ARCHIVES II

NATIONAL ARCHIVES AT COLLEGE PARK

USING TECHNOLOGY

TO SAFEGUARD

ARCHIVAL RECORDS

THE NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA) completed construction of a new facility, the National Archives at College Park, in 1993. Informally known as Archives II, it is the largest and most technically advanced archives building in the world. As it was built primarily to protect the Nation's records, extreme care was taken to design and construct a building that would offer the best possible conditions for the storage, preservation, and use of the archival materials.

The historic National Archives Building, located on Pennsylvania Avenue in Washington, DC, was completed in 1935 and reached its records storage capacity by 1970. To alleviate the space shortage, more than 500,000 cubic feet of records received since 1970 were diverted to the Washington National Records Center in Suitland, MD, and to a leased building in Alexandria, VA. However, these temporary facilities did not meet the criteria set by the National Institute of Standards and Technology for the storage of archival records. Repeated attempts to obtain official support for a new archives building were unsuccessful until after the National Archives regained its status as an independent Federal agency in 1985. In 1987, Congressman Steny H. Hoyer, with the aid of Maryland Senators Barbara Mikulski and Paul Sarbanes, persuaded the University of Maryland to donate 33 acres of land for a new archives building and initiated the legislative process to authorize and finance it. On September 22, 1988, President Ronald Reagan signed the public law authorizing NARA to construct and finance a new archives facility. The groundbreaking ceremony took place on October 17, 1989. The George Hyman Construction Company completed the construction of Archives II in July 1993, and the first NARA staff moved into the building that October.

Designed by Hellmuth, Obata and Kassabaum, architects, and Ellerbe Becket, engineers, the 1.8 million-square-foot building includes records processing and storage areas (stacks), a five-level research center, conservation and special media laboratories, offices, conference and training facilities, an auditorium, a cafeteria, a day care center, and an exercise facility. The central focus of the Archives II design was to create a building with state-of-the-art systems and environments that adhered to the strict conditions necessary for the long-term protection of records. In particular, special attention was given to the design and construction of the records storage environments, the mobile shelving system, fire protection, and security. In addition, the finishes and materials used in the construction of the stacks were carefully studied and selected to minimize the exposure of the records to harmful contaminants. This publication details these design efforts and the resulting systems in operation at Archives II.

CREDITS
Photography: Maxwell Mackenzie, Earl McDonald, Larry Glenn, Spacesaver Corporation
Design: Jennifer Stolk, MacVicar Design + Communications, Inc.

Why Controlled Environments?

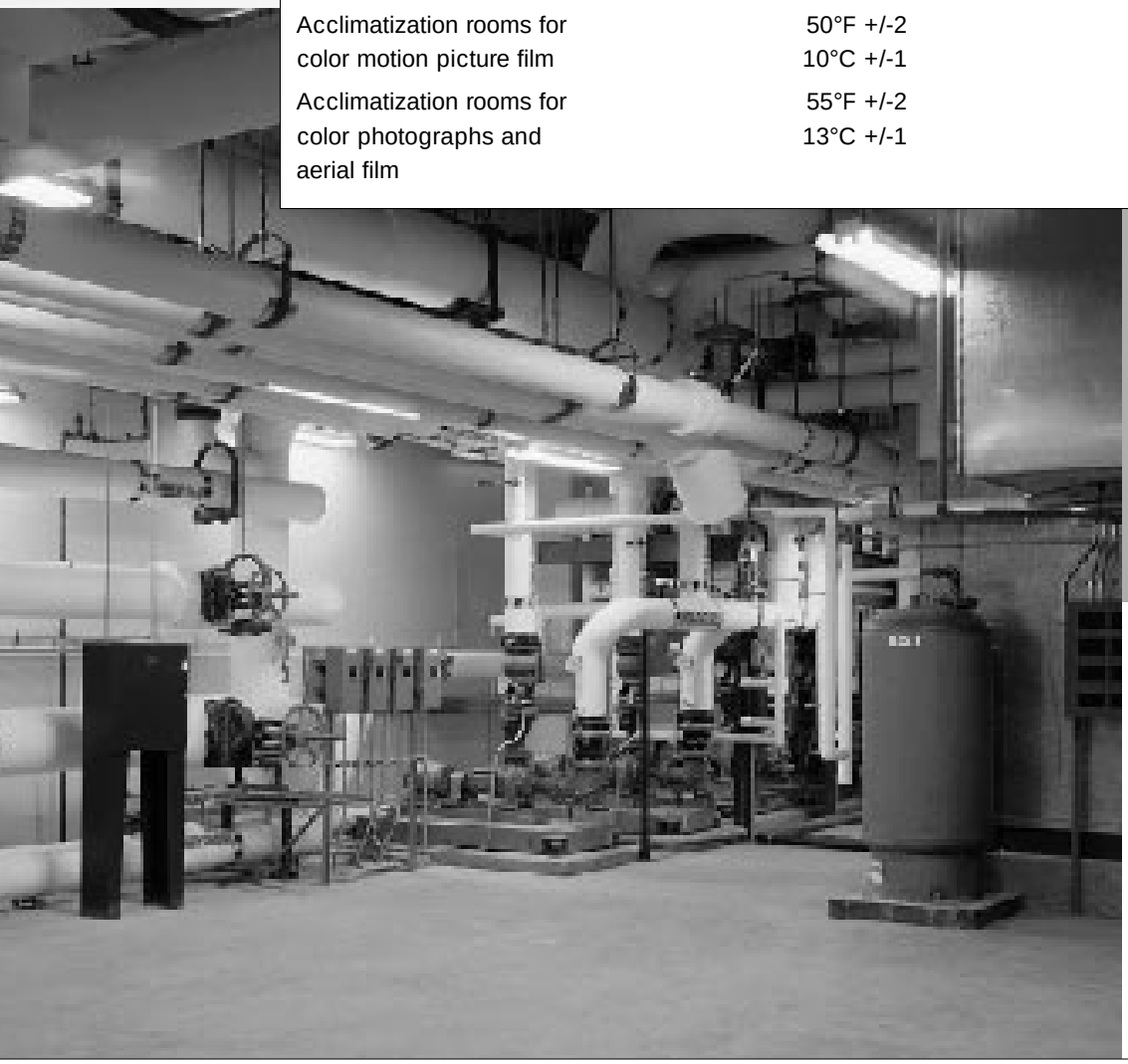
Pleated degas filters remove gaseous pollutants from the records storage areas.

Archives II can house nearly 2 million cubic feet of the permanently valuable records of the Federal Government. In order to achieve the best possible storage conditions, the design effort for the building had to consider the development of mechanical systems that provided strict environmental standards in the records storage areas (or stacks). In addition to maintaining stable and constant temperature and relative humidity levels, the removal of damaging particulate materials and gasses from the air is particularly important to the preservation of archival records. Conditions at Archives II follow guidelines established by the National Academy of Science, the NARA Document Conservation Branch, and other archivists and scientists. The conditions selected for the Archives II records storage environments represent what NARA believes to be a fair balance between providing the best protection for the records and allowing researchers to use and copy them.

