Film

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While all types of motion picture film share some common characteristics, and in visual appearance one type may be indistinguishable from another, film archive practice divides them into three main groups for preservation purposes. Each group requires a separate storage environment, and its own handling precautions.

Cellulose Nitrate Film

Almost all theatrical (35mm) motion picture films prior to 1951 were manufactured on nitrate based stock, highly inflammable, chemically unstable and doomed to eventual decomposition, with a life span that could be as short as 20 years but is more usually 50 or 60 years. (In 1951 the film industry, world wide, changed to cellulose triacetate film and nitrate was phased out). The short life span of nitrate film requires that it be copied before decomposition sets in if it is to be preserved. Pending copying the film needs to be stored in an environment which will maximise its life; additionally, for a number of reasons, there is value in retaining a nitrate original for its life even after it has been copied, as most archives do.

Nitrate storage vaults must firstly allow for the inflammability of the film: they need to be strongly constructed (of cement, brick or stone) and of limited capacity, in most countries this is, by law, 1 million feet of film, with an outlet vent to release pressure and redirect flames in case of a vault fire. Safety precautions are necessary in the design of the vault building to provide for staff exit in emergencies. Nitrate film constantly liberates gases (N_2O, NO, NO_2) which must be ventilated for the sake of both the film and the staff.

The experience of film archives and film stock manufacturers suggests that the optimum storage environment for nitrate is 2°C ± 2°C with R.H. at any stable level (± 5%) between 40% and 60%. Under these conditions decomposition of the base is greatly retarded, along with the fire risk, and other hazards of high storage temperatures such as shrinkage and fungus growth are avoided. Such an environment is expensive to maintain, and where it is unattainable archives opt for the lowest *stable* temperature their equipment can sustain. Film kept at such a low temperature needs to be slowly acclimatised to ambient temperature whenever removed from storage. A period of 8 to 12 hours is sufficient in order to prevent physical distortion and moisture condensation. Acclimatisation is also necessary when the film is returned to storage.

Regular surveillance of the collection is essential in order to detect and remove decomposed footage which not only presents an increased fire risk, but which affects the stability of films stored adjacent to it through the rapid liberation of gases of decomposition. Periodic rewinding of each reel every 2 years or so is desirable to ventilate the gases; some archives use an artificial ageing test to anticipate the onset of decomposition in all their films, and thereby ensure that individual films are copied before decomposition begins. Decomposition can proceed at variable rates: some films visibly deteriorate very slowly over several years, others may go from a perfectly sound condition to a pile of brown dust in a matter of months. Unknown variables related to the manufacture, original processing and subsequent storage of the film affect this behaviour so that no nitrate film can be confidently left, unexamined, for a lengthy period.

It is not necessary to differentiate between black and white, and colour dye films for storage purposes as it is in the case of acetate films. The more stable nature of pre-1951 colour processes, and the relatively short life of the film base, make this unnecessary.

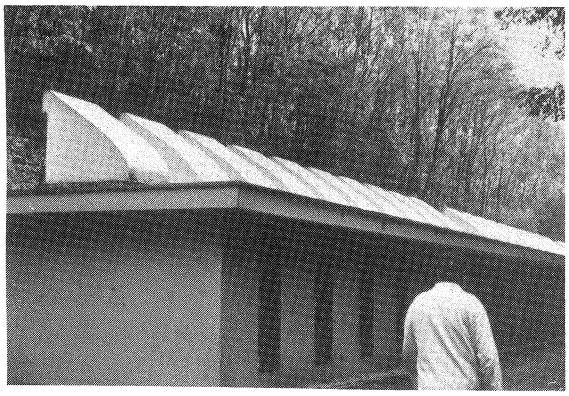

Figure 1. Exterior of block of nitrate vaults at the Centre Nationale de la Cinematographie, Bois d'Arcy (near Paris). Each vault holds 1200 1000-foot cans of film, held at 12°C and 50% R.H. Fire deflectors on the roof will redirect a pressure blast to a stone walled area at the rear.

