VG432
Export of white onions

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Primary Industries SA

Know-how for Horticulture™

VG432

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INDUSTRY RECOMMENDATIONS

The following industry recommendations are made from this project:

1. Continued regular success in the shipment of white onions to European destinations will require a lot of attention to detail in the pre-harvesting, harvesting, curing and packaging stages. A well defined handling method which represents an industry best economical practice procedure for exporting white onions should be further developed if regular success is to be assured.

2. More monitoring of field temperatures and assessment of management treatments on the reduction of field temperatures eg. pre harvest irrigations, leaf cover, early harvesting would be beneficial in reducing harvest damage. A better understanding of critical temperatures in relation to potential for harvest damage is also required.

3. Adequate curing is critical to stabilise onions for the best possible shelf life. However, the reliable assessment of curing is still not easily achieved and there should be continued investigation of new and innovative methods to determine the adequacy of curing.

4. There are significant advantages in storing onions post packing in a controlled temperature and humidity environment. Consideration should be given to the installation of a forced air circulation system in the chamber to improve air circulation through the bags of onions.

5. For the export shipment of white onions through the tropics , the shipping and stowage systems in order of preference would be:
   Reefer > Fantainer, bulk bins > Fantainer, hand stow > Fantainer, palletised.

6. Forced air curing of the onions prior to grading and packing is recommended to reliably ensure the best possible curing.

7. If using fantainers, air flow rates through the container greater than that normally used for brown onions is recommended. However, thoroughly investigate the types of fans being used and their performance in relation to load static pressures and expected airflows.

8. Provide information and encourage the establishment of forced air drying systems for importers if shipping in reefer containers.

9. Simple handling instructions for the onions written in the appropriate language should be attached to each stow, particularly if shipped in reefer containers.

10. Use some form of temperature monitoring equipment in all containers.

11. Develop standardised handling and check procedures for fantainers and reefers.

12. Ensure a thorough Australian wharf checking procedure is in place for all containers to ensure they are on power from the time of arrival.

TECHNICAL SUMMARY

1. A first stage 'best practice' handling procedure for white onions for export was developed.

2. The assessment of onion temperatures in the field at or near the time of harvest showed:
   - 2.1 Onion core temperatures very closely follow air temperatures with little or no lag time
   - 2.2 Onions well exposed to the direct radiation of the sun can have core temperatures up to 5°C above air temperature in the hottest part of the day.
   - 2.3 Position of the onion in the row, degree of exposure, shading from leaf litter etc. can all have an impact on the core temperature of the onion, but harvesting procedures have to be related to the worst situation.

3. A laboratory test procedure was developed to test onions for their sensitivity to bruising.

4. The relationship between onion core temperature and the sensitivity to bruising was assessed with the following results:
   - 4.1 Volume of bruised flesh increased as temperature increased, mainly due to deeper penetration of the bruise.
   - 4.2 A linear relationship between bruising and temperature was obtained over the temperature range of 15-39°C.

5. Weight loss during curing as a indicator of adequate curing was tested with 4 samples in an open shed curing situation. Results were variable but some trends were evident in relation to the potential for constant weight loss as an indicator.

6. A post-packing storage chamber where the temperature and humidity were controlled was constructed for the storage of onions after packing. This resulted in an observed improvement in onion quality at the time of stowage compared to onions stored on the packingshed floor where they were exposed to cooler and damper night time conditions.

7. Laboratory storage tests under simulated tropical transport conditions (high temperature and high humidity) were used to test a range of harvesting, curing and handling treatments as well as the effects of air exchange rate on onion spoilage. The test was very severe with 12 days storage with the temperature greater than 30°C and the relative humidity greater than 90%. The results showed:
   - 7.1 There were no handling systems found to be far superior to any other treatment. Overall spoilage levels were high for all treatments.
   - 7.2 The quantity of sound onions varied from 0.31% to 3.97%. When combined with the quantity of onions showing only minor Aspergillus infections and skin staining, the percentage values rose to between 13.6 and 41%.
   - 7.3 Airflow over the onions during storage influenced the degree of wastage, with more wastage in the lower airflow containers.

8. Results and observations from the export trial shipments were:

8.1 With the reefer containers there was a range of handling problems which reduced their effectiveness but in general they gave a superior outturn compared to the fantainers. Onions arrived in a firmer and fresher condition which was noted by the importers.

8.2 Onions in one fantainer were shipped in bulk bins which outturned in excellent condition, equivalent to the reefers except in freshness and firmness.

8.3 Onions from a fantainer which was hand stowed outturned in better condition than fantainers with palletised stows. There was less evidence of long term wet areas in the stow and this was reflected in lower levels of skin staining and microbial spoilage.

8.4 No comparative data was collected on the effectiveness of the 375mm fans compared to the 300mm, but there was still spoilage problems with these fans when used for palletised stow fantainers.

8.5 Onions which were forced air cured outturned at least as well and in many cases better than those field or shed cured.

8.6 There was a significantly shorter period of tropical conditions exposure (7 days vs 15 days), for those onions which were transhipped through Durban, South Africa. Disadvantages of this are the overall longer voyage time and the risks associated with trans-shipping.

8.7 Importers lack the knowledge of handling techniques and adequate facilities to minimise the condensation on onions arriving in refrigerated containers.

INTRODUCTION

Onions from Australia and New Zealand have been exported to Europe for many years and it has developed in a large and well organised export operation. The principal cultivar exported is the brown skinned 'Creamgold' and related type cultivars. Australian initiative and R&D activities developed the fantainer system as a less costly (than refrigerated containers) method of shipping our onions to Europe. This system has proved to be an efficient and relatively reliable means of shipment for the firm and resilient 'Creamgold' types.

A niche market exists in Europe for good quality white onions in their late winter and early spring period when new season onions from early districts in Spain and other Mediterranean countries are not yet available. The first of these onions also have poor keeping quality and high quality imports can effectively compete in the market place.

Successful export shipments from South Australia to capture this market have been made in the last 10-15 years. However, prior to 1995 there was increasing importer resistance and continually declining sales primarily due to poor outturn. High levels of skin staining and Aspergillus mould infection were the principle causes of the poor outturn. The onions were always shipped in the standard configuration fantainer used for the shipment of brown onions.

The relevant sector of the onion industry in South Australia decided to invest in a R&D project to try and improve this situation. The whole white onion production and handling system from harvesting to importer receival was reviewed and key potential problem areas were targeted for the R&D activities. These activities included some field observations and assessments, curing practices, post packing storage, shipping systems and stowage methods. Both laboratory experiments and trial export shipments were undertaken as part of the project.

PROJECT WORK SUMMARY, METHODS AND RESULTS

1. DEVELOPMENT OF HANDLING PROCEDURE

1.1 Handling Procedures Review

Prior to the harvesting season the 3 key growers supplying onions for the white onion export market were interviewed to determine their normal harvesting and handling procedure for these onions. The information was tabulated and a summary document prepared which outlined the desirable handling procedure for white onions destined for the export market. This was reviewed by the producers and packers and changes made to better suit their handling practices. In view of the doubts about the real causes of the previous poor outturn problems and the high capital cost in implementing some of the recommendations, it was decided to not treat all onions according to the developed handling procedure but ensure that some were handled this way and test the outturn against the growers normal handling procedure.

