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FORECASTING PRODUCTION COSTS FOR FERTILIZER PROCESSES[1/]

by

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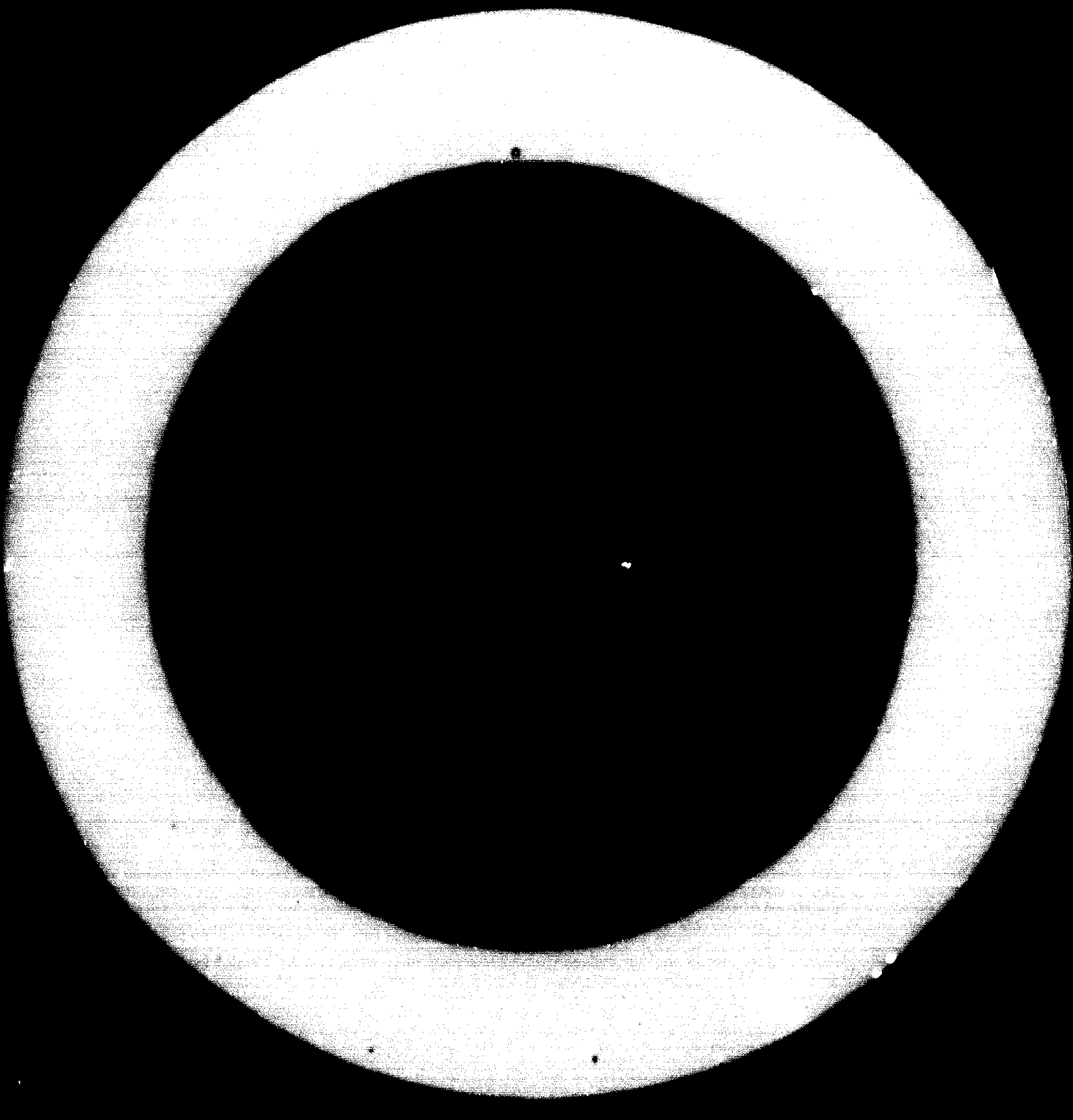

SUMMARY

FORECASTING PRODUCTION COSTS FOR FERTILIZER PROCESSES

Production costs have to be forecast for a number of different purposes - budgeting, feasibility studies, process evaluations and comparisons, assessment of R & D projects, technical literature. In the cases of budgeting and feasibility studies where the cost estimates concern specific plants on known sites, it is possible to adopt definitive costing techniques. There is, however, no uniformity of approach in preparing more generalised production cost data for the other purposes. It is sometimes maintained that any cost data, which are not specific to a particular plant on a specific site, are almost worthless. Such generalised production cost data must continue to be used for the purposes mentioned; this paper therefore reviews the preparation of such data.

The method used for preparing generalised production costs should be such that the data produced are closely related to the costs which the accountant would calculate in retrospect after the plant is in operation.

A plant capital cost which includes all of the elements of cost which will be incurred in building a plant and putting it into operation is constructed.

The major difficulties in preparing generalised production costs are shown to lie in the handling of capital charges and overheads. It is these two elements which result in the greatest differences between production cost figures presented by different sources. In determining the level of capital charges for generalised production costs, the percentage of the total capital cost charged per annum must enable the plant cost to be amortised over the life of the plant at the rate of return demanded for the project. When a single production cost figure is quoted, it is based on current cost and wage levels and does not make allowance for the effects of inflation. Inflation itself should not be regarded as a capital charge; if costs are being calculated without provision for inflation, then the rate of return should be reduced to the level which would apparently be acceptable to the investor if he did not have to cover inflation out of his interest or dividends.