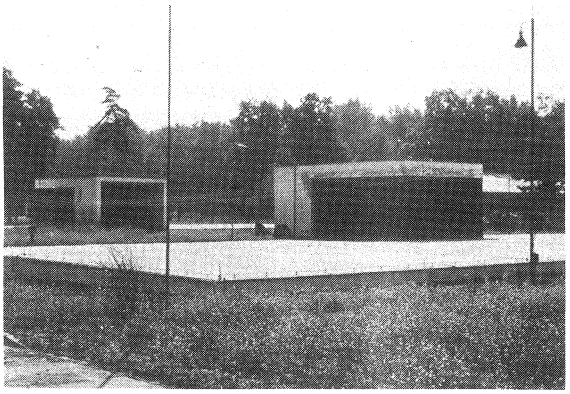

Figure 2. Underground nitrate vaults at the Staatliches Filmarchiv, East Berlin. Each building contains 40 vaults of 1100 – can capacity, held at 6°C ± 2° and R.H. 60% ± 5%. The ground level entrances contain acclimatisation chambers. Fire blowout panels at ground level will deflect a pressure blast vertically upwards. The parkland location reduces atmospheric pollutants.

Cellulose Acetate Film – Black and White

Popularly known as 'safety' film since it is non-flammable, acetate bases have been in increasing use since World War I for non-theatrical and small-gauge film. With the development of cellulose triacetate, which has a physical toughness and dimensional stability comparable to nitrate, the use of 'safety' film became universal. The estimated life of a triacetate film is up to 400 years. Newer bases, such as polyethylene terephthalate, which has an even greater dimensional stability, may be grouped with acetate for storage purposes.

If properly processed, (an essential proviso since commercial laboratories do not routinely wash films to archival standards) black and white acetate films may be expected to last for a considerable time. Since there is no fire risk, storage vaults may be of any convenient volume. An optimum environment here is more easily attainable: 10°C to 12°C, with R.H. 55% ± 5%, though some authorities recommend lower, or even higher, temperatures. Again, stability is of paramount importance.

Before placing the film in storage, it is advisable to ensure that there are no chemicals or other matter remaining on the film which are likely to affect it during prolonged storage. There are tests which reveal the concentration of residual hypo left on the film after the final processing wash (which, if not removed, will cause image degradation in storage) and some protective coatings or 'secret' treatments applied to film emulsions by processing laboratories may have deleterious effects in the long term. As far as possible, the film needs to be chemically clean before it is archived so that all unknown variables likely to affect its behaviour during storage are removed. The Russian film archive, Gosfilmofond, has a vast 'cleaning' machine built by them for this purpose: all incoming new film is passed through its series of washing operations so that an archivally clean film emerges for storage. This is an ideal approach which can't yet be matched in most countries. Some archives recommend periodic rewinding of films in storage to maintain flexibility of the base; this also serves as an opportunity for checking the film for image degradation.

Cellulose Acetate Film – Colour Dye

Colour films must be treated differently in storage because their emulsion (using dyes rather than silver salts) is different and far less permanent than is the case with black and white film. Some colour processes, such as imbibition Technicolor, last well; a number of others have proved to be very unstable with serious, and sometimes total, image fading occurring within less than 10 years. While forecasts will differ, it is prudent to assume that most colour processes currently in use have a stable life of about 20 years under normal uncontrolled conditions. By that time some noticeable colour shift will have occurred, and the film will need copying and colour balancing for continued preservation.

Under conditions suitable for preservation of black and white acetate, colour films will last longer, but this is hardly a satisfactory solution. For long term storage, there are two alternatives:
1. Storage of the colour dye films in 'deep freeze' conditions: −15°C or lower, R.H. at stable level between 15% and 30%. This will significantly retard dye fade so that film life will be much extended. Storage facilities are expensive to build and operate, and for large scale preservation operations there are many practical difficulties still to be

