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Number 52

Second Exercise

September 2015

**National Archives of Australia/ACT Fire & Rescue. Part 2
Fire simulations 2012 and 2013 – Ian Batterham.**

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of Australia).**

Second exercise: 24 May 2013

Introduction

A second exercise was arranged in 2013 for two reasons:

To allow the involvement of the local DisACT group. This group is an emergency co-operation group with representation from local cultural agencies. The exercise was treated as a training opportunity. To further examine some of the remaining questions and questions the first exercise raised.

On top of the questions asked in the first exercise, the following were also to be examined:

- How do a bigger range of thermal papers behave in a fire (thermal faxes, thermal transfer)
- Are half-full boxes more susceptible than full ones?
- What is the nature and effects of fire retardants and volatile plasticisers?
- Are closed compactus an effective fire barrier?
- What is the effect of fire on nitrate film, particularly individual frames on files?
- On shelving, is tightly packed better than loosely packed?
- What effect does fire have on cloth items, plastics and metals?
- To examine any particular materials and storage configurations of interest to other participants

Assistance was provided by Fire Officer Anthony Walker and a fire crew.

Preparation

Storage furniture

As with the first exercise a range of storage furniture was collected in preparation for the exercise:

- A single bay of standard NAA metal shelving
- Two bays of standard NAA metal shelving – to be placed face-to-face to act as a simulated compactus
- A single wooden shelving unit of heavy MDF. Shelves were adjustable, they were seated on metal screws rather than plastic plugs
- Two cloth covered screens for hanging artworks

The container

The furniture was set up the day before the exercise in the container at the Hume site. The container is a standard shipping container of size:

- Length 12.03 metres
- Width 2.35 metres
- Height 2.39 metres

Furniture was arranged in the container as follows:

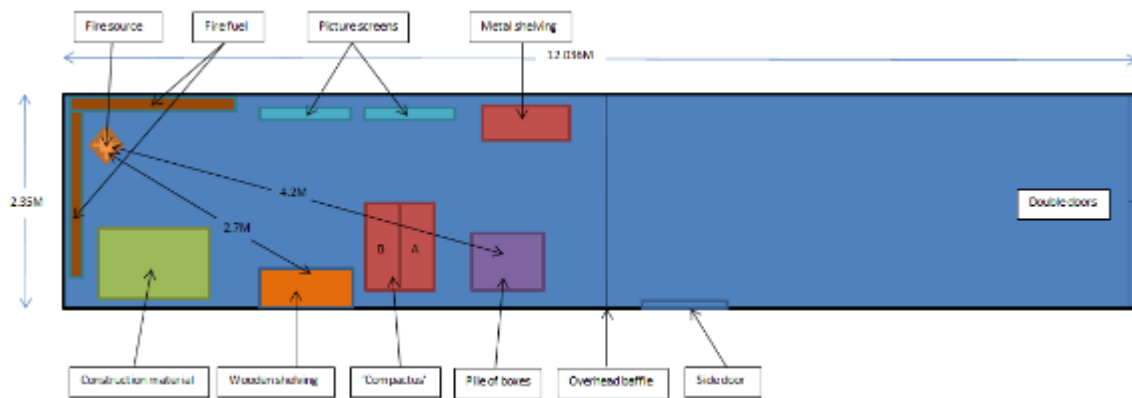


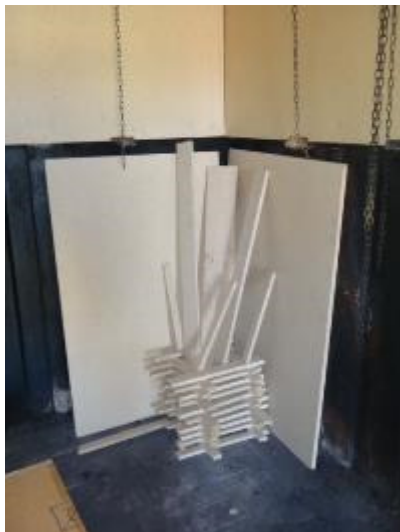
Diagram of the setup within the container

The fire – observations

The progress of the fire was recorded in a number of ways:

- A disposable webcam taped to the transom of the side door
- A thermal camera operated by Anthony Walker
- Two small cameras operated by Anthony Walker
- Thermocouples at 3 different heights beside the side door, closest to the fire
- Various cameras operated by participants, filming from outside the safety perimeter

The fire was lit, using a gas torch, in the back right corner of the container using a 'crib' of chipboard sticks. To provide fuel for the fire the walls and ceiling around the crib were lined with sheets of chipboard.