Temperature and Relative Humidity

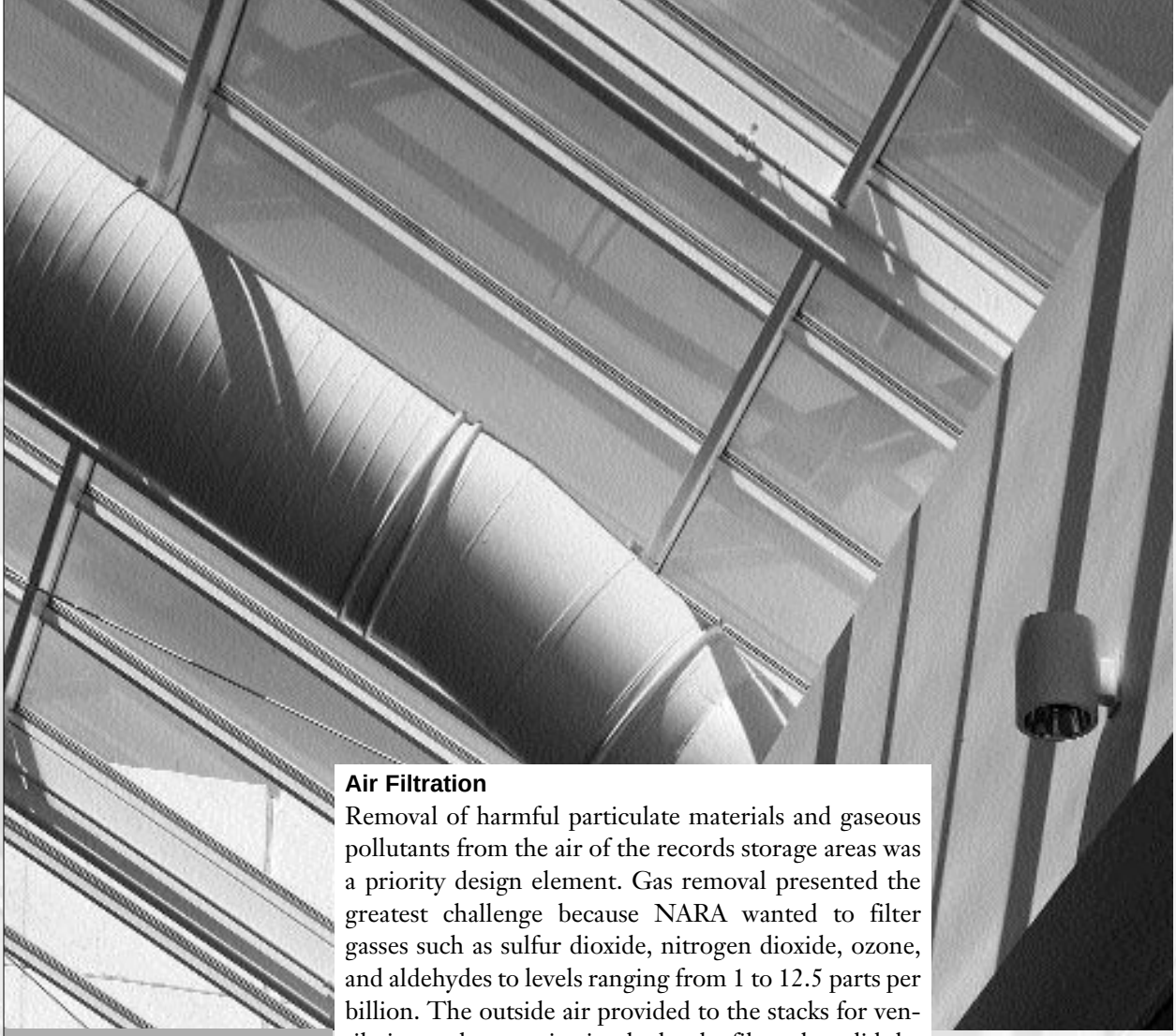
Temperature and humidity requirements for the stacks vary, depending on the type of materials being stored. The crucial design task was to ensure that these different conditions remain stable and constant.

Record Type	Temperature	Relative Humidity
Textual and cartographic records	70°F +/-2 21°C +/-1	45% +/-5 45% +/-5
Black-and-white motion picture film, audiotapes, and sound recordings	65°F +/-2 18°C +/-1	30% +/-3 30% +/-3
Color motion picture film	25°F +/-2 -4°C +/-1	30% +/-3 30% +/-3
Black-and-white photographs, glass plate negatives, negatives, slides, and posters	65°F +/-2 18°C +/-1	35% +/-3 35% +/-3
Aerial film	38°F +/-2 3°C +/-1	35% +/-3 35% +/-3
Magnetic media	65°F +/-2 18°C +/-1	35% +/-3 35% +/-3
Nixon Presidential textual records, gifts, and audiovisual records	65°F +/-2 18°C +/-1	35% +/-3 35% +/-3
Acclimatization rooms for color motion picture film	50°F +/-2 10°C +/-1	30% +/-3 30% +/-3
Acclimatization rooms for color photographs and aerial film	55°F +/-2 13°C +/-1	35% +/-3 35% +/-3



Pressure-reducing stations at various points in the building reduce the steam pressure from 110 pounds per square inch to 15 pounds per square inch for use in heat exchangers, heating coils, and some humidifiers.

Chilled water and glycol systems cool the air in both the outside air and stack air handling units.



The atrium spaces in Archives II are designed with their own air handling systems.

Air Filtration

Removal of harmful particulate materials and gaseous pollutants from the air of the records storage areas was a priority design element. Gas removal presented the greatest challenge because NARA wanted to filter gasses such as sulfur dioxide, nitrogen dioxide, ozone, and aldehydes to levels ranging from 1 to 12.5 parts per billion. The outside air provided to the stacks for ventilation and pressurization had to be filtered, as did the stack return air, which contained gasses originating from the stored archival materials.

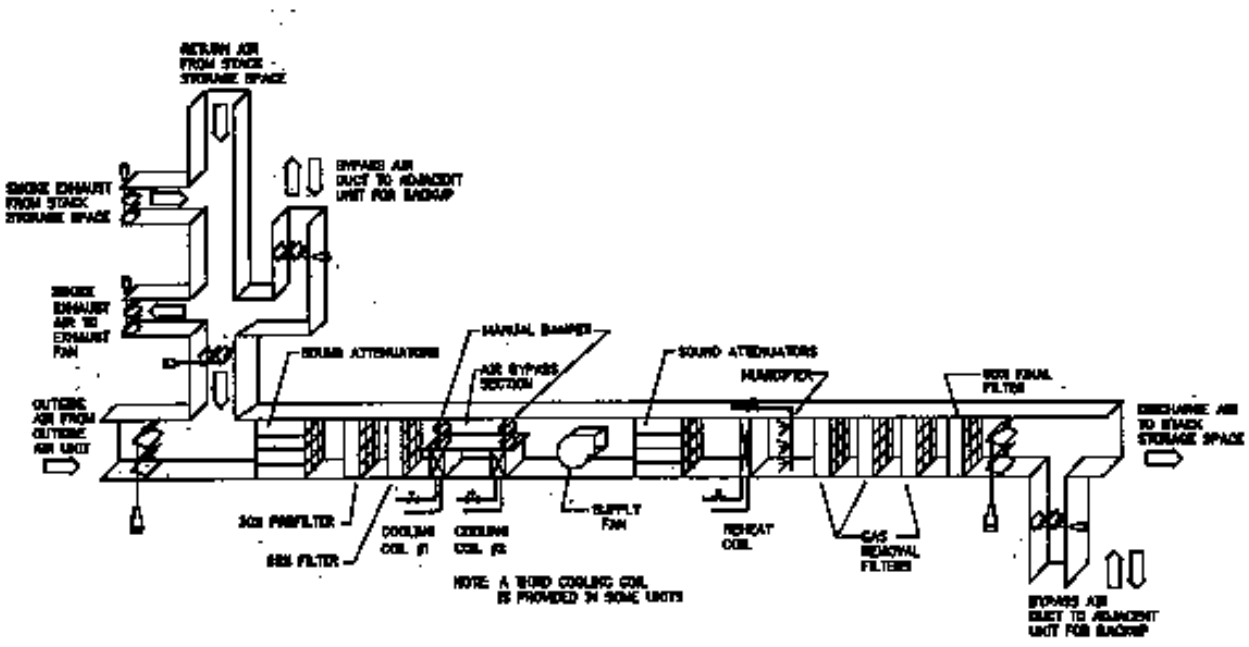
Air Handling System

The Archives II air distribution system consists of both an outside air handling system and a stack recirculating air handling system. Both deliver a consistent-volume air supply in order to maintain uniform temperatures and humidity levels in the stacks. The air in the stacks is primarily recirculated, but it does receive up to 10-percent fresh air from the outside units.