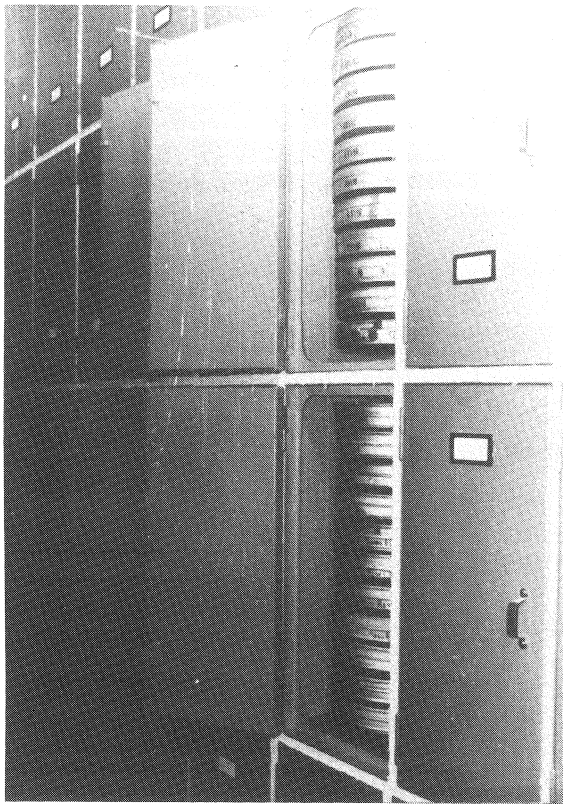

Figure 3. Interior of one vault at the Staatliches Filmarchiv; the 1100 - can accommodation is subdivided into asbestos-lined lockers each holding 11 cans on racks which separate individual cans and eliminate the weight pressures of horizontal stacking.

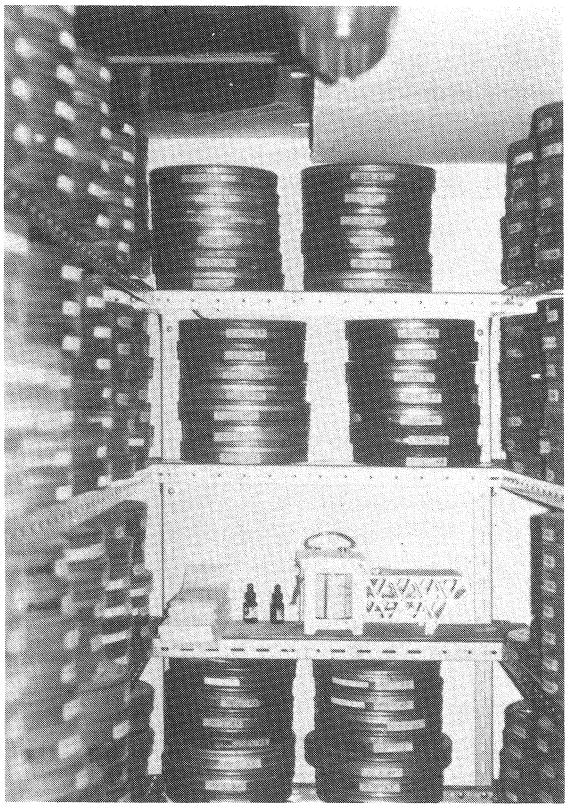

Figure 4. Interior of nitrate vault at the National Film Archive installation at Aston Clinton, outside London. Designed to hold 500 1000-foot cans on simple metal racking. The pressure vent is visible on the top left hand side.

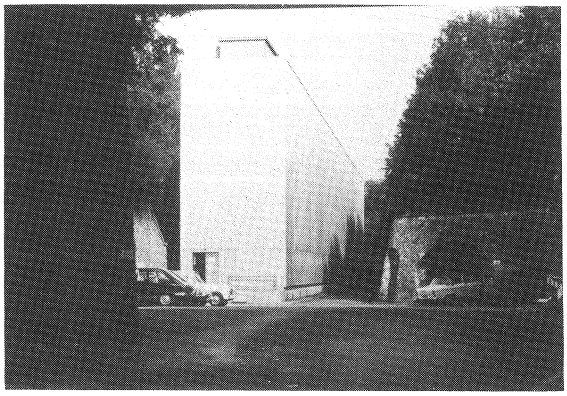

Figure 5. A large acetate storage building at the Centre National de la Cinematographie. The storage environment here is close to optimal, and about 30,000 cans are stored in each unsubdivided area.