The paper concludes with a discussion of methods for handling the special problems of Developing Countries when generalised production costs are used for such purposes as the analysis of process routes.

I. INTRODUCTION

The production cost of a process is probably the most vital piece of information about it. In spite of this, it is frequently difficult to compare or reconcile with one another production costs quoted by different authors or plant suppliers. One reason for this difficulty lies in the fact that production cost calculations often require the participation of engineers, economists and accountants, who do not always understand each other's problems and methods. There is no generally accepted format for presentation of production cost data. The need for a standard format is particularly pressing when different process routes to the same, or similar, products are being compared.

A second feature contributing to the difficulty in calculating production costs is the fact that costs are calculated in a different way according to the purpose for which they are required.

It is necessary to calculate production costs for a number of different purposes which can be divided into two groups:

Prospective costs - estimated costs for some period in the future

Retrospective costs - calculated costs for a past period

Retrospective costs are very much the province of the accountant who must analyse actual expenditure, changes in capital values, etc. Prospective costs are more the field of the engineer and economist.

The purposes for which Prospective and Retrospective costs are likely to be required are shown in Table I.

TABLE I

USES OF PROSPECTIVE AND RETROSPECTIVE PRODUCTION COSTS

PROSPECTIVE	
1.	For assistance in pricing decisions.
2.	Budgeting for the costs of future production from a plant.
3.	Detailed evaluation of an Investment project.
4.	Analysis of alternative ways of achieving the basic objective of an Investment scheme.
5.	Preliminary evaluation of an Investment scheme.
6.	Analysis of Research and Development projects.
7.	Presentation of general process information in technical literature.
RETROSPECTIVE	
1.	Budgetary control - comparison with budget.
2.	Financial control - to enable profit or loss to be determined so that cash resources available for re-investment, dividend, taxation, etc. are known.

Another complication in standardising production cost calculation methods is the range of size of the unit, whose costs of production we may wish to calculate. This could be a single plant unit, a group of plants representing a processing stream or a complete fertilizer complex manufacturing a number of fertilizer materials.

This paper is primarily concerned with Prospective estimation of production costs for individual plants. We must, however, examine Retrospective costs first since the methods of estimating future costs must be related to the way actual costs will be determined by the accountant after a period of operation of the plant.

The detailed analysis of projects in feasibility studies has been dealt with fully in a number of publications. Most Financial Organisations have their own specifications for studies in connection with Loans. In addition O.E.C.D. published a "Manual of Industrial Project Analysis in Developing Countries" in 1968.

II. THE RELATIONSHIP OF PROSPECTIVE TO RETROSPECTIVE COSTS

The accountant will usually analyse the cost of production for a given period in the past - say one year. To do this he needs to know

(a) the cost of the total resources used in that year in connection with manufacture of the product concerned.

(b) the quantity produced in the year.

The cost of resources used would be the sum of the following component costs listed in Table II (some of which may be supplied from other plants on the same site).

TABLE II

ELEMENTS OF PRODUCTION COST (RETROSPECTIVE)

A. Raw materials processed.

B. Process labour and supervision (including direct payroll overheads, and expenses).

C. Catalysts, chemicals, etc. consumed.

D. Maintenance costs (equipment, materials, labour, expenses).

E. Purchased utilities
   Power
   Water
   Gas, etc.

F. Insurance.

G. Apportioned overhead costs (administrative, site costs, selling, distribution costs).

H. Depreciation (the estimated reduction in value of the plant and equipment used during the year).

The total of these elements is the production cost for that year. If it is divided by the number of units produced, then the unit cost is obtained. It will be noted that "Interest" or "return on capital" is not shown in the costs. When the accountant is dealing with the total production costs of a fertilizer complex, then he may subtract these costs from the sales revenue (assuming no change in stocks of product) and hence obtain the gross profit for the year. This gross profit may then be allocated by the company management for interest, dividends, taxes, etc. and the residue retained.

If the accountant is calculating production costs for a single plant unit then he may allocate a proportion of the total interest, dividends, taxes, etc. for the complex to each individual plant as a part of the administrative overheads (G).

It will be clear that Retrospective production costs for a plant or for a fertilizer complex will vary from year to year over the life of the plant. When calculating Prospective costs and building up a single figure to represent the production cost, we must make this a realistic representation of the set of annual costs which the accountant will subsequently calculate for the plant year by year after it has been built.

The elements of Production costs in Table II can now be examined in relation to the list of uses of Prospective production costs given in Table I. It will then be clear which elements will present difficulties when the costs are to be used for the specific purposes listed. Apart from the problems of forecasting future costs and allowing for inflation (discussed in Section IV), there will usually be no difficulty in dealing with items A to F. Furthermore, for budgeting or pricing purposes when a plant is already operating or about to start up, the anticipated overhead costs (G) will be known and a good estimate of the annual depreciation (H) of an established capital value will be possible.

In the case of a detailed project evaluation (item 3 of Table I), it should also be possible to make realistic estimates of overheads and depreciation. The latter may not be required since it is more usual to estimate the year-by-year cash flows generated by the project and derive the return on it or the Net Present Worth by the discounted cash flow method.

