Exposed to Air after Fifty Years!

In 1998, the National Archives and Records Administration embarked on a project to re-encase the United States Constitution, the Declaration of Independence, and the Bill of Rights, collectively known as the Charters of Freedom. This decision led to a multiyear collaborative project involving National Archives staff as well as scientists and technical experts from the National Institute of Science and Technology and other agencies and organizations. Our tale is a trip through time, starting with the critical moment of opening the encasement, then thinking back two hundred years to the creation of the document, and moving forward again to reflect on the conservation and scientific bases for deciding to re-encase the Charters of Freedom after fifty years.

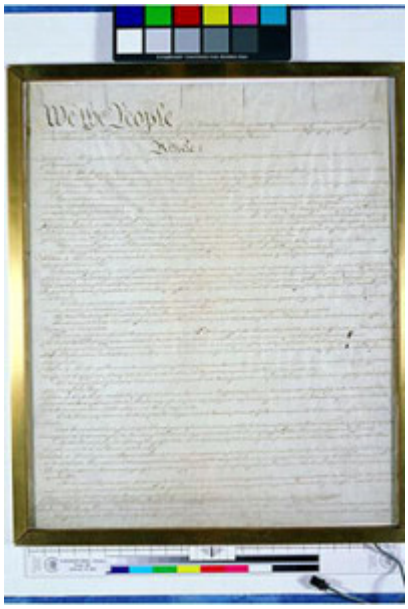

Fig. 1. Page 1 of the Constitution in its 1950s-era NBS encasement. The six slits across the top edge were originally laced with silk ribbon to hold the pages of the Constitution and the Transmittal Page together. Note the leak detector extending from the bottom edge of the encasement. Photograph by Earl

McDonald, courtesy of the National Archives and Records Administration.

A Moment of Action: Wielding the Knife

The moment had arrived. The vault was quiet, the conservators wore gloves and lab coats, and the camera was ready to roll. A small sharp blade probed the pinprick hole in the lead to enlarge it and permit insertion of a larger tool. This simple task normally would not give us pause. But this time we were on the verge of opening the encasement created almost a half century ago to house the Transmittal Page of the United States Constitution, the parchment letter of conveyance signed by George Washington as president of the Constitutional Convention. Successfully opening this encasement would permit us to test and confirm our procedures and to gain confidence before moving on to the encasements containing the remaining four pages of the Constitution, the Declaration of Independence, and the Bill of Rights.

The time had come to liberate the parchment after fifty years, a step fraught with uncertainties and concerns. We were breaking new ground, but at the same time, undoing beautiful craftsmanship that had achieved hermetically sealed encasements in 1951. The encasement design was elegantly simple: two sheets of glass with metallic copper flashed on the edges, joined with solder to a lead ribbon that sealed the three-eighths-inch gap between the glass. Between the glass sheets the historic parchment lay on handmade paper, surrounded by a brass collar or spacer, with a second loose piece of glass resting on the parchment surface.

We knew the structure of the encasement and—theoretically—the path to its opening, but had neither written instructions nor a training film to guide us. We had to learn by doing. While all the calculations and tests on surrogates that preceded this moment indicated that breaking the seal would not result in damage or catastrophic change, we couldn’t help but wonder: Would the glass crack? Would the encasement implode? Would the parchment stick to the glass? Though such speculation was not scientifically based, it was understandable in the circumstances. It was a moment that few conservators had experienced, a moment long anticipated and flavored with a dash of uncertainty and a bit of nervousness, as befitted the responsibility and honor of working with one of the most significant documents in U.S. history.

We inserted a tool with a curved end, handmade of hardened metal, into the breech in the lead strip joining the top and bottom glass of the encasement. We had wondered how readily it would open, but the cutting was easy. With a rocking motion, the blade sliced the lead cleanly, sometimes leaving long curling flourishes of lead in its wake. Only in areas of excess solder surrounding the leak detector was the process difficult and time consuming. A variety of small blades were used carefully to break through the seal, and finally the deed was done: the sheets of glass that had covered the parchment for fifty years could be lifted away. It was a momentous if quiet success, with no resulting alteration to the parchment.

Fig. 2. Gloved hands slowly work the blade back and forth, through the lead seal that holds the top and bottom sheets of encasement glass together. Photograph by Earl McDonald, courtesy of the National Archives and Records Administration.

