

# Chapter 4

## **costs**

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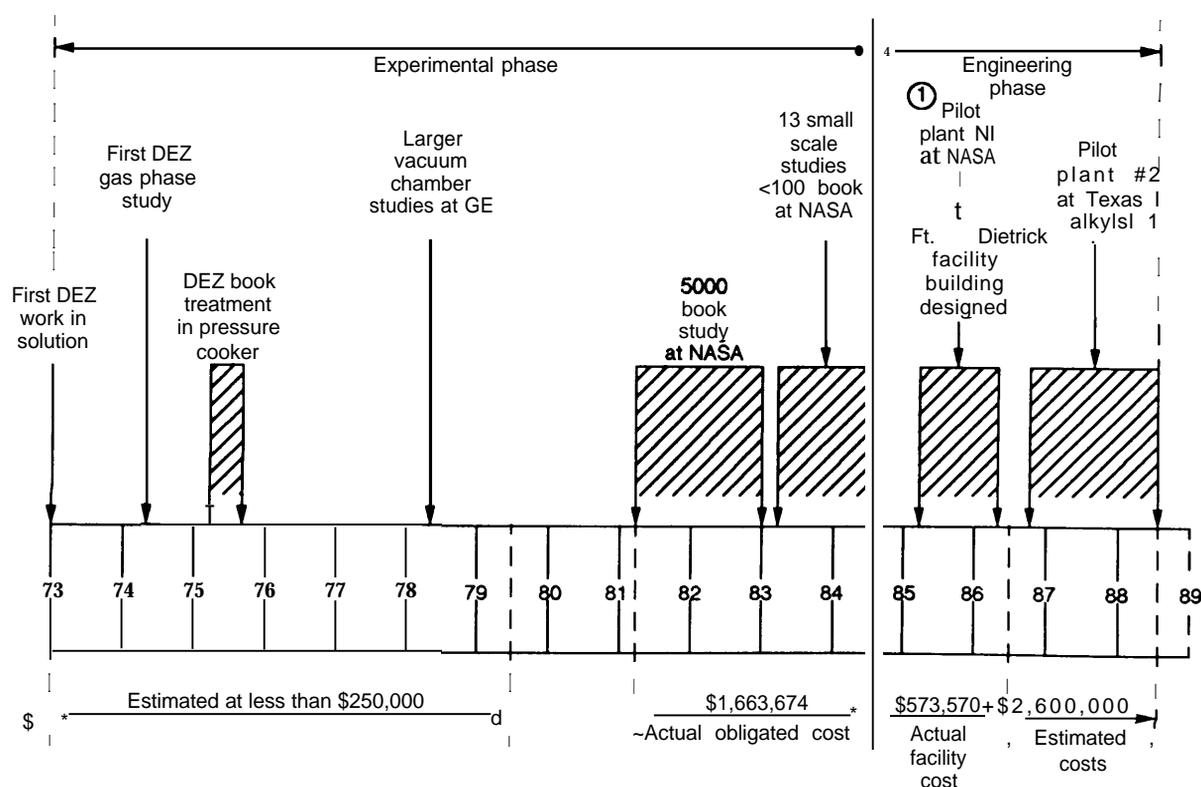
### INTRODUCTION

Since the Library of Congress' process for mass deacidification has been under development for the past 15 years, there have been a number of expenditures that could be categorized as research, development, and testing. Figure 17 displays those past expenditures that can be directly related to the Library's mass deacidification program from 1973 to 1988. It should be noted that certain of these expenditures have been for experiments whose purpose was a search for an optimum process and thus entailed comparison of various chemical treatments and results. Other expenditures were for experiments with the DEZ process alone and were directed toward learning the proper techniques for most ef-

fective results. The experimental phase can be considered to have ended with the completion of the 13 small-scale tests with books at NASA Goddard in late 1984. The Library of Congress reports that expenditures from 1973 through the end of this phase were about \$2.1 million.

If another process were to be pursued for mass deacidification of the Library's collection some of the work already completed on the DEZ process would need to be repeated; other work may need to be repeated depending on the status of development of another process. For example, none of the alternative processes have been subjected to criti-

Figure 17. - DEZ Process Development History



\*Includes up to twenty operational experiments in pilot facility

SOURCE: Library of Congress

cal independent evaluation of treated materials. The Library would most certainly need to compare accelerated aging tests (using standard papers), pH tests, alkaline buffer tests effects on library materials and others, test procedures, and protocols. It may also be necessary to evaluate certain aspects of safety, health, and environmental effects of another process. Therefore, expenditures for experimental work, while essentially completed for the DEZ process, would need to be increased if other chemicals, additional treatment, or new processes were to be considered.