Thus the handling of overhead costs (G), depreciation (H) and return on investment only presents difficulties when dealing with Prospective production costs in a more general way (items 4 to 7 of Table I). It would particularly be of value to the reader of technical literature if a uniform approach were adopted for production cost data presented.

Following this discussion of the relationship between Prospective and Retrospective costs, the next step is to examine how the problem areas (G and H) can be handled in preparing generalised production cost data.

III. CAPITAL COST

Depreciation and return on investment are items which are related to the capital cost of the plant. The construction of capital cost estimates, which are suitable for use in the calculation of Prospective production costs, is examined in this section.

The basic elements of the capital cost of a plant are shown in Table III.

TABLE III

ELEMENTS OF PLANT CAPITAL COST

Equipment

Bulk materials

Construction costs

    Labour, supervision and local expenses

    Construction tools, equipment, materials

    Civil works, provision of site services, etc.

Freight, insurance and duties (if any)

Engineering (design, project management and expenses)

Licence fees

Spares

The sum of these would give the basic cost of designing, purchasing and erecting the plant if the job were carried out by the owner (an established organisation). There are, however, a number of other items which must be taken into account when calculating the full investment cost involved in building the plant and establishing it in normal operation.

Contractor's Costs: If a contractor is used to build the plant on a fixed cost basis then his contingency and profit margin must be added. Contingency will depend on the length of time for the project and the risks involved in the country where the plant is to be built. Also the company buying the plant will have to add to the contractor's price its own costs for personnel overseeing the project. The overall cost should still be lower if an experienced contractor is selected since the contractor will be able to achieve lower costs for the items listed in Table III.

Commissioning Costs: There are a number of expenses under this heading:

Contractor's commissioning charges (if applicable).

Costs of training operating personnel.

Excess production costs (raw materials, labour, etc.) during initial start-up period.

Capital Charges during Construction and Commissioning Period: There is no depreciation charge during this period but a charge should be made for the "idle" capital during this period. If the plant is being constructed through a loan, then interest should be charged on the amount disbursed at the rate provided for under the terms of the loan.

Escalation: During the construction period inflation will increase the costs of materials and labour used in the later stages of construction. If a contractor carries out the project, then his fixed price will include provision for such cost increases. The problem of allowing for inflation during the full life of the plant will be discussed in greater depth later in this paper.

Financing Charges: If the plant is to be purchased by means of a loan then there will be payable certain charges, commissions and insurance premiums. These depend to a considerable degree on the source of the loan, its period, etc.

Consultancy Fees: The owner of the plant may employ consultants to prepare enquiry documents, advise on design and supervise the work of the contractor appointed to build the plant. These costs would largely replace similar expenses in the owner's organisation.

Working Capital: Most plants require stocks of basic raw materials and/or products for satisfactory operation. The cost of these represents an initial expense which will be recovered when the plant shuts down. The return on this capital is a cost of production in the plant, but depreciation does not have to be provided on it. If a detailed analysis of a complete complex is being prepared, then an accurate estimate of working capital can be made and return on this can be handled as a separate item of the capital charges. If not, an allowance should be made equivalent to a part of the working capital - thus reflecting the fact that depreciation does not need to be charged on working capital. (The working capital involved in financing credit for customers and other financial purposes is not considered as a production cost.)

Land: This should be treated in the same way as working capital. It does not depreciate but provision for return on the cost of it should be included in prospective production costs. Price of land varies considerably from site to site. Again in a detailed analysis, an accurate estimate of land cost at a specific location can be included. For generalised costing purposes, an allowance must be made reflecting the fact that there is no depreciation element.

The applicability of the charges itemised above is very much dependent on the way in which the work of constructing the plant is organised and financed. Certain items will always apply and, if the capital cost of the plant used for prospective costing is to be comparable to actual cost incurred in building and commissioning the plant, then an appropriate increment must be added to the total of the elements listed in Table III. Typical percentage figures for the additional costs are given in Table IV.

TABLE IV

TOTAL PROJECT CAPITAL COST

Basic Plant Cost (items listed in Table III)	100
Contractor's Margin and Contingency	5 to 10
Consultancy, Training and Start-up Costs	10 to 15
Interest on Capital during Construction	12
Escalation	10
Financing Charges	0 to 5
Allowance for Cost of Working Capital	3
Allowance for Land	1
Total	141 to 156

It is therefore proposed that in determining the capital cost of the plant for the purpose of calculating prospective production costs, 50% is added to the basic cost of items listed in Table III. This percentage cannot fit all cases perfectly; for example it is rather high for the simple case of the construction of a single new plant in the U.K. It would also be low for a complete fertilizer complex at the South Pole ! It is, however, generally a realistic figure and its use gives a much more appropriate total capital cost than is obtained by using only the sum of the elements listed in Table III.

The items in Table III together with the provision for additional costs listed in Table IV give a realistic estimate of the capital cost involved in building a plant and putting it into operation. This capital cost can be used with the figure for annual capital charges which is developed in the next section.

If a single plant unit is being considered, then the production costs will include the costs of such utilities as power, gas, steam, feed water, cooling water, etc. as are consumed in the process. In estimating a unit cost for these utilities, the necessary capital charges on the capital cost of the utility plants will be included. In the case of generalised costs where no site is specified the possible range of variation of utilities' costs is large. Typical figures are quoted in Section VI. The life of utility plants is often longer than that of process plant units and the depreciation on them is correspondingly lower. If costs are being estimated for a complete site, in which the capital cost of the utilities units has been included in the total capital cost, then the costs of utilities consumed will not be included in the production costs; the costs of operating the utilities plants will be included within a production cost for the whole complex.