The archival storage areas, totaling 691,572 square feet, are arranged horizontally and vertically like shoe boxes. There are five storage spaces at the base, with as many as five storage spaces stacked above them. Mechanical rooms are found at three locations on each floor between the stacks. The mechanical rooms are similarly stacked above one another and contain air handling units that provide air to the adjacent stacks. The heating and cooling distribution piping that serves these units extends vertically from a tunnel area through these mechanical rooms to the mechanical penthouses (which contain 100-percent outside air handling units).

The stacked mechanical rooms between storage areas contain two air handling units, each serving the adjacent storage space. Each pair of air handling units has interconnecting bypass supply-and-return ductwork and dampers. Opening and closing the dampers allows limited back up supply-and-return air capability to a storage space during those times when the adjacent unit servicing that area is deactivated for maintenance or repairs.

To maintain these varied temperatures and relative humidities, the design had to incorporate means of preventing moisture migration through the structure, removing moisture from the outside air used for ventilation, and removing excess moisture in the stacks. Moisture migration from the exterior was addressed by using precast concrete panels backed by metal, double-walled insulated panels. Moisture migration into the stacks from interior spaces was alleviated through the use of glazed block. The removal of moisture was addressed by the air handling system.



TYPICAL STACK AIR HANDLING UNIT

Stack mechanical rooms are located between records storage areas and contain two air handling units, each serving the adjacent storage space.

Outside air entering at the roof passes through a 30-percent prefilter and then through a 65-percent filter to remove particulate matter. The air is then either heated by steam preheat coils or cooled by chilled water and glycol cooling coils to a final discharge temperature of 46 degrees Fahrenheit before further air treatment. The tempered air then passes through four banks of degas filters designed to remove sulfur dioxide, nitrogen oxide, and ozone and finally through a 95-percent particulate filter. At the stack air handling units, the treated air and the recirculated air pass through another set of 30-percent and 65-percent particulate filters. The air flow divides–some to the additional cooling coils and some around the coils via fixed dampers. The resulting air mixture then passes through a hot water heating coil and a clean steam humidifier that uses deionized water for final air tempering and moisture adjustment as required. The air passes once more through three banks of degas filters to remove formaldehyde and then through a final 95-percent particulate filter.

In order to keep the system uniform, the air is distributed into the stacks at ceiling level and returned to the stack air handling units via return ducts located approximately 24 inches above the stack floors. Temperature and humidity sensors are located within the stack ductwork to maintain the set points.

Air Filtration System

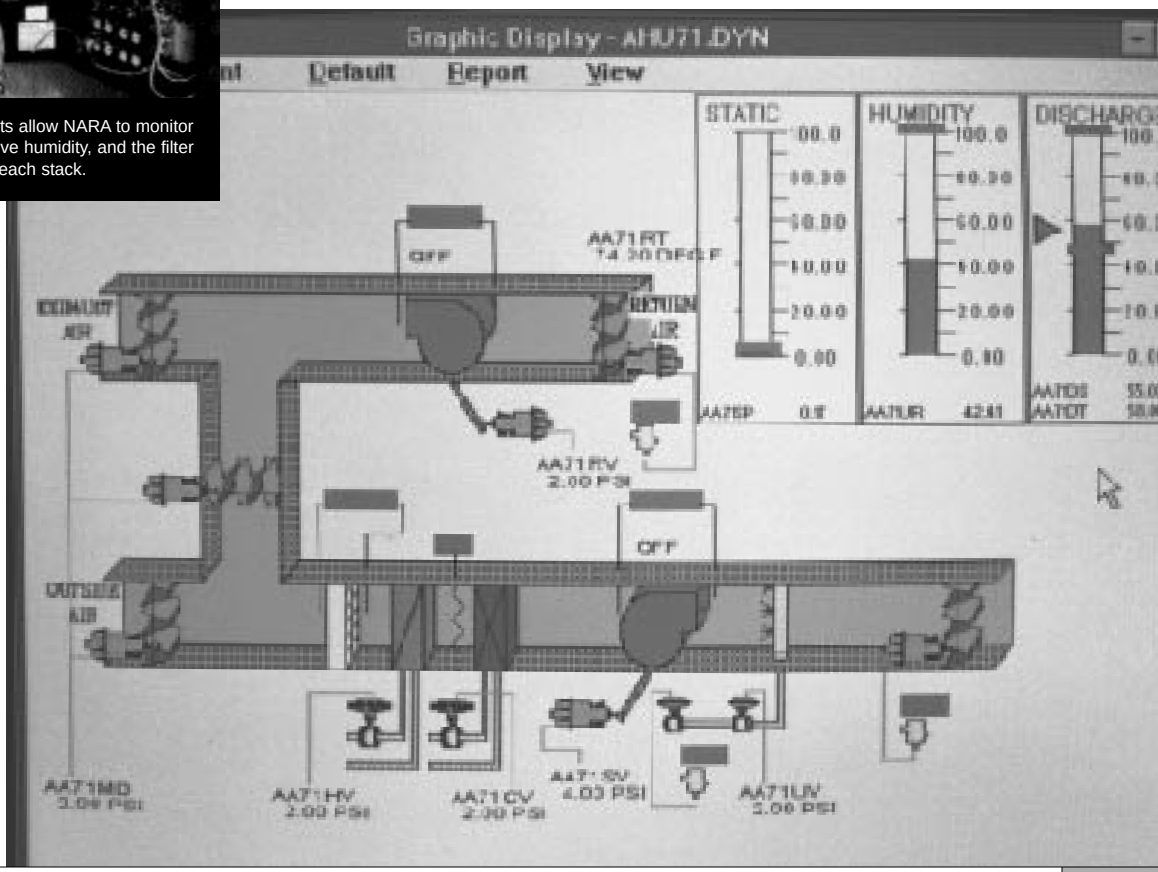
With a total outside air movement of 70,000 cubed feet per minute and a total recirculation of 678,000 cubed feet per minute, the air within the stacks is changed a minimum of six times per hour. To remove the low concentrations of gaseous contaminants in the stacks, two systems were evaluated and deemed acceptable: the conventional 2-inch-deep, impregnated carbon beds and the newer, carbon-impregnated pleated filters. While both systems rely on chemically impregnated carbon as the media, the selected pleated filter system offers the benefit of easier filter replacement. The Archives II stack air handling units, however, are designed to accommodate either system.

There are a total of seven degas filter banks in the outside and stack air handling units. The outside air units have pleated-cartridge degas filters consisting of carbon impregnated with potassium iodide and potassium hydroxide. Filters inside air handling units are impregnated with tromethamine. The degas filters are projected to need replacement every 2 to 3 years. The air handling units are equipped with pressure-sensing devices to detect pressure drops across the particulate filters (indicating saturation and need for replacement). In addition, all stacks are outfitted with a real-time monitoring system to detect low levels of gaseous contaminants and provide early warning of episodic events or filter replacement requirements.

Archival Processing Offices

In order to adhere to strict environmental standards, employee workstations are located outside the stacks. Archival processing offices serve as the work areas for records accessioning, appraisal, arrangement, description, and holdings maintenance activities. While not as complex a system as that found in the stacks, the processing offices are served with cooled and filtered air from the outside air handling units in a manner similar to that used in the stacks.