1.2 Handling Recommendations

The handling procedure developed covered the aspects of harvesting, curing, transport, grading and packing, post packing storage, containerisation and wharf storage. In addition there were some procedures developed for the handling and stowage of reefer containers. The handling procedure developed is attached in Appendix 1.

1.3 Future Development

The laboratory testing and trial export shipments did not provide any evidence of major problems in the handling procedure of any of the producers whether following the documented procedure or their normal procedures. However, this document is the first step in outlining a handling system which will provide for maximising reliable and consistent outturns under a wide range of climatic and storage conditions during harvesting and packing. Producers and packers should be developing their handling procedures along these lines to minimise the risk of poor outturns in the future.

Revision and refinement of the document in the future to provide more objective requirements and measurements will be necessary to develop the handling procedure into an industry standard document.

2. HARVESTING AND CURING

2.1 Field Temperature Assessment

There is a general understanding within the onion industry that harvesting on days of high ambient temperatures is not good for the onions and there are increased levels of damage, particularly bruising. It is also a generally held belief that onion core temperatures lag several hours or more behind the rising air temperatures.

Temperature dataloggers were placed in the field to determine onion surface and core temperatures in relation to air and soil temperatures in the final few weeks preceding harvest. On several days temperatures were also taken at a range of sites and throughout the day using a hand held temperature meter.

Manual temperature meter readings for onions at 4 sites are recorded in Table 1. Readings at sites 1-3 were taken on a warm to hot day and those at site 4 on a very hot day. Onion core temperatures were generally very close to the air temperatures and at the first 3 sites slightly lower than the air temperature. Onion surface temperatures were usually 2-3 degrees warmer than the core temperatures and there appeared to be little influence of shading or exposure on the core temperatures. Although the ambient temperatures during collection of the site 4 data were higher than for the other 3 sites, the difference between soil, onion surface and core temperatures and air temperatures are much greater than for the other 3 sites, particularly the soil temperatures. The first 3 sites all had damp soils which could be the reason for this difference. The potential benefit of light irrigations to reduce soil and onion core temperatures should be investigated.

Figure 1 clearly demonstrates the daily fluctuations in the onion core temperatures in relation to the air temperature. This data supports the manually collected data that the onion core temperatures very closely follow the air temperature and during the hottest part of the day can exceed the shade air temperature by as much as 5°C.

Table 1.: Field temperatures of onions from various sites at selected times during the day.

(a) Site 1 : Small white onions on damp sandy loam soil.

Onion Location Description	Test Time	Temperature				
		Air	Soil	West	East	Core
Onion covered by leaf	11:15am	23.5	21.3	24.6	24.1	21.7
	11:55am	28.4	23.2	28.3	29.3	23.7
	1:20pm	28.3	26.4	31.5	34.4	27.9
	1:50pm	29.7	27.3	34.1	36.1	28.7
Quarter exposed, leaf covered	11:15am	23.5	21.3			20.8
	11:55am	28.4	23.2			23.5
	1:20pm	28.3	26.4			29.7
	1:50pm	29.7	27.3			30.4
Half exposed	11:15am	23.5	21.3		23.1	21.9
	11:55am	28.4	23.2		26.5	24.3
	1:20pm	28.3	26.4		30.1	28.6
	1:50pm	29.7	27.3		31.1	29.7

Table 1 contd.

(b) Site 2 : Medium white onions on a damp sandy loam soil.

Onion Location Description	Test Time	Temperature				
		Air	Soil	West	East	Core
Quarter exposed, east side of bed	11:00am	23.6	24.3	24.2	24.4	22.8
	11:50am	28	27.8	29.5	27.9	26.8
	1:15pm	30.3	32.8	35.2	33.2	32
	1:35pm	33.9	33.2	36.9	34.3	33.1
Leaf covered, centre of bed	11:00am	23.6	24.3			22.5
	11:50am	28	27.8			26.1
	1:15pm	30.3	32.8			30.8
	1:35pm	33.9	33.2			31.7
Mostly leaf covered, centre of bed	11:00am	23.6	24.3			21.2
	11:50am	28	27.8			24.1
	1:15pm	30.3	32.8			27.8
	1:35pm	33.9	33.2			28.3
Exposed	11:00am	23.6	24.3			23.2
	11:50am	28	27.8			26.3
	1:15pm	30.3	32.8			30.3
	1:35pm	33.9	33.2			30.8
Exposed	11:00am	23.6	24.3			22.6
	11:50am	28	27.8			25.6
	1:15pm	30.3	32.8			29.3
	1:35pm	33.9	33.2			29.7

(c) Site 3 : Large white onions on a damp sandy loam soil.

Onion Location Description	Test Time	Temperature				
		Air	Soil	West	East	Core
Three quarter exposed	10:30am	21.8	22.4	21.9	23.9	22.2
	11:45am	27	28.9	27.2	32.3	27.6
	1:00pm	30	34.1	31.7	36.6	32.6
	1:30pm	30.7	35.6	34.9	37.9	33.9
Three quarter exposed	10:30am	21.8	22.4			22.2
	11:45am	27	28.9			27.4
	1:00pm	30	34.1			31.2
	1:30pm	30.7	35.6			31.7
Three quarter exposed	10:30am	21.8	22.4			21.2
	11:45am	27	28.9			28.7
	1:00pm	30	34.1			29.5
	1:30pm	30.7	35.6			30.1
Exposed, east side of row	10:30am	21.8	22.4			26.4
	11:45am	27	28.9			30.4
	1:00pm	30	34.1			32.8
	1:30pm	30.7	35.6			32.9
Exposed, east side of row	10:30am	21.8	22.4			24.6
	11:45am	27	28.9			28.7
	1:00pm	30	34.1			31.2
	1:30pm	30.7	35.6			31.4

There is some evidence for onions less exposed (deeper in the soil) to not reach the temperature extremes of the more exposed onions. Soil temperatures at 2.5cm are buffered in relation to air temperatures but still have a large daily variation and would have little or no influence on onion core temperatures.

Table 1 contd.

(d) Site 4 : Large white onions on dry sandy soil.

Onion Location Description	Test Time	Temperature				
		Air	Soil	West	East	Core
Half exposed on surface	3:15pm	42.6	47.6	48.9	45.1	46.1
	4pm	42.3	50.9	48.2	46.4	46.6
Half exposed, medium size	3:15pm	42.6	53.4	49.7	45.4	45.8
	4pm	42.3	51.3	49.4	46.4	48.3
Quarter exposed, leaf covered	3:15pm	42.6	53.4			43.2
	4pm	42.3	51.3			45.1
Half exposed, no leaf cover	3:15pm	42.6	53.4			47.4
	4pm	42.3	51.3			47.4
Large onion, half exposed	3:15pm	42.6	57.9	46.5	45.8	39.3
	4pm	42.3	50.8	49.3	48.2	41.4
Medium size, three quarter exposed	3:15pm	42.6	57.9			45.7
	4pm	42.3	50.8			46.4

Figure 1:White onion core temperatures in relation to shade air temperature and soil temperature at Mypolonga. South Australia during February 1995. (a) 6th and 7th February; (b) 8th and 9th February; (c) 14th and 15th February.