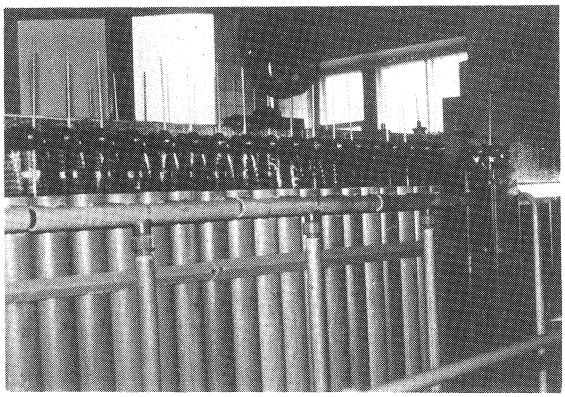

Figure 6. A section of the vast 'cleaning' machine at Gosfilmofond, near Moscow. A unique installation which requires a very large archive to make its operation economic.

solved. Acclimatisation of the film, of course, is essential, and may take as long as 2 or 3 days.
2. The making of black and white tri-separation copies from the colour dye original (i.e. 3 black and white records, each one representing a primary colour, which can be printed back through filters to produce a new colour copy). The tri-separations are stored as black and white films and have the same long life. While inadequate storage over a long period can cause difficulties by introducing differential variation between the three records, the principal drawback of the system is its prohibitive expense (at least in Australia). However, improved methods based on this principle are being developed overseas which might in time alleviate this problem.

Other Aspects

All types of film have in common certain characteristics which suggest certain storage procedures. Some principal considerations are listed below:

1. Films should be wound evenly, neither too loose nor too tight, on plastic or metal cores. This will minimise distortion in the shape of the roll during storage.
2. Films should be stored in cans without any other material (e.g. paper, polythene bags) which could react with them, or cause moisture condensation. Metal cans have the advantage of rigidity and should not chemically react with the film; however, the interior must be rust free. It is an advantage to standardise can sizes (the 10"/1000 ft size is most usual).
3. Films are stacked horizontally on shelves, so that the weight of the film roll is evenly spread. Stacks should be no more than 8 or 9 35mm cans high, so that there is not too much weight concentrated on the bottom can. If standard size cans are used, the weight of the stack tends to be borne at least