Air handler control units allow NARA to monitor the temperature, relative humidity, and the filter and damper status in each stack.



Why Special Materials and Finishes?

An electrostatically applied powder coating system was used at each of the plants producing shelving products for Archives II.

The design and construction of Archives II presented an opportunity to provide the best records storage environments permissible using recent technological advances. In addition to focusing on temperatures, relative humidities, and the air filtration system, NARA attempted to identify and eliminate materials that could give off substances that might damage archival records stored in the stacks.

Although many of the decisions as to which materials could or could not be used in the stacks were based on past performance, some choices entailed new materials with no track records. Final selections were guided by prior tests conducted by NARA and other institutions, new tests completed by NARA and the materials' manufacturers, written information supplied by the manufacturers, and, in some cases, NARA's educated guesses.

The guiding principle for approving materials was that they could not be unstable or slow curing. An initial list of prohibited materials was obtained from the Smithsonian Institution and adapted for Archives II. The prohibited materials were

- Asbestos
- Cellulose nitrate-bearing materials, such as cellulose nitrate lacquers and adhesives
- Cellulose acetate fabrics and films
- Polyurethane products including paints, varnishes, and foams
- Acid-curing silicone sealants and adhesives
- Materials containing sulfur in a form that could be released as hydrogen sulfide or mercaptans. These include (but are not limited to) vulcanized rubber and cadmium sulfide pigments. Neoprene is acceptable.
- Pressure-sensitive (tacky) adhesives
- Unstable chlorine-containing polymers, such as polyvinyl chloride and Saran
- Materials that emit formaldehydes (urea/phenol/resorcinol/formaldehyde), including plywood, particle board, and plastic laminates
- Vinyls
- Oil-based paints or varnishes and modified alkyd paints

Although these materials were eliminated from consideration before construction began, other materials that might be used in the stacks had to be tested because their properties were unknown. Commercially available building materials, while stable from the viewpoint of an architect or builder, are not necessarily acceptable to archivists, conservators, or materials scientists. The fact is, most things used to adhere materials to one another or to coat those materials do not dry, or cure, instantaneously; moreover, nearly all give off some gas or vapor while curing. In consultation with design engineers, builders, archivists, chemists, and conservators, the NARA Research and Testing Laboratory considered, tested, and approved on a case-by-case basis a variety of products proposed for use in the construction of the stacks.

Paint

The prohibition on oil-based or alkyd paints stems in part from research done by Eastman Kodak. According to its studies, oil-based paints discolored black-and-white photographic test prints while latex paints did not. Since equivalent water-based latex paints could be used for every application that would have previously employed oil-based paints, NARA had little difficulty specifying latex paints for the walls and ceilings in the stacks. The original building specification for the ceiling pipes and the exterior stack wall metal panels called for an oil-based primer and alkyd second and third coats. An acrylic primer (water reducible) covered by two coats of latex paint was substituted for these areas.

Caulk

The question of which caulk(s) to use in the Archives II stacks was not easily answered. Caulks are used throughout buildings to seal unlike surfaces to one another. In this case, one caulk was used in the assembly of the air handlers; another was applied off-site between the metal panels installed on the exterior stack walls which were caulked in place by a third substance; and a fourth caulk with flame-retardant capabilities was used where essential building services penetrated the walls or ceilings.

NARA's experience in testing gasketing materials for film cabinets resulted in a preference for silicone caulking. However, the staff was not prepared for the large diversity of cure products associated with these caulks. While the best choice was thought to be a caulk with no curing byproducts, none was available for the intended applications. After extensive examination and consultation, NARA decided to use a caulk that cured with the release of alcohol and avoid those that released acetic acid. A caulk that emitted methanol upon curing was used for the metal parts. The caulk selected to adhere the panels to one another was a nonskinning butyl rubber, which was applied prior to shipment and thus evolved solvent off-site. Caulk that evolved acid upon curing was used, however, in the air handling equipment; in this instance, no other alternative presented itself, and the units have filtration systems designed to remove acid gasses.

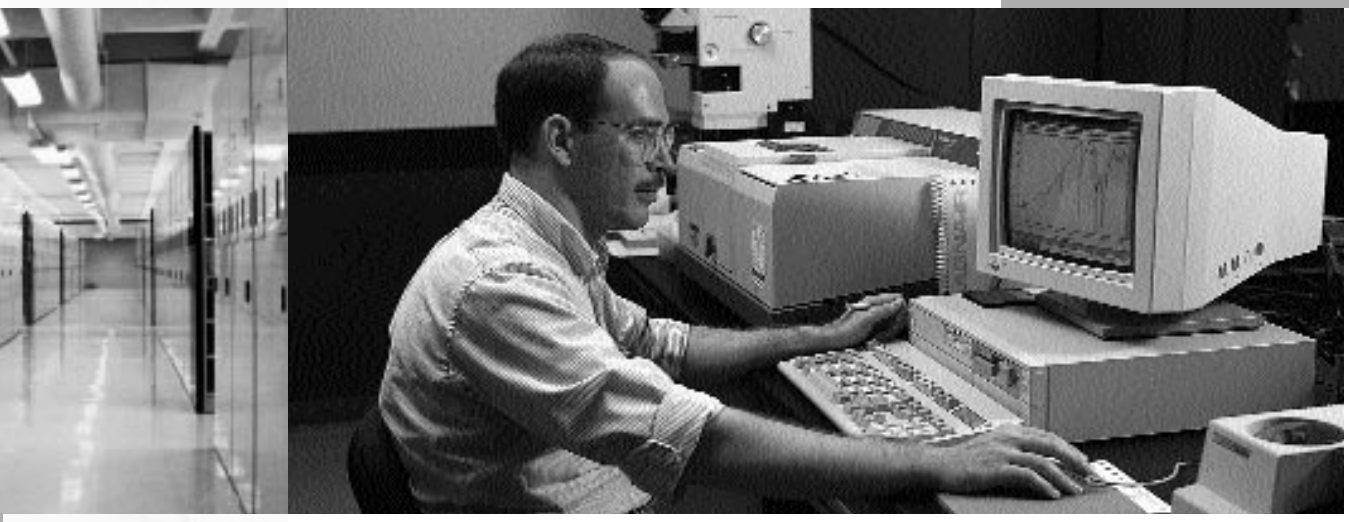
The caulking used for general sealing is a latex caulk containing a flame retardant that would pose a hazard to records in the event of a fire. However, earlier tests showed that this flame retardant remained stable at a high enough temperature that destruction of the records would already be under way by the time the free radicals were released.

Floor Coating

NARA had previously tested floor coatings for the historic National Archives Building and concluded that the less done to a concrete floor the better it was for archival records. Unfortunately, experience also taught the staff that bare concrete floors tended to introduce a good deal of fine dust into the stack environment. Therefore, a search began for an acceptable concrete stack floor coating. After eliminating the originally specified, dry-shake hardener finish due to concerns about the plasticizer and application process, NARA looked at various epoxy floor coatings. After eliminating those containing biocides, solvents, or other objectionable components (such as formaldehyde, acetic acids, and amines), NARA began testing two formulations produced by General Polymers Corporation. As a result of these tests, the agency asked General Polymers to reformulate these two products to eliminate toluene and xylene, which were both potentially damaging to the records. A second reformulation reduced the levels of xylenes and ethylbenzene. The final product, 3505S Special Epoxy Floor Coating, was applied in all stacks and laboratory wet areas after the concrete was shot blasted with an abrasive material so the epoxy would form a strong bond with the concrete.

After much research and testing, NARA chose to cover the concrete floors in all stack areas with a special-formulated epoxy floor coating.

