equipment.

12.05. Credit Side Estimates

The credit side estimates generally cannot be presented sub-group-wise because the output of earthwork is a combined performance of all equipment on the job. These estimates should be framed for the overall use of machines for a particular item of work. Addition of such other charges such as the cost of manual labour, material and services directly debited to work (*e.g.*, explosives, watering charges, etc.) and the over heads (haul road, flood lights, etc.) will then give complete estimated rates for the year for each item of work.

12.06. Plant Hour Cost

We tried to compile the hourly rate of ownership and operating cost of items of equipment working on the different projects studied by us. These are compiled in Appendix 3.5 and the information collected from various projects is in Appendix 6.00. It will be seen that due to want of uniformity in the procedures for accounting and particularly because of different standards used to define the "Plant hour" the cost varies widely. We have indicated standards and typical estimates for some of the commonly used equipment in Appendices 3.3 and 3.6. These should serve as a guide for normal working conditions and will need to be adjusted to meet the special features of any particular project.

RECORD KEEPING FOR MACHINERY

13.01. Log Books and History Books used for Different Purposes

Due to different ideas as to the use for these records different designs for forms and rules for posting them are prescribed by projects to maintain their Log and History Books. Often enough, the forms are made so elaborate that difficulties are found in posting them promptly and the advantage of having reliable and easily available records is lost.

13.02. Study of Various Forms

We have studied the forms and regulations current on the projects visited by us. Log Books are utilised at Lower Bhavani as an account document to incorporate operational cost of the individual equipment and to transfer the cost to the earthwork. On the other hand, the Nangal power channel project utilises neither of the books for accounts of capital expenditure but have devised a third register.

13.03. Correct use of Log Books

In the background of the account procedure suggested by us, we recommend that the Log Books should be used only to incorporate the original data to arrive at the operational cost. It should not be a cost voucher but should be the book in which the performance data is "logged" so that the cost account can utilise the information to base various statistics. It should not contain too many computations but should record the original information only. Being a document of fundamental data, it should not compile copies of cost accounts, *e.g.*, from stores or Muster Rolls. A "Log Book" of a Navigator or a Pilot is used only for such records and we see no reason why processed account figures need be compiled in it.

13.04. Correct use of History Books

The History Book should give all the technical and cost data of the machine to indicate the complete history of the machine for technical and fiscal evaluation of the machine at any time. It should give manufacturers' data about the technical details of the machine, its cost records, history of repairs and alterations, and the abstract of utilisation in terms of hours and the depreciated value.

13.05. Log Book Details

The Log Books are to be utilised for two purposes: (*i*) for a technical control to evaluate how the machine is performing, and (*ii*) for getting the "plant hours" performance classified by works. To determine performance, the total plant hours put in by a machine must be known and causes of "trouble" should be classified. The book must also record the consumption of fuels and lubricants, since the performance of the machine can be judged readily from these figures. It must record the work on which the machine was employed indicating the officer on whose requisition the machine was utilised. We have indicated the form of Log Book in Appendix 4.2. A memorandum of instructions for filling up the book is also appended. These should be printed at the beginning of the books, as is done in the P.W.D. Measurement Books.

13.06. Abstract Log Book by Sub-Groups of Equipment

We have recommended that the machine-wise operation account is too elaborate and is not feasible on jobs employing a large number of machines. We have recommended classifying the running cost under five sub-heads. To get this data, an abstract of Log Books per sub-group of equipment comprising one make, size and type of equipment will be required. A form for the Abstract of Log Book together with the memorandum of instructions is given in Appendix 4.3.

13.07. Importance of Log Books

We attach great importance to the correct and up-to-date posting and careful preservation of the Log Books. They would be given the same care and importance as is customary in the upkeep of the Measurement Books.

The Log Books should be kept always with the machines or available in the field with the operation foreman.

13.08. History Book Details

The form of the History Books is given in Appendix 4.4. A memorandum of instructions for filling in the books is attached. These should be printed at the beginning of the books. It should be possible with this record to evaluate the general condition of a machine at any time, to decide the nature and extent of the next overhaul, to help in scaling the spare parts required in future and to assess its value. The Daily Reports required for day-to-day record of the operation of machinery are given in Appendix 4.00 and are described in Chapters Five and Six.

13.09. Tyre Record

We attach equal importance to the maintenance of correct record of tyres, as their cost is an appreciable fraction of the hourly rate of operating such equipment. A form of tyre record is given at Appendix 4.5.

13.10. Correlation of Records

The correlation of the records in the Log and History Books with the Daily Reports and other records is given below:

Log Books	*Correlated Record*
1. Date	
2. Name of Operator	Operator's Daily Report.
3. Gross hours of machine on duty	Operator's and Foreman's Daily Report.
4. Idle hours :	
(a) No work	Do.
(b) Minor Repairs	Do.
(c) Major Repairs	Do. and Base Workshop Daily Report.
5. Fuels and Lubes	Servicing team's Daily Report.
6. Production with head lifts and nature of materials.	Direction Control Daily Report.
7. Debit to be raised on	Operating Foreman's Daily Report.

History Books	*Correlated Record*
1. Constant data of the machine	Manufacturer's specifications and purchase data.
2. Hisotry of alterations	Base shops job cards.
3. Major Repairs & spares	Do.
4. Monthly summary of operations	Log Book.
5. Cost Account (Monthly) :	
(a) Capital Cost	Account Records.
(b) Cost of alterations and Major Repairs	Base shop job cards.
(c) Deduct depreciation	Log Books.
(d) Deduct Major Repairs	Do.
Tyre Record	Maintenance team's Daily Report.

A large number of daily reports are required on projects to compile the machinery statistics for accounts and for technical scrutiny. They are non-standard forms; projects should have a free hand to get them locally printed to suit the needs of the jobs.

UNIT COST OF EARTHWORK

14.01. Components of Cost

The final cost of an item of work comprises the following distinct sources of expenditures:

(*a*) Machinery ownership and running costs.

(*b*) Cost through Muster Rolls of direct labour and workcharged establishment.

(*c*) Cost of directly debited T. & P. and other materials, *e.g.*, Jackhammers, explosives, etc.

(*d*) Cost of contract work for some items, *e.g.*, dressing.

(*e*) Cost of other services through distributive account such as water supply, haul roads, flood lights, supervisory transport, laboratory and miscellaneous charges.

The method of accounting for these costs to arrive at the unit rates of completed items of work is discussed in the first part of this Chapter. The latter part deals with the unit rates reported by various projects.

14.02. Proper Classification of Items

For facility of a proper cost control it is necessary to decide the sub-heads of accounts through which each item of civil works must be watched. Typical examples of numerical classification are given in Appendix 4.13. The debits of machine hours, materials, labour and contracts are classified by giving proper account numbers for every item of expenditure.

14.03. Measurements of Works

The quantities of the work done should be measured cnce a month on fixed dates. The same care should be exercised in the measurement of departmentally executed works as is normally bestowed on contract works. With these records of quantities and costs, the figures for the sub-head rates can be worked out. The total of such individual unit rates will give the unit rate of a completed item of work.

14.04. Machinery Cost

This is by far the largest item of expenditure on mechanised jobs and hence the account procedure for this should be carefully planned. The Daily Reports of every machine should mention the hours worked on a particular work. The operation foreman or an officer of the direction control should enter the correct account number against each item of work done. These entries are verified and transferred to the Log Books immediately. This becomes the primary record of accounts.

Based on the record in the Log Books, a daily abstract is prepared by the operation foreman giving the total plant hours of work done by each sub-group of equipment, allocating it to the various sub-heads of account. He should then forward one copy to the Civil Engineer in charge of the work. The Civil Engineer must check and reconcile the plant hours from his own records and also the allocation of plant hours to various works sub-heads as this is *his* responsibility.

The plant hours are then recorded progressively by works in a register from day-to-day.

Samples of the Daily Reports and the Register of Equipment allocation are given in Appendices 4.6.1 and 4.15 respectively. The monthly abstracts of plant hours and work done by each sub-group of equipment will also be available from the Abstract in Log Book mentioned in Chapter Thirteen.

At the end of a month the Mechanical Engineer in control of the operation of equipment will intimate to the Civil Engineer in control of the works, the plant hours classified by sub-group of equipment for the services rendered. The Civil Engineer checks and accepts for the debit by giving a corresponding credit to the equipment suspense estimates. The total of the plant hours intimated by the Mechanical Engineer should tally with the workwise total of the plant hours from the Civil Engineer's record. Minor discrepancies should be adjusted as lump entries in the Abstract Log Books.

Based on these fundamental records the debits of machinery cost is transferred to the earthwork from month to month by the normal system of Transfer Entry Orders.

A specimen of such a monthly transaction is given in Appendix 4.16.

14.05. Credits to Capital Accounts

The credits for the hourly cost of equipment will include the hourly rates of (i) Depreciation, (ii) Major Repairs and (iii) Renewal of tyres, etc. These should be taken to the capital account sub-head of the relevant equipment sub-group, treating them as reduction of the expenditure; but the credits and debits should be watched through independent columns so that a complete view of the total debits, credits and balances can be had at any stage.

14.06. Credits to Running Costs

The Running cost can either be cleared at an hourly rate based on actual total cost for the month, or can be cleared on the basis of fixed estimated rates in the first instance and adjusted periodically, say every three months, to tally with the actuals. We recommend the latter procedure as it will give the first approximation of costs very quickly.

14.07. Accounts of Minor Equipment

To avoid such complicated procedure in the case of Minor Equipment used in small numbers, its working costs need not be passed through the capital account. The charges for operation and Major Repairs may be directly debited to works. Maintaining a machinery suspense sub-head account for them is not considered worthwhile. The depreciation of the Capital cost should, however, be progressively charged off at least once in six months based on the proportionate value of the work done.

14.08. Other Charges

The method of accounting for the directly debited labour, work-charge establishment and contract work is too well known in the P.W.D. accounting system to need detailing in this report. The material directly charged to the work should be only such as are not used by the machinery, *i.e.*, explosives etc. We find that some projects directly charge even spare parts issued. We do not recommend such a procedure as this will vitiate the calculation of the working cost of the mechanical equipment.

14.09. Distributive Accounts

The method of transferring the cost of other services (such as the Water supply pipe line at Hirakud) needs to be planned in a more rational way, than has been customary in our accounting system. The U.S.B.R. styles all such services as "Distributive accounts" designated by the profix-D, before the account number. The cost of these services do not figure as independent items of debit, when the work is closed but are cleared by transferring the expenditure to the work concerned. All such important services should be properly estimated under suspense accounts. It is often necessary to sub-divide the estimates for such services into two parts (a) Capital cost and (b) Running charges.

The former is cleared periodically *pro rata* on the value of the work done and the latter is cleared completely from month to month. For example the cost of water supply service to an earthen dam will comprise (*i*) setting up the pumps and pipes lines which form the capital cost and (*ii*) the running charges. The former should be cleared proportionately to the outturn of earth work and the latter should be completely cleared every month, for other services such as haul roads, flood lights, laboratory control, field sheds, etc., the same procedure should be followed. We also recommend that the Special Tools and Plants (Charged) should be cleared periodically in the same manner.

These debits for ancillary services form a substantial part of the unit rates of the work and hence it is improper to omit them in calculating the rates for work. The large variations noticed in the rates between various projects (*vide* Appendix 3.7) is partly due to the want of uniformity in the extent of inclusion of such debits in the system of accounts.

14.10. Study of Reserve Funds

To arrive at the unit rates of earthwork, more exactly, it will further be necessary to periodically study the Reserve Fund for Major Repairs as this forms a very important item of cost. As the hourly rate of levy for Major Repairs is usually an approximate estimate done at the early stage of the project, there is likely to be a large variation between the actual and the anticipations. Whenever the unit rates are reviewed a note explaining the position of the Reserve Funds and adequacy of the rates for Major Repairs and for renewals of tyres, tubes etc., should be furnished.

The unit rates, incorporating all these items of expenditure should be adopted for arriving at the project rates for unit items of civil works. Its relative position in the structure of cost accounting can be seen in the Appendix 3.7. The items of expenditure which a project normally finances separately are discussed hereafter.

14.11. Indirect Components of Units Rates

The following items of expenditure have to be taken into account to arrive at overall unit rates for comparison with the rates of other projects or contractors.

14.12. Interest on Cost of Capital Equipment

It is necessary to take into account the interest on capital invested in equipment when working out the rates for mechanised items of work.

One important point of difference between this charge and the others is that it is proportionate to the capital invested, as progressively depreciated and unlike the charges for depreciation is applied independently of the actual utilization of the equipment in terms of hours worked or outturn achieved. If the equipment is uniformly utilised during the working year, the incidence of interest charge can be spread out uniformly per work hour of each item of equipment in which case this charge will resemble the levy of depreciation charge on hourly basis. Such levy of interest charge, included as a component item of ownership charge, is adopted in estimating the units charge for items of work.

In working the actual cost rates for items of civil work, it is necessary to include a proportionate charge for interest on capital invested in the purchase of relevant items of Special T. & P. based on the outturn achieved during the working year.

The rate of such charge per unit of work increases as the degree of utilisation falls and outturn decreases. This is not adequately realised. This charge can be very high on highly mechanised projects where there is inadequate utilisation of the equipment. Rough calculations show that it varies from about 5% to as high as 20% on our projects.

Incidentally the percentage ratio of the interest charges on the outstanding capital expenditure on equipment to the total value of the work done during the year by the machines is an excellent index for appraisal of the overall efficiency of the working of mechanical equipment. An inter-project comparison of these figures would be an easily obtainable index for efficiency evaluation. We could not work out the figures for the projects for want of inadequate data at our disposal.

A quick method of working out these ratings is given in the Appendix 3.8. For accurate evaluation the actuals of the project will have to be taken.

14.13. Labour Amenities

The expenditure incurred by a project on labour housing and other amenities should be expressed as a percentage of the total project cost and should be figured as a percentage over the project rates of civil items. A contractor is normally required to make his own arrangements for labour housing. The expenditure on this item also affects the wage scales to a certain extent and hence in an overall picture of projects, it is desirable to have an idea of the proportion of such costs. The item should include the cost of the construction township and its maintenance, as the cost of the other free services. such as, the supply of electricity, sanitation, water supply, labour welfare, workmen's compensation and their insurance, if any.

14.14. Stock Losses

Certain amount of loss, due to unutilised and surplus stock, is inevitable on projects. This applies particularly to the spare parts left over as all the parts will not be completely used when the project is completed. A project holding a large stock of spares will have the advantage of low factor of sickness of equipment, good progress and low unit rates, but will lose appreciably in the value of the unutilised surplus stock at the end of the work. A contractor will invariably have to sell off the surplus stock at a considerable loss. We consider that an approximation should be made on each project as to this anticipated loss on stock. It should be worked out as a percentage of the project cost and figured as a percentage component charged on unit rates of civil items.

14.15. Overhead and Centage Charges

The pay and allowances of the permanent and temporary establishment, their leave and pensionary charges, *pro rata* charge of account and audits and the cost of ordinary T. & P. are levied on a project under this head of accounts. The system of engaging supervisory establishment on work-charged roll or under a separate establishment budget head is not uniform on all projects. A work using less funds under work-charged establishment, and more on overheads may give low unit rates but may not be economical on the whole. A contractor will generally incorporate such expenditure in his unit rates. The overheads charges vary from about 10% to 30%. These should be the realistic charges and not the "*Pro rata*" for the work in the entire State.

14.16. Complete Details necessary for Appraisal of Unit Rate

A correct appraisal of the unit rates obtained on a project is possible only if they are worked out completely on the lines indicated. Any partial picture is likely to be misleading.

14.17. Unit Rates on Projects

We have collected information about the actual Rates of earthwork obtained on various projects. For want of uniformity in the estimate structure, the rates are based on different standards, conforming with the cost structure adopted in each project estimates. The summary of a comparative study is given in Appendix 3.7. The following paragraphs give further details.

14.18. Lower Bhavani Project

The information about the project and the statistics concerning the machinery are given in Appendix 6.1.

About 59.1 m. cu. ft. of earthwork was done by earth-moving machinery and 100.4 m. cu. ft. by trucks and manual labour. The earthwork was almost completed when we visited the project.

The average utilisation of the equipment was for 6.040 hours, based on gross hours of work. The effective life used will be between 3,000 to 4,000 hours.

The rates for the earthwork done by machinery are worked out as under: *vide* Statement No. 6.1.6.

Lead one way	Rate (Rs.) per 1,000 cu.ft.
0.75 miles	45.57
1.00 miles	52.32
1.50 miles	56.00

These rates include only the costs of working the machinery. Manual labour utilised as supplement to mechanised work, for dressing the embankment, picking up roots and boulders, levelling and control, civil work-charged establishment, etc., do not seem to have been included in the rates.

There is no day-to-day record of leads and lifts to work out the exact weighted averages. The leads adopted above are, therefore, approximations.

The laid embankment is taken as 2/3rds of the struck bowl capacity of the machines. As majority of the earthwork was being done by manual labour and trucks, a more accurate estimate of the work done by the earth-moving machines was probably not possible. We consider that the assumption made should be accurate within 10 per cent.

The cost of the Special T. & P. is about Rs. 140 lakhs. Out of this the cost of earth-moving machinery totals to Rs. 62 lakhs. A total credit of Rs. 72.5 lakhs is taken for reduction in the cost of the project due to Receipts and Recoveries. Salvage value of Rs. 50 lakhs is adopted in the estimate against the expenditure of Rs. 121 lakhs on equipment.

The value of the earthwork done by machinery works out approximately to Rs. 35 lakhs. The expenditure on the earth-moving equipment was unduly heavy. The large residual life left at the end of the job will probably result in a substantial loss if equipment cannot be transferred at book value.

The life assumed for depreciation for various equipment is given in Appendix 3.2. In view of the lack of intensive utilisation of the equipment per plant hour, the depreciation included in the unit rates of earthwork is rather liberal. The unit rates will be less by about 15% if the charges of depreciation were framed on the basis of the effective plant hours only. This can be seen from the cycle time given in the Statement No. 6.1.6. The cycle time required for such leads should have been only about a half of those given therein.

The charge for the Major Repairs is included at the actuals only as and when repairs are done and debits are raised. As the equipment has worked during its initial portion of life, the project has escaped a greater portion of Major Repairs. Hence the cost of Major Repairs (per plant hour) has been very low, as can be seen from the Statement No. 6.1.3. If a Reserve Fund for Major Repairs as recommended by us, had been created, the rates for Major Repairs to equipment would have increased substantially. The project will have to pay for this either in the form of a lower resale value or accept the debit for the cost of the final overhaul.

The running cost of the equipment is booked through suspense accounts and is watched individually by machines through Log Books. We consider machine-wise accounting unnecessarily elaborate. One estimate for every sub-group of equipment (comprising one make, size and type) should have been adequate.

The costs of ancillary services such as the haul roads, flood lighting, laboratory and field control, transport sheds and sundries are not included in the rates of earthwork. They are stated to be watched under "other sub-heads". Probably here also the expenditure is not separately booked for the work done by machinery and other methods. These costs are substantial charges and will make an appreciable increase in the rates.

The watering charges are included in the rate at Rs. 4.9 per 1,000 cu. ft. It is not known whether these are the charges for operating the watering arrangements alone or include the cost of installation of pumps and pipe lines also.

The cost of the Special T. & P. is taken into account only as far as the rated depreciation on the earth-moving equipment is concerned. A large amount has been spent on other types of Special T. & P. used which do not figure in the unit rates. The increase in the rates due to this charge will be appreciable.

In the inter-project comparison of the rates, the following points are borne out:

Labour Amenities

The cost of the buildings, which is 25 lakhs is about 5% of the cost of the project. The details of the nature of expenditure included as "Rs. 24 lakhs O. Misc." is not available. Probably a part of it is ancillary services for the township in which case its cost should be included under this heading.

The interest on the capital equipment will be a heavy charge on this project. Taking Rs. 80 lakhs as the effective capital on Special T. & P., 2.5 years average use and 4% rate of interest, the interest charges will be Rs. 8 lakhs. The total value of work done by the equipment seems to be Rs. 35 lakhs. This will give an increase on rates, of about 23%. That is heavy.

The stock losses on the project have not been estimated. The project held stock worth about Rs. 19.60 lakhs of which Rs. 8.51 lakhs were machinery spares.

Establishment and overhead centage charges are estimated as Rs. 27 lakhs which works out to about 5% on the project total. The actuals are not known but should be low as the project was completed quickly.

14.19. Tungabhadra Project

The general information about the project is given in the Appendix 6.2.

Mysore/Andhra Side

The project was executed mainly by manual labour with assistance from machinery limited to jobs which were costly or slow for purely manual work.

We could not get adequate information about the unit rates. On the Mysore/Andhra side the work is almost completed and most of the equipment has been transferred. The records have been filed with the result that factual statistics are difficult to get.

The dam proper is constructed of masonry. The mechanisation was limited to the transport of rubble by light rail rolling stock and lifting the materials to the top of the dam by cranes of various types. We were told that the masonry worked out to Rs. 120 per 100 cu. ft. for cement-surkhi mortar (1 cement to 1/4 surkhi to 2¾ sand) and Rs. 105 for lime-surkhi mortar (1 lime to 2 surkhi to 2 sand).

On the canal section, deep excavation in rock was carried out mostly by manual labour supplemented at times by cranes used for lifting up the muck.

The dragline work for earth excavation and casting is said to have worked out to Rs. 30 to Rs. 35 per 1,000 cu. ft.

Some of the high banks were done by earth-moving machinery. We were told that the rates worked as under:

A. (*i*) Excavation : Shovel operation . .	Rs. 13 per 1,000 cu. ft.
(*ii*) Haulage lead ½ to 1½ miles . .	Rs. 25 to 50.
(*iii*) Consolidation	Rs. 6 per 1,000 cu. ft.
TOTAL .	Rs. 44 to 69 per 1,000 cu. ft.
B. *Drawn Scrapers*	
Lead 2 to 6 furlongs (data of 25,000 hrs. of work)	Rs. 31 to Rs. 38 per 1,000 cu. ft.

The value of the Special T. & P. was about Rs. 56 lakhs. Information about the salvage value realised and its effect on the final unit rates was not available.

Hyderabad Side

The value of the Special T. & P. was about Rs. 80 lakhs. The equipment was mainly used on the construction of a dyke 40 ft. in height on the left flank, river diversion and some foundation and canal works. No information regarding the unit rates of earthwork by machinery could be supplied.

The equipment had done relatively little work and was left in a poor state. The Mechanical Engineer looks after the stores, electricity and the production account of earthwork, which makes it difficult for him to devote enough attention to the maintenance of the equipment. The technical set up to look after the machines was poorly organised and inadequately staffed. What struck us was that the money spent on the overhaul of equipment by a contract agreement with manufacturer's agents in India could have been more effectively utilised to strengthen the technical organisation with some more skilled personnel.

We feel it necessary to emphasise, even if it means repetition, that mechanisation carried out half-heartedly will not pay.

14.20. Gangapur Project

Information about the project and the statistics of the machinery are given in Appendix 6.3.

A total of about 125 m. cu. ft. of earthwork for the dam and the waste weir was completed by June, 1953. A monthly progress varying from 3.5 to 6.0. m. cu. ft. was obtained with an investment of Rs. 59 lakhs on earth-moving machinery. About 15% work remained to be done when we visited the works. The entire work is being handled by mechanised construction.

The average utilisation of the equipment is 4,500 hours.

The "plant hour" is defined as effective hour.

The equipment was purchased in two instalments, one in 1948-49 and the other in 1952. The former at pre-devaluation prices was worth about Rs. 35 lakhs and has done nearly 7,000 hours of work.

The rates for excavation and for earthwork worked out up to 1-7-1953 were as under:

Item	Quantity m. cu. ft.	Actual rates per 1,000 cu.ft.
1. Excavation for dam seat	11.65	42.5
2. Excavation for cut off in soft rock	9.92	60.6
3. Excavation for hard rock	1.91	268.1
4. Impervious fill for cut off	10.34	61.2
5. Impervious fill for dam	66.26	65.6
6. Murum casing and rock toe	25.01	95.6
7. Rock pitching	1.25	196.9
8. Metal base	0.28	480.0
9. Slant sand filter	3.17	197.5

These rates include depreciation and running charges of the equipment, direct labour and materials and work-charged establishment. They also include the cost of all distributive accounts such as the purchasing and the maintaining flood lighting arrangements, constructing and maintaining haul roads, running charges of the laboratory and field control, supervisory transport and sundries.

Compared with the list of items recommended by us to be included in the Project Rates, these rates do not include the initial cost of laying the water supply system for watering the earthen dam (which will be 1:5%) and the cost of Special T. & P. (charged) which will be 2%. An addition of 3·5% to the above rates, therefore, will have to be made to work out the project unit rates.

The leads and lifts are recorded daily. Monthly weighted averages are worked out. The typical details are given in Statement No. 6.3.8. The average works out as under:

Materials	Lead (ft.)	Lift (ft.)
Impervious fill	4,132	69
Murum casing	4,361	44

The measurements are based on physical measurements of the compacted embankment. The soil is highly plastic clay giving pay measurements of 55% of the struck bowl capacity of scrapers.

The total cost of the earth-moving machinery is Rs. 59 lakhs, of which nearly Rs. 26 lakhs (mostly post-devaluation purchase) is taken as the residual value after the dam is completed. Part of this is planned to be utilised on the canal works. The value of the earthwork done by the machinery is nearly Rs. 125 lakhs. The expenditure on the earth-moving machinery works out to nearly 48% of the earthwork of the dam.

The life for depreciation assumed is slightly longer than our recommendations. The charges for Major Repairs are levied at a flat rate and the balance of the reserve fund is carried forward to the next year. The Major Repairs and Running Cost of the equipment are booked through separate suspense accounts, maintained by groups of the types of equipment. The account is not sub-divided by makes, types and sizes of equipment in the works register. The cost of the spare parts issued for field or major repairs are booked machine-wise in Log Books. The suspense estimates are cleared monthly on the basis of the estimated rates and yearly adjustments are carried out for the balance amount remaining unadjusted under Running Cost.

The charges for renewals of tyres and tubes are levied at a flat rate and a reserve fund is maintained.

For the inter-project comparison of the rates, the following observations are made :

The cost of labour housing, maintenance and services works out to 4·5%. The interest on the capital expenditure at 4% will be approximately 5%. This indicates intensive utilisation of the equipment purchased. The stock losses on the project cannot be estimated. The project held stock worth about Rs. 18·3 lakhs of which Rs. 10·38 lakhs is book value of spares for earth-moving machinery.

The establishment and overhead centage charges are being levied at *pro rata* rates of establishment to works for the entire State and is estimated @ 30.5%. The actual cost up to the level of the Division inclusive of the cost of T. & P. audit etc. is about 8%. We see no reason why the project should be debited with such unrealistic and heavy charges on *pro rata* basis.

14.21. Hirakud Project

General information about the project and the statistics of the machinery are given in Appendix 6.4.

The estimated quantity of earthwork on the main dam is 450 m. cu. ft. and on the dykes 223 m. cu. ft. About 120 m. cu. ft. of earthwork on dykes is given on contract. The main dam is being done departmentally with earth-moving equipment.

The expenditure on Special T. & P. is Rs. 697 lakhs of which Rs. 3 crores are spent on the purchase of capital earth-moving machinery. A list of the capital equipment and the percentage utilisation is given at Appendix 6.4.

The earthwork done is as under :

Year	*Quantity in m.cu. ft.*
1950-51	22.1
1951-52	44·3
1952-53 (up to June 1953)	63.3
	129.7

The average utilization of the equipment up-to-date could not be obtained but that for the period from October, 1952 to June, 1953 was 824 hours. The 'Plant Hour' was defined earlier as "gross hours of duty" but is now taken as odometer readings or as near an evaluation of it as possible.

The earthwork rate for pervious and impervious fill (on compacted embankment measurement) up to the end of June, 1953 worked out to Rs. 87-2-0 per 1,000 cu. ft.

There is no cost accounting organization. Store issues are not properly classified and priced to date and hence only an overall and approximate figure of unit rate is possible.

The average weighted lead for pervious and impervious fill is 1.9 miles. The rate includes depreciation, major repairs at actuals and running costs of equipment. It also includes cost of water supply, misc. sheds and direct labour but does not include cost of haul roads, flood lights, laboratory control, supervisory transport and sundries.

The life of equipment assumed for depreciation is slightly longer than our recommendations.

Reserve Fund for Major Repairs is not maintained. A large number of machines are sick and the work of major overhauls is in arrears. An improvement in this respect will increase the rates substantially.

The total value of the machinery and spares for Unit 1 (concrete/masonry and earth dam with dykes) is estimated to be Rs. 697 lakhs of which Rs. 471:9 lakhs is depreciation chargeable to works, leaving a residual value of Rs. 225 lakhs. This together with the residual value of "general machinery" and "stores discarded as scrap and useless spares" amount to Rs. 278·3 lakhs. The board has decided not to account for the residual value as reduction of expenditure but to charge it to works. This will mean an increase in the equipment ownership hourly rate of 57%. The ownership cost will, therefore, rise from Rs. 16-5-0 per 1,000 cu. ft. (included in the rate of Rs. 87-2-0) to Rs. 25-6-0 requiring a correction of Rs. 9.3 to the overall rate.

The percentage increase in the rates due to the cost of haul roads, flood lights, temporary sheds, etc., could not be worked out for want of details. However, these were estimated by the Executive Engineer, Mechanical Division, to be about 10·5%. The laboratory is run mostly by regular temporary establishment. No information could be gathered for the debit head of supervisory transport.

The cost of the special T. & P. (Charged) rendering general service, but not charged to unit rates through depreciation, such as the workshop equipment, transport vehicles, tankers, etc., is about half a crore. This will increase the unit rates by nearly 1%.

For the inter-project comparison of rates, the following remarks are made :

The interest charges on the cost of capital equipment will be heavy on this project. Actual figures are not available but taking Rs. 2·00 crores as the effective capital on earth-moving machinery, utilised fcr 2 years, the interest charges at 4% will be Rs. 16 lakhs. The value of the work done may be taken as (140 m. cu. ft. @ Rs. 100 per cu. ft. giving) Rs. 1·4 crores giving the ratio of interest to work done equal to 11%.

The cost of "K Buildings" is 5% over the cost of works. The cost of maintenance and other services is not known.

The overhead charges comprise establishment estimated at 5%, T. & P. ordinary 1% and audit 1%.

The establishment charges are rather low. The Mechanical side needs to be strengthened by having about two more divisions. This will not increase the overheads appreciably but will aid in improving the efficiency of the machines.

Contract Work

The work by contract on dykes is done by earth-moving machinery owned and operated by the contractor. When we visited the work the contractor was working with 4 Nos. DW 21 Scrapers, 2 D-8 Tractors and a Grader.

Earthwork of nearly 22 m. cu. ft. has been done since February, 1953. The soil was taken from the borrow areas located close to the upstream toe. The lead involved was mostly for routing the equipment and was about 2 furlongs. The contract rates were as under :

1. Earthwork in all kinds of soils mixed and laid in layers of 6" to 1 ft. with rough dressing and including all loads and lifts (Measurements are by borrow pits. Compaction departmentally with sheeps foot rollers; loss on compaction about 18%.)	Rs. 45 per 1,000 cu. ft.
2. Earthwork in all kinds of soil laid in layers 6" with rough dressing including all leads and lifts . . . . (Average lead 500 ft. for each 55 ft. additional lead Rs. 1-12-0 per 1,000 cu.ft. bank measurements; compaction by department.)	Rs. 47-8-0 per 1,000 cu.ft.
3. Excavation in all kinds of soil laid in 6" layers with rough dressing including lift and lead. . . . . (Manual work and used 4 Nos. DW 21 Scrapers; bank measure; compaction departmentally.)	Rs. 53-4-0 per 1,000 cu.ft.

We feel that with so much equipment purchased which is not likely to be utilised to its full life, it should have scarcely been necessary to give out the dyke work on contracts. The rates inclusive of compaction, work out to nearly Rs. 60 per 1,000 cu. ft. Departmentally it would probably have been less.

General

Equipment with large portion of residual life and a large quantity of store will be available on completion of this project. If definite plans for its utilisation on other projects can be worked out, it should not be necessary to write off the entire cost of equipment to this project. Better returns from the financial investment and improved efficiency from the personnel can be achieved if a continuity of construction is planned for utilising the residual equipment and spares.

14.22. Damodar Valley Corporation Projects

The information about the project and the machinery statistics is given in Appendix 6·5.

The equipment is pooled for all the projects managed by the Corporation and hence project-wise study of the equipment is not possible.

Maithon Dam and Power House

The Maithon Dam Project is estimated to require the following quantities of earthwork :

49.8 m. cu. yds.	Exc. in common soil.
0.66 ”	Exc. in soft rock.
0.89 ”	Exc. in hard rock.
4.40 ”	Embankment earth.
1.02 ”	Dumped rock.
11.95 m. cu. yds.	TOTAL

The cost of the earthwork proper is Rs. 2.36 crores.

The quantities of earthwork done from the start of the project up to 31-8-1953 and for the last working season are given below :

Items	Total Quantities up to 31-8-53 m.cu.yds.	Quantities done last working season m.cu.yds.
(1) *Shovels and dumpers—*		
(a) Excavation in common soil	1.32	0.84
(b) Excavation in intermediate rock	0.66	0.66
(c) Excavation in hard rock	0.48	0.26
(2) *Tractors with Sheepsfoot rollers, dozers, girders and water tankers—*		
(a) Embankment Earth	2.00	1.21
(3) *Dozers—*		
(a) Embankment dumped rock	0.38	0.38

The weighted average lift and lead were as under:

	Lead miles	*Lift ft.*
Impervious	0.6	25
Semi-pervious	0.6	43
Pervious	0.6	40

We could not get the actual earthwork rates obtained on the project but they were stated to be close to the estimated rates (revised estimate 1952) which are as under:

Item	*Rate Rs. per cu. yd.*
Earth Dam:	
1. Stripping exc.	0 14 4
2. Borrow impervious exc.	2 1 0
3. Borrow semi-pervious and pervious exc.	0 14 4
4. Embankment	0 14 4
Diversion Channel:	
1. Excavation common	1 3 10
2. Excavation Intermediate rock	3 12 0
3. Excavation rock hard and fresh	6 0 0

These rates include the cost of depreciation, Major Repairs and running the equipment. A Reserve Fund is maintained for Major and Minor Repairs and maintenance. The rates also include the cost of temporary office and store sheds, haul roads, flood lighting, work-charged supervisory staff, transport, water supply and sundries. The rate structure is, therefore, almost complete.

The measurements are based on compacted bank for the dam and sections for excavation. The rate for embankment given above is only the rate for processing. The rates of excavation and embankment will have to be added to work out complete rate for the dam.

The share of this project in the construction equipment is estimated to be Rs. 1.42 crores. The total value of the Special T. & P. (which includes Rs. 21.4 lakhs for spares) is estimated at Rs. 2.22 crores against which a salvage value of Rs. 1·00 crores is assumed.

The life assumed for depreciation is almost in the line with our recommendations except in case of excavators for which the life assumed is much longer. A correction in this respect will make a small increase in the unit rates.

In the inter-project comparison of the rates the following points are borne out:

The cost of the sub-head K Buildings is estimated at 6·1% of the cost of works. This is within reasonable limits.

No figures could be worked out for the interest charges over the cost of the capital equipment as the equipment is used as a combined pool for all the projects.

No provision is made in the estimate for stock losses. The project has started to build up its spare parts stores only recently and hence it is too early to judge the stock losses on completion of the work.

The establishment T. & P. audit and overhead charges are established at about 10%.

Panchet Hill Dam and Power House

The information about the project and the machinery statistics is given in Appendix 6.5.

The dam is estimated to require the following quantities of earthwork :

Total excavation: 230 m. cu. ft.

Total Embankment: 202 m. cu. ft.

The total cost of the project is Rs. 14·32 crores of which the earthwork is estimated to be Rs. 2.29 crores.

The earthwork done during the period 31-10-52 to 30-6-53 was 19.4 m. cu. ft. of excavation and 12.9 m. cu. ft. of embankment.

The actual rates of earthwork were as under:

Item	Rate Rs. per yard: Without depreciation			Rate Rs. per yard: With depreciation		
	Rs.	As.	P.	Rs.	As.	P.
Excavation Common	1	3	5	1	11	4
Excavation Int. Rock	2	3	5	2	13	1
Excavation Hard Rock	9	6	0	10	12	2
Embankment	0	13	8	1	2	2

The complete rate for embankment will thus work out to Rs. 2-13-6 per cu. yd. or Rs. 105 per 1,000 cu. ft.

The lead on an average was 800 ft. and lift 18 ft.

The rate structure is similar to that described for the Maithon dam.

The total provision of Special T. & P. in the estimate is Rs. 1·181 crores of which the earth-moving machinery charged to the project is Rs. 74 lakhs. A deduction of Rs. 65 lakhs is provided in the estimate as "Receipt and Recoveries" mostlv for the salvage value of Special T. & P.

The life assumed for depreciation is the same as for the Maithon Dam Project.

In the inter-project comparison the following points are brought out :

The cost of the sub-head K Building works out to 5% the cost of works.

No figures could be worked out for the interest on the capital equipment. The observations made under the Maithon dam applies to this project also with regard to the stock losses and overhead centage charges.

General

The cost structure adopted by the project is almost complete, incorporating most of the factors recommended by us except the Special T. & P. (Charged).

The project have not yet come up to their best production levels which they will reach in this and the next working seasons as they are now almost out of their foundation works. Improved production will reduce rates.

A Reserve Fund is maintained for Major and Field Repairs at a flat rate taken at 100% of the depreciation. The unit rates quoted above will be affected to the extent by which the actuals will vary from the flat rate levy. The adequacy of the flat rates can be judged only after 2 or 3 years.

Although the unit rates appear rather high to us we refrain from commenting upon them at this early state of construction.

14.23 BHAKRA DAM

This is a concrete dam project using earth-moving machinery for the construction of approach roads and for excavation of foundation, tunnels, etc. Bulk of the excavation and embankment is in rock, with an extremely difficult topography. This coupled with the great height of the Dam (680 ft.) makes the cost and production statistics unsuitable for comparison with any other projects under execution in India. The work involves over 5 m. cu. ft. yds. of excavation for the foundations and the power house alone. The general information about the project is given in Appendix 6.6.

We could not get adequate information regarding the unit rates of the work. An analysis of the work of the "Excavaticn of Left Abutment above R. L. 1700" was furnished to us giving a rate of Rs. 3-8-11 per cu yds. as under:

	Rate Rs.	As.	P.	Unit
Labour	0	2	6	per cu. yd.
Materials	1	14	0	"
Machinery charges	1	0	9	"
Compressed air charges	0	5	7	"
Electric charges	0	2	0	"
TOTAL	3	8	11	

It is not clear whether this included transport cost and to what distance and how much of the material was rock requiring blasting.

The project has a provision of Special T. & P. of about 8 crores out of which earth-moving equipment is about Rs. 2 crores. The salvage value is estimated to be about 80% of the residual book value and amounts to about Rs. 0.5 crores. In view of the very long life assumed for depreciation (*vide* Appendix 3.2.) we consider that this value will scarcely be realised but with reference to the magnitude of the work it will not make an appreciable difference in the unit rates.

14.24. NANGAL POWER CANAL

The general information about the project is given in Appendix 6.7.

The work is mainly excavation and embankment for the canal and the two power houses, mostly in sandy loam, with about 20% in gravel or boulder strata. Machinery is used generally in the rugged portions of the canal involving deep cuttings and high banks.

The working condition varied from place to place but normally the lead, compared to similar works on dams, was less. Where the excavated materials was too far away or was inadequate, embankments were done by earth from borrow pits.

About 400 m. cu. ft. of earthwork has been done by machinery and nearly two to three times that was done by manual labour. The canal work lends itself to easy manual work, except for the deep cuttings and banks with long leads. In this respect, a good balance between the work done manually and by machines is maintained on this job.

The structure for rates for mechanised work on the project is peculiar. The Mechanical Engineer (Executive Engineer, Field Division, Nangal) carries out complete items of works at scheduled rates laid down by the Chief Engineer. The profit and loss on working the equipment is accounted under the suspense estimates of owning and operating the equipment. These estimates are watched as "Manufacture accounts" and the profit and loss thereon is dealt with under the normal P.W.D. Regulations for stock manufacture.

The rates for earthwork are based on the pre-war schedules plus premiums. The basic rates are as under:

(i) Excavation in soil with a lead up to 50 ft. . . .	Rs. 3-2-0 per 1,000 cft.
(ii) Extra for lead over 50 ft. for every 25 ft. . . .	Re. 0-2-0 Do.
(iii) Lift from zero to 25 ft. to be paid as lead equals square of lift; and lifts over 25 ft. to be paid as lead equals lift × 25.	

The lead is measured as straight lead or "as the crow flies":

(1) Shovel or dragline work loading	200% over the basic rates.
(2) Dragline work casting on spoil bank . . .	175 % over the basic rates.
(3) D/8 Scrapers	150% over the basic rates.
(4) Motorised Scrapers :	
Lead 500 ft. to 1,100 ft.	190% over the basic rates.
Lead 1,100 ft. to 1,800 ft.	135% over the basic rates.
Lead over 1,800 ft.	110% over the basic rates.

Motor scrapers are not chosen for use on work involving a lead of less than 500 ft.

The scheduled rate for compaction is fixed at Rs. 12-8-0 per 1,000 cu. ft. inclusive of all premiums. This includes watering, rolling and dressing.

There is no hardness, wetness, slush or gravel allowances given over these rates for machinery work. Such allowances are allowed for manual work and to that extent the machine work becomes cheaper still.

"Pay" measurements are based on the "borrow pit" measurements, recorded, by taking cross sections. These are checked by the Civil Engineer on whose behalf the work is done.

The hourly rates of working the machinery include a flat allowance for credit to a reserve fund of Major Repairs.

For a typical case of canal excavation by a dragline casting on spoil bank involving a lift of 30 ft. and a lead of 150 ft. (within the reach of the boom) the rate worked is Rs. 22-2-0 per 1,000 ft. The excavation by the machines generally left the area roughly to the final section, and hence some further excavation for proper sectioning and dressing had to be done by manual labour.

For a typical case of an embankment involving a lead of 2,050 ft. and a lift of 30 ft. and embankment measuring 85% of borrow pit measurements, the embankment rates worked out to Rs. 75 per 1,000 cft. of compacted and dressed embankment. We consider that the rate for excavation and casting is rather low. The rate for embankment, though somewhat high, is reasonable taking into account that usually the Canal excavation and embankment work were done within the same rate.

We were told that the overall position of the profit or loss on the manufacture estimates is, that there is no appreciable credit balance or deficit on the running costs and that there are adequate funds available under the Major Repairs Reserve Fund.

We could not get adequate information to study how far the equipment will be utilised on the project and to what extent these rates will be affected by the assumptions of the salvage value. The project is very large involving much work on canals and hence it is difficult to get an overall picture of how the plant planning has been worked out for the entire job. However we feel that the figures of the life of equipment assumed for calculating the depreciation are too high and are not consistent with the figures normally adopted on such works. A modification in the rates of depreciation to be in line with our recommendations will increase the rates by about 15%.

MANUAL LABOUR *VERSUS* MACHINERY

15.01. Unemployment

The problem of unemployment in India is drawing pointed attention from everyone at present. Doubts are raised as to the value of mechanisation of projects to the country from viewpoint of overall economy. We are of the opinion that a word of caution is necessary before going in for large scale mechanisation. We must find employment for the partially utilised vast resources of unskilled labour particularly in the rural areas.

We must take into consideration the drain on foreign exchange which mechanisation brings about; not only for the purchase of the equipment, but almost twice as much more for the supply of materials and spare parts needed to keep the machines running.

Our resources of skilled personnel to maintain and operate the modern mechanical equipment are limited and our organisational and administrative set-ups are not as yet modified to meet the existing needs of maintaining the equipment at a high standard of efficiency.

We consider that mechanised construction is indispensable under certain conditions for the quick and efficient execution cf our projects. If the scope of mechanisation is limited to the proper spheres and does not interfere with the interests of manual work, the country would gain by the judicious use of machinery; particularly now when the "grow more food" works have to be pushed through and the quick execution of our River Valley Projects is very important to the nation's economy.

15.02. Deciding Sphere of Mechanised Jobs

Before a project is planned for execution, the scope of mechanisation should be studied and limited to jobs which are not feasible without the aid of machines or which cannot meet the time schedules. For works which can be executed within the time schedules and to specifications, by either manual labour or mechanisation, the comparison of estimates will be the deciding factor. We suggest that for such works it would be undesirable to mechanise if the estimates for the mechainsed construction shows saving of about 20 per cent since with the data available at present overall estimates for mechanised work can be framed to approximately 80 per cent accuracy only.

A small amount of mechanisation to supplement the manual labour is our best arrangement. Selected items of work which can accelerate the progress of manual labour should be handled by machinery ; for example transport over long distance, lifting materials to the top of the dam, stone crushing for concrete, compaction of earth-fills, dewatering foundations, etc.

15.03. Production Schedules

The targets set for production schedules and the degree of availability of labour resources in a local area are often guiding factors to decide the necessity of mechanisation. A two-yard excavator with about 10 men can do a job in a day which the same number of men would take a month to do. It is not always that a very tight time schedule is inescapable. If jobs are started well in advance, and time schedules are relaxed where it is reasonably possible to do so, it should be possible to avoid the necessity of rush-schedules on many jobs and thus bring them within the scope of manual labour.

This aspect should be borne in mind while preparing the progress schedules of construction for projects. The large amount of time consumed in planning for equipment and awaiting deliveries will often decrease time schedules sufficiently to enable the work to be done by manual labour.

The partially mechanised Tungabhadra Project and the highly mechanised Vaitarna Dam should provoke a lot of thought in this respect. The change-over from the use of mechanised concrete construction to masonry at Hirakud is another example for such analysis.

15.04. Specification Requirements of Modern Projects

Some of our modern projects are outside the scope of manual labour unassisted by equipment. Jobs such as Bhakra or the earthwork at Hirakud Dam cannot be done without the use of modern machines. If we want the projects to be executed we must have recourse to mechanisation. Even if we were satisfied with completing our projects over an extended time, the specification requirements of such projects make it essential to use machines. It will not be safe to build them by other methods.

15.05. SPECIAL USE OF MECHANISATION

Excavations for foundations, long leads, compaction to specification and excavation and tunnelling in rock are spheres in which mechanisation seems indispensable even on medium sized jobs. Under-water excavation can best be done by draglines. Blasting below water table needs modern drilling and special explosive technique. Haulage over a distance of about 500 ft. cannot be attempted on any large scale without the help of transport vehicles.

15.06 MANUAL LABOUR AND TRUCKS *Versus* EARTH-MOVING MACHINERY

Donkey transport can work to about two furlongs and works can be attempted with bullock carts up to a lead of one mile. But carts are getting scare and costly for such work and the advent of motor trucks has almost completely taken over the transport of building materials. The motor truck transport is cheaper in initial cost but becomes more costly on running expenses with the result that on larger jobs it pays to go in for modern earth-moving equipment. A typical comparison of earthwork by trucks with that by heavy equipment is given in Appendix 5.1. The conclusions evident from the study are as under:

(*i*) A large initial investment is required for earth-moving machinery which can be economically advantageous only when fully utilised. Comparatively little initial investment is required for manual excavation with truck transport and trucks.

(*ii*) The labour strength employed and the construction colony for manual work will be nearly 15 times those required for E. M. Machinery. The employment for manual work will be mostly unskilled labour, whereas that for E. M. Machinery will be mostly skilled.

(*iii*) The unit rates of earthwork based on the total expenditure falls progressively as the earth-moving equipment is utilised for longer period of its life. The unit rate for manual labour remains almost steady.

(*iv*) For jobs involving large quantities of earthwork spread over the lifetime of equipment, machinery work would be much cheaper than manual work.

(*v*) In this specific study, it would not pay to go in for E.M. Machinery for less than 25 m. cu. ft. of earthwork unless the salvage value of the equipr ent can be realised by further use or sale.

(*vi*) Continuity of construction by earth-moving machinery is essential to achieve low rates. For manual work it does not affect the rates appreciably.

It is our contention that a non-technical critic does not realise the strength of labour required to do earthwork manually. If the earthwork of the Hirakud Dam was to be executed by manual labour alone, the strength required would have been nearly 3,00,000. That would make a job impossible to set up or manage.

15.07. No Shortage of Labour in our Country

We, however, think that specialised intricate equipment developed in the West to meet the shortage of man-power, should scarcely be necessary in India. For example, the trench diggers for shallow foundations of buildings, the field channel excavators (developed on All American Canal) or the elaborate rigs to dress the canal banks (used at Friant Project) should scarcely be required in our country. It is sad but true, that there is yet a certain amount of fascination in the minds of amateur engineers in doing jobs by machinery in fields which can be better covered by manual labour. It is necessary, therefore, to study critically each field of work before investing in machinery.

15.08. Our Economic Structure

The modern conception of mechanisation is but an advanced and foreign countries is that an unskilled labourer costs us Rs. 30 to 40 per month whereas U.S.A. has to pay Rs. 1,500 per month. We have plenty of unskilled and little of skilled labour whereas the reverse is the case in U.S.A. On the other hand the imported cost of every dollar worth of equipment and spares is about Rs. 5 and 8 respectively. The value of spares required by the equipment is about 50 per cent of the cost of the equipment.

It is, therefore, wrong to arrive at the conclusion that if an equipment is developed in foreign countries to do economically a particular type of work there, it must be good for us also.

15.09. Necessity of Improving Technique of Manual Labour

The modern conception of mechanisation is but an advanced stage in man's search for tools. It has contributed to the evolution of the world from the time of the caveman of the stone age. The development of the personal tools such as pick axes and the crow bars has been arrested by the over-loading effect of specialised equipment such as excavators. In advanced countries, the development of personal tools has taken the shape of pneumatic diggers, or electric hand drills. In India we have not yet given adequate thought to this problem.

Whereas the modern scrapers are a vast improvement over the earlier models of twenty years back, the small man's tools such as the spade or the basket have not been given enough attention for scientific development. The pre-historic method of transporting soil in little baskets carried over head has seen no improvement since the days of the pyramid. And yet these are the tools through which we are now planning to spend crores of rupees for our development projects. We entirely agree with the thought-provoking article sent from Washington D.C., by Shri N. D. Ghulati that a time and motion study of manual work needs to be pursued on scientific lines and that the workman's tools should be improved to give more performance and less fatigue. We quote the suggestions below :

> "Briefly stated, the idea is that great saving would be obtained in most forms of engineering work involving the movement of earth by a thorough development of the science of earth-work under Indian conditions. Special study would be given to the application to the use of human labour, of the principles of time and motion analysis, which has done so much to increase production in the construction and manufacturing industries in this country......
>
> "The second step in the study proposed would try to bring about more efficient methods with the tools in common use by 'time and motion study'......
>
> "A great deal of study should be given to the best method of carrying out the studies...... One of the first steps should be to get one or two experts in time and motion study from United States to come to India to see the conditions of work there and learn the problems involved......
>
> "Probably the best way to finance these studies, ... would be under the Point Four Programme. Another possibility would be under the Ford Foundation....... A third but less desirable method would be for some time and motion expert to set up a study programme for himself at some University in India, under the Fullbright Act of the United States Government."

15.10. Labour Consciousness to their Amenities

A new aspect that has to be borne in mind in the planning of large concentrated works managed by manual labour is the labour consciousness for their elementary comforts and needs. It was possible in older days to disregard the question of even modest housing, sanitation and health arrangements. Any concentration of labour today raises these fundamental problems. Even a bamboo matting hut costs over Rs. 250 in construction and maintenance over 5 years.

The cost of other services is nearly a third of that. It will progressively become impossible to manage concentrated works without spending large amounts on construction towns. It is only a question of time before the demands of the labour unions in the field of industries pervade the sphere of the construction trade. In any comparison of manual labour *versus* machinery this factor must be carefully considered.

The difficulties normally encountered on jobs managed with manual labour have been summarised by Shri E. Viraraghavan, Superintending Engineer, Hyderabad, P.W.D., as under:

(1) Heavy advances.

(2) Free transport from their villages to the workspot and back after the completion of the season.

(3) More and more amenities.

(4) General decrease in the capacity of their work due to insufficient nutritive food.

He evaluates the economic effect of these overhead expenses on manual labour rates as under :

1. Hutting charges, providing mats, bamboos, coir ropes, etc.	3%
2. Depreciation and mending of tools	1%
3. Transportation charges	3%
4. Watchman charges	1%
5. Advances and food arrangements	7%
TOTAL	15%

If lighting, sanitation, water supply, medical services and the housing better than "bamboo and mats" are provided, the percentage will jump so high that it will be the critical consideration in the evaluation of overall economy. He further works out that the value of the foodgrains required is about 20 per cent of the value of the earthwork.

15.11. Earthworks are More Economical

One of the reasons why large earthwork jobs are now attempted is the development, to a high standard, of the science of Soil Mechanics. An engineer can now use soil as a construction material with known factors of safety in the same way he used concrete or steel. This has made large dams technically feasible.

Note:—D.O. No. CWD-3/W of 16-9-53, addressed to Shri V. T. Krishnamachari (copy to Shri Kanwar Sain) by Shri N. D. Ghulati from Washington, D. C

For the same height of a dam above the foundations, the quantity of earth required is roughly 10 times that of masonry. If, therefore, the rate of earthwork is 1/10th that of masonry, an earth dam will complete with a masonry dam in cost. In the matter of design the earth dam generally does not need to go deep below the ground level except for a small quantity (usually about 10 per cent) for the cut off trench; whereas a masonry dam has to start from sound rock however deep it is. This aspect works in favour of the earth dam. Usually the rates of earthwork are only about 1/10th that of masonry. This makes earth dams cheaper both in quantity and rates.

The development of earth-moving machinery has cut down the rates of earthwork whereas there has been a steady rise in the rates of other materials. To quote Donald and Auckland from "Moving Heaven and Earth":

> "During 1920-30 period, earth-moving was accomplished by steam and gasoline units, and was necessarily slow. Using a 1,000 ft. haul as basic the average delivery was 8 cu. yds. per man-hour at a cost of about 50 cents per cu. yd. During the period 1930-33, the first true gasoline tractor was employed as a haul unit, and this increased production to a figure of 12 cu. yds. per man-hour at a cost of about 45 cents per cu. yd.
>
> "In 1933, when rubber tyres were introduced scraper performance was stepped up and production costs lowered, hauling the same distance (1,000 ft.) during 1933-39 meant a delivery of 60 cu. yds. per man-hour at a cost of about 14 cents per cu. yd.
>
> "In 1939, when a Tournapull was invented a considerable saving both of time and money was effected. Production with this piece of equipment on a 1,000 ft. haul is 130 cu. yds. per man-hour at a cost of 8 cents per cu. yd. delivered."

In India, the rates of mechanised earthwork is only about 1½ times that of pre-war rates, but the rate of masonry has gone up to nearly four times.

We have collected information about some of the large works carried out by manual labour in the country. A summary of the information supplied to us is given in Appendix 5.2.

15.12. Observations on Canal Earthwork

It will be seen from the statistics given in the appendix that the manual labour is utilised mostly for canal work and for minor earthen dams. The rates obtained for canal excavation by manual labour are on the whole such that mechanisation will scarcely be justified on the grounds of cost alone except where long leads and lifts are involved. We think that a good balance is obtained in this respect on our projects and no emphasis needs to be made for leaning more to either side.

We would, however, suggest that there is a greater scope for the use of tramlines and tipping trucks for this type of work than has so far been employed. For large quantities of excavation for canals of small bedwidths in hard materials like the disintegrated rock, the use of back-hoes deserves more attention.

As regards the canal embankments, trucks used on highways are often employed for transport. These are unsuitable vehicles for off-the-road transport which makes for costly running charges. We suggest that for larger works involving short distance transport, the use of small diesel shuttle dumpers 4½ to 6 yds. capacity loaded manually needs to be given more thought.

15.13. Observations on Earthen Dams

For earthen dams, the transport is largely done by commercial trucks loaded and emptied by manual labour. The rates on the whole are higher than those possible with earth-moving machinery.

The Malampuzha dam is a typical example of constructing a small earthen dam with trucks. The overall rate works out to Rs. 93 per, 1,000 cu. ft. of compacted bank. For this method of construction we think that the rate is satisfactory. But an all inclusive rate of about Rs. 60 per unit is achievable by mechanisation even for somewhat longer leads and higher lifts. However, so long as such small dams are attempted as individual works, a higher degree of mechanisation is not desirable.

We think that a better planning should be possible by combining a group of small dam projects under a Central mechanised organisation. If this can be done to pool about 50 m. cu. ft. of earthwork, mechanisation will cut down the cost and time. Uttar Pradesh has already worked on this system successfully completing fair sized dams (30 to 60 m. cu. ft.) in one or two seasons each at attractive rates. Madhya Pradesh has planned in a similar way to construct a large number of minor irrigation works through use of a Central Pool equipment. We feel that this type of planning deserves more investigation.

PART III

SUMMARY

SUMMARY AND RECOMMENDATIONS

We have dealt, in the Report, with the various aspects concerning the economic and efficient utilisation of the earth-moving equipment on River Valley Projects.

We felt it more convenient to deal with the subject according to the arrangement presented in the Report, which covers all the points included in our terms of reference together with such additional suggestions as we wanted to make under item (7). We have given in this part a summary of our recommendations arranged in order of the terms of reference.

(1) The makes, types and sizes of the plant best suited for various types of work with a view to standardisation ; and

(2) combination and matching of plant where more than one unit of plant is involved.

These terms pertain to plant planning and standardisation of equipment which have been dealt with in Chapter Two.

Construction plant should be planned and detailed with the same care as is essential for working out other details of a project. It should be based on carefully collected data regarding materials, progress schedules and specifications.

Planning should take into account the job set up and should aim at utilising about 75% of the life of the capital equipment against a definite programme for utilisation.

Multi-shift working should be a standard feature and suitable allowance or extra pay should be given to the project staff for shouldering the additional responsibility of multi-shift working and cost control.

Yearly financial grants should be arranged in such a way as to avoid piece-meal purchase of equipment causing the introduction of non-standardised equipment.

The "job factor" and the "management fatcor" should be properly evaluated in as far as this affects costs and production. The former will require a detailed study of the materials, topography, design, working conditions and specifications. The latter will depend upon the organisation, personnel, authority vested at various levels, and the available facility for repairs and replacements. The master plan of equipment should bring out all these points and their effects on cost and production.

Proper facilities for ancillary services, *e.g.*, flood-light, railroad, labour amenities, transport for supervisory personnel, communication, etc., should be incorporated in the plan as the efficiency of the equipment operation will depend upon such services.

Equipment and spare parts pools within States are essential for better maintenance and effective utilisation of the large number of construction equipment diffused throughout the States. A Central Organisation under C. W. & P. C. to coordinate the demand for equipment following its release from completed projects is suggested. The detailed sphere of its activity is given in Appendix 7.

The standardisation of power units is equally important.

Small sizes of equipment are not recommended for use on projects except in as far as they may be required to aid the manual work.

It is better to standardise even on a few mediocre types and makes of equipment than to purchase too many makes and sizes of a high quality equipment. Care should be taken to see that the equipment selected is backed in India by satisfactory spare parts, stores and service personnel with the equipment representatives.

The policy of purchase of capital equipment should be coordinated with the overall plans of the project engineer to fit his organisation and job requirements.

The quotations for the purchase of equipment must be weighed with due regard to services which the firm can offer in ex-stock supply of spares and technical assistance.

(3) Correct apportionment of labour to plant.

We understood this term to mean that standards should be laid down to indicate the strength and wages of the technical personnel operating, maintaining and supervising the equipment, *i.e.*, the line and staff organisation.

The organisation required on a mechanised project is given in Chapter Three. The recommendations regarding qualifications, training and wages of the staff organisation is dealt with in Chapter Four and the number of operators required per machine is suggested in Chapter Eleven. No definite standards regarding the strength of the maintenance crews can be given as it will depend upon the organisational set-up and the availability of skilled personnel. However, the standards for labour charges per plant hour for servicing field repairs and Major Repairs have been stated in Appendix 3.3.

(4) Mode of calculation of the working cost of each type of plant per hour ; the unit cost of the work performed by each type of plant on the various projects should be computed for the last working season and variations in cost should be explained.

(5) Suggestions for a unified scale of depreciation to be followed on all river valley projects.

The "plant hour" is defined as "meter hours" where meters are working ; where such meters do not exist, commensurate effective hours, based on the working of similar other machines with meters, should be used. Where even this is not possible, the "effective hour" can be based on the average fuel consumption and the work done per hour, which gives the load factor.

The method of working out the "plant hour cost" of equipment has been detailed in Chapters Eight to Twelve.

The expenditure on the purchase of earth-moving machinery should be accounted for as suspense charges and charged off progressively to works through depreciation. The Spl. T. & P. of general nature need not be watched through individual depreciation account but should be charged off progressively in proportion to the value of the work done. The method of keeping capital accounts of each of the equipment through History Books has been described in Chapter Thirteen. The resale value of equipment can be deducted from the project cost if definite plans for utilisation of the residual life of equipment are worked out. The standards for calculating depreciation have been laid down in Appendix 3.3.

A flat rate of levy is proposed for Major Repairs to equipment, which should be credited to a Reserve Fund and the charges for Major Repairs watched through suspense estimates, should be debited to the fund. Standards for the flat rates of Major Repairs are laid down in Appendix 3.3. The set-up required for overhauls and repairs has been detailed in Chapter Six.

The operating charges should be watched through suspense estimates and cleared monthly by debit to the work to which services are rendered. The clearance rate can either be based on the actual expenses or at an estimated rate subject to periodical adjustment for residual amounts.

The standards for the operating charges, servicing and field repairs have been indicated in Chapter Eleven and Appendix 3.3.

The method of working out unit rates of earthwork by transferring the expenditure on owning and operating equipment, to the items of work concerned, has been prescribed in Chapter Fourteen.

The importance of watching the unit rates down to each individual component of costs is emphasised. The requirements of a complete rate structure have been defined in Chapter Fourteen. These rates should be worked out at two levels: (i) Project rates and (ii) inter-project or "contractors" rates. The nature of the components factors have been indicated.

The actual rates reported by projects include or exclude or partially incorporate these components. The projects do not have the costs of component factors in readily available form to enable an overall comparison of unit rates on a uniform basis, to be made. The rates reported by projects and the component factors which they incorporate have been studied in Chapter Fourteen and tabulated in Appendix 3.7.