The crib and fuel



Lighting the fire

The fire grew quickly and rapidly started generating a lot of smoke. Timing was as follows:

Minute

0.00	Torch applied to crib
1.00	Torch out, crib well alight
1.00-6.37	Fire gradually grows, smoke increases
6.37	First painting falls
6.37-6.55	More paintings fall
6.55	Screens catch alight
6.55-7.13	Remaining paintings fall
7.13	Uniform catches light and quickly falls
8.03	Pile of boxes catches light
9.00	Extinguishing begins
9.27	Visible flames out
11.00	Fire largely out

After the 11.00 minute mark there were still flames inside the compactus. These proved very difficult to extinguish and eventually the compactus was opened up to get more water inside. Even so, certain items kept reigniting and it was another half hour before all flames were out. At a certain point during this period a fan was set up to help clear the smoke, the fan was operated by water pressure from a fire hose.



Later stages of the fire – pile of boxes and contents of metal shelving well alight. Paintings fallen on floor and burning



Extinguishing begins



Smoke and steam billows out



Largely extinguished



Extraction fan

Aftermath

Once the fire was declared out we were allowed to enter the container. To ensure our safety we had to wear respirators and hard hats. The following are general observations about the particular areas. Discussion of individual items is in the following section.

The 'pyramid' of boxes



The 'pyramid' of boxes before and after

The 'pyramid' of boxes had sustained quite a lot of damage, particularly considering it was low down, away from the fire source and behind the 'compactus'. Many of the exposed boxes were largely burnt away leaving their contents exposed. In many cases contents had spilt out allowing the fire better access and causing more damage. The polypropylene box on top had completely melted as had the samples of IsoBoard placed on top.

The metal shelf



The metal shelving before and after

The metal shelf retained its integrity. The cover of the hanging uniform caught fire and they both dropped to the shelf below. The plastic boxes had melted, exposing their contents to damage as had the gramophone record box. The plastic film cans had melted somewhat but not exposed their contents. The unit was sitting out from the wall and as a result heat reached the back of the items on the shelves, particularly the boxes on the top shelf. Heat transfer through the metal was such that the backs of these boxes caught fire and more damage was done on the side facing inwards than the outside.

The art screens



The art screens before and after

The art screens were fairly flimsy affairs and, apart from a metal frame, were all consumed by the fire. Very early in the progress of the fire the pictures started to fall from the screens, it is unsure whether this was a failure of the screws driven into the screens to hang the pictures or of the picture wire/cord. Considerable burning damage was done to the works after hitting the floor.

The 'compactus'



The 'compactus' before and after ('A' left, 'B' right)

It was expected that the compactus would protect its contents from the full force of the fire. The truth was quite the opposite: the contents readily caught fire and considerable damage was done. As with the bay of metal shelving, the fire inside was a result of heat transfer through the metal of the shelving. Furthermore, the fact that the contents were enclosed made it very difficult to extinguish the fire, as water did not easily penetrate. The contents of the compactus continued to smoulder and reignite well after the rest of the fire was out. To fully extinguish the fire inside required the use of large amounts of water which soaked the contents and caused brown decomposition products to be washed down to lower levels. To fully ensure that the fire was out, the firemen eventually pulled the two shelving units apart so they could ensure water got to the smouldering areas.

The wooden shelving



The wooden shelving was close to the fire and facing it directly; its contents therefore sustained a lot of damage. The shelving unit itself retained its integrity and none of the adjustable shelves fell.

