



# Chapter 1

## Overview

1.1 Introduction

# CONTENTS

	<i>Page</i>
Introduction .....	13
Library of Congress' Problem and Strategy . . .	13
Status of the Deacidification Program .....	15
Process Development .....	15
Quality Control .....	16
Book Handling..... +*....*	17
Health and Environmental Assessment .....	18
Funding .....	18
Discussion .....	18

## *Figures*

<i>Figure No.</i>		<i>Page</i>
1.	Library of Congress General and Law Collections Survey of Paper Strength. . .	14
2.	Library of Congress General and Law Collections Survey of Paper Acidity . . .	14
3.	Library of Congress General and Law Collections Survey of Ligninin Paper . .	15
4.	Library of Congress, Mass Deacidification Program: Current Schedule of Major Tasks, January 1988 .....	16

## *Table*

<i>T&amp;le No.</i>		<i>Page</i>
1.	Library of Congress Collections on Paper As of Sept. 30, 1986 .....	14

### INTRODUCTION

Libraries around the world are faced with a serious preservation problem but it is of huge proportions at the Library of Congress. The Library houses over 66 million items, including 14 million books. It is estimated that 25 percent of these books are brittle and another 1 to 2 million are at risk of becoming brittle over the next 20 years. As a major part of their overall preservation effort, the Library initiated a program aimed at deacidifying books en masse. Much of that program has been devoted to the development of a process capable of treating between 500,000 to 1.5 million books per year. The process is unique and has many advantages over more traditional techniques. However, there have been questions raised about the process' effectiveness, safety, and costs,

Part I of this study will evaluate the Library of Congress' mass deacidification program and the is-

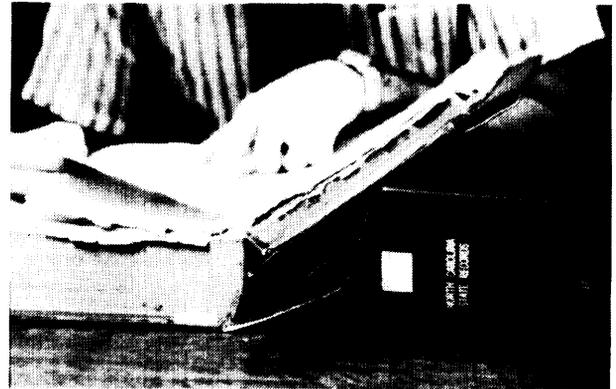


Photo credit: Library of Congress

Brittle book from the Library of Congress' collection.

sues of effectiveness, safety, and cost in an effort to assist Congress with its decision about authorizing this program to proceed.

### LIBRARY OF CONGRESS' PROBLEM AND STRATEGY

The Library of Congress' holdings of over 66 million items ranges from books to maps to musical scores. Books comprise the single largest holding. The Law collection and the General collection contain almost 14 million volumes, and receive over 350,000 additional books each year. In addition to books, the Library holds over 1 million technical reports, 35 million pages of manuscripts, over 3 million sheets of music, and nearly 4 million maps (see table 1). All of these items are at risk of becoming brittle and most are potential candidates for treatment.

In January 1984, the Library sampled the books in their Law and General Book collections to determine how many books were already brittle and how many had high acid content and, therefore, were at risk of becoming brittle. <sup>1</sup>Based on this sam-

<sup>1</sup> *The Design and Analysis of a Sample of the Condition of Books in the Library of Congress, a Report prepared for the Library of Congress by King Research, Inc., Mar. 28, 1984.*

pie, the Library estimated that 25 percent of their collection, over 3 million volumes, had already become too brittle to permit circulation (see figure 1). The pages of these books cracked when folded. Another 45 percent of the books were categorized as weak (i. e., their pages on the average could not withstand 50 folds). Of the collection, 97 percent are acidic (a pH value less than 7. 0), and, therefore at risk of becoming brittle (see figure 2). Roughly 50 percent of the collection is made with paper containing lignin (see figure 3). Lignin is a highly unstable constituent of wood pulp and leads to rapid deterioration of paper. The Library estimates that each year over 77,000 additional books become too brittle to circulate.<sup>2</sup> It should also be noted that the median age of the books in this collection is 25 years.