Another point concerning the calculation of production costs for a complete fertilizer complex is the question of whether or not the return and depreciation on the capital cost of social facilities such as a housing colony should be included in the estimate of prospective production costs. These charges would certainly be included in feasibility study of a specific project, but they are difficult to handle in calculation of generalised production costs of the type being discussed in this paper. This is because the extent of such facilities varies greatly from site to site and their life is usually much longer than that of the process plant units. Also, the operating staff may be required to pay rentals for housing in the colony. It is better that these items are excluded and the costs of them regarded as a part of the overheads (item G of Table II) - if no rentals are charged.

IV. THE TREATMENT OF CAPITAL CHARGES IN PRODUCTION COSTS

We have been considering the build up of production cost data for general purposes such as technical literature, promotional data and general process and process route comparisons. In Section II, the relationship of these costs to retrospective production costs, which would be calculated by an accountant after plant start-up, was examined. It was shown that only the elements of production cost concerned with overhead costs and capital charges present difficulty. In Section III, we developed a capital cost designed to include allowance for all of the normal charges incurred in building a plant and putting it into operation.

The next step is to specify the basis for charging the cost of capital into the prospective production cost. This is a subject already discussed by the author in a paper to The Fertiliser Society last year (proceedings No. 114). It is necessary to charge in the annual production costs a percentage of the capital cost which accurately represents the financial charges (interest, taxes, depreciation, retention, etc.) which would be incurred by the plant over its working life. The problem is to include in a single production cost figure, financial charges which are equivalent to the set of charges allocated retrospectively each year in the life of the plant. Each year this retrospective charge is likely to be a different sum.

Why do the costs of capital change during the life of the plant ?

Firstly, the actual depreciation charged against the plant may vary. More usually a plant is depreciated linearly giving a fixed yearly depreciation charge. Secondly, as the plant grows older the interest charged on the reduced capital value decreases. The financial charges in the generalised production cost must be that percentage of the initial capital value (as calculated in Section III) which, if charged on the plant each year, will allow the capital sum to be amortised over the assumed life of the plant. Next the level at which we will charge "return on capital" must be specified. This is probably the single point which causes greatest variability in production cost data. It immediately raises two important and related points - inflation and the "true" cost of capital in a fertiliser manufacturing enterprise.

Inflation is <u>not</u> a cost of capital. It causes production costs to rise but equally selling prices are increased to cover the increased costs. The investor, however, can only retain the value of his capital against inflation by allocating a proportion of the interest he receives to cover the inflation. When prospective production costs are quoted for a plant, they refer to current cost conditions and therefore the element of interest or return on capital which covers the investor against inflation should not be included in the production costs. It will certainly have to be provided after the plant has started up but, like other inflation-related cost increases, it will be covered by increases in selling prices.

There is another way of justifying the exclusion of the inflation element of return on capital when dealing with production costs related to present day prices. The effect of inflation during the life of the plant is to allow the operating company (the borrower) to repay the lender with money having a lower purchasing power; for this privilege he pays the lender a rate of interest which is more than sufficient to keep the purchasing power of the lender's capital sum intact. When non-inflation conditions are being considered, the operating company repays the lender with money having the same purchasing power and it is unnecessary to pay the extra interest needed to keep the purchasing power of the lender's capital intact.

A further difficulty in providing a percentage rate for return on capital is that interest rates, rates of inflation and taxation all vary considerably from country to country. It is possible, however, to make realistic assumptions and build up a realistic percentage figure to charge for return on investment in the prospective production costs.

For major fertilizer projects it will usually be possible to obtain loan and/or equity finance at interest rates of about 8%. In fact dividends on equity in the U.K. fertilizer industry at present are nearer to 5%, provided the company concerned has a good growth record. Allowing for the fact that the equity holder benefits from the growth of the company, these rates of 8% and 5% are comparable. Figure 1 outlines how a 15% return on capital might typically be allocated. The equity holder can reasonably hope to do better than 3% capital growth after Gains Tax, and this justifies his risk factor. If the 4% inflation element is removed, the company, the equity-holder and the lender can make the same income or somewhat better from a gross return on capital reduced to about 12%.

With 12% return on capital and the same 7% retention (before tax), reference to Figure 1 will show that the equity investor's position will improve somewhat more than that of the loan investor. The fact is, of course, that the dividend and interest rate financial structure would gradually adapt itself to the new situation if inflation were stopped.

Thus the project can pay Company Tax, provide for cash retained and meet equity-holders and lender's requirements of interest (less inflation element) from a return on capital in the project of about 12%. The inflation element for investors like inflation on raw materials, labour, etc. will be met from the inflation in sales revenues.

The return on capital to provide for interest, dividends, taxes and retentions (excluding inflation element) has been defined as 12%. In Table II in Section II, these elements were included as part of the "overheads" (Item G). Now return on capital must be combined with the depreciation element in a percentage figure for the capital charges, which amortizes the plant over its life. Many fertilizer plants operate for more than 20 years, but a typical operating life of plant (perhaps somewhat on the pessimistic side) is required. Taking a figure of 12 years and 12% return on capital, the capital charges element of production cost comes to 16% per annum of the installed capital cost calculated in Section III. Figures for other plant life and return figures are given in Table V.