Pile of construction materials, transport crate and storage box



Pile of construction materials, transport crate and storage box, before and after

Table: Locations of items and effects of the fire

Location/item	Effect of fire
On the floor near the fire source	
Galvanised steel mesh (NMA)	Not affected
Metal tubing (NMA)	Not affected
Steel solid powder coated 1.6mm shelf (NMA)	Not affected
Small wooden exhibition transport crate (NMA)	Top section was burnt, the lower section not burnt as much. Contents were not affected.
Triwall box assembled using hot melt glue with foam insert covered with parsilk (NMA)	Hot melt glue failed and the box separated exposing the contents. Box totally burnt.
Ceiling tile (NMA)	Did not burn but became very brittle – could not pick up without it crumbling.
Sheet of melamine finished board (NMA)	Coating melted, slightly burnt but remained sound.
Red Head matches in glass jar with plastic lid – placed on triwall box (NMA)	Lid melted, glass shattered, matches and box totally burnt.
Framed textile (leaning against wooden shelving)	Smoke and water damaged and glass broken.
Graphic item pasted to cardboard (leaning against wooden shelving) (NGA)	Item almost totally consumed.
On the floor closest to the front of the container	
File material and microfilm reels in various type 1 style boxes. Boxes were of archival corrugated board, standard corrugated board and polypropylene. These were piled in a 'pyramid'.	Top and side boxes badly burnt. Polypropylene box on top totally melted. Contents of boxes burnt on exposed edges. Contents of damaged boxes spilled out on floor in some cases.
2 samples of IsoBoard, placed on top of two boxes. IsoBoard is rigid extruded Polystyrene foam used as thermal insulation. It is constructed of microscopic gas-filled cells which resemble a honeycomb giving it very high compressive strength, as well as its near total resistance to moisture transfer (MOADOPH)	Totally melted over boxes, no evidence of burning.
On the open metal shelf (3 shelves, middle on very large)	
On top of unit	
A solander box	Very badly burnt on outside, contents badly damaged, charred and stained..

Top Shelf	
File material (NAA) in archival type 1 style boxes. Included in boxes were files with attached frames of nitrate film and thermal copies.	Boxes and contents badly burnt on leading edge. Burning worse on the back of boxes against the metal back of the shelving. Nitrate film unaffected, thermal copies darkened on edges but otherwise OK.
Second shelf	
Frames of nitrate film on a simulated file – sitting loose on shelf	Nitrate burnt, file badly affected by the burning DPCU falling on it (see below)
8 reels of microfilm in individual cardboard and plastic boxes	Minimal damage.
Disruptive Pattern Camouflage Uniform (DPCU) jacket on the coat hanger under an unbleached cotton dust cover with a plastic coat hanger (AWM)	The plastic hanger failed fairly rapidly and the exposed, projecting edge of the cotton dust cover burst into flames from the radiant heat (clearly seen in the video). The jacket itself was badly scorched but didn't actually burn (cotton polyester blend).
Gramophone records in red polypropylene box (NFSA)	Box melted somewhat exposing edges of records which melted, warped and charred.
Bottom shelf	
4 cine films in different plastic cans (NFSA)	Film cans melted and distorted some damage to outside windings of film and film reels (?)
Black polypropylene box holding audio cassettes in cases	Box distorted and melted exposing contents to damage.
Grey polypropylene box (Type 5) containing video tapes in cases	Box distorted and melted exposing contents to damage.
Brown corrugated box containing rolls of microfilm in enclosures and two rolls of unused thermal fax paper.	Front of box burnt off, significant damage to exposed rolls of film. Fax paper darkened throughout.
On the 'compactus' (2 units: 'A' closest the entrance – 6 shelves and 'B' closest the fire – 4 shelves)	
Unit 'A' top shelf	
Empty	
Unit 'A' second shelf	
File material (NAA) in 5 type 1 style boxes (3 archival and 2 standard). Included in boxes were files with attached frames of nitrate film and thermal copies.	Major damage to boxes and contents. Burning worse at back of boxes.
Unit 'A' third shelf	