We could not make a more detailed study of the comparative unit rates for lack of adequate data. The projects are not in a position to supply the required information in the time at our disposal. We have suggested the opening of a cost accounting organisation in C.W. & P.C. which should pursue this matter. It is only after the projects maintain their accounts along the lines suggested by us that a periodical comparative evaluation can be accurately made. We recommend that the central organisation should codify detailed procedure.

(6) Standard forms for the history sheet and Log Books of each type of plant.

The Log Book should be used as a primary record of operational data and the History Books should give all the technical and cost data of a machine for technical and fiscal evalution. The forms of the Log Books, History Books, and tyre record are prescribed in Appendices 4.2 to 4.5.

(7) The various factors involved in efficient plant operation emphasising the adverse factors which have been responsible for low output and poor maintenance on the various projects visited.

This reference is dealt with in three parts as under:

(i) Administration and personnel.

(ii) Operation, maintenance and repairs.

(iii) Supplies and spare parts.

Administration and Personel

The most important single factor controlling the efficiency of a project is the management factor. Administration and personnel are a part of the management factor.

Points important to proper administration are:

(1) Proper organisation; in Chart 1 paragraph 3.14 an attempt is made to convey the concept of a *line and staff organisation*.

(2) Authority is not being delegated properly for various reasons as detailed in paragraph 3.3.

(3) Proper codification for procedures organised on mechanised construction does not exist. We recommended that procedures and records be codified by the proper Directorates at the Centre. If proper Directorates to codify procedures do not exist, they should be established.

(4) Decisions must be made rapidly enough to keep in time with rates of production. When modification of design will increase efficiency or lower costs without affecting specifications, it must be allowed. The use of modern office and communications equipment will expedite good administration.

Personnel is discussed into three aspects—selection, training and maintenance of constructive work relationships.

Modern methods of evalution (the use of tests and testing) can be invaluable in selection of personnel for employment and training. At present selection of personnel for employment and for training is unsatisfactory. This matter is covered in Chapter Three.

The training programme under consideration by C.W. & P.C. must be implemented as soon as possible under a new Directorate of Technical Man-power.

In considering the maintenance of constructive work relationship two factors appear. Morale is generally low on the projects, the people are not interested in their work nor informed as to why they are working. More information should be given out to them about the work and their value to it. Pay scales are relatively low for responsibility involved. We have given recommendations about pay scales in Appendix 2.3.

Operation, Maintenance and Repairs

Operational standards can be improved by better plant planning, careful maintenance, and proper conduct of the job. Importance of having trained personnel for operation and repairs is discussed in Chapter Five. Points which need special attention on operation and maintenance on our projects have been high-lighted. Periodical inspection of equipment by base workshop is essential. A scheme of training operators and maintenance personnel is suggested.

Various teams required for servicing and maintenance of equipment are indicated.

Special care is necessary for maintenance of targets.

Careful layout for standardisation of lubricants is recommended. Importance of clean fuel for efficient operation is brought out. Filtered oil can be used for less exacting duties to keep down costs.

Incentive wage for production in excess of standards of operation and maintenance should be a regular feature of wage structure (para 4.25).

Adequate amenities should be offered to the operation and maintenance personnel to enable them to do their duties efficiently and safely, *e.g.*, providing uniforms, warm overalls, goggles, etc.

The standard of repairs is even poorer than operation.

Well-planned repairs facilities are essential to efficient operation. Workshop layout, organisation and repair routines are discussed in Chapter Six. Importance of assembly overhauls and replacements is stressed. Careful inspection at all stages of overhaul and proper planning for reclamation and reconditioning of old parts is essential for ultimate economy.

Supplies and Spare Parts

A large store of spare parts is carried by projects without commensurate advantages as the parts are not ordered carefully A Central Scaling Organisation under C.W. & P.C. to assist the projects to forecast their demands of spare parts and to build up stocks of only useful items is suggested in Chapter Seven and Appendix 7.

Standardisation of equipment is essential to having a satisfactory service of spare parts, from the project stores as well as spare part stock can be cut down only if a project buys equipment in one make and size as far as possible and standardises on power units.

Projects should be allowed to order their spare parts requirements either against D. G. S. D. rate contracts or under normal procedures of tenders. Lengthy procedures are working against economy and are causing overstocking in stores. Attention of the Stores Purchase Committee should be drawn to the necessity of obtaining spare parts and other materials expeditiously by the projects by delegating adequate powers to the project officers.

The importance of forward planning for the parts required for major overhauls is stressed and standards are indicated for the total yearly requirements (para 7.12 and Appendix 3.3) of spare parts and other stores. The Committee's ideas about the value of the stock of spare parts in relation to that of the equipment is given in para 7.13.

Organisation of the store should be such as can render quick service to the project.

Importance of proper storing arrangements and care of spare parts and materials is stressed in para. 7.18.

The use of non-genuine spare parts and the scope of manufacturing spare parts in India have been discussed in paras 7.21 and 7.22.

The effect of the restrictions on the import of some of the spare parts and its harmful effect on efficient operation of equipment is indicated with reference to ball bearings and is suggested that a ban on the import of the types and sizes of ball bearings actually being manufactured in India is all that should be done at present.

(8) Comparison of cost of work which is being carried out by machinery with that carried out by manual labour with recommendations as to the type of work which should be normally carried out with machinery.

Statistics of a large number of major earthwork job, being executed by manual labour is given in Appendix 5.2. The scope of mechanised construction and manual labour work is discussed in Chapter Fifteen.

The jobs which are within the scope of manual labour should not be mechanised unless the estimates indicate a saving of over 20% in costs because we consider that this is the limit of accuracy with which mechanised construction can be estimated at present.

For large earth dams mechanisation is essential for economy and to meet the production targets. Canal excavation has a greater scope for employing manual labour. Judicious use of equipment to assist the manual work is advocated.

Necessity of improving the technique of manual work to achieve better efficiency is brought out (para 15.09).

The labour trend to ask for more amenities is an important factor in the planning of concentrated jobs and should be weighed before deciding to carry out works with manual labour.

Use of off-the-road trucks instead of the highway transport vehicles is suggested for transport with manual labour.

A pool of equipment to handle medium-sized earth dam jobs is recommended for consideration.

General

Appendix 7 compiles our recommendations for assistance required of the Centre by the projects to achieve better standards. These organisations are suggested to be set-up for (i) Machinery Exchange, spare parts co-ordination and scaling of forward requirements of spares, (ii) Technical Man-power organisation to pool and utilise the available resources of skilled personnel for effective utilisation on projects and (iii) Cost accounting organisation to assist the projects to utilise modern methods of cost and production control and to act as a watch dog of the Government of India, working on definite and detailed figures.

All of the three organisations as recommended should codify procedure for the functions with which they are concerned.

PART IV

MEETINGS OF THE COORDINATION BOARD OF MINISTERS

11—1 C. W. & P. C./57

MEETINGS OF THE COORDINATION BOARD OF MINISTERS

MINUTES OF PROCEEDINGS OF THE SUB-COMMITTEE NO. 1 (ON THE REPORT OF THE CONSTRUCTION PLANT AND MACHINERY COMMITTEE) HELD AT NEW DELHI ON 1-10-1954

The following were present:—

Shri A. C. Mitra took chair by special arrangement.

Shri R. K. Gupta, Member.

Shri S. D. Khungar, Member.

Shri H. L. Vadera, Member.

Shri R. F. Kokan }
Mr. P. C. Aggarwal } attended by request.

Mr. G. G. Dhanak, Member-Secretary.

Shri A. N. Malhotra and Shri Sirtaj Singh accompanied Shri Gupta.

Shri L. Venkatakrishnan Iyer could not attend due to other engagements.

The Sub-Committee discussed the two reports of Sarvashri Gupta and Khungar and the note prepared by Shri Dhanak. The conclusions arrived at by them are given herewith. (These should replace the proceedings of the Sub-Committee held at Roorkee.)

1. Standardisation of Plant and Machinery

(i) What is the basis on which such standardisation can be decided?

There is no doubt that standardisation is necessary. The basis of standardisation should be:—

(a) Performance.

(b) After-sale service and availability of spare parts.

(c) Definite indication of manufacture in the country of spares and machines will be an added consideration.

If these are satisfactory then alone should the question of initial cost be considered.

The term performance should be studied with reference to durability, spare parts consumption and operation cost under similar conditions of working. These factors cannot be dealt with purely on statistical basis. The opinion of those who have actually used a large variety of equipment on big jobs, will be the predominating factor in deciding satisfactory performance of any particular machine or machines. We suggest that the recommendations made by the Plant & Machinery Committee should be sent out to such users in such form as may be considered desirable and they should be requested to give their opinion supported by such statistics of performance as they may be able to produce.

(ii) How best can the proposed standardisation and limiting the purchase of equipment to few makes be implemented?

Government of India must take a decision on Standardisation of construction equipment. They should then send a circular to all State Governments requesting them to fall in line with their decision. Government can exercise control of non-standardised purchases by restricting import permits.

(iii) How are the interests of indentors to be safeguarded so that the prices demanded for capital equipment are not unfavourable, and that no monopoly is retained by the principal agents in the supply of spare parts?

There should be about three makes in each range of equipment in the list of standardisation.

The D. G. S. & D. should negotiate, before orders for standardisation are issued, the basis on which the price of equipment and spare parts shall be fixed. Such a price agreement should then form the basis of cost for future purchases. The State Governments should be informed about the arrangements regarding the prices.

(iv) What will be the repercussions on other equipment which are in operation inside the country as regards the supply of spare parts?

Certain repercussions are inevitable. This will, however, be a temporary feature. Such Projects as may still be using non-standardised equipment, will have to make their own arrangements in the shape of forward planning and direct import of spare parts. The advantages of standardisation are so overwhelming that it is worth putting up with such hardships.

(v) How far the standardisation will be practicable keeping in view the standardisation cf power unit as well?

When the main units have been standardised, it will be an advantage to standardise on power units in so far as this may be possible, with the same make and size of engine to serve as easy replacements.

2. Life of Machinery

(i) Should the life of the machinery and other construction equipment be taken as indicated by the Plant and Machinery Committee ?

The Sub-Committee considered it necessary to define the unit for the measurement of the life of a machine.

The age of a machine should be measured in terms of the actual working hours as measured on clock, provided that the average fuel consumption per working hour is what the type of machine would consume, under full operating conditions in a 60 minute hour.

The optimum hourly fuel consumption in Imperial gallons should be rated from the following:—

$$\frac{0{\cdot}5 \times BHP \times C}{8{\cdot}26}$$

Were 0·5 is the specific fuel consumption of HSD.

BHP is the rated HP of the engine.

8·26 is the lbs., to an Imperial gallon of H.S.D.

The value of C should be taken as under:—

0·6 for Shovels and Draglines.

0·6 for Drawn Scraper, Ripper, Sheep Foot Roller.

0·55 for Dozer.

0.40 for Motorised Scrapers.

0·35 for Bottom Dump & End Dump Trucks.

For the projects working on less or more fuel consumption than the fuel consumption as worked out from the formula given above the age, life and the provision for repairs and spares may be increased or decreased proportionately.

In any case a piece of equipment should be written off by at least 1/12th of its life every year whether it is used to that extent or not.

(ii) On the basis of the above definition the life of equipment as recommended by the C. P. & M. C. in their Appendix No. 3·3 may be accepted, except that in the case of Diesel Shovels and Draglines,

$2\frac{1}{2}$ cyds. and above the life should be taken as 15,000 hours, instead of 12,000 hours and in the case of $1\frac{1}{2}$ cyds. Diesel Shovels, the life should be taken as 12,000 hours instead of 10,000 hours.

The examples are given in the appendix to clarify the matter.

On the foot note of Appendix 3·3 the Plant and Machinery Committee has recommended to adopt 25% longer life for electrically operated excavators. This Sub-Committee considered that this percentage be increased to 50%.

(ii) Should the provision for spare parts be taken as per statement given in para 5·47 of Volume No. 1 of the Seminar ?

The Sub-Committee preferred to consider instead the recommendations of the Construction Plant and Machinery Committee, contained in their Appx. 3·3. They agreed in general with the recommendations but considered it desirable to round off the provisions for major and field repairs as under:—

Equipment.—Provision for major and field repairs expressed as percentage of the cost of equipment over its life-equipment over time including the cost of spare parts but excluding tyres, wire ropes, etc.

Carwler, Tractors. Rubber tired, Tractor Dozers, Motorised Scrapers, Bottom Dumpers.	
Excavators and Motors Graders	100%
Portable Air Compressors	90%
Rear Dumpers and Cranes	80%
Towed Graders	60%
Drawn Scrapers	50%

The Sub-Committee considered that these provisions may be taken for average working conditions with reference to any particular type of equipment. If an equipment works under harder conditions. for example, a Bull Dozer or a Rear Dumper working in rock it should need higher provision for major and field repairs.

(iii) Is any modification desired in view of the actual experience that some of the projects may have had in the meanwhile?

This point may be discussed in the open session.

3. Recruitment of Operation and Maintenance Crews

(i) Should there be any minimum qualification required by way of general and technical education?

The Sub-Committee considered that it was necessary to lay down a minimum of standard for literacy, while aptitude tests should be the main criterion. If suitable men with technical qualification are available they should be preferred.

(ii) What will be the nature and period of practical experience which will be essential before one is recruited as an operator or mechanic of earth-moving machinery?

The Indian Army has laid down standards (*vide* Appendix 2·5 of the Construction of the Plant & Machinery Committee's Report) for operators and maintenance crew. In the absence of any better standards these may be adopted with such modifications as the proposed Training Centre at Kotah and Hirakud may have to suggest.

(iii) How far a uniform scale of pay on various projects would be desirable and practicable?

The Sub-Committee considered that it is desirable to have some uniformity in the basic pay of operators and maintenance crew. These may have to be supplemented by suitable local allowances to suit the local conditions such as the variation in the cost of living, housing and other amenities.

(iv) The Plant and Machinery Committee have suggested scales of pay on page 171 of their report and it will be necessary to decide whether it would be possible for the projects to implement the proposals.

The pay scales of operators and maintenance crew require to be revised to attract the right type of men. The Machinery Committee has recommended total emoluments for Class I men on page 171 of their Report and have recommended that for Class II and Class III men, total emoluments should be 75% and 50% respectively of the amount recommended.

The Committee considered it desirable to recommend the basic wages instead of stating the total emoluments. These should be fixed at about 2/3rd of those recommended by the Committee and should be rounded off to the nearest rupee. The local allowances and other amenities will be given in addition to the basic wage. The recommendations of the Sub-Committee would then be as under:—

Foremen	Rs. 14
Assistant Foremen	Rs. 11
Chargemen	Rs. 7
Fitters, Mechanics, Welders, Chargemen and Electricians	Rs. 4
Operators—Excavators and Scrapers	Rs 11
Operators—Graders, Bottom or Back Dumps, Crawler or pneumatic tired Tractor	Rs. 8

Incentive wage for production in excess of standard performance should be a regular feature of wage structure. We consider that it is economical and in the interest of better efficiency to pay the staff by their performances. Sukkur barrage, Gangapur and Sutlej Valley Projects worked on the basis of incentive wage. Schemes of incentive wage will have to be worked out to suit individual jobs.

(v) How far will it be practical to maintain service records of operators and maintenance crew of all categories with a view to its being utilised by any other project which seeks the services of the technician?

There should be no difficulty to lay down suitable forms for recording, in brief, the rating and capability of operators and mechanics. They will carry their records in the same way in which for example, truck-drivers carry their licences. A suitable form should be worked out by the Training Centre.

4. Operating of Training Centre at Hirakud & Kotah

The Sub-Committee agreed to the proposal and desired that it should be implemented quickly. It had no comments to offer.

5. Accounting Procedure

(i) In view of the different administrative set up in some of the projects, will it be practicable to adopt a uniform accounting system?

At present the State Governments prepare their own manuals for different Departments—following, more or less, the manuals of the Central Government on the subject. There should be no difficulty for the State Governments to adopt a more or less uniform accounting system if one is codified in a Manual by the Central Government.

(ii) A standard basic proforma of accounting should be evolved.

(iii) A separate proforma for capital equipment and a similar one for running account of machinery under various subheads should be agreed upon.

Various forms have been recommended by the Plant & Machinery Committee *vide* their Appendix 4. We suggest that the recommendations should be scrutinised by the Rates & Cost Committee which is required to suggest forms for the accounting procedure concerning Special Tools and Plant.

6. Spare Parts and Utilisation of Surplus Machinery

(i) Whether it is practicable for the D. G. S. & D. to fix the rate contract/price agreement with all firms from whom machinery is obtained ?

We think that there should be no difficulty to the D. G. S. & D. fixing up a rate contract/or price agreement with the firms with which the river valley projects are most concerned at present. The difficulty of having to deal with too many firms will be solved when Government issue orders on standardisation. In fact D. G. S. & D. has already, we understand, entered into price agreement with some of the firms.

(ii) What should be the basis of such rate contract or price agreements?

The D. G. S. & D. has already some basis for entering into rate contracts and price agreements with the firms dealing with construction equipment. The matter can be left to the D. G. S. & D.

(iii)* What should be the basis on which the value of used equipment should be decided for transfer from one project to another?

The sale-price of used equipment should be calculated on the basis of the current market price of a similar piece of equipment. If the machine is sold after the satisfactory overhaul, the sale value should be commensurated with the remaining life of the equipment. The calculation of the life should be based on "the recommendations of the Construction Plant & Machinery Committee". If the equipment is transferred before an overhaul; the cost of overhaul should be deducted.

Equipment maintained in a particularly high standard of operating efficiency which has served its full quota of life as indicated by the "Construction Plant and Machinery Committee" is still in good serviceable condition may have to be valued on an *ad hoc* basis by mutual consent or Survey.

In case of difference of opinion, the matter should be decided by an arbitrator.

*This reference was added, for consideration by the Sub-Committee.

FIRST MEETING OF THE COORDINATION BOARD OF MINISTERS

The first meeting of the Coordination Board of Ministers was held at New Delhi on 13th and 14th of October, 1954. The inaugural session, which was held on 13th, was opened with a speech by Shri Gulzari Lal Nanda, Minister for Irrigation & Power and followed by an address by the Prime Minister, Shri Jawaharlal Nehru. Besides the Union Minister and Deputy Union Minister for Irrigation & Power, Ministers and Deputy Ministers in charge of Irrigation & Power from the various States attended the meeting.

Secretaries to the Governments and Chief Engineers for Irrigation & Power also attended the meeting to assist and advise the Ministers.

The meeting of the Coordination Board of Ministers was preceded by a meeting of the advisers and secretaries to the Ministers on 12th at 11 p. m. to discuss the agenda for the Coordination Board of Ministers and to place their views before the Board on the recommendations of the Sub-Committees.

AGENDA

Following was the Agenda for the Meeting:—

I. Report of the Plant & Machinery Sub-Committee.

II. Report of the Soil Conservation Sub-Committee.

III. Report of the Rural Electrification Sub-Committee.

IV. Report of the Sub-Committee on Eradication of Corruption.

V. (i) Report on items 4 and 5 of the terms of reference of the Committee on River Valley Projects Technical Personnel.

(ii) Training of selected Engineers on the River Valley Projects.

VI. (i) Formation of All India Service of Irrigation & Power Engineers.

(ii) Setting up of a reserve of Officers in the States for deputation to the Centre.

VII. Report of the Sub-Committee on Standardisation of Progress Reports and Charts.

DECISIONS

Report of the Plant and Machinery Sub-Committee

(i) The recommendations of the Plant & Machinery Sub-Committee, including the formula for determining the life of the various types of earth-moving equipment were approved, subject to the following modifications:—

(a) The Board observed that the question of fixing basic wages, should be taken up after the Report of the Rates & Cost Committee had been received. As guiding principles for the time being, however, the Board laid down that remuneration should be adequate to attract suitable personnel and that the disparity in the wages between one area and another should be reduced in order that interchange of technical staff between projects may be facilitated. The Board also agreed with the principle of paying an incentive wage to deserving workers.

(b) The Board discussed the recommendations of the Plant & Machinery Committee and decided that the principle of standardisation of important mechanical equipment be accepted with the proviso that the position should normally be reviewed after every five years but that the period could be curtailed if special circumstances so warranted. For this purpose, a standing committee of experts and the Ministries concerned should be constituted by the Central Government. This Committee would be specially charged with the responsibility of ensuring that neither inflation of prices nor other disadvantages resulted from the proposed standardisation. Equipment manufactured in India, the Board decided, should get overriding priority as soon as it was available in the country. The experts Committee would consist of representatives of D. G. S. & D., Ministry of Finance, one representative from each of the projects costing over Rs. 10 crores and representatives from other projects, if necessary. The Committee would also safeguard against any adverse results following from monopolistic tendencies. The number of standard makes of equipment should normally be from two to five. These limits are not to be wholly binding in each case. The Committee would call for quotations from firms before finalising, and all interested be given a chance to represent their cases.

(c) The Board laid down that projects should communicate lists of equipment surplus to their requirements or expected to be rendered surplus in the near future after taking into account the requirements of other projects in the State concerned, to other States and the Central Water & Power Commission, who would circulate the lists to other projects in need of them. The Central Government would use their good offices to ensure maximum utilisation of such surplus equipment.

(d) In view of the proposed standardisation, the Board expressed the hope that manufacturers would carry adequate stocks of spare parts. The individual projects, therefore, would no longer be required to carry unduly large stocks of spare parts hereafter.

(e) The usual formula for determining the price of old equipment would be the Book value less depreciation. In the event of difference of opinion, the matter would be settled by a joint inspection of the two parties, and if, necessary, ultimately by arbitration. This procedure, however, will not hold up the transfer of the machinery.

(f) Regarding the training of mechanical operators and maintenance staff, the Board decided that a few training centres in various parts of the country should be opened at projects which afforded the best opportunities for the purpose. To select the sites for these centres, the Board set up a Sub-Committee of Ministers consisting of Shri Gulzari Lal Nanda (Chairman) ; Shri Mafiz Mohd. Ibrahim, Minister of Irrigation and Finance, U. P.; Shri M. M. Naik Nimbalkar, Minister of Public Works, Bombay, and Shri Bhanumuga Rajeshwara Sethupathi, Minister of Public Works, Madras.

(g) Jobs which are within the scope of being executed by manual labour should not be mechanised unless estimates indicated a saving of over 20% in the cost, provided the period within which a job could be completed by employment of manual labour, was reasonable.

PART V

APPENDICES

APPENDIX 1.1

Government of India

Ministry of Irrigation and Power

No. D W. II-29(78) *New Delhi, the 12th October,* 1953.

From

Shri A. R. Khanna, I.S.E.

Deputy Secretary to the Govt. of India.

To

The Chairman,

Central Water & Power Commission,

New Delhi.

SUBJECT:—*Appointment of a Committee to report on Construction Plant and Machinery used on River Valley Projects and their maintenance and operation.*

SIR,

I am directed to convey the sanction of the President to the setting up of a Committee consisting of the following officers for a period of about two months to report on measures necessary for the efficient operation and maintenance of construction plant and machinery used on River Valley Projects:

(1) Shri K. Gopal Iengar, retired Superintending Engineer, Tungabhadra Project, Madras	*Chairman.*
*(2) Mr. B. H. Lundmark, Mechanical Engineer attached to the Nangal Project	*Member.*
(3) Mr. E. R. Harvey, Colombo Plan Specialist attached to the Hirakud Dam Project	*Member.*
(4) Shri G. G. Dhanak, Public Works Department, Bombay	*Member-Secretary.*

2. The President is also pleased to sanction the creation of two posts of Officer on Special Duty in the Central Water & Power Commission for the above purpose and to the appointment thereto of Sarvashri Gopal Iengar, retired Superintending Engineer, Madras and G. G. Dhanak, Public Works Department, Bombay. As Chairman of the Committee, Shri Gopal Iengar shall draw pay at Rs. 1,525, p.m. less the amount of pensionary benefits equivalent to Contributory Provident Fund benefits in addition to the usual allowances admissible to Government of India Officers. Shri Dhanak shall draw pay at Rs. 1,300 p.m. in the scale of Rs. 1,300—60—1,600 sanctioned for Superintending Engineers in the Central Government plus usual allowances. The other two members of the Committee, *viz.*, Messrs. Lundmark and Harvey

*Later substituted by Mr. R. F. Koken *vide* note under para 1.2 of the Report.

shall continue to draw from their existing organisations (namely the Bhakra-Nangal Project and Hirakud Dam Project respectively) the same pay and allowances they are drawing at present. The Chairman and Members shall draw daily allowance at full rates for the days spent by them on the work of the Committee outside their existing headquarters (Madras being the Headquarters for the Chairman) in the case of prolonged halts exceeding 10 days.

3. The Committee will visit the Major Projects under construction in the country, *viz.*, Bhakra-Nangal Project, Sukhrawa Dam, Damodar Valley Project, Hirakud, Tungabhadra, Lower Bhavani, Gangapur and Vaitarna Projects and after studying the various factors in connection with the construction plant and machinery in use on these projects, make suitable recommendations on the following points:

(1) The makes, types and sizes of plant best suited for various types of work with a view to standardisation;

(2) combination and matching of plant where more than one unit of plant is involved;

(3) correct apportionment of labour to plant;

(4) mode of calculation of the working cost of each type of plant per hour; the unit cost of the work performed by each type of plant on the various projects should be computed for the last working season and variations in cost should be explained;

(5) suggestions for a unified scale of depreciation to be followed on all river valley projects;

(6) standard forms for the history sheet and Log Books of each type of plant;

(7) the various factors involved in efficient plant operation emphasising the adverse factors which have been responsible for low output and poor maintenance on the various projects visited; and

(8) comparison of cost of work which is being carried out by machinery with that carried out by manual labour with recommendations as to the type of work which should be normally carried out with machinery.

4. The following non-Gazetted staff required to assist in the work of the Committee may be sanctioned by the Chairman, Central Water & Power Commission under the powers delegated to him:

Technical Assistant	1	Rs. 160—10—330
Stenographer	1	Rs. 160—10—330.
Typist	1	Rs. 55—3—85—4—125—5—130.
Peons	4	Rs. 30—½—35.

5. The expenditure involved will be debited to the Head "47-Miscellaneous Departments Central Water & Power Commission (Water Wing)".

6. The Committee should submit its report to the Government of India by 10th December, 1953.

Yours faithfully,

A. R. KHANNA

Deputy Secretary to the Govt. of India.

Copy with 9 spare copies forwarded to the Ministry of Finance for information and communication to all Audit Officers concerned. That Ministry concurred vide their U.O. No. 7572-E.G. II/53, dated the 9th October, 1953.

Copy also forwarded to—

1. Accountant General, Central Revenues, New Delhi.
2. The Chief Engineer, Hirakud Dam Project, P. O., Burla.
3. The Chief Engineer & Secretary to the Government of Punjab, Public Works Department, Irrigation Branch, Simla.
4. The General Manager, Bhakra-Nangal Project, Nangal Township, District Hoshiarpur.
5. The Secretary, Damodar Valley Project, Anderson House, Alipore, Calcutta.
6. The Secretary to the Government of Madras, Public Works Department. Madras.
7. The Secretary to the Government of Hyderabad, Public Works Department, Hyderabad.
8. The Secretary, Public Works Department, Bombay.
9. The Secretary to the Government of Uttar Pradesh, Irrigation Department, Lucknow.
10. The Commissioner, Bombay Corporation, Bombay.
11. The Secretary, Tungabhadra Board, P. O. Tungabhadra Dam Hospet Taluk, Mysore.
12. Mr. E. R. Harvey, c/o Chief Engineer, Hirakud Dam Project Hiragud.
13. Mr. B. H. Lundmark c/o General Manager, Bhakra-Nangal Project, Nangal Township, District. Hoshiarpur.

Yours faithfully,

S. VENKATARAMAN,

Under Secretary to the Govt. of India.

APPENDIX I.2.

Itinerary of Contacts Made by the Committee

Projects Visited

(1) Lower Bhavani Project; Dam,

(2) Tungabhadra Project :
   (i) Mysore/Andhra Side; Dam & Canal;
   (ii) Myderabad Side; Dam.

(3) Gangapur Project ; Dam.

(4) Hirakud Project ; Dam and Canal.

(5) Damodar Valley Corporation Projects:
   (i) Maithon Dam ;
   (ii) Panchet Hill Dam.

(6) Bhakra-Nangal Project :
   (i) Bhakra Dam ;
   (ii) Nangal Power Channel and Power Houses.

Project Data Utilised

(7) Jhansi Dams of U.P.

Officers Contacted.

(1) Special Chief Engineer, Irrigation, Madras.
(2) Chief Engineer, Irrigation. Bombay.
(3) Secretary, D. V. C., Calcutta.
(4) Chief Engineer, D. V. C., Maithon.
(5) General Manager, Bhakra Dam, Nangal.
(6) Engineer-in-Chief, Indian Army, New Delhi.
(7) Deputy Director Chief Controller of Imports, New Delhi.
(8) Industrial Adviser, New Delhi.
(9) Bhakra Seminar—Participated in the Proceedings and Discussions.

Firms Visited

(1) Larson Toubro Ltd., Bombay.
(2) Willian Jacks. Calcutta.
(3) Tractors (India) Ltd., Calcutta.
(4) Buckwell (Willcox) Ltd., New Delhi.

Representatives of Firms Contacted

(5) M/s. B. K. Khanna & Co. Ltd., New Delhi.
(6) M/s. Volkart Brothers, New Delhi.
(7) M/s. Associated Exports Imports. (Calcutta).
(8) Pashabhai Patel & Co.. Bombay.
(9) L.A.R. Palit & Company Ltd., New Delhi.

APPENDIX 1.3

Selected Bibliography on Earth-moving Machinery

S. No.	Title	Author	Published by	Year	Contents
1	Hand Book of Earth-moving Machinery.	Various Authors	Central Water and Power Commission, New Delhi.	1951	Contains a series of Lectures delivered at Hirakud on Plant Planning, operation, maintenance and costs of earth-moving machinery.
2	Construction Plant.	H. O. Parrack	Sir Isaac Pitman and Sons Ltd.	..	Problems and Methods of contractor's equipment, its maintenance and projection.
3	Earth-moving, an Art and a Science.	Various Authors	Construction Methods and Equipment.	Jan. 1951 to Sept. 1952.	A series of 19 articles giving detailed information about modern earth-moving equipment, planning, performance, production costs and maintenance.
4	Material handling.	Harry & Stocker	Prentic-Hall Inc., New York.	1946	The fundamental principles involved in the economical handling of materials.
5	Contractors Plant and Machinery.	R. Barnard Way	Crosby Lock Wood & Son Ltd., 20 Tudor Street, E.C.4, London.	1946	Right selection of tools and equipment with a particular reference to the contracting business.
6	Conveyors & Related Equipment.	Wilbur G. Hudson	Jhon Willey & Sons Inc., New York.	1944	A better understanding of the applications and limitations of different material handling equipment.
7	Conveyors & Related Equipment.	Wilbur G. Hudson	John Willey & Sons Inc., New York.	1949	Revised Edition.
8	Mechanical Movements	Thomas Walter Barber, M. Inst. C.E.	E. & F. N. Spon Ltd., 57, Haymarkets, S.W. 1, London.	1948	Suggestive sketches of various methods in use for accomplishing any particular work side by side with scheming and devising Machinery.

APPENDIX 1.3—*contd.*

S. No.	Title	Author	Published by	Year	Contents
9	The Material Handling Manual.	M. M. William, F.R.S.A. and G. W. William Son, M. Inst. C.E.M.I., Mech. E.	Paul Elek (Publishers) Ltd., Diamond House, 38 Hatton Garden, London E.C.E.	1949	Provides a survey of Material handling Equipment.
10	Materials Handling Equipment.	Mathew W. Potts	Pitman Publishing Corporation, New York, Chicago.	1946	Applications of a number of standard types of Material handling Equipment.
11	Conveyors & Cranes.	W. H. Atherton	Pitman Publishing Corporation, New York, Chicago.	..	Design and application of conveying Machinery and Cranes.
12	Lubricants and Lubrication.	James I. Clower	Mc-Graw-Hill Book Co., New York & London.	1939	Devoted to the fundamentals of Lubricants and Lubrication and applies to all types of machinery.
13	Earthwork and its Cost.	Halbert Power Gillete	Gillete Publishing Co., Daily News Plaza, Chicago, Tec. E. & F. N. Spen Ltd., 57 Market Hay, London (England).	1931	Analysis and comparison of Excavation methods and cost under varying conditions.
14	Methods & Plant for Excavation and Embankment.	Charles H. Paul & Charles S. Bennett.	Mc-Graw-Hill Co. Inc., New York, 370 Seventh Avenue, London, 6 & 8 Bouverie St. E.C.4.	1927	Data regarding the more common types of excavators and methods of handling excavation embankment construction.
15	Safety & Economy in Heavy Construction.	Ray J. Reigeluth	Mc-Graw-Hill Co. Inc., New York & London.	1933	Safety & economy necessary in the field of heavy construction.
16	Modern methods and Plant for Excavation.	Sir Henry Japp	..	1931	Gives details of earth-moving equipment and its operation and care.

17	Principles of Modern Excavation & Equipment.	K. F. Park	Letourneau.	..	Gives details of earth-moving machines, their performance and production.
18	Oil Reclamation	H. H. Bell Chairman, Melbourne and Metropolitan Tramway Board.	Commonwealth Engineer	Jan. 1940	Deals with filter units for reconditioning lubricants for reuse.
19	Machinery and Plant in connection with Civil Engineering Construction.	Sir George Mowlen Burt	Journal of the Inst. of Civil Engineers No. 7.	1943-44	A series of articles giving detailed information about cost production and care of earth-moving machinery.
20	Some Aspects of Modern Excavating Machinery.	C. Thomas Mitchell	Road Paper 20 Inst. of Civil Engineers.	Jan. 1946	Deals with the selection performance and cost estimation of earth-moving machinery.
21	Choice and Application of Modern Excavating Machinery.	R. A. Japp	Transactions of Inst. of C.E. Ireland and Vol. 72.	June 1945 to May 1946.	Deals with the selection operation and working cost of various working cost types of earth-moving machinery.

APPENDIX 2.1

Bibliography on Personnel and Administration

Not Printed.

APPENDIX 2.2

Union Public Service Commission

Form of Application for the use of Candidates for Appointment by Selection

Not Printed.

APPENDIX 2.3

Application for Federal Employment

Not Printed.

APPENDIX 2.4

Technical Co-operation Mission to India
November 1953.

Training of Indian Nationals Abroad

Not Printed.

APPENDIX 2·5

INDIAN ARMY

Operator Excavating Machinery

Mustered normally from Recruitment

Item	Class			
	4	3	2	1
Service in Class below in years . . .	..	..	2	2
Education :				
IA Certificate (Roman Hindustani) .	3	3	2	2
IA English Certificate . . .	..	..	..	3
Map reading Standard	3	3	2	2
Technical Testing Board	D	D/E	F	F

Technical Standard—

Class 4—1. Must have a general knowledge of the names and functions of the important component parts of:—

(*a*) Petrol engines, dumpers and tractors, and

(*b*) diesel engine tractors.

2. Must be able to carry out under supervision driver's daily and weekly maintenance of:—

(*a*) Petrol engined dumpers and tractors,

(*b*) diesel engined tractors,

(*c*) bulldozers, and

(*d*) motor graders.

3. Must be able to operate and have a sound knowledge of the employment of:—

(*a*) Petrol engines, dumpers and tractors,

(*b*) diesel engined tractors, and

(*c*) blade graders.

Class 3—1. Must understand thoroughly the working of components of mechanical equipment, such as starting engines, fuel system, main engines, gears, clutches, elevating and tipping mechanisms.

2. Must be able to carry out driver's daily and weekly maintenance, not under supervision of :—

(*a*) Plant as in Class 4, item 2.

(*b*) angle dozers, and

(*c*) rooters, ploughs, rollers, scrapers.

3. Must be able to operate and have a knowledge of the employment of :—

(*a*) Angle dozers, and

(*b*) rooters, ploughs, rollers, scrapers.

4. Must know the correct fuels and lubricants of all plants he has to operate.

Class 2—1. Must have a thorough knowledge of 1st Echelon adjustment and repair of all plant names in preceding Classes.

2. Must be a competent operator of. and have a knowledge of the output of all plant names in preceding Classes. (Tests of operation will be on difficult ground, *e.g.* water-logged, hill sides, jungle, and will examine the driver's judgment of fair risks.) Must be a skilled operator of three of the plants.

3. Must be able to operate (*e.g.*, in emergencies) RB 19 crane.

Class 1—1. Must be able to instruct Operators Exacavting Machinery up to Class 3 standard.

2. Must be able to take charge of, maintain and operate efficiently, when under detachment any of the plant names in preceding Classes.

Artificer ExcavetingMachinery (Maintenance Man)

Mustered normally from : Operator Exc. Machy. Class 3.

Item	Class		
	3	2	1
Service in Class below in years		2	2
Education:—			
IA Certificate	2	2	1
IA English Certificate	3	2	2
Map Reading Standard	2	2	2
Technical Testing Board	D/E	F	F

Technical Standard

Class 3—1. Must understand thoroughly the working of components of mechanical equipment such as starting engines, fuel system, main engines, gears, clutches, elevating and tipping mechanisms.

2. Must be able to carry out without supervision driver's daily and weekly maintenance of :—

(*a*) Plant shown in Operator Excavating Machinery Class 3,
(*b*) face shovel, dragline, grab, RB 19 Crane, and
(*c*) elevating grader.

3. Must be able to operate and have a good knowledge of the components of :—

(*a*) Face shovel,
(*b*) dragline,
(*c*) grab,
(*d*) elevating grader, and
(*e*) RB 19 Crane.

4. Must be a skilled operator of motor grader.

5. Must know the correct fuel and lubricants for plant he has to operate.

Class 2—1. Must be competent operator with a good knowledge of the output of all plant given in preceding Class. (Tests of operation will be on difficult ground *e.g.*, water-logged, hill sides, jungle, and will examine the driver's judgment of fair risks). Must be skilled operator of two of the plants.

Class I. E.—Must be able to instruct Artificers Excavating Machinery up to Class 3 standard.

2. Must be able to take charge of, maintain and operate efficiently when under detachment any of the plant named in preceding Classes.

APPENDIX

Table of Pay Scales of Operation & Maintenance Forces Showing Minimum

Position	Bhakra	Hirakud	D.V.C.	Lower Bhavani	Tungabhadra
Sub-Divisional Officer			11 4 0*	10 14 0*	
			33 5 0	20 13 0	
Overseer	5 13 0		2 8 0*	6 4 0*	
	15 7 0		12 8 0	10 7 0	
Special Foreman	16 7 0	23 12 0			
	15 7 0	30 10 0			
Asstt. Special Foreman	10 14 0				
	15 7 0				
Foreman	8 2 0	15 4 0	5 13 0*		
	15 7 0	23 12 0	24 3 0	12 8 0*	
Assistant Foreman	6 11 0	8 9 0		3 5 0*	
	11 7 0	12 1 0		4 3 0	
Chargeman	5 13 0	6 4 0		2 11 0*	
	8 2 0	13 1 0		3 5 0	
Fitter	4 3 0	3 5 0	4 3 0*	1 2 0*	4 6 0
	5 7 0	7 8 0	10 0 0@	3 0 0	
Mechanic	4 3 0	3 5 0	4 9 0*	2 8 0*	
	5 7 0	7 8 0	7 5 0@	3 2 0	
Welder	4 3 0	4 6 0	3 5 0*		
	5 7 0	10 3 0	10 7 0@		
Turner	4 3 0	3 5 0			
	5 7 0	7 8 0			
Electrician	4 3 0	4 6 0	4 9 0*		
	5 7 0	7 8 0	6 4 0@		
Operator–Excavator	5 7 0	4 9 0	4 6 0*	2 11 0*	
	11 7 0	13 1 0	7 5 0@	3 9 0	
,, Scraper		4 9 0	4 3 0*	2 13 0*	
		13 1 0	7 5 0@	3 12 0	
,, Grader	5 13 0	4 9 0	4 3 0*		
	7 1 0	13 1 0	7 5 0@		
,, Bottom or Backdump	4 3 0	4 9 0	4 3 0*	2 13 0*	
	5 7 0	13 1 0	7 5 0@	3 12 0	
,, Caterpillar	4 3 0	4 9 0	4 3 0*	2 11 0*	
	7 1 0	13 1 0	7 5 0@	3 9 0	
,, Pneumatic tyred Tractor.		4 9 0	4 3 0*		
		13 1 0	7 5 0@		

2·6

and Maximum in Rupees Per Day Including D.A. and Using 24-day Month

Gangapur	Railroads	Equipment Distributors			Recommendations of Committee
		No. 1*	No. 2*	No. 3.	
2 3 0*		Scrivce**			**Manager.
27 1 0		83 5 0			
3 5 0*		Assistant***	54 3 0‡		***Sr. Manager.
11 4 0		62 8 0	83 5 0		‡Service Engr.
		Senior $			$ Stn. Engr.
		41 11 0			
	18 5 0†		20 13 0††		†Locomotive 20 13 0
	23 12 0	29 3 0	37 8 0		††Asstt. Sr. Eng. 26 11 0
	13 9 0[1]				[1] Locomotive 16 4 0
	17 8 0				20 7 0
					10 7 0
					15 13 0
3 12 0	4 6 0			3 9 0	6 7 0
5 8 0	7 11 0			7 1 0	10 0 0
2 13 0*	4 6 0	8 5 0	10 7 0	6 1 0	6 7 0
11 4 0	7 11 0	12 15 0	18 12 0	11 11 0	10 0 0
5 8 0	4 6 0			3 9 0	6 7 0
8 2 0	7 11 0			7 1 0	10 0 0
4 0 0	4 6 0			3 9 0	6 7 0
6 0 0	7 11 0			7 1 0	10 7 0
4 0 0	4 6 0				6 7 0
6 0 0	7 11 0				10 0 0
3 0 0	13 9 0[2]				[2]Locomotive 16 4 0
7 0 0	17 8 0				Driver A 20 7 0
4 0 0	13 9 0[3]				[3]Locomotive 16 4 0
7 0 0	17 8 0[4]				Driver A 20 7 0
2 8 0	9 3 0				[4]Locomotive 11 11 0
6 0 0	15 4 0				Driver B 18 5 0
4 0 0	9 3 0[5]				[5]Locomotive 11 11 0
6 0 0	15 4 0				Driver B 18 5 0
5 0 0	9 3 0[6]				[6]Locomotive 11 11 0
6 0 0	15 4 0				Driver B 18 5 0
5 0 0	9 3 0[7]				[7]Locomotive 11 11 0
6 0 0	15 4 0				Driver B 18 5 0

*Rate does not include dearness allowance.

@Rates higher can be paid if merited.

(For notes please see next page.)

APPENDIX 2·6—*concld.*

NOTE 1: In assembling this table the actual work done by the man involved was the base used. On some projects various designations have been given to mechanics and others in order to allow them more pay. These designations were disregarded and pay given for work done was the deciding factor in the assembling of the table.

NOTE 2: In considering pay scales the committee found the railway scales to be the most commensurate as regards responsibility involved and value of equipment concerned. It is believed necessary to add an allowance to compensate for lack of continuity of employment. We called this added pay a "Construction allowance" and incorporated it in our recommended rates. We computed it as under:—

	Rs.
For Basic salary up to Rs. 100	50 per mensem
Rs. 101 to 150	55 per mensem
Rs. 151 to 200	60 per mensem
Rs. 201 to 300	65 per mensem
Rs. 301 to 500	70 per mensem
Rs. 501 to 750	85 per mensem
Rs. 751 to 1,000	100 per mensem
Rs. 1,001 to 2,000	10% of pay—not to exceed Rs. 150

The scales recommended for operators are for men with Class I ratings as per Appendix 2.5. Rates for Class II operators should be taken as 75% and Class III as 50% of the recommended rates.

APPENDIX 2·7

Project Allowance

Project allowances granted by various States are given below:—

Hydrabad State (Tungabhadra Project)

	Project Allowance.
1. *Officers*	
Executive Engineer.	Rs. 50 p. m.
Asstt. Engineer.	Rs. 36 ,,
Sub Engineer.	Rs. 25 ,,
2. *Subordinates*	Rs. 10 ,,

All are provided with free residential quarters, electricity and water supply.

3. *Temporary employees charged to work*

All facilities as provided for (1) and (2) exclusive of the project allowances.

Madras State (Tungabhadra and Lower Bhavani Projects, Ramapadasagar, Moyar, etc.)

Government of Madras

Allowances—Projects, Major Irrigation and Electricity Schemes—Investigation and execution, greater concession for staff—proposals sanctioned.

G.O.P.W.D. Ms. No. 587, dated 20-2-1948.

ORDER

His Excellency the Governor of Madras, sanctions the grant of the following concessions and amenities to the staff employed on the investigation and execution of big irrigation and electricity schemes in Tungabhadra, Ramapadasagar, Moyar and Lower Bhavani. The S. Es. employed on these schemes will not be eligible for these concessions but they will continue to draw allowances at the existing rates.

A. (1) Provision of free house, free lighting, free electricity, free water supply, free sweeping and free conveyance of provisions from Railway Station to camp sites and compensatory allowance at 15% of pay for non-Gazetted staff and 7½% for Gazetted staff.

(2) Before the provision of free quarters etc., mentioned in clause 1 above compensatory allowance at 10% of pay for Gazetted staff and 30% of pay for non-Gazetted saff.

B. Unhealthy localities allowance—At the rates admissible under the Madras Manual of special pay and allowances, wherever unhealthiness is specially marked.

C. (1) Railway fare for the non-Gazetted staff once in a year to go home and return for self and family.

(2) As regards Machkund Scheme, in addition to the existing concessions the Railway fare to and fro once a year for the officer and family to go to his native place is also allowed. This latter concession will be applicable only for the non-Gazetted staff.

(3) The concessions allowed in paras 1 and 2 above will take effect from the date of this order.

(By Order of His Excellency the Governor).
Sd/XYZ

From the Public Works Department G.O. Ms. No. 1853, dated 24-5-48.

ORDER

The Government approve the proposal of the special Chief Engineer that the compensatory allowance sanctioned in G.O. cited above may be paid on the following scale to the staff employed on the Tungabhadra and Ramapada-sagar Projects.

Non-Gazetted officers

Before provision of amenities	30%
After fre equarters have ben provided	20%
After free quarters and water supply provided	17½%
After free quarters and electricity provided	15%

Gazetted staff

Before proviison of amentities	10%
After fre quarters have been provided with or without water supply and electricity	7½%

The action of the Special Chief Engineer in having issued instructions to the S. Es. to grant the allowances as specified above, in anticipation of the sanction of Government is also approved. The amenities mentioned above should be provided to the extent possible, but the absence of minor ones such as free sweeping and conveyance of provisions in the case of non-Gazetted staff and free water supply, free electricity, free sweeping and conveyance of provisions in the case of Gazetted staff should not be compensated for by any increase in the allowances.

2. As regards the suggestion of the Special Chief Engineer the allowance sanctioned in the above G.O. should be treated as "Special pay" as defined under Fundamental Rule 9 (25), the Government consider that there is not sufficient justification to do so as the compensatory allowance has been given for the unattractiveness of the localities and difficult living conditions and not for arduous nature of the duties.

3. The Audit Officer has raised the following points for clarification :—

(a) Whether the S. Es. are eligible for the project allowance of 10% of pay until all amenities such as rent-free accommodation, free water supply, free electricity, free sweeping etc., are provided.

(b) Whether the concessions granted in G.O. 567, dated 9-2-48, are applicable to P.W.D. staff only and whether orders for regulating the claims of other department staff employed on the above projects will be issued separately.

(c) Whether any minimum or maximum money limit for the drawal of the allowance has been prescribed, if not, whether the absence of this restriction is deliberate and whether the allowance can be allowed for both the Gazetted and non-Gazetted staff wihout any limit.

(d) Whether the concession of free conveyance of provisions from Railway Station to camp site will peruse include conveyance of persons or their servants both ways (from dam site to the Railway Station or shandy) for procuring provisions.

(e) Whether all the concessions sanctioned in the above G.O. are admissible to the P.W.D. staff, irrespective of whether they are recruited locally or obtained on transfer from outside.

The Government have carefully considered the above points and direct that in the case of the S. Es., the position as it was before the issue of G.O No. 587 P. W., dated 20-2-48, should continue as the orders in this G.O. do not apply to them. As regards the drawal of the concession by the Revenue, Public Health, Medical and Agricultural Staff employed on the Tungabhadra and Ramapadasagar Projects, attention of the Audit Officer is invited to the orders issued in Memo. No. 157-SL/47-21, dated 23-3-48 and Memo. No. 2959-SI/48-1, dated 7-5-48. The Audit Officer is informed that no minimum or maximum money limit for the drawal of the allowance has been prescribed and that it can be allowed to both the Gazetted and non-Gazetted Staff without any limit. The concession of free conveyance of provisions from Railway station camp site will include conveyance of persons or their servants both ways (from the camp site to the Railway Station) for procuring provisions. The concessions sanctioned in the G. O. are admissible to the staff employed on Tungabhadra and Ramapadasagar Projects irrespective of whether they are permanent or temporary or whether they are recruited locally or obtained on transfer from outside. The Accountant General is informed that the staff employed on the four big Irrigation and Electricity Schemes (*e.g.*, Tungabhadra and Ramapadasagar, Moyar and Lower Bhavani), are alone eligible for the concessions sanctioned in the G.O.

4. Railway fare for the non-Gazetted staff to go home and return once a year. In the interest of administrative convenience, the Government approve the proposal of the Special Chief Engineer that the Railway fare concession may be availed of once in the period between 20-2-48 and 31-12-48 and thereafter once in every calendar year by all the non-Gazetted staff (P.W.D., Revenue, Public Health, Medical and Agriculture) employed on the Tungabhadra and Ramapadasagar Projects. This concession is admissible in the case of persons proceeding on any leave including casual leave subject to the condition that the person concerned should have served for a period of not less than six months in the project area. No minimum period of stay in the outstation is prescribed to qualify for the payment of this concession.

(By Order of His Excellency, the Governor of Madras)

D. V. KRISHNAMURTHI,

Deputy Secretary to Government.

To the Chief Engineer for Irrigation.

Damodar Valley Corporation

Construction allowance at 20% of pay subject to a maximum limit of Rs. 100 p.m. out of which residential rents are deducted subject to 10% of pay or standard rent whichever is less.

Bombay State (Gangapur Dam)

Staff actually residing at dam site is given free accommodation, but the employees drawing pay in excess of Rs. 250 p.m. are charged rent at 5% of pay or the standard rent whichever is less.

Free electricity, water supply and medical aid is provided. Free transport to Nasik (8 miles) is provided to children attending middle and high school.

33⅓% allowance is given to Gazetted Officers in charge of three shifts when the work is executed in 3 shifts—generally in summer.

Non-Gazetted Officers and employees on mid-night shift get an allowance of 20% of their pay.

Orissa State (Hirakud)

Construction allowance has been sanctioned up to 31-3-1954 which is at 20% of the pay with a maximum of Rs. 150 p.m. Further extension of the allowance has yet to be decided by the Control Board.

House rent is being recovered at 5% of the pay.

Water and electricity concessions are being allowed free up to a certain limit fixed by the Chief Engineer.

APPENDIX 3·1

Plant Population on Project

Sl. No.	Makes of Equipment	Bhakra	Nangal	D.V.C.	Gangapur	Hirakud	Tungabhadra Project		Lower Bhavani	Total	Percentage	Remarks
							Hyderabad	Mysore				
1	2	3	4	5	6	7	8	9	10	11	12	13
Air Compressors												
1	C.P.T. . .	17(2)	*	*	..	*	14(3)	*	*	31	44·8	(1) One size
2	I.R. . .	17(1)	*	*	..	*	..	*	*	7	10·15	(2) Two sizes
3	Le-Roi . .	..	*	*	7(3)	*	..	*	*	7	10·15	(3) Three sizes
4	Gardner Denver	..	*	*	..	*	1(1)	*	*	1	1·45	*Information not
5	Jaeger . .	..	*	*	..	*	1(1)	*	*	1	1·45	given.
6	Miscellaneous .	22(4)	*	*	..	*	..	*	*	22	31·9	
									TOTAL .	69		
Graders												
1	Caterpillar .	4(2)	2(1)	1(1)	1(1)	6(1)	*	*	*	14	38·9	
2	Allis Chalmers.	..	..	8(2)	..	..	*	*	*	8	22·2	
3	Carlisle . .	..	..	..	..	7(1)	*	*	*	7	19·45	
4	Austin Western	..	..	3(1)	..	..	*	*	*	3	8·34	
5	Galion . .	.	.	.	..	2(1)	*	*	*	2	5·55	
6	Adam . .	..	.	..	2	..	*	*	*	2	5·55	
									TOTAL .	36		

APPENDIX 3·1—*contd.*

Plant Population on Project

1	2	3	4	5	6	7	8	9	10	11	12	13
Powered Scrapers												
1	Le-Tourneau .	2(1)	4(1)	15(2)	17(1)	19(2)	10(2)	...	..	67	60·4	
2	La-Plant Choate	..	8(1)	3(1)	..	2(1)	7(1)	..	..	20	18·0	
	Allis Chalmers.											
3	Terra-Cobra .	..	12(1)	4(1)	..	..	..	..	..	16	14·4	
4	Caterpillar .	..	..	..	..	..	..	2(1)	6(1)	8	7·2	
									TOTAL .	111		
Towed Scrapers												
1	Onion Empire	..	..	22(3)	..	..	..	2(1)	4(1)	28	62·2	(1) One size
2	Le-Tourneau .	..	..	..	..	..	..	3(1)	4(1)	7	15·5	(2) Two sizes
3	Caterpillar .	..	..	4(1)	1(1)	..	..	1(1)	1(1)	7	15·5	(3) Three sizes
4	Blaw Knox .	..	..	..	..	..	..	2(2)	..	2	4·45	(4) Four sizes
5	Ruston Bucyrus	..	..	..	.	..	..	1(1)	..	1	2·22	(5) Five sizes
												(6) Six sizes
									TOTAL .	45		
Tractors												
1	Caterpillars .	18(5)	55(6)	10(2)	18(2)	16(2)	9(4)	17(3)	13(1)	156	34·1	
2	Allis Chalmer .	10(1)	4(1)	90(6)	..	8(2)	..	2(1)	..	109	23·0	
3	Fowlers . .	..	17(1)	..	..	54(2)	..	..	11(1)	82	17·9	
4	International .	8(1)	7(2)	11(3)	4(1)	14(2)	..	..	6(1)	50	10·9	
5	Oliver Cletrac.	..	4(1)	2(1)	..	27(2)	..	..	..	33	7·22	
6	Le-Tourneau .	..	..	4(1)	2(1)	10(1)	5(1)	..	..	21	4·58	
7	Ansaldo . .	4(1)	..	2(1)	..	..	..	..	..	6	1·31	

Dumpers

1	Euclids . .	48(4)	38(2)	57(2)	3(1)	22(3)	..	3(2)	11(3)	182	31·2	(1) One size
2	Muir Hill .	20(1)	32(1)	48(1)	..	..	30(1)	7(1)	20(1)	157	26·9	(2) Two sizes
3	Caterpillar .	..	12(1)	..	..	44(2)	..	5(1)	..	61	10·4	(3) Three sizes
4	Le-Tourneau .	..	..	9(2)	6(1)	19(2)	..	5(1)	..	39	6·67	(4) Four sizes
5	Koehring .	12(1)	12(1)	2(1)	..	..	..	6(1)	..	32	5·48	
6	Mack . .	..	..	14(1)	..	16(1)	..	..	..	30	5·14	
7	Aveling Barford	..	..	14(2)	..	..	..	9(1)	..	23	3·94	
8	Miscellaneous .	20(1)	..	..	..	..	..	..	..	20	3·43	
9	Motor Rail .	..	..	..	..	..	..	..	14(1)	14	2·40	
10	Terra Cobra .	..	..	12(1)	..	..	..	..	..	12	2·06	
11	Sterling . .	..	..	..	..	9(1)	..	..	..	9	1·54	
12	Sudworks .	..	..	..	..	3(1)	..	..	..	3	0·514	
13	Balmer Lawrie.	..	..	..	..	..	..	2(1)	..	2	0·343	
									TOTAL .	584		

Excavators

1	P. & H. .	2(2)	..	22(3)	..	2(1)	..	4(2)	..	30	23·3	(1) One Size
2	Ruston Bucyrus	1(1)	..	6(2)	..	4(1)	..	..	10(2)	21	16·3	(2) Two Sizes
3	Lima . . .	..	4(2)	6(2)	..	5(2)	..	3(2)	..	18	14·0	(3) Three Sizes
4	Link Belt Speeder	2(1)	8(1)	..	..	..	..	..	1(1)	2	9·3	(4) Four Sizes
5	North West .	1(1)	1(1)	3(2)	..	..	..	..	5(1)	10	7·0	
6	N.C.K. . .	..	..	8(2)	..	..	..	..	..	8	6·2	
7	Marion . .	3(1)	1(1)	..	..	..	2(2)	..	..	6	4·65	
8	Lorain . .	2(2)	4(2)	..	..	..	..	..	..	6	4·65	
9	Manitowac .	2(1)	..	..	..	..	2(1)	..	..	4	3·10	
10	Bucyrus Erie .	2(1)	..	..	..	..	2(1)	..	..	4	3·10	

APPENDIX 3.1—*concld.*

Plant Population on Project

1	2	3	4	5	6	7	8	9	10	11	12	13
11	Baycity . .	..	..	1(1)	..	..	..	2(1)	..	3	2·33	
12	R. F. Rapier .	..	..	2(1)	..	..	..	..	..	2	1·55	
13	Leonaid . .	2(1)	..	..	..	..	..	..	..	2	1·55	
14	Demag . .	..	..	..	2(1)	..	..	..	..	2	1.55	
15	Priest Men .	..	..	1(1)	..	..	..	..	..	1	0·775	
									TOTAL .	129		

APPENDIX 3.2

Comparative Statement of Life Adopted for Depreciation

Sl. No.	Type of Equipment	Life Hours: Damodar Valley Corporation	Tunga-bhadra (Hydera-bad side)	Tunga-bhadra (Madras side)	Lower Bhavani	Ganga-pur	Hirakud	Nangal Circle	Bhakra Circle	Manufacturers Recommenda-tions	USBR Schedule of Equipment Ownership Expense	Associated General Contractors of America
1	2	3	4	5	6	7	8	9	10	11	12	13
1	Air Compressors .	10,000	..	..	..	10,000	..	..	20,000	..	7,200	7,200
2	Crawler mounted:											
	(1) up to 9 tons .	..	..	..	..	..	..	..	20,000	Lorain 10,000	9,600	9,600
	(2) 9 to 25 tons.	20,000	..	..	..	..	..	..	20,000	L.S. 10,000	13,440	11,300
	(3) 25 to 50 tons	..	..	..	..	..	..	..	20,000 to 25,000	..	13,440	14,460
	Truck Crane .	20,000	..	..	..	..	..	..	..	Lorain 10,000 L.S. 10,000	8,640	7,800
3	Drilling Machines	..	..	..	..	..	..	12,000	12,000	..	11,760	Not included
4	Excavators Draglines:											
	(1) To ¾ cu. yds.	10,000	..	..	10,000	..	..	20,000	20,000	Lorain 10,000	8,640	8,400
	(2) ¾ to 1½ cu. yds.	18,000	..	..	..	..	..	15,000	20,000	P&H 15,000	9,240	9,350
	(3) Above 1½ cu. yds.	24,000	20,000	..	..	15,000	..	30,000	20,000 to 25,000	L.S. 10,000 Ruston Bucyrus to 1½ 15,000 Above 1½ 30,000	10,080	10,500

APPENDIX 3·2—*contd.*

Comparative Statement of Life Adopted for Depreciation

1	2	3	4	5	6	7	8	9	10	11	12	13
	Shovels Backhoes:											
	(1) To ¾ cu. yds.	..	20,000	..	..	10,000	..	..	20,000	Same as	9,600	9,400
	(2) ¾ to 1½ cu. yds.	12,000	..	..	..	..	..	15,000	20,000	Draglines	11,220	11,400
	(3) Above 1½ cu. yds	16,000	..	18,000 to 24,000	..	15,000	16,000	30,000	20,000 to 25,000	..	11,520	12,000
5	Graders . .	10,000	..	..	..	10,000	7,000	8,000	..	Aills Chalmers 10,000 Caterpillar 10,000	9,600	9,600
6	Loaders . .	..	..	..	..	10,000	12,000	..	..	Euclid 14,000	7,200	7,200
7	Scrapers—Drawn and Towed	..	..	24,000	..	..	..	..	12,000	..	9,600	9,600
	Motorised .	10,000	10,000	12,000	..	10,000	8,000	15,000	15,000	Allis Chalmers 10,000 Le-Tourneau 10,000 Caterpillar 10,000	7,880	9,600
8	Tractors Crawler:											
	(1) To 80 H.P. .	8,000	20,000	10,000	..	..	7,000	10,000	10,000	Allis Chalmers 10,000	8,640	..
	(2) Above 80 H.P.	10,000	20,000	10,000	10,000	10,000	8,000	12,000	12,000	International 10,000 Caterpillar 10,000	7,880	9,600
	(3) Pneumatic Tyred	10,000	..	..	10,000	..	..	..	..	Le-Tourneau 10,000	7,880	..