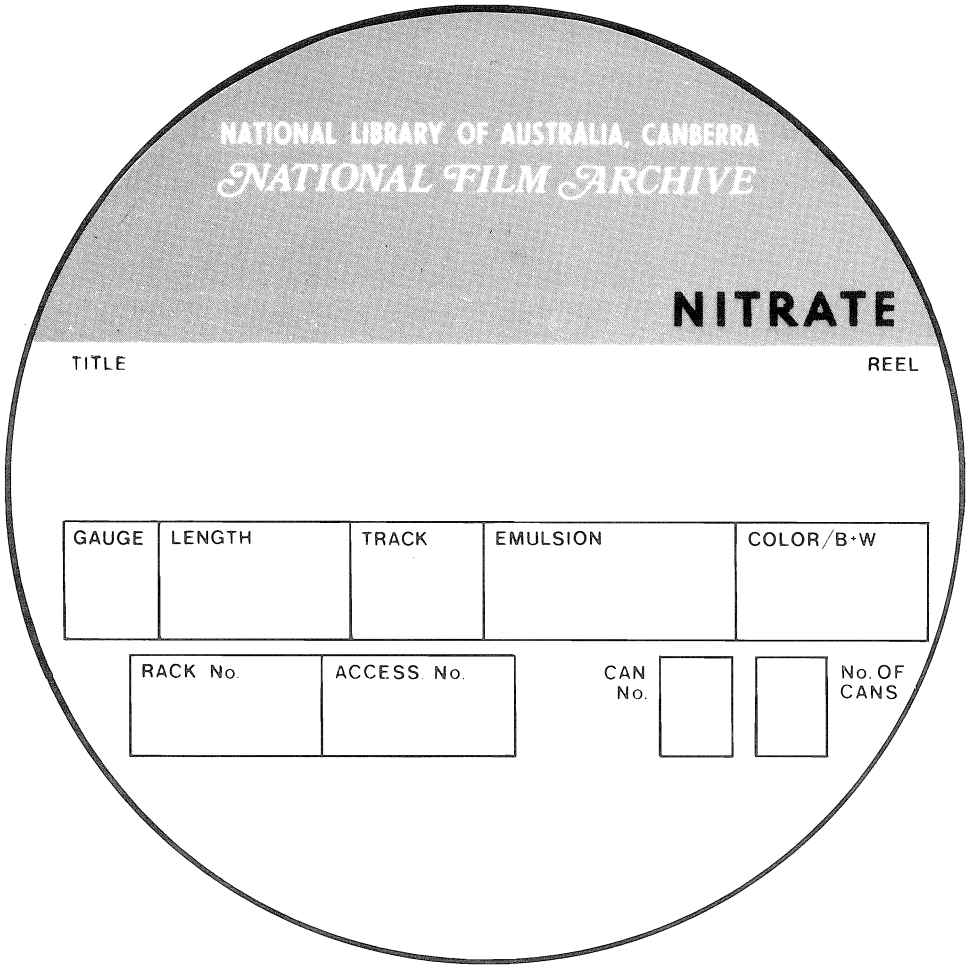

Figure 7. Film archive can label — blue for nitrate, green for acetate preservation copies, orange for acetate viewing prints.

NLA 193

FILM ARCHIVE

EXAMINATION AND PRESERVATION RECORD

TITLE ON FILM

PRODUCTION CO.
DIRECTOR
RELEASE DATE
MAJOR CREDITS OR CONTENTS

REMARKS ON CONTENTS

REMARKS ON TECHNICAL CHARACTERISTICS

DATE BEGUN | DATE COMPLETE | EXAMINER

SILENT/MUTE/COMPOSITE/SOUND ONLY

COLOUR: B&W/TINT/TONE/COLOUR
COLOR PROCESS:
COLOR PATCH LOCATION:
TINT RECORD MADE?:

FORMAT: SILENT/ /ACADEMY
WIDESCREEN MASKED [:] .....
SCOPE [:] .....

TRACK: AREA / DENSITY / MAG /
SOUND SYSTEM:

STOCK

STOCK DATE

EMULSION

BASE COMPOSITION

GENERATION

TOTAL LENGTH — breakdown overleaf

LAB. TITLE

ACCESSIONED TITLE

VIEWED ON: BY: DATE:

DEFECTS see also overleaf

NITRATE SAFETY

LOCATION NO.

EXAMINATION VIEWING of this copy

SOUND	A	B
Visual track defect		
Clarity		
IMAGE		
Contrast (tonal range)		
Acutance/Resolution		
Grading		
Steadiness		
Cropping		

COLOUR	A	B
Fade		
Balance		

Dens. site .....
.....
.....

BLEMISHES IN PRE-PRINT (not elsewhere recorded)

CODE: **A** = in original processing/production
B = result of damage/deterioration IN THIS COPY

MARK AS FOLLOWS: '—' indicates no defect observed.
'**E**' indicates a defect detected by eye, '**D**' a defect detected by densitometer

LABORATORY WORK on and from this copy

DATE	LAB	O/No.	WORK REQUIRED, COMMENTS, RETURNS

CODE

GAUGE

No. CANS

☐ TICK IF COPIED

Figures 8 & 9. National Library of Australia's film archive "tech sheet" — a sheet is raised for each new preservation copy as it is accessioned and is maintained, in conjunction with supplementary records, as a permanent dossier on that film.

PHYSICAL CONDITION of this copy

Reel / Spool No.	Dirt, Oil	Light Scratch		Heavy Scratch		Perf. damage	Track damage	Curl	Buckle Wave	Image Fade	Roll-end damage		Decomp		No. Repair Splices	% Shrink Long	LENGTH
		Base	*Emul.*	*Base*	*Emul.*						*Head*	*Tail*					
1																	
2																	
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6																	
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14																	

COMMENTS ON CONDITION, Details of repairs, sections removed, etc.

CODE: Mark grid as follows: '—' indicates no defect, 'X' indicates defect present to minor degree but ignored, '$\frac{1}{4}$' indicates defect present to extent that will affect resulting copy and must be taken account of. Comments regarding such defects can be inserted vertically in vacant space in appropriate column.

GENERAL CONDITION:

NEW / GOOD / FAIR / POOR

Good: no splices in 200'
Fair: one splice in 200'
Poor: 2 or more splices in 200'
Drop condition one category for:
- Heavy scratches
- Damaged or stretched perfs
- Groups of repair splices affecting continuity

DESTRUCTION RECORD *see also* COMMENTS *above, for sections destroyed*

Material destroyed:

Authorised:

Date:

Reason:

Destruction carried out by:

Date:

partly by the circumference of the cans, and not the film rolls themselves.