(a)

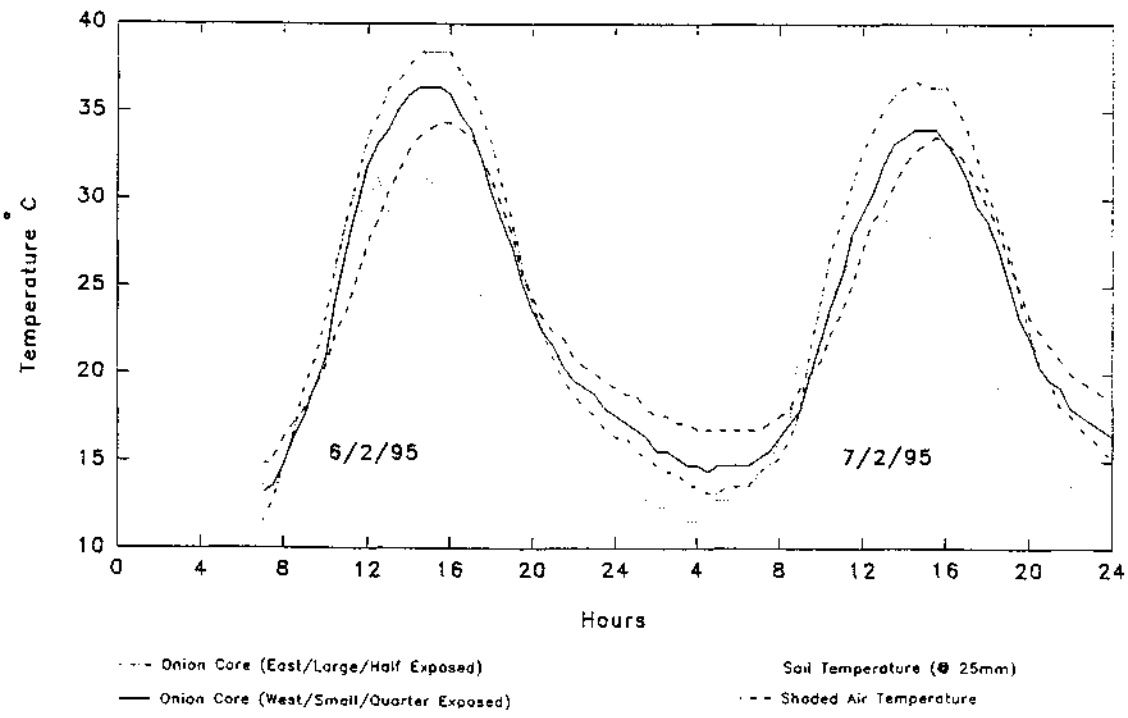
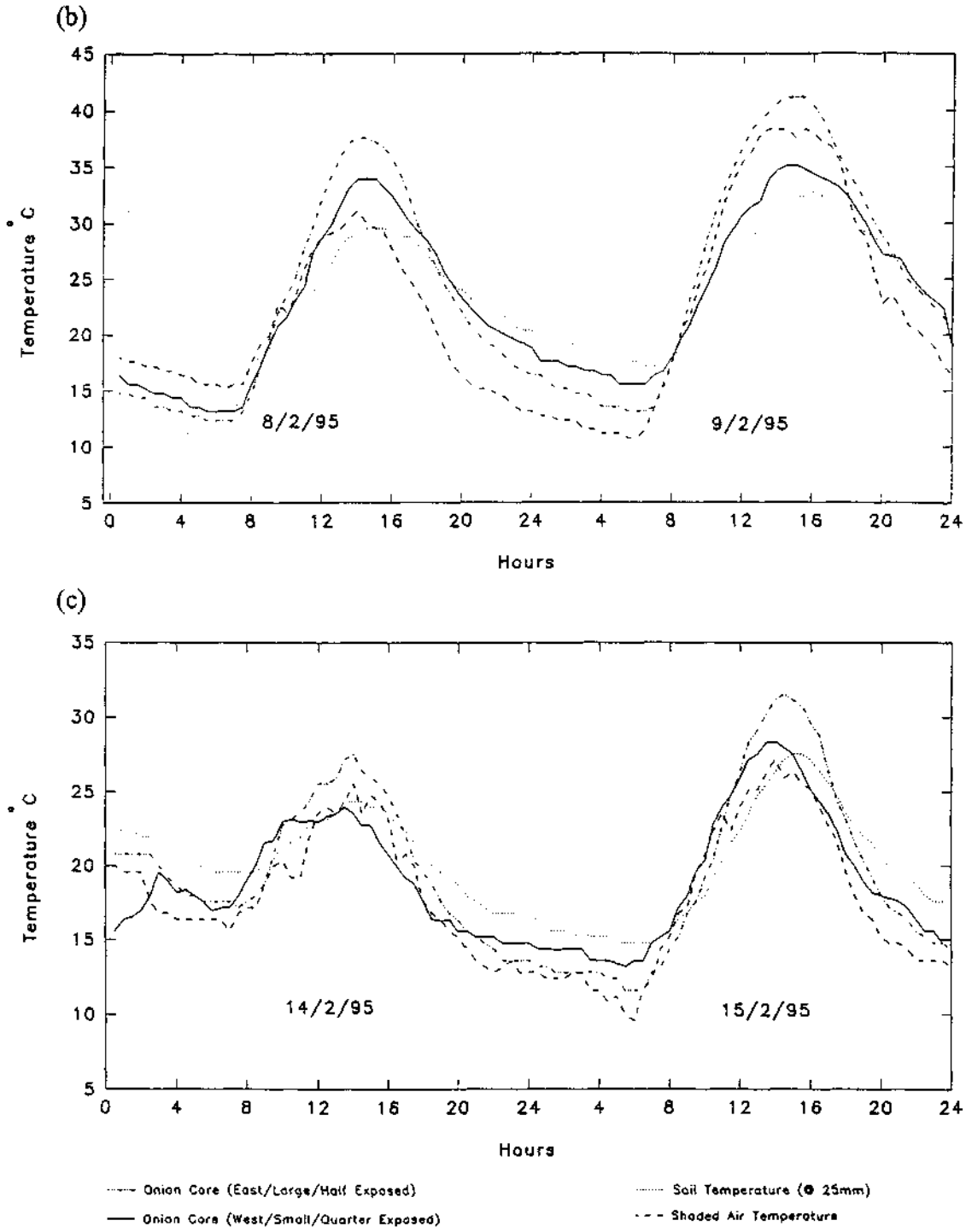


Figure 1 contd.