NARA continues to monitor the stacks and track ongoing research on the materials and finishes used in the records storage environment.



Shelving, Cabinet, and Cart Paint

Experience with typical paints used on metal products showed that most cured slowly, remained sticky, or emitted harmful gasses as they dried. Investigations into applications of paint on metal revealed that the electrostatically applied powder coating system (a dry system requiring no organic solvents or drying oils) eliminates the greatest potential hazards to archival materials.

Powder coatings come in a number of finely divided polymer materials such as epoxy powder, polyester triglycidyl isocyanurate (TGIC), polyurethane, and a polyester-epoxy hybrid. NARA used the report by the Canadian Conservation Institute (CCI) on "The Suitability of Powder Coatings for Use in the Museum Environment" as a starting point for specifying paint for the archival storage systems. Experimental findings from the CCI document indicated that powder coatings would be appropriate for use in storage areas for sensitive artifacts. Although all the tested coatings showed no sign of reactivity or degradation, the TGIC best withstood the methyl ethyl ketone (MEK) rub test. NARA expanded CCI's initial test list to reflect the type of archival materials being stored and to encompass a wide range of solvents and insecticides that might be used in the archival storage environment. Using the American Society for Testing of Materials (ASTM) tests, both an independent laboratory and the NARA Research and Testing Laboratory studied shelving coatings.

A summary of the specifications for testing painted metal surfaces follows:

1. Chemical resistance of coating and finishes, which included hardness test (ASTM Method 3363) and the effect of 24-hour contact with the following reagents: cold water, 5% sodium carbonate solution (2 hours with powder-coated finish only), 5% sodium hydroxide in water, 5% thymol in ethyl alcohol, 5% ethyl alcohol in water, chlorinated cleaning solution (e.g., Lysol disinfectant), 3.5% ammonia, and insecticides including pyrethrins, Diazinon, beniocab, propoxur, and resmethrin.
2. Coating softening on exposure to chemical vapors (ASTM Method 3363).
3. Coating stability (ASTM D-4526). Vapors from the sample could not contain aldehydes or low molecular weight organic acids or solvents.
4. Thermogravimetric analysis (TGA). A 100 mg metal sheet containing the cured powder coating sample was placed in a thermogravimetric analyzer and heated from 30 to 700 degrees Celsius at the rate of 10 degrees per minute in a flow of dry air. ~~To be acceptable, the sample had to show a weight loss no greater than 2 percent of the original weight of the coating.~~
5. Coating adhesion (ASTM D-3359). The coating had to meet classification 5B (no flaking).
6. Coating durability (ASTM D-4060). No more than 65 mg of the sample shall be lost after 1,000 cycles of the Tabor Abrasor equipped with CS-10 wheels under a 1 kg load per wheel.

The NARA Research and Testing Laboratory considered, tested, and approved on a case-by-case basis a variety of products proposed for use in the records storage areas.

Test results showed that the epoxy-polyester hybrid outperformed the polyester TGIC coating. The shelving manufacturers only bid powder coatings, so the two tests of most importance in making comparisons were the coating adhesion and coating durability tests. The epoxy-polyester hybrid fared better in the latter test and slightly better in the former. Information from the coating manufacturer, Morton International, showed that compared to TGIC coatings, epoxy hybrids have a smoother finish and more abrasion resistance (due to the epoxy component). Both coatings were softened by a couple of insecticides in the tests. The TGA and Gas Chromatograph with Mass Spectrometric Detector (GC/MS) results were similar for both, except for the

fact that the TGA decomposition peak for the epoxy hybrid showed evidence of the multicomponent nature of that system, while the peak for the polyester TGIC coating was singular and sharp. The basic information obtained from the TGA for both coatings was the same–they both began to lose weight at about 300 degrees Celsius, which indicates that both are quite stable. In comparison, the baked enamel coatings that NARA had previously examined began to lose weight at as low as 200 degrees Celsius.

All shelving products used in the Archives II records storage areas–including the mobile storage system, shelves, map cases, microfilm cabinets, and roller drawers–are covered with the epoxy-polyester hybrid powder coat paint. In addition, the paint is used on all carts, laboratory casework, shelving in laboratories and records processing offices, and file cabinets.

The guiding principal for approving materials was that they could not be unstable or slow curing.

Shelving and Cabinet Materials

NARA required shelving and cabinet manufacturers to have an independent laboratory test their plastics, rubbers, lubricants, adhesives, and any other component of their shelving systems. Rubber bumpers had to be of an acceptable neoprene material. The high-density mobile storage system used shielded bearings containing no lubricants, and silicones and petroleum were prohibited. The aluminum carriages were left uncoated, and the shelving sign holders were either uncoated aluminum or painted with the epoxy hybrid paint.

Other Stack Finishes

The stack light fixtures were left bare aluminum because an acceptable paint could not be found. Stack fire extinguishers are stainless steel and devoid of the familiar red enamel paint.

As a final step in the construction of Archives II, the finished building was allowed to sit empty for several months to allow for the venting of gasses. Once the air filtration system was operational, it removed any gasses left in the stack environment.

With Archives II, NARA has provided the best archival storage environment that current science and technology can provide. The archivists, conservators, and chemists continue to monitor the stacks and track ongoing research on the materials and finishes used in the records storage environment.

Why Mobile Storage?

Archives II holds over 2 million cubic feet of archival materials, including paper records, photographs, maps, drawings, motion picture film, and electronic records. To store and protect these documents while still making them easily accessible to researchers, NARA installed the world's largest high-density mobile storage system. A number of factors led to this decision–the primary reason being the need for maximum storage density to address current and future storage requirements. The selection was also influenced by site restrictions, financial considerations, and aesthetic concerns which also limited the overall size of the new facility. NARA wanted the new building to be as cost-efficient as possible while still fulfilling stringent quality requirements and providing environmentally sound records storage.

Given these restrictions, high-density mobile shelving, or compact shelving, offered the best solution. Traditional stationary shelving would have required a building of nearly 2.7 million square feet–in other words, one too large and too expensive.

Capacity and Storage Efficiency

The mobile storage system, developed and installed by H&S Constructors, a joint venture of Spacesaver Corporation and Harnischfeger Engineers, Inc., provides maximum space efficiency and storage capacity. The system consists of wheeled carriages that can accommodate a variety of storage housings. The carriages run on tracks and compact together to eliminate unnecessary aisles. Only one "movable" aisle is needed for each module of mobile carriages, so at least twice as much material can be stored in the same space as with fixed shelving. In addition to conventional storage containers, the mobile system houses map cases for storing oversized records; microform cabinets for storing microfilm, microfiche, and aperture cards; and roller drawers for storing photographic negatives.

Electric operation was chosen for the mobile shelving system because of its ability to power heavily loaded or extra-long carriages.

All stacks are equipped with an electric, high-density mobile storage system provided by H&S Constructors, a joint venture of the Spacesaver Corporation and Harnischfeger Engineers, Inc.

The system compacts almost 2 million cubic feet of storage capacity into an area of 691,572 square feet. The 2,000 carriages roll on more than 80,000 feet (over 15 miles) of rail recessed in the concrete floor.

Protection of Collections and Users

To protect against long-term damage, all mobile system components and finishes were tested to ensure that they were stable, inert, chemically resistant, and unable to off-gas harmful chemicals. As part of a state-of-the-art fire protection system, the mobile units feature a special "fire park" mode controlled by the building's fire management system. Should a fire break out, 4- to 6-inch flue spaces are automatically created between the carriages (or ranges) so sprinkler water flows more efficiently, and the flames have far less chance of "jumping" across aisles. (This same mode is used in the evenings to provide fire protection and allow air circulation through the collections.) The building also has quick-response sprinklers and smoke detectors to set off the alarms and sprinklers at the first threat of smoke or fire.