9	Trucks											
	Back Dumpers :											
	(1) To 5 cu. yds.	8,000	10,000	10,000	10,000	10,000	10,000	10,000	..	Euclid 15,000	9,600	9,600
	(2) Above 5 cu. yds.	10,000	..	10,000 to 12,000	16,000	10,000	10,000	12,000	12,000 to 15,000	Le-Tourneau 10,000	..	..
	Bottom Dumpers .	10,000	..	10,000 to 12,000	16,000	10,000	15,000	..	..	Euclid 20,000 Caterpillar 10,000 Le-Tourneau 10,000	7,880	9,600
10	Roller—Sheepsfoot	..	..	..	..	10,000	10,000	..	..	..	7,880	5,760

APPENDIX 3·3

Depreciation, Major and Field Repairs

Committee's Recommendations

Sl. No.	Equipment		Plant Hours for Depreciation	Cost-expressed as % of the cost of equipment over life time								Total for Major and Field Repairs
				MAJOR REPAIRS				FIELD REPAIRS				
				Spares	Material	Labour	Total	Spares	Material	Labour	Total	
1	2		3	4	5	6	7	8	9	10	11	12
1	*Crawler Tractors:*											
	Diesel 41 to 52 B.H.P. . .		9,000	35	4	9	48	9	4	37	50	98
	65 to 89 B.H.P. . . .		9,000	35	4	9	48	9	4	34	47	95
	89 to 135 B.H.P. . .		10,000	36	5	10	51	10	5	27	42	93
2	*Rubber Tyred Tractor dozers:*											
	Diesel 140 to 180 B. H. P. .		10,000	36	5	10	51	10	5	36	51	101
3	*Scrapers Motorised:*											
	Capacity cu. yds.											
	Struck	*Heaped*										
	6 to 10	9 to 13	9,000	34	5	9	48	9	5	37	51	99
	10 to 14	13 to 17	10,000	36	5	10	51	10	5	36	51	102
	16 to 20	21 to 25	10,000	36	5	10	51	10	5	27	42	93
4	*Scrapers Towed:*											
	Capacity cu. yds.											
	Struck	*Heaped*										
	9	11	10,000	20	3	5	28	5	3	22	30	58
	12	15	10,000	20	3	5	28	5	3	20	28	56
	14	18	10,000	20	3	5	28	5	3	16	24	52

5 *Bottom Dumpers:*									
10 to 12 cu. yds. . . .	10,000	36	5	10	51	10	5	36	51	102
15 to 18 cu. yds. . .	10,000	36	5	10	51	10	5	27	42	93
6 *Rear Dumpers:*										
10 to 12 cu. yds. . .	10,000	32	4	9	45	9	4	21	34	79
15 to 18 cu. yds. . .	10,000	32	4	9	45	9	4	23	36	81
7 *Excavators:*										
¾ cu. yds.	9,000	32	4	8	44	8	4	35	47	91
1½ cu. yds.	10,000	38	5	10	33	10	5	38	53	106
2½ cu. yds.	12,000	40	6	11	57	11	6	33	50	107
3½ cu. yds.	12,000	40	6	11	57	11	6	30	47	104
8 *Graders:*										
Towed 10 ft. blade . . .	8,000	20	3	5	28	5	3	23	31	59
Towed 12 ft. blade . . .	10,000	20	3	5	28	5	3	20	28	56
Motor 10 ft. blade . . .	10,000	41	5	11	57	11	5	45	61	118
Motor 12 ft. blade . . .	10,000	41	5	11	57	11	5	41	57	114
9 *Air Compressors:*										
Portable										
105 C. F. M. . . .	6,000	27	3	7	37	7	3	30	40	77
210 C. F. M. . . .	8,000	34	4	9	47	9	5	34	48	95
315 C. F. M. . . .	8,000	34	4	9	47	9	5	28	42	89
500 C. F. M. . . .	8,000	34	4	9	47	9	5	25	39	86
Stationery										
up to 160 C. F. M. . .	10,000	27	3	7	37	7	4	27	38	75
160 to 500 C. F. M. . .	10,000	34	4	9	47	9	5	25	39	86

APPENDIX 3.3—*concld.*

Depreciation, Major and Field Repairs

Committee's Recommendations

1	2	3	4	5	6	7	8	9	10	11	12
10	*Cranes:*										
	Mobile Pneumatic .										
	4 to 6 tons . . .	9,000	27	4	7	38	7	4	29	40	78
	8 to 12 tons . . .	10,000	27	4	7	38	7	4	22	33	71
	15 to 25 tons . . .	12,000	27	4	7	38	7	4	20	31	69

NOTES:—(1) Excavators

Adopt uniformly for Shovels and Draglines; when used as cranes adopt 25% longer life.

For Electric models adopt 25% longer life and same provisions for repairs as for corresponding diesel sizes.

(2) For Tractor attachments, *e.g.*, Bulldozer blades, rooters, sheepsfoot rollers, etc., adopt the life and provisions for repairs similar to the tractor concerned.

(3) Cost of tyres, wire ropes, etc., not included.

APPENDIX 3·4

Percentage Utilisation of Equipment

Sl. No.	Projects	Tractors			Dumpers			Excavators		
		Scheduled working hours	Actual working hours	Percentage	Scheduled working hours	Actual working hours	Percentage	Scheduled working hours	Actual working hours	Percentage
1	Gangapur	2,37,171	1,08,082	45·5	96,982	36,497	37.6	25,872	16,580	64.0
2	D. V. C.	4,57,790	2,44,456	53·3	5,62,718	2,65,719	47.2	2,01,648	1,05,597	52.3
3	Lower Bhavani	1,89,268	1,31,495	69.4	3,64,114	2,32,546	63.8	1,06,111	85,055	80.0
4	Hirakud 11/51 to 6/52	14,400	7,876	54.6	1,04,400	34,147	32.8	..	..	..
	Do. 1/51 to 21-7-51	2,800	531·5	19.0	..	..	..	..	..	..
	Do. 9/51 to 6/52	4,000	3,191	79.6	25,200	15,550	61.5	3,830	2,758	71.8
5	Tungabhadra (Hyderabad)	81,900	56,700	69.4	96,000	15,100	15.7	17,500	5,722	32.7
6	Tungabhadra (Mysore)	97,900	54,800	56.0	1,54,300	94,830	61.5	58,600	23,450	40.0
	TOTAL	10,85,229	6,07,127	56.2	14,03,714	6,94,416	49.6	4,13,561	2,39,162	57.8

NOTE:—The plant hours performed by machines to those that could have been done as a maximum scheduled, for one, two or three-shift work as the case may be, are tabulated below.

APPENDIX 3·4—*Contd.*

Percentage Utilisation of Equipment

Sl. No.	Projects	Scrapers			Graders			Loaders		
		Scheduled working hours	Actual working hours	Percentage	Scheduled working hours	Actual working hours	Percentage	Scheduled working hours	Actual working hours	Percentage
1	Gangapur	1,72,389	1,00,371	58.2	10,500	4,600	43.8	1,750	1,275	73.2
2	D. V. C.	73,576	41,381	56.2	34,788	14,074	40.4	..	..	..
3	Lower Bhavani	..	..	..	..	..	..	..	..	..
4	Hirakud 1/51 to 6/52	..	..	..	..	..	..	7,200	4,370	60.7
	Do. 1/51 to 21-7-51	28,000	6,415	22.9	..	..	..	..	..	..
	Do. 9/51 to 6/52	76,000	16,701	22.0	..	..	..	..	..	..
5	T. B. P. (Hyderabad)	1,08,000	48,989	45·3	..	..	..	..	..	..
6	T. B. P. (Mysore)	47,800	28,500	59·5	..	..	..	..	..	..
	TOTAL	5,05,765	2,42,357	48.0	45,288	18,674	41.2	8,950	5,645	63.0

APPENDIX 3·4—*Concld.*

Overall Percentage Utilisation on Projects

Projects	Scheduled working hours	Actual working hours	Percentage
1. Gangapur	5,44,664	2,67,405	49·10
2. Damodar Valley Corpn. 8	13,30,520	6,71,227	50·4
3. Lower Bhavani	6,59,493	4,49,096*	68·2*
4. Hirakud	2,65,830	91,566	34·5
5. Tungabhadra (Hyderabad)	3,03,400	1,26,511	41·6
6. Tungabhadra (Mysore)	3,58,600	2,01,580	56·2
TOTAL	34,62,507	18,07,385	52·0

*"Plant hour" taken as gross hours of working the machine.

NOTE:—The plant hours performed by machines to those that could have been done as a maximum scheduled, for one, two or three-shift work, as the case may be, are tabulated below.

APPENDIX 3·5

Ownership and Operating Cost of Equipment on Projects (Actuals)

Equipment	Project	Life assumed	Depreciation rate/hr.	Major Repairs/hr.	Tyres and Tubes/hr.	Fuels Lubr./hr.	Operator Wages/hr.	Other charges/hr.	Total/hr.
1	2	3	4	5	6	7	8	9	10
Crawler Tractors:									
1. D/8	(1) Nangal Circle . .	12,000	‡10·00	5·00	..	8·93	2·56	3·00	29·49
2. ,, ...	(2) T. B. P. Hyderabad .	20,000	*4·12	4·12	..	4·75	0·56	2·12	15·67
3. ,, ...	Gangapur . . .	10,000	†8·5	§8·56	..	6·00	1·04	2·25	26·35
1. D/7	Nangal Circle . .	12,000	‡7·56	3·81	..	7·00	2·43	2·25	23·05
2. ,, ...	T. B. P. Hyderabad .	20,000	*3·60	3·60	..	3·56	0·56	2·12	13·44
3. ,, ...	T. B. P. Mysore/Andhra .	10,000	‡7·50	4·32	..	3·50	1·00	0·75	17·07
4. ,, ...	L. B. P.	10,000	‡9·70	1·43	..	3·94	1·00	0·25	16·32
Excavators :									
1. Lima 3½ cu. yds. . .	T. B. P. Mysore/Andhra	24,000	‡15·54	0·50	..	7·81	1·87	1·06	26·78
2. Lima 2½ cu. yds. . .	Nangal Circle . .	30,000	‡12·50	4·37	..	10·56	4·68	3·12	35·23
3. Manitowac 2½ cu. yds. .	T. B. P. Hyderabad .	20,000	*10·28	10·28	..	11·19	0·63	2·75	35·13

Dumpers :									
1. Euclid Bottom Dump 17 cu. yds. capacity.	L. B. P.	16,000	*10·25	0·12	1·93	2·63	1·00	0·18	16·11
2. Do.	T. B. P. Mysore/Andhra .	12,000	‡10·38	0·56	1·75	2·68	1·45	0·33	17·15
1. Euclid Rear Dump 11 cu. yds. capacity.	L. B. P.	16,000	‡9·32	0·25	1·12	2·43	1·00	0·12	14·24
2. Do.	Nangal Circle . .	15,000	‡8·87	3·12	£	4·25	2·00	2·25	20·49
3. Do.	T. B. P. Mysore/Andhra .	12,000	‡12·17	0·25	1·75	3·06	1·56	0·49	19·28
Motor Scrapers:									
1. Le-Tourneau 12/15 cu. yds.	Gangapur	10,000	†10·0	§7·50	5·73	4·93	1·47	4·62	34·23
Do.	T. B. P. Hyderabad . .	10,000	‡12·81	6·43	6·43	7·75	0·56	1·75	35·73
2. La-Plant Choate									
Model TS200S heaped, Cap. 17 yds.	Nangal Circle . .	15,000	‡9·75	4·87	£	7·50	2·18	2·43	26·73
Do.	T. B. P. Hyderabad .	10,000	‡12·87	6·43	6·43	11·05	0·56	1·75	39·09
3. Terra-Cobra Model T. C. heaped Capacity 17 yds.	Nangal Circle . .	15,000	*7·75	3·87	£	7·93	2·18	1·93	23·66
4. Cat. D. W. 10 . .	Do.	15,000	*6·87	2·38	£	5·25	2·00	1·75	18·25
Do.	L. B. P.	16,000	*7·25	2·62	3·12	3·68	1·25	0·5	18·42
Do.	L. B. P. Mysore/Andhra .	12,000	‡9·20	0·50	3·56	7·62	1·25	1·62	23·75

NOTES:—T. B. P. means Tungabhadra Project. L. B. P. means Lower Bhavani Project.

(1) Nangal Circle means reserve fund account for Major Repairs. The actual cost of Major Repairs is at present lower than the figures given.

(2) The cost of Major Repairs for T. B. P. Hyderabad appear to be estimated values.

(3) *Pre-devaluation prices. ‡Post-devaluation prices.

†Partly both. §Average of four years. £ Included in other items.

(4) For Nangal Circle the entries in columns 7, 8 and 9 are for stores, workcharged establishment and repairs and replacement respectively.

APPENDIX

Ownership and Operating

Equipment	Cost (Rs.)	Recommended life Hrs.	Cost Depreciation (Excluding Tyres)
Crawler			
90 B. H. P. Tractor . . .	88,400	9,000	9 13 0
Crawler			
130 B. H. P. Tractor . . .	1,18,932	10,000	11 14 0
12/15 cu. yds. Motor Scraper .	1,79,245	10,000	16 4 0
17/25 Bottom Dump . . .	2,43,681	10,000	20 4 0
13/17 Rear Dump . . .	1,72,480	10,000	15 6 0
9 B. V. Loader	2,34,300	14,000	15 2 0
1½ cu. yd. Shovel . . .	2,92,768	10,000	29 4 0
2½ cu. yd. Shovel . . .	4,28,964	12,000	35 14 0
3½ cu. yd. Shovel . . .	6,14,650	12,000	51 4 0
100 H. P. Grader . . .	83,160	10,000	7 8 0

3·6

Cost of Typical Machines

per Plant Hour

Major Repairs	Field Repairs	Belt, Tyres & Tubes	Operating cost	Fuels & Lubes	Sundries	Overheads 2%	Total cost per Plant Hr.
4 12 0	4 14 0	..	1 14 0	5 11 0	0 3 0	0 9 0	27 12 0
0 1 0	5 0 0	..	1 14 0	7 5 0	0 3 0	0 10 0	32 15 0
8 4 0	8 4 0	†5 9 0	1 14 0	8 11 0	0 3 0	1 0 0	50 1 0
10 10 0	8 12 0	‡10 1 0	2 0 0	10 13 0	0 3 0	1 4 0	64 9 0
6 15 0	5 10 0	†6 4 0	1 14 0	8 12 0	0 3 0	0 14 0	45 14 0
7 8 0	7 12 0	§3 15 0	2 2 0	9 5 0	0 3 0	0 15 0	46 14 0
15 8 0	15 8 0	..	2 2 0	10 13 0	0 3 0	1 7 0	74 13 0
20 5 0	17 12 0	..	2 2 0	13 4 0	0 3 0	1 13 0	91 5 0
29 3 0	24 10 0	..	2 2 0	14 6 0	0 3 0	2 7 0	124 3 0
0 4 0	4 4 0	6 0 0	1 14 0	5 9 0	0 3 0	0 8 0	30 7 0

*Includes 10% for landing charges, tax, erection and test.

†Life at 3,000 hours.

‡Life at 3,500 hours.

§Belt life at 3,000 hours.

APPENDIX

Unit Rates of Earth-

Projects	Material	Quantity m. cu. ft.	Period	Lead	Rate Rs. per 1,000 cu. ft.	Basis of quantity of earthwork
1	2	3	4	5	6	7
1. Lower Bhavani	Impervious fill Pervious fill	36.3 22.7	6-1-1949 to June 1953	0.75 miles 1.0 miles 1.5 miles	45.57 52.32 56.00	Embankment taken as 2/3 of struck Bowl Capacity.
2. Gangapur	Impervious fill	38.3	7/52 to 6/53	0.76 miles	61.8	Compacted embankment sectional measurement.
	Do.	62.2	2/49 to 7/53	0.76 miles	65.6	
	Murum Casing	7.7	Do.	0.95 miles	81.2	
	Do.	25.0	Do.	0.95 miles	95.6	
3. Nangal Power Canal.	Loam	(2)	Typical	Lead 2,050 ft. lift 30 ft. Lead 150 ft lift 30 ft.	75.0 22.2	Do.
4. Hirakud	Impervious fily-Clay Loam to Clay. Semi-pervious fill gravelly soil	143.3	1950 to June 1953	Average weighted lead 2.5 miles.	87.0	Do.
5. D. V. C. Maithon.	Impervious fill-Sandy loam.	35.4	1-10-52 to August 1953	Lead weighted average 1 2/3 miles Avg. weighted lift 45 ft.	(4) 109.0	Do.
6. D.V. Panchet Hill.	Common earth	Excavation 19.5 m. cu. ft. Embankment 13 m. cu. ft.	31-10-52 to 30-6-53	Avg. lead 800 ft. Avg. lift 18 ft.	110.0	Do.

NOTES :—(1) The entry is with reference to the standards recommended by the Committee,

(2) A total of about 400 m.cu.ft. of earthwork on canal is done with machinery. excavation and compacted embankment.

(3) Information not collected.

(4) Estimated.

3·7

work on Projects

Investment on earth-work machinery Rs. Lakhs.	Life of equipment utilised	Rate of Depreciation (1)	Major Repairs	Running cost of machinery	Haul Road	Flood Light	Laboratory and field control
8	9	10	11	12	13	14	15
62	1/2 Approx.	Low	At actuals; no reserve fund.	Included through suspense.	Not included; see remark col. 14.	Not included; watched separately through grouped subheads.	As in previous column.
59	3/4 Approx.	Slightly low.	Reserve fund maintained.	Do.	Included.	Included.	Included.
145	1/3 Approx.	Low	Do.	Do.	Do.	Do.	(3)
300	1/5 Approx.	Do.	At actuals; no reserve fund.	Do.	Not included, will be about 5 per cent.	Not included; estimated about 2 per cent.	Not included.
Pool for the entire DVC Project Rs. 420.	1/5 Approx.	Do.	Reserve Fund maintained.	Major and field repairs through suspense. Rest directly to works.	Included.	Included.	Do.
	Do.	Do.	Do.	Do.	Do.	Do.	Do.

low means longer life assumed.

Nature of work varied; straight casting, excavation, transport and waste bank or

Unit Rates of Earthwork

Projects	Watering charges	Transport, temporary sheds and sundries	Manual labour and overheads	Tools and plants charged	Total project rate
16	17	18	19	20	21
1. Lower Bhavani	Included.	Not included; see col. 14.	Not included; see col. 14.	Not included.	
2. Gangapur	Partially included, full charge will increase rates by 1·5%.	Included.	Included	Not included; will be nearly +2.0%.	
3. Nangal Power Canal	Included	Do.	Do.	Not included.	
4. Hirakud	Do.	Do.	Do.	Do.	
5. D.V.C. Maithon	Do.	Do.	Do.	Do.	
6. D.V.C. Panchet Hill	Do.	Do.	Do.	Do.	

on Projects—*contd.*

Labour Amenities	Interest on Capital	Loss of stock	Establishment, Overhead centage charges	Total Inter Project rate	Remarks
22	23	24	25	26	27
Not included; will be over 5%.	Not included; will be about 23%.	Not included.	Not included.		Nearly 2/3rd work done by manual labour and lorries.
Not included; will be about +4.5%.	Not included; will be about 5%.	Do.	Not included; approximated +8% (Actuals).		Entire work done by machines.
Not included.	Not included.	Do.	Not included; 8·5% estimated.		Work done by machinery only studied.
Not included; approximated 5%.	Not included; but will be about 11%.	Do.	Not included.		Entire work done by machinery.
Not included; estimated 6.1%.	Included; 4½ per year on gross working hrs.	Do.	Not included; estimated @ 10%.		Do.
Not included, estimated 5%.	Do.	Do.	Do.		

APPENDIX 3·8

Ratings of Efficiency of Equipment on Projects

Let

P = rate of interest.

C = cost of capital equipment.

D = the total life hours used for depreciation.

H = average annual plant hours used on work.

Y = number of years for which interest is charged or equipment is utilised.

Then

$\frac{C}{D}$ = the hourly rate of depreciation.

$\frac{HC}{D}$ = the annual total of depreciation.

and the outstanding capital cost after Y years equals :

$$= C - \frac{Y(HC)}{(D)} = C - \frac{HYC}{D} \qquad \ldots\ldots (1)$$

The average capital cost during the period Y equals the mean of the original capital cost and the residual value, or :

$$= \frac{C + \left(C - \frac{HYC}{D}\right)}{2} = \frac{C}{2\,D}(2D - HY) \qquad \ldots\ldots (2)$$

The interest on this amount will equal :

$$= \frac{PC}{2\,D}(2D\text{-}HY) \qquad \ldots\ldots (3)$$

The value of work done by the machines may be expressed in terms of the hourly rate of depreciation as work done in Y years equals :

$$= \frac{(HYC)}{(D)} E = \frac{HYCE}{D} \qquad \ldots\ldots (4)$$

Where E equals : $\frac{\text{Value of work done by equipment}}{\text{depreciation of equipment}}$

Then the ratio of interest charges to the value of the work done may be expressed as a ratio I :

$$I = \frac{\frac{PC}{2D}(2D - HY)}{\frac{HYCE}{D}} = \frac{P}{2HYE}(2D\text{-}HY) = \frac{P(2D - HY)}{2HYE} \qquad \ldots\ldots (5)$$

If 'P' is expressed as a percentage, 'I' will also be a percentage. This is the function discussed in the report. If 'P' is assumed as the same rate of interest for all projects, the relative evaluation of the projects can be accomplished by computing the value of 'I' from the actual values of H, Y, E and D obtained on each project.

In the following development, the factor 'P' is eliminated in order to reduce the number of variables (for a true comparative evaluation 'P' should be assumed the same for all projects. If this is done, it ceases to be a variable and can be taken as unity and disregarded). 'I' will be the index for comparison.

Dropping P :

$$I = \frac{2D - HY}{2HYE} \text{ or } \frac{2D}{2HYE} - \frac{HY}{2HYE}$$

$$= \frac{D}{HYE} - \frac{1}{2E} \quad \ldots\ldots (6)$$

The ratio of the life of equipment for depreciation (D) to the portion of life utilised (HQ) is $\frac{D}{HY}$, let $L = \frac{D}{HY}$, substituting L for $\frac{D}{HY}$ in (6)

$$I = \frac{L}{E} - \frac{1}{2E} = \frac{2L-1}{2E} \quad \ldots\ldots (7)$$

The value of 'I' decreases as the equipment is more intensively utilised. In order to make the formula easier to use let 'R' equal the reciprocal of 'I' or

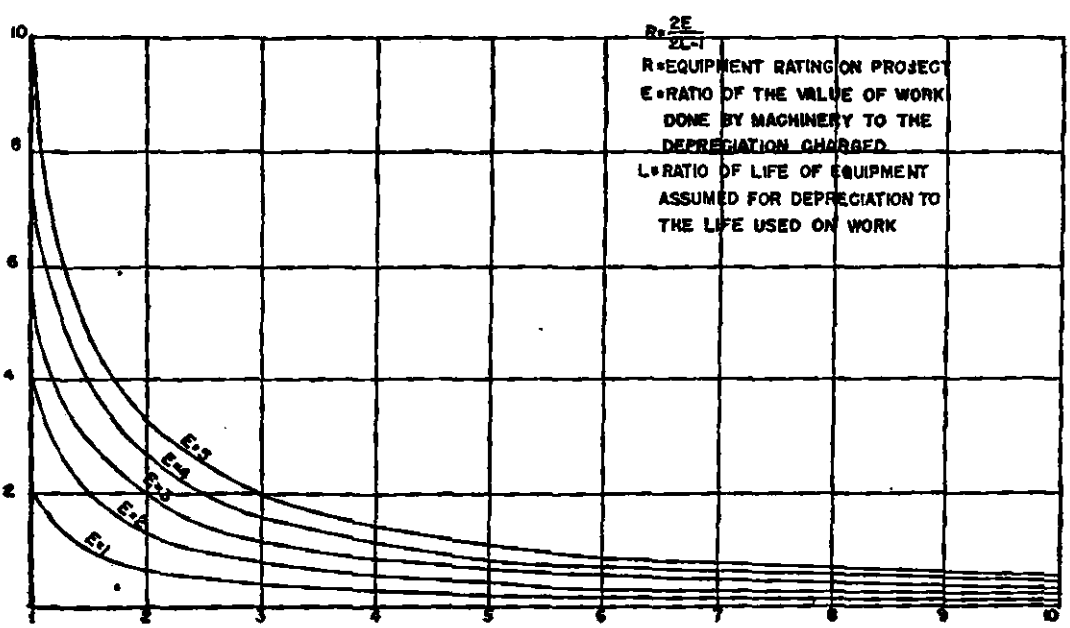
$$R = \frac{1}{I} = \frac{2E}{2L-1} \quad \ldots\ldots$$

Now the values of 'R' will increase as equipment is more intensively utilised.

Values of 'R' for various values of 'E' and 'L' are given in the following graph :—

APPENDIX 8.8

GRAPH SHOWING PROJECT RATINGS



It can be seen from the development of the formula that the ratio of interest on capital invested in equipment to the value of work done is the basic measure for the evaluation of the efficiency of equipment on a project. As stated in the report, this concept used with accurate figures is the most accurate method of evaluation as it will account for investment in equipment at various stages of construction—its reduction by changing off depreciation progressively, and the actual value of the work done.

The formula expresses the idea simply, and if care is taken to use representative values for the variables, a value for 'R' can be arrived at quickly and is a fair index of efficiency.

In the final formula (8) these are only two variables, 'E' and 'L'. 'E' is the ratio of the value of work done to the value of depreciation charged during the period of work. 'E' will improve if more work is done for the amount of depreciation charged. Consider 'E' as an index of operational and maintenance efficiency*. 'R' increases directly as 'E' improves. 'L' is the ratio of equipment life assumed to life used on the project up to the date of evaluation. It is possible to calculate 'L' for any stage in the construction of a project.

Let us consider 'L' at the end of a project. If the project is completed with a high residual value in equipment (a high value of L), too much equipment was purchased. This indicates wasteful plant planning. The value of 'L' reaches unity when a project is completed having utilized the full life of its equipment. The value of 2L—1 becomes 1 and 'R' is expressed by 'E' already defined as the operational and maintenance efficiency. Conversely, if too much equipment was purchased, the value of 'L' will be large and the value of 'R' will fall. This is to show that plant planning is definitely a factor in evaluation.

A project must satisfy two criteria :

(1) Equipment must be intensively utilised (concept of 'E').

(2) Plant planning must be balanced (concept of 'L').

At any intermediate stage, possibly two years after the project work began, only a small part of the life of the equipment will have been utilised so the value of 'L' will be high and that of 'R' low. This shows that enough use is still not being made of the equipment; the more that intensive use is made of the equipment year after year, the better are the ratings. Therefore, 'R' improves from year to year progressively as the equipment is intensively utilised.

The next question is; can the rating of a project be compared to that of another at different stages in the life of the equipment? The reply is negative. For a comparative study, the time base should be the same, *i.e.*, at the end of one year, two years, etc.

The second question is; how does the assumption of various lives for calculating depreciation of equipment affect the rating? The following example will show the reply.

Cost of an excavator=say Rs. 2.0 lakhs.

Work done per year=say Rs. 0.8 lakhs.

Plant hours put in one year=2,000 hrs.

*Note:—In calculating E only the value of work done by machines can be used. Work done by manual labour and other factors not pertinent must be disregarded.

The value of R at the end of one year will be :

$D=5000,\ R=\frac{8}{16}$ (Extremely low life)

$D=10{,}000,\ R=\frac{8}{18}$ (Normal life)

$D=20{,}000,\ R=\frac{8}{19}$ (Extremely high life)

This shows that the value of 'R' is not appreciably affected within the limits of a reasonable assumption for 'D'. Even the slight gain which a project may record at the end of one. two etc., years, will be offset in the final ratings which will be low if a large surplus life is left due to the assumption of a very high value of 'D'.

Another approach for a comparative evaluation of projects is to take 'E' for a definite period—say one year or two years and 2L—1 for the final condition. This will then enable a comparison of project ratings at any stage on similar footing still expressing the elements of the efficiencies of operation and planning. In such cases, care should be taken to assume realistic values of 'L'. If the value of 'L' on completion is taken lower than "actual on completion", the value of the rating will be unrealistic to that extent:

We do not want to claim a universal application of the formula for all conditions, *e.g.*, when 'L' becomes ½, 'R' becomes infinity for a further decrease in the value of 'L', 'R' becomes negative. For such values, the conception of rating breaks down.

Our idea in suggesting the formula is to indicate a line of thought and not to divert the practical engineer to a theoretical mathematical pursuit. The important concept which the formula (8) brings home is that the efficiency of equipment on a project will depend upon: (a) the intensive use of the equipment, and (b) the plant planning. We claim no more importance for the mathematical evolution of the formula than this.

APPENDIX 4·1

Equipment Record

........................Project.

Project Serial No. ....Equipment ....

Manufacturer ....Model, Type etc. ....

Manufacturer's Sl. No....................Other Nos. ....

Purchase Order ....Measurement Book ....

Description ....Cost Billed ....

..............................Transport ....

..............................Erection & Trial ....

Total.

Received from ....

Date of Receipts ....

Engine Make ....Model & Sl. No...............

Aux. Engine Make ....Model & Sl. No...............

APPENDIX 4·1—*contd.*

B. H. P. of Engine ....

Tyre Sizes ....

Aux. Equipment ....Make & Model & Capacity.............

EL System ....

Hyd. System ....

Air System ....

Clutch ....

Transmission ....

PCU ....

APPENDIX

Part I—

Date and Month	Name or No. of Operator	Clock hrs. of work	Effective plant hrs.	Idle hours			Lubricants	
				No work	Field Repairs	Major Repairs	SAE	SAE
1	2	3	4	5	6	7	8	9
	Totals for the Month							

Monthly Abstract	
Account Nos. of work	Plant hrs.
Checked by	
Debit transferred to works	TEO NO.OF

Signature of Accountant

No. 4·2

Operation

Next filter change fuel..............at hrs.
.. lubes............at hrs.
Engine Oil change................at hrs.
Transmission change...............at hrs.
Final drive change................at hrs.

Lubricants		Production				Officer Requisition-ing	Signature of Foreman	Re-marks
SAE	SAE	No. of trips	Account No. of work	Lead	Lift			
10	11	12	13	14	15	16	17	18

APPENDIX 4·2—*contd.*

Instructions for Filling in Log Books

1. Log Books are the primary record of the machine. They should be maintained with the same care as is bestowed on Measurement Books.

2. Two Log Books should be maintained for each machine; one for even months and the other for odd months. When one book is submitted for checking, the other remains on works.

3. The books should remain with the machine or be kept in the field with the operation foreman. It should not be treated as an "office record" for compilation at leisure.

4. Manufacturer's instructions for preventive maintenance should be copied in the appendix to the Log Books carefully.

5. The books should be reviewed every month by the...............for technical scrutiny, and by the Accountant for proper maintenance and transfer of debits.

The following instructions should be noted for filling in various columns:

Column (1) Date . . .	Leave one, two or three lines depending upon the number of shifts the job is working. Use one line for each shift. Have the line broad enough for at least 2 entries sometimes necessary for columns 2, 12-15.
Column (2)	Operator. Give name of operator or his No. Indicate absent where necessary.
Column (3)	Clock hours of work. Give gross hours by watch for which the machine was on duty.
Column (4)	Effective "plant hours". Give meter hours where meters are working. If not, give commensurate effective hours based on the record of similar other machines with meters or else evaluate. See that, taking into account the condition of the engine, the "effective hours" give reasonable fuel consumption for the machine per hour. (50 to 60% of the full load rated B. H. P. consumption.) This can also be approximated from the work done.
Columns (5) to (7) . . .	Idle hours. Indicate clock hours for which machine was idle, under no work, under field or Major Repairs as the case may be. The total of the idle hours plus effective hours will differ, from the clock hours of work to the extent of "ineffective hours". For example, a machine which was in field for 8 hours in a shift, may record 3 effective plant hours, 2 idle for field repairs, one for no work and two hours ineffective.
Columns (8) to (11) . . .	Enter fuels and lubes issued. Indicate brands of lubricants used by suitable prefix, *e.g.*, R 3 for Rotella 3 gallons.

Column (12) . . . . . Give no. of trips made for machines like scrapers, dumpers, etc. For loaders, excavators, etc., give the no. of trips of the carrier units. Define carriers by a prefix, *e.g.*, for a loader an entry C35 would mean Cat. bottom dump 35 trips.

Column (13) . . . . . Account no. Give the accounts no. of the job for which the work is done, *e.g.*, 15.2 may mean excavation for semi-pervious fill, island section. This will also indicate the nature of the material. If this information is not implied, add suitable suffix, *e.g.*, S for Soil, R for Rock etc.

Columns (14) & (15) . . . Give daily leads and lifts. Have separate entries when the machine has worked on more than one material or quarry. Where production is controlled by civil side, figures for columns 12 to 15 will be given by other officer in his daily report.

Column (16) . . . . . This column will be necessary only when the machines work for more than one officer. In most of the cases, column 13 should give indication regarding the controlling officer for whom the machine worked.

Column (17) . . . . . The foreman should make daily entries and sign.

Column (18) . . . . . Utilise for recording reference to any special features, *e.g.*, report of accidents, etc.

At the end of every month total up columns 3 to 12. Give abstract by account Nos. of the trips done. Workout weighted average leads and lifts. (Total of daily trips into daily lead ÷ total trips gives weighted lead.)

APPENDIX 4·2—*concld.*

Part II—Field repairs, Preventive Maintenance and Inspections

Next periodical inspection due on . ...

Repairs and Preventive Maintenance — Materials used.

Date	Brief description of Repairs or maintenance/or Inspection Reports and compliance	Time Taken Hours	Description or Part name	Part No.	Quantity	Cost	Allocation	Date	Indent No.	Remarks

Instructions

Make daily entries of the field repairs carried out and the parts repaired or replaced by the various maintenance teams.

Copies of the Daily Reports of the maintenance teams should be routed through the officer maintaining the Log Books to enter or check the information.

Entries of periodical maintenance should be made in this part giving necessary details.

Inspection Reports should be written in this part whenever the machine is inspected.

Appendix to Log Book

Copy here the manufacturer's instructions regarding periodical maintenance, say every

(*a*) 8 hours

(*b*) 16 "

(*c*) 100 "

(*d*) 500 "

(e) 1,000 "

(*f*) 5,000 " etc.

APPENDIX 4·3

Abstract Log Book

1. Sub-group name.
2. Numbers of machines.
3. Previous Log Book No.
4. Name of officer to whom issued.

Scheduled Running cost per hour from	Amount

Abstract of Operation

MONTH—

S. No.	No. of Machine	Clock hrs. of work	Effective plant hours	Idle Hours			Fuel	Lubricants			Production			Remarks
				No work	Field Repairs	Major Repairs		SAE	SAE	SAE	No. of trips	Lead	Lift	

Totals for the month.

Abstract for Accounts.

Account No. of works	Plant hours
Total.	

Checked by

Debit transferred TEO No. of to works.

Signature of Accountant.

APPENDIX 4·3—*contd.*

Instructions for Filling in

Abstract of Log Books

1. General instructions given under Log Books to be repeated.

2. Maintain an Abstract Log Book for one sub-group of equipment comprising all machines of one make, type and size.

3. Fill in these books every month from the monthly totals given in the Log Books.

4. Submit every month before.........for checking and accounting.

APPENDIX 4·4

History Books

First Sheet

No. of machine.
Short Description.
Previous History Book No.
Name of Organisation.
To whom issued.

PART I (Leave 30 pages)

Manufacturer's bata (I page)

1. No. of Machine.
2. Name of Machine.
3. Capacity.
4. Model and serial No.
5. Make, Model and H.P. of Engine.
6. Serial No. of Engine.
7. Manufacturers of Sub-assemblies
   (a) EI system.
   (b) Transmission and clutch.
   (c) Air Compressor or Hydraulic system.
8. Tyre sizes and recommended pressures.
9. Capacities of :
   (1) Crank Chamber.
   (2) Transmissions.
   (3) Final drive.
   (4) Hydraulic.
   (5) Coolant.
   (6) Other information.
10. Ref. to spare parts catalogue and service book No.

Purchase Data (2 sheets)

1. Reference to Purchase order.
2. Supplied by or received in transfer from.
3. Date of receipt at.
4. Date first put to use.
5. Condition when received.
6. Price paid to supplier.
7. Cost of Transport erection and trial.

Rs. ——————

Total cost Rs. ——————

8. Transferred to

9. Life fixed for Depreciation..............hours.

Hourly Rates of	Depreciation	Major Repairs	Tyres and tubes
From			

History of Alterations (5 Sheets)

Date	Job Card No.	Description, including Nos. of spare parts added	Amount	Remarks
TOTAL FOR THE MONTH				

Major Repairs and Overhauls (22 Sheets)

Date	Job Card No.	Description, including Nos. of parts replaced or reconditioned	Amount	Remarks
TOTAL FOR THE MONTH.				

PART II

Operation (5 Sheets)

Monthly abstract.

Same as in Abstract Log Book

for the machine, *vide* pages 208-209.

APPENDIX

Part III-A—Cost Accounts:

Month	Purchase Price	Alterations		Total Cost Price	Plant Hours Worked	Depreciation		
		Reference	Amount			Rate	Amount	Progressive Depreciation Amount
1	2	3	4	5	6	7	8	9

4·4—contd.

Description and Major Repairs

Residual value	Major Repairs Debits			Major Repair Credits				Balance of Major Repairs Reserve Fund
	Reference	Amount	Progressive Amount	Reference	Rate	Amount	Progressive Amount	
10	11	12	13	14	15	16	17	18

APPENDIX 4·4—contd.

Part III-B—Cost Accounts : Tyres, Tubes, Belts, etc.

Month	Effective Plant Hours	DEBITS				CREDITS				Remarks
		Reference	No. of Tyres, Tubes etc.	Amount	Progressive Amount	Rate	Amount	Progressive Amount	Balance Sinking Fund	
1	2	3	4	5	6	7	8	9	10	11

APPENDIX 4·4—*concld.*

Instructions for Filling in History Books

1. History Books are technical and accounts documents. They should be maintained with the same care as is given to measurement books.

2. Two History Books should be maintained for each machine, one for even months and the other for odd months. When one book is submitted for checking, the other remains on work. Carry forward totals should be taken in the second book after the first comes back checked.

3. The Book should remain with the officer in charge of Major Repairs, or the foreman of the Base Shop as the case may be.

4. Books should be reviewed every month in Parts I & II by the........Engineer and Parts III A and III B by the Accountant.

5. *Part I.* Entries of alterations and Major Repairs should be made from job cards. This must give the relevant details; list all spare parts repaired or replaced. If Major Repairs are carried out in field or by the Field Repairs Team, they must be covered by job cards to bring the information to the History Books.

Part II. Copy the monthly totals from Abstract of Log Book for the machine. Give progressive totals.

Part III A. Alterations should be carried out through job cards only. The cost should be entered monthly.

Depreciation should be charged at rates worked out in Part I and levied uniformly for plant hours used. Column No. 10 [=(2)+(5)−(9)] will give the residual value of the capital cost of the machine at any time.

The cost of Major Repairs and Overhauls should be abstracted from Part I, and entered in columns 11 and 12. Column 14 will indicate the reference to the Transfer entry order raising debits to works and credits to Major Repairs for the plant hours worked. Adopt hourly debits at uniform rates mentioned in Part I purchase data. Column 18 will indicate the position of the reserve fund with reference to the machine.

Part III B. include only the cost of replacements. Repair charges should be debited to running cost.

When a partially utilised tyre is re-used on another machine, give credit to the machine from which it is taken off and debit to the machine where it is utilised. Pass the transaction through job card to keep good accounts. Column (10) will give the position of the reserve fund for the machine for tyres and tubes.

Maintain accounts in the same way for loader Belt, replacing the word "Belt" for "tyres and tubes".

APPENDIX 4·5

Project Name

Cost per Tyre Mile/Hour Record

Size	Make	Original Cost........................
Serial No.	Type	Cost of Repairs New Treads............
Brand No.	Plies	
Purchased 19	From	Net Cost............................
City or Branch	Total Mileage or Hours	Cost per Mile or Hour................

Vehicle Number	Wheel Position	Applied		Removed		Mileage or Hours	Reason Removed, Nature of Repairs	Cost of Repairs Rs. As. Ps.
		Date	Meter Reading or Hours	Date	Meter Reading or Hours			

APPENDIX 4·6

Forms for Machinery Record

The various forms required for technical control and accounts are compiled in this Appendix. They should be printed in suitably bound books. Where more than one copy is required, it is a good plan to have a distinguishing colour specified for each.

The following forms are given in this Appendix:

4·6·1 Daily Operation Report.

4.6.2. Eight Hours Maintenance Report.

4·6·3 Daily Field Repair Report.

4·6·4 Daily Servicing Report.

4·6·5 Accident/Breakdown Report.

4·6·6 Shift Charge Report.

4·6·7 Weekly Plant Details and Progress Report.

4·6·8 Monthly Report of Materials used on Machines.

4·6·9 Advice of Transfer Debit between charges.

APPENDIX 4·6·1

Operation reports

DATE ______________ 1957.

SHIFT ______________

MACHINE No. ___________ HOURS ______________

Machine No.	Nature of Work	Account Classification	Lead & Lift	Period	Working Time	Meter Reading		Plant Hours	Operators	No. of Trips	Remarks
						Open	Close				

Foreman Incharge

Copy forwarded to :

NOTE : Forward daily

One copy to Operation Control (Civil Side).

One copy for Log Book Record.

One copy to Mechanical Engineer-in-Charge.

One Copy STUB.

Each Copy should have a distinguishing colour.

APPENDIX 4·6·2

Eight Hours Maintenance Chart

Excavator

Machine No. ________________ Date ________________

Work to be done	Shift 1	Shift 2	Shift 3
Engine			
(1) Check Oil level			
(2) Check Radiator level . . .			
(3) Check Fuel Oil level . . .			
(4) Check Water Pump grease cup (1 turn).			
(5) Check Water temperature . . .			
(6) Check Oil temperature . . .			
(7) Check Oil Pressure			
(8) Check Air Cleaner and Breather caps .			
(9) Inspect for Fuel Oil and Water leaks			
(10) Idle Engine before starting (10 minutes)			
Excavator			
(11) Lube all 8 hour grease points with wheel bearing grease			
(12) Lube open gears and sprockets with open gear compound			
(13) Etc.			
(14) Check Controls, clutches, brakes . .			
(15) Check dipper teeth			
(16) Inspect loose nuts and bolts . .			
(17) Inspect Oil leaks in Hyd. system Etc.			
Operator			
Mechanic			
Supervisor			

APPENDIX 4·6·3

Daily Field Repairs

SECTION	SHIFT	DATE

MACHINE NO.	REPAIRS CARRIED OUT & PARTS USED	REMARKS

Incharge of Section.

Plant Engineer.

APPENDIX 4·6·4

Daily Servicing Report

Date ____________

Shift ____________

Remarks

(1) Tournapulls with Scrapers

M/C: H.S.D. No.	Lubricants 30	40	90	140
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
19				
20				
21				
22				
23				
TOTAL				

(2) Tourna Trailors & Excavators

M/C: H.S.D. No.	Lubricants 30	40	90	140
13				
14				
15				
16				
17				
18				
65				
66				
67				
68				
69				
70				
59				
TOTAL				

(3) Tractors and other machines

M/C: H.S.D. No.	Lubricants 30	40	90	140
24				
25				
26				
27				
28				
45				
46				
47				
48				
49				
50				
51				
52				
53				
54				
55				
56				
57				
58				
60				
61				
63				
64				
71				
72				
73				
74				
TOTAL				

I/C of Section. ENGINEER.

16—1 C. W. & P. C. 57

APPENDIX 4·6·5

Accident/Breakdown Report

(For Mech. Equipment other than Motor Vehicles)

N. B.—No requisition for repair of accident cases can be received unless this form is lodged duly filled in.

A	B	C
OPERATOR	OWNING DEPARTMENT	Equipment particulars Make : Sl. No. Model : Regd. No.
D OPERATING CONDITIONS Attachments installed at time of accident. Type Make Sl. No.	**E** Precise time of accident/ breakdown. Name of Supervisor present at breakdown :	**F** Location of Machine : Job on which machine was working :

G	H
DESCRIPTION OF OCCURRENCE (Here state as fully as possible the condition under which machine was operating—speed, load, lubricant, pressure, etc.)	Apparent damage to the machine (Greatest details possible)

		I	J
Was injury sustained by Operator. If operator was injured give details here.	Yes/No		If persons other than operator were injured, give names and addresses and details of injuries.

K	L
Sig. of Operator. Sig. of Supervisor.	

Disposal of this from :

2 copies to Workshop Superintendent.
1 copy to the Construction Plant Engineer.
1 copy to owning deptt.

APPENDIX 4·6·6

Shift Charge Report

PLANT HOURS OF EACH MACHINE = PLANT ENGINEER

Date :—

M/C No.	A. SCRAPERS				Total	M/C No.	C. TRACTORS				Total	Remarks
	First Shift		Second Shift				First Shift		Second Shift			
	Plant hour	Condition	Plant hour	Condition			Plant hour	Condition	Plant hour	Condition		
1						24						
2						25						
3						26						
4						26						
4						27						
5						28						
6						47						
7						48						
8						49						
9						50						
10						51						
11						52						
12						53						
13						54						
14						54						
15						55						
						56						
						57						
						58						
						59						
						60						
						61						
						62						
						70						
						71						
Total						72						
						73						
						Total						
						26						
						27						

APPENDIX 4·6·6—*contd.*

Shift Charge Report

B. TRAILORS & EXCAVATORS

M/C No.	First Shift		Second Shift		Total
	Plant hour	Condition	Plant hour	Condition	
13					
14					
15					
16					
17					
18					
65					
66					
67					
68					
69					
70					
59					
Total					

D. ATTACHMENTS

M/C No.	First Shift		Second Shift		Total
	Plant hour	Condition	Plant hour	Condition	
Rollers					
Rollers					
Graders					

First Shift I/C
Time Keeper

Second Shift I/C
Time Keeper

Foreman.

APPENDIX 4·6·7 ORIGINAL

MECHANISED EARTH MOVING CIRCLE S. C. D.

Camp LEFT BANK MAIN CANAL

Weekly Plant Details & Progress Report.

Week Ending 25-4-1953

Srl. No.	Description of Machines Attachments & Equipment	Nos of Equipment	Details of Works & Hours Worked 1A	2A	3A	4A	5A	6A	7A	8A	9A	10A	Total	Total Working Hours (working hrs & Estimated Hours) 72
1	LA PLANT CHOATE-SCRAPER-T.S.300	237	62½									½	63	
2	"	543	59½									¾	60¼	
3	"	585	50¼									½	50¾	
4	D. ROADSTER-TOURNA PULL-SCRAPER	7231	41½										41½	
5	"	7223												
6	"	7238	52										52	
7	"	7220	57¼										57¼	
8	ALLIS CHALMER-HD-19 DOZER	2480	39½										39½	
9	ALLIS CHALMER-HD-19 PUSHER	2475	69½									¾	70¼	
10	INTERNATIONAL HARVESTER TD-18A.DOZER	28652												
11	"	28654		62¼								1¼	63½	
12	CATERPILLAR-D7-3T + No.70 SCRAPER	12432	60									1	61	
13	AUSTIN WESTERN-99H MOTOR GRADER	3206			6¼								6¼	
14	TOURNACRANE	7221				2				2			4	
15	WATER TANKER	2833					10						10	
16	GENERATOR	44382						24½	22½				47	
17	"	99182							1				1	
18	WD-9 WHEEL TRACTOR	51163									13		13	
19														
20														
	Total		492	62¼	6¼	2	10	24½	23½	2	13	4¾	640¼	

Weekly Progress Report

Name of Area, Block or Mouza	Classification	Previous Total Acres	Previous Total Cu. Yds.	Current Total Acres	Current Total Cu. Yds.	Total to Date Acres	Total to Date Cu. Yds
LEFT BANK MAIN CANAL- 567 & 584 ch. and 525 & 530 ch.	EXCAVATION		304,480		29,076		333,556
Total			304,480		29,076		333,556

Remarks: Sd- Civil Engineer

Description of Works

1A CANAL EXCAVATION
2A. LEVELLING SPOIL BANKS
3A DRESSING SIDE SLOPES OF CANAL
4A LOADING MACHINERY PARTS
5A TRANSPORTING WATER
6A FIELD LIGHTING
7A MAINTENANCE YARD LIGHTING
8A UNLOADING MACHINERY PARTS
9A TRANSPORTING
10A JOURNEY

Officer SIGNATURE

Camp & Date PANAGAR-26-4-53

REMARKS

Copy to Director of Soil Conservation

Facing page 230.

APPENDIX 4·6·8

Acquittance of Materials Received

MONTHLY MATERIAL LIST — M. R. No.————

MONTH———— SECTION AND SHIFT———— DATE————

Date of Indent	Indent	Description	Part No.	Quantity	Rate	Cost	Name of work	Quantity used	Machine No.	Balance	Remarks

Incharge———— Plant Engineer————

APPENDIX 4·6·9

Advice of Transfer Debit Between Sub-Divisions

No. 2371

Dated the 19

To

The Plant Engineer, Gangapur Storage Division, Gangawadi.

The undersigned has to advise that a sum of Rs. 123/12/- as detailed below has been debited in transfer to his sub-division against the work shown below and to request that acceptance may please be furnished to this office under intimation to the Divisional Office, Suspense Clearance Account for M & R to Fordson Tractors with trailors for the month of May '53 (21-4-53 to 20-5-53).

M. R. No. and date	Particulars of the work carried out	Head of account	Quantity Gallons.	Amount
May 1953	S 1.34 Major Replacement to tractors.	68 Const.	9	49-8-0
	S 2.54 Sundries . . .		4	22-0-0
	S 3.2 M & R Workshop for 1953-54.		4	22-0-0
	S 3.3 Do.		5½	30-4-0
		TOTAL	22½	123-12-0

(Sd.)

Sub-Divisional Officer,

————Sub-Division.

Acceptance of Transfer Debit Between Sub-Divisions

No. Dated————

The undersigned has to inform————that his advice of transfer debit No.————dated————against the work————has been accepted fully/ in part or rejected for Rs.————and incorporated in the work abstract for the month of————.

Sub-Divisional Officer,

————Sub-Division.

APPENDIX 4·7

Workshops Instruction

Engine Shop

(1) The assemblies labelled, will be given to the stripping bay to be dismantled and washed. The assembly will be checked and new spares ordered on the job card.

(2) Progress Foreman will issue job cards for each engine assembly.

(3) A full record will be maintained on the job card of all spares used or details of repair, inspection and final test. The job card will then be returned to Progress Department for reference in case of any defects arising after delivery of engine to outside sources.

(4) Spares required should be entered on job card as early as possible to enable stores to take action, especially when spares are not held in stock.

(5) All spares totally unserviceable and not repairable will be placed in salvage so that no doubt arises at a later date whether the parts are in fact serviceable or not.

(6) Every effort will be made to reclaim such parts and the Foreman i/c must pay particular attention to this matter. Constant check will be made to ensure that the strictest economy is being made.

(7) On commencement of assembling of the engines the Foreman i/c will draw the required stores and they will be placed in appropriate cabins in the section where the work is being carried out.

(8) It is the duty of the Foreman i/c to inspect the work on completion at each stage the engine will pass through, and all parts fitted during these stages must be examined by the Foreman i/c.

(9) In the case of cylinder blocks and crankshafts before passing to the machine shop on a job card supplied by Progress Section, each item will be labelled with the sizes required to be machined for any difficulties arising in conforming with these measurements, the matter will be referred by the machine shop Foreman to the Foreman i/c, engine and sub-assembly shop. On no account will machine shop work to other sizes than those stated on the job card be done without the sanction of the Foreman i/c, engine and sub-assembly shop.

(10) Closest co-operation of the Foreman i/c, machine shop and Foreman i/c, engine and sub-assembly shop must be maintained, avoiding any misunderstanding and difference of measurements.

(11) All work returned from machine shop must be carefully checked by the Foreman before issue to the engine and sub-assembly shop.

(12) On completion of engine assemblies a 100% "running in" test will be made. The oil pressure at commencement and end of test, number of hours run and general performance will be entered on the job card.

(13) In the case of work being requested by the engine and sub-assembly shop to be carried out by other ancillary trades such as electrical, etc., application will be made to Progress Department for a job card authorising the work. The item will then be sent direct to the ancillary shop concerned.

(14) A return will be submitted to Progress Department on the weekly output of assemblies every Saturday morning together with completed job cards.

(15) Priorities will only be given by Progress Foreman.

(16) A job book will be kept showing date in, work done and date out of all assemblies.

(17) Equipment and holdings in the engine shop will be checked monthly by the Foreman incharge.

(18) The Foreman will be responsible for any equipment and tools in the workshop; any losses or breakages will be reported to the Workshop Engineer.

(19) All material drawn from expense store will be drawn on Foreman's signature.

(20) *Under no circumstances will any material be issued unless the job card has been received.

(21) All tools in sub-stores will only be issued against a signature. These will be returned each night, a full check will be made and tools charged against individual concerned if not returned after three days. All losses will be reported to Workshop Engineer.

(22) Fire precautions will be taken and Fire Points kept in order and ready for use.

(23) All labour queries such as pay, number of hours, etc., will be dealt with by Chief Clerk.

(24) Overtime will be kept to a minimum and sanctioned only by the workshop engineer.

(25) Waste material will be placed in bins and disposal arranged by stores. Every effort to avoid waste of material must be made.

(26) All tools and equipment must be kept well maintained and at the end of each day left spotlessly clean. The Foreman i/c will be responsible for the cleanliness, tidiness and orderliness of the shop and an exceptionally high standard is expected in this respect.

(27) All letters to outside units will originate from the workshop engineers' departments who are only permitted to undertake inter-departmental communications.

(28) It is the Foreman's responsibility to implement these instructions to avoid possible breakdown of production.

*No work shall be undertaken unless a Requisition (*vide* form attached) is placed on the workshop by a duly authorised officer.

ACCP. TO APPENDIX 4·7

Requisition on Workshop

From
Reqrd. on

Description of Job	Name of work & Sub-Head	Debits Raised

STUB OF INDENTOR

SIGNATURE————

DESIGNATION————

Requisition on Workshop

From
Reqrd. on

Description of Job	Name of work & Sub-Head	Debits Raised

RETURN TO INDENTOR WITH COMPLETED JOB

SIGNATURE————

DESIGNATION————

Requisition on Workshop

From
Reqrd. on

Description of Job	Name of work & Sub-Head	Debits Raised

WORKSHOP RECORD

SIGNATURE————

DESIGNATION————

Workshop Instructions

Stores

(1) All job cards for drawing on stores will be issued by Progress Department and given a control number.

(2) Departments will make out spares required on the Job Card and Stores will mark availability.

(3) Job cards with spares outstanding in any large amount will be brought to the notice of the Progress Foreman.

(4) The price of each stores item demanded will be entered on the job card.

(5) No spares will be issued unless a job card or in the case of minor assembly work, an inter-departmental chit* is presented to the Stores. The inter-departmental chits to bear the signature of the Foreman or Chargehand in-charge.

(6) Items drawn from main Stores by Departmental Stores in bulk will be issued out to jobs only on the presentation of a chit signed by the Foreman or Chargehand in-charge.

(7) Tools drawn from Tools Stores, on signature, will be returned each day. Checks will be made every three days and the Workshop Engineer notified of non-compliance of this instruction.

(8) Tools that cannot be returned will be debited to the individual on whose signature they have been drawn.

(9) Any spares which are required to be manufactured in workshops will be demanded through Progress Office. who will check with stores against availability and quantity required.

(10) When the Department concerned has manufactured the item they will be brought on charge by Stores and issued out against normal demands.

(11) Any enquiries regarding stores will be made through Progress Office.

(12) Any demands placed on Stores will give complete information concerning the item, *i.e.*, section part number, designation and quantity.

(13) Upon completion, the job card will be returned to Progress Department with all spares used marked clearly.

(14) Entry to Stores is forbidden to all personnel except the Stores staff. Permission to enter Stores may only be given by the Chief Storekeeper.

(15) Fire precautions will be taken and Fire Points kept in order and available for use.

(16) All Labour queries will be dealt by the Chief Clerk or Workshop Engineer.

---

*Requisition for materials, *see* Appendix, 4·12.

APPENDIX 4·8

Equipment Inspection Report

(Other than Motor Vehicles)

Item............Project............Date..................

Make............Model............Serial No............

Total	Capacity	Licence
(Miles or hrs.)	(Tons, yds., etc.)	(or Project Sl. No.)

No.	Item	*Code	No.	Item	*Code
1.	Operating test.		34.	Rollers (Lower).	
2.	Engine (General).		35.	Rollers (Carrier).	
3.	Compression test (Record).		36.	Tracks.	
4.	Vacuum test (Record).		37.	Track-frame.	
5.	Radiator and Hose.		38.	Stabilizer Assembly.	
6.	Water pump (Motor).		39.	Equalizer Spring.	
7.	Fan Belt.		40.	Frame.	
8.	Carburettor or Injectors.		41.	Steering Gear and Connections.	
9.	Ignition.		42.	Springs, Shackles and Bushings.	
10.	Injection Pumps.		43.	Front axle, Spindle Bolts and Bushing.	
11.	Fuel Pumps.		44.	Wheel Alignment.	
12.	Fuel Filter.		45.	Brakes (Service and Hand).	
13.	Air Cleaner.		46.	Wheel Bearings.	
14.	Oil Filter.		47.	Tires.	
15.	Oil Pressure (Record).		48.	Fenders.	
16.	Oil Cooler.		49.	Battery and Cables (Record test).	
17.	Crankcase Breather.		50.	Fuel tank and Lines.	
18.	Governor.		51.	Body, Cab or House.	
19.	Starter (Electric).		52.	Instrument Panel Gauges, etc.	
20.	Generator.		53.	Power control unit.	
21.	Wiring.		54.	Hydraulic Pump.	
22.	Blower or Supercharger.		55.	Hydraulic Controls.	
23.	Starting Motor (Gas or Air).		56.	Hydraulic Hose.	
24.	Muffler and Exhaust Pipe.		57.	Mechanical Controls.	
25.	Master Clutch.		58.	Mold board.	
26.	Transmission.		59.	Cutting Edges.	
27.	Transfer Case.		60.	End Bits.	
28.	Universal Joints.		61.	Cables.	
29.	Differential or Bevelgear.		62.	Sheaves.	
30.	Steering Clutches.		63.	Tandem Drives.	
31.	Final Drives.		64.	Drive Chains.	
32.	Sprockets.		65.	Circle and A Frame.	
33.	Idler.		66.	Scarifier.	

*Good ()

No.	Item	*Code	No.	Item	*Code
67.	House Rollers.		84.	Crusher Jaws and Plates.	
68.	Centre Pin Bushing.		85.	Eccentric Shaft and Bearings.	
69.	Swing Gear and Bushing.		86.	Compressor (General).	
70.	Swing clutches.		87.	Compressor Valves.	
71.	Vertical Swing shaft.		88.	Unloading valves and Controls.	
72.	Drum Shaft and Bearings.		89.	Water Pump ; Impeller Packing, etc.	
73.	Hoist Drum Bushings.		90.	Light Plant ; Armature Brushes, etc.	
74.	Hoist Clutch Linning.		91.	Welder Armature, Brushes and Bearings.	
75.	Hoist Drum Brake Bands.		92.	Boats or Barges, Hull, etc.	
76.	Open Gears.		93.	Winch.	
77.	Vacuum and Hydraulic Controls.		94.	Pull Tongue and Hitch.	
78.	Fairleads.		95.	Lubrication (General).	
79.	Boom.		96.		
80.	Dipper Stick.		97.		
81.	Buckets.		98.		
82.	Elevator Belt or Chain.		99.		
83.	Screen and Shaker Bearings.		100.	Condition of entire unit.	

*Good ()

Compression Test : 1 2 3 4 5 6 7 8

Battery Test Volts.

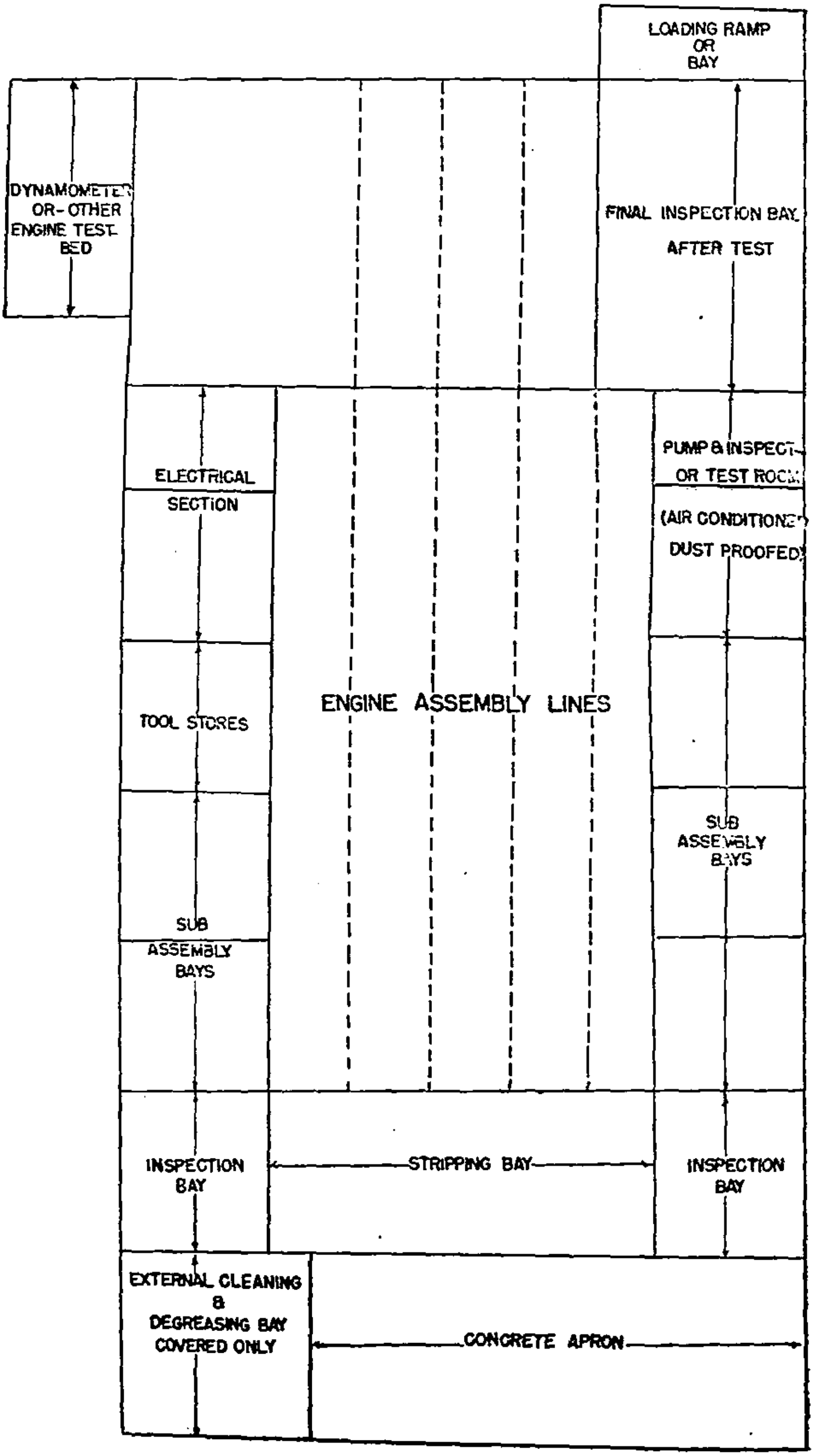
Gravity.

REMARKS

Inspector. Approved.

Adjustment or Mechanical Attention Needed (M). New Parts Needed (N).

ENGINESHOP & LAYOUT



Facing page 239.

