PARBICA

Pacific Regional Branch of the
International Council on Archives

The Darwin Shipping Container Trial: Report and Results

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EXECUTIVE SUMMARY

The possible use of shipping containers for record storage was raised at the PARBICA 8 General Conference in Fiji in August 1999. It was thought that containers might provide a low cost alternative to more expensive purpose built record storage repositories. Shipping containers were known to be in plentiful supply in all Pacific countries and furthermore were relatively cheap to acquire, establish and maintain.

A working party was established at PARBICA 8 to further consider the use and suitability of shipping containers as a low cost record storage alternative. PARBICA subsequently agreed to fund the trial use of a container, which took place in 2001-02 in Darwin, Northern Territory. Darwin was considered an ideal location for testing the suitability of shipping containers because of its tropical climate.

A 20 ft container was purchased and installed in March 2001. A decision was made to insulate but not aircondition the container because some countries cannot guarantee the regular supply of electricity needed to power an airconditioning unit. Approximately 150 boxes of records were stored inside the container along with two dataloggers. One of the dataloggers was placed on a shelf and the other inside a box. They were set to record temperature and relative humidity levels at regular intervals. Control data provided by the Australian Bureau of Meteorology consisted of similar readings taken at the nearby Darwin airport.

An interim report was presented to the PARBICA 9 General Conference in Palau in August 2001 and the trial concluded at the end of March 2002. After 12 months the overall results of the trial were not encouraging. Both temperature and relative humidity levels were too high (particularly during the wet season) to ensure long-term record preservation. Nevertheless, the experiment did yield much useful information. The humidity levels for the datalogger placed inside the storage box were, for example, on average 7% lower than those for the datalogger placed on a shelf. The experiment clearly demonstrated the buffering effects that storage boxes have. Hence, regardless of their environment, records should always be stored in boxes and not simply placed on a shelf or on the floor.

Despite the limitations of shipping containers, it is recognised that some countries may have no option other than to use them for record storage. The National Archives of Australia has therefore developed a set of specifications dealing with the establishment and maintenance of shipping containers for this purpose. These have been prepared as a separate document.

2. THE ORIGIN OF THE SHIPPING CONTAINER TRIAL

In July 1999 a series of discussions took place on the possibility of using shipping containers as an alternative to purpose built record storage repositories. The discussions were between Stephen Yorke (then with the National Archives of Australia), Pat Jackson (working as a records management consultant at the Lands Management Division in Kiribati) and Ted Ling (National Archives of Australia). It was recognised that shipping containers were plentiful throughout the Pacific region and that they could be established quickly and fairly cheaply. It was also

known that some countries, like Kiribati and East Timor, were already using them for record storage. In some cases containers were being used because of the lack of available funding to provide a more permanent solution, while in other cases they were being used because buildings were not available due to warfare or civil unrest.

The 1999 discussions centred on how the use of shipping containers might best be translated into practice, by providing archival institutions with practical experience on how best to use them.

In August 1999 at the PARBICA 8 General Conference in Fiji, one of the issues discussed by delegates was the importance of low cost record storage options for implementation in the Pacific region and in other tropical areas. It was suggested that shipping containers be considered as a possible solution.

One of the resolutions of the conference recognised 'the importance of low cost archival storage to assist the preservation of archives in the region and the need to identify alternative storage options for implementation in the Pacific and other tropical areas.' The resolution indicated that suitable alternate storage facilities would need to be:

- cheap to construct from readily available materials;
- easy and inexpensive to maintain;
- resistant to environmental problems (cyclone or typhoon damage, tropical storms, humidity levels, vermin); and
- secure.

Following the conference, PARBICA commissioned a working party comprising of Stephen Yorke, Pat Jackson and Ted Ling, to further develop the concept of using shipping containers for the storage of archives. Over the next twelve months the working party developed a series of specifications and made contact with other institutions already using shipping containers.

Correspondence with University of the West Indies (UWI) Archivist, Ms Victoria Lemieux, revealed that the UWI Archives and Records Management Program had maintained a series of interconnected shipping containers since 1992. The airconditioned containers are reported to have worked satisfactorily as record storage facilities. Although this long-term use of shipping containers was revelatory, the working party was also keen to study the use of non-airconditioned containers. They recognised that some countries would be unable to guarantee the regular supply of electricity needed to power an airconditioned container and further acknowledged that the quality and past maintenance of the container's airconditioning unit would not always be known. The working party resolved to concentrate on containers that were insulated but not airconditioned.