Adequate load-bearing capacity was provided for the floors in each records storage area. To obtain this strength, the architects specified two-pour, steel-reinforced floors. The slab features a special two-way concrete joist design similar in appearance to a waffle.

To ensure durability, all components of the mobile system—including the floors, rails, mobile carriages, stationary platforms, wheels, drive shafts, and motors—had to satisfy strict criteria for strength, rigidity, resistance to seismic forces, and conformance to deflection requirements. Similar standards also apply to the shelving, map cases, microfilm cabinets, roller drawers, and art racks. In some cases, these criteria exceeded the current industry and institutional standards.

The building design took into account the safety of the users as well as stored materials. Aisle entry sensors detect a user entering an aisle and lock the system. An infrared optical safety sweep system detects objects or people in its path and upon detection will automatically shut down the system. For added security, the mobile system's electric controls are tied into the building management control system, and storage modules in restricted areas require security cards and access codes to prevent unauthorized use.

Structural requirements for the shelving in Archives II exceed industry standards. The shelving system features 18-gauge, four-post steel shelving and 11-gauge steel shelf supports for maximum stability.

Electric Operation

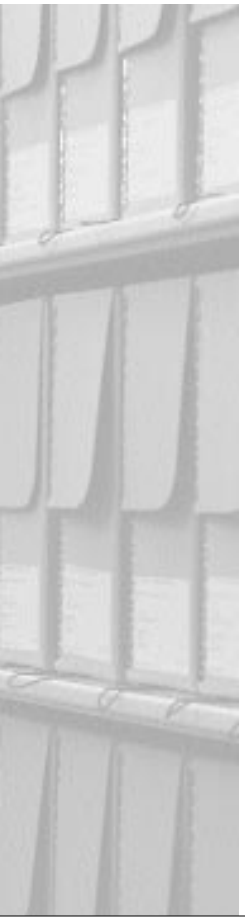
Electric operation was chosen for the mobile shelving system because of its efficiency in powering heavily loaded or extra-long carriages. Carriages range in length from 13 to 70 feet. NARA specified DC electric motor drives and controls for their smooth and controlled acceleration and deceleration; this is especially important for moving collections that are delicate, fragile, or sensitive to vibration.

System Design Considerations

- *Floors.* Adequate load-bearing capacity was provided for the floors in each records storage area. The floors are designed to support 350 pounds per square foot with a maximum deflection rate of L/750, where L is the dimension from center line to center line of the columns. To obtain this strength, the architects specified two-pour, steel-reinforced floors. The slab features a special two-way concrete joist design similar in appearance to a waffle. Metal reinforcing mesh was placed over the slab before the second pour for additional strength, and upon the completion of each floor, the concrete was sealed with an approved epoxy-type sealer.
- *Rails.* For the system to operate properly, it is critical for the rails to be precisely level and exactly parallel to each other. Problems were avoided in Archives II by a number of measures. Fully adjustable leveling screws were used to ensure accurate installation and long-term reliability. The rails were anchored to the floor with standard, screw-type concrete fasteners. The rails feature interlocking tongue-and-groove joints to assure proper alignment and load transfer as well as smooth and easy carriage movement. Once leveled and anchored, the rails were set in a thicker than normal, full-length bed of high-strength, hydraulic, non-shrinking grout. For added protection during construction, the rails were covered with inverted 22-gauge steel channels after the second pour of the floor.

- *Mobile Carriages.* The carriages feature a welded aluminum uniframe construction that provides a high strength-to-weight ratio; prevents binding, racking, and misalignment; and eliminates the need for fasteners that can loosen or break. The design carries the specified weight of records or other materials stored on it without distortion and evenly transfers weight onto the wheels. The standard carriages have a load-bearing capacity of 1,000 pounds per linear foot of carriage length, while the largest carriages (for map cases) can bear 2,000 pounds per linear foot. The system features 5-inch case-hardened steel wheels that have been ground and balanced for smooth operation; permanently lubricated and shielded ball bearing for long, maintenance-free life; and a steel drive shaft with keyway couplings to eliminate wear and ensure long-term system reliability.
- *Shelving.* Structural requirements for the shelving in Archives II exceed current industry standards. To attain the deflection requirement of L/320, the system features heavy-duty, 18-gauge, four-post steel shelving and 11-gauge steel shelf supports for maximum stability. The system contains more than 80,000 single-faced sections of four-post shelving for textual records storage, more than 1,600 sections for cold storage, and more than 500 sections for light storage for a total of 520 miles of shelving. Mobile systems in cold storage feature special open, through-style shelving and stainless-steel wire racks that have been designed without any sharp, exposed metal edges. Also provided are sliding reference shelves to provide the users with a surface to place and review materials.

The carriages feature a welded aluminum uniframe construction, which provides a high strength-to-weight ratio; prevents binding, racking, and misalignment; and eliminates the need for fasteners that can loosen or break.



- *Map Cases.* Archives II contains the world's largest installation of map cases (in excess of 10,000) on mobile storage units. The double-wide carriages used to store the map cases range from 16 feet long (holding up to 30 cases back to back) to 64 feet long (140 cases). Each map case stored on the mobile system is 15⅜ inches high, 44½ inches deep, and from 55 to 64 inches wide. The map cases were stacked three high upon installation, but the system's modular design enables cases to be added up to five high, as needed. All carriages, including those containing map cases, have identical, full-length face panels for a uniform appearance.
- *Art Racks.* Archives II has two mobile art rack systems, one with 24 screens and the other with 15 screens, to store framed maps and other records that are best stored by hanging from a rack. The systems are moved manually and "nest" to store twice as much in the same space as fixed racks.
- *Electrical Systems.* The new-generation controls used in the system at Archives II allow every function to be programmed onsite; they are also interfaced into the building management system for added flexibility. Electronic controls for the DC motors provide smoother starting, operation, and stopping. A sequential movement system protects stored materials by preventing the carriages from touching one another and minimizing vibration. Power for the systems is delivered by an overhead pantograph. A portable, battery-operated power pack provides a temporary means of operating the system during a power outage.
- *Lighting.* Building lights were installed perpendicular to the carriages, and the system is tied into lighting interface boxes within the mobile storage system. When a shelving module is accessed, only the lights above that module are turned on, thus helping conserve electricity. Additional lighting, not tied into the mobile system, is located in the main aisles of each stack area.

Why Fire Protection?

To achieve fire protection for the archival records stored at Archives II, a unique systems interface was developed between the fire sprinkler system, fire detection and alarm system, and mobile compact shelving control system.

Flue spaces between the carriages reduce the time it takes to put out a fire and the amount of fire damage in a mobile shelving system.

Protecting the Stacks

The decision to use high-density mobile shelving in the stacks of Archives II necessitated new design concepts for fire protection. Previous fire tests had shown that automatic sprinkling systems (the most reliable fire protection tool) were inadequate for safeguarding documents in this type of shelving system.

The following objectives were chosen to achieve improved fire protection for archival stack storage:

1. Limit sources of ignition.
2. Provide early warning of incipient fires.
3. Minimize the exposure any archival record storage area has to fire in another part of the building.
4. Improve the ability of the sprinkler systems to control and extinguish fires in compact shelving.

The first three objectives were readily incorporated into the overall design of the building using smoke detection systems and fire-rated enclosures.