This percentage figure for capital charges does not include any margin to allow for "risk" or uncertainty in achieving the estimated capital cost or forecast raw materials, labour costs, etc. It is applied, however, to a complete figure for the capital cost of the installed and operating plant. Any necessary risk analysis can be carried out in the normal way by applying probability distributions to the values of variables in which there is uncertainty; this is a more appropriate technique than the simple expedient of a mark-up on the return-on-capital called for from the project.

FIGURE 1

APPROXIMATE DISPOSITION OF GROSS RETURN

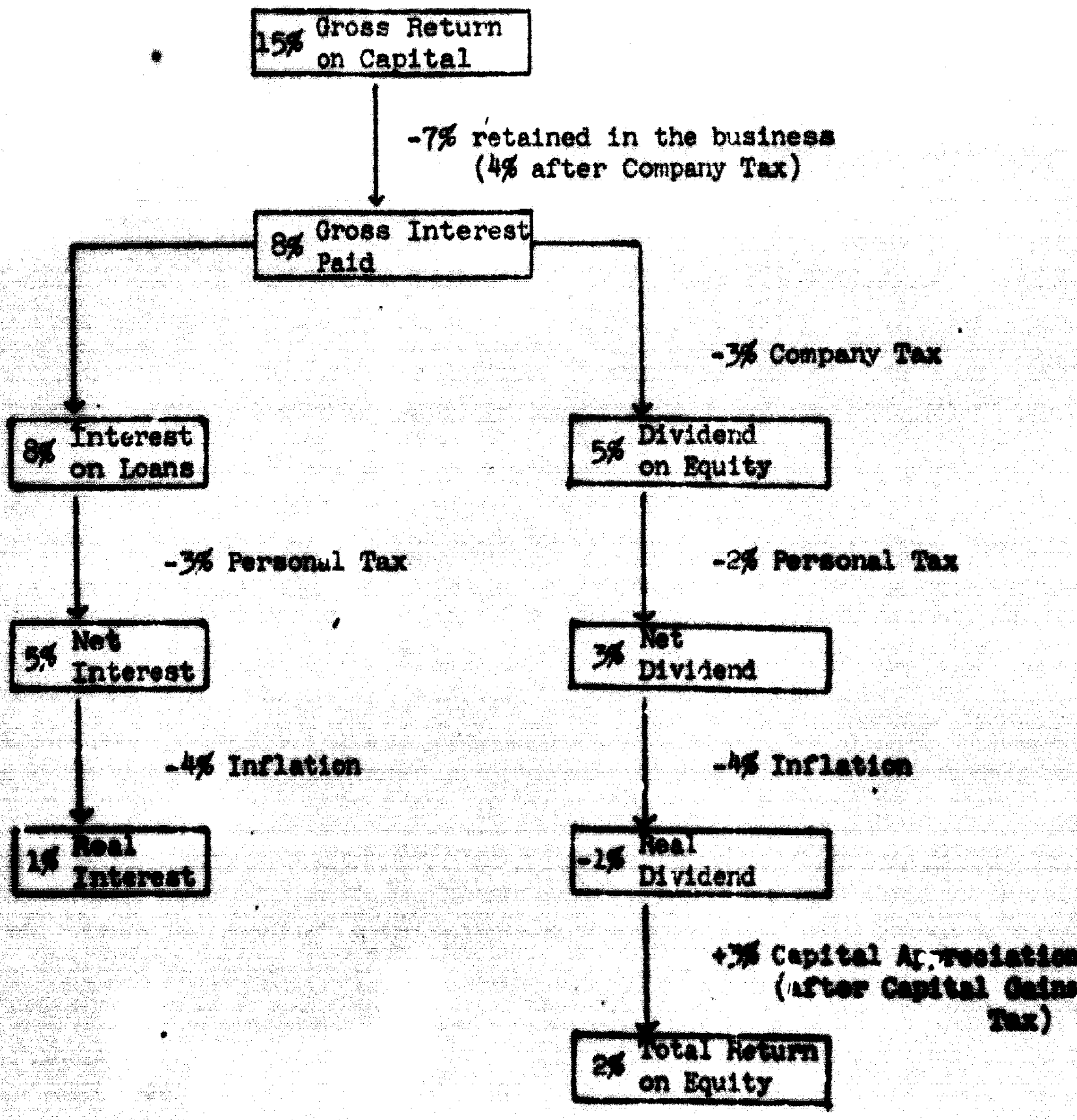

TABLE V

CAPITAL CHARGES FOR GENERAL PRODUCTION COSTS (% OF CAPITAL COST)

Life Of Plant (Years)	Return on Capital			
	7%	10%	12%	15%
5	24.1	26.4	27.7	29.7
10	14.1	16.3	17.7	19.9
12	12.6	14.7	16.1	18.5
15	11.3	13.1	14.7	17.1
20	9.4	11.7	13.4	16.0

V. OVERHEADS

We have already included in the Capital Charges certain financial costs (tax, dividends, interest) which the accountant would allocate as overheads when calculating production costs retrospectively. The remaining overheads which would be allocated to a plant production cost are:

Administrative costs - management costs, communications, expenses, depreciation on administrative offices, buildings and equipment, etc.

Selling expenses - sales staff, advertising, quality control, etc.

Distribution and transport costs.

Common site costs - local taxes, road and rail maintenance, etc.