APPENDIX 4·9

Breakdown and layout of Sections in an Engine Shop

1. External cleaning	Stripping	Cleaning	Inspection.
2. Starters	Dynamos	Magneto's	
3. Compressors	Blowers		
4. Clutch	Water Pump		
5. Starting Engine	Lub. Oil Pump		
6. Fuel Pump	Injectors		
7. Cylinder Heads			
8. Caterpillar			
9. Cummins			
10. Buda			
11. G. M., etc.			
12. Test Benches			

13. Separate gang for installation, removal of Engines from Equipments who will also do all field work which requires engine fitters from shops.

APPENDIX 4·10

Engine Inspection Sheet

Engine Type Engine No.

Taken from Fitted To

No.	Component	Inspection Data	Charge hand/ Inspector
1	Cylinder Liner and packing ring .	Check that liner is correct for engine, *i.e.*, Cast iron, etc., oversize or standard, clearance from top of liner to block.	
*2	Crankshaft and Main Bearings .	*(a) Check main bearings in crankcase. (b) Check crankshaft for freedom, end play and main bearing nuts to torque wrench. (c) Check main bearing nuts for locking.	
3	Pistons and con. rods . .	(a) Check pistons and con. rods assembled on bench for:—Gudgeon pin, freedom circlips fitted O. K. correct piston for engines, rings for liners, rings fitted and spaced correctly. (b) Check pistons and con. rods fitted to crankshaft :—freedom of con. rod on crankshaft, and play of con. rods, tightness of nuts to torque wrench.	
4	Oil Seal	Check that oil seal is new one and fitted correctly.	
5	Timing Gears and Housing .	(a) Timing gear housing :—Check Seals are fitted, tightness of nuts. (b) Check back lash of timing gears, idler geared shaft, timing.	
6	Lub. Oil Pump and Sump . .	(a) Lub. oil pump freedom of gears, locking of nuts. (b) Sump, check screen and section housing. (c) Tightness of nuts.	
7	Camshaft and Bushes . .	(a) Camshaft and bushes, backlash of gears, timing, locking.	
8	Cam follower	(a) Cam follower Timing roller, etc.	

No.	Component	Inspection Data	Charge hand/ Inspector
9	Cylinder Head and Valve Assy	(a) Cylinder head gasket to be correct one for engine. (b) Tightness of nuts with torque wrench.	
10	Push rod and Rocker Arm Assy	(a) Push rods, check that inlet, exhaust and injector rods are correctly fitted.	
11	Flywheel and housing	Check flywheel housing alignment, dewel wear, locking of flywheel.	
12	Exhaust, inlet and water manifolds.	Manifolds check for correct gaskets, tightness of nuts.	
13	Fuel Injector	Check Injector tightness with torque wrench.	
14	Fuel Pump and Assy connections	Check fuel pump timing, tightness of nuts, washer of connecting pipes.	
15	Waterpump Fan and Drive	Waterpump gasket fitted, locking of fan and drive, tension of belt.	
16	Blower	(a) Blower : No foreign matters inside. (b) Check gasket drive and connection.	
17	Filter and Connections	Filter, check correct one for engine. Inlet and outlet fitted correctly.	
18	Self Starter	Self starter, Backlash of gears, Tightness of nuts.	
19	Dynamo	Dynamo, Dust Cover fitting Drive and Chain.	
20	Starting Engine	Starting Engine, checking of dogs and pinion, clutch clearance.	
21	Magneto	Magneto timing, leads, etc.	
22	Carburettor	Carburettor gaskets etc.	
23	Compressor	Compressor, belt correct tension and alignment, clearance of loading and unloading valves.	
24	Clutch Assembly	Main engine clutch correct disc, pilot bearing, clearance and adjustment, tightness of nuts.	
25	Final Inspection	General exterior check, tightness of nuts and final adjustments, tappet clearances etc.	

APPENDIX 4·11

Note on Job Cards

1. Job Cards

These are of two types, i.e. the Sectional Job Card and the Master Job Card. The Sectional Job Card is for use in those workshop sections where debit is incurred on a job. The Master Job Card is for recording the labour and material abstract from the Sectional Job Cards. Job Cards are issued by the Progress Section of the workshops. The Sectional Job Cards and Master Job Cards for the same job will bear the same number to facilitate grouping.

2. Stores Requisition

Material for use on a job are obtained through stores requisitions—sample form is furnished in Appendix 4·12. They are made out by the Progress section from the estimates received from the workshop sections and are sent to the stores for compliance. Thus requisitions are made out in quadruplicate; one is recorded in Progress Section and the remaining three are transmitted to the stores. After posting issues and costs, one is retained by the stores, the second accompanies the stores issued, and the third is routed through the Progress Section to the Cost Account Section. The requisitions for each sectional job card should be made separately, to correspond with the separate sections of the stores. Items of stores, which have to be procured in bulk by sections and retailed on jobs, such as oils, electrodes, gas, etc., will be issued by internal stores attached to sections and such issues with cost will be recorded on the job cards for inclusion in costing the job.

3. Estimate Form

The workshop sections make out the list of material and parts required for a job on the estimate form.

Routing of Work in Workshop—The routing of work in the workshop is as follows:—

The requisition for repair of equipment (*vide* sample form given in Appendix 4.7), accompanied with its history book and report of its condition from the Plant Engineer is sent to the Progress Section, who issues sectional job cards to the (EAT) Dismantling and Assembly and (ID) Inspection Department and, if necessary, to the (R & I) Recepit & Issue Section for the preliminary items of work. After inspection of the dismantled parts and assemblies, the ID Section will specify the items of repairs to be carried out on Inspection Reports and send the parts to the concerned sections for estimating. The concerned Section Chargehand lists the parts and material required for the work and makes out an estimate of labour required in terms of man-hour at standard rate of wages in the different wage categories. Such standard rates of wages are fixed for the different trades for purposes of estimating. The estimates are routed to the Progress Section through ID. The Progress Section after consolidation of the sectional estimates, take a decision

APPENDIX 4.11

SECTION JOB CARD

DATE-

SECN- NO-

EQUIPMENT- TYPE- NO -

LIFE- WHOLE. RESIDUAL.

COST- ESTD:- ACTUAL-

DESCRIPTION OF REPAIRS PRIORITY -

DATE: COSTS I-SECN. OFFICER

NATL. DESCRN	FROM SECN. QTY	RS	AS	LABOUR RATES	DATES 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	TOTAL	TOTAL RS	AS
						ENTRIES IN MAN HOURS																										
TOTAL																														TOTAL		

STORE REQNS

REQ-NO	DATE	REQ.NO	DATE	REQN.NO	DATE	REQN.	DATE	REQN.	DATE	REQN.	DATE	REQN.	DATE	REQN.	DATE

SEC. CHARGE HAND: I-SEC.OFFICER

TECHNICAL INFORMATION ON REVERSE

Facing page 242.

APPENDIX 4.11

MASTER JOB CARD

DATE - NO-

EQUIPMENT- TYPE- NO.-

LIFE- WHOLE- RESIDUAL-

COST- ESTD- ACTUAL-

DESCRIPTION OF REPAIRS.

DATE I. SECN. OFFICER

COSTS

SECN	LABOUR		SECN. MATERIAL			STORE. REQN NO			STORE.REQN.			STORE REQN.			STORE REQ			STORE REQN		
RGI	RS	AS		RS	AS		RS	AS		RS	AS		RS	AS	NO.	RS	AS	NO.	RS	A
EAT																				
MP																				
EL																				
BWS																				
FS																				
PS																				
CUS																				
ES																				
TO																				
U:%																		TOTAL		
TOTAL			TOTAL			TOTAL									TOTAL			TOTAL REQ.		

TOTAL SHOP

W.H.%

T.D.A.

ACT.HEAD

DATE.

P.SECN.OFFICER

ACOUNTS-OFFICER

TECHNICAL INFROMATION ON REVERSE

Facing page 242.

STORE REQUISITION

DATE

EQUIPMENT- TYPE-
NO-

REQN NO.-
STORE SECN.-
COST

WORKS SECN.-
JOB NO.-
PRIORITY -

REQUISITION		SUPPLIED		COST		REMARKS
QTY.	DESCRIPT.	QTY.	DESCRIPN.	RS	AS.	
TOTAL						

P.DEPT	STORE STOCK	STORE COST	CHARGE HAND

Facing page 242.

on repairs to equipment and issues sectional job cards to concerned section through the ID. At the same time, requisitions for supply of stores are made out by the Progress Section and transmitted to the stores for action.

The Section Chargehands after completing the work and after the work is passed by the ID send the part or assembly to the EAT Section and complete posting of the job card. Then it is returned to the Progress Section through ID Section, who fills in the technical information that has to be recorded in the History Book. The Progress Section abstracts the labour recorded in the sectional job cards on to the Master job card and also records the requisitions as compiled by the stores and transmits the Master job card to the cost account section for raising debit. The Progress Section records the technical information abstracted from the sectional job cards in the History Book of the equipment.

Workshop Accounts—The operation account for the workshop is a suspense account to which is debited the operating cost of the workshop and the cost of stores supplied against workshop requisitions. It is cleared by transfer of debit to the debit heads of accounts concerned. The operating cost of the workshop is made up of the direct charges incurred by the workshop sections and the indirect charges incurred under WM Workshop Ownership charges and charges due to ancillary services, such as power and water supplies, etc., and

N. P.—Indirect or unproductive labour charges, covering supervision ; clerical work, security etc:

The debits due to those indirect charges are relieved by distributing them to jobs, on the basis of a percentage on labour for N.P.—Charges and a percentage on the total actual cost for WM charges.

17—1 C. W. & P. C./57

APPENDIX 4·13

Numerical Classification

Typical examples of account numbering systems

I. Classifying Capital Equipment

10.0.0	Crawler tractors.
10.1	D/8 Tractors.
10.1.15	Fifteenth number in the sub-group.
10.2	D/7 Tractors.
10.2.09	Ninth number in the sub-group, 10.2
11.0.0	Rubber tyred tractors. (Sub-classification similar to the above.)
20.0.0	Scrapers
20.1	9/11 cu. yds. 'x' make.
20.2	12/15 cu. yds. 'y' make.
20.2.17	Seventeenth number in the sub-group, 20·2.

II. Machinery Accounts Classification

Prefix D to denote "distributive account".

Prefix ± to denote "debits or credits".

D+1.00 Purchase account of capital equipment.

D−1.00 Deduct depreciation of capital equipment.

D+2.00 Major repairs ; expenditure.

D+2.00

D−2·00 Major repairs ; deduct receipts.

These can further be sub-divided to the sub-heads recommended in the report as under :

D+2.11 Major Repairs spare parts.

D+2.12 Major Repairs labour and overheads.

D+2.2 Renewals of tyres and tubes.

The expenditure on a particular sub-group of equipment can be expressed as under :

10.2/D+2.11 debits Major repairs, spare parts D/7 sub-group.

Expenditure on any particular machine can be indicated as under :

10.2.09/D+2.11 to mean major repairs to the No. 9 D/7 tractor ; spare parts.

This is how the job cards in the base shop will specify their account Numbers.

Accounts classification for running expenses of machinery can be expressed as under

D+3.00 Running cost of earth-moving machinery.

D+3.10 Fuels and Lubes.

D+3.20 Operators and mates.

D+3.30 Maintenance crew.

D+3.40 Other stores.

D+3.50 Overheads.

This can be connected to the sub-group of machinery as under :
10.2/D+3.10 Fuels and lubes for D/7 sub-group.

III. Works Accounts

Each item of work can be given a suitable No. designed by a prefix to indicate location or a particular section of work, *e.g.*, A for 'A' Section of dam.

A 100.00	Pervious fill A Section.
B 200.00	Pervious fill B Section.

These can be sub-divided to the number of individual controls required, *e.g.*,

B 200.00	Pervious fill.
B 200.10	Excavators.
B 200.20	Transport-vehicles.
B 200.30	Levelling, watering and rolling.
B 200.31	Levelling.
B 200.32	Watering.
B 200.33	Rolling.
Etc.	

A D/7 working on levelling the fill in B Section will indicate in his daily report "5 plant hrs. for B 200.31".

General

A complete system covering all phases of works and activities should be worked out for the entire project and as soon as a working estimate is sanctioned. Numbers once given should not be changed. For this the first design of numbering should be susceptible of expansion in any sphere. A large number of books showing all these classifications should be published by the project and be given to every member of the staff who have occasions to classify a service or supply. Revised editions should be issued to maintain them up-to-date.

APPENDIX 4·14

Store Classification

Head	Allotted number to each ledger in section		Location	Remarks
	Ledger No.	Bin Nos.		
1	2	3	4	5
Fuel & Lubricants				
H.S.D. Powerine etc.	6.1 A	1—100	Oil Section	NOTE : Items are arranged by assembly with part No. and vocab. index to each Ledger. Each Bin No. indicates a definite item, *e.g.*, 7.11/14 cylinders head part No. xyz for Tournapull. Column 4 also gives location of rack box, pigeon-hole, etc.
Petrol	6.1 B	1—100	Do.	
Other Fuel	6.2	1—100	Yard Section	
Other Lubs	6.3	1—100	Petrol Section	
Greases	6.4	1—100	Do.	
Spares				
For Tournapull	7.11	1—15	Spares section	
For Tournapull	7.12	16—34	Do.	
For Tournapull	7.13	35—54	Do.	
For Tournapull	7.14	55—60	Do.	
For Tournapull	7.15	1—33	Do.	
For Tournapull	7.16	34—42	Do.	
For Tournapull	7.17	1—20	Do.	
For Tourna-Trailer	7.18	1—12	Do.	
For Euc. Dumper	7.19	1—100	Do.	
For Euc. Dumper	7.20	1—100	Do.	
For Cummins Engines	7.20	1—100	Do.	
Euc. Loader	7.20	1—100	Do.	
Ford Motors	7.21	1—100	Motor Section	
Ford Motors	7.21	1—100	Do.	
Chev. Motor	7.22	1—100	Do.	
Chev. Motor	7.22	101—200	Do.	
Chev. Motor	7.22	201—300	Do.	
For Dodge	7.23	1—100	Do.	
For Dodge	7.23	101—200	Do.	

APPENDIX 4·15

Statement of Plant Hours and Work Done

Period from..................to............

Equipment Sub-Group	No. of Hours	Rate	Plant Hours worked for										
			6.23		6.25		*						
			Hours	Amount	Hours	Amount							

* NOTE : Each No. indicates a work and sub-head.

Debit issued by..............................

Plant Engineer.

Debit accepted by..........................

S.D.O. ....Sub-Divn.

APPENDIX

Statement

Depreciation and operation costs of various

Name of machine Plant Hours	Rate	Tournapulls 3926	Rate	T. Trailer 2944	Rate
1	2	3	4	5	6
	Rs. As.	Rs. As.	Rs. As.	Rs. As.	Rs. As.
Depreciation . . .	10 0	39,260 0	13 0	38,272 0	8 8
M. Repairs* . . .	1 0	3,926 0	1 0	2,944 0	1 12
Type replacement . .	5 0	19,630 0	3 0	8,832 0	0 12
M. Replacement† . .	10 0	39,260 0	5 0	14,720 0	12 0
Fuel Oil, grease . . .	6 0	23,556 0	5 0	14,720 0	8 0
Pay of operators . . .	1 8	5,889 0	1 8	4,416 0	1 4
Other staff . . .	1 8	5,889 0	1 8	4,416 0	1 4
Sundries	6 0	23,556 0	3 0	8,832 0	1 8
	41 0	160,966 0	33 0	97,152 0	35 0

*Labour only.
†Spare parts.

4·16

'B' (Credits)

earth-moving machines adjusted as per debits.

Period:— 21-4-1953 to 20-5-53

Tractor 5292	Rate	S.F.R. 1343	Rate	Graders 23	Attachment I Rate	Attachment I Rooters 504	Rate	Air compressors
7	8	9	10	11	12	13	14	15
Rs. As.	Rs. As.	Rs. As.	Rs. As.	Rs. As.	Rs. As.	Rs. As.	Rs. As.	Rs. As.
44,982 0	1 8	2,014 8	2 8	57 8	1 0	504 0	2 4	792 0
9,261 0	0 4	335 12	0 4	5 12	0 4	126 0	1 0	352 0
3,969 0	..	..	..	..	..	..	..	..
63,504 0	0 4	335 12	0 4	5 12	0 4	126 0	1 4	440 0
42,336 0	0 1	1,343 0	1 0	23 0	1 0	504 0	3 4	1,144 0
6,615 0	..	..	..	..	..	..	..	..
6,615 0	1 4	1,678 12	1 4	28 12	1 4	630 0	1 0	352 0
7,938 0	2 4	3,021 12	2 4	51 12	2 4	1,134 0	0 12	264 0
1,85,220 0	6 8	8,729 8	7 8	172 8	6 0	3,024 0	10 0	3,520 0
					GRAND TOTAL .		.	4,58,784 0

APPENDIX 4·16—*contd.*

Statement 'A' (Debits)

Accompaniment to T. E. O. No. Stat/3, dated 1st July '53

Constructing Embankment

68 *Construction*

Period : 21-4-53 to 20-5-53

Item No.	Name of Work	Section C Rs.	As.	P.	Section D Rs.	As.	P.
1.1	Stripping for the Dam seat	231	0	0	..		
4.1	Clearing and opening the quarry	23,018	12	0	..		
4.3	Excavating, transporting and dumping soil	385	0	0	24,022	0	0
4.4	Grading	1,59,714	12	0	5,425	0	0
4.52	Transporting and sprinkling	35,988	12	0	4,793	4	0
4.6	Mixing, and sheeps foot rolling	31,872	0	0	..		
5.1	Clearing and opening the quarry	19,716	4	0	..		
5.3	Excavating, transporting and dumping soil	58,359	8	0	7,380	0	0
5.4	Grading	17,342	8	0	2,196	4	0
5.52	Transporting and sprinkling	525	0	0	..		
5.6	Mixing and sheepsfoot rolling	16,932	0	0	2,137	4	0
8.12	Transporting and laying sand	9,611	0	0	2,863	8	0
13.2	Maintenance of quarry road contingencies	6,899	0	0	..		
	Installation of Piezometer	3,520	0	0	..		
		3,84,115	8	0	48,817	4	0
	TOTAL				4,32,932	12	0
	Constructing and maintaining a diversion road from right end of Dam				70	0	0
	P.W.D.						
	6.23 Rock removal				14,965	8	0
	6.25 Transport				10,815	12	0
	GRAND TOTAL				4,58,784	0	0

APPENDIX 5·1

Manual Labour *Versus* Earth-Moving Machinery

A typical example of earthwork in clay loam for a dam involving a lead of one mile is studied. The same progress schedules are assumed for both the alternatives.

Manual Work and Trucks

(*i*) Labour required for excavation, filling in trucks, and unloading per truck	20 Nos.
(*ii*) Rate per 1,000 cft. of borrow pit	Rs. 25·00
(*iii*) Rate per 1,000 cft. of compacted fill assuming borrow to bank equal 80%	Rs. 31·25
(*iv*) Levelling, watering and rolling per 1,000 cft. . . .	Rs. 12·00
(*v*) Transport—	
(*a*) Average No. of trips per day per truck carrying 5 tons pay load	15 Nos.
(*b*) Total mileage per day per truck including 20% unproductive	36 miles
(*c*) Fuel at 5 gls. to a mile at 2/12 per gln. . . .	19.25 per day
(*d*) Lubricant per day, say	Rs. 3
(*e*) Total for transport with truck hired @ 25 per day .	Rs. 47·25
(*vi*) Outturn 75 tons per day taking laid dry density of 100 lbs. per cft. plus 15% moisture, pay load per day . . .	1,500 cft.
(*vii*) Transport rate per 1,000 cft.	Rs. 31·50
(*viii*) Dressing per 1,000 cft.	Rs. 2·5
(*ix*) Total rate per 1,000 cft., say	Rs. 77·25
(*x*) Adding 8% for auxiliary services per 1,000 cft. . . .	Rs. 82·5
(*xi*) Total labour strength required for a progress of 43,700 cft. per day (which is the outturn adopted for comparison with earth-moving machinery)	
(*a*) Labour for excavation, loading and unloading, about .	600
(*b*) Labour for compaction and watering	150
(*c*) Labour for truck and its maintenance	150
TOTAL .	900
(*d*) Trucks including 25% of sickness	40 Nos.
(*e*) Bullock pairs for compacting Roller	30. Nos.
(*xii*) Cost of trucks @ Rs. 15,000 each	Rs. 6,00,000
To make the comparison as favourable as possible to using trucks the capital cost is not accounted for: trucks can be hired readily or sold off at any time at the residual book value.	
Ancillary equipment at 10% of the value of trucks . .	Rs. 60,000
(*xiii*) Housing and services taken at Rs. 250 per labour including maintaining camp for 5 years and services, *e.g.*, medical attention, lights, water supply, etc.	
Total for 900 persons . .	Rs. 2,85,000

(*xiv*) Interest on capital cost at 6% for 5 years on depreciated scale (effective $\frac{N+1}{2} = 3$ years) . . . . . . Rs. 51,000.

(*xv*) Overhead charges for management will be higher, say . 12%

Earth-moving Machinery

Assume a small fleet

4 Nos. 12/15 cu. yds. Scrapers	Rs. 6 lakhs.	9·8 lakhs
1 No. D/8 Tractors for pushing	Rs. 1·10 ,,	
1 No. D/8 Tractor for compaction and dozing . . .	Rs. 1·10 ,,	
1 No. D/8 Tractor Spare	Rs. 1·10 ,,	
1 No. Sheepsfoot roller	Rs. 0·50 ,,	
Add 20% for ancillary T. & P.	Rs. 2·00 lakhs	
TOTAL .	Rs. 11·8 lakhs	

1. Cost of ownership and operating per hour

Equipment	Ownership (Rs.)	Operating (Rs.)	Total (Rs.)
Scrapers	15	35	50
Tractors with Rollers, or Dozers, etc.	12	23	35

2. (*a*) Equipment availability 9 hours in 16 or 55%.

(*b*) Operating efficiency 45 min. in an hour.

(*c*) Theoretical cycle time . . . . 8 minutes.

(*d*) Pay load per trip . . . . 8 Cu. yds.

(*e*) Daily production compacted bank 43,700 cft.

3. Daily cost for 9 plant hours per day

Equipment	Operating	Operating & Ownership
4 Scrapers	1260	1800
2 Tractors	414	630
TOTAL	1674	2430

4. Unit rates per 1,000 cft.

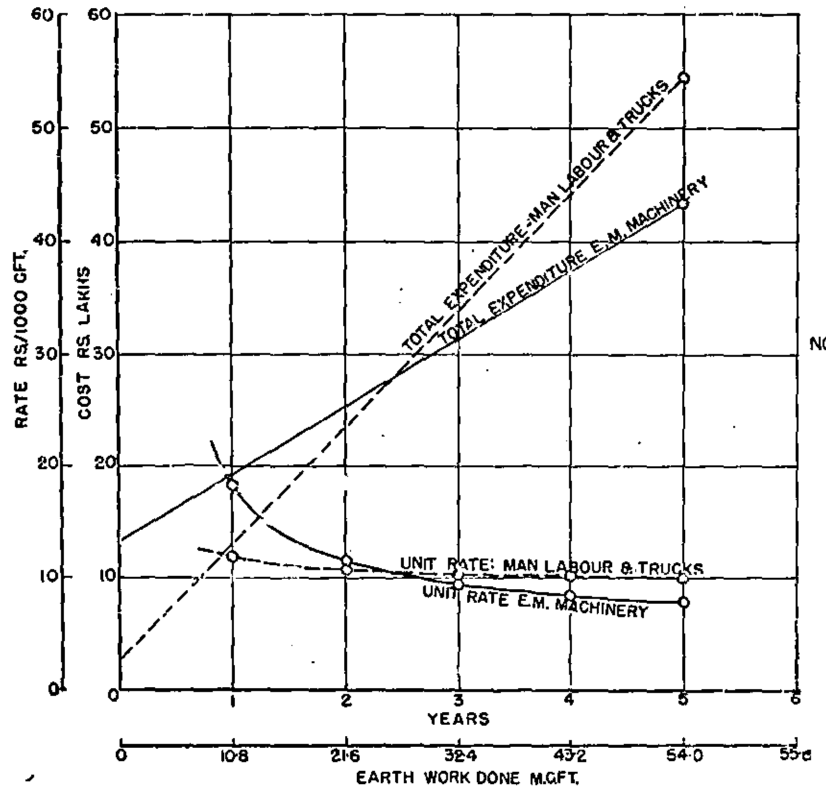
Machinery	38·4	55·8
Add for Sundries	2·5	2·5
	40·9	58·3
Add for other services, *e.g.*, flood light, haul roads, watering, stock loss etc. at 15%.	6·1	8·7
	47·0	67·0
Add for dressing	2·5	2·5
	49·5	69·5

5. Labour strength required @ 10 per machine . . . . 60 Nos.

6. Cost of housing and camp maintenance and services @ Rs. 2,500 per head . . . . Rs. 1,50,000

APPENDIX 5.1

EXPENDITURE AND RATE FOR DOING EARTH WORK BY MANUAL LABOUR
&
TRUCK VS. E.M. MACHINERY



NOTE:–
UNIT RATES WORKED-OUT ON
TOTAL EXPENDITURE
TRUCKS ON HIRE, E.M.
MACHINERY OWNED.

7. Interest on capital @ 6% per year on depreciated scale for 5 years (effective $\frac{N+1}{2}$ = 3 years) . . . . . Rs. 2·39 lakhs

8. Overhead centage charges for management T & P, etc., will be lower, say 6%

At the end of 5 years, the equipment will be fully depreciated and the other charges, *e.g.*, for labour camp etc. written off. Taking 250 working days per year the overall position after carrying out 54 m. cft. of earthwork will be as under:

Item	E. M. Machinery	Manual labour & trucks
1. Capital investment		
(*a*) Equipment	11·8	0·6
(*b*) Camp	1·5	2·25
	13·3	2·85
2. Unit rates per 1,000 cft. laid bank		
(*a*) including Dep.	69·5	82·5
(*b*) excluding Dep.	49·5	..
3. Working cost over 5 years (Rs. Lakhs)	26·73	44·55
4. Earthwork done (m. cft.)	54	54
5. Interest on Capital (Rs. Lakhs)	2·39	0·51
6. Overhead centage charges on value of work done		.
(*a*) 6%	2·25	..
(*b*) 12%	..	6·68
7. Total cost after 5 years (Rs. Lakhs)	44·67	54·59

The progressive expenditure and the unit rates of earthwork are shown in the graph on the back page.

APPENDIX 5·2

Information of Some Large Earthworks Executed Manually

Damodar Valley Corporation

The P.A. to the Chief Engineer, D.V.C., writes :

"It may, however, be stated that the construction of earth dams and concrete gravity sections of the magnitude involved (in DVC) should not only be uneconomical by manual labour but would hardly be feasible."

"However, the Chief Engineer agrees that smaller earth embankments, masonry dams and irrigation canals of moderate sizes may present features which can be tackled better by manual labour under Indian economic conditions. Even in such cases the availability of labour in sufficient number, their wages and standard of living and the time that can be afforded for execution are of overwhelming importance and a careful study of the advantages and disadvantages of both the types of construction for the particular local conditions have to be gone into before a decision regarding adoption of one method of the construction in preference to another is decided upon."

The Engineer in charge of Barrage and Irrigation works of the D.V.C. supplied the following information:

The earthwork involved in the canal and drainage channels is 165 crores of cft. distributed as under:

Canal	*Bed Width*	*Nature of Soil*	*Lead*	*Lift*	*Quantity (Crores cft.)*
			ft.	ft.	
1.	Over 80 ft.	Stiff clay	150	20	42
2.	40 to 80 ft.	Clay	100	10	60
3.	15 to 40 ft.	Clay & Loam . . .	70	7·5	18
4.	Below 15 ft.	Clay & Loam . . .	40	0·5	20
Drainage Channel					
5.	Over 80 ft.	Stiff clay	150	20	11
6.	40 to 80 ft.	Clay	100	10	5
7.	15 to 40 ft.	Clay & Loam . . .	80	7·5	8
8.	Below 15 ft.	Clay & Loam . . .	40	0·5	1
		TOTAL .			165

"Machineries are not economical for canals of small bed width and where depth of cutting does not exceed 10 to 12 ft. The rate of excavation by machinery does not change appreciably in canals of different bed widths whereas with manual labour the rate of small bed width is considerably less. Considering the types of soil, the reduction of rates by manual labour is considerably less than by machine as soil gets easier."

The rates of earthwork by manual labour are as under :

Nature of Work	*Rate per 1,000 cft.* (Rs.)	*Soil*
Canal 80 ft. bed width & above	Not suitable for manual labour	Stiff Clay
40 to 80 ft.	22 to 28	Clay
15 to 40 ft.	20 to 24	Clay & Loam
Below 15 ft.	18 to 24	Clay & Loam

The rates include:

(*a*) Jungle cutting.
(*b*) Ploughing under seat of bank.
(*c*) Nicking out lines.
(*d*) Setting out profiles.
(*e*) Rough dressing.

Consolidation and watering is not done. Measurements are based on borrow pits. An average monthly production of 54 m. cft. of earthwork is achieved with a labour strength of nearly 6,000 persons. No transport units are required.

Lower Bhavani Dam (Madras State)

A total of 32·7 m. cft. of embankment was carried out with excavation, loading and unloading by manual labour and transport by trucks, through contract agency. Measurements are based on borrow pits which gives 80% on bank. The soil is gravelly involving a lead of 10 to 20 yards for loading into trucks and 1/2 to 1 mile transport. An average progress of 1·5 m. cft. was obtained per month with a strength of 600 labour, 30 heavy trucks, two road rollers, one rooter and one water tanker. The labour camp was maintained by the contractor. The rate worked out as under :

Excavation, loading and unloading trucks and transport.	Rs. 39/10/- per 1,000 cft.
Watering	Rs. 4/2/- per 1,000 cft.
Scarifying and spreading earth	Rs. 4/6/- per 1,000 cft.
Consolidation	Rs. 6/7/6 per 1,000 cft.
TOTAL	Rs. 54/8/6 per 1,000 cft.

Converted to bank measurement this will give a rate of Rs. 68/4/- per 1,000 cft. all inclusive.

Lower Bhavani Canal Project

The earthwork involved is nearly 500 m. cft. including rock blasting. Of this, nearly 470 m. cft. is completed. The work was done by manual labour but machinery such as drop-side or tipper lorries, dumpers, tramlines and tipping wagons hauled by diesel locos were used where haulage of over 1/2 furlong was involved.

The manual work was carried out mainly through job workers and by contract. The average labour cost came to Rs. 35 per 1,000 cft. of earthwork excluding the rock requiring blasting. Measurements are based on borrow pits. The soils met with are hard soil, red earth and gravel with overlying strata of soft, disintegrated and hard rock. The lead and lift for manual labour varies from 100/150 yards and 4/6 yards respectively. A monthly progress of 8 m. cft. of work including rock blasting was achieved with about 15,000 labour. No labour camp was maintained at Government cost. The rate includes excavation, conveyance by machinery to the extent required, and rough banking but does not include "special consolidation" and watering, the rate for which is Rs. 8 to 12 per 1,000 cft. extra.

Malampuzha Dam (Madras State)

A total of 4.6 m. cft. of earthwork out of a total of 7 m. cft., is being done by manual labour. Measurements are based on truck-measure which is taken as 120% of the compacted bank. The lead and lifts are 4 furlongs and 10 yards respectively. A monthly production of 0.3 m. cft. is achieved with 300 labour, 10 trucks, one bulldozer (for loosening earth), two road rollers, 2 sheepsfoot rolers, one scraper, one dozer, 2 water lorries and a disc harrow. The labour camp is maintained by the contractor. The cost of the finished item of embankment comes to Rs. 93 per 1,000 cft. The soil is stiff clay, stiff black cotton, hard red earth, shales, murrum and ordinary gravel. The rate includes all charges such as consolidation, watering, etc. The portion of the rate for spreading soil, watering and consolidation comes to Rs. 19/8/- per 1,000 cft.

Malampuzha Canals

The total quantity of earthwork on main canals is 71 m. cft. and on distributaries 110 m. cft. of which 64 and 62 m. cft. respectively are completed by manual labour through job work. Basic rates of earthwork were as under :

Excavation including Lead of 10 yds. and lift 2 yds. in hard Stiff Clay, hard red earth and gravel soil	Rs. 16 to 21 per 1,000 cft.
In soft laterite	Rs. 25 per 1,000 cft.
In hard laterite	Rs. 37 per 1,000 cft.
In soft disintegrated rock	Rs. 180 to 200 per 1,000 cft.
Additional leads and lifts were paid as under:	
Lift	Rs. 1 per yd. per 1,000 cft.
Lead (Over basic) Tramlines	Rs. 5 per furlong per 1,000 cft.
Trucks or Dumpers	Rs. 20 to 25 per 1,000 cft. for about 1/2 mile.
Compaction	
Hand Rammers and watering	Rs. 1·5 per 1,000 cft.
Power Rollers and lorry watering	Rs. 5 to 20 per 1,000 cft.

The most convenient method of construction for low banks was found to be excavation by manual labour and transport by tramlines in one cu. yd. wagons.

Hyderabad State

Information about 5 minor irrigation works is supplied varying in the quantity of earthwork from 2·9 to 6·3 m. cft. The work is carried out by contract, piece work and what is called "zonal System". Payments are based on bank sections. For the Khasapur project, optimum moisture compaction is observed giving a ratio of bank to borrow from 85·5% to 78%.

The all-in rate varied from O.S. Rs. 35 to O.S. Rs. 67 per 1,000 cft. depending upon leads and lifts.

Monthly progress achieved varied from 40 to 46 units of earthwork (1,000 cft.) with a labour strength of 1,000 to 1,250.

Godavari North Canal Project

A total of 90 m. cft. of earthwork is done by manual labour through the agency of contracts. The excavation is in soils varying from soft murrum to rocky murrum, removable by pick and crow bar. An average monthly progress of 2.63 m. cft. is achieved with a labour strength of 5,000. Transport is done by head load and rail trucks; compaction by Diesel rollers. The labour camp is maintained by the contractor. The average rate for cutting and banking for the canal worked out to Rs. 60 per 1,000 cft. The compaction is done departmentally at Rs. 5 per 100 cft.

Mayurakshi Reservoir Project (West Bengal)

About 560 m. cft. of earthwork for the canal excavation is carried out through a number of contractors. The measurements are based on borrow pits. The ratio of bank to borrow works out to 110%.

An average production of 25 m. cft. (should probably be 250 m. cft.) is reported to be obtained per working season from November to June with a strength of about 12,000 persons.

The rates were as under:

Excavation including a lead of 100 ft. and lift of 5 ft. for soil:

Main canal	Rs. 30 per 1,000 cft.
Distributaries	Rs. 19/4/- per 1,000 cft.
Additional rate for hard murrum	Rs. 6 per 1.000 cft.
Laterite rock	Rs. 80 to 100 per 1.000 cft.
Hard rock	Rs. 200 per 1,000 cft.
Extra for lead	Rs. 3 per 1,000 cft. per 50 ft.
Extra for lift	Rs. 3 per 1,000 cft. per 4 ft.

The rates are all inclusive for excavation but an extra charge of Rs. 7/8/- per 1,000 cft. is incurred for watering, ramming, consolidation, dressing and turfing for embankment.

Hirakud Dam Project (Orissa State)

The cost data for earthwork by machinery is discussed earlier. A production of 7·7 m. cft. of earthwork per month for the dam involving lead up to 3 miles is achieved with a strength of 500 crew operating the machinery.

The canal work is done mainly by manual labour. A total of 328 m. cft. of earthwork is done through contractors. A monthly progress of 7·4 m. cft. of earthwork is obtained with an average strength of 6,600 labour. Leads involved vary from a basic of 50 ft. to a maximum of 200 ft. for excavation and up to about 600 ft. for bank. Cuttings are indifferent kinds of soils varying from average soil to hard rock. All lifts over the basic 5 ft. are converted into lead at the rate of 1 lift equals 12½ lead. Camps are maintained by contractors. The rates are as under:

1.	Overall cost of earthwork in all kinds of soil with disintegrated rock up to 25 % and average leads	Rs. 35 per 1,000 cft.
2.	Ordinary soil	Rs. 30 per 1,000 cft.
3	Disintegrated rock	Rs. 50 per 1,000 cft.
4	Soft rock	Rs. 60 per 1,000 cft.
5	Medium soft rock	Rs. 75 per 1,000 cft.
6.	Hard rock	Rs. 75 to 150 per 1,000 cft.

Cost factors not covered by the above are :

1	Dressing, watering, and ramming	Rs. 5 per 1,000 cft.
2	Ploughing for seat	Rs. 10 per acre.
3	Jungle Clearance	Rs. 30 to 60 per ocre.
4	Grubbing out roots	Rs. 40 to 80 per acre.
5	Dog Belling	Rs. 10 per mile.

APPENDIX 6·1

Lower Bhavani Project Headworks

General Information

A composite dam is being constructed across the river Lower Bhavani. 22 miles from Metupalliyam. The flanks are in earthen embankment and the central portion of the dam is in masonry holding the spillway and the power house.

The embankment comprises 95:5 m. cft. of semi-previous fill and 6:7 m. cft. imprevious fill. The excavation for foundation for the earthen dam comprises:

0·43 M. cft.	Clay
7·82 M. cft.	Hard gravelly soil
3·93 M. cft.	Soft integrated rock
3·63 M. cft.	Hard rock

Very little of the excavation was under water table. The total cost of the project is Rs. 9·3 crores made up of Rs. 3·875 crores for the canals and Rs. 5·425 crores for the dam. The main sub-heads of the Headworks are as under:

		Rs.
(a) Preliminary expenses		1·2 lakhs
(b) Land		73·0 lakhs
(c) Works		320·0 lakhs
(d) Buildings		25·0 lakhs
(o) Miscellaneous		24·0 lakhs
(p) Maintenance		..
(v) Special T. & P.		144·0 lakhs
TOTAL		587·2 lakhs
Deduct Receipts and Recoveries	72·5 lakhs	514·7 lakhs
Add Overhead charges		27·8 lakhs
GRAND TOTAL		542·5 lakhs

The project organisation comprises an Executive Engineer working under the direct control of the Chief Engineer, Irrigation, Madras. The direct control is said to have cut down the routine to the minimum and helped the project to quick execution. The administration chart of the project organisation is given in Statement No. 6:1.

The project drawings were prepared in the C.D.O., Madras and the working drawings are prepared in the Executive Engineer's office.

The heavy earth-moving equipment is working in two shifts *i.e.* 6-30 A.M. to 12-30 P.M. and 12-30 P.M. to 6-30 P.M. All other works are executed in one shift, *i.e.*, from 7-30 A.M. to 12-30 P.M. and 2-0 P.M. to 6-0 P.M. The work shuts down for about 20 days in monsoon. All Sundays and 6 additional holidays are observed as non-working days on the field.

The average lead for the dam varied from a minimum of 1/2 mile to a maximum of 2½ miles but the weighted average would be between 1 and 1½ miles.

The project was planned to carry out about 50% of the impervious and the entire pervious fill by machinery. The rest of the semi-pervious fill and the foundation was planned to be executed by manual labour and trucks. The rates in the estimate were based initially on the schedule of rates but these were not followed *in toto*. Tenders were called for the excavation and transport of earth for various leads. The lowest quoted rate was reduced further based on the observations made in the transport cost by lorries. These rates were then adopted for the working estimates. It was not known at the time of preparation of the estimates what machines would be available in the market and hence it was considered safe to adopt these rates for the estimates.

There has been no revision in the estimate of the original project estimate but modification is carried out by reducing the masonry work and increasing the earthwork. The increase in the prices since the sanction of the estimate is offset by the saving on account of the partial change-over from masonry to earth.

The project has completed the following quantities of earthwork upto 30-6-1953.

Materials	Units of 1,000 cft.		
Impervious fill	By Euclids 36351	By Lorries 32149	Total 68500
Semi-pervious fill	Tractors & Scrapers 22759	Departmental Lorries 35498 By contractors Lorries 32743	91000

Soils.—The impervious zone is made up of lean clay with a borrow pit dry density of 100 to 107 lbs. per cft. laid at compacted dry density of 105 to 117 lbs. per cft. The natural moisture content varied from 6 to 9% the optimum moisture specified is 13 to 19%.

The semi-pervious zone is made up of sand with some clay binder having a borrow pit density of 110 to 120 lbs. and compacted dry density of 120 to 130 lbs. The natural moisture specified is 8%.

Occasionally during monsoon and in times of high winds, water is supplemented on the dam to make up for the evaporation losses; otherwise the entire watering is done at the quarry. The compaction of the impervious zone is done by Sheep Foot Rollers of U.S.B.R. standards, having 230 lbs. per square inch intensity of pressure. 18 passes are required to give the maximum dry density. The semi-pervious zone is compacted by ordinary 11 tons Diesel Road Rollers. 16 passes are found necessary to give the desired dry density. The soil does not need to be rooted.

Accounts and Costs

The project operates under the ordinary system of post-audit. No resident Accounts Officer is posted to the job.

The cost of all the machines is provided under Spl. T. & P. as a final charge. This includes the earth-moving machinery, the trucks and other tools. A list of the equipment on the job is given *vide* Statement No. 6·2

The estimate provides for the rates of earthwork excluding the depreciation cost separately included under the Spl. T. & P. The cost of the Spl. T. & P. is a final charge during the construction period. An estimate for the salvage value is prepared to watch the disposal of machines. The salvage value realised in future will be deducted from the cost of purchase of the machines and the balance will be debited to the work as depreciation, to work out the final rates of earthwork.

The 'plant hours' is defined as "hours during which the machine has been taken out from garage till it returns back". The periods when the machines are serviced and major field repairs are carried out, are deducted. The refueling time and the time taken to move the unit from garage to work and back is included in 'Plant hours'. No deductions have been made for occasional waiting time at loading sites.

The expenditure on operating the equipment is watched through suspense estimate. Every year one annual estimate is prepared for "maintenance of plant and machinery". All the initial expenditures on machines are booked to these suspense estimates, in the first instance, classified individually by each machine. The suspense accounts are cleared monthly.

The pay measurements are calculated on the basis of the compacted embankments constructed both by the machinery as well as by lorry transport.

The estimated and the actual costs of operating the machinery are given in Statements No. 6. 1·3, 4 & 5. The unit rates of earthwork are given in Statement No. 6·3. This includes depreciation, working expenses, and spare parts of the machinery. This does not include other charges not connected with the machinery.

Stores

The Sectional Officer in charge of the works can originate a requisition. This is scrutinized by the S.D.O. and countersigned for compliance by the main stores. If the articles are not available, the Assistant Engineer, Stores, places an indent on the Executive Engineer, who in turn, calls for quotations. The quotations are prepared and orders placed on the lowest quoted company consistent with quality. In some cases, the sample order is placed to satisfy regarding the quality. Advantage is taken of the D.G.S. & D. whenever possible as a direct demanding officer.

The materials are received by the Supervisor who takes the delivery of the consignment, checks the contents and records them in the measurement books. They are then check-measured by the Assistant Engineers, Stores, and handed over to the store-keeper. The store-keeper issues them to the field staff on the certified requisition as stated above. The indents and the issues are checked by the Executive Engineer to ensure adequacy of spares and to avoid duplication of orders.

Open and competitive quotations are called for articles in the open market and at least three to four quotations are obtained and compared before placing an order. For articles of propriety nature, the orders are placed on the firms after getting their quotations. Where the D.G.S. & D. contracts are operated upon, no quotations are called for but orders are placed directly against the contracts.

Purchase orders are placed generally within a week of the receipt of the quotations and, in urgent cases, orders are sent immediately. Normal purchase orders are complied with by the firms within a month except in very urgent cases, when immediate deliveries are required. In case of emergency, local purchases are resorted to. The purchase of items on single tender system is restricted to Rs. 1,500 for articles other than machinery parts. There is no limit for the purchase orders based on quantitative quotations provided that there are duly sanctioned estimates to accommodate the expenditure.

The staff looking after the stores is indicated in the statement of organisation.

The sanctioned reserve limit of stock and the stock balance on hand is given in Statement No. 6. 1. 7.

Store Accounts

The procedure for store accounts is detailed below:

The indents are always prepared in Quadruplicate Machine-wise. One copy is maintained by the S.D.O., who makes the indent. Three copies are sent to Main Stores. After issue, one copy is returned back with issues noted, to the indentor. One copy is maintained in General Stores itself and the other copy is sent to Division Office by Stores. At the end of the month, S.D.O. Stores sends compilation of all issues as "Stock Issue Statement". There is no limit to the number of items that can be drawn on one requisition.

The S.D.O., Field Machinery accounts for these materials through his 7-F accounts, on the suspense estimate maintained. The receipts are shown material-wise and issues are shown machine-wise under each item of material. This 7-F statement is checked with Stores Sub-Division "Stock Issue Statement" at Division Office.

The issue of materials are noted in the Log Book also for each machine and the log books of all machines are submitted to Division Office on the 10th of every month. The cost of all the Stores and spares shown against each machine concerned is entered into the log book and finally adjusted to the work concerned. Thus there is a cross-check of all receipts and issues by the Purchasing Officer, Drawing Officer, and Executive Engineer at every stage of withdrawal and use of stores.

The Use of Spare Parts on Machines

As and when an indent is made out for spare parts, for a particular machine, this is being checked with the old spare parts registers which show all the spare parts drawn on that machine from the time the machine was received in the project to date.

The account is maintained by Bin cards and Ledger system.

The charges for storage and handling is raised at 1%.

Operational Staff

Excavators

The operators are allocated by machines. There are 34 operators and 32 mates. The maintenance staff is also attached to individual machines. The operator and the cleaner look after the maintenance under the supervision of the mechanic in charge of the group of machines. A Junior Engineer supervises the work. The following Supervisory staff are attached to the groups of machines:

Chief Excavator Foreman	1
Assistant Foremen . .	2
Foreman . . .	1

The pay scales of operators are as under:

1. Tractor Operator . .	Rs. 65–5–85
2. Excavator . .	Rs. 65–5–85
3. Euclid Driver .	Rs. 70–5–90
4. Scraper ,, . .	Rs. 70–5–90

These rates are low even accounting for the fact that the wage rates in Madras are rather lower than in other parts of the country.

Dumpers, Scrapers, Tractors and Graders

The population of equipment under this heading is 70. Except for dumpers the rest of the equipment is working two shifts.

There are two operators for each machine except for small dumpers. In all there are 106 operators.

The servicing and maintenance is done by driver and cleaner under check of the mechanics in charge of the particular group of machines. The junior engineer borne on provincial establishment supervises the work.

Minor Field Repairs

There is no separate bifurcation between the field repairs and major overhauls. The men on the field are increased or decreased as per demand. During other times these men are retained to work on major repair section. The field repair team is divided into two groups, *i.e.* (a) Right flank earth dam, machinery (b) Left flank earth dam, machinery. The strength in the two groups is as follows:

(*a*) Assistant Foreman

Fitter I	at Rs. 3/-/-	2 Nos. a day
Fitter II	at Rs. 2/8/-	8 Nos. a day
Fitter II	at Rs. 2/4/-	7 Nos. a day
Fitter II	at Rs. 2/-/-	9 Nos. a day
Fitter II	at Rs. 1/12/-	8 Nos. a day
Heavy load II	at Rs. 1/8/-	6 Nos.
Work Assistant or Chargeman		2 Nos.
Man Mazdoors I	at Rs. 1/4/-	11 Nos.
Do.	at Rs. 1/2/-	5 Nos.
Boy Mazdoors	at Rs. -/10/-	4 Nos.
Heavy Load I	at Rs. 2/8/-	4 Nos.

(*b*)	Fitter I	at Rs. 2/8/-	3 Nos. per day
	Fitter II	at Rs. 2/4/-	1 No.
	Fitter II	at Rs. 2/2/-	2 Nos.
	Fitter II	at Rs. 2/-/-	2 Nos.
	Heavy Load II	at Rs. 1/8/-	2 Nos.
	Man Mazdoors	at Rs. 1/4/-	4 Nos.
	Do.	at Rs. 1/2/-	2 Nos.

The work of field repairs and major repairs is managed as under:

The field repairs include:

(1) Failure of wire ropes and replacements.
(2) Starting troubles.
(3) Oil Block troubles.
(4) Clutch and brake adjustments.
(5) Power control unit adjustment.
(6) Change of cutting edges and dipper teeth.
(7) Failure of tyres—removal and replacement.
(8) Track adjustment.

Major Repairs

The major repair section is divided into the following groups:

(1) Caterpillar units—D7. and DW-10.
(2) Excavators.
(3) Euclids.
(4) Dumpers, TD-18 Nos. and rollers.

Personnel Working in each Section

The drivers and cleaners always work on the machines during major repairs.

Caterpillars

(1) Foreman I at Rs. 250/- plus D. A.
 (*a*) Work Assistant or Chargeman 2 Nos. Rs. 60/- plus D. A.
(2) Mechanics 3 Nos. at Rs. 60/- plus D. A.
(3) Fitter II class 3 Nos. at Rs. 2/8/-.
(4) Fitter II class 2 Nos. at Rs. 2/4/-.
(5) Fitter II class 2 Nos. at Rs. 2/-/-.
(6) Fitter II class 4 Nos. at Rs. 1/12/-.
(7) Fitter II class 2 Nos. at Rs. 1/8/-.
(8) Fitter II class 2 Nos. at Rs. 1/4/-.
(9) Fitter II class 2 Nos. at Rs. 1/2/-.

Excavators

(1) Chief Excavator Operator I at Rs. 350/- plus D. A.
(2) Mechanics 3 Nos. at Rs. 70/- plus D. A.
(3) Fitter II class 4 Nos. at Rs. 2/- per day.

Euclids

(1) Asstt. Foreman 1 No. at Rs. 100/- plus D. A.
(2) Mechanic I No. at Rs. 75/- plus D. A.
(3) Fitter II class I at Rs. 2/8/-.
(4) Fitter II class I at Rs. 2/4/-.
(5) Fitter II class I at Rs. 1/12/-.
(6) Fitter II class I at Rs. 1/8/-.
(7) Fitter II class I at Rs. 1/4/-.

Dumpers and TD-18 Tractors and Rollers

(1) Asstt. Foreman 1 No. at Rs. 90/- plus D. A.
(2) Fitter I class 1 No. at Rs. 3/-/-.
(1-a) Work Assistant or Chargeman Rs. 60/-/- plus D. A.
(3) Fitter II class 3 Nos. at Rs. 2/8/-.
(4) Do. 2 Nos. at Rs. 2/4/-.
(5) Do. 5 Nos. at Rs. 2/-/-.
(6) Do. 1 No. at Rs. 1/8/-.
(7) Do. 3 Nos. at Rs. 1/4/-.
(8) Do. 2 Nos. at Rs. 1/2/-.
(9) Do. 3 Nos. at Rs. -/10/-.

NOTE.—The supervisory staff like foreman of all groups will be attending on field repairs also if breakdowns become heavy on a particular day.

The workshop has a separate accounting system. Works on field equipment are watched through job cards. The overhead charges are 25 per cent. on labour; 1% centage charge is added. The record of the cost of tyres, is carefully maintained. The cost data is given in Statement No. 6. 1. 8.

A tyre maintenance team is maintained comprising 3 mechanics, 6 fitters, 1 supervisor, and 4 labourers.

The Foreman, Assistant Foreman and mechanics are maintained on monthly basis. First-class fitter on daily rolls are promoted as mechanics on monthly wages as need arises. Other personnel are on daily wages.

Haul Roads

No separate equipment are maintained for haul roads. When roads are to be constructed, the equipment working on the dam is diverted. There is motor grader on the work. Tractor-drawn scrapers and dozers are utilised to maintain the roads, ten numbers water tankers drawn by Field Marshal Tractors and 11 Nos. tractors with water tankers, working in single shift, water the roads to keep them dust free. A team of 8 fitters class II, is maintained to look after the repairs of the tractor drawn water tankers. The maintenance of trucks is carried out in the automobile shop on order requisition.

STATEMENT No. 6·1·1

Bhavani Dam

Organization

Not printed.

STATEMENT

Lower Bhavani Headworks

(1)	Type of Equipment (2)	No. of Machines in Project (3)	Make, Model and size Nos. in each (4)	Month, year of purchase (5)
I.	EUCLID DUMPERS			
	Euclid Bottom Dumper No. 1 .	6 Nos.	U.S.A. Make 25 FDT	5-9-1949
	Euclid Bottom Dumper No. 2 .		Model 13/7 Cu. Yds.	5-9-1949
	Euclid Bottom Dumper No. 3 .		Do.	26-10-1950
	Euclid Bottom Dumper No. 4 .		Do.	26-10-1950
	Euclid Bottom Dumper No. 5 .		Do.	1-11-1950
	Euclid Bottom Dumper No. 6 .		Do.	16-11-1950
	Euclid Bottom Dumper No. 7 .	3 Nos.	70 FDT Model 17 Cu. Yds.	7-7-1952
	Euclid Bottom Dumper No. 8 .		Do.	7-7-1952
	Euclid Bottom Dumper No. 9 .		Do.	7-7-1952
	Euclid Rear Dumper No. 10 .	2 Nos.	5 FDT Model 9.6/11 Cu. Yd.	15-7-1952
	Euclid Rear Dumper No. 11 .		Do.	15-7-1952
II.	DW 10 CATERPILLAR SCRAPER			
	DW-10 Caterpillar Scraper 1 .	6 Nos.	U.S.A. Make DW-10 Model	14-7-1949
	DW-10 Caterpillar Scraper 2 .		7/9 Cu. Yd.	30-9-1949
	DW-10 Caterpillar Scraper 3 .			4-9-1951
	DW-10 Caterpillar Scraper 4 .			4-9-1951
	DW-10 Caterpillar Scraper 5 .			1-10-1951
	DW-10 Caterpillar Scraper 6 .			1-10-1951
III.	EXCAVATORS			
(A)	10 R.B. Excavator No. 1 .	4 Nos.	Ruston Bucyrus	9-10-1950
	10 R.B. Excavator No. 2 .		10 RB 3/8 Cu. Yd.	16-7-1950
	10 R.B. Excavator No. 3 .		Do.	27-3-1950
	10 R.B. Excavator No.4 .		Do.	11-6-1951
(B)	19 R.B. Excavator No. 1 .	6 Nos.	Ruston Bucyrus	8-3-1950
	19 R.B. Excavator No. 2 .		19 R.B. 5/8 Cu. Yd.	10-3-1949
	19 R.B. Excavator No. 3 .		Do.	29-1-1951
	19 R.B. Excavator No. 4 .		Do.	15-11-1951
	19 R.B. Excavator No. 5 .		Do.	28-7-1952
	19 R.B. Excavator No. 6 .		Do.	14-8-1952
(C)	1. Northwest Excavator No. 1	5 Nos.	U.S.A. Make, Northwest	15-11-1951
	2. Northwest Excavator No. 2		3/4 Cu. Yd.	15-11-1951
	3. Northwest Excavator No. 3		Do.	15-11-1951
	4. Northwest Excavator No. 4		Do.	15-11-1951
	5. Northwest Excavator No. 5		Do.	9-7-1952
(D)	1. L.S. 50 Excavator No. 8 .	1	U.S.A. Make LS=50 1/2 Yds.	8-4-1951

No. 6·1·2

Division Capital Equipment (Bhavanisagar)

Month, year first put into operation	Total purchase price (Rs.)	Whether required new or from disposal	Ordered through	Remarks
(6)	(7)	(8)	(9)	(10)
5-9-1949	87,992 0 0	Brand new	M/s. Blackwood Hodge (India Ltd.)	
5-9-1949	90,084 0 0	Do.	Do.	
26-10-1950	124,822 0 0	Do.	Do.	
26-10-1950	124,822 0 0	Do.	Do.	
1-11-1950	124,993 0 0	Do.	Do.	
16-11-1950	125,016 0 0	Do.	Do.	
7-7-1952	164,369 0 0	Do.	Do.	
7-7-1952	164,369 0 0	Do.	Do.	
7-7-1952	164,369 0 0	Do.	Do.	
15-7-1952	149,432 0 0	Do.	Do.	
15-7-1952	149,432 0 0	Do.	Do.	
15-7-1949	81,328 0 0	Brand new	M/s. Larsen and Toubro Ltd.	They are permanently hooked to C-10 Caterpillar — Two Wheeled scrapers.
30-9-1949	79,324 0 0	Do.	Do.	
5-9-1951	142,649 0 0	Do.	Do.	
5-9-1951	142,648 0 0	Do.	Do.	
1-10-1951	123,774 0 0	Do.	Do.	
1-10-1951	123,774 0 0	Do.	Do.	
9-10-1950	42,657 0 0	New	M/s. William Jacks & Co.	Three Nos. have got shovels and draglines. One No. is having Dragline attachment only.
16-7-1950	42,675 0 0	Do.	Do.	
27-3-1950	54,947 0 0	Do.	Do.	
11-6-1951	42,675 0 0	Do.	Do.	
3/50	89,012 0 0	Do.	Do.	All are having shovel and dragline attachments.
3/49	56,127 0 0	Do.	Do.	
1/51	85,054 0 0	Do.	Do.	
11/51	90,406 0 0	Do.	Do.	
7/52	79,551 0 0	Do.	Do.	
8/1952	76,451 0 0	Do.	Do.	
11/51	1,08,775 0 0	Do.	Do.	All are having shovel and dragline attachments.
11/51	1,08,775 0 0	Do.	Do.	
11/51	1,08,775 0 0	Do.	Do.	
11/51	1,08,775 0 0	Do.	Do.	
7/52	1,30,249 0 0	Do.	Do.	
4/51	88,824 0 0	Do.	M/s. Larsen & Toubro Ltd.	It has got a shovel and dragline attachment.

STATEMENT

(1)	(2)	(3)	(4)	(5)
	IV. T.D. 18 TRACTORS			
1.	TD-18 Tractor No. 4		U.S. International Harvester and Co. TD-18 Model.	1-11-1949
2.	TD-18 Tractor No. 5			15-12-1950
3.	TD-18 Tractor No. 6			3-2-1950
4.	TD-18 Tractor No. 13			18-12-1949
5.	TD-18 Tractor No. 14			22-8-1949
6.	TD-18 Tractor No. 15			5-2-1950
	V. CATERPILLAR D7 TRACTORS			
1.	D7 Tractor No. 1		U.S.A. Make Caterpillar	10-11-1949
2.	D7 Tractor No. 2		Do.	2-12-1950
3.	D7 Tractor No. 3		Do.	7-1-1951
4.	D7 Tractor No. 8		Do.	2-7-1951
5.	D7 Tractor No. 9		Do.	23-9-1949
6.	D7 Tractor No. 10		Do.	25-10-1949
7.	D7 Tractor No. 11		Do.	10-6-1950
8.	D7 Tractor No. 12		Do.	6-3-1951
9.	D7 Tractor No. 16		Do.	12-11-1951
10.	D7 Tractor No. 17		Do.	
11.	D7 Tractor No. 18		Do.	
12.	D7 Tractor No. 19		Do.	
13.	D7 Tractor No. 20		Do.	
	VI. AVELING BARFORD ROLLERS			
1.	A.B. Roller No. 1		U.S. Make	16-6-1950
2.	A.B. Roller No. 2		Do.	8-5-1950
3.	A.B. Roller No. 3		Do.	16-6-1950
4.	A.B. Roller No. 4		Do.	8-5-1950
5.	A.B. Roller No. 5		Do.	23-9-1949
6.	A.B. Roller No. 6		Do.	1-2-1950
7.	A.B. Roller No. 7		Do.	1-3-1950
	VII. DUMPERS (DIESEL & PETROL)			
1.	Muirhill Dumper (Petrol)	1	English BD 3 Cyd. Model	15-12-1949
2.	Muirhill Dumper (Diesel)	2	Do.	
3.	Muirhill Dumper (Diesel)	3	Do.	23-9-1949
4.	Muirhill Dumper (Diesel)	4	Do.	20-4-1951
5.	Muirhill Dumper (Diesel)	5	Do.	20-4-1951
6.	Muirhill Dumper (Diesel)	6	Do.	29-4-1951
				29-4-1951

No. 6.1.2—contd.

(6)	(7)	(8)	(9)	(10)
11/49	44,091 0 0	New	M/s. Volkart Brothers	They have got 4 Nos. of Onion Empire Make Angledozers and 2 Nos. of Le Tourneau Make Angledozers. But they are not used at the dam. The TD-18 were used for hauling scrapers and disc-barrows.
12/49	44,116 0 0	Do.		
2/50	46,188 0 0	Do.		
12/49	44,663 0 0	Do.		
8/49	43,965 0 0	Do.		
2/50	46,188 0 0	Do.		
11/49	79,783 0 0	New	M/s. Larsen & Toubro	Caterpillar 7A Angle-Dozer Attachments.
12/50	89,299 0 0	Do.	Do.	Do. Do.
1/51	81,430 0 0	Do.	Do.	Do. Do.
7/51	96,847 0 0	Do.	Do.	7S Bull-dozer
9/49	96,846 0 0	Do.	Do.	7S Bull-dozer
10/49	22,435 0 0	Old	Old Military surplus transferred from Agricultural department.	L.B.P. Nos. 10, 11 and 12 are used for hauling sheepsfoot rollers, Disc-liharrows etc.
6/50	24,728 0 0	Do.		
3/51	27,924 0 0	Do.		
11/51	96,847 0 0	New	M/s. Larsen and Toubro	Angle Dozer attachment.
	50,792 0 0	Old	Bought from C.T.O., New Delhi & Reconditioned at Messrs. Larsen and Toubro, Madras.	
	50,793 0 0	Do.		
	50,793 0 0	Do.		Le Tourneau Angle Dozer.
	50,793 0 0	Do.		Do.
6/50	48,000 0 0	New	Messrs. Jessop & Co., New Delhi.	
5/50	48,000 0 0	Do.	Do.	
6/50	48,000 0 0	Do.	Do.	
5/50	48,000 0 0	Do.	Do.	
9/49	48,000 0 0	Do.	Do.	
2/50	48,000 0 0	Do.	Do.	
3/50	48,000 0 0	Do.	Do.	
12/49	16,099 0 0	New	M/s. McLeod & Co., Calcutta.	
9/49	26,854 0 0	Do.	Do.	
4/51	30,589 0 0	Do.	Do.	
4/51	30,529 0 0	Do.	Do.	
4/51	30,529 0 0	Do.	Do.	
4/51	30,529 0 0	Do.	Do.	