To improve the ability of the sprinklers to cover the records stored in mobile shelving, NARA adapted a number of approaches. Before authorizing a final approval of the mobile shelving system, NARA had Underwriters Laboratories (UL) of Northbrook, IL conduct a series of fire tests on the mobile units. Four findings emerged from the tests:

1. During a fire alarm and at night, the mobile system should leave 4- to 6-inch spaces between the carriages to serve as flues, which reduce the time it takes to put out a fire and the amount of fire damage. The greater the flue space, the sooner a fire is detected and the sprinklers activated. Once the sprinklers are activated, the spaces allow the water to cascade down the front of the shelves and prevent flames from "jumping" across the aisles to adjacent carriages.
2. Early suppression fast response sprinklers with "quick-response," heat-activated sensors on the ceiling above the mobile system modules provide greater protection. In the UL tests, sprinkler heads rated at 165 degrees Fahrenheit responded soon enough to put out the fire and permit salvage of a sizable portion of the burning records.
3. Smoke detectors provide valuable early warning, especially when carriages are compacted.
4. Fires in mobile shelving systems can be contained within a single module if the sprinkler system is activated. This is an essential requirement for the overall fire safety of this facility.

Accordingly, the mobile shelving system at Archives II is configured so that when a fire alarm goes off during operating hours, the building control system signals the mobile carriages to go into the "fire park" mode. A red light blinks on each carriage, and the carriages automatically move to create uniform flue spaces of approximately 5 inches and then lock in place. For added safety, the "fire park" mode does not override safety sensors–the carriages will not move if there is a person or object in their path. When the fire signal ends, the carriages return to their ready state but stay in the "fire park" mode. As an additional protection measure, the units are programmed to assume this same configuration after hours. Carriages in the "fire park" or "night park" mode remain so until reactivated by the building management system.

Other fire protection features include

- Wet pipe automatic sprinkler system with 0.30 gallons per minute square foot density over 1,500 square feet; quick response sprinklers with nominal 160 degrees Fahrenheit temperature
- Complete area smoke detection with addressable smoke detectors and remote graphic annunciators outside each stack area
- Two-hour fire-rated separation between each stack area and adjacent spaces
- Interface with heating, ventilating, and air-conditioning system to permit smoke removal
- Manual hose outlets at the entrance to each stack area

Sprinkler Protection in Non-Stack Areas

While the stack areas are protected by a "specialized" sprinkler system, the remainder of the building is protected with a combined sprinkler/standpipe system of various design densities as required by the Standard for the Installation of Sprinkler Systems, NFPA 13. Occupancy classifications in the non-stack areas of the building include

Light Hazard

- Offices
- Archival processing offices
- Day care facility
- Atrium spaces
- Lobbies and circulation spaces
- Computer rooms
- Cafeteria seating area
- Auditorium seating area

Ordinary Hazard

- Mechanical equipment areas
- Loading dock
- Storage rooms
- Cafeteria service areas
- Auditorium stage and proscenium

The sprinkler system is zoned to match the fire alarm system zones by floor and area of the building. NARA decided that where possible, the sprinkler zones would be supplied with water from a single riser; this minimizes the amount of time required to shut off a zone after a sprinkler activation (from a fire or from sprinkler damage) and limits the amount of residual water damage.

Because the items stored at Archives II are "one-of-a-kind" and cannot be replaced, a backup fire pump system was provided in case the first pump failed or was out of service for maintenance.

Fire Pumps

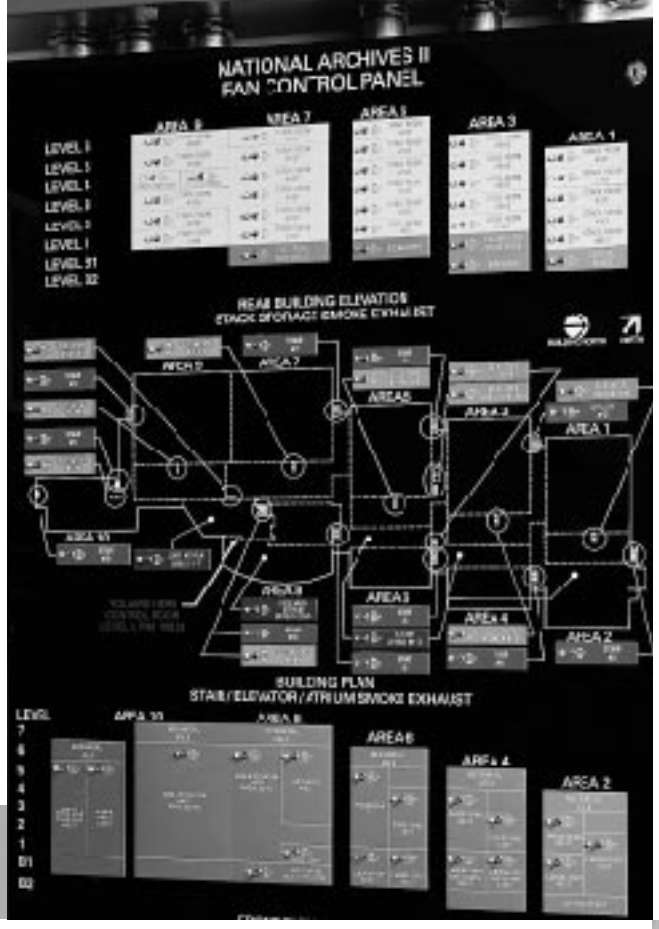
Due to the height of the building and the hydraulic demand of the various sprinkler/standpipe systems, the municipal water supply required supplemental pressure to meet the design densities. Because the items stored at Archives II are "one-of-a-kind" and cannot be replaced, a backup pump was provided in case the first pump failed or was out of service for maintenance.

Fire Alarm System

With almost 2,000 smoke detectors and 500 other initiating points, the fire alarm system design had to be capable of processing vast amounts of information in order to monitor the fire detection devices and interface with the building automation, security, and elevator recall systems.

Several factors demanded that a building this size have an intelligent, addressable fire alarm system. The first important factor was the smoke detector maintenance and testing requirements required by the building codes. It was important to choose a system that featured a simplified and more cost-effective procedure for conducting mandatory testing and sensitivity checks. With the intelligent, addressable system, each device on the system reports individually with a unique address, and the fire detection sensors–heat and smoke–have no hard self-contained alarm set point. The system also checks each sensor's sensitivity from the control panel or central control unit. These capabilities dramatically reduce labor and associated costs.

The second factor was the multiple interface requirements needed between the fire alarm system and the building automation system for smoke removal, a special elevator recall system, and the extensive building security systems. In addition, original building program requirements included a future 25-percent build-



The fan control panel allows the fire department to manually control the smoke removal system.

ing expansion capability. A software-driven, intelligent, addressable fire alarm system is easier to expand and integrate with the existing system.

Detection

Although Archives II is fully outfitted with sprinklers, the extensive archival collections and atrium design demanded the addition of almost 2,000 smoke detectors. Complete automatic smoke detection is provided in each of the atria, which include the entrance atrium, three stack area atria, and the research atrium; each of the stacks; and throughout the day care center.

In accordance with building codes, ionization smoke detector sensors are provided at the top of each atrium. These atria are separated from the rest of the building with 1-hour fire-resistant construction. Adjacent corridors, open to the atrium, are also provided with smoke detection. Within the stack areas, ionization-type and photoelectric-type detectors are alternated on 25-foot spacings. Stack areas containing magnetic tape, film media, or a great deal of plastics are designed with ionization-type detectors only and also are spaced on 25-foot centers. Smart graphic annunciators are located at each stack entrance, with signals multiplexed from the fire data-gathering panel. Annunciator lights are provided for each device, including water flow. Information regarding the actual devices in alarm is available in the fire control room near the entrance lobby, the security office, and the fire data-gathering panels.

Data-processing computer rooms are provided with ionization-type smoke detectors located at the ceiling. Photoelectric-type detectors are provided under the raised floor. Those at the ceiling have conventional spacing of 900 square feet. Detectors beneath the floor are reduced to 12-foot centers (150 square feet) due to air velocity factors.