The levels of these costs can and do vary very widely from plant to plant, site to site and from one company to another. Also the way in which the cost accountant allocates these costs retrospectively between plants and products is variable. In some cases certain overheads would be allocated only to particular plants - e.g. selling expenses may be allocated solely to plants making the end-products not to intermediate plants. The most realistic method of dealing with overheads is probably to relate them to plant "processing" cost - i.e. all costs excluding raw materials. The processing is the business activity of the plant and it is to this business activity that overheads relate. Thus a figure of 10% of the production costs, excluding raw materials, is proposed for general overheads.

VI. PROSPECTIVE PRODUCTION COSTS

The previous sections of this paper have been concerned with the development of a basis for calculating production costs for such general purposes as technical and promotional literature, comparisons of process routes and assessment of R & D projects. It was pointed out earlier that more detailed analyses of projects must include data specific to the site, fertilizer producing organisation and country concerned. The basis for generalised costing developed in the previous sections can be applied to a single plant, a processing train or to a complete complex. Figure 2 shows a urea plant diagrammatically. The dotted lines lettered A, B, C encircle sections for which prospective production costs might be required.

A - a single plant

B - a processing stream

C - the complete fertilizer complex

For a plant of 1000 MTPD urea, the capital cost of the complete complex can be constructed as outlined in Section III. This is done in Table VI below, where the capital costs are those which would typically be incurred in a Developing Country. The amounts added to the basic plant cost - $16 million and $1.3 million - are close in total to the 50% mark-up proposed in Section III. Import duties, residential building and staff facilities have been excluded. The prospective production costs for the complex are estimated in Table VII.