STATEMENT

(1)	(2)	(3)	(4)	(5)
7	Motor Rail Dumper Diesel	7	English XDCMD 3 cyds. Model	29-4-1951
8	Motor Rail Dumper Diesel	8	Do.	15-7-1949
9	Motor Rail Dumper Diesel	9	Do.	29-4-1951
10	Motor Rail Dumper Diesel	10	Do.	6-6-1951
11	Motor Rail Dumper Diesel	11	Do.	6-6-1951
12	Motor Rail Dumper Diesel	12	Do.	8-6-1951
13	Motor Rail Dumper Diesel	13	Do.	8-6-1951
14	Motor Rail Dumper Diesel	14	Do.	4-6-1951
15	Motor Rail Dumper Diesel	15	Do.	13-6-1951
16	Muirhill Dumper Diesel	16	English BD	18-7-1951
17	Muirhill Dumper Diesel	17	3 CYDS Make	18-7-1951
18	Muirhill Dumper Diesel	18	Do.	29-3-1951
19	Muirhill Dumper Diesel	19	Do.	24-4-1951
20	Motor Rail Dumper Diesel	20	English XD make BD Model	27-8-1949
21	Muirhill Dumper Diesel	21	Do.	29-3-1951
22	Muirhill Dumper Diesel	22	Do.	9-9-1950
23	Muirhill Dumper Diesel	23	Do.	19-4-1951
24	Motor Rail Dumper Diesel	24	XD Make BD Model	23-7-1951
25	Muirhill Dumper Diesel	25	BD Make	19-4-1951
26	Motor Rail Diesel	26	XD Model	15-9-1949
27	Muirhill Dumper Diesel	27	BD Make	19-4-1951
28	Motor Rail Dumper Diesel	28	XD Make	15-7-1949
29	Motor Rail Dumper Diesel	29	Do.	9-9-1950
30	Muirhill Dumper Diesel	30	BD Model	26-8-1952
31	Muirhill Dumper Diesel	31	Do.	26-8-1952
32	Muirhill Dumper Diesel	32	Do.	26-8-1952
33	Muirhill Dumper Diesel	33	Do.	5-3-1953
34	Muirhill Dumper Diesel	34	Do.	8-5-1951
	VIII. Field Marshall Tractors			
1	Field Marshall No. 1		English Make	21-8-1949
2	Field Marshall No. 2	11 Nos.	Do.	12-8-1951
3	Field Marshall No. 3		Do.	24-4-1951
4	Field Marshall MSZ-9785		Do.	15-11-1949
5	Field Marshall MSZ-1205		Do.	22-2-1950
6	Field Marshall No. MSZ-2818		Do.	19-4-1951
7	Field Marshall No. MSZ-3815		Do.	14-2-1952
8	Field Marshall No. MSZ-1159		Do.	20-12-1949
9	Field Marshall No. MSZ-1047		Do.	3-1-1950
10	Field Marshall No. MSZ-1061		Do.	3-1-1950
11	Field Marshall No. MSZ-1983		Do.	3-1-1950
	IX. Rooters			
1	Le Tourneau Rooters 4 Nos.	5 Nos.	U.S.A. Make	1/50
2	Blaw Knox Rooters 1 No.		Do.	3/50
	X. Scrapers Units			
1	L.S. Carryal Scraper 4 Nos.		U. S. A. Make	1/50
2	Onion Empire Scraper 4 Nos.		11 Cyd.	1/50
3	Caterpillar 1 No.		Do.	1/50

No. 6·1·2—*contd.*

(6)	(7)	(8)	(9)	(10)
4/51	30,529 0 0	New	M/s. McLeod & Co., Calcutta.	
7/49	26,209 0 0	Do.	D.G.I.& S., New Delhi.	
4/51	26,115 0 0	Do.	M/s. Parry & Co.	
6/51	26,210 0 0	Do.	Do.	
6/51	26,792 0 0	Do.	D.G.I.& S., New Delhi.	
6/51	26,793 0 0	Do.	Do.	
6/51	26,765 0 0	Do.	Do.	
6/51	26,784 0 0	Do.	Do.	
6/51	26,940 0 0	Do.	Do.	
7/51	26,948 0 0	Do.	M/s. McLeod & Co.	
7/51	29,024 0 0	Do.	Do.	
3/51	29,025 0 0	Do.	Do.	
4/51	27,615 0 0	Do.	Do.	
8/49	29,143 0 0	Do.	D.G.I.& S., New Delhi.	
3/51	26,840 0 0	Do.	M/s. McLeod & Co.	
9/50	18,003 0 0	Do.	Do.	
4/51	16,100 0 0	Do.	Do.	
7/51	28,211 0 0	Do.	Do.	
4/51	26,798 0 0	Do.	D.G.I.& S., New Delhi.	
9/49	28,142 0 0	Do.	M/s. McLeod & Co.	
4/51	26,798 0 0	Do.	D.G.I.&S., New Delhi.	
7/49	28,580 0 0	Do.	M/s. McLeod & Co.	
9/50	36,799 0 0	Do.	D.G.I.& S., New Delhi.	
8/52	28,718 0 0	Do.	M/s. Parry and Co.	
8/52	28,211 0 0	Do.	M/s. McLeod and Co.	
9/52	28,214 0 0	Do.	Do.	
3/53	28,475 0 0	Do.	Do.	
5/51	30,845 0 0	Do.	Do.	
8/49	5,710 0 0	New	M/s. Marshall & Sons Ltd. (India).	
8/51	12,043 0 0	Do.	Do.	
4/51	11,008 0 0	Do.	Do.	Water tank mounted trailers and platform trailers.
11/49	11,065 0 0	Do.	Do.	
2/50	11,008 0 0	Do.	Do.	
4/51	10,804 0 0	Do.	Do.	
2/52	13,347 0 0	Do.	Do.	
12/49	10,876 0 0	Do.	Do.	
1/50	6,003 0 0	Do.	Do.	
1/50	6,758 0 0	Do.	Do.	
1/50	11,995 0 0	Do.	Do.	
1/50	7,936 0 0	New	M/s. Larsen Toubro Ltd.	
3/50	10,000 0 0	Do.	Do.	
3/50	26,043 0 0 each		M/s. William Jacks.	
3/50	31,902 0 0 each	New	Do.	
3/50	32,053 0 0 each	Do.	Do.	

STATEMENT

(1)	(2)	(3)	(4)	(5)
XI. SHEEPSFOOT ROLLER				
Sheepsfoot Roller (6′ Yoke × 5′ Dia)	5 Nos.	6·5 Tons (Empty)		

Trucks	
Chevrolet	35
Passenger Cars	34
Dodges	36
Fargo	29
Commer	18
Morris	16
Bedford	7
Carrier	2
Ford	5
International	1
TOTAL	163

No. 6.1.2—*contd.*

(6)	(7)	(8)	(9)	(10)
			2 Nos. Locally made and 3 Nos. manufactured at Madras Workshops.	

19—1 C. W. & P. C./57

STATEMENT

L. B. P. Headworks

Data For Cost

Sl. No.	Type of Equipment	Make, model & size	Fuel gallons per operating hour and issue rate for fuel	Oil, grease, and waste including servicing labour per operating hour	Operator wages per operating hour
(1)	(2)	(3)	(4)	(5)	(6)
1.	Euclid . .	Euclid 25 FDT Bottom Dump 13 cu. yds.	2·25×1/8/- =3/6/-	-/12/- -/5/4 1/1/4	-/13/6
2.	DW-10 Tractor .	Caterpillar DW -10 7/9 yds.	2·5×1/8/- =3/12/-	1/-/6 -/5/4 1/5/10	-/14/3
3.	19 RB Excavator .	Ruston Bucyrus 19 RB5/8 cu. yds.	0·583 gln. =1/8/-	-/12/5 -/5/4 1/1/9	-/13/8
4.	Northwest Excavator	Northwest 3/4 cu. yds.	1·0 gln. @ 1/8/-	-/5/4 -/11/2 1/-/6	-/13/8
5.	D-7 tractor . .	Caterpillar D-7	2 gls. per hr. 2×1/8/- =3/-	-/10/3 -/5/4 -/15/7	-/12/2
6.	TD-18 Tractor .	International Harvester Make	2 gls. per hr. 2×1/8/- =3/-	-/9/6 -/5/4 -/14/10	-/12/2
7.	Road Roller .	11 Ton Diesel Road Roller	1 gln. per hr. @ 1/8/- = 1/8/-	-/12/9 -/5/4 1/2/1	-/5/8

No. 6.1.3

Division, Bhavanisagar

Estimating of Machinery

Auxiliary personnel wages per operating hour	Repair parts (Spare parts) cost per operating hour	Tyres, Tubes and Flaps cost per operating hour	Sundries and Misc. cost per operating hour	Total cost per operating hour	Remarks
(7)	(8)	(9)	(10)	(11)	(12)
-/4/-	1/13/-	3/9/8	-/1/-	11/-/6	
-/12/-	4/2/8	4/1/8	-/1/-	15/1/5	
-/8/-	1/4/-	..	-/1/1	5/4/6	
-/8/-	1/4/-	..	-/1/-	5/3/2	
-/8/-	2/1/8	..	-/-/7	7/6/-	
-/2/-	3/5/4	..	-/-/6	8/2/10	
-/2/-	1/4/-	..	-/1/9	4/6/10	

STATEMENT

Public Works Department

L. B. P. Headworks

Data For Cost Accounting

Type of Equipment	Make, model and size	Per operating hour: Fuel — Gal.	Fuel — Cost	Oil grease waste	Operator wages (includes cleaners)
(1)	(2)	(3)		(4)	(5)
Euclid	1	1·33	1 12 0	0 11 0	1 1 0
	2	1·27	1 10 0	0 12 0	1 1 0
	3	1·25	1 11 0	0 10 0	1 0 0
	4	1·33	1 12 0	0 10 0	1 0 0
	5	1·32	1 12 0	0 10 0	1 0 0
	6	1·27	1 11 0	0 10 0	1 1 0
	TOTAL . .	7·77	10 4 0	3 15 0	6 3 0
	AVERAGE . .	1·30	1 11 0	0 11 0	1 1 0
DW-10	1	2·26	2 10 0	14 0	1 9 0
	2	2·26	2 9 0	1 1 0	1 10 0
	3	2·22	3 2 0	0 12 0	1 1 0
	4	2·26	3 1 0	0 12 0	1 1 0
	5	2·18	3 0 0	0 12 0	1 2 0
	6	2·06	2 14 0	0 11 0	1 2 0
	TOTAL . .	13·24	17 4 0	4 14 0	7 9 0
	AVERAGE . .	2·21	2 14 0	0 13 0	1 4 0
Excavator					
North-West	1	0·88	1 3 0	0 10 0	1 5 0
	2	0·85	1 2 0	0 12 0	1 3 0
	3	0·97	1 5 0	0 14 0	1 3 0
	4	0·83	1 2 0	0 10 0	1 7 0
	5	0·85	1 1 0	0 6 0	0 13 0
	TOTAL .	4·38	5 13 0	3 4 0	5 15 0
	AVERAGE .	0·88	1 3 0	0 10 0	1 3 0
Excavator	2	1·08	1 8 0	0 7 0	0 15 0
North-West	3	1·11	1 10 0	7 0	0 14 0
	TOTAL . .	2·19	3 2 0	0 14 0	1 13 0
	AVERAGE . .	1·10	1 9 0	0 7 0	0 15 0

No. 6.1.4

Division, Bhavanisagar
of Machinery (Actual)

per operating hour					
Auxiliary personnel wages including charges for servicing, major and minor overhauls	Repair parts (Spares)	Tyres, Tubes and flaps	Sundries and miscellaneous cost	Total	Remarks
(6)	(7)	(8)	(9)	(10)	(11)
0 9 0	2 5 0	2 3 0	..	8 9 0	
0 11 0	2 8 0	1 2 0	..	7 12 0	
0 4 0	1 4 0	1 15 0	..	6 12 0	
0 3 0	0 10 0	0 6 0	..	4 9 0	
0 3 0	0 7 0	0 3 0	..	4 3 0	
0 3 0	0 7 0	0 6 0	..	4 6 0	
2 1 0	7 9 0	6 3 0	..	36 3 0	
0 6 0	1 4 0	1 1 0	..	6 1 0	
1 2 0	4 5 0	3 1 0	..	13 9 0	
0 4 0	5 8 0	3 11 0	..	14 11 0	
0 7 0	1 7 0	2 10 0	..	9 7 0	
0 5 0	1 10 0	3 0 0	..	9 13 0	
0 6 0	1 6 0	2 5 0	..	8 15 0	
0 6 0	1 10 0	4 3 0	..	10 14 0	
2 14 0	15 14 0	18 14 0	..	67 5 0	
0 8 0	2 10 0	3 2 0	..	11 3 0	
0 9 0	2 5 0	..	..	6 0 0	
0 8 0	3 2 0	..	..	6 11 0	
0 7 0	2 1 0	..	..	6 14 0	
0 4 0	1 14 0	..	..	5 5 0	
0 4 0	0 9 0	..	..	3 1 0	
2 0 0	9 15 0	..	..	26 15 0	
0 6 0	2 0 0	..	..	5 6 0	
0 6 0	0 14 0	..	..	4 2 0	
0 7 0	1 3 0	..	..	4 9 0	
0 13 0	2 1 0	..	..	8 11 0	
0 7 0	1 1 0	..	..	4 7 0	

STATEMENT

Public Works Department

L. B. P. Headworks

Data For Cost Accounting

(1)	(2)	(3)		(4)	(5)
Euclid	7	1·47	2 6 0	0 8 0	1 0 0
	8	1·52	2 2 0	0 8 0	1 0 0
	9	1·42	1 15 0	0 9 0	0 15 0
	TOTAL	4·41	6 7 0	1 9 0	2 15 0
	AVERAGE	1·47	2 2 0	0 8 0	1 0 0
Euclid	10	1·35	1 14 0	0 8 0	1 0 0
	11	1·30	1 13 0	0 11 0	0 15 0
	TOTAL	2·65	3 11 0	1 3 0	1 15 0
	AVERAGE	1·33	1 13 0	0 10 0	1 0 0
D-7	8	2·08	2 14 0	1 1 0	1 0 0
	16	2·33	3 2 0	0 13 0	1 0 0
	TOTAL	4·31	6 0 0	1 14 0	2 0 0
	AVERAGE	2·16	3 0 0	0 15 0	1 0 0
TD.18	13	2·14	2 11 0	1 3 0	0 15 0
A.B. Roller	4	0·70	1 2 0	0 9 0	0 12 0

No. 6.1.4—*contd.*

Division, Bhavanisagar

of Machinery (Actuals)

(6)	(7)	(8)	(9)	(10)	(11)
0 3 0	0 1 0	..	..	4 2 0	
0 3 0	0 3 0	5 13 0	..	9 13 0	
0 2 0	0 2 0	..	..	3 11 0	
0 8 0	0 6 0	5 13 0	..	17 10 0	
0 3 0	0 2 0	1 15 0	..	5 14 0	
0 2 0	0 9 0	..	..	4 1 0	
0 2 0	..	2 3 0	..	5 12 0	
0 4 0	0 9 0	2 3 0	..	9 13 0	
0 2 0	0 4 0	1 2 0	..	4 15 0	
0 4 0	1 11 0	..	..	6 14 0	
0 3 0	1 3 0	..	..	6 5 0	
0 7 0	2 14 0	..	..	13 3 0	
0 4 0	1 7 0	..	..	6 10 0	
0 5 0	3 7 0	..	..	8 9 0	
0 3 0	1 3 0	..	..	3 13 0	

NOTE:—The figures are from total cost divided by total hours.

STATEMENT

L. B. P. Headworks

Data For Cost Accounting

	Type of Equipment	Make, model and size	Fuel gallons per hour and cost of fuel		Oil, grease and waste including servicing labour per operating hour	Operator wages per operating hour
	(1)	(2)	(3)		(4)	(5)
1.	Euclid Bottom Dumper 150 HP 17 cyd. heaped 13 cyd. stuck.	13/17 cyd. fitted with 150 HP Cummins.	1·30	1 11 0	0 11 0	1 0 0
2.	Do.	13/17 cyd. fitted with 200 HP Cummins.	1·47	2 2 0	0 8 0	1 0 0
3.	Do. Rear Dump . .	9·6/11 cyd. fitted with 150 HP Cummins.	1·33	1 13 0	0 10 0	1 0 0
4.	19 RB Excavator .	5/8 cyd. shovel fitted with 54 HP Ruston Engine.	0·88	1 3 0	0 10 0	1 3 0
5.	Northwest Excavator .	3/4 cyd. shovel fitted D-318 Caterpillar engine of 70 HP.	1·10	1 9 0	0 7 0	0 15 0
6.	D7 Tractor for levelling.	Caterpillar fitted with 70 HP engine.	2·18	3 0 0	0 15 0	1 0 0
7.	DW 10 Tractor-*cum*-scraper . .	Caterpillar fitted with 100 HP engine.	2·21	2 14 0	0 13 0	1 4 0
8.	TD-18 Tractor . .	International Harvester make fitted with 65 HP.	2·14	2 11 0	1 3 0	0 15 0
9.	Aveling Barford Road Roller . .	"Jessop" make fitted with Ruston Diesel Engine 50 HP.	0·70	1 2 0	0 9 0	0 12 0

No. 6.1.5

Division, Bhavanisagar

of Machinery (Actuals)

Auxiliary personnel wages per operating hour	Repair parts (spare parts) cost per operating hour	Tyers, tubes and flaps cost per operating hour	Sundries misc. cost per operating hour	Total per operating hour	Remarks
(6)	(7)	(8)	(9)	(10)	(11)
0 6 0	1 4 0	1 1 0	..	6 1 0	
0 3 0	0 2 0	1 15 0	..	5 14 0	
0 2 0	0 4 0	1 2 0	..	4 15 0	
0 6 0	2 0 0	..	..	5 6 0	
0 7 0	1 1 0	..	..	4 7 0	
0 4 0	1 7 0	..	..	6 10 0	
0 8 0	2 10 0	3 2 0	..	11 3 0	
0 5 0	3 7 0	..	..	8 9 0	
0 3 0	1 3 0	..	..	3 13 0	

STATEMENT

L. B. P. Headworks

Unit Cost

Distance in miles	Cycle time	Rate per hour: Working expenses	Rate per hour: Spares	Rate per hour: Depreciation	Work done per hr. in cu. ft.	Rate per 1,000: Excavation and Loading
					D.W. 10 *Tractor*-cum-*Scraper II Cyds.*	
3/4 mile	18	5 7 0	5 12 0	7 4 0	275×60 / 18 =917 cft.	1000×5/7/- / 917
Additional charges.	1. Pusher Unit					0 15 0
	2. Consolidation charges					
					Euclid Bottom Dumper—13 *Cyds. loaded by Excavator*	
1 mile	23	3 12 0	2 5 0	7 1 0	350×60 / 23 =913 cft.	3/12/-×1000 / 913 =10 12 0
1½ miles	27	3 12 0	2 5 0	7 1 0	350×60 / 27 =778 cft. =	3/12/-×1000 / 778 =10 12 0

No. 6.1.6

Division, Bhavanisagar

of Earthwork

cubic feet loose

Transport	Unloading & levelling on embankment	Spares	Depreciation	Watering charges per 1,000 cu. ft.	Consolidation charges per 1,000 cu. ft.	Total per unit of 1,000 cu. ft. loose
		$\frac{1000\times5/12/-}{917}$	$\frac{1000\times7/4/-=}{917}$	Nil	Nil	20 1 0
5 14 0		6 4 0	7 15 0			
		0 4 0		1 12 0		2 15 0
				3 3 0	4 6 0	7 9 0
		Total per 1000 cu. ft. loose.				30 9 0
		Add 50% to get rate for compacted unit.				15 4 6
					TOTAL	45 13 6
3/4 cu. yds.	$\frac{2/5/-\times1000}{913}$		$\frac{7/1/-\times1000}{913}$			
4 2 0	1/13/=2	2 9 0	7 12 0	3 3 0	4 11 0	34 10 0 per loose unit.
		Add 50% to get rate per compacted unit.				17 7 0
					TOTAL .	52 5 0
	$\frac{2/5/-\times1000}{778}$		$\frac{7/1/-\times1000}{778}$			
4 13 0	1 13 0	3 0 0	9 1 0	3 3 0	4 11 0	37 5 0
			Add 50 per cent.			18 10 6
				Rate per compacted unit		55 15 6
					Or	56 0 0

STATEMENT No. 6.1.7

L. B. P. Headworks Division, Bhavanisagar

Subhead-wise Reserve Limit of Stock and the Balance as on 30-9-53

Serial No.	Name of Sub-head	Reserve limit	Closing balance as on 30-9-53	Remarks
1	Cement	1,75,000	Nil	
2	Building materials	24,000	30,145 15 0	
3	Timber	50,000	31,514 9 3	
4	Metals	7,50,000	6,00,397 14 0	
5	Fuel	50,000	45,178 10 10	
6	Painters stores	11,000	10,423 4 7	
7	Miscellaneous general . .	1,10,000	83,685 5 9	
8	Lubricants	40,000	44,831 4 9	
9	Pipes & specials	1,40,000	2,09,133 13 3	
10	Electricals	50,000	53,447 9 9	
11	Machinery spares	11,00,000	8,51,041 10 7	
			19,59,800 1 7	

STATEMENT No. 6.1.8

Size	Ply.	Machine	Life in hours	Position	Cost per tyre	Average cost per hour
(1) 21·00×24 .	20	Euclid Bottom Dumper	6,000	Driving & Rolling	5070	0 13 6
(2) 11·00×24 .	14	Do.	5,500	Front	1100	0 3 2
(3) 21·00×24 .	20	DW-10	5,600	Driving & Rolling	5070	0 14 6
(4) 12·00×20 .	14	Do.	5,200	Front	1170	0 3 7
(5) 13·00×24 .	16	Aveling Barford	Not reserved so far	Front	1800	..
(6) 14·00×24 .	20	Do.	..	Front	1800	..
(7) 13·00×24 .	8	Muirhill Dumper	4,200	Rear	1800	0 6 10
(8) 31·00×9 .	8	Do.	3,700	Front	357	0 1 7
(9) 14·00×28 .	8	Field Marshall	4,000	Rear	790	0 3 2
(10) 0·00×19 .	6	Do.	4,000	Front	159	0 0 8

APPENDIX 6.2

Tungabhadra Project

The project is now controlled by the Tungabhadra Control Board under the Chairmanship of Shri Kanwar Sain, I.S.E. The participating Governments are Hyderabad on the left and Mysore/Andhra on the right. The general information about the project is given below:

Catchment Area	10,880	sq. miles
Maximum flood gauged	3·3	lakh cusecs
Maximum flood provided	6.5	lakh cusecs
Maximum water spread	133	sq. miles
Rainfall at the dam	20	inches
Rainfall in the catchment	41	inches
Capacity of lake	1,33,000	M. cft.
Length of Dam		
Non-spillway section	3,642	ft.
Spillway section	2,300	"
Earthen Dam	450	"
Composite	1,550	"
TOTAL	7,942	ft.
Height of the dam from deepest foundation	160	ft.
Earth Dam Maximum	70	"
Gates spillway 33 Nos. 60'×20'		
Contents of masonry in the dam	32	M. cft.
Contents of earth in the dam	10	M. cft.

Low level canal 267 miles long; area 2,91,000 acres.

Left bank canal 215 miles long.

Capacity of the power house, 4 Nos. : 9,000 K.V.A. of which three are to be constructed immediately and the fourth will be constructed later.

Mysore/Andhra Side

The power house at the canal will be constructed at the 8th mile of the canal for a discharge of 2,500 cusecs and a head of 110 ft. with three generators of 9,000 K.V.A. capacity each.

The dam is almost completed. It requires relatively very little earthwork. Most of the canal work was done by manual labour. At the deep cuttings labour was assisted by cranes for lifting 1 cu. yd. wagons loaded with debris. The wagons were shunted away by rail lines at ground level to the spoil banks. The deep embankments were done by earth-moving machinery. The basic rates of earthwork were as under :

Earth	Rs. 20 to Rs. 24 per 1,000 cft.
Soft rock	Rs. 40 per 1,000 cft.

The wages of the unskilled labour was Rs. 1-2-0 per day ; those of masons varied from Rs. 2-12-0 to Rs. 3-8-0.

Dam

The dam is constructed of granite masonry. Cement mortar is used for the lower part of the dam and the spillway section and line mortar for other parts of the dam. The cement mortar is 20% surkhi and 80% cement with 2·75 part of sand. The sand is brought by rails from a distance of 25 miles. The lime surkhi mortar is 2 of sand to 2 surkhi to 1 of lime. Good lime is available locally at Rs. 60 per 100 cft. and is burnt at site intermitent kilns.

The value of the Spl. T. & P. on the Mysore/Andhra side for the canal and the dam was Rs. 56 lakhs. The value of the spares held is not accurately known. Stationary compressors of 500 cfm. capacity left over at Mettur, were repaired and installed for this work at a central compressed air station.

The maximum strength of labour on the dam was 20,000, most of whom had to be imported from elsewhere through a special recruitment agency. The construction town provides the following housing accommodation; 8,000 temporary hutments for labour, 1,000 for permanent unskilled labour, 1,000 for mistries, mechanics etc., and 200 for officers. The job workers provide their own hutments. The cost of the project is as under:

Land	Rs. 2·3 crores
Works	Rs. 3·9 crores
Total cost of Headworks	Rs. 8·0 crores
Canals	Rs. 12·0 crores
GRAND TOTAL	Rs. 26·2 crores

The total cost of canal and the headworks on the Hyderabad side is estimated to be nearly Rs. 25 crores. Gates for the spillway and regulation are manufactured for both the sides of the project in a workshop specially set up at the project.

Machinery

The statistics of equipment on the project are given in Statement No. 6.2.1.

The operating cost per hour of equipment is given in Statement No. 6.2.2.

The percentage utilization of equipment for canals and headworks is given in Statement No. 6.2.3.

More detailed information about cost accounting could not be obtained as the work has closed down and there has been a great amount of reorganisation and transfer of records consequent to the transfer of the project from Madras to Mysore/Andhra State.

Hyderabad Side

The machinery is situated at three different places; (1) dam site at Munirabad; (2) canal construction division No. 2, Gangavati; and (3) canal circle Yermarus. The major portion of the machinery is at the dam.

The information regarding the capital equipment at the project is given in Statement No. 6.2.4.

The information about the estimated and the actual costs of operating the equipment is given in Statement No. 6.2.5.

The life adopted for calculating the depreciation is given below:

Machine	Estimated life		Percentage Depreciation
	Years	Hours	Per year
Manitowac Dragline	10	20,000	10
Laplant Choate Scraper	5	10,000	20
Letourneau Tournapull	5	10,000	20
Letourneau Super 'C' Tournadozer	5	10,000	20
Caterpillar No. 12 Motor Grader	5	10,000	20
Caterpillar D.W. Tractor with PD. 10 Dumper	5	10,000	20
Caterpillar D.8 Tractor	10	20,000	10
Caterpillar D.7 Tractor	10	20,000	10
Caterpillar D.6 Tractor	10	20,000	10
Caterpillar D.4 Tractor	10	20,000	10
Bucyrus Eric Crane (Shovel)	10	20,000	10
Chaseside Lifter Shovel	5	10,000	20
Muir Hill Dumper	5	10,000	20
Diesel Road Roller 10 tons	10	20,000	10
Diesel Road Roller 6 tons	10	20,000	10
Carry all Scraper	5	10,000	20
Rooter	10	20,000	10
D.7 Tractor mounted with Trackson Pipe Layer	10	20,000	10
Jones Crane 2 Ton (Cap)	10	20,000	10

The Executive Engineer made some valuable suggestions regarding the procurement of spare parts which we quote below:

"The present procedure is to obtain the spares through the Central Stores Purchase Office of Commerce and Industries Department which necessarily means delay in the supply of spares. This procedure is not suited for the project works particularly in the case of earth-moving machinery as the loss by the way of lay off of the machinery is considerable."

"The procedure suggested is that the Executive Officer under whose control the machinery is working should be given the powers to effect direct purchases and passing of the firm's bills to any limit, from the approved suppliers without the medium of any other Government Agency provided proper sanction is there. Alternatively the Executive Officer under whom the machinery is working be delegated with the powers of stocking the spares in reserve to 40% of the value of the plant and machinery on the field. This figure of stock suspense would be beyond the limits of Government Stores. As such it is very essential to use equipments in India of which the suppliers guarantee to keep all the spares in sufficient quantity which could be treated as bulk stores on which the indenting officer can rely for emergency supplies."

The skilled personnel employed on operation and maintenance is given below :

Labour Required During Operation

Operation

Machine	*Operators*	
4 Scrapers	4	
2 Dozers	2	
1 Grader	1	
1 D. 7 Tractor	1	
1 Water Lorry	1	
	9	
Attendants	2	one at the quarry and the other at site of work.
Time-Keepers	2	
	13	

Labour for Servicing and Running Repairs

Mechanic	1
Fitter	1
Electrician	3
Assistants	5
Time-Keeper	1
Store Attendant	1
Chargeman	1
	11

Labour Required for Repairs

Chargeman	1
Mechanic	1
Fitter	1
Assistants	3
Electrician	1
Store Attendant	1
Time-Keeper	1
Chowkidars	3
	12

History Sheets and Log Books

Daily machine reports give particulars regarding the total number of hours, actual plant hours, the fuel consumption, lubricants used and the output of each machine during the working period.

The History Book of the machines gives the particulars regarding the plant hours, the fuel and lubricants consumption, the replenishment of spare parts, tyres, tubes and the nature of repairs carried out by the workshops.

The History Sheets of the plant contains full description of the specifications of the equipment, parts supplied, date of receipt, value and service particulars. The book also gives the amount of hire charges recovered, expenditure on maintenance and special repairs. The information is abstracted from the log books, annual maintenance and special repair estimates.

Job Card system of accounting is maintained for the particulars of spare part issued and the repair charges incurred.

Machines are often given on hire to contractors. Plant hour is therefore, defined as the gross hours for which the machine was on duty.

STATEMENT

MADRAS

PROFORMA

Statistics on the Working of Earth-moving Machinery

Serial No.	Name of machine with its project identification number	Total landed cost in Rs.	Total number of hrs. worked up to 1-4-52	Total number of hours machine could have worked if weather conditions had permitted	Total number of hours machine has been lying idle	
					For major repairs	For periodical overhaul
1	2	3	4	5	6	
I.	*Excavators Dragline*					
1.	Lima Excavator No. 5244 with dragline attachment with a 2½ cu. yd. bucket and 80 ft. boom.	3,24,000	1150	2200	Break-up not available both clubbed together. 1050	
2.	Marion Excavator with 1½ cu. yd. draglines bucket boom length 80 ft.	2,26,000	1513	3800	2287	
3.	P & H Excavator No. 13151 dragline with bucket 1½ cu. yd.	1,28,000	1087	2200	1113	
4.	P & H Excavator 3/4 cu. yd. dragline.	72,000	2394	5200	2806	
5.	P & H Excavator 3/4 cu. yd. dragline.	72,000	1105.5	3900	2798.5	
II.	*Excavators Shovels*					
1.	Lima Excavator No. 5244 with shovel attachment cap. 3½ cu. yds.	3,24,000	1510·½	2200	683·½	

No 6·2·1

SIDE

in Tungabhadra Project Canals Circle, Bellalry

Cost per unit output or per hour inclusive of depreciation interest on capital, overhauls, repairs and maintenance.	Average lead and lift and nature of soil for which figure in the previous column refers.	Cost per unit output or per hour as per project estimate (Manual labour)	Remarks
7	8	9	10
Rs. 27/14/- per solid unit of 1,000 cft.	Canal excavation in slushy soil classification ranging from black cotton soil to soft disintegrated rock with an average of one extra lead & four extra lifts.	Rs. 45 per unit	Idleness is due to welding of teeth for the bucket, snapping of bucket rope engine trouble, time lost in shifting machine in slushy ground and servicing.
Rs. 30 per unit (solid) .	Canal excavation in slushy soils classification ranging from S. B. C. to S. D. R. with an average of one, extra lead and four extra lifts.	Rs. 45 per unit	Machine was under repairs, swing clutch broken rotary-seal damaged.
Rs. 15/4/- per solid unit .	Canal excavation in hard red earth and gravelly soil with initial lead and lift.	Rs. 24/6/- per unit.	Idleness is due to the time lost in shifting of machine and servicing.
Rs. 19/11/- per solid unit .	Excavation in borrow pits in stiff black cotton soils and loading into dumpers.	Rs. 23 per unit	Machine is sick.
Rs. 15/10/- per solid unit .	Excavation in borrow pits in S. B. C. and loading into dumpers.	Rs. 23 per unit	Machine is sick and sent to Headworks for repairs.
Rs. 12/12/- per solid unit .	Excavation in borrow pits in hard stiff clay and red earth loading in dumpers and dumpers wagons etc.	Rs. 24/6/- per unit	Idleness is due to engine trouble, time lost in shifting machine in slushy soil and servicing

STATEMENT

1	2	3	4	5	6
2.	P & H Excavator 3/4 cu. yd. shovel	72,000	966	1700	734
		12,18,000	8727	21200	
III.	*Hauling Machinery : Dumpers*				
1.	Euclid bottom dumper No. 6018 cap. 13 cu. yd.	1,24,000	1,583	2,400	817
2.	Euclid bottom dumper No. 6019 cap. 13 cu. yd.	1,24,000	1,133	2,400	1,267
3.	Euclid Rear dumper cap. 10 cu. yd.	1,46,000	648	800	152
4.	D. W. 10 dumper wagon cap. 14 cu. yd. heaped.	78,000	1,822	2,200	378
5.	A. B. Dumper No. 00379 cap. 4½ cu. yd.	35,000	845	1,400	555
6.	A. B. Dumper No. 00380 cap. 4½ cu. yd.	35,000	1,822	3,000	1,178
7.	A. B. Dumper No. 00384 cap. 4½ cu. yd.	35,000	2,012	3,000	988
8.	Tourneau rocker E. 92213 cap. 8 cu. yd.	84,000	792	2,200	1,408
9.	Tourneau rocker E. 2215 cap. 8 cu. yd.	84,000	384	2,200	1,816
10.	Tourneau rocker 2218 cap. 8 cu. yd.	84,000	700	2,200	1,500
11.	Koehring dumper No. 31533 cap. 6 cu. yd.	16,600	847·5	2,800	1,952·5
			12,588·5		

AVERAGE=1144·4 hrs.

No. 6·2·1—*contd.*

7	8	9	10
Rs. 14/2/- per solid unit .	Excavation in borrow pits in hard stiff black cotton soil and loading into dumpers.	Rs. 23 per unit	Machine is sick and sent to Headworks for repairs.
Rs. 20/14/- per solid unit .	Conveying loaded earth and dumping on the bund with a lead of 0 to 6 furlongs and a lift of 5 to 25 above G.L.	Rs. 57 per unit	
Rs. 22/15/- per solid unit .	Conveyance of excavated earth and dumping on the banks with an average lead of 6 furlongs and lift of 5′ to 25′ above G. L.	Rs. 57	
Rs. 34/3/- per solid unit .	Do.	Rs. 57	
Rs. 19/3/- per solid unit .	Do.		
Rs. 77/10/- per solid unit .	Conveyance of dumped earth & depositing on the bank with a lead of one mile.	Rs. 82/8/- per unit	
Rs. 54 per solid unit .	Do.	Rs. 82/8/- per unit.	
Rs. 63/6/- per solid unit .	Do.	Rs. 82/8/- per unit.	
Rs. 46/1/- per solid unit .	Conveyance of dumped earth and depositing on the bank with a lead of 4 furlongs.	Rs. 57 per unit	Sick due to steering motor trouble.
Rs. 47/1/- per solid unit .	Do.	Rs. 57	Rear axle bearing replace.
Rs. 58/10/- per soild unit .	Conveyance of dumped earth and depositing on the bank with a lead of 4 furlongs.	Rs. 57 per unit	Gear lever, knob repaired.
Rs. 20 per solid unit .	Conveyance of dumped earth and depositing on the bank with a lead of 0 to 7 furlongs.	Rs. 82/8/- per unit	

STATEMENT

1	2	3	4	5	6
IV. *Scrapers*					
1.	D. W. 10 No. 1 tractor with scraper attachment.	85,000	1,654	3,500	1,846½
2.	D. W. 10 No. 2 tractor with scraper attachment.	85,400	1,752	3,100	1,348
3.	D. 7 Tractor 3T 13582 with 10 cu. yd. scraper attachment caterpillar No. 70.	75,000	1,087	1,800	713
4.	H. D. 10 W. Allis Chalmer Tractor No. 9643 with Blawknox Scraper 8 cu. yd.	84,000	324	1,100	776
5.	H. D. 10 W. Allis Chalmer Tractor No. 9644 with 8 cu. yd. Onion Scraper attached.	84,000	960	2,400	1,448
			5,777		
	AVERAGE=1155.4 hrs.				
6.	D.7 Tractor with Bull-Dozer . .	35,000	..	..	..
V. *Road Rollers*					
1.	10 ton A.B. Roller No. ING D. 209 .	31,000	1,304	2,200	896
2.	10 ton A.B. Roller No. ING D. 313 .	31,000	632	1,200	568
			1,936	3,400	
	AVERAGE=968 hrs.				

No. 6·2·1—*contd.*

7	8	9	10
Rs. 38/8/- per solid unit .	Scraping earth in stiff clay and red earth and conveyance with a lead of IM 4F and depositing on the bank in thin layers.	About Rs. 120 to 140 if done by manual labour & carts.	The machine was lying sick.
Rs. 36/7/- per solid unit .	Scraping earth in stiff clay & red earth and depositing on bank with a lead of IM.	About Rs. 120 to 140 if done by manual labour and carts.	
Rs. 9/5/- per solid unit .	Scraping earth in S. B. C. & gravel & conveying with a lead of 3 F. & depositing on banks in thin layers.	Rs. 73 per unit.	
Rs. 37/8/- per solid unit .	Scraping earth in hard gravel and conveying with lead of 1½ to 2 F. and depositing on the banks in thin layers.	Rs. 73/4/- per unit	Machine is sick.
Rs. 18/9/- per solid unit .	Scraping earth in S. B. C. and hard red earth and conveying with a lead of 3 to 6 furlongs and depositing on banks in thin layers.	Rs. 73/4/- per unit.	Sick, repairs to steering and clutch etc.
Rs. 15 per unit . .	Bulldozing and depositing on banks with a lead of average 1½ furlongs in S. B. C.	Rs. 48 per unit.	
Rs. 10/8/- per solid unit .	Rolling the earth spread in layers.	Rs. 16 per unit.	
Rs. 4/3/- per solid unit .	Do.	Rs. 16 per unit.	

STATEMENT

1	2	3	4	5	6
VI.	*Air Compressors*				
1.	500 cu. ft. Compressor (new) . .	50,000	170	184	14
2.	210 cu. ft. Compressor . . .	33,000	888	2,000	1,112
			1,058	2,184	
	AVERAGE=529 hrs.				
VII.	*Stone Crushers*				
1.	Petrol Crusher No. E/M 8909 . .	5,000	1,476	4,600	3,124
2.	Diesel Crusher No. 3736D . . .	5,000	649	..	..

No. 6·2·1—*concld.*

7	8	9	10
Rs. 11/1/- per hour . .	Used for drilling operations for tunnel works.	No information is available.	
Rs. 4/3/- per hour . .	Used for vibrating concrete and foundation and excavation in rocks etc.	Do.	
Rs. 13/4/- per unit . .	Crushing 4" to 6" rubble into metal size 1½" to 2" and below.	Rs. 45 per unit.	
Rs. 11/12/- per unit . .	Do.	Rs. 45 per unit.	Complete details are not available regarding hours of work.

STATEMENT

T. B. P.

Data for Cost Estimating

(Cost per

Type of equipment	Make, model and size	Fuel gallons per operating hour and issue rate for fuel	Oil, grease and waste including servicing labour per operating hour (Rs.)	Operator wages per operating hour (Rs.)
1	2	3	4	5
I. Excavating machinery.	(*a*) Lima Model 1201 Excavator No. 5245.	H. S. D. Oil 3.5 Gallons @ Rs. 1/8/- per Gal.=Rs. 5/4/-.	2 9 0	1 14 0
	(*b*) Marion Excavator with caterpillar D. 17,000 Engine, Type 93-M Excavator No. 9675.	H.S.D. Oil 2.4 Gals. @ Rs. 1/8/- Gallon= 3/10/-.	1 0 0	0 11 6
	(*c*) P. & H. 655-B Excavator 13152.	H.S.D. Oil 2½ Gallons @ Rs. 1/8/- per Gal.=3/12/-.	2 6 6	1 6 0
II. Scrapers Motorised	D.W. 10 Tractor with No. 10 Scraper Combination+D. 6 Pusher 1/2 No.	H.S.D. Oil 3¼ Gallons @ Rs. 1/8/- per Gal. = 4/14/- 1⅔ Gal. H. S. D. Oil per hour= Rs. 2/8/- for ½ No. 1/4/-	2 12 0 0 14 0	1 4 0 0 10 0
III. Tractors (Crawler Type).	(*a*) D.7 Tractor with Dozing Attachments.	H.S.D. Oil 2.2 Gallons /hr. @ Rs. 1/8/- per Gal.= Rs. 3/5/-.	0 14 0	1 4 0
	(*b*) D.7 Tractor with Scraper attachment.	H.S.D.Oil 2¾ Gallons hr. @ Rs. 1/8/- per Gal.=4/2/-.	1 9 0	1 4 0
IV. Transporting or hauling machinery	(*a*) Caterpillar D. W. 10 Tractor with No. 10 Wagon 8.9/14 cu. yd. capacity.	2 Gal. H.S.D. Oil /hr. @ Rs. 1/8/- per Gal.= Rs. 3/-/-	1 4 0	3 2 0

No. 6·2·2

CANALS

of Machinery (Actuals)

operating Hour)

Auxiliary personnel (wages per operating hour) (Rs.)	Repair parts (Spare Parts Cost per operating hour) (Rs.)	Tyres, tubes & flaps (Cost per operating hour) (Rs.)	Sundries and Misc. (Cost per operating hour) (Rs.)	Total cost per operating hour (Rs.)	Remarks
6	7	8	9	10	11
1 0 0	0 8 0	..	0 1 0	11 4 0	
0 5 0	0 1 0	..	0 0 6	5 12 0	
1 1 0	0 5 0	..	0 0 6	8 15 0	
1 9 0	0 8 0	3 9 0	0 1 0	1 · 9	
0 4 0	0 4 0	..	..	3 4 0	
0 10 0	1 3 0	..	..	7 4 0	
0 8 0	0 0 0	0 14 0	0 1 0	9 0 0	
0 14 0	1 3 0	1 14 0	0 3 0	11 8 0	

STATEMENT

1	2	3	4	5
	(*b*) Euclid Bottom Dumps 25 F.D.D./ 58-W. 13/14-cu. yd. capacity.	H.S.D. Oil @ 1.5 Gal. @ Rs. 1/8/- per Gal.=Rs. 2/4/-.	0 7 0	1 5 0
	(*c*) Euclid Rear Dump 9.7/11.4 cu.yd. capacity Model B-5 F.D.	H.S.D. Oil 1.7 Gal. /hr.@ Rs. 1/8/- per Gal. = Rs. 2/9/- . . .	0 8 0	1 9 0
	(*d*) Tourna Rocker 7 cu. yd. 9 Tons G. M 8 T.D. Roadster E. 9 Rocker.	H.S.D. Oil 1.7 Gallons @ Rs. 1/8/- per Gal.= Rs. 2/9/- . . .	0 9 6	1 5 6
	(*e*) A.B. 4½ cu. yd. Shuttle Dumpers with 4 A.J. Dorman Diesel Engine.	H.S.D. Oil 0.4 Gal. /hr. @ Rs. 1/8/- = Re. -/9/6 . .	0 1 6	0 10 6
	(*f*) Balmer Lawrie Dumpers Type BD DA. with perkins Diesel Engine.	H.S.D. Oil 0.5 Gal. /hr. @ Rs. 1/8/- =Re. -/12/- ..	0 13 0	0 11 6

No 6·2·2—*contd.*

6	7	8	9	10	11
0 5 0	0 9 0	1 12 0	0 2 0	6 12 0	
0 7 0	0 4 0	1 12 0	0 1 0	7 2 0	
0 8 0	0 7 0	2 0 0	0 1 0	7 8 0	
0 12 0	0 6 6	1 8 0	0 2 0	4 2 0	
1 7 0	5 0 0	1 8 0	0 0 6	10 4 0	

STATEMENT

Data for Cost Estimating

(Cost per

MYSORE/

"HEAD

Type of Equipment	Make, model and size	Fuel gallons per operating hour and issue rate for fuel (Rs.)	Oil grease and waste including servicing labour per operating hour (Rs.)	Operator wages per operating hour (Rs.)
1	2	3	4	5
D. 7 Tractor Bull-Dozer	(*a*) Caterpillar American Car Foundry Co., Diesel Run petrol Starter.	2-14-0 840 (Gallons H. S. D. Oil @ 1-7-0 per gallon and 4 gallons petrol @ Rs. 3-2-0 —Rs. 1220 for 426 hours. *i.e.*, 2 gals. H.S.D. oil per hour.)	0 10 0	1 0 0
	(*b*) Massey Harris 4 wheeled Tractor Perkins Diesel.	2-14-0 (H. S. D.oil, 4 miles per gal. and 8 M. P. H. @ Rs. 1-7-0 per gallon.)	0 6 3	0 7 3
Lima G. M. Engine Diesel.	Model No. 3055C Built by Lima Locomotive Works Engine Shovel and Crane Division 62 H. P. Capacity of Bucket 3/4 cu. yd.	2-2-0 (H. S. D. oil @ 1-8-0 per gal. 200 gallons for 140 hrs. *i.e.*, 1.4 gals/hour.)	0 7 0	1 10 0
Koehring Dumper G. M. Engine D esel Driven 4 Cylinders 50 H. P.	U. S. A. Model 471 R.C. 34.	1-13-0 (0.9 gal. per hour @ 1-7-0 per Gallon H. S. D. Oil 1-5-0 C Oil @ 7-8-0 per gal. 13 gals. for 197 hours = 0-7-11/hour = 1-5-0 + 0-7-11 = 1-12-11 or Rs. 1-13-0.)	0 8 0	0 14 0
Muir Hill Dumper, petrol Driven 30 H. P. Bucket 50 Cu. ft. Fordson Engine.	30 H. P.	2-4-0 (Petrol @ 3-2-0 per gal on 106-1/2 gallons for 148-1/2 hrs. = 332-12-10 for 148-1/2 hours =2-4-0 per hour *i.e.*, 0.7 gal. hours.)	0 4 6	0 15 6

No. 6·2·2—*concld.*

of Machinery (Actuals)

Operating Hour)

ANDHRA SIDE

WORKS"

Auxiliary personnel wages per operating hour (Rs.)	Repair parts Spare parts (Cost per oprea-ting hour) (Rs.)	Tyres, tubes & flaps (Cost per operating hour) (Rs.)	Sundries and misc-ellaneous (Cost per operating hour) (Rs.)	Total cost per opera-ting hour (Rs.)	Remarks
6	7	8	9	10	11
0 4 0	4 5 0	..	0 8 0	9 9 0	
0 6 0	0 4 0	0 13 4	0 1 2	5 4 0	
0 7 0	3 4 0	..	0 8 0	8 6 0	
0 8 0	0 6 0	2 0 0	0 8 0	6 9 0	
0 7 0	0 12 0	1 8 0	0 7 0	6 10 0	

STATEMENT

MYSORE

Tungabhadra Project—Percentage Utilisation of

Sl. No.	Type of Equipment	Numbers	Make, Model and Size	Life period in terms of working hrs. adopted for calculating depreciation
1	2	3	4	5
I	Excavators	1	Lima 1201 Type Excavator No. 5244.	24,000
		1	Lima 1201 Type Excavator No. 5245.	24,000
			Marion Excavator Type 93-M (with boom length 80/) No. 8975.	18,000
		1	Marion Excavator Type with boom length 70/, No. 9675.	18,000
		1	P. & H. Excavator Model 655B No. 13151.	18,000
		1	P. & H. Excavator Model 655B No. 13152.	18,000
		1	P. & H. Excavator Model 255A No. 12108.	10,000
		1	P. & H. Excavator Model No. 12106.	10,000
II	Scrapers		D. W. 10 Tractor with No. 10 Scraper combination *Motorised* I. V. 1139.	12,000
			I.V. 1294 . . .	12,000
			Letourneau Scraper 8 *cu. yd.*	
			L. S. J.	24,000
			L. S. J.	24,000
			L. S. J.	24,000
			Onion Scraper 8 *cu. yd. Model E. K.* 9.	
			(*i*)	24,000
			(*ii*) .	24,000
			Caterpillar Scraper 8 *cu. yd.*	
			Model No. 70	24,000

No. 6·2·3

ANDHRA SIDE

Equipment—"CANALS"

Theoretical working hrs. for plant that could have been possible up to 30-4-1953	Actual working hrs. put in up to 30-4-1953 nearest to 100 working hours.	Remarks explaining difference between actual working hours (col. 6) and Maximum possible working hours (col. 5)
6	7	8
7,200	4,700 (from log books)	Machine could not do full work due to slushy condition of ground, snapping of bucket and boom ropes propel chain and decarbonizing and repairs to jackshaft.
6,400	4,000 (from log books)	Engine went out of order in the initial stages during trial run by firm's representative, due to damage to radiator and buffer spring in the shovel boom, snapping of propel chains and due to shifting from place to place.
7,400	2,500 (from hour meter)	Slushy conditions, Engine trouble, idle for want of dumptors, winch trouble and due to intermittent work as a crane.
1,200	950	Main Clutch bearing failed.
7,600	3,300	Time lost in transit due to shifting from place to place.
7,600	2,900	Damage to boom and front end due to accident.
10,800	2,400	Sick for a long time for want of spares.
10,400	2,700	Do.
7,800	3,600 (from hour meter)	Repairs to bowl—no pushing unit for a long time—hard soils—want of tyres.
6,000	3,400 (from hour meter)	Hard soils—want of tyres and piston and Engine replacements.
3,400 3,400 6,800	2,500 2,500 4,500	For want of continuous work and tractors not being readily available and periodical slushy condition of soil due to rains.
5,200 4,800	3,200 2,800	Non-availability of Tyres.
10,400	6,000	Failure of shroud bearing, non-availability of blades.

21—I. C. W. & P. C. 57.

STATEMENT

1	2	3	4	5
III	Tractors (*A. Crawler Type*)	..	*D. 7. Tractor with dozing attachment* 7-M 7181 S.P.	10,000
			3-T. 8515	10,000
			3-T. 7961	10,000
			3-T. 13582	10,000
			3-T. 13583	10,000
			3-T. 13584	10,000
			3-T. 13585	10,000
			3-T. 13586	10,000
			3-T. 13587	10,000
			D. 7. Tractor without dozing attachment.	
			3-T. 18427	10,000
			3-T. 20034	10,000
			3-T. 20035	10,000
			3-T. 20899	10,000
			D. 8 Tractor S. No. 8 R.	
			3802	10,000
			D. 6. Tractor with dozing attachment.	
			8. U. 2890	10,000
			8. U. 2899	10,000
			David Brown Crop Master.	
	Tractors (*B. Wheel Type*)		No. 13754	10,000
			McCormick Tractor W.D.9.	
			M.D.B. 1134	3,000
			M.D.B. 1006	10,000

No. 6·2·3—*contd.*

6	7	8
10,000	3,500 (from hour meter)	Due to greater attention required machine being old.
10,000	3,100 (from hour meter)	Due to work in sandy reaches sprockets and track pins and bushes worn out rapidly and they could not be readily replaced.
10,000	4,800 (from hour meter)	Sick for a long time for want of tracks.
5,200	3,900 (from hour meter)	Time lost in servicing and minor repairs.
5,200	4,100 (from hour meter)	Do.
5,200	3,900 (from hour meter)	Do.
5,000	4,100 (from hour meter)	Do.
5,000	4,000 (from hour meter)	Do.
5,000	4,700 (from hour meter)	Do.
2,200	2,000 (from hour meter)	..
900	900 (from hour meter)	Excess is due to working in two shifts.
1,100	1,100 (from hour meter)	Do.
300	300 (from hour meter)	Do.
1,800	1,100 (from hour meter)	Idle for want of P.C.U. and draw bar bracket.
6,800	2,400 (from hour meter)	No regular work—Old winch requires constant repairs—dozing attachment received late—worked only for hauling sheepsfoot roller.
6,000	3,800 (from hour meter)	Worked as a pusher for two motorised scrapers, pushing attachment has to be improvised.
3,000	1,100 (from hour meter)	No regular work. Worked as scarifier whenever required.
7,600	3,000 (from log books)	Being a hauling unit used only whenever required.
7,600	3,000 (from log books)	Do.

STATEMENT

1	2	3	4	5
	Transporting or Hauling Machinery.	..	Caterpillar D.W.10 Tractor with No. 10 Wagon 8.9/14 cu. yd. capacity.	
			I.V. 1450	10,000
			I.V. 1451	10,000
			I.V. 1456	10,000
			I.V. 1627	10,000
			D.W.10 Tractor with Wagon 1 No. 2186.	10,000
			Euclid Bottom Dumps 25 F.D.T. 13/14 cu. yd. 58 W 6018.	12,000
			58 W. 6019	12,000
			Euclid Rear Dump 9.7/11.4 Model B. 5 F.D.	12,000
			Tourna Rocker 7 cu. yd. G. M. 8 T. D. Roadster E.9 Rocker.	
			T.R. 2214E. 9	10,000
			T.R. 2215E. 9	10,000
			T. R. 2216E. 9	10,000
			T.R. 2217E. 9	10,000
			T.R. 2218E. 9	10,000
			Aveling Barford 4½ cu. yd. Shuttle Dumpers with 4 A. J. Dorman Diesel Engine.	
			S.A. 00379	10,000
			00380	10,000

No. 6·2·3—*contd.*

6	7	8
5,400	1,200 (from hour meter reading)	Initial stages—Idle for want of work. Idle for want of tyres and replacement of pistons.
5,400	2,000 (from hour meter reading)	For want of work in initial stages. Idle for want of steering seal and pistons.
5,400	2,700 (from hour meter reading)	Do.
4,800	4,100 (from hour meter reading)	Idle for want of replacement of piston.
600	300 (from hour meter reading)	Being old, gave constant trouble (Steering column seal, brake system).
5,000	3,900 (from log books)	Time lost in servicing, replacement of clutch bearings, injector.
5,300	5,300 (from log books)	No major repairs—worked extra hours for urgent works.
3,800	3,800 (from log books)	Do.
5,000	1,900 (from log books)	Constant electrical and clutch troubles.
5,000	2,100	Do.
5,000	2,200	Do.
5,000	2,600	Do.
4,200	3,200	Do.
10,000	6,900	Idle for want of tyres, injectors. Constant breaking of clutch bolts.
10,000	7,500	Do.

STATEMENT

1	2	3	4	5
			00381	10,000
			00382	10,000
			00383	10,000
			00384	10,000
			00385	10,000
			00407	10,000
			00408	10,000
			Balmer Lawrie Dumpers Type B.L.D.A. with Perkins Diesel Engine	
			(1) 1003	10,000
			(2) 1004	10,000

No. 6·2·3—*contd.*

6	7	8
10,000	7,000	Idle for want of tyres, injectors. Constant breaking of clutch bolts.
10,000	6,500	Do.
10,000	7,400	Do.
10,000	6,400	Do.
10,000	7,200	Do.
10,000	4,900	Do.
10,000	5,200	Do.
2,200	250	Premature failure of transmission housing and engine front support brackets. Non-availability of spares.
2,200	280	

STATEMENT

MYSORE/

Tungabhadra Project Headworks—

Sl. No.	Type of Equipment	Numbers	Make, Model and Size	Life period in terms of working hours adopted for calculating depreciation
1	2	3	4	5
1.	Shovels	1	Lima Shovel Cum Drag-line.	10,000
2.	Tractors . .	2	(*a*) D. 7. Caterpillar Tractor with bulldozing attachment.	10,000
			(*b*) Massey Harris 744 D Perkins Diesel.	10,000
3.	Dumpers	11	(*a*) Koehring & Co. fitted with 4 Cycle Engine 50 I. H. C.=4 Nos.	10,000 (each)
			(*b*) Muir Hill 30 H. P. Petrol driven=7 Nos.	10,000 (each)

No. 6·2·3—*contd.*

ANDHRA SIDE

Percentage Utilisation of Equipment — *Head works*

Theoretical working hours for plant that could have been possible up to 30-6-1953	Actual working hours put in up to 30-6-1953 nearest to 100 working hours	Remarks explaining difference between actual working hours (col. 6) and maximum possible working hours (col. 5)
6	7	8
8,400	3,500	The difference was mainly due to the conversion of the old unserviceable petrol engine to diesel engine during 11/51 and 2/52 and also due to breakdown now and then.
8,400	6,600	The machinery has been completely reconditioned during the idle hours. Idle due to repairs.
5,200	3,500	..
8,600 (each)	7,600 (each)	The machines were idle for servicing and repairs.
7,800 (each)	4,200 (each)	Do.

STATEMENT No. 6·2·4

Tungabhadra Project Hydrabad

Capital Equipment and Its Utilisation

Sl. No.	Type of Equipment	No. of Machines in the Project	Make and Model or Size Nos. in each	Month & Year of Purchase	Month & Year first put into operation	Total Purchase Price	Whether acquired new or from disposal	Ordered through
1	2	3	4	5	6	7	8	9
1.	Motor Scraper	7	Laplant Choate Motor Scraper 15 to 17·5 cu. yds. capacity with Buda Super Charged Diesel Engine.	January 1949	3 Nos. Sep. '49 3 Nos. Aug. '49	5 Nos.† 1,30,000 O.S. Approximate One @ 1,00,000 (approximate) One on loan from GNCP.	New	Supplied through Overseas Trading Company.
		8	Super "C" Tournapulls of 12/15 cu. yds. capacity with cummins Diesel Engines.	1949	6 Nos. Put in commission in 1951.	6 Nos. @ 1,50,000 O.S.†	Disposal	Do.
		1	Model "C" Tournapull Roadster C. 12 to 15 cu. yds. capacity with cummins Engines.	These machines are transferred from GNCP. Kaddam & information and History sheets are being awaited.	Not known. Information awaited; working since January 1953 in this project.	..	Received from G.N.C. Project in working condition.	
		1	Model "D" Tournapull Scraper 5 to 8 cu. yds. with cummins Diesel Engine.	1-"C" Roadster 1 "D" Roadster 1-LPC. Scraper.	..	..	Do.	

2.	Tractor Bull-Dozer	9	Caterpillar Tractor Company manufacture Tractor Bulldozer of the following.					
			D—4 Tractor 2	1945	1945	20,977 (O.S.)	Received from P.W.D. Workshops	Overseas Trading Company, Bombay.
			D—6 Tractor 2	April 1947	April 1949	2 Nos. @ 50,543 each		
			D—7 Tractor 2	April 1947	April 1949	2 Nos. @ 84,300 each		
			D—8 Tractor 3 fitted into caterpillar Engines.	Feb. 1947	Feb. 1949	3 Nos. @ 96,000 each		
	Tractor Bull-Dozer	5	Letourneau Manufactured Super "C" Tournadozer equipped with Rubber Tyres and Bulldozer Blades.	3 Nos. Oct. '50 1 No. Nov. '50 1 No. May '52	Oct. '50 Nov. '50 May '52	3 Nos. @ Rs. 1,38,239	New	M/s. William Jacks and Company Ltd.
		4	Nos. equipped with Buda Diesel Engine,	13-5-1952	13-5-1952	1,49,885	New	Do.
			1 No. equipped with General Motors Engine and Torque Converter.	11-6-1952	11-6-1951	1,41,885	New	Do.
3.	Cranes	2	Caterpillar D—7. Tractor with Trackson Pipe Layer attachment 2 Nos. with "CAT" engine.	January 1948	1948	..	New	Unserviceable.
		3	Super Jones Crane Fitted with Ruston Engine 3 Nos.	1. 8-10-46 2. 8-10-46 3. 8-10-46	October '46 Do. Do.	94,367 for three	New	Y. K. & L. Steel Tomterss Engineering Ltd.
4.	Dragline	2	Dragline Excavator, speed Crane manufactured by Manitowac Dragline Co. Equipped with Buda Diesel Engine.	1. Nov. '49	Feb. 1950. The second machine is being assembled.	2 Nos. @ Rs. 2,18,260 each.	New	M/s. Jari & Co., New Delhi.
5.	Shovels	2	Bucyrus Erie Shovel with clamshell attachments equipped with Chrysler Engine.	Aug. 1950	Sep. 1950	17,5006 I.G.*	Disposa	Central Stores

STATEMENT No. 6·2·9—*contd.*

1	2	3	4	5	6	7	8	9
6.	Dumpers	30	Muir Hill Dumpers 3 cu. yds. capacity fitted with Fordson Petrol Engines.	1946	1947	14,184 each	Only eight machines have been on work from the beginning.	Boydell & Co., Manchester.
7.	Air Compressors	2	Consolidated Pneumatic Tool Co. Stationary type Air Compressors 80 H.P. Electric Motor through V. Belts—capacity 5,000 cu. ft.	One received during the year 1947 (May) The second in the year 1950 (Oct.)	1947 Dec. 1950	15,850 I.G.* 32,800 I.G.*	New New	
		1	Stationary Air Compressors C.P.T. Make driven by 60 H.P. Electric Motor.	1947	1947	6,800 I.G.*	New	
		2	C.P.T. Portable Air Compressors 315 cu. ft. capacity driven by Caterpillar Diesel Engine.	January 1949	January 1949	..	New	
		1	Gardner Denver Portable Air Compressors 315 cu.ft. capacity driven by Caterpillar Diesel Engine.	June '50	June '50	Rs. 46,000 O. S.†	Received from Manair Project as good as new.	
		9	C.P.T. Portable Type Air Compressors 210 cu. ft. capacity driven by Caterpillar Diesel Engine.	5 Nos. in March 1948 4 Nos. in 1947	..	2 Nos. 24,500 4 Nos. 22,500 3 Nos. 23,500	..	
		1	JAEGER Portable Air Compressor 210 cu. ft. capacity driven by Caterpillar Diesel Engine.	January 1949	January 1949	..	Received from Investigation Circle as good as new.	

* I.G.—India Govt. Currency.
† O.S.—Osmania Currency.