The fire alarm evacuation system is used for general evacuation and uses bell/strobe appliances. In addition to conventional strobe visual warning signals, supplementary visual alarm signal rotating beacons are located within the stack areas to help alert the hearing impaired.

A fire control room is provided in close proximity to the first-floor lobby entrance. This serves as the main center for coordinating a fire emergency response.

Smoke Removal

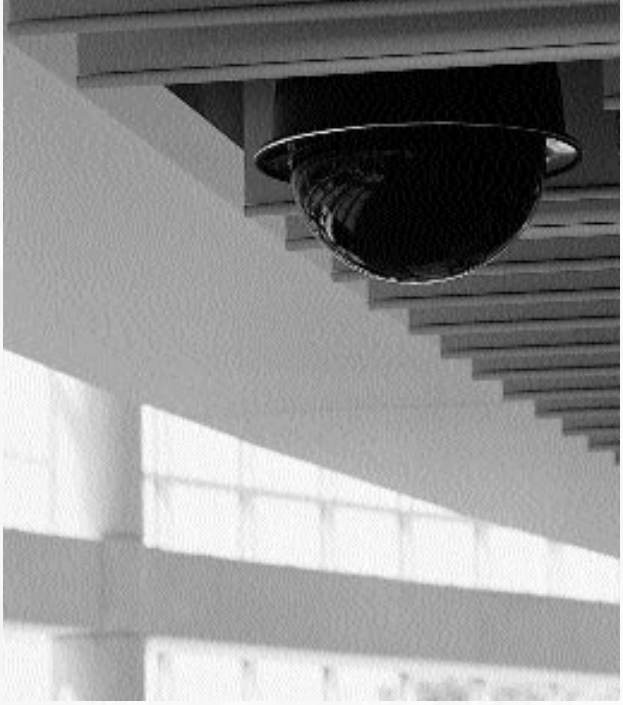
The Archives II building has its own central heating and cooling plant. A smoke removal sequence was included in the control portion of the air handling system design, with the building automation system controlling fans and dampers. In addition to the automatic controls, full manual control of the smoke purge system is provided in the fire control room. This is accomplished by a dedicated "manual fan control panel" with control switches. The color-coded panel shows the building in plan and elevation view with the switches located in the areas or close by to help select the proper activation.

In the stacks, the dedicated heating, ventilating, and air-conditioning (HVAC) system supply air at the ceiling and exhaust it low near the floor. Using the HVAC system for smoke removal without compromising emergency egress required additional dampering and relays. Dedicated smoke-removal fans are used in the stacks and provide approximately eight air exchanges per hour. While one stack is in smoke removal, the others go into a recirculation mode that puts them at slightly higher pressure to prevent smoke migration.

During a fire alarm and at night, the mobile system will leave 4- to 6-inch spaces between the carriages to serve as flues, which reduce the time it takes to put out a fire and the amount of fire damage.

Why the Need for Security?

NARA is entrusted with safeguarding the permanently valuable records of the Federal Government. Archives II holds a wide variety of archival materials, including paper records, maps and drawings, photographs, films, and electronic records. Some of these contain sensitive/classified information; all are irreplaceable. Hence the need for security–in this instance a state-of-the-art, flexible, and cost-effective security system designed to protect NARA staff and archival records alike from such threats as theft, unauthorized disclosure of classified information, sabotage, and espionage.



Cameras are one of the security devices used by NARA staff in the research rooms to monitor researchers.

Security Design

The design of Archives II attempts to strike a balance between the public's right to access historical records and the need to protect these documents. The security controls were carefully designed so they would not unduly restrict the archival and research processes. The basic overall approach is to establish secure zones within the facility that limit access to authorized personnel only. Researchers and the general public are separated from archives storage and operations via an architecturally isolated "security envelope." This lets them freely visit areas such as the cafeteria and the auditorium and conduct research without being burdened by extra security procedures.

- *Public Areas*. The cafeteria, convenience shop, and researcher registration office are located off the lobby and are easily reached by all visitors without a security check. The auditorium, meeting rooms, and researcher locker room are located one floor below the lobby and are accessed by an elevator and staircase located in the lobby. Other areas of the building cannot be accessed without going through a security checkpoint.
- *Offices*. Visitors must pass through a security checkpoint before entering the administrative areas of Archives II.
- *Non-public Areas*. Entrance to the records storage areas (stacks), archival processing offices, and laboratories is controlled by electronically activated security doors, which use card reader sensors for access.
- *Steny H. Hoyer Research Center*. All research of archival records takes place in the research center. Protection of these valuable records is largely achieved through continual monitoring by the Archives II staff during the research process. The only public entrance/exit is a security gate manned by one or more security guards. After entering the center from the lobby, researchers are free to visit any research room on floors two through six. Visitors must have their researcher cards scanned by an automatic reader to log in and out of the center or individual research room.

All researchers are required to have a researcher card and must have checked all belongings in the locker room before entering the research center. Loose notes brought into the center are stamped and approved by the staff, and computers and film equipment are examined by the security guards. NARA provides researchers with marked paper, cards, pencils, and gloves; these can be found at an information center located in each research room.

To enhance monitoring of research activities, visual obstructions in the research rooms have been kept to a minimum. Security in the rooms is maintained by specially trained NARA staff. Each room contains surveillance cameras, a central reference desk and monitor desks situated so that all researchers can be observed by the staff. Copy machines are located next to the monitor desks so the staff can watch researchers making copies of original records. Team research rooms in the textual research room are equipped with glass walls for easy observation. Reference copies of videotapes are encoded for easy detection by antitheft devices located at the exit.

Security Systems

Security at Archives II is achieved by physical security construction, electronic security systems, continuous personnel access control, 24-hour guard service, and a reserve guard force. The security operation is monitored by NARA security staff.

Physical construction of records storage areas includes heavy-duty hardware, metal doors, masonry fire walls, concrete floors and ceilings, and door-locking devices. There are no windows in the stack areas.

Electronic security systems include a security management system, which monitors intrusion detection and access control; the system is located in a central security console in the security control room. This console includes a computerized security control unit to monitor intrusion alarms and access, closed-circuit television (CCTV) monitors, a videotape recorder, and a master intercom station. Backup fire alarm equipment is also located at the main security console. The security management system provides access control for designated security doors using card readers, provides alarm monitoring, and contains software and hardware features to support these functions.

The CCTV system monitors specific locations, including entrances, high-security stacks, the research center, and emergency exits.

The access control system consists of security card readers that communicate with the security management system. Card readers provide controlled access for entry at the employee entrances, all records storage areas, and other sensitive/secure locations.

The access control system consists of some 140 security card readers that interface with the security management system. Card readers provide controlled access for entry at employee entrances, records storage areas, processing offices, laboratories, the loading dock, and other sensitive/secure locations. The card readers maintain the separation between NARA staff and the general public and monitor access into all controlled areas.

The CCTV system monitors specific locations, including entrances, high-security stacks, the research center, and emergency exits. Monitors are located at the security control console, loading dock, lobby security desk, and monitor desks in the research center.

The security intercom system is a two-way network used for communication between the security control room and NARA personnel. Call boxes are located at entrances to stacks, processing offices, and stairwells, as well as in other sensitive locations. The call box permits immediate contact with security officers in the event of an emergency. In locations of high security, call boxes operate in conjunction with CCTV surveillance cameras.

A 24-hour guard service protects the building and staff and monitors the security management system located in the security control room. The console pictured here includes a security computer that monitors intrusion alarms and access, closed-circuit television monitors, a videotape recorder, and a master intercom station.

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