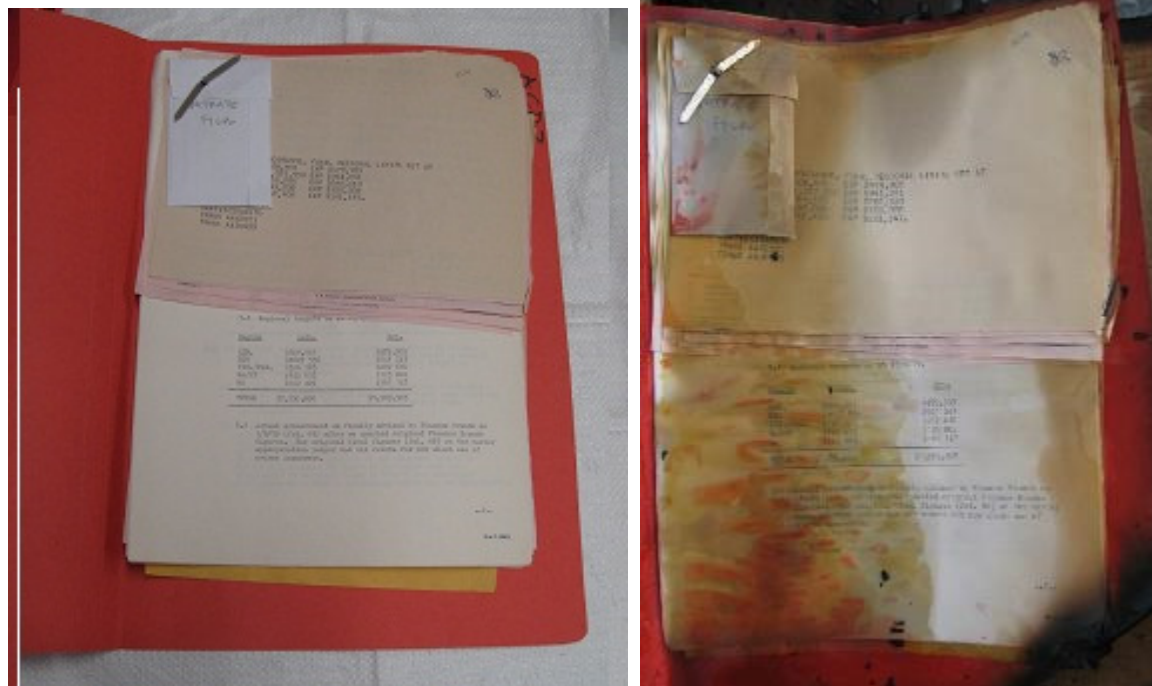
File material in 2 archival type 1 style boxes	Outside of boxes charred, boxes and contents wet and stained.
Small black polypropylene box containing a couple of negatives in Printfile sleeves and a couple of photos (NLA)	Outside of box melted at top. There was some water damage and curling to the contents, otherwise unaffected.
Glass lidded jar containing Red Head matches (NMA)	Plastic lid melted and burnt, matches not burnt.
Unit 'A' fourth shelf	
File material in 4 archival type 1 style boxes	Boxes not burnt, boxes and contents wet and stained.
Floral photo album, ring binder, with plastic pages, colour photos slipped in slots	Leading edges melted and charred, photos and pages wet and stained. Charring inside album around metal binders, probably due to heat transfer.
Blue photo album, spiral bound, with plastic pages, colour photos slipped in slots	Charred on outside and inside spine. Photos survived OK.
Wedding photo album (the word 'PHOTOS' on cover), 'magnetic' style with colour photos	Charred on outside, photos survived OK.
2 x Polypropylene albums in sleeves	Charred and melted on outside, photos survived OK.
Slide storage sleeves (polypropylene)	Edges charred and melted, outermost slides charred and melted on edges.
Unit 'A' fifth shelf	
File material in single archival type 1 style box	Box not burnt, box and contents wet and stained.
Plastic lidded tub	Slightly melted and stained.
Unit 'A' bottom shelf	
Empty	
Unit 'B' top shelf	
File material in single archival type 1 style box	Severely burnt, largely lost
Polypropylene box (type 5) containing CDs in cases and microfilm on rolls.	Box totally melted, CDs and cases melted and very badly damaged, film badly damaged.
Two cine films in plastic cans	Plastic cans totally melted, films badly damaged.
Unit 'B' second shelf	
File material in single archival type 1 style box	Severely burnt.