STATEMENT No. 6·2·5

Data for Cost Estimating of Machinery

Sl. No.	Type of Equipment/ Make, Model and Size	Fuel gls. per operating hr. and issue rates for fuel	Oil, grease & waste including servicing labours for operating hour	Operator wages per operating hour	Auxiliary personnel wages per operating hour	Repair parts, spare parts, cost per operating hour	Tyres, tubes and flaps, cost per operating hour	Sundries & miscellaneous, cost per operating hour	Depreciation	Interest	Total cost per operating hour I.G. Re.
1	2	3	4	5	6	7	8	9	10	11	12
1.	Laplant Choate	8 3 0	2 14 0	0 9 0	2 4 0	4 11 9	7 10 0	3 3 6	9 7 6	3 3 6	42 2 3
2.	Tournapull	5 12 0	2 0 0	0 9 0	1 12 0	4 11 9	7 0 0	3 3 6	9 7 6	3 3 6	37 11 9
3.	Tournadozer	8 2 0	2 2 0	0 9 4	2 4 0	6 13 0	7 0 0	4 2 0	13 10 0	4 2 0	48 12 0
4.	Dragline	8 5 0	2 14 0	0 10 0	2 12 0	10 4 6		5 3 0	10 4 6	5 2 3	45 7 3
5.	Motor grader	2 4 0	1 8 0	0 9 0	2 4 0	2 4 0	3 4 0	1 8 9	4 8 0	1 8 9	19 10 6
6.	Muirhill Dumper	2 2 0	1 8 0	0 7 0	0 8 6	0 5 5	0 10 0	0 4 0	0 10 10	0 4 0	6 11 9
7.	D—8	3 9 0	1 4 0	0 9 0	2 2 0	4 2 0		2 0 6	4 2 0	2 1 0	19 13 6
8.	D—7	2 6 3	1 3 0	0 9 0	2 2 0	3 9 6		1 12 9	3 9 6	1 12 9	17 0 9
9.	D—6	2 1 0	1 2 0	0 9 0	2 2 0	3 1 3		1 9 0	3 1 3	1 8 9	15 2 3
10.	D—4	1 2 0	0 12 0	0 9 0	1 12 0	1 9 0		0 12 6	1 9 0	0 12 6	8 14 0
11.	310 cu. ft. Compressor Portable	3 6 0	1 4 0	0 9 0	1 0 0	2 4 0		1 1 9	2 4 0	1 2 0	12 14 9
12.	210 cu. ft. Do.	2 4 0	1 2 0	0 9 0	0 15 0	1 6 0		0 11 0	1 6 0	0 11 0	9 0 0
13.	500 cu. ft. Stationary	6 4 0	0 10 0	0 9 0	0 13 6	1 15 0		0 15 0	1 15 0	0 15 6	14 1 0
14.	210 cu. ft. Do.	4 10 0	0 10 0	0 9 0	0 13 6	0 13 3		0 6 6	0 13 3	0 6 9	9 2 3

NOTES:

(1) The figures given under column 7 of this statement are based on the purchase price of the machine less the value of the original tyre repairs and spares are estimated as ·10% of the average yearly investment.

(2) *Column No.* 7 : Under this column the extra cost that would be incurred towards the heavy special repairs to be carried out to the machines of the half of their estimated life period. In the case of Dragline, Track type Caterpillar, Bulldozers and Compressors whose life is taken as 10 years, repairs have to be carried out two times *i.e.,* one after 5 years and the other after 7½ years and each reconditioning will cost about 25% of the total investment towards the cost of the machine.

(3) *Column No.* 8 : This figure is arrived at by dividing the total value of the tyre replacement by the estimated life of the tyre which under the existing working condition here is taken as 2,000 working hours.

(4) *Column No.* 10 : The hourly depreciation charge is the Book value of the machine less the value of the original tyres divided by the entire depreciation period in hours.

(5) *Column No.* 11 : Interest at 5% on the Capital Cost.

STATEMENT No. 6·2·5—*contd.*

Data for Cost of Machinery (Actual)

Sl. No.	Type of Equipment/ Make, Model and Size	Fuel gls. per operating hr. & issue rates for fuel	Oil, grease & waste including servicing labours for operating hours	Operator wages per operating hour	Auxiliary personnel wages per operating hour	Repair parts spare parts, cost per operating hour	Tyres, tubes and flaps, cost per operating hour	Sundries & miscellaneous cost per operating hour	Depreciation	Interest	Total cost per operating hour
1	2	3	4	5	6	7	8	9	10	11	12
1.	Laplant Choate	8 3 0	2 14 0	0 9 0	2 4 0	6 7 0	6 7 0		12 14 0	3 3 6	42 14 0
2.	Tournapull	5 12 0	2 0 0	0 9 0	1 12 0	6 7 0	6 7 0		12 14 0	3 3 6	39 0 0
3.	Tournadozer	8 2 0	2 2 0	0 9 0	2 4 0	8 4 0	8 4 0		16 8 0	4 2 0	51 0 0
4.	Dragline	8 5 0	2 14 0	0 10 0	2 12 0	10 4 0			10 4 6	5 2 3	40 4 6
5.	Motor grader	2 4 0	1 8 0	0 9 0	2 4 0	3 1 0	3 1 3		6 2 6	1 8 9	19 10 6
6.	Muirhill Dumper	2 2 0	1 8 0	0 7 0	0 8 6	0 8 0	0 8 0		1 0 3	0 4 0	6 9 0
7.	D—8	3 9 0	1 4 0	0 9 0	2 2 0	4 2 0			4 2 0	2 1 0	17 13 0
8.	D—7	2 6 3	1 3 0	0 9 0	2 2 0	3 9 6			3 9 6	1 12 9	15 13 0
9.	D—6	2 1 0	1 2 0	0 9 0	2 2 0	3 1 3			3 1 3	1 8 9	13 7 0
10.	D—4	1 2 0	0 12 0	0 9 0	1 12 0	1 9 0			1 9 0	0 12 6	7 15 0
11.	310 cu. ft. Compressor Portable	3 6 0	1 4 0	0 9 0	1 0 0	2 4 0			2 4 0	1 2 0	11 13 0
12.	210 cu. ft. Do.	2 4 0	1 2 0	0 9 0	0 15 0	1 6 0			1 6 0	0 11 0	8 5 0
13.	500 cu. ft. Do.	6 4 0	0 10 0	0 9 0	0 13 6	1 15 0			1 15 0	0 15 6	13 1 0
14.	Do. Stationary	4 10 0	0 10 0	0 9 0	0 13 6	0 13 3			0 13 3	0 6 9	8 11 6

NOTES:

(1) *Column No.* 7 : Repair parts and spare parts cost per operating hour in this case is 10% of the average yearly investment.

(2) *Column No.* 8 : In this case also the tyre replacement and repairs cost is taken as 10% of the average yearly investment.

(3) *Column No.* 10 : The hourly depreciation in this case is calculated on the Book value of the entire machine without deducting the value of original tyres.

(4) *Column No.* 11 : Interest on Capital at 5%.

APPENDIX 6·3

Gangapur Project (Bombay State)

This is an earthen dam being constructed across the river Godavari, 8 miles to the west of Nasik. The total quantity of earthwork involved is 158 m. cu. ft. of which 10 m. cu. ft. was excavation for foundation above water table and 2·3 m. cu. ft. below water table. The dam was estimated as per 1948 project to cost Rs. 2·35 crores. The 1953 Revised Project amounts to Rs. 2·5 crores. The increase in the cost is due to the increase in prices consequent to the devaluation and the Korean War; there is no increase in the scope of the project.

The estimated provision for the main sub-heads according to the 1953 Project Estimate provision is as under:

	Rs. (lakhs)
(a) Preliminary expenses	0.62
(b) Lands	20.50
(c) Works	178.22
(d) Buildings	12.25
(o) Miscellaneous	3.62
(p) Maintenance	3.55
(v) Special T. & P.	11.71
TOTAL	230.47
Deduct receipts and recoveries	7.00
BALANCE	223.47
Add overhead charges (Actuals)	26.51*
TOTAL	249.98
Say	250.00
Add Special T. & P. earth-moving equipment	59.78
Deduct depreciation of Special T. & P. earth-moving equipment used on work	33.09
Deduct anticipated salvage value	26.69
GRAND TOTAL	250.00

The project is managed by an Executive Engineer responsible to a Superintending Engineer and Chief Engineer. The project organisation and the pay scales are given in Statement Nos. 6.3.1 & 1A respectively.

The project and the working drawings are prepared in the office of the Executive Engineer. Post-audit system of accounts is maintained with three Divisional Acountants. Normal P. W. D. account procedures are followed.

*It is understood that the Government has instructed that this figure should be revised to normal *pro rata* charges in the State which is nearly 30.5%.

The work is done in two shifts, from 5 A. M. to 1.30 P. M. and 1.30 P.M. to 10 P.M. A third shift from 10 P.M. to 5 A.M. does the maintenance of machines. During hot weather, the operation also is carried out for three shifts.

Earthwork is closed for 58 days on average due to rains; only Sundays are observed as non-working days. The average weighted lift and lead were as under:

Materials	*Lead*	*Lift*
Pervious and impervious fills.	4,000 ft. approx.	45 ft. approx.

The entire work is being executed by earth-moving machinery, except about 10 per cent of rock excavation for foundation. The rock blankets is done entirely by manual labour.

The estimates are based on the rates analysed on the basis of cost of owing and operating the equipment. The list of equipment is given in Statement Nos. 6.3.2 & 2.A.

The machinery cost account is maintained in sub-groups of equipment comprising the following:

1. Scrapers—17 Nos.— A all of the same make.
2. Tourna Trailers and Excavators—The cost is maintained co-jointly for 6 Tourna Trailers, 3 Excavators and 3 Euclid Dumpers.
3. Tractors—The cost is maintained in a group comprising D-7 and D-8 tractors, TD. 24, and 2 Nos. Tourna Dozers.
4. Air Compressors, comprising of 315, 210, 105 cfm. compressors.

The cost of individual sub-groups is, therefore, not specific except for the sub-group of scrapers. The figures given by the project for the estimated and actual cost of operating the equipment are given in Statement Nos. 6.3.3 & 3.A.

The equipment is purchased under Spl.T. & P. earth-moving machinery which is operated as 'Capital Cost Suspense Account'. Depreciation is charged depending upon the plant hour utilisation at the rates mentioned in Statement No. 6.3.2.

Plant hour is defined as the effective hours recorded on meters where these are working. Where there are no meters, effective hours are based on the work done during the gross working hours taking the load factor into consideration.

The accounts for running and major repair costs of the equipment are also operated as suspense accounts. The cost of plant hour is charged to the work concerned through transfer entry orders every month.

The daily plant hours of various equipment are distributed to civil items of the estimate. At the end of a month, plant hour debits are raised to various civil items through a form given as Statement No. 6.3.4.

Decimal classification system of account numbers is maintained both for civil items as well as for machinery accounts. All "Distributive" accounts are designated by a prefix S to distinguish them for final charges. A specimen of account numbers is given in Statement No. 6.3.5.

About 85% of the total quantity of work was completed when we visited the project.

The impervious fill is made up of plastic clay having a borrow pit dry density of 75 to 85 lbs. per cft. and varying in moisture from 17 to 27 per cent. In the fill the dry density varies from 100 to 116 lbs. per cft. with optimum moisture varying from 15 to 22%+ −2%. The previous fill is made up of disintegrated basalt varying from big boulder to fine soil. The borrow pit dry density varies from 110 to 117 lbs. per cft. and is rolled to a dry density of 120 to 140 lbs. per cft. The natural moisture varies from 2 to 14%. The bank is rolled at optimum moisture varying from 10 to 14%.

Both the soils are very hard and have to be rooted repeatedly before loading with scrapers.

The rate structure is complete as far as the ownership and operating cost of equipment are concerned. A large number of distributive accounts is maintained to transfer the cost of all ancilliary services to earthwork. These include haul roads, flood lighting, workcharged and supervisory staff, transport of supervisory staff, running the laboratory, running charges for watering etc. The rate, however, does not include the cost of installing the water supply scheme for the fill, the labour hutments and amenities, preliminary investigations, maintenance of construction town, etc.

The rates of earthwork provided for in the revised estimate (based on the actuals up to June 1952) are given in Statement No. 6.3.6.

The actual cost of earthwork based on data up to June 1953 is given in Statement Nos. 6.3.7 and 7.A.

The lead and lift obtained during the period 1-4-53 to 20-10-53 is given in Statement No. 6.3.8.

The items of component costs included in the rates are indicated in para 14·20.

Besides the earth-moving equipment listed in the Statement No. 6.3.2., the following Spl. T. & P. (charged) is purchased, the cost thereof is not transferred to rates.

Items	Cost in Rs. lakhs
(a) Prime movers	1·51
(b) Pumping equipment	1·26
(c) Light vehicles	3·85
(d) Construction plant (minor)	0·70
(e) Hoisting and lifting equipment	0·25
(f) Compressed air equipment	0·51
(g) Forced grouting etc.	0·67
(h) Workshop machinery	0·94
(i) Garage equipment	0·25
(j) Machineshop erection	0·20
(k) El. installation	0·30
(l) Establishing Soil Mechanic Lab.	0·60
(m) Minor tools	0·36
TOTAL	11·04

22—1 C. W. & P. C./57.

Staff

The organisation looking after the operation, maintenance and repairs is given in Statement No. 6.3.9. The mechanical side of heavy equipment is headed by a Plant Engineer. The operators are generally maintained per machine per shift.

Stores

The requisitions for materials are originated at the level of foremen or overseers. They are checked by the Plant Engineer or the S.D.O. regarding the necessity. A contact is made with the store to find out whether the material is available in stock. If not, an indent is sent to the Executive Engineer for procurement. In some cases, the S.D.O. in charge of stores calls for quotations and submits them for approval of Executive Engineer and passing purchase orders. For materials of technical specifications, the Plant Engineer calls for quotations directly and submits the papers for issuing a purchase order to the Executive Engineer. The Executive Engineer has a purchase branch in the stores branch to deal with purchase orders.

Materials and spare parts are procured through one of the four channels stated below:

(1) *D. G. S. & D.*—Free use is made of the rate contracts fixed by the D. G. S. & D. where the Executive Engineer is nominated as direct demanding officer, *e.g.*, P. O. L.

(2) *Director of Industries* has fixed up rate contracts with firms whose equipment is working at the dam for supply of spare parts. These are operated upon directly. In addition, the Director of Industries handles individual orders of large magnitude when urgent delivery is not required.

(3) *Petty Supply Contracts.*—These are fixed directly by the Executive Engineer for supply of hardware and automobile spare parts locally available.

(4) For items not covered by the above, the Executive Engineer has powers of purchase amounting to Rs. 20,000 for spare parts and Rs. 25,000 for other materials per month. In addition, spare parts worth Rs. 30,000 per month can be purchased with the prior approval of the Superintending Engineer.

The time required by the Store Purchase Officer (Director of Industries, Bombay) to process the order is, on an average, 2½ months. Materials required within about 3 months are handled under the local purchase powers of the Executive Engineer.

It has been possible to keep the machines supplied with spares and materials and reduce the sickness on account of the powers given for local purchase.

The Store is divided into two parts: (i) spare parts ,and (ii) other materials. The account of spare parts is maintained on (a) Card Index system for executive control, and (b) on Ledger for numerical and cost accounts. The account of other materials is maintained on ledger both for executive control as well as for accounts. The spare parts are classified under minimum and maximum balances. Items of usual requirements of materials are classified to indicate minimum balances for re-order.

Purchase orders are issued within a week of the receipt of the requisition from the officers concerned where they can be placed against rate contracts. Items requiring quotations take about a month.

The materials received are first taken to stock. The account is maintained under ordinary system of stock maintenance in P. W. D.

The store is classified into the following sections :—

(1) Automobile spare parts.

(2) General T. & P.

(3) Disposal materials.

(4) Spare parts of earth-moving machinery.

(5) Hardware (Minor).

(6) Construction materials, *e.g.*, cement, steel.

(7) P. O. L.

The store has one S. D. O. and 5 Overseers. They maintain about 200 ledger books and handle about 2,000 indents per month.

The materials are issued only as and when required; no store is maintained by other S.D.Os. The store also handles all T. & P. accounts of all the officers at the dam.

The account of the spare parts and materials is maintained by "Store accounts No." system of indentifying materials. This has helped quick and accurate accounting of a large number of items.

The overhead charge of Re. 0-0-6 per rupee is levied to cover the handling and storage charges.

The value of the spare parts and other materials, which did not move for one year, is as under:

	Rs.
1. Automobile spares	36,300
2. Spares of earth-moving machinery	3,03,000
3. Hardware, metal and pipes	2,69,100
4. P. O. L.	1,600
TOTAL	6,10,000

The value of the stock on hand is Rs. 19 lakhs of which spares is worth Rs. 11 lakhs.

The Division also acts as a custodian of the spare parts Centrally held for tractors and other equipment operating on the 4 major projects in the State. A separate sub-division looks after the receipt, issue and custody of the spare parts. The value of these spares held is about Rs. 7 lakhs.

STATEMENT No. 6·3·1

Organisation of Gangapur Project

Not Printed.

STATEMENT No. 6·3·1A

Gangapur Storage Division

Statement showing the pay scales of various officers and of other staff

Sl. No.	Designation	Pay Scales or Daily Wages	Remarks
1.	Deputy Engineer . .	220—15—400—E.B.—20—520—E.B.—25—650.	
2.	Overseers . . .	80—5—100—8—140—E. B.—10—220—E.B.—10—270.	
3.	Asstt. Plant Engineer .	205—15—250.	
4.	Foreman . . .	140—10—270.	
5.	Asstt. Foreman . .	70—3—85—4—105—5—145.	
		Daily Wages	
6.	Scraper Driver 1st class .	6 to 7 per day.	
7.	Scraper Driver 2nd Class .	5 to 6 per day.	
8.	Scraper Driver 3rd Class .	4 to 5 per day.	
9.	Grader Driver I . .	4 to 6 per day.	
	Grader Driver II . .	$3\frac{1}{2}$ to 4 per day.	
	Grader Driver III .	$2\frac{1}{2}$ to $3\frac{1}{2}$ per day.	
10.	Tourna Trailor Driver: .		
	IInd Class . .	4 to 5 per day.	
	IIIrd Class . .	3 to 4 per day.	
11.	Excavator Operator:		
	I Grade . .	6 to 7 per day.	
	II Grade . .	4 to 6 per day.	
	III Grade . .	3 to 4 per day.	
12.	Tourna Dozer Traxacavator & Tractor Operator Ist Grade .	5 to 6 per day.	
13.	Tourna Trailor operator:		
	IInd Grade . .	5 to 6 per day.	
	IIIrd Grade . .	4 to 5 per day.	
14.	Loader Driver:		
	Ist Grade: .	5 to 7 per day.	
	IInd Grade.	4 to 5 per day.	
	IIIrd Grade	3 to 4 per day.	
15.	Quarry Foreman I . .	3 to 5 per day.	
	Do. II .	2 to 3 per day.	
16.	Tools and Stores Attendant	2 to 3 per day.	
17.	Trip Counter . . .	$1\frac{3}{4}$ to 2 per day.	
18.	Timekeeper . . .	3 per day.	
19.	Fuel Oil man . . .	$1\frac{1}{2}$ to $2\frac{1}{2}$ per day.	
20.	Greasers	$1\frac{1}{2}$ to $2\frac{1}{2}$ per day.	
21.	Trained Mazdoor . .	$3\frac{1}{2}$ per day.	

STATEMENT No. 6·3·2

Gangapur Project

Capital Equipment

Sl. No.	Type of equipment	No. of machines on the project	Make and Model or Size and Nos. in each	Month & Year of purchase	Month and Year first put into operation	Total purchase price	Whether acquired new or from disposal	Ordered through
1	2	3	4	5	6	7	8	9
1	Motor Scrapers	17	Super C Tournapulls 12/15 cu. yd. capacity 13 Nos. with cummins diesel engines. 4 with G. M. 671 series diesel engines.	4 Nos. Nov. '49 4 Nos. Apr. '49 4 Nos. Nov. '49 4 Nos. Apr. '52 1 No. August '52	Feb. '49 May. '49 Dec. '49 Apr. '52 Oct. '52	13 Nos. @Rs. 87,500 each. 4 Nos. @Rs. 1,42,000 each.	16 Nos. New 1 No. from Mahi Canals Project, as good as new	Directly from the firm of Messrs. William Jacks, Bombay.
2	Motor Trailors.	6	Super C Tournapulls with W 210 Trailors 13/17 cu. yd. capacity, fitted with cummins engines.	..	4 Nos. Feb. '49 2 Nos. May '49	Rs. 5,35,700	New	Do.
3	Demag Excavators	2	2½ cu. yd., capacity with 2 Dragline, 1 shovel and 1 Drag shovel attachment.	..	May '51 Nov. '51	Rs. 6,21,900	New	Kamani Engineering Corporation.
4	LS 85 Excavator	1	3/4 cu. yd. capacity shovel, Drag shovel and clamshell attachments.	..	Feb. '50	Rs. 1,52,000	New	Larsen & Toubro.
5	Euclid Rear Dumpers	3	B5FD 9/11 cu. yd. capacity	..	June '52	Rs. 4,50,500	New	Blackwood Hodge.
6	Euclid Loader	1	Model 10 BV, 54" belt	..	Dec. '52	Rs. 2,77,200	New	Do.

7 Caterpillar Tractors.	12	D8 size, two with Dozer blades.	..	2-Feb. '49 1-May '49 2-June '49 2-July '49 1-Aug. '49 2-Aug. '50 1-May '52 1-Oct. '52 & one not operated.	Rs. 8,43,800 (Total for S. No. 7 & 8).	1 New 11 Old	One new & one reconditioned. Larsen Toubro. One from Disposals. One from a local agent. Rest from Casavan Co., U.S.A.
8 Caterpillar Tractors.	6	D7size 4 with Dozer Blade	..	Feb. '49—1 May '49—2 June '49—1 Sep. '50—1		1 New 5 Old	1 New. 1 reconditioned. Larsen Toubro. 1 from C. T. O. 2 from Casavan Co., U. S. A. 1 from local agent.
9 Traxcavator	1	T7 Traxcavator fitted on a D7 Tractor, 2½ cu. yd. capacity.	..	Aug. '50	Rs. 1,19,900	New	From Larsen & Toubro.
10 Motor Grader	1	Caterpillar No. 112 with a 12" blade.	..	Oct. '49	Rs. 56,800	New	Do.
11 Tourna-Dozer.	2	Super C with 180 H. P. Buda Engine.	..	Nov. '49	Rs. 2,00,100	New	William Jacks & Co., Ltd.
12 International Tractors.	4	TD24	..	Apr. '52	Rs. 4,16,000	New	Volkart Bros.
13 Drawn Scrapers.	1	Cat No. 80 with 17 cu. yd. capactiy.	..	..	Rs. 42,500	New	Larsen & Toubro.
14 Sheepsfoot Rollers.	4·5	Each unit is of 4 Drums & 4' dia. & 4' long.	..	..	Rs. 48,100	Two new 2·5 Disposal.	William Jacks & Co., Ltd. Rest from Disposal.

STATEMENT No 6·3·2A—*contd.*

1	2	3	4	5	6	7	8	9
15	Rooters	5	One No. 28 Caterpillar make Two K-30 LeTourneau Two RL-3 Wooldridge	..	..	Rs. 52,400	New	One from Larsen & Toubro. Two from William Jacks. Two from B. K. Khanna.
16	Disc. Harrows	2	..	..	..	Rs. 6,000	Old	Transferred from Agricultural Department.
17	Drawn Grader	2	..	..	..	Rs. 30,600	Old	Do.
18	Air Compressors.	7	2 of 315 CFM . 2 of 310 CFM 3 of 105 CFM . All LeRoi Make	..	April '49—2 March '49—2 105 { March '49—1 April '49—1 Jan. '50—1	Rs. 1,46,000	New	B. K. Khanna Delhi.
19	Tractair	1	L eRoi Make, 105 CFM	..	March '49	Rs. 15,300	New	Do.
20	Stone Crushers.	2	Baxter 20"+9" Jaw operating with a set of granulator jaws 20"+5".	..	..	Rs. 14,250	New	Marshall Sons.
21	Drill Sharpeners.	1	DS6, Wagner make	..	..	Rs. 19,200	New	Consolidated Pneumatic Co.
22	Wagon Drills	2	LeRoi Make	..	..	Rs. 16,500	New	B. K. Khanna

STATEMENT No. 6·3·2A—*contd.*

Gangapur Project

Percentage Utilisation of Equipment

Type of machine	Nos.	Make, Model and Size	Life period in terms of working hours adopted for calculating depreciation	Theoretical working hrs. from plant that could have been possible up to 30-6-1953	Actual working hrs. put in up to 30-6-1953	Remarks explaining difference between actual working hours (Col. 6) and maximum possible working hours (Col. 5)
1	2	3	4	5	6	7
Tournapulls with Scrapers.	13	Super C Tournapulls 12/15 cu. yd. capacity.	10,000 each	1,57,878	89,896	The difference in the hours of Col. Nos. 5 & 6 is due to all factors connected with the construction. Non-availability of spares, materials, non-availability of lights, working in harder stuff like hard murum or in a very wet soil will contribute for more break-downs. For first two years we had not enough pullers nor trained personnel and most of the work was in hard murum unfavourable conditions like digging of foundations contributed for more break-downs.
	4	Australian LeTourneau make Tournapull with scrapers fitted with G. M. Engine 671 series.	10,000 each	14,511	10,475	The above factors are applicable to all types of machines.

STATEMENT No 3·6·2A—*concld.*

1	2	3	4	5	6	7
Tourna Trailors	6	LeTourneau make 13/17 cu. yd. capacity.	10,000 each	82,226	29,106	Tourna-trailors could not be extensively used till December 1952 as there were no suitable loading units.
Demag Excavators	2	Demag 2½ cu. yd. capacity	15,000 each	14,756	8,357	Demag excavators did not give a satisfactory and continuous service.
LS 85	1	3/4 cu. yd. capacity	10,000 each	11,116	8,223	
Euclid Rear Dumpers.	3	B5FD 9/11 cu. yd. capacity	10,000 each	14,756	7,391	These were not extensively used until December 1952 when the Loader was put into operation.
Euclid Loader	1	10 BV Model 54" belt	10,000 each	1,750	1,275	It has started working only from December 1952.
Caterpillar Tractors	11	D8 size, two with dozer blades	*7,000 each	1,20,672	56,947	Some reconditioned tractors did not give satisfactory and continuous service.
	1	D8 New Do.	10,000 each			
	5	D7 size, four with dozer blades	*7,000 each	74,765	29,873	
	1	D7 size Do.	10,000 each			
Traxcavator	1	Caterpillar make	10,000 each	8,876	4,368	It did not give satisfactory and continuous service.
Motor Grader	1	Caterpillar make No. 112	10,000 each	10,500	4,600	Do.
Tourna Dozer	2	LeTourneau make Super C	10,000 each	20,790	8,891	Do.

TD24	4	International Harvestor Corporation.	10,000 each	20,944	12,371	Do.
Air compressors	7	LeRoi make	10,000 each	90,531	34,178	All units are scarcely required at one time.

*Second hand.

NOTE.—While calculating depreciation cost of tyres is not deducted.

STATEMENT

Estimated Rates for Cost of

Types of Equipment	Make, Model and Size	Fuel gls. per operating hr. and issue rates for fuel	Oil, grease and waste including servicing labour per operating hour	Operating wages per operating hour
1	2	3	4	5
		Rs. A. P.	Rs. A. P.	Rs. A. P.
Tournapull with Scrapers	..	5 0 0	1 6 0	1 8 0
Tourna Trailors	..	4 0 0	1 6 0	1 8 0
Tractors	..	6 0 0	2 4 0	1 4 0
Attachment — Grader	..	..	1 4 0	..
Attachment — Cat.	..	..	1 4 0	..
Attachment — Roller	..	..	1 4 0	..
Attachment — Rooter	..	..	1 4 0	..
Air Compressors	..	2 2 0	0 7 0	0 8 0

No. 6·3·3

Operating Machinery for 1952-53

Auxiliary personnel wages per operating hour			Repair parts (Spare parts)—cost per operating hour			Tyres, tubes and flaps—cost per operating hour			Sundries and misc. —cost per operating hour			Total cost per operating hour			Remarks
6			7			8			9			10			11
Rs.	A.	P.	Rs.	A.	P.	Rs.	A.	P.	Rs.	A.	P.	Rs.	A.	P.	
1	2	0	11	0	0	5	0	0	6	0	0	31	0	0	
1	2	0	9	0	0	3	0	0	3	0	0	23	0	0	
1	0	0	13	12	0	0	12	0	1	8	0	26	8	0	
1	0	0	0	8	0	..			2	4	0	5	0	0	
1	0	0	0	6	0	0	2	0	2	4	0	5	0	0	
1	0	0	0	8	0	..			2	4	0	5	0	0	
1	0	0	0	8	0	..			2	4	0	5	0	0	
0	7	0	0	8	0	..			1	0	0	5	0	0	

STATEMENT

Data of Cost Accounts of Machinery

Types of Equipment	Make, Model and Size	Fuel gls. per operating hr. and issue rates for fuel (Rs.)
1	2	3
1. Tournapull with Scrapers .	Model Super C 'T' pulls 12/15 cu. yd. with 150 HP. 6 cylinders Cummins Diesel Engine.	3·11 gls. per hr. Rate of issue is Rs. 1/3/-. Avg. per gl. Rs. 3/10/-.
2. Tourna trailors & Excavators	T. Trailors 6 Nos. 15/16 cu. yd. capacity & 2 Demag and 1 LS 85 and 3 Dumpers.	1·88 gls. per hr. 2·23 Rs.
3. Tractors of D7, D8, TD 24, Tourna Dozer and Mortor Graders, Excavators	Caterpillar International & Letourneau Caterpillar.	3·33 gls. 3·95 Rs.
4. Air Compressors . . .	LeRoi make 315 CFM 210 CFM 105 CFM	1·48 gls. 1·74 Rs.

No. 6·3·3A

(Actuals) for the Year During 1952-53

Oil, grease and waste including servicing labour per plant hr.	Operator wages per plant hr.	Repair parts (Spare parts) cost per plant hr.	Tubes, tyres and Flaps—cost per plant hr.	Sundries and misc. —cost per plant hr.	Auxiliary personnel wage per plant hr.	Total cost per plant hr.
4	5	6	7	8	9	10
1·80	1 47	10 34	5 73	3·23	1·39	27·96
1 7	1 5	3 84	34	2·42	1·49	13·52
2 05	1 04	10 90	08	·92	1·33	20·38
81	·38	2·41	..	·70	·78	7·62

STATEMENT No. 6·3·4

	Stripping Dam seat		Excavation in cut off trench						Filling in cut off			
Account Nos.	1.1		2·1		2·21		2·23		3·1		3·2	
MACHINES	Hours	Amount	Hours	Amount	Hours	Amount	Hours	Amount	Hours	Amount	Hours	Amount
		Rs. A. P.		Rs. A. P.		Rs. A. P.		Rs. A. P.		Rs. A. P.		Rs. A. P.
Scrapers . .												
T.' Trailors . .												
Tractors . .												
Cat Scraper .												
S. F. Roller. .												
Rocter . .												
Grader . .												
Comp . . .												
J. Hammer and W. Drill												
Drill Sharpener .												
TOTAL . .												

STATEMENT No. 6·3·5

Gangapur Dam

Statement showing the correct classification of account Nos.

4. *Core work of soil (Hearting)*

(4·1) Clearing and opening the quarry.

(4·2) Ripping.

(4·3) Excavating, transporting and dumping soil.

(4·4) Grading.

(4·5) Watering the Dam.

(4·51) Pumping.

(4·52) Transporting and sprinkling.

(4·6) Mixing and sheeps foot rolling.

S 1·10 *Depreciation and major repairs to Tournapulls with Scrapers*

S 1·11 Depreciation.

S 1·12 Major repairs.

S 1·13 Tyre replacement.

S 1·14 Major replacement.

S 2·10 *Operating Tournapulls with Scrapers.*

S 2·11 Fuel Oil and grease.

S 2·12 Pay of operators.

S 2·13 Other staff.

S 2·14 Sundries, small tools and minor replacements.

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STATEMENT No. 6·3·6

Gangapur Project

Estimated Rates (1953—Project)

Sl. No.	Item	Per	Rate
1.	Excavation for preparing the seat of the Dam and throwing the material out of the Dam area.	100 cft.	4.005
2.	*Cut-off trench*		
	Excavation for cut-off trench in soil and murum above and below water table and removing the excavated material to a lead of 2,000 ft.	100 cft.	6.71
3.	Excavation for cut-off trench in rock requiring blasting and removing the material average lead 2,000 ft. and average lift 20 ft.	100 cft.	28.29
4.	Grouting of foundation including drilling holes taking water tests and forcing cement under pressure.	Rft.	20.035
5.	Filling in cut-off trench with selected impervious material, including rolling, watering, hand tamping at sides, etc. Average lead for material 3,000 ft.	100 cft.	6.64
6.	*Embankment*		
	Embankment for hearting and random and semi-pervious Zone in soil including laying, watering, rolling, etc., complete.	100 cft.	7.53
7.	Embankment in murum casing and rock toe including laying, watering, rolling, dressing, etc., complete.	100 cft.	10.26
8.	Rock blanket of 2′—0″ thickness of dumped and laid rubble including average lead of 2 miles and lift up to 80 ft.	100 cft.	20.24
9.	Metal base for rock blankets average lead 2 miles and max. lift 80 ft.	100 cft.	31.74
10.	*Road on the top of Dam*		
	Providing dry stone rubble parapet wall of 3′—1/2″ height along with u/s side of the top of the Dam.	Rft.	4-0-0
11.	Providing stabilized murum road over the top of the Dam. Murum mixed with 5% bitumen laying and rolling, etc., complete.	100 cft.	30-0-0
12.	Sloping Sand filter.	100 cft.	23-9-0

STATEMENT No. 6·3·7

A Statement showing the Rate of Earthwork done at Gangapur Dam from 1st July 1952 to 1st July 1953 (with overheads)

Items	Name of Work	Total Expenditure	Total Quantity	Actual rate of cost	Estimated rate of cost
		Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.
1·1	Stripping for the Dam Seat	165 0 0	..	..	4 0 0
2·1	Cut-off trench (Excavation in soft rock).	1,887 0 0	..	..	6 11 0
2·21	Cut-off trench (Excavation in hard rock).	..	..	..	28 4 0
3.	Filling in cut-off trench . .	5,106 0 0	..	..	6 10 0
4.	Core work of soil (Hearting) .	23,67,891 0 0	38·3028	6 3 0	7 8 0
5.	Murum Casing and rock toe .	6,33,633 0 0	7·7815	8 2 0	10 4 0
7·1	Rock Blanket	36,614 0 0	..	.	20 13 0
7·2	Metal Base	6,884 0 0	..	..	31 12 0
8.	Slant sand filter . . .	1,37,122 0 0	..	..	23 10 0
		32,05,491 0 0			

STATEMENT No. 6·3·7A

A Statement showing the Rate of the Earthwork done at Gangapur Dam from the beginnig to 1st July 1953 (with overheads)

Items	Name of Work	Total Expenditure	Total Quantity as per M. B.	Actual rate of cost	Estimated rate of cost
		Rs. A. P.		Rs. A. P.	Rs. A. P.
1·1	Stripping for Dam seat .	4,93,909 0 0	11·6500	4 4 0	4 0 0
2·1	Cut-off trench (Excavation in soft rock)	6,02,239 0 0	9·9170	6 1 0	6 11 0
2·21	Cut-off trench (Excavation in hard rock)	5,11,529 0 0	1·9081	26 13 0	28 4 0
3.	Filling in cut-off trench .	6,34,687 0 0	10·3438	6 2 0	6 10 0
4.	Core work of soil (Hearting)	43,22,091 0 0	66·2580	6 9 0	7 8 0
5.	Murum, Casing and rock toe	23,93,387 0 0	25·0087	9 9 9	10 4 0
7·6	Rock Blanket	2,47,129 0 0	1·2540	19 11 0	20 13 0
7·2	Metal Base	1,36,886 0 0	·2850	48 0 0	31 12 0
8	Slant Sand filter . .	6,28,113 0 0	3·1700	19 12 0	23 10 0
		99,69,970 0 0	120·7946		

STATEMENT No. 6.3·8

A Statement showing the monthly Records of Leads and Lift for the period from 1st April 1953 to 20th October 1953

Month of operation	Hearting		Murum Casing		Remarks
	Haul	Lift	Haul	Lift	
	ft.	ft.	ft.	ft.	
1/4/53 to 30/4/53	3,960	55	3,000	31	
1/5/53 to 31/5/53	3,960	65	5,000	45	
1/6/53 to 30/6/53	8,313	72	9,140	34·45	
1/7/53 to 31/7/53	9,240	60	13,860	40	
1/8/53 to 31/8/53	9,240	60	13,860	40	
1/9/53 to 30/9/53	11,081	78·4	13,995	54·8	
1/10/53 to 20/10/53	12,060	93	14,060	62	

STATEMENT No. 6·3·9

Teams for Operation, Maintenance and Repairs of Equipment

Sl. No.	Name of Section	Shifts	Incharge of Section	Mechanics	Strength excluding incharge
1	Major Repairs to Tournapulls . .	I	1	3	11
2	Major Repairs to Tournapulls . .	II	1	2	12
3	Major Repairs to Tractors . . .	I	1	2	14
4	Major Repairs to Tractors . . .	II	..	4	14
5	Maintenance of Tournapulls . .	I	1	1	14
6	Maintenance of Tournapulls . .	II	1	1	14
7	Maintenance of Tractors . . .	I	1	4	11
8	Maintenance of Tractors . . .	II	1	3	9
9	Electrical Repairing	I	..	..	11
10	Electrical Repairing	II	1	..	12
11	Air Compressors-Repairs and Operating	I	1	1	12
12	Air Compressors-Repairs and Operating	II	1	1	9
13	Excavator Maintenance . . .	General	1	1	6
14	Day Time Servicing	General	..	1	17
15	Tractor Maintenance T.D. 24 . .	General	1	..	19
16	Reconditioning	General	1	2	13
17	Night Servicing	General	1	1	18
18	Tournapull Engine Repair . .	General	1	3	12
19	Operating	I	1	..	56
20	Operating	II	1	..	56
21	Workshop	I	1	3	27
22	Workshop	II	1	3	29
23	Workshop (Foundry) . . .	General	..	..	11
			19	36	407

APPENDIX 6·4

Hirakud Dam Project

A composite dam is being constructed across the Mahanadi river, approximately 9 miles from Sambalpur. The dam 15,000 ft. in length, incorporates the power house and one spillway on the left flank, the centre portion an earthen embankment, and a second spillway, with the right-flank, an earthen embankment.

In addition, there are approximately 17 miles of low dykes. The total quantity of earthwork in the main dam is as under:

Stripping for Dam	9.30 m. cft.
Excavation for foundation in stiff clay, disintegrated rock, soft rock and hard rock	8.67 m. cft.
Earthwork for embankment and cut-off	432.40 m. cft.
TOTAL	450.37 m. cft.

In addition, the following earthwork is required for the dykes:

Earthwork for Left dyke	99.6 m. cft.
Earthwork for Right dyke	123.0 m. cft.
TOTAL	222.6 m. cft.

The maximum depth of cutting for the cut-off was 60 ft. The water table was about 5 to 6 ft. below ground level.

The main sub-heads of the headworks are as under:

Unit No. I

	Lakhs of Rupees
A. Preliminary	48·24
B. Land	949·45
C. Works	2,113·20
K. Buildings	213·25
M. Plantation	1.00
O. Miscellaneous	167·43
R. Communications	72.00
	3,564·57
Maintenance at 1% (Except B Land)	26.15
Q. Special T. & P.	1,124.06
Less amount chargeable to works	471·94
	666.12
Losses on stock	10.00
Unforeseen	20.00
TOTAL I WORKS	4,272.84

	akhs of Rupees
Establishment at 5%	213.64
Tools and Plant at 1%	42.73
Less receipt on capital account by way of rent	17.00
TOTAL DIRECT CHARGES .	4,512.21
Direct Charges :	
Capitalisation of abatement and Land Revenue	7.80
Audit Charges @ 1% I. Works and 7 lakhs F.A's. Organisation .	35.72
TOTAL DIRECT AND INDIRECT CHARGES.	4,555.73

The project organisation comprises:

1. A Chief Engineer
2. 4 Superintending Engineers—
   (a) Electrical Circle.
   (b) Hirakud Dam Circle.
   (c) Development Circle.
   (d) Canals Circle.

Under the Hirakud Dam Circle are:—

(1) Executive Engineer, Mechanical Division (Mechanical Engineer).
(2) Executive Engineer, Earth Dam Division (Civil Engineer).
(3) Executive Engineer, Right Side Dam (Civil Engineer).
(4) Executive Engineer, Left Side Dam (Civil Engineer).

The details of the Mechanical Division Organisation are:—

1 No. General Foreman.
1 No. S.D.O. Earth-moving Machineries.
1 No. S.D.O. Workshops.
1 No. S.D.O. General Repairs sub-division.

The details of the Earth Dam Division are:—

3 Nos. S. D. O. Mechanical.
1 No. P. A.
2 Nos. S. D. O. Civil.

Details of the Divisional staff are given in the Statement 6.4.1.

The Right Side and Left Side Divisions have:—

1 No. S. D.O. Mechanical.
4 Nos. S. D. O. Civil.

The project drawings were prepared by the C.W. & P.C. A designs office is also attached to the office of the Chief Engineer

There is a Financial Adviser on the Project. A Chief Accounts Officer assisted by four Accounts Officers and Divisional Accountants take care of the accounting side. There is a Resident Audit Officer and all payments are pre-audited.

The Heavy earth-moving equipment is working in two shifts, *i.e.* :

1st Shift . .	5 A.M. to 1 P.M. (Scrapers, Road Maintenance).
	6 A.M. to 2 P.M. (Dumpers, etc.).
2nd Shift . .	3 P.M. to 11 P.M.
	4 P.M. to 12 P.M.

The maintenance staff commences work at 8 A.M. and discontinues at 4 P.M. The shifts are staggered in relation to each other, due to the difficulty of transporting staff with too few available vehicles. All static maintenance is done during the period 1 P.M. to 4 P.M. Mobile equipment is maintained during shift hours.

The monsoon period shuts down work for approximately 100 days per year. Sundays and additional 10 days are holidays.

The weighted average land up-to-date has been 1·9 miles; this will considerably increase during the present working season.

The project was planned for heavy earth-moving equipment to complete the main dam embankment, after stripping and trench work had been carried out by manual labour. The dykes were planned to be completed by manual labour and machinery.

The projects estimates were revised in October 1953. The rates being based on actual working experience of the earth-moving machinery and manual labour.

The quantities of earthwork executed up to the end of 1952-53 season were 129.4 m. cft. This figure does not include work completed by contractors or manual labour on the dykes.

The elements that go to working out the rates of earthworks by machinery are as under:

(i) All costs of operating charges of machinery, such as depreciation, repairs, servicing operation, etc.

(ii) Maintenance of Rail Roads.

The following items are not included in the rates but are separately watched:

(a) Construction of Haul Road (cost will be about 5% of earthwork rates).

(b) Flood-lighting (cost will be about 2% of eathwork rates).

(c) Housing, field establishment and field garages (cost will be about 3½%).

(d) Total cost of K Buildings on the Project about 3%.

Soils

The impervious fill is made up of clay loam to clay with a borrow pit density of 100 to 110 lbs. per cft. The natural moisture content varies from 10 to 14%; in addition during the months of April, May and June, an additional 5 to 7% is necessary. This is added usually at the borrow pits.

The semi-previous fill is a gravelly soil, with a dry density of from 110 to 120 lbs. per cubic foot in the borrow pit. The natural moisture content is 7 to 10%, with a specific density on the embankment 112 to 125 lbs. per cubic foot.

Optimum moisture content is slightly below optimum in hot whether (about 3·5%). During monsoon moisture content is increased by 3 to 4 per cent at the borrow area. The compaction of both semi and pervious zones is done by sheepsfoot rollers, 40″ in diameter loaded with sand and water giving a density of 290 to 350 lbs. per sq. inch. Sixteen to eighteen passes are required to give the specified dry density. Rooting of borrow areas is not altogether necessary and is carried out only about 10% of the time.

Embankment Inspectors and their assistants carry out specifications control on borrow pit and embankment.

Accounts and Costs

The costs of all machines and special Tools are charged as a final charge in the first instance to the sub-head 'Q. Special Tools and Plant' in the estimates. Credit is given to the sub-head per working hour of the earth-moving machinery as a depreciation by debit to earthwork.

A list of the equipment on the job is given *vide* Statement No. 6.4.2.

The plant hour was formerly taken as gross hours on duty; Odometer readings should be about 60% of these hours. Present day practice is to take Odometer readings or make as accurate an evaluation of time as possible.

The expenditure on operating the equipment is through suspense estimates prepared for groups of various equipment. The suspense estimates are being cleared quarterly. The periodical clearance is based on the actual cost of operating the equipment; depreciation being charged on the basis of plant hours utilised and the estimated life.

Pay measurements were formerly recorded once in three months or a year. Now, these measurements are recorded monthly. The measurements are entered by S.D.O.s for laid embankments.

The actual costs of operating the machinery are given in Statement No. 6·4.3. The unit rates of earthwork are given in Statement No. 6.4.4 & 4A. The hourly utilisation of equipment from 10/52 to 6/53 is given in Statement No. 6.4.8. The overall average is 824 hours. This is low for two-shift working.

Store

The Sectional Officer in charge of the works can originate a requisition. Executive Engineers and Superintending Engineers check it and forward it to the Chief Engineer's office. The requisitions are checked there by a special branch headed by an Assistant Engineer. A certificate of non-availability of stock accompanies each requisition. The Chief Engineer's office then plans out the purchase, either from the open market or through the D.G.S. & D. Copies of the purchase order are endorsed to the Store and the Indenting Executive Engineer.

On receipt of the material, the store records the receipt on "Goods received sheets", connects the bill with the G. Rs. and sends it to the Accounting Section for payments. An intimation is sent to the Indenting Officer notifying receipt of the goods.

The Provisioning Department is not integral with the Store. The Chief Engineer's office does all provisioning.

The average time required from issuance of the purchase order to receipt of the material may vary from 15 days to 3 years.

The Stores Section is divided into two separate sub-divisions, Control of each sub-division is given to S.D.O.s with an Executive Engineer in complete charge. The sub-divisions are further broken down as under:

1. Plant and Machinery Sub-division—

(a) Machinery.

(b) Spare Parts.

(c) Diesel Engines Sections.
(d) Auto Section.
(e) Earth-moving Machinery Section.
(f) Cranes, Shovels, Tractors Section.
(g) Petrol Engines and Miscellaneous Section.
(h) Small Stores and Pneumatic Spares Section.

2. *Stores Sub-division*—

(a) Electrical Stores.
(b) Tools and Plants.
(c) Iron Mongeries.
(d) Metals and Structures.
(e) Buildings Material and Civil Stores.
(f) Pipe fitting and Sanitary-ware
(g) Railways and Bridging.
(h) Petrol, oils and lubricants. Tyres and Tubes and Gas-chemicals.

Each section is in charge of one Store-keeper assisted by one Assistant Store-keeper, work-charge clerks, store attendants, mazdoors and work sarkar (semi-clerical post).

Numerical accounts are maintained in the sub-division. Pricing of articles (Issue Rates) and debits for the issues are worked out in the Divisional Office.

No provision is yet made for the Stores Section to requisition and handle stock items.

Maximum and minimum limits for stock are not yet fixed.

The system for marking and indentification adpoted is Bin Cards for location and item classification and manufacturers part numbers for identification.

The system for Recording Stores is Bin Cards in the Store and Price Ledgers in Divisions.

Manufacturers part numbers are used in place of Stores Item numbers, but for fixing location in stores the number and description of the part is required as the inventory of Bin Cards is made out alphabetically.

Requisitions are made out by the supervisors and countersigned by the S.D.O.s who have the authority to make an indent. Four copies are made:

(a) one copy remains with the indentor;
(b) one copy with store-keeper in Stores;
(c) one copy to Executive Engineer, Plant and Stores Division, who passes it on to the Chief Engineer's Office. After review and entry in a Register, it is returned to Executive Engineer, Plant and Stores Division; and
(d) one copy to Executive Engineer indenting the material with the advice for transfer debit.

Stores are issued to other Divisions as transfer of stock in the first instance.

There is no fiscal limit placed on an indent but items are limited to 8 numbers or whatever can be lifted in a day.

The stores have not been evaluated but it is estimated that the value is approximately Rs. 5 crores.

Stores charges are cost price plus freight plus transport plus 3% overhead charges.

General

Indents on Central Stores are generally not piecemeal. A small store is maintained by the Indenting Divisions for retailing to jobs against anticipated urgent demands.

Stores are issued finally to works and costs are compiled through Form 10 by debit to works.

Old spares are returned to the Central Stores except where the indenting officer wants to retain the old parts. Central Stores has plans to reclaim old parts. Numerical accounts of old parts and replacement assemblies are maintained in the Central Stores and the Machinery Division.

Operational Staff

The operators and mates are maintained on the basis of 1 per shift per machine plus one extra for the group of machines. The operators are allocated by machine.

For the basic machines (loaders and excavators) one fitter and two greasers are allocated to each machine for maintenance. In addition, each group of machines has the services of one supervisor, one assistant foreman, one chargeman and an additional mechanic.

The basic equipment is checked weekly (Sunday) by a workshops party under the supervision of a Special Foreman.

The pay scales of the skilled personnel are given in Statement No. 6.4.5.

Dumpers, Scrapers, Tractors and Graders

The number of operators required for these types of equipment are fixed by the assumption that 75% of the total number of machines will be in continuous operation. An additional 10% number of operators in excess of the number of working machines are kept as a reserve.

Maintenance is done in individual sections during the operational periods. The equipment being withdrawn one or two at a time dependent on the work to be carried out on individual equipment.

For each three hauling units, a field staff of one mechanic, a fitter with one helper plus a pool group of four mazdoors are maintained.

In addition, each group of equipment has the services of ;

1 Welder,

2 time-keepers,

1 store-attendant, and

1 chowkidar.

A general foreman supervises the work between the field and the workshop. He is assisted by a Foreman. The wide dispersal of the equipment makes this arrangement necessary.

The electrical staff are divided one to each group of equipment per shift, with the exception of electrically operated equipment (Le Tourneau Scrapers) where two electricians are maintained in each shift.

The staff position of the Earth Dam Division is given in Statement No. 6.4.7.

STATEMENT No. 6·4·1

Statement of Staff in Earth Dam Division

Not Printed.

APPENDIX 6·4·2

Hirakud Project

Sl. No.	Name of Machine	No.	Total cost
1	Caterpillar D. W. 20 Wagons	43	93,39,256*
2	Caterpillar D. W. 10 Wagons	1	1,26,274
3	Euclid Bottom Dumper	4	3,70,712
4	Euclid Bottom Dumper	9	9,82,800
5	Euclid Rear Dumper	9	13,66,560
6	Tourneau Trailor Super (Tournapull)	18	15,29,440
7	Tourna Rocker with C. Roaster Tournapull	1	1,69,336
8	Rear Dumpers Mack type	16	24,79,750
9	Sterling Rear Dump 14.5 cu. yds. struck/16.5 cu. yds. heaped	9	9,22,833
10	Sudworks pay load capacity 12.0 tons	3	3,37,800†
11	Caterpillar D-8 Tractor	11	6,17,341
12	Caterpillar D-7 Tractor	5	55,000‡
13	Tractor HD-5	1	27,400
14	Tractor HD-15	2	1,80,000
15	Fowler Marshall Tractor	48	8,39,160
16	Fowler Challengers	6	4,40,640
17	T. D. 6 Tractors	2	33,000‡
18	T. D. 18 Tractors	12	11,00,000
19	Oliver Cletrac FLE	21	15,64,150
20	Oliver Cletrac D.D.	6	2,06,190
21	Le-Tourneau Dozers	10	9,80,000
22	P. & H. Shovels 1½ cu. yds.	2	3,07,940
23	Lime Shovels 3½ cu. yds.	3	10,40,492
24	Lime Shovels 2½ cu. yds.	2	5,50,000
25	R. B. 54 Shovel	2	4,03,000
26	Walking Dragline 5 cu. yds.	2	86,589
27	Caterpillar Graders	6	3,58,448†
28	Carlisle Graders	7	3,15,440
29	Gallion Graders	2	25,860‡
30	La-Plant Choate	2	2,10,516
31	Le-Tourneau C. Roadster Scraper	17	19,67,492
32	Le-Tourneau (Roadster)	1	5,500
		TOTAL	2,89,60,892
		Say.	3.00 crores.

NOTE.—Adding some misc. equipment not listed individually.

*approximate.
†new and disposal both.
‡disposal.

STATEMENT No. 6·4·3

Date for Cost Accounting of Machinery (Actuals)

Sl. No.	Type of Equipment	Make, Model and Size	Fuel gls. per operating hr. and issue rates of fuel ***	Oil, grease waste (including servicing labour per operating hour)	Operator wage per operating hour	Auxiliary personnel wages per operating hour	Repair (Spare parts cost per operating hour)	Tyres, tubes and flaps cost per operating hour*	Sundries and Misc. cost per operating hour**	Total cost per operating hour	Remarks
1	2	3	4	5	6	7	8	9	10	11	12
1	Euclid Loader 3 Nos.	9BV&6BV=190HP 9′—6½″ =150HP	4.2	5 9 0	3 4 0	2 0 0	8 1 0	Nil	0 15 0	25 4 0	
2	Caterpillar Bottom Dumpers DW—20 16 Nos.	DW—20 =215HP	3.5	2 15 0	1 8 0	0 2 0	1 10 0	1 13 0	0 10 0	12 3 0	
3	Caterpillar Bottom Dumpers DW—10 1 No.	DW—10	2.9	1 11 0	3 1 0	0 2 0	0 4 0	1 15 0	0 4 0	11 1 0	
4	Caterpillar D-8 Tractors 6 Nos.	D-8 =130HP	4.85	0 7 0	1 7 0	1 3 0	0 15 0	Nil	Nil	10 5 0	
5	Lima Shovel 3 Nos.	3½ cu. yds. type 1201=236HP	4.0	7 11 0	2 4 0	1 7 0	6 8 0	Nil	0 15 0	24 0 0	
6	R. B. Shovel 2 Nos.	2½ cu. yds. type Sv RB 31′-3″=202 HP	3.0	6 1 0	2 8 0	1 3 0	0 9 0	Nil	0 8 0	14 11 0	
7	Tourna trailors 7+11 Nos.	Model 'C'	2.8	3 5 0	1 3 0	1 12 0	4 0 0	6 0 0	Nil	19 14 0	

*Taken from actual issues from Stores.

**As in column 4 quantity in Gals. per hour asked. Hence total cost per hour cannot be given.

***From 15th June, 1953 onwards 1-5-0 per Gal. before that 1-8-0 per Gal.

STATEMENT No. 6·4·3—*contd*

1	2	3	4	5	6	7	8	9	10	11	12
8	Euclid Rear Dumpers 9 Nos.	B5FD =,150HP	2.0	2 7 0	2 8 0	0 2 0	2 12 0	4 14 0	0 3 0	15 8 0	
9	Euclid Rear 8TD 6 Nos.	8TD=275HP	4.1	1 7 0	1 5 0	1 12 0	2 4 0	5 0 0	0 2 0	18 3 0	
10	Sterling Rear Dumpers 5 Nos.	340H=225HP	3.8	4 8 0	5 6 0	4 15 0	3 0 0	0 12 0	0 3 0	23 11 0	
11	Cyclope Rear Dumpers 3 Nos.	German	2.0	2 7 0	4 10 0	0 7 0	0 3 0	Nil	0 4 0	10 9 0	
12	Tourna Rocker 1 Nos.	E 18=165BHP	2.8	3 4 0	0 9 0	0 3 0	1 4 0	Nil	0 5 0	9 3 0	
13	'C' Roadster Scrapers 17 Nos.	Let. Scraper, 165HP='C' Roadster.,	3.0	5 0 0	2 14 0	0 15 0	6 8 0	8 0 0	0 8 0	27 11 0	
14	La-Plant Scraper 2 Nos.	..	2.0	3 0 0	9 0 0	2 0 0	0 2 0	2 15 0	0 1 0	19 2 0	
15	Caterpillar D-7	.. =81HP	2.0	1 4 0	5 6 0	0 1 0	0 8 0	Nil	Nil	8 13 0	
16	F.D.E. Cletrac 11 Nos.	F.D.E.=130HP	3.8	3 0 0	2 12 0	0 8 0	3 0 0	Nil	0 1 0	14 4 0	
17	DD. Cletrac 2 Nos.	D.D.=65 HP	1.50	0 8 0	1 2 0	0 6 0	0 4 0	Nil	0 1 0	4 4 0	
18	Fowler Tractors 27 Nos.	Marshall VF =38 BHP	3.25	1 4 0	1 4 0	0 9 0	1 3 0	Nil	Nil	8 8 0	
19	Caterpillar Power Grader 4 Nos.	Cat. ,70BHP	3.0	2 5 0	0 15 0	4 0 0	1 9 0	1 3 0	0 3 0	14 1 0	
20	Letourna Dozers 6 Nos.	Super'C'=180HP	4.8	4 15 0	1 10 0	0 10 0	1 8 0	Nil	0 8 0	15 7 0	
21	Allis Chalmer . .	HD-15 = ..	2.7	0 12 0	0 5 0	0 4 0	Nil	Nil	Nil	4 13 0	
22	Euclid Bottom Dumper 4 Nos.	58 W=190HP	2.7	1 2 0	1 12 0	1 7 0	1 14 0	3 13 0	0 8 0	14 0 0	

STATEMENT No. 6·4·4

Rate Analysis for Earthwork on Dam by Machinery

(1) Working of Machinery Expenditure booked up to end of June 1953.

	Rs.
W/C Establishment on earthwork only	6.41
Materials 9.39-5 lacs pipes Balance =4.39	5.79
Pipes $\frac{5+12}{43} = \frac{1.40}{5.79}$	
Misc. and Sheds	0.41
Working of Machinery	42.06 3.28
Labour	1.00
Stock issues for 3/53 & 4/53	5.56
Stock issues for 5/53 & 6/53	0.50
	65.01
Add for jungle cutting, grubbing out roots, stripping and compaction	6.23
Labour on overhaul for July to September	3.80
Liabilities	4.50
Expenditure on Gap. I	5.00
	84.54
Deduct expenditure on spares adjusted in the above	34.41
Balance Expenditure on working of machinery	50.13

Quantity of Earthwork Done

Earth Dam	12.13 Crores
Gap No. I	0.81 ,,
Haul Road 51-52	0.12 ,,
Haul Road 52-53	0.23 ,,
Batching Plant	0.04 ,,
TOTAL	13.33 crores

Therefore rate per 1,000 cft.=Rs. 37/10/-

Ownership cost 21,76,300 : 16/5

Expenditure on spares including working on National Highway and sub-Dam

Mechanical Division	47.36
Power Channel Division	0.22
TOTAL	47.58

Earthwork done in E. Dam Gap. I and Haul Roads	13.33
Earthwork done in Power Channel Division	1.00
TOTAL	14.33

∴Rate per 1,000 cft. $\frac{47.58}{14.333}$ =33/3/-

∴Rate per 1,000 cft..................... 87/2/-, Say Rs. 87

STATEMENT No. 6·4·4A

Tender Rates on Dykes

(1) Earthwork in all kinds of soils mixed and laid in layer of 6 with rough dressing and including all leads and lifts . . . . 45/- per 1,000 cft.

Maximum lead goes 500 ft. measurements by borrow pit; Compaction departmentally by Sheepsfoot Rollers; loss on Compaction about 18%. .

(2) Earthwork in all kinds of soil laid in 6" layers with rough dressing including all leads and lifts . . . . 47/8/- Do.

Average lead 500 ft. extra for each 55 ft. Additional lead 1/12 per 1,000 cft. Bank measurement. Compaction done departmentally by Sheepsfoot Rollers. Contractor used Le-Tourneau Scrapers and manual labour.

Excavation in all kinds of soil laid in 6" layer with rough dressing including all lead and lifts . . . . 53/4/- Do.

Manual work and used 4 Nos. Cat.-DW 21 Scrapers. Bank measurement. Compaction Departmentally.