It was soon realised that to test the feasibility of using non airconditioned shipping containers a trial needed to be undertaken. Such a trial would require funding and a suitable location would need to be found. It was originally hoped to conduct the trial in Fiji but the political environment following the coup of May 2000 made this impracticable and it was decided that the trial would instead be held in Darwin, Australia.

A submission was then made to PARBICA to fund the trial. The request was approved and PARBICA agreed to finance the project to the value of AUD$4,500.

3. DARWIN, NORTHERN TERRITORY, AUSTRALIA

Darwin is located in the Northern Territory of Australia at latitude 12°S and longitude 131°E. The city is located within a tropical environment with distinct wet and dry seasons. The dry season lasts from May to August. The wet season lasts from November until March. The average annual rainfall is 1,600 mm and virtually all of this falls in the wet season.

The maximum daily temperature is in the high 20°sC during the dry season and about 35°C in the wet season. Minimum temperatures in the dry season can be about 15°C and 28°C in the wet season.

Relative humidity levels in the wet season are very high and regularly remain above 80% for weeks at a time. In the dry season relative humidity levels can be as low as 30% and sometimes lower.

During the wet season the area is often subjected to tropical cyclones and can receive up to ten cyclones in a single season.

4. SETTING UP THE SHIPPING CONTAINER

The trial took place at the premises of the Northern Territory Archives Service (the archival authority of the Northern Territory Government) located in the Darwin suburb of Winnellie.

A standard 20 ft steel container was acquired by the National Archives of Australia at a cost of just under AUD$3,850 and placed in position in March 2001. The container was 8 ft wide and 8.5 ft high and had a storage capacity of 29.50 cubic metres. It was mounted on blocks above a concrete slab. Placing the container on blocks reduced the possibility of insects or other pests gaining access to the container underneath the base.

The attached photographs 8.1a and 8.1b show the container being placed in position.

The container was insulated but was not airconditioned. Again, the aim of the Darwin trial was to use a non-airconditioned container and rely on natural ventilation in order to ensure stable environmental conditions. This was a deliberate decision, because in some countries the electrical power needed to operate an airconditioned container cannot be guaranteed. A further problem with airconditioned containers, as stated previously, is that the overall quality of the airconditioning unit may not be known, nor how soundly the unit has been maintained in the past.

The Darwin container was filled with steel shelving and approximately 150 boxes of records (these were records from the National Archives of Australia's Darwin Office that had already been marked for destruction).

Ideally, if a shipping container is to be used for record storage in tropical locations it should be placed under a carport, or other form of canopy, in order to reduce the impact of the sun and rain. The attached photographs 8.2a and 8.2b illustrate a permanent canopy that could be used; this particular canopy was developed by Australian architect Sean Godsell[1]. A canopy also helps to increase the volume of airflow across the top of the container and contributes to better ventilation within the container, thus helping to maintain stable environmental conditions. However, if a canopy is considered too expensive, then a tarpaulin could be used. The limited funds available, and the short-term nature of the Darwin trial, precluded the installation of a canopy, although the roof of the container was painted white to reduce the harsh impact of the sun.

Two ACR Smartreader™ dataloggers were placed inside the container. One datalogger was placed inside a storage box and the other was placed on a shelf. The dataloggers recorded temperature and relative humidity levels every 30 minutes. They were calibrated beforehand to ensure their accuracy. The Australian Bureau of Meteorology provided comparative control data (temperature and relative humidity levels) from readings taken at nearby Darwin airport.

The container remained in position for a period of 12 months – from March 2001 to March 2002. This report covers measurements taken from the day the container was established on 31 March 2001 until the end of the trial on 31 March 2002.

5. THE RESULTS OF THE TRIAL

The weather during the trial period was typical for the Darwin area, with respect to both the dry and wet seasons. However, unlike many other wet seasons, on this occasion there were no cyclones.

Throughout the trial period, control data provided by the Bureau of Meteorology, indicated that during the dry season (May to August 2001) external temperature levels ranged from a minimum of 16°C to a maximum of 34°C. Relative humidity levels ranged from a minimum of 14% to a maximum of 99%.