4. Film handling and examination is a subject of its own. Suffice to say here that considerable care, cleanliness and manual deftness is essential to prevent the many kinds of physical damage which occur easily and cannot be retrieved.

These considerations are important because poor storage procedures can quickly nullify the benefits of an ideal storage environment. Nor is it possible to apply these procedures without staff who are not only knowledgeable and meticulous, but also attuned to the extreme long term goals of their work.

Technical Records and Control

The methodical preservation of films depends on control systems sufficiently elaborate to ensure the orderly progression of preservation steps, a knowledge of all variables likely to affect a particular film in long term storage and a means of 'housekeeping' to control user access and ensure that films are not misplaced or misused. Such a system will include the following elements:

Data compiled on initial examination of the film: a detailed technical description and assessment of film condition and quality.

A progressive record of what happens to the film after archiving: bench examination, copying, viewing. Notation of changes and deterioration, recording of results of tests and observations.

A numerical location and auditing system capable of maintaining a complex collection in perfect order, without loss or confusion.

A labelling system to ensure proper identification of the contents of each can and its preservation status.

The internal records of the Film Archive of the National Library of Australia incorporate these elements, and the present system was evolved from those in use at many overseas archives, by comparative study and some simplification.

Video Media

In recent years, film as a medium for recording moving images has been supplemented by the growth of video — videotape in all its forms, and now videodisc. Archives must concern themselves with the preservation, therefore, of images that are generated and recorded electronically rather than photographically, and are recorded to an increasing extent on videotape.

Ideal conditions for tape storage are a little easier to maintain than for film: 20°C ± 5°C, with R.H. 50% ± 10%. Again, stability is of paramount importance. However, there are additional considerations: the storage area should have a positive internal pressure to prevent the entry of dust (which easily becomes embedded in, and damages, the tape) and considerable thought must be given to the presence of electrical influences in the area which might have a deleterious effect on the recorded signals. The storage racks need to be electrically grounded. Unlike film, the tape should be stored upright in plastic containers designed to support the weight of the reel at the hub.

Videotape is still a relatively new medium, just 20 years old. The long term behaviour of tape under proper storage conditions is still a matter for some speculation, particularly since their manufacturing technology has developed rapidly and tapes in use today are far more durable and stable than their counterparts twenty years ago.

It is clear, however, that videotape has a far shorter useful life than film. The recorded signal degrades steadily through the influence of magnetic fields both from within the tape (the successive layers tend to 'print through' on each other) and externally, and the tape can deteriorate physically in a variety of ways: oxide particles lifting off the base as the adhesive binder deteriorates, the base itself buckling or distorting under improper storage conditions. While such effects can be retarded by frequent rewinding and polishing of the tape, large scale maintenance requires costly equipment and is very labour intensive.

With a useful life that may be considerably less than 20 years, it is doubtful whether videotape can be regarded as an archival medium at all at the present stage of its development. All things considered, it is cheaper to make a transfer to film which will last longer and is more easily maintained, although the initial transfer cost is quite high, this is the course currently followed by most film archives. It becomes a growing problem as film is progressively replaced by video in all television programming.

Conclusion

This paper has been a prescriptive, rather than descriptive, account of film preservation requirements, and a necessarily generalised one. Film preservation is a highly expensive undertaking and, according to their size and affluence, film archives throughout the world vary in their ability to meet all of these standards, and in the aspects to which priority is given, where this is necessary.

Like so many aspects of conservation, film preservation in Australia is still underdeveloped by overseas comparisons. There are probably no storage facilities currently in use for archival purposes where all the requirements outlined above are observed: much important film, in fact, is stored under circumstances not conducive to its survival for even a reasonable length of time.

The National Library's film archive has chosen to emphasise the development of storage and handling procedures of an acceptable archival standard. They are strict, and become increasingly so with the passage of time. The building of optimum storage facilities for each type of material is still to come, and will not come cheaply. When it does, it is important that the capability to use such facilities properly and efficiently will already exist.

References

International Federation of Film Archives, Preservation Committee, 1965, *Film Preservation*, National Film Archive, London.

Sargent, Ralph N., 1974, *Preserving the Moving Image*, Corporation for Public Broadcasting and National Endowment for the Arts, Washington.