Following the completion of the NASA small-scale tests, an expenditure of about \$574,000 was devoted to the ill-fated first pilot plant. The Library of Congress considers that sum to be basically a loss to the Library, however, engineering and safety lessons were learned and have been applied to later work.

Starting in 1987 the Library of Congress' expenditures on the DEZ process can be directly related to engineering development, construction, and operation of the mass deacidification facility. For the purposes of this OTA evaluation, these expenditures can be put into three categories as follows:

1. Engineering Development Costs
  - Design and Construction of Pilot Plant (Texas Alkyls)
  - Hazard and Safety Review/Technology Management
  - Initial Health & Environmental Studies
  - Pilot Plant Test Program
2. Capital Costs—Full-Scale **Facility**
  - Toxicological Risk Assessment
  - Environmental Impact Assessment
  - Plant Engineering and Architectural Design
  - Plant Construction Management and Inspection
  - Materials Handling—Engineering and Procurement
  - Construction of Plant
  - Commissioning and Startup Costs
  - Contingency Costs
3. Facility Operating Costs
  - Personnel—Plant Operations
  - Personnel—Book Handling/Transportation
  - DEZ Usage

- Utilities and Other Chemicals
- Maintenance Materials and Spares
- Operating Supplies
- Laboratory, Quality Control Costs
- Book Handling, Warehousing Expenses
- Insurance, Taxes and Other Indirect Costs
- Research Allowances and Contingency
- LOC Management Costs

To evaluate the per-book deacidification cost, OTA considers the first two categories above as capital costs and the third as annual operating costs. The total capital cost can be converted to an annual cost using an accepted rate of return over an assumed life of the project. For example, for a 10 percent<sup>1</sup> annual rate of return over a 20-year project life, a capital recovery factor<sup>2</sup> is 11.7 percent. Therefore, OTA chose to use a 12 percent capital recovery factor in arriving at a per book cost estimate.

The per-book cost of the DEZ facility will also vary considerably depending on the actual capacity or throughput finally realized when the plant is built. Since many costs (except for DEZ usage, certain labor, and supplies) will be fixed when the plant is operating, a large increase in capacity will result in a substantial decrease in per-book costs. Therefore, one of the goals of the pilot plant test program is to reduce the cycle time (and thus increase the plant capacity) to the most cost-effective level. The optimum cycle time will not be determined until a series of tests are completed in mid-1988. This study therefore assumes a capacity of 1 million books per year for the full-scale plant when estimating per-book costs.

The actual construction costs for the full-scale plant are also subject to some uncertainty. Major decisions on plant configuration—such as the size and number of treatment chambers—will not be made until some pilot plant tests are completed and a design study is done. Also the engineering design of the full-scale plant will not be started until mid-1988. Therefore, capital cost estimates must be considered only preliminary numbers for budgetary purposes. Plant operating cost estimates, however, may not be subject to as much variation only be-

<sup>1</sup> Approximately the current rate for long-term government bonds.  
<sup>2</sup> An annual payment that will repay a loan in X years with compound interest on the unpaid balance.

cause the major cost categories (labor, DEZ usage, overhead) will not change significantly even if plant design changes are made. However, over the 20-year life of the plant these costs will undoubtedly change depending on inflation, possible plant improvements needed, and changes in chemical costs.<sup>3</sup>

The following sections of this chapter present and discuss the cost estimates that have been prepared by the Library of Congress for design, development, construction, and operation of the DEZ mass deacidification facility. Part II of this report presents available data for alternative processes. While it is difficult to make cost comparisons because very little of the data are comparable in terms of accuracy and completeness, OTA has made some initial comparative comments. One basis of comparison is on the pilot plant level. It should be noted that the Library of Congress' pilot plant at Texas Alkyls has a capacity of about 50 books per 8-hour shift using a 55-hour cycle time even though much of the machinery is sized for a much larger capacity.<sup>4</sup>This

<sup>3</sup>OTA has not investigated possible cost changes for DEZ but notes that only one supplier now produces the chemical and future prices will largely be determined by that supplier. One or two other suppliers could produce DEZ and have in the past, but the market is not now attractive for them.

<sup>4</sup>The DEZ pilot also has a number of purposes and its design was based on the need to conduct a wide range of experiments as well as engineering tests. Comparisons with other plants, without such design constraints, must therefore take this into account.