STATEMENT No. 6·4·5

Scales of Pay for Work-charged Establishment, Hirakud Dam Project

Sl. No.	Name of Post	Grade	Scales of Pay
	GROUP I—Mechanical		
1	Foreman	..	300-20-500
2	Assistant Foreman	..	150-7-185-8-225
3	Chargeman	..	100-8-140-10-200/10-250
4	Shovel, Crane, Scraper, Tractor Bull-Dozer, Euclid Wagon Operators and Drivers (Crane Winch and Maulage) and Mechanics	I	185-5-250
		II	125-5-185
		III	90-5-125
		IV	75-3-105
		V	60-2½-75
5	Machine Tool Operator	I	90-5-125
		II	75-3-105
		III	60-2½-75
		IV	40-2-60
6	Fitter and Mechanic	I	90-5-125
7	Pattern Maker		
8	Blacksmith	II	75-3-105
9	Copper and Tinsmith		
10	Moulder	III	50-2½-75
11	Turner		
12	Pipe Jointer	IV	40-2-50
13	Instrument Mechanic including Meter Mechanic		
14	Welder	I	125-5-185
		II	105-5-125
		III	75-3-105
		IV	55-2½-75
15	Hammerman	..	35-1-50
16	Driver Locomotive	I	185-5-250
		II	125-5-185
		III	75-3-105
17	Driver Road Roller	I	90-5-125
18	Driver Stationery and Marine Steam Plant (including steam power and Launch Propulsion Engines) Driver Stationery and Electricity driven	II	75-3-105
		III	55-2½-75
19	Operator Gas producing plant	I	90-5-125
		II	75-3-105
		III	55-2½-75
20	Driller	I	90-5-125
21	Blaster	II	75-3-105
		III	55-2½-75
22	Sarang	I	75-3-105
23	Rigger	II	50-2½-75

STATEMENT No. 6·4·5—*contd.*

Sl. No.	Name of Post	Grade	Scales of Pay
24	Cleaner (all cases of plant)		
25	Greaser or Oilman	..	25-1-30
26	Fireman or stocker		
27	Boiler Attendant	..	40-2-50
28	Driller Apprentice	..	40-2-50
29	Coalman	..	35-1-40
30	Driver (Concrete Mixer)	..	55-2½-75
31	Helper	..	25-1-30
32	Attendant (Pump)	..	25-1-50
33	Petrol or Diesel Pump Operator	..	55-2½-75
34	Motor Driver	..	55-2½-75
35	Timekeeper	..	55-3-85-4-125
36	Upholster	..	55-2½-75
37	Dent Beater	..	40-2-50

GROUP II—Electrical

Sl. No.	Name of Post	Grade	Scales of Pay
1	Foreman	..	300-20-500
2	Assistant Foreman	..	150-7-185-8-225
3	Chargeman	I	185-5-250
4	Cable Jointer	II	100-8-140-10-200-10-250
		III	125-5-185
		IV	75-3-105
5	Shift Engineer	..	160-10-330
6	Armature Winder	I	125-5-185
		II	90-5-125
		III	75-3-105
7	Fitter		
8	Electrician	I	90-5-125
9	Lineman		
10	Wireman	II	75-3-105
11	Switch Board Attendant	III	55-2½-75
12	Instrument Mechanic		
13	Lineman	I	90-5-125
		II	75-3-105
		III	55-2½-75
		IV	35-2-55
14	Battery Charger	..	90-5-125
15	Battery Repairer	..	75-3-105
16	Meter Inspector	..	100-8-140-10-200/10-300
17	Meter Reader	..	55-3-105
18	Wireless Operator	I	90-5-125
		II	75-3-105
19	Timekeeper	..	55-3-85-4-125

STATEMENT No. 6·4·5—*contd.*

Sl. No.	Name of Post	Grade	Scales of Pay
	GROUP III—Civil Engineering		
1	Works Superintendents and Managers	..	300-20-500
2	Surveyors	..	100-8-140-10-250
3	Work Sarkars	I	100-8-140-10-250
		II	55-3-85-4-125
		III	45-2-58
4	Works Inspectors and Assistant Managers	..	90-5-125
5	Embankment Inspector	..	100-8-140
6	Assistant Embankment Inspector	I	60-2½-75-3-105
		II	4-5-255-3-70
7	Assistant Silt Analyst	..	75-3-105
8	Mason Mistri	..	90-5-125
9	to 18 Plumber, Mason, Carpenter, Painter, Bricklayer, Sanitary and Gas Fitter, Plate Layer, Well Borer and Rock Driller, Polisher, Stone Cutter Mistri	..	105-5-125
19	Rent Assessor	..	55-3-85-4-125
20 21	Regulation Jamadar Stone Cutter Mistri	..	30-½-35
22 23 24	Petrolman Pipe Lineman Sewerman	..	15-½-20
25	Sounder	..	25-1-30
26 27	Gauge Reader Discharge or sounding attendant	..	20-1-30-2-50
28	Timekeeper	..	55-3-85-4-125
	GROUP IV—Miscellaneous		
1	Station Master	..	60-4-120-EB-5-170
2	Train Examiner	..	80-5-120-8-160
3	Railway Guard	..	60-4-120-EB-5-170
4	Fireman	..	40-1-50
5	Head Shunter	..	75-5-105
6	Shunter	..	60-2½-70-2½-85
7	Keyman Railway	..	35-1-40-EB-1-50 (same as pointsman)
8	Timekeeper	..	55-3-85-4-125
9	Mate (Railway Trained)	..	30/- fixed
10	Mazdoor (Do.)	..	15/- fixed
11	Spikeman (Do.)	..	15/- fixed
12	Traffic Inspector	..	160-10-250
13	Telephone Operator	..	55-3-85-4-130
14 15	Telephone Attendant Stores Attendant	..	30-½-35
16	Observer	..	45-2-55-3-70
17	Gurkha Chowkidar	..	30-½-35

STATEMENT No. 6·4·5—*concld.*

Sl. No.	Name of Post	Grade	Scales of Pay
18	Bahishtees or watermen		
19	Chowkidar		
20	Dak Runner—Foot		
21	Farrash		
22	Khalasi (Survey and other)	..	Rs. 13/- fixed
23	Sweeper		
24	Beldar		
25	Gate Keeper		
26	Bullockman and cartmen*	*For Govt. Cart 13/- fixed.	
27	Mazdoor †	† As fixed by D. C., Sambalpur	
28	Dak Cyclist	..	20/- fixed
29	Trolly Jemadar	..	20/- fixed
30	Sweeper Jemadar	..	18/- fixed
31	Trollyman	..	18/- fixed
32	Mali Chowkidar at Rest House	..	16/- fixed
33	Mali	..	15/- fixed
34	Mate		
35	Driver	..	90-5-125
36	Sarang		
37	Tide Watcher	..	55-1-60
38	Sukhani		
39	Lescar	..	30-½-35 Navigation Survey only.
40	Greaser		
41	Leadsman		
42	Lineman	..	25-1-35
43	Head Boatsman		
44	Boatman	..	20-1-30

STATEMENT No. 6.4.6

Revised Set-up of Divisions and Sub-divisions in the Hirakud Dam Circle on Reorganisation

Not Printed.

STATEMENT No. 6·4·7

Earth-moving Machine Hours Statement

(For the period from October 52 to June 53)

Sl. No.	Machine Description	Machine number	Hours run from Oct. 52 to June 53	Average Utilisation
1	2	3	4	5
1	Euclid Loader	1	656	
2	Do.	2	1,530	
3	Do.	3	2,113	1,099
4	Caterpillar DW 20	1	1872	
5	Do.	2	1193	
6	Do.	3	1406	
7	Do.	4	382	
8	Do.	5	2019	
9	Do.	7	2317	
10	Do.	8	2497	
11	Do.	9	2168	
12	Do.	10	1904	
13	Do.	11	2066	
14	Do.	12	1849	
15	Do.	13	1366	
16	Do.	14	1694	
17	Do.	15	1648	
18	Do.	16	2519	1723
19	Caterpillar DW 10	1	1021	1021
20	Euclid Bottom Dumper	1	599	
21	Do.	2	986	
22	Do.	3	1288	
23	Do.	4	695	892
24	Caterpillar D 8	2	1359	
25	Do.	12	1136	
26	Do.	11	1280	
27	Do.	14	1332	
28	Do.	15	729	
29	Do.	1	363	
30	Do.	3	199	
31	Do.	13	754	894

STATEMENT No. 6·4·7—*contd*

1	2	3	4	5
32	Lima Shovel	1	1743	
33	Do.	2	590	
34	Do.	3	2080	
35	R. B. Shovel	1	1639	
36	Do.	2	1664	1543
37	Tourna Trailers	1	232	
38	Do.	2	857	
39	Do.	3	829	
40	Do.	4	517	
41	Do.	5	964	
42	Do.	6	1505	
43	Do.	7	1604	
44	Do.	8	1647	
45	Do.	9	1164	
46	Do.	10	1066	
47	Do.	11	238	
48	Do.	12	1104	
49	Do.	13	1350	
50	Do.	14	1648	
51	Do.	15	847	
52	Do.	16	1437	
53	Do.	17	983	1058
54	Euclid Rear Dumper (B 5 FD)	1	1562	
55	Do.	2	1163	
56	Do.	5	1085	
57	Do.	6	1008	
58	Do.	7	1176	
59	Do.	8	1016	
60	Do.	9	1308	
61	Euclid Rear Dumper (8 TD)	1	373	
62	Do.	3	981	
63	Do.	4	734	
64	Do.	5	1333	
*58	Do.	7	1008	
65	Do.	6	405	1019
66	Sterling Dumper	3	36	
67	Do.	4	338	
68	Do.	6	816	
69	Do.	8	787	424
70	Cyclop Rear Dumper	1	481	
71	Do.	2	305	
72	Do.	3	554	446
73	Tourna* Rocker	1	1354	1354

STATEMENT No. 6·4·7—*contd.*

1	2	3	4	5
74	'C' Roadster Scraper	1	100	
75	Do.	2	442	
76	Do.	3	1517	
77	Do.	4	1256	
78	Do.	5	1130	
79	Do.	6	765	
80	Do.	7	1308	
81	Do.	8	962	
82	Do.	10	1612	
83	Do.	11	13	
84	Do.	12	1354	
85	Do.	13	930	
86	Do.	14	1529	
87	Do.	15	1317	
88	Do.	16	904	
89	Do.	17	1154	1018
90	La Plant Choate	1	571	
91	Do.	2	95	333
92	Caterpillar D/7	2	539	
93	Do.	3	251	
94	Do.	4	247	
95	Do.	1	8	
96	Do.	7	66	
97	Do.	10	5	186
98	Cletrac FDE	1	1314	
99	Do.	3	905	
100	Do.	4	1	
101	Do.	9	1191	
102	Do.	11	811	
103	Do.	7	244	
104	Do.	6	1085	
105	Do.	8	607	
106	Cletrac TD	2	1318	830
107	Fowler Tractor	4	244	
108	Do.	26	70	
109	Do.	27	341	
110	Do.	31	128	
111	Do.	10	1113	
112	Do.	11	448	
113	Do.	32	935	
114	Do.	14	859	
115	Do.	16	1047	
116	Do.	17	589	
117	Do.	18	1003	
119	Do.	44	1487	

STATEMENT No. 6·4·7—*concld.*

1	2	3	4	5
120	Fowler Tractor	47	1462	
121	Do.	48	1576	
122	Do.	15	616	
123	Do.	38	568	
124	Do.	2	513	
125	Do.	37	382	
126	Do.	3	618	
127	Do.	45	366	
128	Do.	12	683	
129	Do.	19	623	
130	Do.	35	602	
131	Do.	39	115	
132	Do.	36	12	670
133	Power Grader	1	1495	
134	Motor Grader	2	1265	
135	Do.	1	248	1002
136	Letourneau Dozer	1	501	
137	Do.	2	593	
138	Do.	3	930	
139	Do.	5	1036	
140	Do.	4	44	
141	Do.	8	545	
142	Do.	9	632	612
143	International Tractor	1	253	
144	Do.	3	1211	732
145	Fowler Challenger	2	1021	
146	Do.	5	1179	
147	Do.	6	435	
148	Do.	1	189	
149	Do.	3	53	575
150	Allis Chalmer	1	953	
151	Do.	2	448	
152	Do.	3	151	
153	Do.	5	68	405
154	Caterpillar D 8	9	4	
155	Do.	10	120	
156	Do.	16	7	
157	Do.	17	51	45

OVERALL AVERAGE 824 hrs.

APPENDIX 6 5

Damoder Valley Projects

The following River Valley Projects are being constructed :—

(i) Maithon.
(ii) Panchet Hill.
(iii) Konar.
(iv) Tilaiya.
(v) Bokaro Thermal Power House.
(vi) Barrage and Irrigation Canals.

The construction equipment for the projects operates as a pool although their purchase is allocated project-wise. Maithon and Panchet Hill Dams were visited by the Committee. These are being constructed departmentally. Konar was a contract job.

The organisation of the D.V.C. is given Statement No. 6:5:1. Every project is in charge of a Project Manager. The Plant Engineer looks after all the equipment.

The project drawings and estimates are being prepared by the American Consulting Engineer's firm—Messrs Harza Engineering Co. The detailed working drawings, where needed, are prepared in the office of the Construction Superintendent.

The account is maintained mostly on the C. P. W. D. system. There are Resident Audit Officer and Divisional Accountants, in addition to a cost accounting section.

The work goes on in 3 shifts of 8 hours each at Maithon and in 2 shifts at Panchet Hill. Work is closed down for about 100 days in a year due to rains. All Sundays and about 12 other holidays are non-working days.

The estimated rates in the 1952 revised estimate were given by Messrs Hazra Engineering Co.

The information about the earth-moving equipment is given in Statement No. 6·5·2.

The provision of Spl. T. & P. in the project includes the cost of spare parts also. The workshop equipment is charged to the rates. Minor toors. office furniture, etc., is covered under 1% provision of ordinary T. & P.

The cost of Spl. T. & P. equipment is charged progressively to works through depreciation account.

The information about the hourly operating charges was not available.

The life adopted for depreciation is given in Appendix 3·2. The plant hour is defined as "net hours of work". "Field Repairs" is defined as repairs done in field. The account of field and Major Repairs is not separate. The operating charges are debited directly to earthwork but the Major Repairs and Field Repairs are levied at 100% of depreciation and are watched through a Reserve Fund.

The suspense estimates are cleared at the end of every working season on the basis of the analysis of rates worked out by the Cost Engineer.

Measurements of the work done are taken weekly. Materials are first taken on stock. Stores are issued against requisition from Assistant Superintendents or Assistant Engineers. A copy of the requisition is sent to Accounts Officer after issue of stores to the field where site accounts records are maintained. The actual consumption to particular works is found from Measurement Books and site accounts. The consumable stores and space are ultimately charged to works.

Labour is paid monthly for work-charged and fortnightly for daily rated staff. All staff except *mazdoors* are on monthly wages.

Log Books are maintained by Machanical Supervisors and are filled in from the Daily Field Return and Progress Cards. The same form of the Log Books is used for all types of equipment. The Log Books do not compile actual costs but record data for cost compilation in the costing section. They show day-to-day record of repairs, replacement and performance.

Detailed history card of each tyre has not been maintained. The information available is only with regard to the following equipment :

Tyre	*Life in hours*	
	On rock	*On soil*
1800×25-24 ply rear		
1400×24-20 ply front mack	3000	3500
1400×24-20 ply rear		
1200×24-16 ply front Euc.	2000	2400
1200×24-12 ply front		3000
2400×25-24 driving and trailing Euc. 71 FDT . . .		4200

Store

Officers not below the rank of Executive Engineers are authorised to draw requisitions—indents for purchase. Assistant Superintendents hold similar powers.

Indents are usually placed through the Head of the project to the Purchase Department which places the order in accordance with the standing procedure. Blue indents are used for "Top priority" to get materials in less than 3 months; pink, delivery after 3 months—goods ordered by officers under powers delegated to them and white for delivery after 3 months against Corporation's specific sanction. For stores exceeding in value Rs. 50,000 for which delivery is required after six months, the order is placed on D. G. S. & D. Specialised machinary is purchased by the Corporation's own Purchase Branch.

Detailed procedure for store purchase is laid down in the Corporation's memorandum which is a carefully worked out document.

The average lapse of time from the receipt of indent to the issue of the orders is 6 to 12 weeks for ordinary and 1 to 6 weeks for emergent indents. Emergent purchase of substantial value can be indented on Purchase Department, certified as "Emergent". The department processes such orders under priority. Emergent requirements not of substantial order can be purchased by projects directly.

The store organisation is sub-divided into following parts:

1. Central spare parts under Construction Plant Engineer.
2. General store under every project.
3. Electrical stores under Electrical Department.
4. Steelyard under machine and fabrication shop.

All stores are in charge of Stores Officers, and are held as stock.

Minimum balances for stock (usually required general store) and spare parts are laid down for a few items. This is being extended as experience is gained.

Account is kept in bound ledgers as well as bin cards. For spare parts, card system is being introduced. Spare parts are distinguished by manufacturer's Nos. "Store item system" is not in use.

The value of the spare parts held was as under:

Excavators	Rs. 5,00,000
Dumpers	Rs. 6,19,000
Tractors	Rs. 9,80,000
General	Rs. 6,00,000

Nearly 80% of the spares were received commencing November-December, 1952. The stock is still being built up.

The centage charges for storage and handling are 11%.

Maithon Dam

The quantities of earthwork involved are given below:

1. Excavation in common soil	4.979 m. cu. yds.
2. Excavation in soft rock	0.660 ,,
3. Excavation in hard rock	0.985 ,,
4. Embankment earth	4.397 ,,
5. Embankment dumped rock	1.022 ,,

The excavation involved for foundation was above water table. The quantities were as under:

1. Excavation in common soil	0.390 m. cu. yds.
2. Excavation in rock	0.272 ,,

The cost of the project is given below:

Item	*Amount Revised* 1952
I. Works—	
	Rs. (*lakhs*)
A. Preliminary	27.0
B. Lands	148.0
C. Works	356.9
D. Spillway and sluice equipment	205.7
K. Buildings	61.0
M. Plantation	3.0
O. Miscellaneous	54.8
P. Maintenance	11.8
Q. Spl. T. & P.	222.3
TOTAL WORKS	1090.5

Item	*Amount Revised* 1952 *Rs.* *(lakhs)*
II. Establishment	76.3
III. T. & P.	11.8
IV. Suspense	Nil
V. Deduct receipts & recoveries on Capital Equipment	—139.8
VI. VII. VIII. Capitalised abatement of Land Revenu, Audit charges and overheads	24.8
TOTAL—DAM AND APPURTENANT WORKS	1063.60

The actual earthwork rate for Maithon was not supplied but it is stated to be close to the estimated rates. The information regarding the estimated rates, lead lift and the components which the rates include are given in para 14.22 of the report.

The soil comprises impervious, semi-pervious and rocky materials (Acid Granulites and Hornblend Gneiss). Much of the common soil received from the Diversion Channel was mixed with loose big boulders. The borrow pit dry density varies from 105 to 118 lbs./cu. ft. The natural moisture content is 5 to 8% ; the optimum specified is 14 to 17%. Water is added both at the quarry as well as the fill. Compaction is done with 300—400 p.s.i sheeps-foot rollers making 8 to 12 passes. The soil does not need to be rooted.

The operating hours of various equipment during the period 1-7-52 to 30-6-53 and the output were as under :

Shovels	16,000 hrs.	Production. 1.8 m. cu. ft. Excavation. 1.59 m. cu. yd. Embankment. (1–10–52 to 30–6–53.)
Dumpers	64,800 hrs.	
Tractor	26,300 hrs.	
Graders	5,800 hrs.	

The bank measurement is the same as the pit measurement and hence bank or pit measurements are taken as a basis of quantities.

The strength and pay of the maintenance and supervisory staff on equipment are given in Statement No. 6·5·3.

For 3-shift working of 9 excavators, 27 operators are maintained. The maintenance teams work in a group. The pay of excavator operators varies from Rs. 150 to Rs. 250 p.m. The cost of operation, maintenance and supervision worked out is as under:

	Rs.
Operators	672 p.m. per shovel.
Maintenance	1,943 Do.
Supervisory staff	7,025 p.m. for 9 shovels and 36 dumpers.

The information about the personnel in the Dumpers, Tractors and Graders group is as under:

Name of Machine		*Nos.*
Bottom Dumpers	14 cu. yds.	19
Rear Dumpers	15 „ „	8
„ „	11 „ „	8
Tractors	HD20	14
„	HD15	7
Tourna Dozers	Super C	2
Motor Graders	AD4	3
	TOTAL	61

For 3-shift working the following operators are maintained :

	Nos.
Dumper operators	114
Grader operators	8
Tractor operators	51

Service and maintenance personnel and general staff not specifically allotted are listed in Appendix 6·5·3. The charges of operation per plant hour come to Rs. 2/5/- for dumpers and Rs. 1/8/- for tractors or graders.

Panchet Hill

The estimated cost of the project is as under :

	Rs. (lakhs)
A. Preliminary	22.0
B. Lands	201.0
C. Works	564.6
D. Buildings	50.0
E. Miscellaneous	36.9
F. Plantation	2.0
P. Maintenance	13.0
V. Spl. T. & P.	181.2
	1070.7
Deduct receipt and recoveries	−65.10
Establishment	64.5
T. & P. ordinary	10.8
Capitalised abatement of land revenue	3.0
Audit charges	2.7
Overheads	18.8
Hydro-electric installation including civil works	327.2
TOTAL FOR PROJECT	1432.6

The quantities of earthwork estimated and executed are given in para-14·22 of the report.

The work of stripping was done entirely by manual labour. Other earthwork is being done by machinery.

The oils vary over a wide range as under :

1. Laterite soil; course grained clay, sand (SC).
2. Sticky soil; fine grained sandy clay (CL).
3. Weathered greenish hornblend gneiss (GM & GP)
4. Weathered granulitic gneiss (SP & GP).
5. Weathered garnetiferrous talcose micaceous gneiss (SM).

The borrow pit density is 11‡13 lbs. The natural moisture content varies from 5 to 10% ; and the optimum from 2 to 12%. Watering is done both at quarries as well as at fill.

Compaction is done by sheepsfoot and squarefoot rollers of 290-390 p. s. i. doing 10 to 12 turns. Coarse and rock soil is compacted by 6 to 8 passes of tractors. Rooting is not required except for hard and intermediate rock which is lossened by blasting.

The unit rates of earthwork and the elements of cost included are given in para 14·22 of the report.

Eight operators are maintained for 3 excavators and one loader working double shift. No mates are employed. Maintenance is done by separate teams, comprising 43 persons. The cost of operator and supervisory establishment came to Rs. 5/6/1 per hour.

The following supervisory staff looks after the entire group of equipment :

1 Chargehand.

5 Asstt. Engineers.

3 Overseers.

1 Foreman.

75 operators are maintained for a group of 46 machines comprising Dumpers, Scrapers, Tractors and Graders of which normally 23 Nos. are on work doing two shifts. The operator's charges work out to Rs. 1/4/- per plant hour.

The strength of the field repairs team is as under :

Supervisors	2
Skilled	17
Unskilled	16
Non-technical	14

Major Repairs shop is divided into seven sections as under:

Section	*No. of persons*
1. Electrical	5
2. Welding	10
3. Engine Room	12
4. General Repairs	56
5. P. O. L. Store	8
6. Tool Store	8
7. Office	8

Workshop cost is not debited to the cost of equipment but is debited directly to rates.

Barrage and Irrigation

The quantity of earthwork involved in the Barrage and Canal Works are as under:

	m. cft.
Main canal	700
Branch canal	250
Distributaries	450
Drainage channels	250
Barrage	120
TOTAL	1,770

The soil on Barrage works is coarse sand; that on canal works is mainly loam. The entire excavation for the Barrage was under water.

The cost of the project is estimated as under :

	Rs. (lakhs)
Preliminary expenses	27.72
Land	360.82
Works	959.93
Buildings	103.43
Miscellaneous and service road	104.43
Special and ordinary T. & P.	69.32
	2,087.88
Deduct receipt and recovery	—17.30
Add overhead and indirect charges	207.08
TOTAL	2,277.65

The work is shut off for about 140 days due to rains. Sundays and important holidays numbering 40 are observed as non-working days.

The lead and lift varied as under :

Work	*Lead*	*Lift*
CANAL WORK		
Minimum	70	10
Maximum	150	25
Weighted average	100	15
BARRAGE		
Minimum	300	10
Maximum	2,000	20
Weighted average	500	12

Earthwork planned to be done by machinery is 350 m. cft. and that by manual labour 1,200 m. cft. of which about 20 m. cft. is accomplished with machinery. The rates provided are based on 1953 estimates in which the rates are considerably increased.

The construction equipment is charged to works through depreciation account. Miscellaneous equipment worth about Rs. 12 lakhs is charged finally to works.

The estimated rate by machinery is Rs. 28 to 40 per 1,000 cft. and by manual labour Rs. 18 to 32 per 1.000 cft. A note on costing furnished by the project is given as accompaniment 6:5.

APPENDIX 6·5·1

Organisation Chart

Not Printed.

APPENDIX 6·5·2

Damodar Valley Corporation

*Indicates Second hand equipment purchase.

Equipment & Size	No. & Make	Purchase Price (Rs.)
Excavators—		
3/8 cu. yds.	1 Priestmen	54,477
5/8 „ „	4 Ruston Bucyrus	2,86,836
3/4 „ „	5 NCK 304	4,06,010
	2 North West-25	2,02,024
	1 Bay City-65	*
	1 P & H-255	*
1 cu. yd.	2 Rapier-440	2,07,722
1/4 „ „	3 NCK 605	4,95,000
	1 NW-6	1,45,650
	4 PH 65513	4,48,000
	2 Lima	5,46,000
2½ cu. yd.	16 PH 965 A	58,24,000
	4 Lima 803	15,64,888
	2 Ruston Bucyrus-54	5,39,880
		1,07,21,387
Mobile Cranes—		
20 Tons	3 P & H Truck mounted crane	6,17,799
8 Tons	1 Bay City	*
6 Tons	1 Neal Mobile	70,000
6 Tons	1 K. L. Johnee	86,899
7 Tons	1 Tourna Crane TM-20	23,000*
Do.	2 D-Roadster	2,14,820
Do.	1 Tourna Crane TM-20	1,07,410
Do.	1 Super 'C' TM-20	91,600
1 Ton	2 Fork lifter Ross Carrier	41,000
	2 Jumboo Crane	72,026
	3 Tractor Cranes	—
5 Tons	1 Cryslar Mobile	13,500
		13,38,054
Bottom Dumpers—		
13/15 cu. yds.	31 Euclids	51,15,000
18 „ „	3 Letourneau	4,95,590
17 „ „	7 Terra Cobra	9,57,950
14 „ „	6 Super 'C' Tournapull	7,39,380
		73,07,920

Equipment & Size	No. & Make	Purchase Price (Rs.)
Dear Dumpers—		
15 cu. yds.	14 Mack	21,47,040
10 ,, ,,	25 Euclid Model B.5 T.D.	37,25,000
		58,72,040
Shuttle Dumpers—		
3 cu. yds.	48 Muir Hills	3,96,000
4½ ,, ,,	4 Aveling Barford	1,53,548
18 ,, ,,	10 ,, ,,	11,88,860
— ,, ,,	2 Koehrings	1,54,330
		18,92,738
Power Scraper—		
1½ cu. yds.	3 Super 'C' Letourneau	4,12,158
8 ,, ,,	12 'D' Roadster	11,12,400
17 ,, ,,	4 Terra cobra	6,00,000
	3 Laplant-Choate TS-300	4,55,457
		25,80,015
Tow Scraper—		
20 cu. yds.	3 Onion Empire BT-20	2,39,550
13 ,, ,,	10 Onion Empire EH-13	4,66,750
9 ,, ,,	9 Onion Empire EK-9	2,43,900
	Cat Model 70	1,36,240
		10,86,440
Tractors—		
	28 Allis-Chalmers HD-20	29,40,000
	9 HD-19	7,20,000
	26 HD-15	17,68,000
	10 HD-10	5,81,000
	7 HD-5	3,02,000
		63,11,000
Crawler Tractors—		
	3 International TD-24	2,68,350
	4 International TD-18	3,36,228
	4 International TD-14	2,74,500
	6 Hanomag	1,35,000
	2 Caterpillar D-8	1,63,904
	8 Caterpillar D-7	5,19,200
	2 Ansaldo Model TCA-70	79,920
	1 Continental	41,000
		18,18,102

Equipment & Size	No. & Make	Purchase Price (Rs.)
Wheel Tractors—		
	4 Tourna Dozers	5,34,488
	4 International WD-6	60,150
	2 M. M. Tractors	21,380
	2 Oliver K. D.	26,840
	7 Ferguson	48,300
	2 Fordson Major	24,000
	1 John Deer	23,404
		7,38,562
Motor Graders—		
	3 Austin Western	1,54,185
	5 Allis-Chalmers AD-4	3,48,500
	3 Allis-Chalmers AD-40	2,21,085
	1 Caterpillar Motor	70,313
		7,94,083
Sheepsfoot Rollers—		
	3 Allen	28,534
	5 Tampo	1,17,250
	2 Tourna Packer	66,260
	2 Blawknox	16,490
	1 Sheepsfoot Rollers	7,000
		2,35,534
Rooters—		
	1 Le-Tourneau Rooter	6,000
	3 Le-Tourneau K-30	43,947
	2 Le-Tourneau H-5	11,960
	2 Empire 3 RK	27,400
	3 Caterpillar 18 Ripper	51,126
Loaders—		
	2 Euclid Loaders	3,99,400
Tractor Tankers—		
	3 Allis-Chalmers Water-Tankers	27,075
		5,66,908

STATEMENT No. 6·5·3

Statement Showing Number of Personnel in the Maintenance Gang for Excavators

Serial No.	Kind of personnel	Nos.	Pay of each per month (Rs.)	Remark
1	Mechanics	5	150	
		1	160	
		1	185	
		3	120	
		1	100	
		1	180	
2	Foreman	1	540	
		1	500	
		1	300	
		1	395	
		2	200	
		1	250	
		1	140	
		1	160	
3	Fitter	1	220	
		6	150	
		5	120	
		2	160	
		3	130	
		2	140	
		1	185	
		1	110	
		1	240	
4	Helper	22	65	
		46	80	
		2	120	
		16	90	
		12	75	
		4	85	
		1	100	
5	Blacksmith	2	120	
6	Supervisor	1	150	
		1	125	
		1	180	
7	Electrician	1	110	
		2	150	
8	Welder	2	160	
		3	150	
		1	250	
		1	90	
		1	80	

STATEMENT No. 6·5·3—*contd.*

Statement Showing Number of Personnel in the Maintenance Gang for Dumpers and Tractors

Serial No.	Kind of personnel	Nos.	Pay of each per month (Rs.)	Remarks
1	Mechanics	1	225	
		4	200	
		1	140	
		2	130	
		2	180	
		2	150	
		1	110	
		1	250	
2	Greaser	11	90	
		5	85	
		12	80	
		1	75	
		2	100	
		2	65	
		1	70	
3	Fitter	1	90	
		1	80	
		1	110	
		1	150	
		1	100	
		2	120	
		1	130	
4	Foreman	1	300	
		1	350	
5	Work Sircar	1	65	
		6	90	
		1	120	
		2	100	
		1	70	
		1	75	
		1	110	
		1	150	
6	Driver	1	105	
		2	120	
7	Helper	3	90	
		4	80	
		14	75	
		3	65	
8	Mechanical Supervisor	1	150	
		1	175	
9	Electrician	1	150	
10	Chowkidar	2	65	

STATEMENT No. 6·5·3—*contd.*

Statement Showing Number of Personnel for Supervision Time Keeping Store Keeping etc.

(For Excavators and Dumpers)

Serial No.	Kind of presonnel	Nos.	Pay of each per month (Rs.)	Remarks
1	Chowkidar	5	65	
2	Shovel Supervisor	1	110	
		12	90	
		4	75	
		1	70	
3	Work Supervisors	6	100	
		23	90	
		4	110	
		1	125	
		3	120	
		1	150	
4	Time Keeper	1	90	
		2	100	
5	Store Munshi		110	

APPENDIX 6·5·4

Notes on Costing

1. A construction equipment depreciation schedule for normal use of 2,000 working hours per year has been issued by the Corporation. For assessing depreciation this schedule is to be used. For machines not listed in the schedule, Chief Engineer's instructions are to be obtained. Depreciations of machines are to be taken on their net working hours.

2. Repairs and overhaul are to be taken as 100% of depreciation. This will cover all spares and labour for major repairs as also small parts, bolts and nuts, etc. for any minor repairs and maintenance.

3. Interest is to be charged at rate of 4¾% per annum on the gross working hours.

4. All fuels, lubricants, engine oils, etc. are to be shown separately.

5. Operation staff will include : (i) Operators, (ii) Drivers, (iii) Helpers and (iv) any other work-charged personnel and daily labour directly employed on the job.

6. For field maintenance only direct labour charges such as mechanics, greasers, daily labour, etc. are to be taken into account.

7. Overheads will comprise the following:—

(i) Expenses of field supervisory staff employed full time on the job.
(ii) Proportionate share of expenses of—
 (a) Field supervisory staff not employed full time on the job,
 (b) Executive Engineer and his office,
 (c) Accounts Office, and
 (d) G. P. Fund contributions of staff in (i) and (ii).

Proportionate shares in (ii) above will be decided by the Executive Engineer and the Accounts Officer.

8. Depreciation at 33⅓% is to be taken of the cost of:—
(i) Temporary sheds ;
(ii) camp equipments ; and
(iii) small and general tools issued to field staff.

These percentages especially of items (i) and (ii) may be varied by the Executive Engineer in consultation with the Accounts Officer and the Engineer-in-charge.

9. Transport and other charges of machines are to be booked separately.

10. All other consumable stores including wire ropes to be shown separately.

11. For any earthwork two unit rates are to be worked—
(a) Direct Labour Machine, Supervision and small repair charges, and

(b) Direct Labour, Machine, Supervision and small repair charges plus interest, overheads and tools and plant charges.

Rate (a) will be comparable with estimated rates whereas Rate (b) will be comparable with the rates of other agencies including Contractors doing the same kind of work.

12. Transport charges of machines from one place to another are to be shown separately. These charges are to be debited to the terminal job. A more convenient way is to debit to terminal job all remaining fuel, and other consumable stores and the salaries of operators etc. from the hour they start for the terminal job.

Method of Calculating Earthwork Rates

A. (1) Total direct Labour for the period.

(2) Total direct Supervision.

(3) Total direct Fuel.

(4) Total direct Field maintenance staff.

B. (1) Depreciation for net working hours.

(2) Maintenance—Depreciation.

(3) Interest for the period.

(4) Depreciation of Camp Equipment for the period.

(5) Overheads of Supervisory staff—

(Asstt. Engineer and office)

(Executive Engineer and office)

(Accounts Officer and office).

APPENDIX 6·6

Bhakra Dam Project

A concrete dam across the river Sutlej, 680 ft. high and requiring nearly 5 million cu. yds. of concrete is being constructed. The excavation mostly in rock over 5 million cu. yds. will be required. Earth-moving machinery is utilised mainly on the excavation of the approach roads, foundation for the dam and the power house and the tunnels.

The primary sub-heads and the estimated cost is given below:

	Rs.
A. Preliminary	1,18,77,000
B. Land	3,44,43,000
C. Works	32,82,37,000
K. Buildings	3,44,65,000
M. Plantation	2,00,000
O. Miscellaneous	81,47,000
R. Railways and Communications	2,22,41,000
TOTAL WORKS	43,96,10,000
B. Land	3,44,43,000
Total works *Less* B. Land	40,51,67,000
P. Maintenance	
1% of cost I-Works	40,52,000
Total I-Works (I) Headworks	44,36,62,000
I—Works (6) Special Tools and Plants:	
A—Capital cost	8,87,52,000
B—Deduct for depreciation included in rates for works under C-works and sale of machinery on completion of work	—7,43,38,000
I—Works (7) Losses on stock, L.S.	2,00,000
Unforeseen L.S.	25,00,000
Total I Works	46,02,76,000
II—Establishment	
(i) Establishment charges including leave salary and pensionary charges	4,34,26,000
(ii) Establishment charges on account of specialists	4,98,85,000
(iii) Establishment charges on account of C.A.O.'s Office at 1/2% of I-Works	23,01,000
TOTAL ESTABLISHMENT	9,56,12,000
III—Tools and Plant	
1% of I-Works	46,03,000
IV—Suspense	
Nil	
V—Receipts on capital account for Buildings and Railway	1,02,12,000
Total direct charges	55,02,79,000
VI—Indirect Charges	
Capitalisation of the abatement of Land Revenue and Audit and accounts	31,94,000
TOTAL	55,34,73,000

The value of Special T. & P. is estimated at Rs. 8·87 crores of which the earth-moving machinery is nearly Rs. 2 crores. Nearly 70% of the life of equipment is planned to be utilised on the work and the re-sale value is taken at 80% of the book value.

The general organisation of the project is given in Statement No. 6·6·1.

The information about the capital equipment is given in Statement No. 6·6·2.

The information about the estimated cost and the actuals of ownership and running cost of equipment is given in Statement No. 6·6·3 & 4.

Efficiency of utilisation is controlled through a form devised for each type of equipments. A typical summary is given in Statement No. 6·6·5·

The cost of earth-moving machinery is debited, in the first instance, to the project as an independent charge under "Special T. & P." but is transferred to work through depreciation, progressively according to utilisation.

The "plant hour" is defined as the total hours of work for each machine irrespective of the meter reading. The field repairs is defined as the work that can be done in the field. The plant engineer or the Master Mechanic decides which work should be done in the field and which in the shops.

The running expenditure of the equipment is watched through suspense estimates which are cleared monthly on the basis of the estimated rates of owing and operating the equipment and log book records. The adjustment for the residual charges on suspense is carried yearly.

Log Books

The form of the log book and rules for their maintenance is given *vide* Statement No. 6·6·5.

The quantities are based on physical measurements by the P. W. D. staff according to the normal P. W. D. regulations.

Stores

A small store is maintained at the dam site for about 15 days' requirements. The main store is located at Nangal which issues the materials to the sub-store as transfer of stocks. The issues from the sub-store are according to the normal stock regulations of the P. W. D. accounts.

Technical Personnel

Excavators—The number of operators engaged are equal to twice the number of excavators plus about 1/6 as reserve. Generally, one operator is allocated to one machine. Maintenance is carried out through crew system employed for the entire group of equipment. Information about the wages is attached *vide* Statement No. 6·6·7.

The information about the strength of establishment under various teams is given in Statement No. 6·6·8.

Mostly rock-grip types of tyres are used. Separate tyres account is not maintained. The cost is included in the cost of spare parts.

All staff is maintained on monthly wages.

The information about the stock and accounting system is given under Nangal Project..

STATEMENT No. 6·6·1

Organisation of Bhakra Dam Administration

Not Printed

STATEMENT No. 6·6·2

Work-charged Establishment Employed in Lubrication Sub-division

Foreman	7 Nos.
Chargeman	14 Nos.
Drivers	14 Nos.
Greasers	24 Nos.
Cleaners	36 Nos.
Work mistries	5 Nos.

Organisation of Excavation Right Division (Twoshift)

Executive Engineer.	2 American Supervisors.
1 S. D. O. Accounts and Estimating.	1 Assistant Supervisor.
7 S. D. Os. Excavation Work.	

Organisation of Excavation Left Division (Twoshifts)

Executive Engineer.	1 American Supervisor.
1 S. D. O. Accounts and Estimates.	1 Assistant Supervisor Excavation General.
4 S. D. Os. for Excavation.	1 Assistant Supervisor Drilling and Blasting.
2 S. D. Os. for Drilling and Blasting.	2 E. L. Shovel.

STATEMENT No.6.2.6—*Contd*

Bhakra Dam Project

Capital Equipment

Serial No.	Type of Equipment	No. of Machines on the Project	Make and Model or Size and Nos. in each	Month and year of purchase.	Month and year 1st put into operation	Total Purchase Price	Whether acquired new or from disposal	Ordered through
1	2	3	4	5	6	7	8	9
1	(A) Tractors (40)	6	Caterpillar—D. 8 with Dozer	1 : 8/48 1 : 10/48 1 : 3/50 2 : 6/52 1 : 9/53		3@ 327204 2@ 15394 1@ 134488	New Old from Disposals. New	Willcox-Buckwell India Ltd. From Disposals. Willcox-Buckwell India Ltd.
		5	Caterpillar D.7	2 : 3/50 3 : 11/48		2@ 128988 3@ 19515	New Old from Disposals.	Do. From Disposals.
		4	Caterpillar D.6	1 : 9/51 1 : 9/52 1 : 9/53 1 : 3/53		2@ 133899 3@ 137342	New New	Willcox-Buckwell, India Ltd. M/s. Tractor Equipment Corpn. India Ltd., New Delhi.
		2	Caterpillar D.4	1 : 5/47 1 : 11/51		1@ 9270 1@ 24557	Old New	(Disposals). From Baud Khel Thal (W.B.)
		1	Caterpillar R.4	1 : 11/49		1@ 5000	Old	From Disposals.
		10	Allis Chalmers HD 20	6 : 8/52 4 : 9/52		8@1118016 2@ 286728	New New	8 Pasha Bhai Patel & Co., Bombay. 1 Narwana Circle. 1 Bhakra Main Line Circle.
		4	Ansaldo Fossarti AF 8 Diesel Tractors with Dozers	1 : 11/52 1 : 12/52 2 : 1/53		4@ 4114203	New	United Provinces Comml. Corpn., New Delhi.

		8	International T.D. 24 . .	1 : 2/53 5 : 3/53 2 : 5/53	1@ 135018 5@ 675100 } New 2@ 270040	M/s. Volkart Bros., Ltd., Bombay.
2	Motor Graders	4	Motor Graders No. 212 . . Motor Grader No. 12 . .	1 : 7/52 1 : 11/52 1 : 8/53 1 : 7/53	1@ 55628 New 3@ 29140 New	M/s. Willcox-Buckwell (India) Ltd.
	pers	2	D. Roadster made Rocker fitted with 4 cylinders G.M. Engines.	11/52	2@ 224344 New	William Jack Co. (India) Ltd. Bombay.
	Excavators Operating as Dragline shovels and Cranes.	17 14 —— 31	(Shovels) 1. Ruston Bucyrus 120 (Cranes) shovel. 2. Bucyrus Erie 38 B. Shovel 2 Nos. 1¼ cu. yds. 3. Main Speed Shovel 1¾ cu. yds. 2 Nos.	1 : 3/53 4 : 5/53	1@ 680005 New 2@ 610520 New 2@ 667670 New	Ruston Bucyrus Ltd., U.S.A. M/s. Bucyrus Erie, U.S.A. Do.
			4. Link Belt Speeder Shovel 2½ cu. yds. 3 Nos.	1 : 12/52 1 : 3/50	1@ 62300 Old	From Disposals.
			5. P. & H. Shovels ¾ cu. yds. 1 No.	1 : 3/49	1@ 68986 Old	Do.
			6. Marion Shovels 2½ cu. yds. 3 Nos.	1 : 3/48 2 : 11/50	3@ 1008179 New	Blackwood Hodge & Co.
			7. Lorain Shovels J-80 1¾ cu. yds .	1 : 2/53	1@ 298080 New	Volkart Bros., Ltd., Bombay.
			8. Leonard Shovel ¾ cu. yd. .	1 : 7/49	1@ 109644 New	Do.
			9. Leonard Electric Shovel 2½ cu. yds. 2 Nos.	2 : 10/53	2@ 902650 New	M/s. Greave Cotton & Co.
			10. N.W. 1½ cu. yds. Shovel .	1 : 3/48	1@ 50000 Old	From Disposals.
			11 P & H. ½ cu. yd. 1 No. .	1 : 2/49	1@ 49428	

STATEMENT No. 6·6·2—*concld.*

1	2	3	4	5	6	7	8	9
4	Cranes		Lorain Thew Shovel Crane 524 15 tons 1 No.	1 : 3/53		1@ 302205	New	Volkart Brothers.
			Lorain do. 45 tons 1 No.	1 : 4/53		1@ 496000	New	Volkart Brothers.
			Link Belt Cranes 10·30 tons 1 No.	1 : 3/48		1@ 62300	Old	Disposals.
			Quickway Motor Crane 5 tons 1 No.	1 : 5/50		1@ 25350	Old	Central Workshop, Amritsar.
			Tractor Crane D-7 7tons 2 Nos. .	2 : 5/49		2@ 28210	Old	Disposals.
			Stilleg Derrick Hudson Crane 7 tons 2 Nos.	2 : 4/49		2@ 104350	Old	Disposals.
			Fork Lifter No. 1735LI, 1739 LI, 2 Nos.	2 : 1/53		2@ 70214		
			PH 5 Tons Cranes 1 No. . .	1 : 1/47		1@ 26662	Old	Disposals.
			Tractor Crane T.D. 142 tons 3 Nos.	2 : 11/49 1 : 6/49		3@ 12779	Old	Disposals.
5	Dumpers	52	Koehring Dumpers 12	8/49		12@ 678048	New	B. K. Khanna & Co.
			Dumpers 3 cu. yds. cap. 20	7/50		20@ 537172	New	Cannon Bunkuley & Co., Ltd.
			Dumper Mix Hill 2 cu. yds. 20	6/47		20@ 169783	New	G. Boydell & Co.
6	Compressors	46	Air Compressor 315 CFM 16 .	2 : 3/47 1 : 7/47			17 Old	16 from Disposals. 1 from Ingersol Rand.
				1 : 5/47 4 : 1/49 2 : 7/45 2 : 2/50 2 : 9/50 2 : 9/52		16@ 406285		5 from Ingersol Rand. 12 from Consolidated Pneumatic Co., Ltd., Bombay. 6 from CPT Co., Bombay. 1 from Hissar on transfer. 2 from ISM, U.S.A. 3 from M/s. Albert Herbert Co., Ltd., Calcutta.
			210 CFM 4 105 CFM 7	4 : 9/49 1 : 7/46 1 : 3/50 1 : 9/50 2 : 1/51 1 : 2/51 1 : 1/49			29 New	
			160 CFM 1	1 : 1/49		1@ 11540		
			500 CFM 3 . .	3 : 11/47		3@ 88927		
			Compressor 1000 CFM Elec.	12 : 11/49		12@ 781373		
			70 CFM	2 : 5/48		2@ 24560		
			92 CFM Air Compressor 1	1 : 10/50		1@ 2730		

7	Crushers	7	Rock Crushers 56 VA	1 :	6/47	7@ 125955	Old	Disposals.
			Stone Crushers Petrol 16″×9	1 :	4/48			
			Pioneer Rock Crusher Model 3	1 :	2/50			
			Stone Crusher 42 VA	3 :	3/50			
			Primary Rock Crusher 25 cycl.	1 :	6/50			
8	Euclids	12	27 F.D. 15 Ton	12 :	5/49	89799 each	New	
		8	80 F.D. 15 Ton	8 :	3/53	14600 each	New	
		8	1 U.D. 10 Ton	8 :	3/53	117310 each	New	
		20	31 T.D. 22 Ton	20 :	3/53	220000 each	New	

STATEMENT

Bhakra Dam

Data for Cost Estimating

(1953-54

Sl. No.	Type of Equipment	Makes, Model and Size	Fuels Gls. per operating hr. & issue rate for fuel Qty.	Oil grease and waste including labour rate per operating hour	Operator wages per operating hour
1	2	3	4	5	6
1	Tractor Dozer	H. D. 20 Allis Chalmer	5½ 1 8 0	3 9 0	1 5 0
2	Tractor Dozer	T.D. 24 International	4½ 1 8 0	3 14 0	1 5 0
3	Tractor Dozer	D. 8 Caterpillar	3½ 1 8 0	3 15 0	1 5 0
4	Tractor Dozer	A. F. 8 Ansaldo Fossati	3½ 1 8 0	3 1 0	1 5 0
5	Tractor Dozer	D. 7 Caterpillar	2½ 1 8 0	3 9 0	1 5 0
6	Tractor Dozer	D. 6 Caterpillar	1¾ 1 8 0	3 5 0	1 5 0
7	Tractor Dozer	D. 4 Caterpillar	1½ 1 8 0	2 6 0	1 0 0
8	Motor Grader Scraper	Caterpillar	1¾ 1 8 0	2 12 0	1 5 0
9	Shovel	Marion 2½ cu. yds.	5 1 8 0	4 13 0	1 7 0
10	Shovel	Manitowac 1¾ cu. yds.	2¼ 1 8 0	3 12 0	1 5 0
11	Shovel	P & H 1¾ cu. yds.	3 1 8 0	4 3 0	1 5 0

No. 6·6·3

Projects

of Machinery

Rates)

Auxiliary Personnel wages per operating hour	Repair parts (spare parts) cost per operating hour	Tyres, Tubes and Flaps cost per operating hour	Sundries and Misc. cost per operating hour	Total cost per operating hour	Remarks
7	8	9	10	11	12
2 1 0	4 11 0	..	2 5 0	31 8 0	This includes dep-reciation @ 9/5 per hour.
2 1 0	4 6 0	..	2 3 0	29 4 0	This includes dep-reciation @ 8/11 per hour.
1 12 0	4 14 0	..	2 7 0	29 4 0	This includes dep-reciation @ 9/11 per hour.
1 15 0	4 5 0	..	2 3 0	26 11 0	This includes dep-reciation @ 8/10 per hour.
1 12 0	3 12 0	..	1 14 0	23 8 0	This includes dep-reciation @ 7/8 per hour.
1 9 0	3 2 0	..	1 9 0	19 12 0	This includes depre-ciation @ 6/4 per hour.
1 6 0	1 4 0	..	0 10 0	11 6 0	This includes depre-ciation @ 2/8 per hour.
1 9 0	3 2 0	Item No. 9 includes cost of item 8	1 9 0	29 4 0	This includes depre-ciation @ 6/5 per hour.
3 1 0	5 1 0	..	3 10 0	40 0 0	This includes depre-ciation @ 14/8 per hour.
2 9 0	4 9 0	..	3 4 0	31 12 0	This includes depre-ciation cost @ 12/15 per hour.
2 13 0	4 1 0	..	2 15 0	31 8 0	This includes depre-ciation cost @ 11/11 per hour.

STATEMENT

1	2	3	4		5	6
12	Shovel	Lorain 1¾ cu. yds.	3	1 8 0	3 15 0	1 5 0
13	Shovel	38-B 1½ cu. yds. .	3	1 8 0	4 1 0	1 5 0
14	Shovel	P & H 1½ cu. yds.	2½	1 8 0	4 4 0	1 5 0
15	Shovel	Lorain ¾ cu. yd. .	1¾	1 8 0	3 12 0	1 5 0
16	Shovel	Orton ¾ cu. yd. .	¾	1 8 0	3 8 0	1 5 0
17	Shovel	P & H ½ cu. yd. .	2½	1 8 0	3 8 0	1 5 0
18	Shovel	North West 1½ cu. yds.	2½	1 8 0	4 2 0	0 13 0
19	Tourna Rocker	..	1¾	1 8 0	3 3 0	0 15 0
20	Motor Crane	Lorain 45 Tons	10	1 8 0	3 13 0	5 0 0
21	Motor Crane	Lorain 30 tons	4 4	1 8 0 3 2 0	3 14 0	5 0 0
22	Crane	Washington .	Electric Charges 120 units.	0 2 6	3 10 0	4 0 0
23	Crane	Colby . .	100 Units	0 2 6	3 10 0	4 0 0
24	Motor Crane Old	Lorain . .	2 gls.	1 8 0	4 4 0	5 0 0
25	Crane	Orton 5 tons .	1¾	1 8 0	1 11 0	1 4 0
26	Crane (converted from 1½ cu. yds. Shovel)	P & H . .	2½	1 8 0	4 1 0	1 3 0

No .6·6·3—*contd.*

7	8	9	10	11	12
2 9 0	4 1 0	..	2 15 0	31 0 0	This includes depreciation @ 11/11 per hour.
2 9 0	3 13 0	..	2 11 0	29 12 0	This includes depreciation @ 10/13 per hour.
3 1 0	1 11 0	..	1 4 0	17 0 0	This includes depreciation @ 1/11 per hour.
2 9 0	1 15 0	..	1 15 0	18 0 0	This includes depreciation @ 3/14 per hour.
2 13 0	1 15 0	..	1 15 0	18 0 0	Do.
2 7 0	1 4 0	..	1 4 0	16 0 0	This includes depreciation @ 2/8 per hour.
3 12 0	2 0 0	..	1 5 0	16 0 0	Do.
1 5 0	2 10 0	..	1 14 0	20 8 0	This includes depreciation @ 7/8 per hour and contingencies @ 2 per cent.
19 2 0	5 10 0	..	5 10 0	79 5 0	This includes depreciation @ 22/6 & 2/12 per hour for Ford Truck.
16 10 0	3 12 0	..	3 12 0	69 5 0	This includes depreciation @ Rs. 15/1 per hour & 2/12 for Truck.
18 14 0	5 10 0	..	4 0 0	71 0 0	This includes depreciation @ 16/12 per hour.
18 14 0	5 2 0	..	3 10 0	65 8 0	This includes depreciation @ 14/10 per hour.
10 1 0	1 9 0	..	0 15 0	30 4 0	This includes depreciation @ 1/9 per hour.
10 11 0	1 5 0	..	0 15 0	22 3 0	This includes depreciation @ 3/11 per hour.
3 4 0	3 0 0	..	1 8 0	19 12 0	This includes depreciation @ 3/- per hour.

STATEMENT

1	2	3		4	5	6
27	Crane	Wrecker . .	2½	1 8 0	1 1 0	2 8 0
28	Crane (converted from ½ cu. yd. Shovel)	P & H . .	2½	1 8 0	4 11 0	1 4 0
29	Crane (converted from ¾ cu. yd. Shovel)	Link Belt . .	2	1 8 0	1 11 0	1 4 0
30	Crane	Quickway Mobil	1½	3 0 0	2 7 0	0 13 0
31	Tractor Crane	D.7 (6 Tons) .	2	1 8 0	3 6 0	0 15 0
32	Euclid with Trailer.	D.7 cu. yd. 27 FD	2½	1 8 0	1 8 0	1 0 0
33	Crane	TD 14 (2 Tons)	1¾	1 8 0	3 6 0	0 15 0
34	Truck with Trailer.	Federal . .	4	3 0 0	0 10 0	1 0 0
35	Truck with Trailer	International .	3	1 8 0	1 8 0	1 0 0
36	Auto Car with 45 Ton Trailer	..	2	3 0 0	0 10 0	1 0 0
37	Truck with Winch	G. M. C. .	2	3 0 0	0 5 0	1 0 0
38	Euclid	31 TD 22 Tons	4Gl./3.69	1 8 0	3 8 0	1 5 0
39	Euclid	27 FD 15 Tons	2.5 Gl. 2.42	1 8 0	3 8 0	1 5 0
40	Euclid	1 U.D. 10 Tons	2 Gl.	1 8 0	2 8 0	1 5 0

No. 6·6·3—contd.

7	8	9	10	11	12
7 8 0	1 4 0	..	0 15 0	20 3 0	This includes depreciation @ 3/3 per hour.
10 7 0	1 10 0	..	0 15 0	20 14 0	This includes depreciation @ 2/11 per hour.
10 5 0	1 1 0	..	0 8 0	18 14 0	This includes depreciation @ 1/1 per hour.
1 0 0	1 9 0	.	0 12 0	14 3 0	This includes depreciation @ 3/2 per hour.
1 13 0	1 15 0	..	1 0 0	14 0 0	This includes depreciation @ 1/15 per hour.
4 6 0	3 10 0	Item No. 9 includes cost of item 8.	2 10 0	27 4 0	This includes depreciation @ 10/6 per hour.
1 13 0	0 12 0	..	0 8 0	11 0 0	This includes depreciation @ 1/- per hour.
8 6 0	1 7 0	..	0 12 0	25 10 0	This includes depreciation cost @ 1/7 per hour.
4 6 0	2 0 0	Item No. 9 includes cost of item 8.	1 6 0	20 6 0	This includes depreciation cost @ 5/10 per hour.
4 4 0	0 12 0	Do.	0 6 0	13 12 0	This includes depreciation cost @ -/12/- per hour.
4 0 0	0 11 0	Do.	0 5 0	13 0 0	This includes depreciation @ -/11/- per hour.
1 15 0	5 2 0	Do.	3 11 0	36 4 0	This includes depreciation @ 14/11 per hour.
1 12 0	2 9 0	Do.	1 13 0	22 0 0	This includes depreciation @ 7/5 per hour.
1 9 0	2 11 0	Do.	1 15 0	21 12 0	This includes depreciation @ 7/12 per hour.

STATEMENT

1	2	3	4		5	6
41	Muir Hill Diesel Dumper	3 cu. yds.	0·75 Gl.	1 8 0	2 1 0	0 9 0
42	Petrol Dumper	..	1·25 Gl.	3 0 0	0 10 0	0 6 0
43	Koehring Dumper	..	1 Gl.	1 8 0	2 1 0	0 9 0
44	Thames Tipper	..	1·25 Gl.	1 8 0	1 11 0	0 15 0

No. 6·6·3—*concld.*

7	8	9	10	11	12
1 0 0	1 1 0	Item No. 9 includes cost of Item 8.	0 9 0	8 9 0	This includes depreciation @ 2/3 per hour.
0 12 0	0 5 6	Do.	0 5 6	6 14 0	This includes depreciation @ 11/- per hour.
0 11 0	1 14 0	Do.	0 15 0	11 6 0	This includes depreciation @ 3/12 per hour.
0 15 0	0 11 0	Do.	0 8 0	8 12 0	This includes depreciation @ 1/15 per hour, and 2 per cent contingencies.

STATEMENT

Bhakra Dam

Data for Cost Accounting

Sl. No.	Type of Equipment	Make, Model and Size	Fuel gls. per operating hr. and issue rate for fuel	Oil, grease and waste including servicing labour per operating hour	Operator wages per operating hour
1	2	3	4	5	6
			Rs. A.	Rs. As. P.	Rs. As. P.
1	Tractor, H.D. 20	Allis Chalmer, H.D. 20	5 gls. @ 1/6 = 6 14	2 8 0	1 0 0
2	Tractor, D-8 .	Caterpillar, D-8 .	3½ gls. @ 1/6 = 4 13	1 10 0	1 4 0
3	Tractor, D-7 .	Caterpillar, D-7 .	2½ gls. @ 1/6 = 3 7	1 12 0	1 2 0
4	Tractor, D-6 .	Caterpillar, D-6 .	1¾ gls. @ 1/6 = 2 6	1 15 0	0 12 0
5	Tractor, D-4 .	Caterpillar, D-4 .	1½ gls. @ 1/6 = 2 1	0 15 0	0 12 0
6	Euclids .	Euclid, 27F.D.-15 tons	2 gls. @ 1/6 = 2 12	2 1 0	2 0 0
7	Marion Shovel .	Marion, 93 M, 2½ cu. yds.	5 gls. @ 1/6 = 6 14	2 8 0	2 8 0
8	Link-Belt Shovel	Caterpillar 2K. 175 2½ cu. yds.	5 gls. @ 1/6 = 6 14	1 15 0	0 12 0
9	N. W. Shovel	North-West Eng. Co. 1½ cu. yds.	2¼ gls. @ 1/6 = 3 1	3 4 0	1 8 0
10	P. & H. Shovel	Harnischfiger 1½ yds.	3 gls. @ 1/6 = 4 2	3 4 0	1 9 0

NOTE:—Exact figures for light repairs, greases and sundries etc., could not be calculated figures, near the mark, have been given.

No. 6·6·4

Project

Machinery (Actuals) for the year

Auxiliary personnel wages per operating hour	Repair parts and spare parts cost per operating hour	Tyres, tubes and flaps cost per operating hour	Sundries and Mis. cost per operating hour	Total cost per operating hour	Remarks
7	8	9	10	11	12
Rs. As. P.	Rs. As. P.	Rs. As. P.	Rs. As. P.	Rs. As. P.	
1 2 0	6 0 0	..	4 15 0	34 8 0	Including depreciation: 12/1.
1 6 0	4 14 0	..	5 6 0	29 1 0	Including depreciation: 9/12 per hour.
1 6 0	3 12 0	..	6 11 0	25 11 0	Including depreciation: 7/9.
0 11 0	2 9 0	..	4 13 0	18 4 0	Including depreciation: 5/2.
0 15 0	1 4 0	..	1 4 0	8 7 0	Including depreciation: 1/4.
1 8 0	2 1 0	4 0 0	1 4 0	21 10 0	Including depreciation: 6/-.
4 0 0	3 3 0	..	9 0 0	37 4 0	Including depreciation: 9/3.
1 13 0	3 11 0	..	2 10 0	28 4 0	Including depreciation: 10/9.
2 4 0	2 0 0	..	7 0 0	21 7 0	Including depreciation: 2/10.
2 4 0	2 4 0	..	4 8 0	20 15 0	Including depreciation: 3/-.

as it would take very long to do because they have grouped under one head stock. Approximate

STATEMENT No. 6·6·5

Caterpillar Tractors (New)

Month	No. of Machines: Working	No. of Machines: Under overhaul	No. of Machines: Total	Basic Schedule hours	Average working hours	Average idle hours	Average breakdown hours	Average overhaul hours	Average breakdown hours including overhaul hours	Efficiency as compared with basic schedule hours. col. 6/5 × 100	Average break-down including overhauling: Compared with basic schedule hours. col. 10/5 × 100	Average break-down including overhauling: Compared with working hours col. 10/6 × 100	Average break-down excluding overhauling: Compared with basic schedule hours. col. 8/5 × 100	Average break-down excluding overhauling: Compared with working hours col. 8/6 × 100	Remarks
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
April	1	..	1	432	153	40	23	..	23	35.4	5.31	15.0	5.31	15.0	
May	2	..	2	448	230	83	54	..	54	51.25	12.1	23.4	12.1	23.4	
June	3	..	3	429	161	67	41	39	80	37.2	18.5	49.7	9.5	25.4	
July	3	..	3	464	147	194	73	..	73	31.6	15.75	49.5	15.75	49.5	
Aug.	3	..	3	432	166	59	87	..	87	38.4	20.1	52.4	20.1	52.4	
Sept.	2	1	3	448	193	82	39	43	82	43.0	18.3	42.5	8.6	20.2	
Oct.	4	..	4	432	196	122	45	..	45	45.4	10.4	22.9	10.4	22.9	

The information on some of columns above have been worked out as follows:

Column 5.—Basic schedule hours have been taken as two shifts of 8 hours each for all days excluding holidays.

Column 6.—These figures are based on the actuals recorded in the log books.

Column 7.—Idle hours have been filled from the log books. These have been taken as a full shift of 8 hour a day when the machines remained idle throughout the month.

Column 9.—These figures are based on the actuals recorded in the log books. In case of machines under overhaul for whole days the hours under overhaul have been taken as 8 hours only per day.

STATEMENT No. 6·6·6

Bhakra Dam

Log Book for——————————(Machine)

Name of Division　　　　　　　　No. of machine

Date	Shift No.	Breakdown hours if any	Description of breakdown or reasons for idle hours.	Estimated on which machine employed	Site of work, kind of work	Progress of work	Name and signature of foreman/overseer and checking officers.	Fuel and Lubricants and petty Stores							Details of Repairs				Remarks
								Fuel Oil H. S. Diesel	Petrol	Lubricants Engine	Lubricants gear	Grease	Filters	Other Stores	Name and signature of foreman/overseer and checking officers.	Time and date on which remained under repairs.	Details of spare parts issued and reason for undue delay for repairs.	Name and signature of foreman/overseer workshops and checking officers.	

Rules for Maintenance of Log Books for Earth-moving Machinery

The following rules should be observed for issue, custody, maintenance, checking and accounting of log books.

A. Issue and Custody

1. Log books are very important records of working of machines and are to be kept with same care as Measurement books.

2. All log books will be numbered and their pages machine numbered.

3. All log books will be issued from the office of the Executive Engineer, Mechanical Field Division (Supdt. Mechanical Field Department), who will keep a record of number of log books and machines to which these relate. The Executive Engineer, Mechanical Field Division, will supply a list of all log books issued (with serial number of machines) at the end of every month to the Administrative Officer in duplicate and one copy to the P.A. to Joint Director, Construction and Plant Design.

4. Two log books will be maintained for each machine, one for the month of January, March, May, July, September and November and the other for the month of Feb., April, June, August, October and December.

5. The log books will be issued by the Executive Engineer, Mechanical Field, to the Divisions (Departments), *e.g.*, (Excavation Right or Left or Bridge) where the machines concerned are working. The Executive Engineer of that Division in turn will make the S.D.O. (Assistant Superintendent) concerned responsible for the log books with the machines working under the latter. The Executive Engineers and S.D.O. (Assistant Superintendent) will maintain a register of log books like register of Measurement books. When a machine is transferred from one S.D.O. to another, the log books will be transferred along with the machine and the changes incorporated in the register of log books. In case a machine is transferred from one Division to another, the transfer of log books should be notified to the Executive Engineer, Mechanical Field, who will always maintain an up-to-date record of distribution of all log books and also to the new Superintendents (Executive Engineers). The Executive Engineer, Mechanical Field Division, will periodically check the list with the log books.

6. The log books will be kept in a cloth cover with the machine and in the charge of representative of the Division using the machine. When this machine is in use, the log book will be kept with the operator and when the same is not in use it will be kept with the Chowkidar. These log books should be readily accessible to all the Divisions all the time.

