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## Operating Costs

Unlike capital cost estimates, operating cost estimating errors are difficult to see, even in hindsight. If more operators, utilities, or raw materials are needed during actual operations than projected in the early feasibility studies, no one seems to notice. This lack of feedback on estimating operating costs means the engineer doing the early studies must do an especially careful and complete job. The estimator should also undertake an operating audit as soon as possible to validate the estimating techniques.

### Estimating Form

A systematic method of developing operating costs should be devised. A table or form that everyone becomes familiar with helps to make all studies uniform and complete. Reference 1 presents a good form and checklist.

### Building Up the Operating Cost

The trick to getting a good estimate of the operating costs is being thorough. Accounting plant cost statements help, but of necessity, many costs are lumped into one category so it is difficult to determine all of the items to be included in a first of a kind, or grassroots, plant. Some of the expense items are discussed in the following sections, but each project will have its own unique costs that must be estimated.

### Raw Materials

The amount of raw materials needed is supplied by the licenser or process developer. However, unless similar plants are in operation, allowances for unforeseen

impacts on raw material usages must be included. Such items as offspec material, spills, plant upsets, and operator inexperience can increase the quantity of raw materials used.

Once the volume of raw material is set, the price must be estimated. In some studies, a captive source is available with a set transfer price. In other studies, contracts for raw materials will be far enough along to establish the price. However, in some studies, contacts with vendors and the literature is the only source of raw material prices.

The *Chemical Marketing Reporter* tabulates the current list price for many chemicals. These prices, like "off the cuff" estimates from vendors, tend to be conservative. The *European Chemical News* also publishes chemical prices for many places in the world. These prices are sometimes better to use for raw materials.

After the volume and price of the raw materials have been set, the freight estimate must be made. A call to the local rail, barge, or truck office by the traffic department or the engineer will get a price. Here again, the price tends to be conservative for preliminary studies since several months or years elapse before serious freight rates are negotiated.

### Operating Labor

The engineer estimating the operating labor must visualize the plant operation, degree of automation, and the labor climate for the project being estimated. For most hydrocarbon processing plants, each control room should have at least one operator with no outside duties. For very large control rooms, more than one such operator may be needed.

The number of outside operators will depend on the layout of the equipment, and the number of operating levels that have pumps, valves, or other equipment needing attention. In remote locations, operators should never work alone. A not-so-good alternative to a second "buddy" operator might be a closed circuit TV in the control room, or a good voice communication system that allows a second person to make sure the remote operator is okay. Certain units, such as boilers and water treating units, tend to be manned with their own operator, even if the amount of equipment does not justify an operator. Laboratory personnel, loading rack operators, guards, and daylight operators must be considered.

When the number of operators per shift has been estimated, multiply the number by five to get the total operating personnel to cover all shifts. This provides for days off, some training, and sick leave. The price per person must be estimated for the project location. Fringes, taxes, and other overheads must be added.

When the engineer has decided on the number of operators and estimated their cost, it is wise to consult an old operating hand who has worked shift on a similar plant to review the number of operators and other assumptions.

### **Maintenance Labor and Materials**

Maintenance labor is usually estimated as a percentage of the capital cost of the project, or as a percentage of the maintenance materials, which in turn is estimated as a percentage of the project cost. For many petrochemical and refinery projects, the maintenance materials can be estimated as 2%–3% of the current cost of the project. The ratio of labor to materials is around 50-50. Exact ratios for the type of project being estimated should be obtained from historical data if available. Get relatively current percentages for materials and labor because the numbers change with economic conditions and the learning curve on the plant. An older plant with all the bugs worked out usually requires less maintenance than a new plant. Reference 2 presents data on the maintenance cost as a percentage of current replacement cost, percentage of original cost, and percentage of depreciated value for many chemical, refining, and other companies.

### **Supplies and Expenses**

This account covers everything from chemicals and catalysts to paper clips. Safety supplies, protective cloth-

ing, and tools can usually be estimated knowing the number of operators. When all known items have been estimated, an allowance for unforeseen things should be added.

### **Supervision**

All salaried employees working directly with the plant operation should be included in the estimate of supervision costs. The plant manager's secretary and other supervision support personnel are sometimes included as supervision even though they are not salaried nor in a direct supervisory position. The main thing is to make sure all employee costs are included in some category, but not duplicated in some other category.

### **Administrative Expenses**

The allocation of home office expenses shows up in this category. It has been argued that home office expenses do not increase with the addition of a new plant or unit. However, a full allocation of home office overhead should be made for each study, since old units are phasing out or losing profitability. The new units must carry their share. Further, as discussed next in the section on Economics, each new unit must stand on its own and contribute to the overall company's profitability. The cost of yield clerks, plant accountants, plant personnel representatives, plant transportation department personnel, etc., must be estimated and included here.

### **Utilities**

The cost of utilities is one of the most significant, yet difficult chores encountered in estimating operating costs. As discussed earlier, the amount of utilities required for both the process and the offsite areas must be estimated as accurately as possible. If utilities are generated in the project, the utilities required to operate the utility area must be included. Any increase in the project requires re-estimating the utilities consumed in the utility area. This can result in a trial and error calculation to get the total cost of utilities.

The cost of fuel for generating steam and electricity is usually a major one. The efficiency from fuel to finished utility must be determined. The choice of fuel can become a major study in many circumstances. Future availability and price must be considered.