2.2 Bruising and Harvest Conditions

During hot weather conditions, onion are not harvested due to an increased damage, particularly from bruising on the harvesting machinery. During this project it has been shown that onion core temperatures closely follow ambient air temperatures and can reach core temperatures near 50°C on very hot days. However, there has been no attempts to date to relate core temperatures to degree of bruising or to define a critical

temperature at which to cease harvesting. The objective of this experimental work was to develop a standardised bruising and assessment method and then test the relationship of core temperature to the extent of bruising.

A test rig was set up consisting of a piece of 20mm PVC pipe 620mm long through which a coach head bolt with nuts attached (45.6g) was dropped onto the onion. To hold the onion in place, four sharpened pins were attached to the base of the pipe. Prior to dropping the bolt, the head was pressed onto an ink pad to provide an ink mark on the onion skin to indicate the point of impact.

Onions prior to bruising were heated to the test temperature for 24hrs prior to bruising in a controlled temperature cabinet. After bruising the onions were assessed by cutting the onion in halves through the bruise site and placing the cut face of the onion into a petri dish of lactophenol methyl blue thinned using 98% ethanol. After staining for 30 seconds, the halves were removed and placed on hand towel to absorb the excess stain and onion juice. The bruise area was stained dark blue and the width and depth recorded.

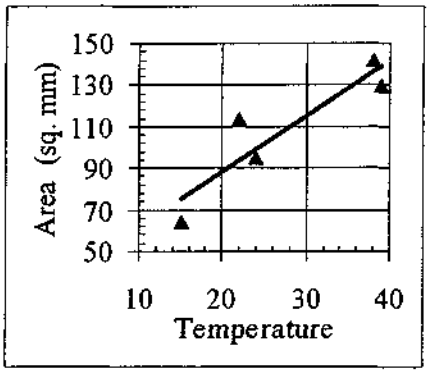
Onions for the bruise testing were from one site, harvested on the same day and stored for 6 weeks at 10°C prior to testing. A sample of between 40 and 50 onions was tested at each temperature.

Table 2 : Onion bruise width and depth (mm) in relation to onion core temperature at the time of bruising.

Temperature	Width	Depth
15	13.88	4.61
22	15.82	7.15
24	14.46	6.54
38	16.37	8.66
39	15.44	8.41

Test results showed that the area of bruised flesh stained after halving the onion, increased as the onion core temperature at the time of bruising increased (Figure 2). This was principally due to an increase in the depth of the bruise with little change in the width (Table 2). The width is probably closely related to the surface area of the impact object and during harvesting and handling the width of the bruise will most likely be related to the size and nature of the object causing the bruise. Hence it is likely that harvesting under high temperature conditions allows increased bruise damage due to bruises penetrating deeper into the onion.

Figure 2 : Onion bruise area (mm^2) in relation to onion core temperature at the time of bruising.



There has been no attempt during this work to define a critical bruise depth (volume) in relation to a commercially acceptable damage level. The limited data collected to date indicates a linear relationship and if this would continue to hold true in future tests then the definition of a critical harvest temperature will be difficult. Further testing is required to better understand the situation, particularly with onions which have been freshly harvested as this will possibly influence the results.

2.3 Curing Tests

2.3.1 Treatments

Adequate curing of onions is essential to ensure the best possible shelf-life and minimise the impact of possible high temperature and high humidity conditions during transit. In the project, four different curing treatments were applied to the onions prior to grading and packing. Onions from these treatments were used in both the export shipments and laboratory experiments. The four basic curing and handling techniques used are described below.

(a) Partly Green plus Forced Air Curing

Forty bins of onions without topping and tailing were harvested directly into bins prior to complete drying of the tops. The onions were cured with a forced air curing system for 5 days and then left in an open shed at the packing shed for a further 7 days prior to grading and packing. The forced air fans were operated continuously for the 5 days of curing. Maximum daytime temperatures ranged from 27 - 33.5°C with minimum at night in the 5 - 10°C range (Figure 3(a)). During the first 15 hours of curing, the air temperature on the inside air plenum chamber was approximately 1°C cooler than the ambient air. This is most likely due to the evaporative cooling effect of moisture vaporising from the onion surface and leaves (Figure 3(a)). As expected the core temperature of onions not near the surface of the bin changed in temperature more slowly and to a lesser extent than those on the surface Figure 3(a)). Relative humidity readings taken during the curing run (Figure 3(b)) show that an increase of around 20% (maximum daily difference at early pm) occurred as the air passed through the bins of onions. By early pm on the last day (9/2), this had reduced to around 15% which would suggest that some drying of the onions had occurred. It is unlikely that moisture loss had reached a constant rate at the completion of this curing run and hence curing may not have been as good as possible.

(b) Field Cured plus Forced Air Curing

Bins of field cured onions were placed on the forced air curing system for 5 days and packed at the completion of this curing treatment. During this run the forced air fans were switched off from approximately 7pm until 9:30am the following morning. Figures 4(a) and 4(b) show the temperatures and relative humidity recorded during this run. The effect of having the fans off at night is evident in the onion core temperatures showing little decline at night (Figure 4(a)). Despite the generally lower

Figure 3(a): Temperature data relating to forced air curing of onions (Run 1).

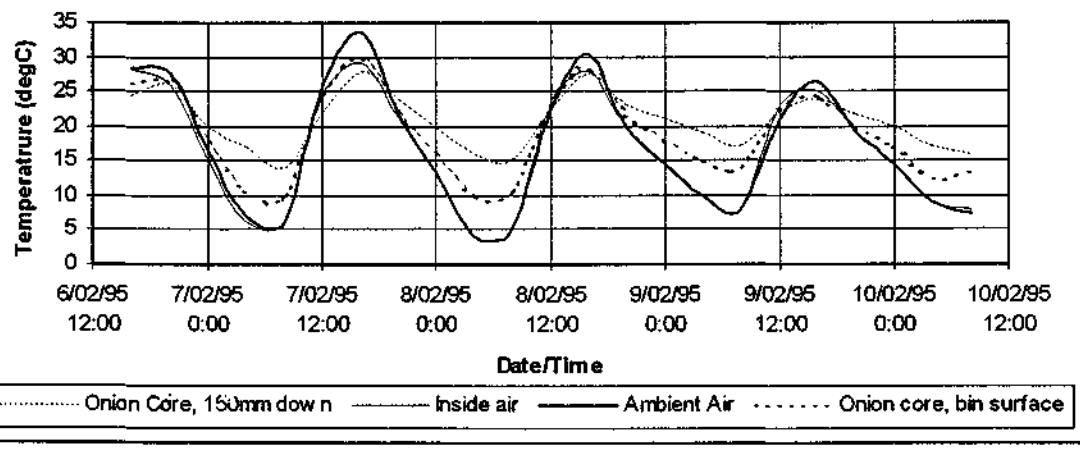
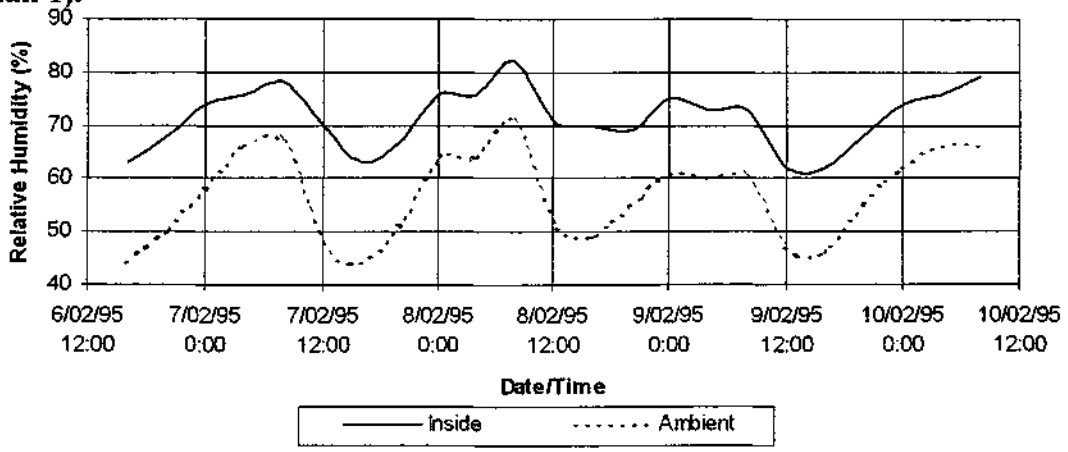