During the wet season (November 2001 to March 2002) the external temperature levels ranged from a minimum of 22°C to a maximum of 35°C. Relative humidity levels ranged from a minimum of 22% to a maximum of 98%.

Datalogger 1 – Readings taken from inside a storage box

During the dry season (May to August) the temperature ranged from a low of 17°C to a high of 31°C, with the average being in the mid to high 20s°C. Relative humidity levels ranged from a low of 42% to a high of 76%.

During the wet season (November to March) the temperature ranged from a low of 26°C to a high of 35°C, with the average being in the low 30s°C. Relative humidity levels ranged from a low of 74% to a high of 81%.

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1 See *Future Shack* story on the use of shipping containers as alternative low cost housing at: http://www.architectureaustralia.com.au/aa/aaissue.php?issueid=200109&article=11&typeon=2

Datalogger 2 – Readings taken from one of the shelves

During the dry season (May to August) the temperature ranged from a low of 17°C to a high of 31°C, with the average being in the mid to high 20s°C. Relative humidity levels ranged from a low of 43% to a high of 84%.

During the wet season (November to March) the temperature ranged from a low of 28°C to a high of 35°C, with the average being in the low 30s°C. Relative humidity levels ranged from a low of 81% to a high of 90%. There were many instances were relative humidity levels were in the high 80s%.

Comments on the readings

Attachment 3 contains a summary of the temperature and relative humidity readings recorded weekly by the two dataloggers at 6.00am and 6.00pm.

The trial demonstrated that there was a marked difference between the readings from the datalogger placed on the shelf and the one placed inside a storage box, especially as far as relative humidity levels were concerned. While there was only a slight difference with respect to temperature levels – the datalogger placed inside the box was on average about 1°C cooler than the one placed on the shelf – relative humidity levels were on average 7% lower. The buffering effects of the storage box obviously worked well to help reduce humidity levels. This clearly illustrates that, regardless of their storage environment, all records should be placed in boxes and not kept loose on shelves or placed on the floor.

The trial also indicated that although environmental conditions inside the shipping container were high, they were more stable and less prone to major fluctuations than was the case for external conditions. Conditions outside the container could fluctuate substantially during a 24-hour period, but this was not the case inside the container. It has long been recognised that stable environmental conditions, and the prevention of major fluctuations in these conditions, will considerably help with long-term record preservation. The summary in Attachment 4 clearly demonstrates this point. It provides a summary of readings taken during the first week of November 2001 and compares the daily variations in both temperature and relative humidity both inside and outside the shipping container.

6. CONCLUSION

The results of the shipping container trial were not as encouraging as was originally hoped. In general, relative humidity levels inside the container, particularly during the wet season (November 2001 to March 2002) were simply too high for long-term record preservation. Once humidity levels rise and remain above 60% there is every possibility that mould spores will develop and damage records. Unfortunately, the levels recorded during the container trail were regularly above 70%. Furthermore, although high temperatures are not considered as threatening to record preservation as high humidity levels are, the temperature levels in the container were also above those normally recommended for long-term record preservation.

However, in considering these results, it is important to note that the trial did rely entirely on natural ventilation. The container was not airconditioned and no ceiling

fans or ventilators were used. Furthermore, there was no canopy over the container. Additional measures, such as these, would undoubtedly improve internal environmental conditions and should be considered by those institutions that intend to use shipping containers for record storage. It would have been a simple task, for example, to add power and install one or two ceiling fans in the Darwin container to promote greater air movement. It is known that fans help to keep air moving within a confined area and reduce the possibility of mould spores adhering to record surfaces in the event that they do develop. A dehumidifier or moisture absorbing crystals such as *Camel Closets*™ or *Damp Rid*™ should also be considered to assist reducing the effects of high humidity levels. To be effective, they would need to be emptied at regular intervals.

With the completion of the Darwin trial the National Archives of Australia has prepared a set of specifications and drawings for acquiring and fitting out a shipping container. These are attached as a separate document.

7. ACKNOWLEDGEMENTS

Photographs 8.1a and 8.1b of the Darwin shipping container were taken by Kathleen Sullivan, National Archives of Australia, Darwin Office.

Photographs 8.2a and 8.2b of a purposely-designed canopy to be placed over a shipping container were taken by photographer Earl Carter and have been reproduced with his permission.