FIGURE 2

DIAGRAM OF UNITS IN TYPICAL UREA FERTILIZER COMPLEX

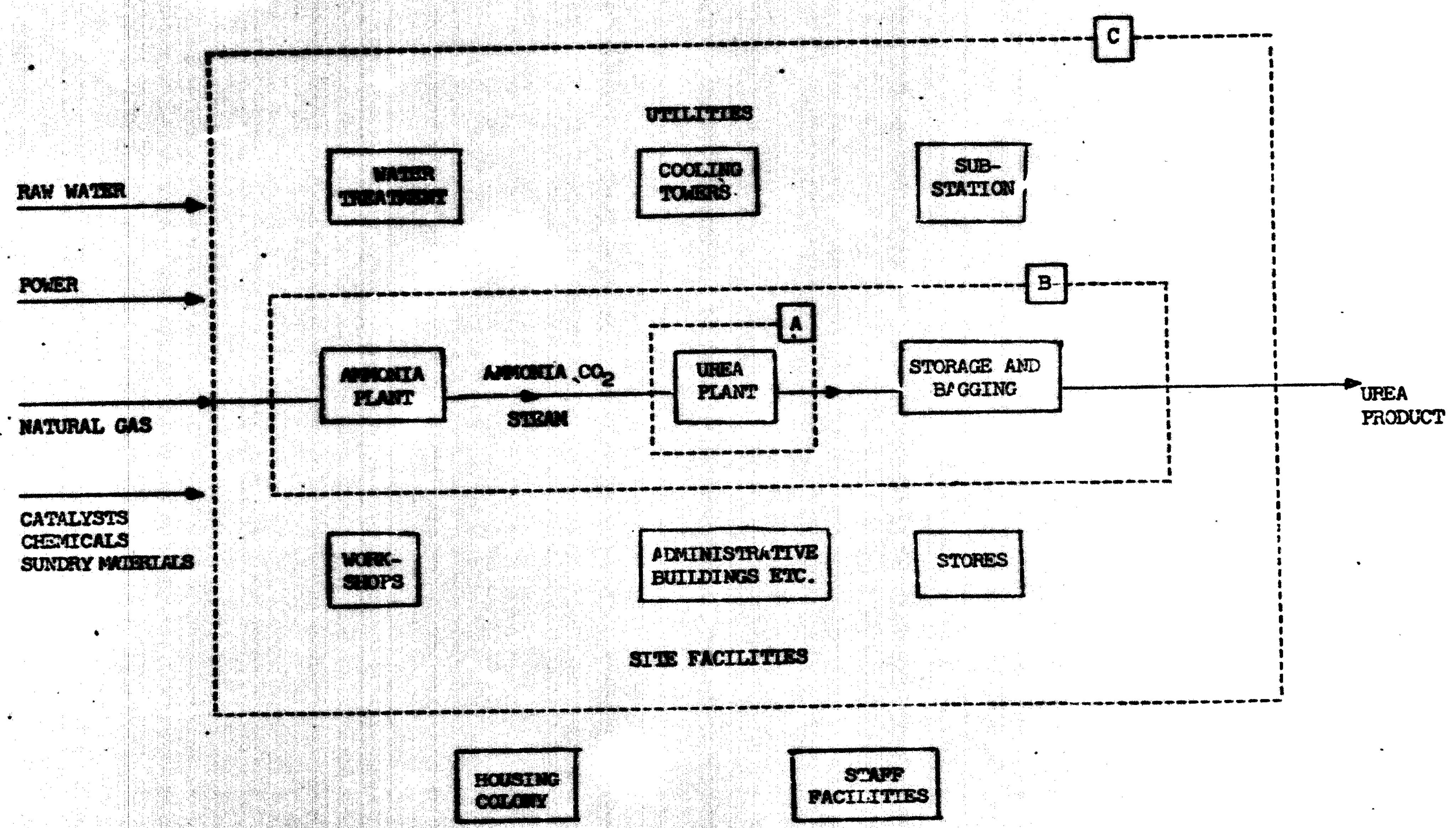

TABLE VI

CAPITAL COST FOR 1000 MTPD UREA PROJECT IN DEVELOPING COUNTRY

	$ Million	
Equipment, Bulk items	13.2	
Construction		
Civil works, site facilities	9.5	
Labour, supervision, local expenses	2.2	
Tools, equipment, materials	1.3	
Freight, Insurance	2.2	
Engineering, Licence fees	3.9	
Spares	1.3	
Basic cost of erected plant		33.6
Contractors' Margins and Contingency	3.6	
Consultancy, training and start-up costs	4.3	
Escalation (3½ year period - 10%)	3.4	
Interest during Construction (12%)	4.0	
Financing Charges (2%)	0.7	
		16.0
Total Cost Erected and Commissioned Plant		49.6
Allowance for Working Capital (3%)	1.0	
Allowance for Land (1%)	0.3	
Allowance for Land and Working Capital in Capital Cost used as basis for Capital Charges		1.3
		50.9

TABLE VII

PRODUCTION COSTS FOR 1000 MTPD UREA COMPLEX

		Unit Cost	Annual Cost $ Million
Natural Gas	$0.21 \times 10^9 m^3$	$ 10/1000m^3	2.10
Utilities			
Power	67×10^6 Kwh	$ 0.010/Kwh	0.67
Raw Water	$3.5 \times 10^6 m^3$	$ 0.02/m^3	0.07
Catalysts and Chemicals, materials			1.60
Maintenance Costs (4% of Capital $ 50.9m)			2.04
Insurance (0.3% of Capital $ 50.9m)			0.15
Labour			0.50
Capital Charges (16% of Capital $ 50.9m)			8.15
Overheads (10% of Costs excluding Raw Materials - $ 13.18m)			1.32
			16.60

For Annual Production 330,000 MT $ 50/MT Urea

If we now consider a single plant in such a complex (case C) or the processing stream (case B), then values are needed for the unit costs of utilities. In the situation where a flowsheet for the complex incorporating the single plant has been prepared and the capital costs for the utility plants have been estimated, then unit costs for the utilities can be calculated; this is done using the procedure for capital charges and overheads which has been outlined in previous sections. More usually, when production costs for a single plant are being presented, data for each utility plant are not prepared in detail; in this case typical unit costs for utilities are assumed. Utility unit costs, which depend on the costs of fuel, power, raw water, etc. vary from one location to another. When a new plant is being considered on an existing site, the costs of utilities can depend on the precise energy balance for other plants already in operation. Any set of values for utility unit costs can be subject to argument. If generalised cost data are to be presented, however, then a set of typical unit costs must be selected. Such a set is proposed in Table VIII. Use of these utility cost figures for presentation of prospective production costs would lead to greater uniformity and comparability of cost data.

TABLE VIII

TYPICAL UTILITY COSTS FOR USE IN PRODUCTION COSTS

Utility	Unit	Proposed Unit Cost ($)
Electric Power	kWh	0.10
Naturel Gas * (1000 Btu/scf)	1000 m^3	10.00
Water		
Raw water	m^3	0.02
Process water (potable)	m^3	0.05
Boiler feed water	m^3	0.15
Circulated cooling water	m^3	0.005
Steam Condensate	m^3	0.15
Steam h.p.	MT	1.50
l.p.	MT	1.10

* Other fuel gases and fuels at equivalent thermal cost.

VII. PROSPECTIVE PRODUCTION COSTS FOR DEVELOPING COUNTRIES

So far in this paper, the analysis of prospective production costs has been equally applicable to Developing and Developed Countries. The particular problem, which needs to be considered in the case of Developing Countries whose currency is not freely convertible, is the influence the project will have on the country's balance of payments. In a Developing Country, a significant proportion of the cost of a project will have to be paid in convertible currency, since specialised equipment, engineering services and technology will be imported. The cost of these imports is usually covered by long-term financing. Projects are therefore required to cover the payment of interest and capital on such financing in convertible currency by either import replacement or exports from the plant. Continuing imports of raw materials, chemicals, spares, etc. must also be similarly covered.

When a detailed feasibility study for a fertilizer project in a Developing Country is being carried out, the project must be analysed financially at three distinct levels.

Commercial Viability: This is the normal assessment of return in local currency for the project and is based on the year-by-year cash flows during the assumed life of the plant.

Impact on Balance of Payments: In a feasibility study it is not difficult to assess the extent of capital and operating cost payments which must be made in convertible currency. On the benefit side it is usual to assume that the foreign currency savings of the project are the full foreign exchange cost (c & f) of the amount of fertiliser equivalent to that produced in the plant; it is tacitly assumed that, if the fertiliser were not made in the plant under consideration, it would be imported. (This is not always a realistic assumption. The Government of the country concerned must make provision for the payment of the convertible currency elements of capital and operating costs.) Once annual cash flows have been subdivided into local currency and convertible currency elements and the net saving in convertible currency payments has been estimated, the local currency cost of saving each $ can be assessed. This cost is then compared with the figures for other projects and with the rate acceptable for the country concerned.