Figure 3(b): Relative humidity data relating to the forced air curing of onions (Run 1).



ambient relative humidity during this run and higher average ambient temperatures there is less moisture loading (RH increase) of the air as it passes through the bins of onions (figure 4(b)). This is probably due to the more advanced cured stage of the onions in this run (ie field cured versus some green tops).

Figure 4(a): Temperature data relating to the forced air curing of onions (Run 2).

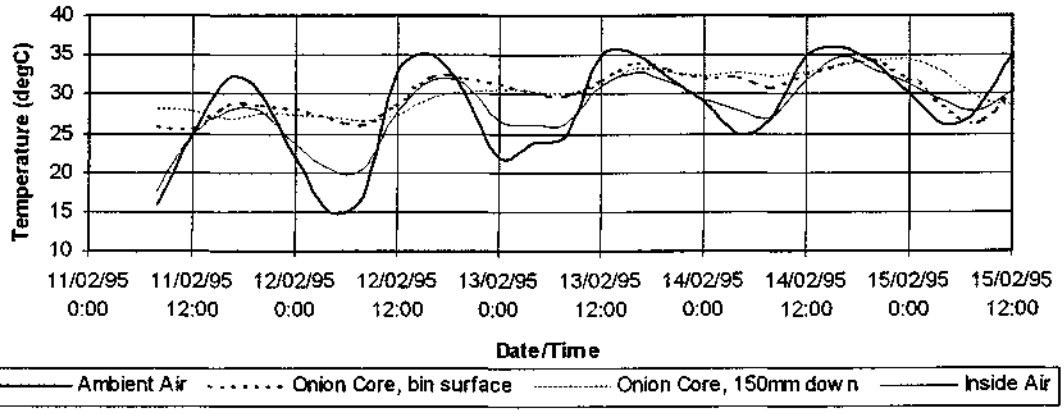
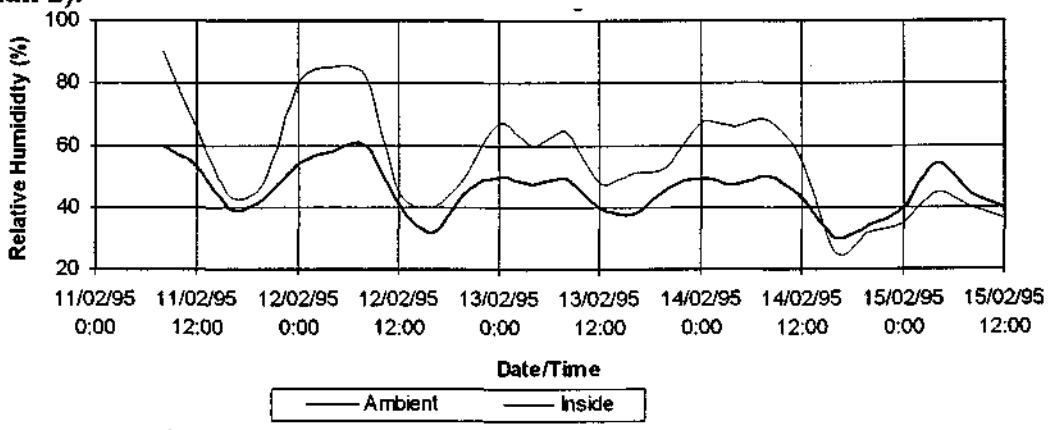


Figure 4(b): Relative humidity data relating to the forced air curing of onions (Run 2).



(c) Partly Green plus Open Shed Curing

The same onions as used in curing treatment 1. were used in this test except they were cured by placing in a well ventilated, open sided shed for a similar period of time. Temperature and relative humidity data recorded for this shed are shown in Figures 5(a) and 5(b).

Figure 5(a): Temperature and relative humidity data for onions cured in bins in an open sided shed.