DPCU pants in an archival corrugated board box of type 10 design (AWM)	Box severely burnt. The pants were severely damaged by the fire.
Khaki peaked cap in an archival corrugated board box of type 10 design (AWM)	Box severely burnt. The cap was badly scorched but survived better than expected probably due to the pants box above and the surrounding packing providing some degree of insulation.
Unit 'B' third shelf	
File material in 5 archival type 1 style boxes	Boxes not burnt, boxes and contents wet and stained.
Large polypropylene costume box containing lab coat wrapped in tissue – on top of archives boxes. Projecting across into Unit "A".	Box partly melted and badly distorted, coat partly consumed.
Unit 'B' bottom shelf	
Large grey/white board box containing lab coat wrapped in tissue	Box intact, coat and tissue stained and wet but intact.
Archival type 10 box containing various small cine films and video tapes (on top of large box)	Box and contents wet and stained, otherwise seem OK.
On the open wooden shelf (5 shelves evenly spaced)	
On top of unit	
A solander box containing photographs, laser prints and negatives.	Very badly burnt on outside, contents, charred and stained but OK.
Top shelf	
File material (NAA) in 4 archival archival type 1 style boxes. Included in boxes were files with attached frames of nitrate film and thermal copies. Also included a file with folios in polyethylene bags.	Boxes burnt away and contents badly charred at front. Polyethylene bags melted and adhered at edges where heat reached them, otherwise OK.
Second shelf	
Telephone (ACT Archives)	Partly melted.
3 medallions in plastic bags (ACT Archives)	Plastic bags melted and adhered to the medallions.
Spindle of CDR (ACT Archives)	Partly melted.
Headphones (ACT Archives)	Partly melted.
2 plastic spray bottles containing ethanol/water (NLA)	Both bottles melted to the liquid line and then stopped.
Third shelf	
Pile of small framed items	Badly charred at front.

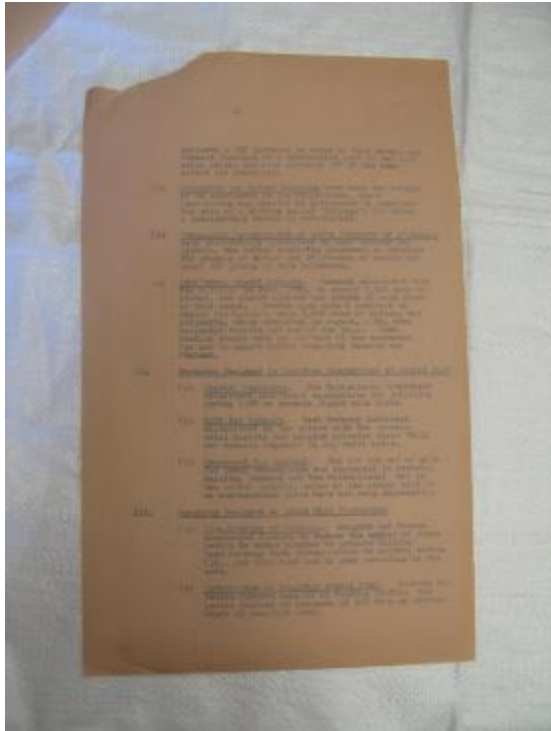
Triwall box assembled using hot melt glue with foam insert covered with parsilk, containing a fake object (NMA)	Box burnt away and contents badly charred at front. Parsilk melted where heat the worst.
Frames of nitrate film on a simulated file – sitting on top of box	File almost totally consumed, including film.
Fourth shelf	
Nally lidded tub (NMA)	Tub badly melted.
Glass jar with plastic lid containing box of matches on top of Nally tub (NMA)	Lid melted, contents did not burn, and jar sank into Nally tub.
Bottom shelf	
Gramophone records in red polypropylene box (NFSA)	Box fell sideways, the box melted significantly, considerable charring, melting and warping of gramophone records inside.
On the screens	
2 artworks in Fini frames glazed with Perspex	Both fell face down. Charred and water damaged but artwork survived OK.
6 artworks in wooden frames glazed with glass	Fell off the screens, either through failure of the picture wire or the screw they were hanging on. All items were very badly burnt and all glass broke. Where the item fell face down, the artwork was not totally destroyed, although charred and stained. Where the item fell face up the artwork was largely lost.
1 artwork in a metal frame glazed with glass	The metal frame fell face down. The corner of the frame closest the fire was actually burnt away, the burning continued into the artwork causing significant loss.
Wooden tribal mask	Charred.