7. If a machine is transferred out of the Directorate, the log books are not to be sent along with the machine, but should be returned to the Executive Engineer, Mechanical Field Division, for record, but essential data, *e.g.* number of hours the machine has worked should be supplied.

B. Maintenance of Log Books

8. A form of log book proposed, is attached* herewith. This will be maintained as follows:

Column 1 to 8	By the Division using the Machine (Excavation Right or Left).
Column 9 to 16	Executive Engineer, Mechanical Field incharge of Lubrication.
Column 17 to 19	By the Division carrying out maintenance and repairs.
Column 20	By any Division when necessary.

9. Totals should be struck for each page and carried over to next page. A grand total should be struck for each month. The hour meter reading at the end of the month should also be noted and compared with the working hours otherwise recorded. The total number of hours machine has worked since purchased and its last major overhaul should also be recorded where known. At the end of month, an abstract should be prepared for the following:

Name of work to which charges to be made	Working hours	Quantity of work done

10. On the first page of the log book the sanctioned scale ot fuel and lubricants for working hours should be noted.

C. Checking

1. All Executive Engineers and S.D.Os. will inspect the log books during their tour of inspection and go into reasons for low progress and/or lesser number of working hours for excessive issue of stores. They should sign the log books in token of their inspection.

12. The Sub-Divisional Officer, Estimates and Accounts, will check it for completion at the end of the month before submission.

D. Accounting

13. The log books will be sent by the S.D.Os. to the Executive Engineers on 1st and by the Executive Engineers, to the Administrative Officer by the 6th of the next month along with an abstract of debits and credits.

14. Necessary debits and credits will be raised in the Administrative Officer's Office.

15. The log books will be returned by the Administrative Officer to the Executive Engineer concerned by the 20th for use next month.

M. R. CHOPRA,
Joint Director,
Directorate of Construction and Plant Design,
Nangal Township.

*Not Reproduced

STATEMENT No. 6·6·7

Copy of Letter No. 470 CD, dated 5-3-53 from General Manager, anb Secretary to Government Punjab, P.W.D. Irrigation Branch, Bhakra Dam, Ellerslie,Simla-2 to the Administrative Officer, Directorate of Construction and Plant Design, Nangal Township

Sanction is accorded to the revised wage scale for the undermentioned categories of workcharged establishment employment in the Bhakra Dam Administration, with effect from 1-1-53.

Name of post	Revised wages approved by the Finance Department			
			Apprentice	
	Min.	Max.	Min.	Max.
1	2	3	4	5
GROUP A				
Foreman Special	300	500	..	..
Structural Shop	..	..	..	..
Processing Plant	..	..	..	..
Batching and Mixing Plant	..	..	..	..
Placement Plant	..	..	..	..
Erection of Trestles	..	..	..	..
Maintenance of Special Plant	..	..	..	..
Repair of Special Plant at Bhakra Site	..	..	..	..
Welding Machinery and Structural	..	..	..	..
Earth-moving	..	..	..	..
Drilling	..	..	..	..
Civil Rigging	..	..	..	..
2. *Foreman*	210	300	..	..
Heavy Plant Overhaul	..	..	..	..
3. *Foreman Miscellaneous*	150	225	..	..
Automobile	..	..	..	..
Machine Shop	..	..	..	..
Foundry	..	..	..	..
Carpentry	..	..	..	..
Reinforcement	..	..	..	..
4. *Assistant Foreman (Special)*	210	300	..	..
For jobs given under Foreman (Special)	..	..	..	..
5. *Assistant Foreman*	150	225	..	..
For jobs against Foreman	..	..	..	..
6. *Assistant Foreman (Miscellaneous)*	120	150	..	..
For jobs given under Foreman (Miscellaneous)	..	..	..	..

1	2	3	4	5
7. *Chargeman* (*Special*)	150	225	..	..
For jobs given against Foreman (Special)	..	..	..	..
8. *Chargeman*	130	150	..	..
For jobs given against Foreman .	..	..	..	..
9. *Chargeman* (*Miscellaneous*)	100	130	..	..
For jobs against Foreman. . .	..	..	..	..
GROUP B				
1. *Template Maker of Steel Structural. Fitter Steel Structure*	100	150	50	75
Erector Steel Structure . . .	..	..	..	..
Cable Jointer	..	..	..	..
2. *Journeyman* (*Special*)	60	100	50	55
Pattern Marker	..	..	..	..
Moulder	..	..	..	..
Turner	..	..	..	..
Welder Electric and Gas . . .	..	..	..	..
Instrument Mechanic (Including telephone and refrigerator mechanic).	..	..	..	..
Fitter Mill, Wright	..	..	..	..
Electrician (Special) . . .	..	..	..	..
Switch Board Control Wireman .	..	..	..	..
Armature Winder	..	..	..	..
Cable Jointer	Deleted *vide* C.E. No. 2560/B.D. dated 10th June 1953			
3. *Journeyman* (*Mechanical*)	60	90	50	55
Tool Operator (Machine) . .	..	..	..	..
Fitter Heavy Machine . . .	..	..	..	..
Blacksmith	..	..	..	..
Copper and Tin Smith . . .	..	..	..	..
Pipe Jointer	..	..	..	..
Diesel Mechanic	..	..	..	..
Carpenter	..	..	..	..
Motor Mechanic	..	..	..	..
4. *Journeyman* (*Electrical*)	60	90	50	55
Fitter	..	..	..	..
Electrician (Ordinary) . . .	..	..	..	..
Wireman-Lineman	..	..	..	..
Switch Board Attendant . . .	..	..	..	..
Armature Winder	..	..	..	..
Driller Jack Hammer . . .	..	..	..	..
Blastman	..	..	..	..

1	2	3	4	5
GROUP C				
Operators and Drivers				
1 *Shovels, Draglines and Cranes (Diesel)*				
Up to 1½ cu. yds. size Light . .	90	125	50	75
2 cu. yds. to 5 cu. yds. Heavy . .	125	225	50	75
2. *Shovels Electrical*				
2½ cu. yds. to 5 cu. yds . . .	125	225	50	75
Whirly Crane truck Crane, Hammarhead Crane and Dorrick Crane. .	180	325	50	75
3. *Drivers of Carriers*				
LIGHT VEHICLES				
Cars, Petrol Trucks 2½ tons etc. .	60	90	50	55
HEAVY VEHICLES				
Diamond tools, macks, dumpers, etc.	60	90	50	55
EUCLIDS				
Donkey Loco Driver . . .	90	125	50	75
Main Line Loco Driver . . .	60	90	50	55
4. *Tractor Operator*				
(Light Tractors)				
D/4 Fowler Marshall, etc. . .	60	90	50	55
D/6, D/7, D/8 Road Graders T.D. 24 H.D. 20	00	130	50	75
5. *Operators Stationary Plant* . . .	60	90	50	55
(Mechanical or Electrical)				
Air Compressors, Pump, Pumpcrete, Welding Sets, Concrete Mixes, Small Generating Sets.				
GROUP D				
Aggregate Plant Control Batching and Mixing	150	200	50	75
Plant Hoisting double drums plumbers				
GROUP E (Transportation)				
Station Master	75	100	..	..
Train Examiner, Railway Guard	75	100	..	..
Shunter	[illegible]	60	..	..
Gangman, Trolley Man, Keyman, Gangmate	35	45	..	..
Trolley Jamadar, Brakesman	40	50	..	..

1	2	3	4	5
GROUP F (Semi-skilled)				
Cleaners Greasers Fireman Boiler Attendants Attendants Concrete Mixer Attendants Workshop Gangman Hammerman T.M. Mate Gangmates Coalmen Condensor Attendants	30	40	..	..
Muckers	30	40	..	..
Mucker Jamadars	35	45	..	..
Slingers	40	60	..	..
Barryman (Crowbarman)	35	50	..	..

Endt. No. 471-73/BC dated the same by the Assistant Secretary to the Government of Punjab, Finance (Works) Department.

Copy forwarded to :

1. Accountant General, Punjab, Simla.
2. Chief Accounts Officer, B.N. Project.
3. Resident Audit Officer, Nangal, for information.

STATEMENT No. 6·6·8

Construction Force Report

Departmen: Excavationt Right

Sl. No.	Category of Establishment with trades	No. of men working in each shift: 1st shift	2nd shift	3rd shift	Total	Remarks
I.	S. Foreman	..	3	2		
	Foreman	..	1	..		
	Assistant Foreman	..	2	4		
	Chargeman	1	5	2		
	Assistant Special Foreman	..	2	..		
	Special Chargeman	..	..	1		
					23	
II.	*Journeymen*					
	Drillers	9	49	44		
	Blastmen	2	4	5		
	Barrimen	..	..	3		
	Fitters	..	7	5		
	Makers	6	36	31		
	Carpenters	..	2	..		
					203	
III.	*Operators and Drivers*					
	(Shovel Operators and Drivers)					
	Shovel Operators	1	11	9		
	Tractor Operators	1	17	8		
	Euclid Operators	1	30	16		
	Tourna Rocker Operators	..	3	3		
	Tanker Drivers	1	1	1		
	Compressor Drivers	..	2	1		
	Motor Graders	..	1	..		
	Truck Drivers	..	1	1		
					109	
IV.	*Other Semi-skilled & Miscellaneous Establishment*					
	Supervisors	1	13	12		
	Work Mistries	3	11	7		
	Surveyors	..	4	..		
	Wiremen	..	..	1		
V.	*Unskilled Labour*					
	Coolies	6	56	17		
	T.M. Mates	3	3	3		
	Chowkidars	4	..	1		
					93	
			GRAND TOTAL		480	

Department : *Excavation Left*

Sl. No.	Category of Establishment with trades	No. of men working in each shift: 1st shift	2nd shift	3rd shift	Total	Remarks
I.	Foremen	1	3	2	6	
	Assistant Foremen	1	5	1	7	
	Chargemen	..	12	5	17	
					30	
II.	*Journeymen*					
	Fitters	2	6	7	15	
	Carpenters	1	1	..	2	
	B/smiths	..	1	..	1	
	B/men	7	4	5	16	
	Drillers	27	60	39	126	
					160	
III.	*Operators and Drivers*					
	Sh. Operators	6	6		12	
	Elec. Sh. Operators	1	2		3	
	Elec. Sh. T. Operators	3	3		6	
	Shovel Greasers	3	..		3	
	Shovel Tr. Operators	1	3		4	
	Euclid Operators	20	19		39	
	M.G. Operators	1	..		1	
	Compressor Drivers	1	..		1	
	Truck Drivers	6	3		9	
	Tractor Operators	10	9		19	
					97	
IV.	*Other Semi-skilled & Miscl. Establishment*					
	Supervisors	4	14	4	22	
	G/Munshis	1	3	..	4	
	G/Mistries	3	9	10	22	
	Muckers	42	83	68	193	
	Gangmen	..	4	..	4	
	Turners	..	1	..	1	
	Khalasis	..	1	..	1	
	Surveyor	..	1	..	1	
	Coolies	1	4	9	14	
	C.R. Drivers	..	4	3	7	
					269	
V.	*Unskilled Labour*					
		90	268	198	556	

STATEMENT No. 6·6·8—*contd*

Construction Force Report

D partment : Bhakra Shops

Sl. No.	Catagory of Establishment with trades	No. of men working in each shift			Total	Remarks
		1st shift	2nd shift	3rd shift		
I.	*Foremen*	5	10	2	17	
	Assistant Foremen	..	7	3	10	
	Chargemen	15	13	11	39	
II.	*Journeymen*	33	105	53	191	
III.	*Operators & Drivers*	7	9	5	21	
IV.	*Other Semi-skilled & Miscl. Establishment*	11	32	13	56	
V.	*Unskilled Labour*	2	6	2	10	
					344	

APPENDIX 6·7

Nangal Project

The project comprises construction of a weir across the river Sutlej and canals for irrigation and power. A high-level canal starts off directly from the weir with hydel stations at the falls. The power channel is entirely lined. Earth-moving equipment was utilised mainly on the excavation and embankment for the canal and the foundations of the power house. Organisation chart with particular references to the staff of the Mechanical Division is given in Statement No. 6.7.1.

Post-audit system of accounts is maintained under normal P.W.D. Regulations.

The work goes on normally in two shifts except where there is no arrangement for lighting. There are about 250 working days in a year excluding holidays and Sundays etc.

About 400 million cft. of earthwork is done by machinery. Works, which would have been costly for execution by manual labour, have been set apart for equipment. About 200 million cft. of earthwork was done in one year ending November 1953.

The purchase cost of the equipment is debited, in the first instance, to Special T. & P. and is transferred to work through depreciation account. The running cost of equipment is watched through suspense estimates called "manufacturing estimates".

The soil is compact sandy loam. Nearly 20% of the work is in gravel or boulder. Watering is necessary for embankment and is done at the fill. Canal banks are compacted by sheepsfoot rollers of 250 bs. per sq. inch intensity.

The information regarding the capital equipment and life used is given in Statement No. 6.7.2.

The information regarding the working rates of various earth-moving machinery is given in Statement No. 3.

Copy of a typical "manufacturing estimate" for Euclid Trucks is given in Statement No. 6.7.3.

The receipts for the levy of major repair charges and the expenditure for overhaul is watched through a separate register. Every overhaul has to be covered by a specific estimate sanctioned for the purpose and the expenditure thereof is entered in the register. The record gives a complete story of the life hours used, amount credited by depreciation and the position of the major repair fund.

The life adopted for depreciation of earth-moving machinery is given in Appendix 3.2. Static equipment such as workshop machinery, winches, pumps, etc., is depreciated at 5% per year. Individual account of these machines is not maintained. Their residual value is determined *ad hoc* as the occasion arises. The terms 'Running Repairs' and 'Major Overhauls' are defined as under:

Running repairs are all repairs found necessary to a machine which is in current use to keep it working. These include replacement of minor parts.

Major Repairs and Overhauls are found necessary to a machine that is not in commission and which are required to permit of its again being efficiently put into use. This will include replacement of costly spare parts.

The provision for running repairs and major overhauls is made at a percentage of depreciation according to the table given below:

	Heavy Repairs & Overhauls (per cent)	Running Repairs (per cent)
TRACTORS, DOZERS & SCRAPERS		
(1) Motorised Scrapers La Plant Choate Terra Cobra	50	25
(2) Tractor, Scrapers, Crawler or Dozers	50	35
D8, D7, D6, D4	60	40
Fowler Marshall V.F.	75	40

	Major Overhauls (per cent)	Ordinary Overhauls (per cent)
SHOVELS, DRAGLINES & CRANES		
(*a*) Lima 3½ cu. yds. Marrion 2½ cu. yds. Link Belt 2½ cu. yds.	35	25
(*b*) Lorrains 3/4 cu. yds. P. & H. Shovel	60	40

ORTON

	(Per mile)	(Per mile)
TRANSPORT VEHICLES		
G.M.C. Trucks and Studebaker, Tippers	0 2 0	0 2 0
Tankers	0 2 6	0 2 6
Diamond Tee	0 4 0	0 9 0
Macks 10 Tonners	0 6 0	0 10 0
CARS		
De-soto, Jeep Willys, Land Rovers	0 1 0	0 2 0
Command Cars	0 1 0	0 2 0
Weapon Carriers	0 1 6	0 2 0
Personnel Carriers		
Jeeps	0 1 0	0 1 6
Ambulance Cars	0 1 6	0 2 0
Humber Station Wagon	0 1 6	0 2 0

	Major Overhauls (per cent)	Ordinary Overhauls (per cent)
EARTH-MOVING MACHINERY		
Euclid	35	25
Koehering Dumptors	50	30
Muir Hill Dumptors 3 cu. yds.	50	30
Muir Hill Dumptors 2 cu. yds.	100	(spare 50% parts cost very high, original purchase very low)
D.W. 10	35	25
Batching Plant	100	50
Batching and Mixing Plant	75	40
Tournā Mixers		
Paver Mixers	50	25
Truck Mixers	100	50
Air Compressors—Electric	35	25
Portable Diesel Air Compressors	50	25
Pump Crete	50	25
Failing Drilling Rig	150	100
"Speed Star" Rig	50	25
Stationery Machinery	40	20

Plant hour is defined as the total clock hours for which the machinery worked. Debit is raised on the basis of rates fixed separately for "plant hours" and "idle hours".

Log Books: The machinery record is based on the primary records maintained in log books.

The rates are discussed in the body of the Report.

Stores

There is a large project store maintained at Nangal. The Executive Engineer and the American Supervisors originate their demand through requisitions. These are checked by the Joint Director, Construction and Plant Design, and are sent to the S.E. Area No. I with copies to the officers who requisition the store. The requisitions are checked by the Stores-Division store, enquiries are issued to 20 to 30 firms depending on the nature of the with regard to the availability in stock. If the material is not available in the material required. On an average 1 to 1½ month is required from the receipt of the requisition to the issuance of the purchase order, the time varying from 2 days in very urgent cases to about six months. Requisitions are marked 'Ordinary', 'Urgent' and 'Immediate' by the requisitioning officer and are handled according to the urgency indicated. On an average, it takes two months for general stores and six months for spare parts from the date of purchase order to the receipt of material in the stores. In case of emergency, purchase enquiries are made telegraphically and petty stores are purchased locally. There is an officer of the project attached to the Washington Embassy for procurement of materials required urgently from U.S.A.

The S.D.O. Receipt under the Executive Engineer, Stores Division, receives the materials and checks it against the purchase order and records receipt in "Goods Receipt" form. He is helped in this by Assistant Stores Holders, Overseers and Munshis. Copies of the daily receipt of the stores are sent to the Indenting Officer.

The Stores Organisation is divided into four parts as under:

1. Executive Engineer (Procurement) to dispose off the requisitions up to the issue of purchase orders.
2. Executive Engineer (Stores Division) to receive the materials, arrange and index them in Bins and issue them including settlement of the payment to the firms.
3. Executive Engineer, Bhakra Sub-store, catering to the needs of the works at the dam.
4. Stock verification Agency comprising of Stores Inspector of the rank of S.D.O. working directly under the S.E., Area No. I, verifying the balances continuously almost once in three months.

Minimum and maximum balances are mentioned on the Bin cards. The Assistant Store Holder puts up requisition for stock items when they run below the minimums. These are checked by the S.D.O., and E.E. and are sent to E.E. (Procurement). The E.E., Stores Division, decides which items shall be classified "stock items".

The system of marking and identification used in the Stores is 'Vocab System', Tally cards and tags are used for identification. Record is kept in Kalmazoo Visible Binders, Bin Cards and Ledger system described above.

Six copies of an indent on the store are required. These are utilised as under:

2 copies with the indentor of which one is a gate pass.
1 copy for store record with the section holder.
1 copy to the Executive Engineer demanding the store.
1 copy for accounts, and
1 Divisional Block copy.

Generally about 5 items are allowed to be included in one indent for the facility of entries of the materials and rates.

The total value of stock at the end of October, 1953 was Rs. 3,27,94,000 classified as under:

	Rs.
(i) Electrical section	60,00,000
(ii) Lubricants and Fuels	30,00,000
(iii) Building material	90,00,000
(iv) Spares	1,10,00,000
(v) Steel	20,00,000
(vi) Miscellaneous	17,94,000

The value of the stores in hand not utilised for one year has not yet been ascertained. The yearly issues are about Rs. 1·25 crores.

Storage and handling charge at 1% is levied on the issue rates to cover the workcharged establishment, carriage of materials from station to store, loading, unloading and upkeep of stores.

The Assistant Store Holder is a senior man recruited by Punjab Public Service Commission and carries a pay scale of Rs. 300—12½—400. Store Munshis are paid Rs. 80 in the scale of Rs. 80—4—120.

STATEMENT No. 6·7·1

Organization Chart of Nangal Project

Not Printed.

APPENDIX

Nangal

Statement of Earth-moving Equipment

Sl. No.	Type of Equipment	No. of Machines on the Project	Make, Model or Size and No. in each	Month and Year of Purchase	Month and Year first put into operation
1	2	3	4	5	6
1	Euclid End Dump . .	12	B5FD	12/51	1/52
	Euclid End Dumper	14	Do.	9/52	10/52 to 11/52
2	Euclid Bottom Dump .	12	27 FD	11/49 to 4/50	11/49 to 6/50
3	DW-10 Scrapers . .	12	Caterpillar 8.9 cu. vds.	6/52	7/52
4	Koehering Dumper . .	12	W-60 6 cu. yds.	3/49 to 10/49	6/49 to 11/49
5	Muir Hill Dumpers . .	32	WD 2 cu. yds.	10/46 to 7/47	up to 8/47
6	Crawler Tractor . .	13	Caterpillar D/8	3/47 to 7/52	4/47 to 7/52
7	Crawler Tractor . .	21	Caterpillar D/7	11/48 to 11/51	12/48 to 1/52
8	Crawler Tractor with Hydraulic Dozer . .	11	Caterpillar D/6	6/49 to 9/52	7/49 to 10/52
9	Crawler Tractor with Traxcavator . .	1	Caterpillar D/4	3/50	4/50
10	Crawler Tractor . .	1	Caterpillar D/4	11/49	1/50
11	Crawler Tractor . .	6	Caterpillar D/2	1/52	1/53 to 2/53
12	Motor Grader . . .	2	Caterpillar	1-12/51 1-8/48	1/52 1/49
13	Crawler Tractor . .	17	Fowler Marshall VF5	6/51 to 10/52	7/51 to 11/52
14	Crawler Tractor . .	4	Oliver Clea Track D.D.	8/52 to 10/52	8/52 to 10/52
15	Crawler Tractor . .	5	International T.D. 14	8/49 to 4/50	9/49 to 5/50

6·7·2

Power Canal

and Life adopted for Depreciation

Total Purchase Price	Whether acquired new or from Disposals	Ordered through	Life period in terms of working hrs. adopted for calculating depreciation	Actual working hours put in upto 31-3-53 Avg./each	Remar
7	8	9	10	11	12
17,34,900	New	Blackwood Hodge and Co. Ltd., Calcutta.	15,000	3,785	
20,93,000	New	Do.	15,000	960·3	
9,88,625	New	Do.	15,000	4,998	
12,40,320	New	Do.	15,000	2,229	
5,06,220	4-Disposals 8-New	Disposal B.K. Khanna	8,000 12,000	3,688·2	
2,84,587	New	M/s. B. Boydell & Co., Hyderabad (Deccan).	10,000	4,051·6	
11,58,949	3-Disposals 10-New	Disposals M/s. Buckwell (Willcox)	8,000 12,000	3,523	
6,22,783	16-Disposals 5-New	Disposals M/s. Buckwell (Willcox)	8,000 12,000	3,679	
6,50,208	New	Do.	12,000	2,381	
39,006	New	Do.	12,000	2,256	
24,557	New	Do.	12,000	3,071	
1,11,000	New	Do.	10,000	..	
17,200 16,450	Disposals Disposals	Disposals Do.	8,000 8,000	1,877 3,987	
3,58,650	1-Disposals 16-New	Do. M/s. Marshall & Sons	10,000 10,000	1,960	
2,42,675	New	M/s. William Jacks	12,000	1,526	
45,000	Disposals	Disposals	8,000	3,353	

APPENDIX

1	2	3	4	5	6
16	Crawler Tractor . .	2	International T. D.9	8/49	9/49
17	Crawler Tractor . .	4	Allis Chalmers . HD7	4/51 to 5/51	5/51 to 6/51
18	Excavators . . .	8	Link Belt K-580 . 2½ cu. yds.	2/51 to 9/52	11/51 to 4/53
19	Excavators . . .	2	Lima 1201 Dragline 3½ cu. yds.	11/49 to 10/50	12/49 to 12/50
20	Excavators . . .	2	Lima 803 Shovel 2½ cu. yds.	2/52 to 1/53	2/53 to 3/53
21	Excavators . . .	3	Lorain L-82 2 cu. yds.	6/49 to 10/51	8/49 to 12/51
22	Excavators . . .	1	Lorain Dragline . 3/4 cu. yds.	6/49	9/49
23	Excavators . . .	1	North West . Model—6 1½ cu. yds.	6/49	9/49
24	Excavators . . .	1	Shovel 93-M . Marion 2½ cu. yds.	2/50	3/50

6·7·2—*contd.*

7	8	9	10	11	12
14,000	Disposals	Disposals	8,000	3,013	—
1,31,342	New	M/s. Pasha Bhai Patel, Bombay	10,000	3,703	
21,79,990	1-Disposals 7-New	Disposals M/s. Willon	15,000 30,000	2,678	
7,60,204	Disposals	Disposals	30,000	7,520	
7,51,800	New	M/s. B.K. Khanna	30,000	478	
1,62,696	Disposals	Disposals	15,000	3,531	
71,018	New	U.S.A. through I.S.M.	20,000	5,230	
50,120	Disposals	Disposals	15,000	6,706	
2,80,216	New	M/s. Black Wood	30,000	5,55	
1,45,35,496		OVERALL AVERAGE		3,323	

APPENDIX 6·7·3

Typical Manufacturing Estimate

(Project)	Fund (Major Head)	80-A Capital outlay on Multi-purpose River Valley Scheme:
(Canal or Branch) . . .	(Minor Head)	Bhakra Nangal Project I,
(Name of Work) Working 48 No. Euclid Trucks in Field Divn. for the year 1953-54.	(Service Head)	Bhakra Dam IV, Suspense
	(Detail Head)	and Stock Mfg.

ABSTRACT OF ESTIMATE FRAMED BY S. Sirtaj Singh Sahi, Executive Engineer, Field Division, Nangal.

No. or Quantity	Abstract of Expense	Rate At			Rate Per	Amount	Total
	OPERATION FOR 163008 Hours						
	Direct Charges	Rs.	A.	P.		Rs.	
I.	Workcharged Establishment (for 203760 hours including idle hours as per detail)	2	0	0	Hour	4,07,520	
II.	Stores as per detail	4	4	0	,,	6,92,784	
III.	Repairs and Replacement as per details	2	4	0	,,	3,66,768	
	Indirect Charges						
IV.	Depreciation charges as per details .	8	14	0	,,	14,46,696	
V.	Major repairs and Overhauling as per details	3	2	0	,,	5,09,400	
	TOTAL	20	8	0		34,23,168	

Outturn

Working 163008 hours. @ Rs. 20/8 per hour	33,41,664
40752 Idle hours @ Rs. 2 per hour	81,504
	34,23,168

Working Rate per hour Rs. 20/8.

Idle Rate per hour Rs. 2/.

Name of Estimate: Working 48 No. Euclid Trucks in Field Divn. for the year 1953-54.

Details of Working Hours

Assuming that 46 No. Euclid Trucks will run for double shift for the whole year and 2 No. Euclid Trucks will run for double shift from 1-9-53 to 31-3-54. The working hours come to $46 \times 12 \times 30 \times 8 \times 2 + 2 \times 7 \times 30 \times 8 \times 2 = 271680$. Assuming 25% stoppages due to breakdowns holidays and rainy days etc., total working hours come to $271680 \times 75/100 = 203760$ hours. As per last year's experience of the working of these Euclids, it has been observed that these machines do not actually work for the full working hours, but remain idle for about 20% of this time for which establishment charges have only been provided in the estimate.

Net working hours . . . . $203760 \times 80/100 = 163008$

Idle hours . . . . $203760 \times 20/100 = 40752$

Direct Charges

I. *Work-charged Establishment per month single shift 14 Nos. Euclids:*

Designation	Grade	Average Pay	Amount Rs.	A.
2. No. Foreman	150—5—200	175+45+10=230 P.M.	460	0
3. No. Chargemen	100—3—130	115+40+6= 161 P.M.	483	0
5. No. T. Mates	25—1—30.	28+30= 58 P.M.	290	0
14. No. Operators	60—4—100/5—150	110+40+10=160 P.M.	2,240	0
14. No. Cleaners	25—1—30	28+30= 58 P.M.	812	0
1½. No. Electrician	50—2—60/3—90	69+40=109 P.M.	163	8
3. No. Chowkidars	18—½—23	18+30=48 P.M.	144	0
2. No. Khallasis	20—½—25	22/8+30=52/8 P.M.	105	0
3. No. Time Clerks	50—2—70	60+40+100 P.M.	300	0
		Total for one month	4,997	8

Net working hours per month for 14 Euclid Trucks single shift=14×8×30×75/100=2520 hours.

Rate per hour 4997/8/2520=Rs. 1/15/9 or Say Rs. 2.

Cost for 203760 hours=203760×2=Rs. 4,07,520.

II. *Stores per Machine per hours:*

	Rs. A. P.
1¾ gallon H.S. Diesel Oil @ Rs. 1/10/- per gallon	=2 13 8
1/9 gallon Shell Remula @ Rs. 6/14/- per gallon	=0 12 0
1/8 lb. G.G. Grease @ Rs. 1/1/- per lb.	=0 2 2
1/32 gallon Gear Oil E.P. @ Rs. 7/2/- per gallon	=0 3 7
TOTAL	=3 15 6
1/8 lb. Cotton Waste @ Re. -/11/- per lb.	=0 1 4
1/48 gallon Hydraulic Oil @ Rs. 5/9/- per gallon	=0 1 10
Petty stores such as sand paper, files, gharas, glasses, welding rods etc. L.S. .	=0 1 3
Total for one hour	=4 3 11
Say .	4 4 0
Cost of working 163008 hours @ Rs. 4/4/- per hour.	6,92,784

III. *Repairs and replacements charges @ 25% of depreciation rate:*

8/14/-×25/100=2/3/6 or Say Rs. 2/4 per hour

Cost of working 163008 hours @ 2/4/- per hour.=Rs. 3,66,768.

Indirect Charges

IV. *Depreciation Charges:*

	Rs.
12 No. Old Euclid Trucks @ 89,587	10,75,044
12 No. New Euclid Trucks @ 1,44,575	17,34,900
24 No. Euclid Trucks @ 1,49,500	35,88,000
Total cost of 48 Nos. Euclids	63,97,944
Average cost of one Euclid Truck	1,33,291
Life of each Machine	15,000 hours.

Depreciation rate per hour. 133291/15000=Rs. 8/14/2, Say, Rs. 8/14/-
Cost of working 163008 hours. @ Rs. 8/14/- per hour=Rs. 14,46,696

V. *Major repairs and special overhauling charges 35% of Depreciation:*

Charges $\frac{8/14 \times 35}{100}$ =Rs. 3/1/8, Say, Rs. 3/2/-.

Cost of working 163008 hours. @ Rs. 3/2/- per hour=5,09,400.

APPENDIX 7

Assistance to Projects by C. W & P. C.

7.1. Introductory

We have indicated in the Report the nature of help which the Government of India can render to the projects with reference to the aspects covered by this Report. The spheres where such assistance is needed, have been mentioned at the appropriate places in the Report. This appendix is added to collect all such suggestions and recommendations and to give more details.

To our knowledge, the sphere of the Central Water and Power Commission's activities appears to be three-fold—

(1) to assist the projects in the design and execution ;

(2) to advise Government of India, on the technical aspects of projects and to act as their agents concerning the financial and other aids rendered by the Government of India to the River Valley Projects in various States ; and

(3) to execute some of the centrally administered projects.

We understand that Government of India may not utilise C.W. & P. C. for item (3) in future. With regard to item (1), *i.e.*, the assistance which projects should receive from the Centre, we have suggested three spheres in which the Centre can do much to improve the performance of equipment on various River Valley Projects. These are with reference to :

(1) Technical Manpower.

(2) Machinery and Spare Parts.

(3) Cost Accounting.

In the Report we have styled the organisation for providing these services as "Directorates" but our intention is not to define, by the use of the word, the type and strength of the organisation. This will be a matter of details for the C.W. & P. C. to decide depending upon the scope prescribed.

7:2. Technical Manpower

The categories of the technical personnel dealt with by this Directorate can be very wide. We understood at the Bhakra Seminar that there is already a move to pool the engineers who posses the specialised knowledge required on engineering projects. We think this is a step in the right direction. The importance of the "management factor" in the conduct of a project construction has been stressed in Chapters 3 & 4. There is a general dearth of engineers having the requisite knowledge for construction of projects. The situation is accentuated by the additional demand for experienced engineers for the Cost Control Department on jobs executed by Government. The specialised knowledge and experience gathered by the engineers, who have been given the opportunity to work and learn on projects should be utilised by deputing them to work on other projects. Such a policy is of more importance with reference to the technicians trained on the projects. We estimate that there are over 4,000 operators and nearly three times that number of other technicians who have received a certain amount of training and experience on projects. Unless a Central Employment Bureau can guide them to other projects where their experience can be helpful, the benefit of such valuable training will be lost to the country. In the absence of such an organisation, projects will have to depend upon raw hands and train them in a wasteful manner. The magnitude of mechanised construction, in relation to the vastness of this country, is so small, that unless a central agency operates to guide the trained and experienced men from project to project, it will not be possible for the men to determine for themselves where scope exists for their employment.

In the field in which we are most concerned, such an organisation will need to maintain an inventory of all the experienced technicians, keep it up-to-date regarding the type of experience gained by them, their pay etc. A watch must be kept as to when they will be released from one project and where they can be re-employed.

The better talent in the country is averse to following the construction trade because of the insecurity of employment. They choose the more permanent jobs. By its very nature, construction cannot offer much security, but an organisation of this nature by affording better continuity of employment, will generate an improved sense of security. The cadre as a whole will attract more and better talent.

We have recommended that schools for training operators and maintenance personnel should be started in the country. The admission to the School, should aim at country-wide representation, so that trained men are distributed on projects all over the country and the greatest benefit is achieved from the training. The administration of these schools will have to be properly attended to, to make them effectively available to the several States. Without such backing, the schools will step down in their utility to training a few raw hands from local areas, who will have no future to utilise the training. This will be no gain to the country against the heavy expenditure necessary to run such a School. We have also recommended conducting examinations at project headquarters. Personal contacts with the executives and the technicians can greatly increase the utility of the Training Centre.

7.3. Machinery and Spare Parts

The value of the equipment on the six projects visited by us amounts roughly to Rs. 20 crores. We believe there is equipment of equal value at least on other projects. As far as we can estimate, the definite plan for their utilisation covers no more than 3/4th the life of the equipment at most. Thus a residual investment of over Rs. 10 crores on machinery will remain for future utilisation on other projects and works. The limitations of plant planning are such that it is not possible to plan for 100% utilisation of equipment without leaving any residual value. This is an intrinsic feature of mechanised construction. States often do not have immediate plans for further utilisation of released equipment in their own State, and unless continuity of utilisation is arranged, the equipment will be wasted through physical deterioration and obsolescence. The Machinery and Spares Directorate can keep a record of the Major equipment in use on projects, watch their release and plan their future utilisation. In case of Inter-State transactions, it can act as an arbitrator for pricing the old equipment.

The spare parts wing of this Directorate is even more important. It will have to operate in two spheres:

(a) Correlate the surplus spares on projects to requirements of others, and
(b) help the projects to scale forward demands.

The availability factor of equipment for work, on the projects visited by us is an average of 52%. The remaining 48% is idle largely due to sickness The most common reason for the sickness is "want of spare parts". The projects not visited by us, may have, we think, even a worse situation. We estimate that nearly a third of the sickness of equipment is due to spare parts not being available in their own stores or with the dealers. That means that equipment of the value of about Rs. 6 crores in immobilized for want of spare parts. The consequent loss by the dislocation of the progress of the work on the projects is very great. Even the interest @ 4% on the value of such equipment will be Rs. 24 lakhs per year. And yet, our study of the spare parts stores on projects shows that there is over Rs. 6 crores of money locked up in spare parts. A great portion of this store has no future for immediate or remote utilisation. It is only a matter of time before it will have to be written off due either to physical deterioration or obsolescence. The situation requires urgent remedy and unless quick action is taken, the projects will have to face the loss due to unutilised or "dead" spares. Even if this Directorate succeeds to utilise only 10% of such spares, the country will stand to gain over half a crore of rupees besides putting to work some of the immobilised equipment.

Our ideas about the working of this wing are given below:

The Spare Parts Wing should keep up-to-date record in card index system of the spares available with various projects including the standards fixed for minimum balances. A routine should be established by which the projects would keep the Centre informed monthly about their surplus balances and issues. A six-monthly bulletin should be published by the Directorate, listing the "Surplus spares". These bulletins should be classified by equipment and a sufficient number of copies should be supplied to each project for them to be made available to all concerned. The projects can then know the location of parts required by them. The Directorate should keep up the books up-to-date. It must operate on business principles and should be set up for quick routing of correspondence. We consider that about 20 clerks working on Kardex cabinets should be able to keep the work up-to-date.

The States will have to come to an understanding regarding the costing of the spare parts sold from one project to another outside the State. We suggest that the spare parts over the maximum balances (worked out as a result of systematic scaling mentioned later) should be regarded as surplus and transferred at current market rates and those below maximum balances have a suitable overhead charge added to cover the cost of storage interest etc.

The Scaling Department should help the projects to detail their forward demands for stocking and for planned overhauls. An efficient working of this organisation will reduce the evil of overstocking in future. Every project should have a Scaling Engineer belonging to the project organisation who works according to rules set up by the Centre. On small projects this work can be done by one of the officers of the project if the employment of a whole time man cannot be justified. The Central Scaling Engineer with the help of the Project Scaling Engineer can then work out the details of future sealing.

The Scaling Organisation will have the advantage of the central record of movement of spare parts and will be able to build up excellent records to help forecast requirements accurately. The Scaling Engineer should visit the various projects and help them work out their six-monthly forward demands. He should be a man of long experience on Earth-moving and Civil Engineering equipment, and should have an intimate knowledge of each type of equipment and the conditions of work. It will be impossible to find such a man in India but we think there should be no difficulty to get a foreign expert qualified to do the work. It is only by long experience that initial scaling can be satisfactorily achieved. Scaling demands:

(1) Experience over a long period.
(2) Knowledge of equipment performance schedule and rundown of job.
(3) Planned arrival time of spares.
(4) Knowledge of spares and supplies issued over a given period.
(5) Knowledge of Operational Standards.
(6) Knowledge of reconditioning capacity by projects and agents.
(7) Knowledge of workshop facilities and personnel available.
(8) Knowledge of manufacturer's recommendations as to fixed life of components.

It is not possible for States to individually staff such a post by an adequately qualified man; therefore assistance from the Centre is necessary.

7:4. Cost Accounting

The importance of Cost Accounting and the part it can play in pointing the attention of executives on questionable costs has been stressed in the report. The modern industries in the West* use cost accounting as a tool to watch and improve their efficiency. Inasmuch as a departmentally managed mechanised construction is an industry with its own cost and production problems the project personnel do need the assistance of such a section.

We wish to make it quite clear that our conception of such an organisation is not to add yet another financial control for which there can be no room or scope. The organisation contemplated by us should "measure performance against approved operating plans and standards and report and interpret results of operation at all levels of management. This function includes the design, installation and maintenance of accounting and cost systems and records, the determination of accounting policy and the compilation of statistical records as required".

In this respect cost accounting is an advanced stage of auditing and compiling the actuals—a duty which the A. Gs. do at present. The A. G. stops where the engineer has to start. The regular P.W.D. account does not help the engineer adequately in his technical analysis but with the influence of the audit acts as watch-dog only to detect deviations from the P.W.D. Code Rules.

In their endeavour to improve the financial control on projects, some of the Governments have set up a "Financial Adviser". This has not helped the project officers in their search for financial tools of control and economic

*_Vide_ "Cost Accounting and Productivity" Report by a group of European experts published by the Organisation for European Economic Cooperation, Paris, 1952.

costs. Where the financial control has been invested with authority without commensurate responsibility, the results have been more unsatisfactory still. To cite a specific example, we noticed an apparent absence of up-to-date progressive cost data at Hirakud though we understand that a Financial Adviser has been active on the project for the last four years.

In a big project executives are too busy to check costs in their elementary spheres, compare them with the previous statistics or standards and work out technical interpretations of causes in order to suggest remedies. The lower range of the executive staff are even more ignorant of cost controls on the jobs entrusted to them. They are neither informed about their efficiency in terms of exact statistical indices which would help them improve nor are they held responsible for what would be unmistakable inefficiency if compared with suitable standards. In fact, little information about standards exists except the overall items and costs given in estimates which in themselves are based on the "best guess" without any real background. It is easy to understand why costs have gone high on our projects as compared with the estimated costs and why it took so long to realise it.

The new concept of cost accounting, in the hands of properly qualified people should go a long way towards improving the situation. It is a service that can be rendered only by persons who are in a position to "collaborate with the executive management, particularly the engineers, in enquiring into causes and effects in the sphere of costs". This can best be done by engineers with wide project experience supplemented by special training in cost accounting.

The sphere of this work is so new and so vast, that much pioneering work will be required to establish correct procedures for the organisations. It should not degenerate into "another series of periodical reports" or an inanimate compilation of actuals without interpretation. We think the Centre should make a beginning by establishing a Cost Accounting Directorate. It should guide the projects in devising suitable organisations, routines and reports and should educate the staff in the use of this new tool.

There is yet another reason to justify the necessity of such an organisation. Government of India is giving a large amount of money to the States to execute projects. It should be their natural concern to determine how efficiently the funds are utilised. At present the Government receives periodical reports which have little value for such evaluation. When the Government of India calls for cost statistics, they are not reported on a uniform basis and are not compared with a common standard. This gives either a partial or an incorrect picture. A properly designed cost accounting system will help every one to be adequately and immediately informed about the conduct of the job. It can pin-point the causes of inefficiency. In the interest of the finances advanced to the States, Government of India should be interested in having such an organisation.

We are aware that trained personnel for this type of work will not be readily available. That is the greater reason to make an early beginning. There are many institutes* and educational faculties devoted to this subject in U.S.A. Training a few of our project engineers and entrusting them to pursue their subject with interest will be a step in the right direction towards effecting an overdue improvement.

*American Management Association, American Institute of Accounts, the National Association of Cost Accountants, and the Controllers' Institute of America.

PART VI

REPORT OF CONSTRUCTION PLANT AND MACHINERY COMMITTE (SUPPLEMENTARY REPORT)

REPORT OF CONSTRUCTION PLANT AND MACHINERY COMMITEE

(Supplementary Report)

Report on the Scope for Production, within the Country, of the Plant and Machinery required on River Valley Projects

1.01. Government of India, Ministry of Irrigation and Power required the Committee by their letter No. DW. II-29 (78), dated 3rd December, 1953 to examine the scope for replacing imports of construction plant and machinery in use on the River Valley Projects by production within India and to make their recommendations in this regard.

1.02. The Committee considered this question from two aspects:—

(i) The scope of manufacturing construction plant and machinery; and

(ii) the scope of manufacturing spare parts for such machinery.

1.03 MANUFACTURING CONSTRUCTION PLANT AND MACHINERY IN INDIA

It is necessary first to assess the probable number of each type of equipment likely to be requnred for the construction of the River Valley Projects. As far as the projects included in the first Five-Year Plan under execution are concerned, they have already purchased most of their equipment and very few remain to be purchased. As regards the River Valley Projects, in the second Five-Year Plan, the Committee understands that the Plan will give more weight to medium and small-sized schemes in preference to major ones. Major projects *e.g.*, Chambal, Kosi, Krishna and Koyna will probably be the only remaining large ones to be undertaken. These projects will need to have their construction plant planned individually to suit the special characteristics of each of them. These projects will probably absorb much of the serviceable equipment, released from the major projects which are nearing completion.

1.04. Thus, the bulk of the demand for equipment is expected from the medium and small-sized projects of which, there probably will be many in the Plan. We visualise that the medium-sized schemes will cost about 10 crores each and involve about 150 million cft. of earthwork with about 100 miles of canal and branches each. The cost of minor schemes will probably be in the range of Rs. 5

crores each requiring 75 million cft. of earthwork and about 50 miles of main canal and branches. On these projects, the bulk of the work on the canals and even some work in the dam will probably be within the scope of execution by manual labour. Thus, mechanisation on these projects will be limited to filling up the gaps in each work, unsuitable for manual labour.

1.05. Equipment for Medium-Sized Project

For a typical medium-sized project, we think that the plant planning will be broadly on the following lines :—

	Rs. in Lakhs
1. 2½ cyds. shovels; 2 Nos. @ Rs. 3.5 lakhs each	7.00
2. Dragline and Clamshell attachment; 2 Nos. @ Rs. 0.5 lakh each	1.00
3. 13 cyds. Bottom Dumpers; 10 Nos. @ Rs. 1.6 lakhs each	16.00
4. 130 D.B.H.P. Heavy Crawler Tractors with Dozer and P.U.C.; 9 Nos. @ Rs. 1.3 lakhs each	11.70
5. 20 cyds. Power Scrapers; 12 Nos. @ Rs. 2.3 lakhs each	27.60
6. 100 H.P. Graders; 1 No. @ Rs. 0.9 lakh	0.90
7. 10-Ton Motor Crane; 1 No. @ Rs. 2.0 lakhs	2.00
8. Minor equipment L.S. Rs. 20 lakhs	20.00
Total	86.20

1.06. Equipment for Minor-Sized Project

For a typical minor project, the equipment required will be roughly as under :—

	Rs. in Lakhs
1. 1½ cyds. shovels; 2 Nos. @ Rs. 2.5 lakhs each	5.00
2. Dragline and Clamshell attachment; 1 No. @ Rs. 0.5 lakh	0.50
3. 6.5 cyds. End-dumpers; 6 Nos. @ Rs. 0.9 lakh each	5.40
4. 80 D.B.H.P. Medium Tractors with Dozer and P.U.C.; 6 Nos. @ Rs. 1.0 lakh each	6.00
5. 3 to 4.5 cyds. End-dumpers for use with manual labour; 12 Nos. @ Rs. 0.5 lakh each	6.00
6. 5-Ton Mobile Crane; 1 No. @ Rs. 1.2 lakhs	1.20
7. Minor equipment L.S. Rs. 10 lakhs	10.00
Total	34.10

1.07. We have not specified in these estimates minor construction equipment of general utility such as:—

Air Compressors.	Dewatering Pumps.
Motor Tractor with low-bed trailers, for transporting equipment.	Well Points and Pumps.
	Air Tolls.
Crushers and Granulators.	Electric Welding Sets.
Belt Conveyors.	Generator Sets up to 30 kW.
Concrete Mixers.	Machine Tools.
Rippers and Rooters.	Truck Repair equipment.
Compacting Rollers.	Minor Workshop equipment.
Decauville Locos and Trucks.	Minor Materials handling equipment.
Percussion Drills and Rotary Drills.	

1.08. Out of this lot of construction equipment, those listed below are of general utility nature, and will be required for engineering works in general in the country.

80-D.B.H.P. Medium Size Tractors.	Decauville Locos and Trucks.
3 to 4.5 cyds. End-dumpers.	Dewatering Pumps.
Crushers and Granulators.	Well Points and Pumps.
Air Compressors.	Electric Welding Sets.
Trailers with Wheeled Tractors.	Generator Sets up to 30 kW.
Belt Conveyors.	Air Tools.
Concrete Mixers.	Compacting Rollers.
Rotary and Percussion Drills.	Rippers and Rooters

1.09. WORKSHOP TOOLS AND REPAIRS EQUIPMENT

None of these machines are at present manufactured in India except the very minor equipment like Concrete Mixers and some Dewatering Pumps of small capacities.

1.10. To assess the probable demand for these items of equipment for the River Valley Projects, we have assumed that an annual grant of Rs. 80 to 100 crores will be allotted for the implementation of the medium and minor-sized projects in the second Five-Year Plan. Nearly half of the amount will be spent through entirely unmechanised manual labour leaving about Rs. 40 to 50 crores for works which will be partially mechanised. On a highly mechanised earthwork project, the cost of equipment is about 1/3rd of the work. Assuming that most of the projects will be constructed by only partial mechanisation. we take it that the requirements of equipment will be only about 1/6th of the value of the work. In other words, the expenditure on construction equipment will be about Rs. 7 to 8 crores per year.

1.11. Assuming further that there will be one medium-sized project to every 2 minor-sized projects, the demand of construction equipment will be about 5 groups of machines detailed in para 1.05 and 10 groups of the machines detailed in para 1.06. In other words our annual requirements will be roughly as under:—

Type of Machine	No.	Description	Price each (Rs. Lakhs)	Amount (Rs. Lakhs)
Excavators	10	2½ cyds. with Dragline etc. attachments.	4.0	40
Do.	10	1½ cyds. Do.	3.0	30
Tractors	45	130 D.B.H.P.Crawler with Dozer & P.U.C.	1.3	58.5
Do.	60	80 D.B.H.P. Crawler with Dozer & P.U.C.	1.0	60
Dumpers	50	13 cyds. Bottom-dumpers.	1.6	80
Do.	60	6.5 cyds. End-dumpers.	0.9	54
Do.	120	4 to 5 cyds. End-dumpers.	0.5	60
Graders	5	100 H.P. 12 ft. blade.	0.9	4.5
Scrapers	60	20 cyds. Motor Scrapers.	2.2	132
Cranes	5	10-Ton Motor Cranes	2.0	10
Do.	10	5-Ton Do.	1.2	12
Minor Equipment		Lump.		200
			TOTAL	741

Say Rs. 7.5 crores.

1.12. The estimate given above will vary within a wide bracket depending upon the requirements of the various jobs. We, however, think that this list gives an approximate idea of the overall requirements of the equipment for the River Valley Projects in order to examine the scope of production of the equipment in the country.

1.13. Any scheme for indigenous manufacture of construction equipment will need to have a fairly large and steady demand. The list worked out above shows that the demand for this type of equipment is limited. It is unlikely that private firms will be able to undertake independently the manufacture of such highly complicated machines for so small a demand at this stage. It will have to be undertaken either as a quasi-commercial State-owned concern such as the Machine Tool Factory at Jalahalli, Bangalore, or by private concerns connected with suitable foreign firms. Even then the development will have to take place step by step and stage by stage according to a long-term plan somewhat similar to the one that has already been worked out for the automobile industry in this country.

1.14. In the manufacture of heavy equipment, the availability of the material for manufacture has to be considered more carefully. Such equipment require alloy steels of various specifications, steel castings, high carbon steels and a large amount of non-ferrous alloys. The country's capacity for such raw materials is limited at present. The steel castings are made at present at Bombay, Calcutta and Muradnagar but their capacity is limited.

1.15. As regards the alloy steels, the only possibility at present appears to be utilisation of the resources of the Ordnance Metal and Steel Factory at Ishapore. It is understood that the capacity of this factory is limited by the existing rolling capacity. It seems difficult to utilise this factory readily to any large extent for supply of alloy steel materials required for the manufacture of earth-moving equipment or their components.

1.16. The manufacture of construction equipment can be considered in two different categories:—

(a) Complicated machines *e.g.*, shovels, tractors, etc., and

(b) simpler equipment *e.g.*, concrete mixers, rippers, compacting rollers, etc.

1.17. The modern machines included in the first category are very complicated and their present design and specifications are a result of a long period of evolution after repeated trials and rectification of errors. They incorporate a large number of patents and specifications rights. It will be difficult for us to get into this field at this stage unless we arrange for the necessary association with the foreign manufacturers for the supply of raw materials, semi-processed components and the technical key personnel with the technical "Know how", as is done in the country for the new industries concerning the manufacture of Mechanical and Electrical plant.

We recommend that a scheme of Industrial Development for manufacture of one or two principal items of equipment, in general demand, be evolved and implemented, as a beginning. The items recommended are the 80-H.P. Crawler Tractor with accessories, and 3 to 4.5 cyds. End-dumpers.

1.18. As regards the minor pieces of equipment, which are comparatively simpler, there should be no difficulty in manufacturing them in India. We were told that the Amritsar Workshop has manufactured concrete-mixers of 10/7 cft. capacity utilising imported power units for driving them.

We further think that Rippers and Rooters, Sheepsfoot Rollers, Rubber-tyred Compacting Rollers and Dozer Blades, etc. can be manufactured with very little difficulty. There are already a large number of factories manufacturing pumps of various types. Although most of these are manufactured for agricultural requirements, the manufacture of a range of pumps required on construction jobs can easily be undertaken by some of the firms. Similarly, the equipment required for well-point pumping can be manufactured in India, using imported power and pumping units. As regards the welding plants and generators, the country has already started manufacturing motors up to 50 H.P. and small generators. If demand of River Valley Projects for these items of equipment can be bulked, their manufacture in the country should not present much difficulty.

1.19. As regards machine tools, quite a few of them are already being manufactured in this country. Machine tools manufactured by M/s. Kirloskar Mysore at Harihar is one of the typical examples. Government has given adequate protection to this industry.

1.20. The Central Workshop at Amritsar was visited and the scope of its utilisation for manufacture of some of the equipment was examined. A statement showing the main equipment and their capacities is appended. It will be noticed that the workshop does not have a steel foundry. The steel castings required by the workshop are obtained from the steel foundries at Muradnagar (near Delhi), Calcutta or Bombay. Besides this, certain items of balancing equipment of a special-purpose nature will have to be provided to make the production of equipment and spare parts economical.

On account of the distant location of the source of structural and alloy steel and the steel foundries, there is likely to be serious handicap for making even a modest venture for the manufacture of earth-moving machinery at Amritsar, except for the manufacture of simple items such as Concrete Mixers.

This workshop is already handling the works in connection with the Bhakra Nangal Scheme and it can handle similar requirements for the other River Valley Projects, as required. The manufacture of rolling stock and locomotive parts for the Northern Railway has just been started in the workshop. To our judgement, the utilisation of the workshop completely for the railway purpose appears ways, it should be possible to utilise the project workshop at Nangal for the general requirements of the State after transferring some of the machines which may be redundant at Amritsar. When the load of the Bhakra Nangal and other River Valley Projects on the Amritsar workshop is reduced, there will be relatively very little work left to justify its existence unless the Railways take it over.

2.00. Spare Parts Manufacture

Approximation of Demand

2.01. Construction equipment worth about Rs. 40 crores is operating on the River Valley Projects at present. We consider that these require spare parts worth Rs. 2 to 3 crores per year. We have taken a census of the types, makes and sizes of equipment operating on the River Valley Projects studied by us. The information about the plant population is given in Appendix 3.1 in our Report. It will be seen that the number of different types, sizes and makes of equipment is so large and consequently the requirement of each of the spare parts is so small that their manufacture on an economical basis is not practicable. It may be stated that the total number of spare parts even in a single machine would run into four figures. The range of spare parts for all the makes and sizes of equipment required can be easily imagined. Under these circumstances, it is extremely difficult, to concentrate on any particular range of spare parts for the purpose of manufacturing them in India.

2.02. The manufacture of simple parts such as bolts, nuts, piston rings, liners, etc. in the factories, already established in the country is feasible, if supply of raw material and adequate demand are assured. The latter condition will automatically follow standardisation of equipment when the recommendations made by us in this respect are implemented.

2.03. At present there is difficulty in getting special types of bolts, nuts and studs for equipment particularly in the specialised and precision varieties. These can be manufactured by firms in the country which specialise in such work, provided that the required alloy steel bars can be made available to them.

2.04. In the matter of seals, packings and gaskets, there is a good scope of manufacturing them in India. In most of the cases, the raw materials will have to be imported but even partial processing will be a step in the right direction. We suggest that the development of their manufacture may be referred to the Development Wing of the Ministry of Commerce and Industry.

2.05. The main difficulties in the manufacture of spare parts are as under:—

(a) Manufacturing the parts to the correct specifications; and

(b) correlating the demand to the supply.

The manufacturers of the equipment cover most of their products by patent rights and special specifications for the raw material which do not correspond to commercial brands. 'Tie up' or association with manufacturers thus becomes necessary. Any sub-specification spare part is not recommended for adoption as it may lead to a deterioration in the efficiency of equipment performance. This will apply to all complicated parts requiring special heat treatments, fine tolerances or alloys of very special nature.

2.06. The major difficulty about the spare parts is the correlation of the demand and supply. By its very nature, the supply of the spare parts has to be effected very quickly to be useful. Adequate stocks have to be held ready on the shelves to be delivered at a short notice on demand. It is difficult to anticipate exactly which parts will be required in the near future. Hence the range of spare parts to be carried in stock is very large. Often enough there will be deterioration in the quality of the materials and some parts in the stores will have to be scrapped because of the obsolescence of the machines. This together with the overhead expenditure for setting up the store, handling the correspondence, giving quotations and collecting bills, increases the cost to a large extent. It is very difficult to have a comprehensive store even with spare parts manufactured in India to meet the requirements of the projects. Even the manufacturers' representatives in India have not been able to do well in this respect particularly for the machines for which the population in India is low, although some of the agents in India have an understanding with their principles that the parts, that cannot be sold, can be returned by them to the manufacturers.

2.07. Under these circumstances, we feel that only a very limited service can be rendered, even if some parts can be manufactured in India and stored in a Central Government Store. We feel the best that can be done at present, is to pick up items of spare parts of simple nature, not requiring very close tolerances and special alloys and which can be manufactured without transgressing on the patents and specifications rights. Even then, it will not be possible to undertake the manufacture piecemeal. A forecast will have to be made of the bulk requirements and the components got manufactured in batches from the best sources available in the country. They will then have to be stocked and sold to the projects as and when required, through one or more centrally located stores. Such an organization can be successful only after the standardisation of the equipment is implemented.

2.08. We are aware that there are quite a few minor parts for which there should be no necessity to import, but it will be necessary to make them available to the projects from a Central Government Store; whereas, the remaining equipment of complicated parts, which form the greater portion, will have to be ordered from the stocks of the manufacturers' representatives in India. However, for making a beginning we would suggest a scheme as under for consideration.

2.09. The Central Scaling Organization, which we have suggested in the Report (*vide* Appendix 7) should make an inventory of such parts as are required in large numbers for the equipment in the country, from a study of the records of the various projects. They should then determine which parts are simple and can be manufactured in India, without transgressing on the patent and specification rights. These can then be manufactured at any of the workshops in India and stocked in a Central Store. All the projects should then be kept informed that these parts are available from stock and that they should not be imported through the manufacturers' representatives. For such a set up, it will be necessary to have a large stock of spare parts of ready delivery. One or more Central Stores will have to be maintained, adopting commercial accounting system, because it will need a considerable capital, administrative expenditure and there will be some inevitable loss by deterioration and obsolescence.

2·10. We consider that any approach on these lines is a low efficiency solution of the problem. The rational and best plan would be to invite some of the manufacturers of repute in the earth-moving equipment field and ask them to set up an industry in the country, or to associate with a State-owned set up. We understand that Australia invited the 'Le-Tourneau' firm and organised the manufacture of Scrapers in their own country; many of the parts are still imported but it is a start in the right direction for the country's effort at industrialisation. We think that a similar approach would give more beneficial and lasting results.

Statement of Equipment at Amritsar Workshop

(a) *Carpenters Shop*. The equipment in this shop consists of 6 Nos. Saws, 2 Nos. Wood Planers, 1 No. Wood Working Lathe, 2 Nos. Mortizing Machines and 1 No. Wadkin's Router.

(b) *Heat Treatment Section.* This section consists of 6 Nos. Electric Salt Bath Furnaces, 5 Nos. Case Hardening Furnaces, 6 Nos. Oil Fired Tool Hardening and Annealing Furnaces, 2 Nos. Tip Brazing Machines and 1 No. Vickers Hardness Testing Machine.

(c) *Smithy Shop.* It is equipped with 15 Nos. Black Smiths Hearths, 7 Nos. Billet Heating Furnaces, 14 Nos. Hammers, 1 No. Clevel and Power Press and 2 Nos. Belt Forging Machines.

(d) *Mill Wright Shop.* The equipment in this shop consists of 15 Nos. Centre Lathes, 1 No. Capstan, 7 Nos. Shapers, Slotters and Planers, 2 Nos. Pipe Threading and Cutting, 2 Nos. Horizontal Borers, 7 Nos. Vertical and Red Drills, 5 Nos. Grinders and 3 Nos. Welding Machines.

(e) *Tool Shop.* This shop consists of 11 Nos. Centre Lathes, 5 Nos. Universal Milling Machines, 2 Nos. Vertical Milling Machines, 28 Nos. Grinders, 6 No. Shapers, Slotters and Planers, 2 Nos. Engraving and Marking Machines, 1 No. Jig Borer, 2 Nos. Drilling Machines (Vert. and Radial), 1 No. Boring Machine (Horizontal), 1 No. Contouring Machine, 1 No. Die Sinking Machine, 1 No. Universal Broach Sharpener and 1 No. Sawing Machine.

(f) *Steel Shop.* It is equipped with 7 Nos. Punching and Shearing Machines, 6 Nos. Bending and Straightening Machines, 5 Nos. Presses, 11 Nos. Drills, 9 Nos. Floor Grinders, 2 Nos. Lathes, 2 Nos. Welding Machines and 1 No. B.O.C. Flame Cutting Machine.

(g) *Foundry Ferrous and Non-Ferrous.* The equipment in this section consists of 4 Nos. Cupolas 3-Ton and 15-Cwts. capacity, 2 Nos. Sand Seiving and Sand Treating Mill, Bowland Grinder, Tumbling Barrel, Shot Blast Cabinet, Metal Cutting Saw and 3 Nos. Non-Ferrous Melting Furnaces.

(h) *Heavy Machine Shop.* This shop consists of 7 Nos. Centre Lathe Heavy, 10 Nos. Central Lathe Medium, 5 Nos. Centre Lathe Light, 3 Nos. Turrets Heavy, 4 Nos. Capstan Lathes, 4 Nos. Plano and Uni Mills, 10 Nos. Verti., Horiz., and Slot Milling Machines, 7 Nos. Planers (Heavy and Medium), 7 Nos. Vertical Boring Mills, 6 Nos. Hori. Borers, 9 Nos. Slotters and Shapers, 13 Nos. Drills (Radial and Vertical), 9 Nos. Grinders, 11 Nos. Gear Cutters, 1 No. Broaching Machine, 1 No. Pipe and Rod Threading and 1 No. Surface Gear Hardening Machine.

(i) *Light Machine Shop.* The equipment in this shop consists of 5 Nos. Central Lathes Medium, 11 Nos, Centre Lathes Light, 17 Nos. Turret Lathes and 7 Nos. Capstan Lathes, 9 Nos. Universal and Horizontal Milling Machines, 2 Nos. Vert. Milling Machines, 1 No. Slot Hydro Mill, 2 Nos. Vert. Boring Mills, 4 Nos. Slotter and Shapers, 10 Nos. Drills, 4 Nos. Grinders, 5 Nos. Automatics, 1 No. Pipe and Rod Threading and 1 No. Oil Grooving Machine.

Statement of Capacities

(1) Steel Structural Shop . . .	15 tons per day.
(2) Smithy Shop . . .	900 man-hours per day.
(3) Machine Shop . . .	900 machine-hours.
(4) Foundry . . .	3 tons.
(5) Carpenters Shop . . .	600 man-hours.

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