<sup>2</sup> 'Congress Considers 'Brittle Books', " *Publisher's Weekly*, March 1987, p. 13.

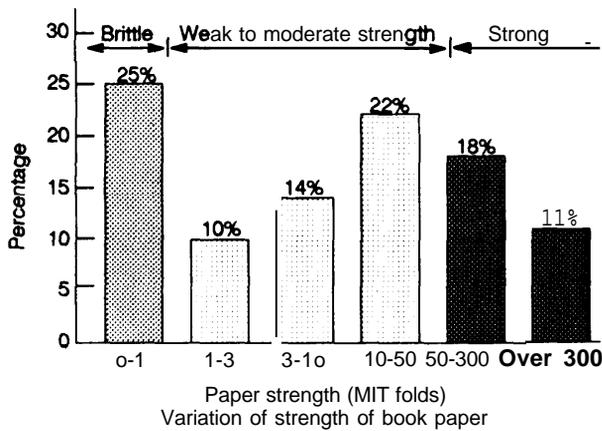
**Table 1.—Library of Congress Collections on Paper As of Sept. 30, 1986**  
(numbers rounded to nearest thousand)

	Collection	Volumes	Sheets
DEZ treatment expected . . . . .	Regular books . . . . .	14,046,000	
DEZ treatment planned . . . . .	Manuscripts. . . . .		35,522,000
	Maps . . . . .		3,862,000'
	Sheet music . . . . .		3,699,000
DEZ treatment considered . . . . .	Other printed materials . . . . .		6,647,000'
	Technical reports . . . . .	1,414,000	
	Art books . . . . .	348,000	
	Music manuscripts. . . . .		319,000
	Prints and drawings . . . . .		257,000
	Pamphlets . . . . .		179,000C
	Popular applied graphic arts. . . . .		95,000
	Posters . . . . .		61,000
No DEZ treatment. . . . .	Rare books. . . . .	594,000	
	Fine prints . . . . .		95,000 <sup>b</sup>
	Bound newspapers. . . . .	40,000	

<sup>a</sup>Includes some volumes.  
<sup>b</sup>Includes some portfolios.  
<sup>c</sup>Mostly booklets.

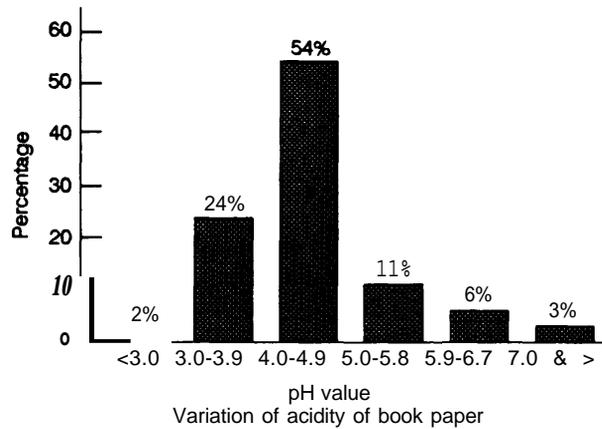
SOURCE: Library of Congress

**Figure 1.—Library of Congress General and Law Collections Survey of Paper Strength**



SOURCE: Library of Congress, January 198.

**Figure 2.—Library of Congress General and Law Collections Survey of Paper Acidity**

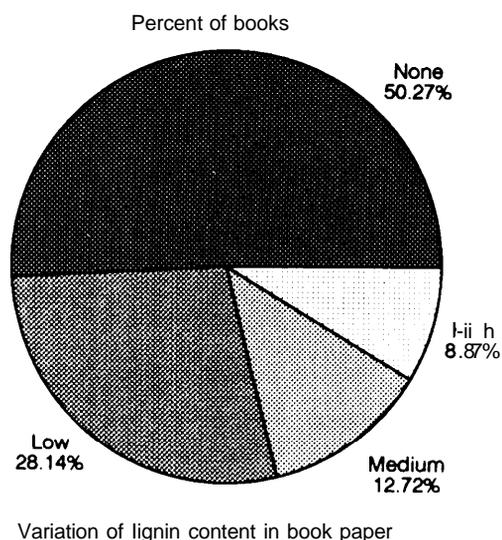


SOURCE: Library of Congress, January 198.