Examples of particular items

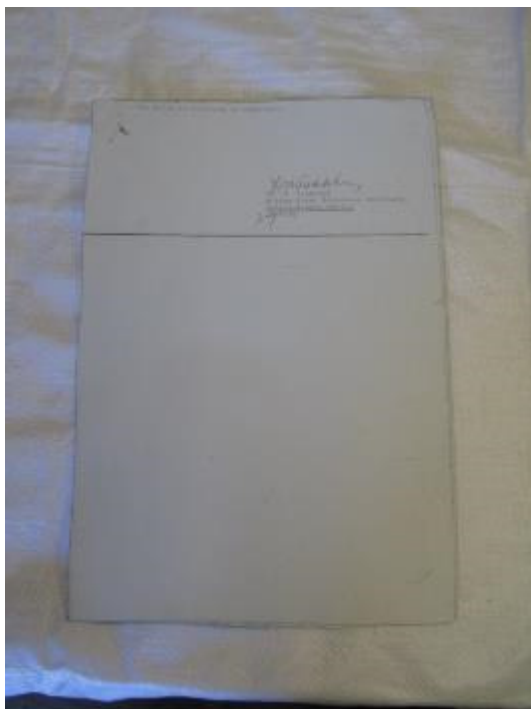
1 File material



Nitrate film on a file – its presence did not seem to increase the dangers of burning. In this case the film did not burn although the file is singed, in cases where the file was more badly burnt, the nitrate burnt as well. Notice the brown water staining and running of the dye from the red file cover.



Thermo-fax paper on a file. The paper darkened where it reached a sufficient temperature.



Thermal fax paper on a file. Burnt but did not darken

2. Photograph Albums





The photograph albums were packed tightly in the 'compactus'. There was some damage to the albums but the photos survived.



3. Slide sleeves



The slide sleeves, slide mounts and slide film all melted where the heat reached them

4. Framed items



All the framed items fell from the screens, after which the screens were consumed. Damage to the material was related to whether it fell face-up or face-down



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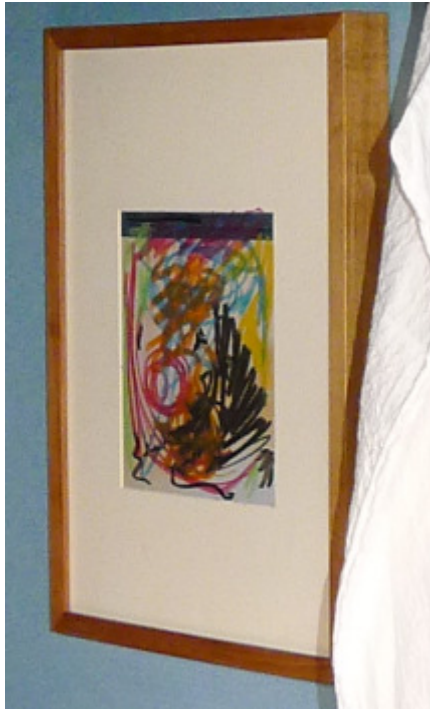
Wooden frame with glass. This item fell face-up and was lost



Wooden frame with glass. This item fell face-up and whilst there was much damage, the object survived.



Metal frame with glass. Fell face –down. The metal frame appears to have facilitated heat transfer leading to significant burning of the object.





Fini frames – wood with Perspex. Both fell face-down and sustained bad damage to their backs. The objects themselves both survived with some water staining. The pastel (top) dislaved some cracking.

5. Solander boxes





One solander box was placed on top of the wooden shelving and one on top of the metal shelving. The box on the metal shelving (left) sustained the most damage, possibly due to the greater air circulation around it.

6. Textiles



The lab coat in the polypropylene box was on the compactus, unit B, third shelf. The box melted significantly and the contents very badly damaged.





The lab coat in the grey/white board box was on the compactus, unit B, bottom shelf. It sustained no fire damage but was wet and stained.