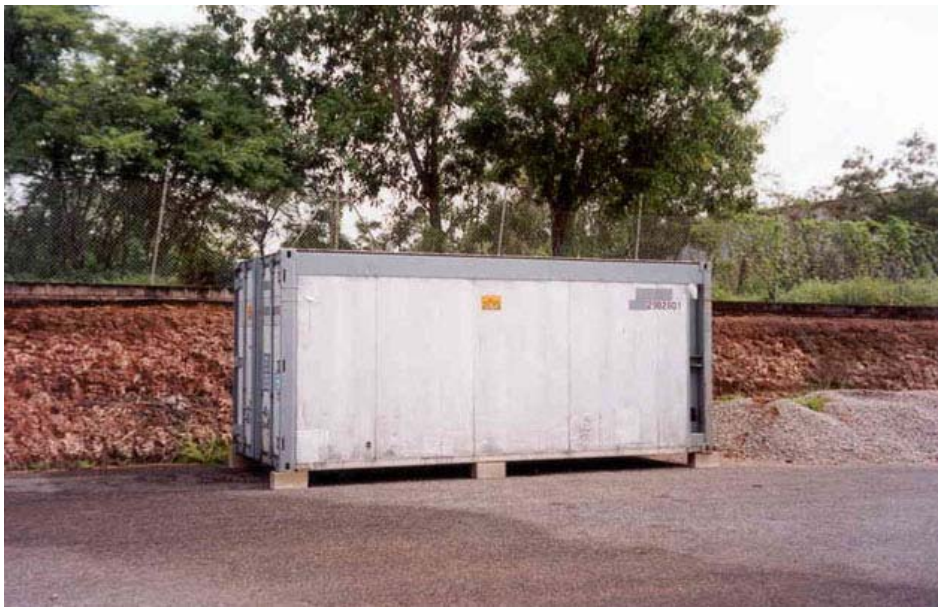
Stephen Yorke, Pat Jackson and Ted Ling would like to thank PARBICA for its support and assistance during this project.

8. ATTACHMENTS

8.1 Shipping container being placed in position

8.1a

8.1b



8.2 Roof structures for shipping containers used to store records

Photographic illustrations of the type of roof structure that could be used with a shipping container. A roof structure was not used in the Darwin trial (Photographs taken by Earl Carter, on behalf of Sean Godsell; reproduced with permission).

8.2a

8.2b

8.3 Shipping container environmental test results

Date	Time	Temp (°C) DL1	Temp (°C) DL2	RH% DL1	RH% DL2
31-Mar-01	600	28	28	75	84
31-Mar-01	1800	31	31	76	83
07-Apr-01	600	30	30	75	84
07-Apr-01	1800	31	31	76	82
14-Apr-01	600	30	30	75	82
14-Apr-01	1800	31	32	75	81
21-Apr-01	600	28	28	76	84
21-Apr-01	1800	30	31	76	83
28-Apr-01	600	29	29	76	84
28-Apr-01	1800	32	32	75	83
03-May-01	600	30	30	76	84
03-May-01	1800	30	30	76	84
10-May-01	600	28	28	76	83
10-May-01	1800	30	31	79	82
17-May-01	600	28	28	77	84
17-May-01	1800	31	31	76	83
24-May-01	600	26	26	76	84
24-May-01	1800	28	28	76	81
31-May-01	600	25	25	76	83
31-May-01	1800	27	28	76	82
07-Jun-01	600	28	28	77	84
07-Jun-01	1800	30	30	76	82
14-Jun-01	600	29	29	76	85
14-Jun-01	1800	31	31	76	83
21-Jun-01	600	27	27	75	83
21-Jun-01	1800	28	28	76	81
28-Jun-01	600	26	26	76	83
28-Jun-01	1800	29	30	76	81
07-Jul-01	600	27	27	76	83
07-Jul-02	1800	29	30	75	81
14-Jul-02	600	17	17	45	45
14-Jul-02	1800	20	20	42	43
21-Jul-02	600	26	26	48	50
21-Jul-02	1800	24	24	48	50
28-Jul-02	600	24	23	74	81
28-Jul-02	1800	25	26	74	79
04-Aug-02	600	26	25	74	83
04-Aug-02	1800	27	28	75	80
11-Aug-02	600	26	26	75	84
11-Aug-02	1800	28	28	75	81
18-Aug-02	600	27	27	75	82
18-Aug-02	1800	29	30	74	79
25-Aug-02	600	26	25	74	81
25-Aug-02	1800	28	29	74	80