In an effort to preserve their collection, the Library operates a comprehensive preservation program which includes rare book and document conservation, extensive environmental control, microfilming, book binding, and new optical disk formatting. Microfilming represents a major part of the preservation effort devoted to transferring information from brittle materials. Besides maintaining the newspaper collection on microfilm, the

Library also microfilms between 10,000 and 20,000 brittle monographs and serials per year at a cost of about \$40 per volume. It is the largest microfilming operation in the world. Even so, they cannot keep up with the number of books that are deteriorating. With 3 million books already brittle and 70,000 additional books becoming brittle each year, the Library's stacks will hold about a 200-year backlog of brittle books by the year 2000.

Figure 3.—Library of Congress General and Law Collections Survey of Lignin in Paper



SOURCE: Library of Congress, January 1984.

To slow down the embrittlement of acidic books, the Library decided to develop a mass deacidification process that would run in parallel with the microfilming program. It is important to note that deacidification is not an alternative to microfilm-

ing but a complimentary treatment that delays the need to transfer information to a new media. Deacidification by itself, i.e., without parallel strengthening, cannot help the 3 million books that are already brittle.

The basic strategy of the deacidification program is to treat all new acquisitions entering the collection first, before putting them into the stacks. In addition, books already in the collection would be selectively deacidified over time. The Library set a goal of deacidifying their entire book collection in 20 years.

The rationale for treating the incoming books first is that it should increase the cost-effectiveness of the program. Deacidification is generally believed to extend the life of a book by two to five times. Therefore, if paper in a new book has 50 years of useful life remaining, deacidification can extend this to 100 to 250 years. If paper in an old book has only 5 years of life remaining, deacidification will only extend its life 10 to 25 years.

The Library also wants to be able to treat other formats, and has expressed intentions of experimenting with adding a strengthening step to the process.

## STATUS OF THE DEACIDIFICATION PROGRAM

The Library began its mass deacidification program in 1973. The program now consists of four basic subprograms:

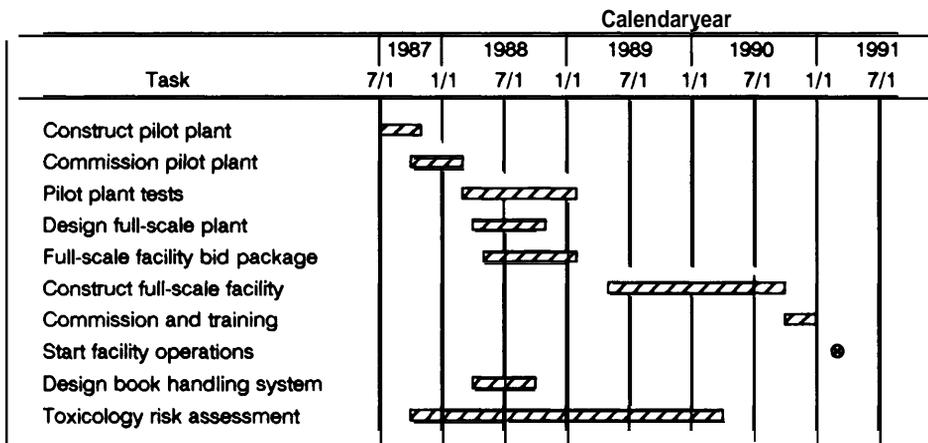
- the development of the plant engineering and large-scale facility for the mass deacidification process;
- the development of an appropriate quality control program;
- the development of a book handling management program; and
- an assessment of the health and environmental impacts.

A master schedule for the program is shown in figure 4.