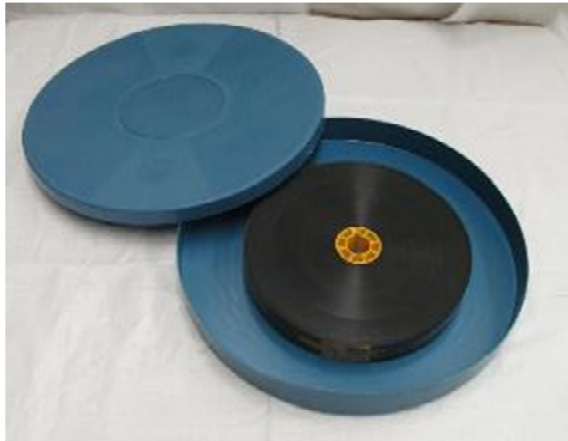


The Disruptive Pattern Camouflage Uniform jacket with cotton dust cover caught fire and fell on to the red file below. The cover was largely consumed and significant damage was done to the uniform itself.

7. Audio Visual material



Gramophone records in red polypropylene boxes. The boxes melted and ran. The records were warped, and melted on the edges where they received the greatest heat.



Cine film in plastic film cans. The effects were based on the amount of heat received. The examples shown were at the top shelf of compactus 'B' and were greatly damaged. Other films were less damaged. Often water got into the film can.



CDs and microfilm. The effects were based on the amount of heat received. The example shown was on the top shelf of compactus 'B' The grey polypropylene box melted, the CDs and films were significantly heat affected.



Videos and audio cassettes. These were on the bottom shelf of the metal shelving unit. The boxes had melted, it may have been possible to retrieve some of the tapes.

8. Storage and transport enclosures



The exhibition transport case was significantly charred on the outside. The interior was entirely unscathed.



Triwall boxes held together with hot melt adhesive. The box nearest the fire source was largely destroyed. The box on the wooden shelving was only burnt at the front.

9. Isoboard samples



The Isoboard totally melted but showed no signs of burning

Conclusions

Best storage practice for fire safety

The two exercises carried out have revealed a lot about the best way of storing and packaging materials for fire protection. The following recommendations are made:

- Always tightly pack materials and minimise air gaps, whether in boxes or on shelves
- Avoid plastics where possible, use plastic boxes and enclosures only where there is no alternative
- When crating items use the heaviest wood possible
- In framing, where possible use wooden frames, the heavier the better
- In framing, where possible use Glass not Perspex (this should be weighed against the fragility of glass)
- Compactus makes firefighting very difficult as water can't penetrate; examine options such as the use of open walls or mesh instead of solid steel shelving. For examples look at Novalok products (www.novalok.co.nz).

Fire recovery recommendations

The two exercises carried out have revealed a lot about the best way of retrieving fire damaged materials. The following recommendations are made:

- Safety first – be aware of materials that may fall and the some things may be still smouldering
- Wear full respirator and gloves– fires produce nasty gases and deposits
- Find a suitable safe place to transport the material to. The area will need to be secure, weather tight, have a lot of floor or table space and should be well ventilated and well lit. The material will be smelly and messy so this needs to be considered – e.g. consider people working nearby.
- Use trays or crates to move items – they will be fragile and need support
- Remove material fallen on floor first. In this way people will not walk on it when retrieving the remaining material.
- Throw away damaged unimportant things, for example boxes and shelves.
- Don't write anything off. Immediately after a fire the temptation may be to simply throw things away. However, some things that look lost may be able to be retrieved to some extent once they are separated, cleaned and dried.
- As soon as possible remove excess water using cloth, sponge or blotting paper
- Where items are still strong rinse them with clear water to remove soot and stains
- Proceed from here as with flood recovery

Future work

If another exercise is carried out, the following questions should be considered:

- Do finger holes in boxes make any difference in a fire?
- Are smoke damaged video tapes and CDs playable after cleaning?
- What protection is provided by non- corrugated paperboard boxes

Biography

Ian Batterham was among the first intake of students for the original materials conservation course at the CCAE. He graduated in 1980 and took up a position at the National Archives of Australia, where he remains to this day. Over the years Ian has carried out a range of significant treatment projects including work on the Walter Burley Griffin Canberra designs. He is author of the book 'The Office Copying Revolution' published by the NAA. He has completed a Masters Degree in Materials Conservation at the University of Canberra and has often filled in as lecturer in Paper Conservation there. He is currently Assistant Director, Preservation at the NAA where he carries out a range of research work, currently including modification of storage standards, storage for fire protection and paper quality in the 20th century.