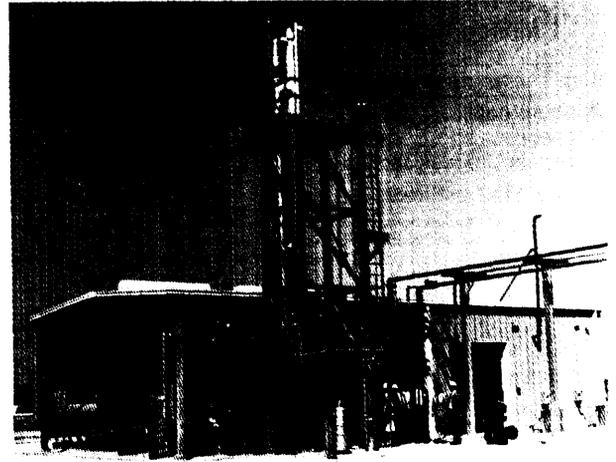


Photo credit: Library of Congress

DEZ pilot plant at Texas Alkyls

could possibly be compared (with some caution) to the Canadian Library plant with a present capacity of 150 books per 8-hour shift; and with a pilot plant designed, but not built, by the Koppers Co. with a projected capacity of 100 books per 8-hour shift. Such a comparison is very rough at this time, but, when two or more pilot plants of roughly similar capacity begin obtaining actual operating history, more accurate cost comparisons could be made.

## COST ESTIMATES FOR THE DEZ FACILITY

### *Engineering Development*

The costs for engineering development for the LOC deacidification facility have been assumed by OTA to include all work associated with designing, constructing, and testing the second pilot plant at Texas Alkyls. As of this writing, most of those costs are quite firm but the number of tests (and thus the costs of tests) may vary before they are completed in mid-to-late 1988. Table 10 displays the estimated costs of engineering development that were supplied by the Library to OTA.

### *Capital Costs—Full-Scale Facility*

At OTA's request the Library of Congress prepared a capital cost estimate for the full-scale de-

Table 10.—LOC Engineering Development Cost Estimate for DEZ Mass Deacidification Program

|                                     |        |                 |
|-------------------------------------|--------|-----------------|
| Pilot plant design and construction | ... .. | \$.1.9 million  |
| Pilot plant test program            | .....  | 0.8 million     |
| Other                               | .....  | 0.1 million     |
| Total                               | .....  | ..\$2.8 million |

NOTE: These costs were incurred and obligated in 1987 and 1988.

SOURCE: Library of Congress.

acidification facility. That estimate is in appendix C of this report. Table 11 summarizes the LOC cost estimate. Several categories are *not included* in the LOC estimate. OTA believes the costs could vary considerably because of the number of unknowns about the facility at this time. OTA also believes the cost estimates are low; OTA advisors are concerned that the plant design assumptions are

**Table 11.—LOC Capital Cost Estimate for 1 Million Books/Year Deacidification Facility**

| Item                                | Cost (\$ millions) |
|-------------------------------------|--------------------|
| Building cost . . . . .             | 1.8                |
| Site work . . . . .                 | 0.3                |
| Chemical process facility . . . . . | 2.8                |
| Total LOC estimate . . . . .        | 4.9                |

NOTES: 1. Costs based on assumption of two separate structures—a support building and a chemical treatment facility.  
 2. Chemical plant cost is based on a hypothetical chamber size for four chambers.  
 3. Chemical plant assumes hardware similar to pilot plant.  
 4. Not included in estimate are: utilities, site development, emergency power, contingency.  
 5. Plant assumed to be located at Ft. Detrick, MD.

SOURCE: Library of Congress.

too optimistic (e. g., a 36-hour cycle time and few backup systems); OTA is concerned because the full-scale chemical plant cost appears low if compared with budgetary scale-up factors which are used as rough guidelines in the chemical industry. OTA has not, however, prepared an independent cost analysis and therefore its comments on costs must be considered only as cautionary.

### ***Facility Operating Costs***

Table 12 is a summary of LOC estimates of annual operating costs for the full-scale facility with an assumed capacity of 1 million books per year. (See app. B for the LOC estimates and assumptions.)

OTA reviewed these costs and considers several of the categories to be too low. First, projected la-

**Table 12.—LOC Operating Cost Estimate for 1 Million Books/Year Deacidification Facility**

| Item  | Annual operating cost (\$ millions) |
|---|-------------------------------------|
| Plant costs (chemicals/supplies/ utilities) . . . . . | 1.0                                 |
| Operating labor . . . . .                             | 0.6                                 |
| Plant overhead . . . . .                              | 0.1                                 |
| Administrative costs . . . . .                        | 0.1                                 |
| Total LOC estimate . . . . .                          | 1.8                                 |

NOTES: 1. Operations are 24 hours/day, 350 days/year.  
 2. Plant assumed to be located at Ft. Detrick, MD, and thus no costs are included for taxes, insurance, safety and fire protection, etc.  
 3. Contractor supervision and operation is assumed with fee for this at 15 percent of labor cost.  
 4. No costs are included for book handling and transportation to and from the Library but this was estimated at \$0.70 per book.