### *Process Development*

Most of the effort to date has focused on process development. Beginning in 1973, the Library's chemists explored various ideas in mass deacidification and invented a unique process utilizing diethylzinc (DEZ) vapors. Numerous laboratory and large-scale tests have been conducted to verify and develop the process. Currently, a pilot-scale system (capable of treating 300 books at a time) has been designed and constructed at Texas Alkyls, outside Houston. Texas Alkyls is the principal manufacturer of DEZ in the United States and has been working with the Library since the beginning of its program.

Figure 4.-Library of Congress, Mase Deacidification Program:  
Current Schedule of Major Tasks, January 1988



SOURCE: Office of Technology Assessment, 1988; based on information received from Library of Congress

This is actually the second pilot plant that has been built by the Library. The first was designed, built, and operated by Northrup Services, Inc., on site at NASA's Goddard Flight Center in Greenbelt, Maryland. This plant was demolished in 1986 after two fires and an explosion rendered it inoperable. DEZ is pyrophoric, i.e., it will spontaneously ignite in air. Therefore, fire is a hazard that must be safely managed. This issue will be more fully discussed in chapter 5.

Construction of the Texas Alkyls pilot plant was completed in October 1987. The first tests of the plant began in December 1987.

The Library has contracted with Texas Alkyls to run 10 to 15 tests during 1988. These tests will evaluate the system's operability, effectiveness of treatment, safety, and economics. They will also be used to optimize the process parameters, cycle times, and final design (including plant capacity), for a full-scale system.

The full-scale plant is scheduled to begin construction in 1989 and to begin operation in 1990-91. The plans for who will design, construct, manage, and operate the plant have not yet been determined. The option that has received the most attention is to locate the plant at Fort Detrick in Frederick, Maryland. Under this option, the U.S. Army Corps of Engineers would contract for the



B w w g d DEZ m p m  
A

design and manage the construction of the plant. The Library has stated its interest in contracting the management and operation of the plant to a private chemical company that has had experience in handling materials such as diethylzinc.

### *Quality Control*

A quality control program is being designed to ensure that the effectiveness of the process is maintained. As of January 1, 1988, test criteria had been

proposed that include accelerated aging/fold endurance tests and analysis of the following major factors:

- completeness of deacidification,
- average percent zinc oxide deposited,
- uniformity of zinc oxide deposited,
- cover stains,
- text block rings,
- odor, and
- other.

Tests at the Texas Alkyls pilot plant are planned to provide information so that a statistically validated quality assurance program can be developed. The most important issue that will be addressed is the evaluation of test books as surrogates for actual books in the Library's collection. This evaluation will include data on suitability of various test papers, correlation of test book characteristics with regular books, and determination of a dose-response curve for test papers and its correlation with regular books. If test books do not provide a suitable surrogate for actual books, then an alternative approach will be necessary. A consultant to the Library has suggested using purchased used books to represent books already in the Library collection and extra copies of new books that are to be treated.

Another issue that will be addressed is the appropriate number, format, and placement in chamber of test books.

The pilot plant tests to develop a quality control program will also provide a large reservoir of treated books of known characteristics and composition for research purposes; and data to correlate new test paper behavior with that of papers previously used but now unavailable.

### ***Book Handling***

Book handling and its management represents a major part of the deacidification program. This part of the program has been divided into three integrated projects:

- the movement of books between the Library and the treatment facility,
- the procedures for returning treated books to circulation at the Library, and
- coordination with other preservation programs.



*Photo credit: Library of Congress*

First prototype of book handling carts for DEZ treatment.

The movement of books involves both logistics and design. The Library has experience in moving tens of thousands of books each year, but not a million books each year. Loading docks must be redesigned, and equipment including fork lifts, carts, etc., must be designed to operate in relatively confined spaces. The obsolete loading dock at the Jefferson Building has been redesigned by an outside consultant and construction work is to begin in 1989. The Library has also contracted with an outside firm to study the design of book-handling equipment and logistics.

The procedure for returning treated books to circulation basically requires some form of identification that the book has been deacidified. Logistics and the design of that identification system are considered very important by Library and preservation specialists. These topics will be addressed by the aforementioned study.