01-Sep-02	600	27	27	75	83
01-Sep-02	1800	29	30	75	81
08-Sep-02	600	29	29	75	84
08-Sep-02	1800	30	31	75	82
15-Sep-02	600	30	30	75	84
15-Sep-02	1800	32	33	74	81
22-Sep-02	600	30	30	76	83
22-Sep-02	1800	32	32	75	83
29-Sep-02	600	31	31	75	83
29-Sep-02	1800	33	33	74	81
06-Oct-02	600	30	30	75	83
06-Oct-02	1800	32	33	74	81
13-Oct-02	600	31	31	75	83
13-Oct-02	1800	33	33	74	81
20-Oct-02	600	29	29	76	84
20-Oct-02	1800	31	32	75	83
27-Oct-02	600	32	32	74	83
27-Oct-02	1800	34	34	74	81
03-Nov-02	600	32	32	74	83
03-Nov-02	1800	34	35	74	81
10-Nov-02	600	32	32	75	84
10-Nov-02	1800	34	35	75	82
17-Nov-02	600	31	30	76	85
17-Nov-02	1800	33	33	75	82
24-Nov-02	600	33	33	75	84
24-Nov-02	1800	35	35	74	82
01-Dec-02	600	31	31	77	88
01-Dec-02	1800	33	34	77	85
08-Dec-02	600	30	30	77	88
08-Dec-02	1800	31	31	77	86
15-Dec-02	600	28	28	78	89
15-Dec-02	1800	31	32	77	86
22-Dec-02	600	31	31	76	86
22-Dec-02	1800	33	34	76	84
29-Dec-02	600	30	29	77	89
29-Dec-02	1800	32	33	76	86
05-Jan-02	600	29	29	77	87
05-Jan-02	1800	32	33	77	86
12-Jan-02	600	31	31	76	86
12-Jan-02	1800	32	33	76	84
19-Jan-02	600	30	30	77	89
19-Jan-02	1800	31	32	77	88
26-Jan-02	600	33	32	78	90
26-Jan-02	1800	34	35	77	87
02-Feb-02	600	32	32	77	88
02-Feb-02	1800	32	33	77	87
09-Feb-02	600	26	26	78	90
09-Feb-02	1800	26	26	79	90
16-Feb-02	600	30	29	79	91
16-Feb-02	1800	31	32	78	90

23-Feb-02	600	29	29	80	93
23-Feb-02	1800	30	30	80	92
02-Mar-02	600	30	30	80	92
02-Mar-02	1800	31	31	79	92
09-Mar-02	600	30	29	80	93
09-Mar-02	1800	32	32	80	94
16-Mar-02	600	30	30	81	95
16-Mar-02	1800	32	33	80	91
23-Mar-02	600	31	31	79	95
23-Mar-02	1800	33	34	80	94
30-Mar-02	600	31	31	81	95
30-Mar-02	1800	33	33	80	94

DL1 Datalogger 1, placed inside a box
DL2 Datalogger 2, placed on a shelf

8.4 Comparison of maximum and minimum temperature and relative humidity fluctuations

Date	External Temp Range (°C)	DL 1 Temp Range (°C)	DL 2 Temp Range (°C)	External RH Range (%)	DL1 RH Range (%)	DL1 RH Range (%)
1-Nov-2001	25-33	31-33	31-34	60-83	74-75	81-84
2-Nov-2001	26-35	30-34	30-34	46-94	74-75	81-84
3-Nov-2001	28-34	31-34	31-35	63-92	74-75	81-83
4-Nov-2001	23-34	31-35	31-35	51-93	73-74	80-83
5-Nov-2001	25-33	30-34	30-34	48-83	74-76	82-85
6-Nov-2001	26-31	31-33	31-33	65-94	75-76	84-85
7-Nov-2002	26-33	31-32	31-33	61-92	75-76	84-85

DL 1 Datalogger 1 (placed inside a storage box)
DL 2 Datalogger 2 (placed on a shelf)