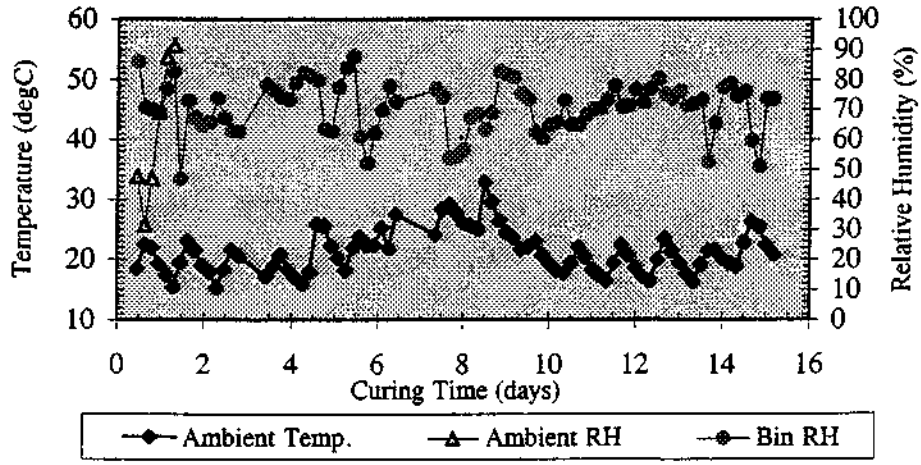
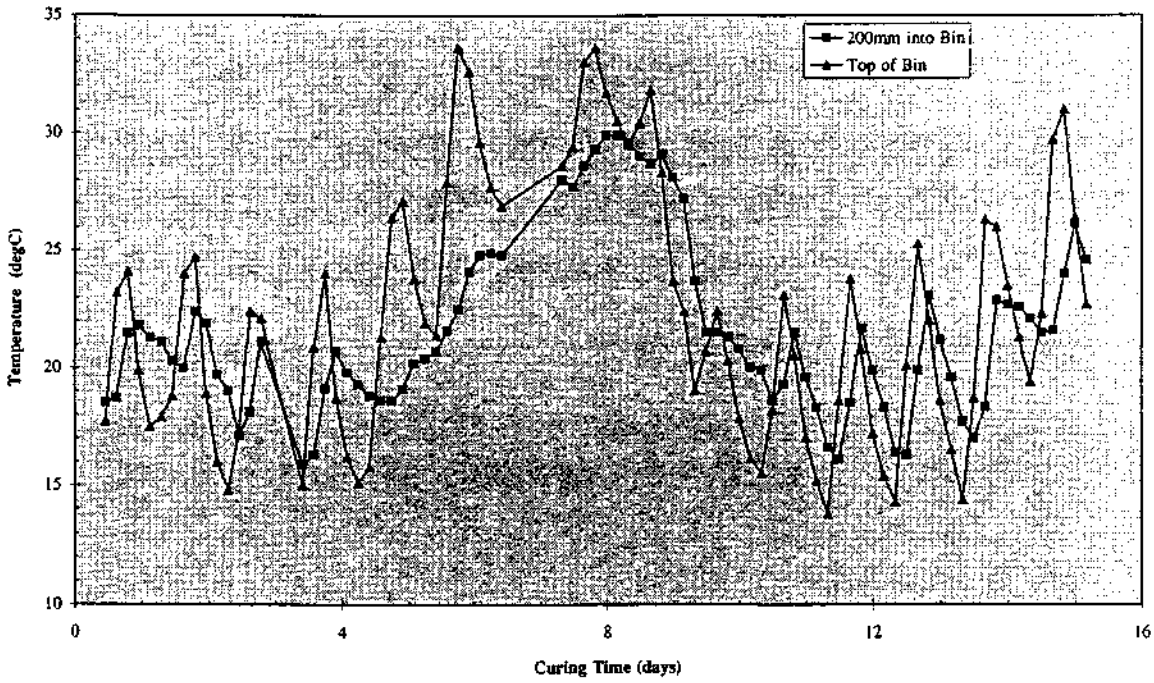


Figure 5(b): Core temperature of onions on the surface of a bin and at 200mm deep in the bin during curing in bins in an open sided shed.



(d) Field Cured Onions

Onions were left in the field until all the tops had dried, they were then undercut and left in the field for a further 1 - 2 days before picking up into bins. These were the same onions as used in treatment 2. except they were not forced air cured.

2.3.2 Laboratory Experiments

Laboratory testing was designed to test the impact of the curing treatments and air flow rate during storage on the resistance of the onion to Aspergillus infections and skin staining under severe tropical conditions (high temperatures and high humidity). A controlled temperature storage room at the SARDI Plant Research Centre was set-up to approximately simulate sea shipment voyage from Australia through the tropics to Europe.

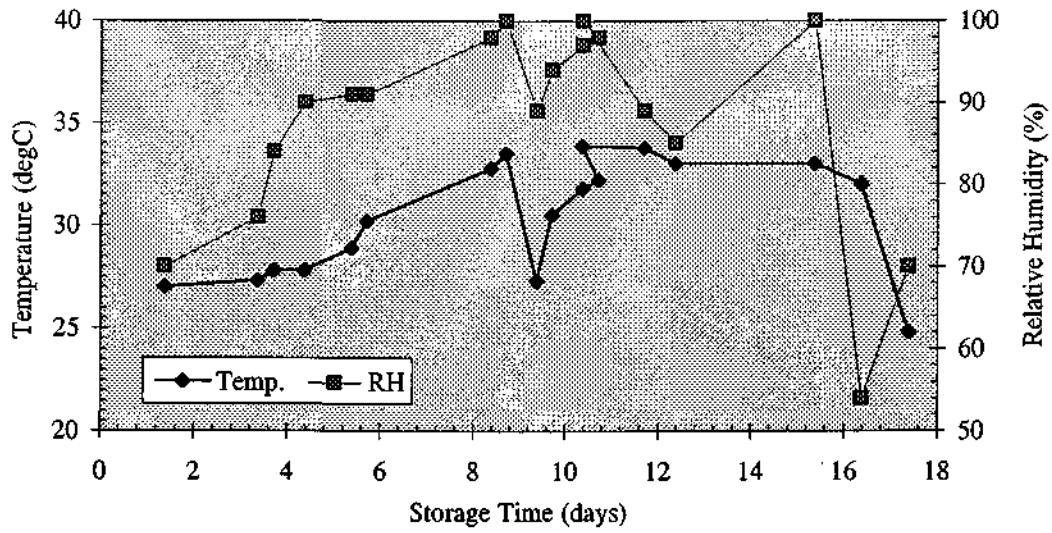
The proposed temperature and relative humidity settings for the room are outlined in Table 3.

Figure 6. shows the actual temperature and relative humidity data for the storage room.

Table 3.: Proposed Temperature and Relative Humidity Conditions for Simulated Tropical Sea Shipment of Onions.

Day No.	Temperature (°C)	RH%
0	27	70
2	30	85
4	34	95+
11	30	85
15	25	70
22	Start Onion Assessment	

Figure 6: Temperature and relative humidity conditions during simulated sea shipment storage trials.



(a) Curing Treatment Post Packing Storage Comparison.

Onions from 7 different curing and handling regimes (Table 4.) were packed into a 1.2 metre square wooden base with a slatted base inside the controlled environment room. Air was drawn over the onions, using a fan in the lid of the base at a rate equivalent to 50 air changes per hour. Three 20 kg bags of onions from each of the 7 treatments were placed randomly into the box and not disturbed for the duration of the trial.

Test samples 7, 5 and 3 are the samples arising from the curing treatments (a), (b) and (d) respectively, as described in Section 2.3.1.

Table 4: Description of laboratory experimental test samples.

No	Sample Description
1	Open shed, bin cured, 7 days post packing storage on packingshed floor, cv Southland.
2	Open shed , bin cured, post packing storage in heated storage room, cv Southland.
3	Fully dried before harvest, field cured, post packing storage in heated storage room, cv Southland.
4	Open shed , bin cured, post packing storage in coolstore at 4°C, cv Southland.
5	Field cured, forced air cured in bins, post packing storage in heated storage room, cv Southland.
6	Open shed, bin cured, 1 day post packing storage on the shed floor, cv. Southland.
7	Early harvested, forced air cured, post packing storage in heated storage room, cv Yates.

Storage results (mean of 3 bags) are summarised in Table 5. The quantity of sound onions in all samples was very low which is indicative of the severity of the treatment. percentage of onions assessed as marketable ranged from 13.6% (Sample 7.) to 41.4% (Sample 3.). The poor performance of Sample 7. was primarily due to a cultivar effect. This was the only Yates cultivar sample in this trial and there was no direct comparison of a field cured sample. In the export shipments, the Yates cultivar had a less successful out-turn than the Southland cultivar.