The Library has three ongoing preservation activities that also involve pulling books from the stacks for treatment of some kind. In addition to microfilming, the Library has relabeling and re-binding programs. Currently, these programs are not coordinated and books are selected independently from the collection. However, these programs will have to be coordinated with the mass deacidifi-

cation program to ensure an efficient operation. The coordination between microfilming and deacidification is the most problematic. Deacidifying a brittle book is not cost-effective. However, the number of brittle books that would be pulled from the shelves would quickly overwhelm the microfilming capability of the Library. The costs associated with storing and managing a separate inventory of brittle books while they await processing may be prohibitive. The Library staff is still discussing this issue.

Book handling is a critical factor in any large-scale deacidification program. It may actually limit the eventual capacity of the deacidification system and, although only rough estimates have been made, OTA believes it could represent a major operating cost.

### ***Health and Environmental Assessment***

The Library has completed some limited laboratory toxicology studies and extensive literature studies on the health effects of treated books on library workers and users. The major change imparted to books during the treatment is the deposition of zinc oxide in the paper. In general, zinc oxide is considered a benign substance. However, the effects of exposing the skin to treated papers or ingesting treated papers orally were examined on mice and rabbits. No adverse effects were identified. The Library has also designed an extensive animal study to examine the effects, including carcinogenic effects, of chronic inhalation of the dust that may be associated with the process or the treated paper. The study was begun in 1987 and will take at least 2 to 3 years to complete.

## **DISCUSSION**

The Library of Congress has recognized the problem of acid deterioration of books and other paper materials for a long time. It has invested considerable effort in the investigation of deacidification processes and has selected one process that best suits its objectives.

The Library's strategy is to deacidify all new books as they enter the Library (about 350,000 per year). In addition, the Library plans to treat the

The Library also intends to assess the environmental impact of the full-scale plant. The Library did make an earlier preliminary assessment, during the design of the first pilot plant, but this must be redone to take into account the new design. Who will perform the new assessment, and in what detail, will be determined after the design and operations planning for the full-scale plant is completed.

### ***Funding***

The Mass Deacidification Program is a line item in the Library's budget. Since the beginning of the program in 1973, the Library has spent \$4.5 million on process development. Design, construction, and testing at the Texas Alkyls pilot plant has cost \$2.8 million. Additional funds have been spent on designing and planning for the book handling management. The animal study will cost about \$1.5 million.

The Library, at the request of OTA, has estimated the capital and operating costs for the full-scale plant assuming it will be placed at Fort Detrick. These costs were estimated (by Library engineers working in conjunction with the pilot plant design team and architects working on the full-scale design) at \$4.9 million to build and \$1.8 million per year to operate at a capacity of 1 million books per year. OTA added a rough estimate of certain costs not included in the above figures and concluded that total capital costs may be \$11.1 million for the facility and total annual operating costs may be \$2.8 million.

rest of its book collection over a 20-year period. Deacidifying old books, without strengthening, may not be as cost-effective as doing both—i.e., deacidification and strengthening. The Library intends to incorporate strengthening into its program at some future time, but has not yet selected an approach to do so.

Selection of the DEZ process by the Library has followed a logical laboratory routine in comparing

---

alternatives on the basis of criteria established by the Library for its collection. However, since a decision to pursue the diethyl zinc (DEZ) process in the late 1970s, the Library has directed very little effort toward supporting the development or testing of other alternatives. The Library has investigated and kept informed of other paper preservation work in the United States and abroad, however, most of its effort has been devoted to perfecting the DEZ treatment process and solving the engineering, plant safety, and other problems associated with the DEZ chemical treatment plant.

The Library of Congress has built its second DEZ pilot plant and has begun a series of engineer-

ing and process effectiveness experiments as of this writing. It has done early planning but has not yet made firm decisions about the management, design, construction, and operation of a full-scale facility. A total system design would include book selection, handling and transportation, and procedures for contracting and management of the full-scale plant. The Library of Congress needs to consider important details of project planning and management soon in order to more accurately determine costs, capacity, and operational results of this major undertaking.