Impact on Internal Economy: The local currency element of the project must be financed and the project will pay a return on this local capital. A second benefit to the Internal Economy will be the revenue payable to the Government in the form of duties and taxes (on imported equipment, possibly on local resources used and also on profits made by the project and salaries paid to the workers).

Although it is possible to analyse each of these aspects when undertaking a feasibility study, it is not possible to develop a general prospective production cost which takes into account the balance of payments aspect of a project. When considering a particular Developing Country, however, it is feasible to develop a "hypothetical" production cost using a Shadow Rate of Exchange and compare this cost with the cost of equivalent imported fertilizer also converted to local currency at the Shadow Rate. The Shadow Rate used would be the local currency cost of saving convertible currency which is acceptable to that Developing Country. The hypothetical production cost is calculated by subdividing the capital cost (Table VI) and the production cost (Table VII) into local and convertible currency elements. The convertible element is then changed into local currency at the Shadow Rate and added to the local element. (The local element should not normally include taxes, duties, etc., which are payable to the Government concerned).

If the example in Section VI is used, we can consider a fictitious country whose rate of exchange is 1$ = 10 fs and for which the shadow rate is 15 fs to the $. For such a project the capital cost would be approximately 60% convertible currency and 40% local currency.

TABLE IX

HYPOTHETICAL PRODUCTION COST OF UREA IN A DEVELOPING COUNTRY

	fs Million	$ Million
Capital Cost	204	30.5

	Local Currency fs Million	Convertible Currency $ Million	$ Converted at Shadow Rate (1$ = 15 fs) fs Million	Hypothetical Production Cost fs Million
Annual Production Costs				
Natural Gas	21.0			21.0
Power	6.7			6.7
Raw water	0.7			0.7
Catalysts, Chemicals		1.60	24.0	24.0
Maintenance				
Local (4%)	8.1			8.1
Foreign (4%)		1.22	18.3	18.3
Insurance	1.5			1.5
Labour	5.0			5.0
Capital (16%)	32.6	4.88	73.2	105.8
Overheads (assumed local)	13.2			13.2
				204.3

For Annual Production 330,000 MT   fs 619/MT Urea

This hypothetical cost can be compared with the cost of imported urea (c & f). In this example, provided that imported urea costs more than $619/_{15}$ = $ 41.3/MT, then the project is acceptable; i.e. the cost of saving each $ is less than 15 fs.

It is a fact that fertilizer projects in Developing Countries result frequently in increased local usage rather than import substitution; furthermore, much imported fertilizer is obtained under long term credit or aid arrangements. In these circumstances the justification of projects on the grounds of balance of payments benefits is difficult to sustain. It is important to consider therefore what additional higher value products could be made in association with fertilizer projects in Developing Countries so that exports of these products at prices based on marginal or subsidised costing would compensate for the outflow of convertible currency attributable to the project. Such arrangements do present commercial problems and this may explain why plants with this type of export by-product have not proved popular in Developing Countries.

VIII. REVIEW OF ESTIMATING TECHNIQUES FOR PRODUCTION COSTS

1. Estimate basic capital cost of plant.
2. Mark up by 50% to obtain investment for installed and operating plant.
3. Estimate production costs using 16% of investment figure for annual capital charges.
4. If the costs of utilities are not being calculated for utility plants associated with the plant under consideration, use the typical figures in Table VIII.
5. For the cost of overheads, add 10% of the production costs (excluding raw materials).
6. To consider the effect on balance of payments for a developing country, calculate "hypothetical" production cost by adding local costs of production to foreign exchange costs converted to local currency at the Shadow Rate. Compare the "hypothetical" cost with the cost of equivalent imports (also converted to local cost at the Shadow Rate). If the import cost is higher then the project is acceptable on this basis of assessment.

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Agenda item V/4

SUMMARY

FORECASTING PRODUCTION COSTS FOR FERTILISER PROCESSES[1]

by

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Production costs have to be forecast for a number of different purposes - budgeting, feasibility studies, process evaluations and comparisons, assessment of R & D projects, technical literature. In the cases of budgeting and feasibility studies where the cost estimates concern specific plants on known sites, it is possible to adopt definite costing techniques. There is, however, no uniformity of approach in preparing more generalised production cost data for the other purposes. It is sometimes maintained that any cost data, which are not specific to a particular plant on a specific site, are almost worthless. Such generalised production cost data must continue to be used for the purposes mentioned; this paper therefore reviews the preparation of such data.

The method used for preparing generalised production costs should be such that the data produced are closely related to the costs which the accountant would calculate in retrospect after the plant is in operation.

A plant capital cost, which includes all of the elements of cost which will be incurred in building a plant and putting it into operation, is constructed.

The major difficulties in preparing generalised production costs are shown to lie in the handling of capital charges and overheads. It is these two elements which result in the greatest differences between production cost figures presented by different sources.

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In determining the level of capital charges for generalised production costs, the percentage of the total capital cost charged per annum must enable the plant cost to be amortized over the life of the plant at the rate of return demanded for the project. When a single production cost figure is quoted, it is based on current cost and wage levels and does not make allowance for the effects of inflation. Inflation itself should not be regarded as a capital charge; if costs are being calculated without provision for inflation, then the rate of return should be reduced to the level which would apparently be acceptable to the investor if he did not have to cover inflation out of his interest or dividends.

The paper concludes with a discussion of methods for handling the special problems of Developing Countries when generalised production costs are used for such purposes as the analysis of alternative process routes.

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