SOURCE: Library of Congress.

bor costs are considered low because they do not make enough allowances for overtime, maintenance, training, turnover, and contingency. Second, the contractor's fee is considered low because of the special requirements for experience and competence. Third, costs for Fort Detrick services (e. g., security, grounds maintenance, safety, and fire protection) are not included; nor are costs for staff training, drills, and skills upgrading. Finally, book handling and transportation costs are not included although previous estimates of these costs are noted. OTA advisors also were concerned that insurance against an accident did not show up as a cost or a contingency; and that no allowance was made for possible increases in the cost of DEZ.

## **DISCUSSION**

There are several difficulties with analyzing the available cost estimates for the DEZ mass deacidification process. First, a number of design and program management decisions are yet to be made and these could affect costs substantially. Second, the cost data presented by LOC does not include some possible major costs such as book transportation and handling, plant commissioning, and contingencies. Third, the LOC estimates appeared to be on the low side when reviewed by OTA's advisors. Finally, a consistent method for projecting total costs and per-book costs has not been determined.

OTA believes it is important to develop a consistent method and accurate cost projections with

contingencies as soon as possible. Such projections are important to decisions (yet to be made) about size or capacity of the full-scale plant. They are also important if any of the possible alternative processes are to be evaluated. At present it appears that at least two alternative processes would have much lower costs than the DEZ process but this conclusion is based on incomplete cost data and no consistent method for comparison.

Even though it may not be accurate, OTA prepared its own very rough estimate of the DEZ program total costs to determine a possible range of per book treatment cost that may be applied if all elements are included. This estimate was made only

for the purpose of this report. New data could change it. Final per-book costs are presented as a +/-20 percent range because of the uncertainties involved.

Table 13 displays the OTA estimate of capital costs, operating costs, and per-book costs.

To derive a total capital cost estimate OTA included the engineering development costs and the toxicological risk assessment costs. OTA then made rough estimates of materials handling facilities, and commissioning costs. OTA also added about a 6 percent contingency.

To derive a total operating cost estimate, OTA added about 10 percent more labor costs, a higher contracting fee, and a fee for Ft. Detrick services to the LOC estimate. OTA then added a book handling and transport cost based on an earlier LOC estimate.

For a very rough estimate of per-book costs of deacidification at the LOC facility, OTA has included engineering development and plant construction in one total capital cost estimate. We then assumed a 12 percent per year capital recovery factor for this total and added the annual facility operating cost to that. The total per book treatment costs thus determined are from \$3.50 to \$5.00 per vol-

**Table 13.—OTA Capital and Operating Cost Estimates for 1 Million Books Per Year Deacidification Facility**

|  |                 |
|--|-----------------|
| <b>Capital cost:</b>                             |                 |
| LOC estimate . . . . .                           | \$. 4.9 million |
| OTA additions:                                   |                 |
| Toxicological risk assessment . . . . .          | 1.5             |
| Transport and materials handling . . . . .       | 0.5             |
| 6-month commissioning . . . . .                  | 0.9             |
| Contingency . . . . .                            | 0.5             |
| Engineering development . . . . .                | 2.8             |
| Total capital cost . . . . .                     | \$11.1 million  |
| <b>Annual operating costs:</b>                   |                 |
| LOC estimate . . . . .                           | \$. 1.8 million |
| OTA additions:                                   |                 |
| Added labor . . . . .                            | 0.1             |
| Added contractor fee . . . . .                   | 0.1             |
| Ft. Detrick services . . . . .                   | 0.1             |
| Book handling and transportation . . . . .       | 0.7             |
| Total operating costs . . . . .                  | \$ 2.8 million  |
| <b>Per-book costs:</b>                           |                 |
| Total capital . . . . .                          | \$11.1 million  |
| Annual capital recovery @ 12 percent . . . . .   | 1.3 million     |
| Annual operating costs . . . . .                 | 2.8 million     |
| Per-book cost @ 1 million books/year = . . . . . | \$4.1           |
| *20-percent range of per-book cost = . . . . .   | \$3.50-\$5.00   |

SOURCE: Office of Technology Assessment, 1988.

ume. A number of OTA advisors believe that the higher (\$5.00) per-book cost is the most realistic but without a more systematic and detailed estimate this cannot be confirmed.