A Moment of Action: Wielding the Pen

Jacob Shallus dipped his quill pen in ink and placed it onto a bare sheet of parchment lined with pale brown crayon guidelines to begin to write out the formal copy of the new nation's Constitution, to be approved by the Constitutional Convention on Monday, September 17, 1787. The clerk's job was demanding. He had little time to take the corrected draft and write out a "fair" or final legible copy over the course of a weekend in Philadelphia. Corrections were difficult to make since parchment was such an unforgiving medium. Words were scraped away with a penknife or inserted carefully in the lines of text, and then listed in an errata paragraph to attest that the approved document was unaltered.

Shallus could never have imagined that two centuries later conservators would peer through a binocular microscope to examine his pen strokes. Shallus was a clerk trained to create a fine handwritten text. In his work, he wrote a very legible script with titles that were engrossed, that is, made larger and darker. His tools were quill pens cut from large feathers, and ink made from oak galls, iron, and gum arabic, often with a colorant such as logwood added to the initially pale ink. Following English practice, Shallus wrote important legal documents on parchment, animal skin that was specially treated with lime and stretched. It was expensive, generally imported from Great Britain, but could be expected to last a very long time.

More than two hundred years later, conservators in the no-longer-young nation examined his handiwork to determine its condition. The parchment, sensitive to changes in humidity, now undulated in many cockles or "hills and valleys." While the text remained very legible, we could see under the microscope that many small flakes of ink had disappeared and other lifted flakes were tenuously attached. In the past insects had nibbled the parchment, leaving lacey, vulnerable edges on some sheets. The treatment we devised to address these

conditions was conservative, designed to stabilize and preserve the legibility of the text. We adhered insecure ink flakes with parchment size (a gelatin made by cooking small parchment scraps), using the fine tip of a 0000 watercolor brush to apply drops of size no larger than a period at the end of a sentence.

Fig. 3. A conservator carefully examines the text under the microscope—letter by letter, word by word—looking for any flakes of ink that need to be secured. Using a fine-tipped brush, she applies a very small amount of warm parchment size that wicks under flakes to adhere lifting ink back into position. Photograph by Earl McDonald, courtesy of the National Archives and Records Administration.

We also carefully cleaned dirt and grime in bare areas of the parchment—taking special care to avoid disturbing Jacob Shallus's rule lines—and removed old adhesive on the reverse which distorted the parchment sheet. As a final step, the parchment, humidified to fully relax it, was dried under tension to return it to a flat plane. The challenge was to make the parchment limp without softening the ink so that it could be realigned to remove the distortions of fifty years or more.

Science in the Support of History

Opening the encasement was a step in a process that began almost twenty years earlier with questions raised about the safety and stability of the Charters' encasements. In 1982, the National Archives invited a panel of respected scientists and preservation professionals to assess the preservation needs of the Charters of Freedom. They advised comparing images of the Charters made at intervals over time, to look for changes that might raise concerns. The National Archives turned to the Imaging Processing Lab at the Jet Propulsion Laboratory (JPL) to assist in this effort. Borrowing NASA technology, the JPL developed an imaging system like that used in space exploration. The resulting Charters Monitoring System (CMS) created digital image files by scanning one-inch squares on each document. During imaging, the encased document lay on a tabletop with legs that floated on nitrogen in cylinders, which acted as shock absorbers to eliminate vibration. An overhead charged-couple device "camera" captured the relative brightness of 1028 lines of 1028 pixels in each patch

through glass layers, using precise positioning to allow return to the exact spot in future scans.

The National Archives received the Charters Monitoring System in 1987. Our staff made baseline measurements for patches on the pages of the Constitution. In following years, patches were re-scanned and compared pixel by pixel to the baseline image, to show physical changes. In 1996, after more than 125 scans, staff reported the findings. The CMS did not reveal feared changes in ink intensity or loss of ink. In all the scans on the seven encased documents, just one insecure flake of ink was noted on a raised ridge of parchment on the Transmittal Page of the Constitution. Jacob Shallus might have been befuddled by the technology, but he surely would have been pleased that his text had survived so well.

But if the ink of 1787 was holding its own, the encasements of 1951 were not. The CMS space-age technology ultimately confirmed findings made in 1987 with the microscope: minute crystals and microdroplets of liquid on surfaces of the two glass sheets over each document. The scans confirmed that these changes in the glass progressed between 1987 and 1995. Conservators using a binocular microscope could focus to see crystals and liquid droplets on the glass surfaces. These signs of glass deterioration were a clue to the relative humidity inside the encasements. Glass deteriorates at a relative humidity over 40 percent. But the encasement helium had been carefully humidified to 30 percent. This low humidity was to minimize parchment hydrolysis, a chemical term that means “water cutting.” Evidence emerged of progressive glass deterioration and raised concerns of possible parchment deterioration by hydrolysis.