Table 5: Percent sound marketable and spoiled onions from experimental tropical storage trial.

Sample No	Sound	Soft Rots	Aspergillus			Staining		Marketable(6)
			Mild(1)	Moderate(2)	Severe(3)	Mild(4)	Severe(5)	
1	0.34	13.75	8.71	14.18	28.69	16.85	17.49	25.9
2	1.28	14.14	16.87	19.18	19.94	14.76	13.83	32.91
3	2.91	11.8	10.13	16.15	9.29	28.38	21.1	41.42
4	2.83	18.36	14.78	20.21	15.96	15.17	12.69	32.78
5	3.57	14.34	11.56	15.13	9.36	19.94	26.1	35.07
6	3.97	15.49	11.53	14.15	15.63	17.87	21	33.37
7	0.31	30.09	4.63	14.83	29.46	8.71	11.96	13.65

Notes:

(1) Less than 25% of the surface area affected.
(2) 25-50% of the surface area affected.
(3) More than 50% of the surface area affected.
(4) Less than 40% of the surface area affected.
(5) More than 40% of the surface area affected.
(6) Combined percentage of sound, mild aspergillus and mild staining percentages.

In comparing all the Southland samples (Nos 1 - 6) there was little difference between any of the samples. Storage of the onions outside of the heated storage room for an extended period (7 days) may lead to a decrease in marketable yield (Sample 7.) As a Demonstration type trial, none of the differences between samples 1. - 6. were large

enough to conclude that any of the treatments were a significant improvement in handling.

(b) Variable Air Flow Comparison

Three wooden boxes (400 mm square) with a slatted base were loaded with 60 kg of bulk onions. Each box was fitted with a sealed lid with a variable speed fan attached. Fan speeds were adjusted to obtain air flows equivalent to approximately 30, 50 and 80 air changes per hour. The rate of 50 and 80 air changes per hour were chosen to approximate the air flow in onion fantainers fitted with 300 and 375 mm fans. Fantainers equipped with both size fans were used in the export shipments. Onions for this test were taken from curing treatment 1. described above. The percentage of sound and marketable onions from this test was very low (Table 6.). There was a trend for an outturn of better quality onions from the 80 air changes per hour storage but differences were small.

Table 6. Effect of airflow rate (air changes per hour) on the percent of sound, marketeable and spoiled onions exposed to simulated severe tropical enviroment conditions.

Air Flow	Sound	Soft Rots	Aspergillus			Staining		Marketable(6)
			Mild(1)	Moderate(2)	Severe(3)	Mild(4)	Severe(5)	
30	0.98	16.73	10.91	17.67	29.73	9.34	14.64	21.23
50	1.63	19.72	7.58	20.94	26.74	13	10.4	22.21
80	2.51	15.66	10.52	17.9	21.01	13.69	18.7	26.72

Notes:
(1) Less than 25% of the surface area affected.
(2) 25-50% of the surface area affected.
(3) More than 50% of the surface area affected.
(4) Less than 40% of the surface area affected.
(5) More than 40% of the surface area affected.
(6) Combined percentage of sound, mild aspergillus and mild staining .

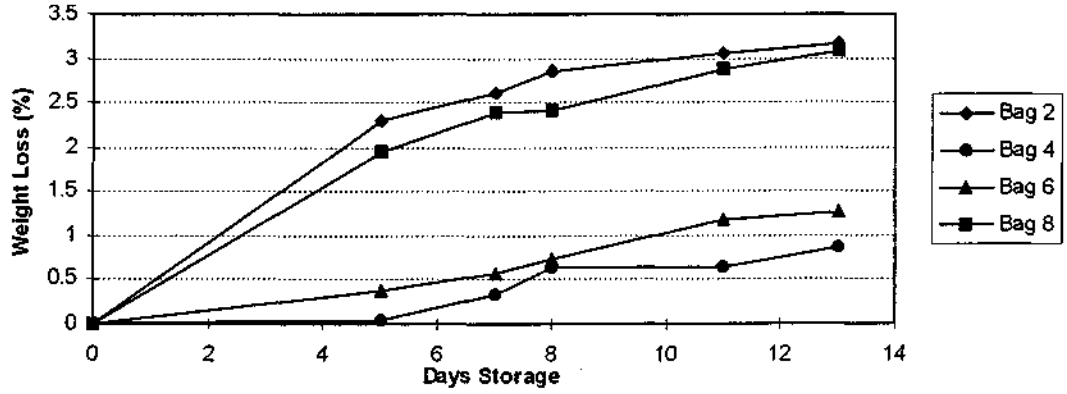
2.4 Adequate Curing Tests

The weight loss of onions during curing has been used by other researchers as a means of assessing whether curing is adequate or complete. Theoretically when the rate of loss of weight reaches a constant value, the moisture loss is then from deep within the onion and hence curing is complete as all the excess surface moisture has been lost.

This technique was assessed in a preliminary way during the project by monitoring the change in weight of a representative sample of 1 - 1.5 kg of onions in a net bag placed on the surface of bins in an open storage shed. The history of the onions ie harvest time, weather conditions at time, degree of field curing etc used in the test samples was not known and could be the reason for the differences in cumulative weight loss observed between the samples (Figure 7.). The bag 4 and 6 samples may have been from bins harvested on a hot dry day from a field of onions which had well dried and matured tops. However the rate of weight loss was relatively constant over the last 6 days of storage at 0.094, 0.089, 0.115 and 0.114% per day for Bags 2, 4, 6 and 8 respectively.

The results from this brief assessment suggest that monitoring weight loss could be useful in assessing the adequacy of curing. Further work is required to confirm these results and the practical assessment of onions in the centre of bins still needs to be assessed.