What was going on inside the sealed encasements in the 1980s could only be learned indirectly. Conservation staff peered through a glass window looking for clues about whether moisture was excessive and whether any helium remained. A few simple techniques gave some answers. An ice cube placed briefly on the outer glass made water condense on the inner glass. Measuring the resulting dew point temperature confirmed a relative humidity higher than 30 percent. To see if helium remained, we relied on an encasement with an odd visual effect that indicated a tight seal. The encasement for the Transmittal Page had a faint pattern of concentric rings at its center. These so-called Newton’s rings result when a very narrow space diffracts light. In this encasement, the narrow gap was between the surfaces of the two glass sheets pressed closely together by atmospheric pressure. The rings indicated the container was sealed but at a partial vacuum. After fifty years helium may have escaped, but the seal was intact.

The rings were intriguing, but did helium remain inside or was there a vacuum? Were the other encasements without Newton’s rings still sealed? And what was inside them: air, helium, a mixture, or a vacuum? Helium is so small a molecule that it escapes slowly through some types of glass and very readily through the smallest hole. The leak detectors indicated that air had not infiltrated. But

would the leak detectors work in a vacuum if the helium had escaped?

So the question persisted whether helium was still in any of the encasements. We wanted an answer before breaking the seal, to permit sampling the interior gas for analysis before it dissipated. We contacted a NASA scientist who had attempted to sample “old” air in sealed colonial lead coffins. But we needed answers without penetrating the encasement seal. His NASA team worked to measure gasses in the upper atmosphere by aiming a laser beam out an airplane window to the wing tip. In the Charters’ encasements, the laser beam would traverse a millimeter gap between the glass layers. Amazingly, the NASA laser beam study showed the absorption pattern of helium in each encasement they studied. Helium—some helium at least—remained. Knowing this led to developing special procedures to sample the gas inside of each encasement before it was opened and lost forever.

A Moment of Contemplation: Looking to the Future

As the vault door closes, we think of the work accomplished and what lies ahead. The Constitution has now been examined, documented, and treated—and sealed in elegant and technologically advanced encasements. Two sapphire window ports in the side of each encasement permit a light beam to traverse the inner atmosphere below the document platform allowing conservators to monitor the conditions within. Changes—such as the presence of oxygen—that could have a detrimental effect on the documents will let future caretakers know that it is time to act. Intervention could be simple—replenishing the inner atmosphere with argon or, more complex, unbolting the encasement lid to break the seal designed to hold for one hundred years or more and again exposing the Constitution to air. We can’t help but wonder how long this work will hold and what new tools will be available to preserve this document in the future.

Could any of the Framers of the Constitution have ever imagined the steps that future caretakers would take—and the amazing space-age tools and technologies that would be brought to bear—to ensure the preservation of their words written on parchment in 1787? While some might argue that the Constitution is merely a musty document—old ink on old parchment—the ideas it contains continue to be argued and brought to bear on every aspect of American life. The concepts remain fresh and pertinent to the latest-breaking news—to events that the Framers could not have imagined.

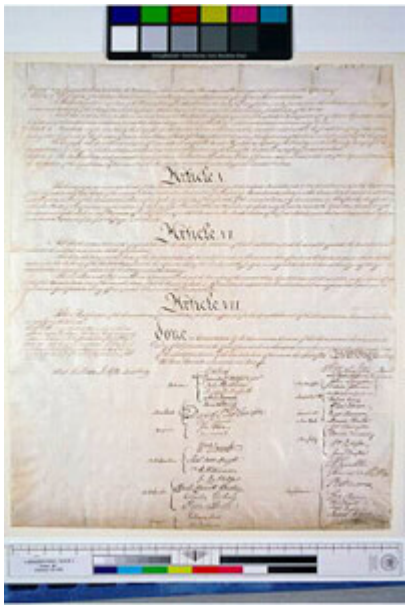

Fig. 4. Page 4 of the Constitution after removal from the 1950s-era NBS encasement. It was signed on Monday, September 17, 1787. Note the somewhat grimy bottom edge, a result of that section being exposed while the parchment was rolled at various times in the past. Photograph by Earl McDonald, courtesy of the National Archives and Records Administration.

The Constitution, Bill of Rights, and Declaration of Independence will be back on public view in the Rotunda of the National Archives Building in the fall of 2003. For further information on the Charters Re-encasement Project, click here.

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