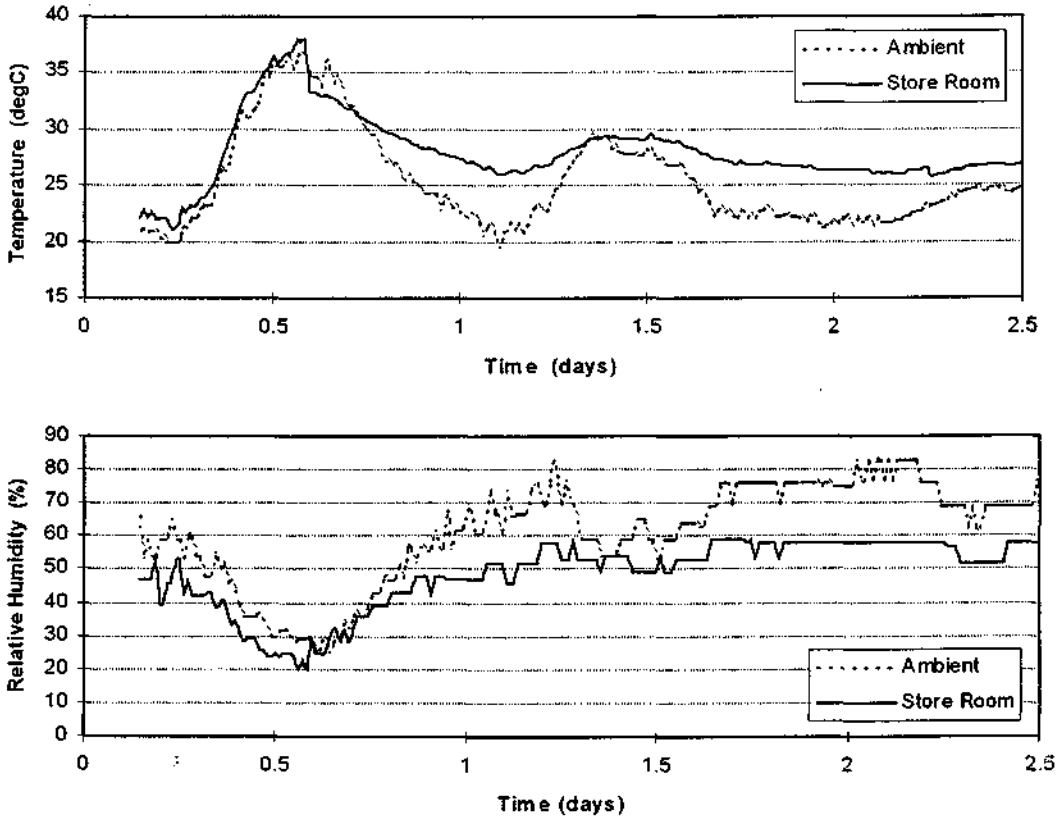
Figure 7: Cummulative weight loss during curing of onions on the tops of bins stored in a open sided shed.



2.5 Post Packing Storage Conditions

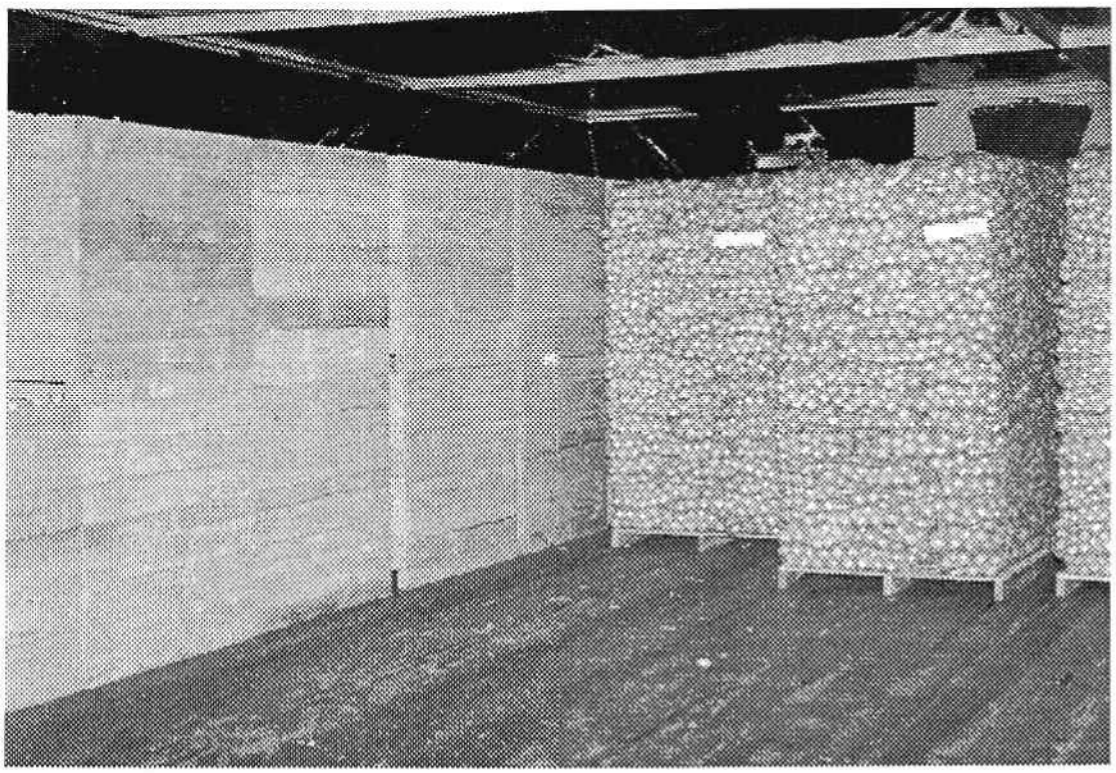
A post packing storage chamber was constructed at the principal onion packing shed involved in this project. The conditions in this chamber were controlled to keep the temperature greater than 20°C and the relative humidity below 75%. Condition control was achieved with an automatic computerised control system which controlled the heating and ventilation of the room. After grading and packing, pallets of onions were held in this store until either placed into the coolstore for pre-cooling for refrigerated shipment or loaded into the shipping fantainers. Typical temperature and RH conditions in the chamber over a 3 day period are shown in Figure 8.

Figure 8: Example of temperature and relative humidity conditions in the post packing storage chamber compared to ambient conditions.



The results of laboratory tests with onions from the store versus samples held in the open packingshed suggest that there are some potential benefits (Table 4.). On site observations were that onions from the store always had a very crisp and dry feel to them when loading into the shipping containers. This is not always the case with onions held on the packingshed floor where they are often exposed to cool damp conditions at night.

Data collected at export outturn assessments was not sufficient to either support or discredit the use of the chamber, however, very few onions were handled outside the chamber because of the observed general benefits to onion quality.



Pallets and bulk bins of onions stored in the post packing storage chamber.

3. EXPORT SHIPMENTS

During the export season of this project 13 containers of onions were shipped to destinations in Southern France on two different ships. Table 7. summarises the ships, container type and onion storage method used for each container. All pallets of onions were coded to identify their source and pre-shipment handling to allow for assessment of the impact of these factors on outturn conditions. All containers were equipped with temperature monitoring equipment ranging from electronic data loggers to simple use strip chart recorders.

The ship Floriani sailed from Adelaide on 13/3/95 and arrived in Durban on 12/4/95 for transhipment to the Aurora which arrived at Marseille on 3/5/95. The ship Nelson Bay sailed from Melbourne on 18/3/95 and arrived at Fos in Southern France on 28/4/95.

Table 7: Summary of ships, container types and onion stowage methods used for shipments to Farnce during this project.

Container No.[1]	Ship	Container Type	Stowage Method
1	Floriani	Reefer	Palletised
2	Floriani	Fantainer [2]	Hand Stowed
3	Floriani	Fantainer	Palletised
4	Nelson Bay	Reefer	Palletised
5	Nelson Bay	Fantainer	Palletised
6	Floriani	Fantainer	Bulk Bins
7	Floriani	Reefer	Palletised
8	Nelson Bay	Fantainer	Palletised
9	Nelson Bay	Reefer	Palletised
10	Nelson Bay	Reefer	Palletised
11	Floriani	Fantainer	Palletised
12	Nelson Bay	Fantainer	Palletised
13	Nelson Bay	Fantainer	Palletised

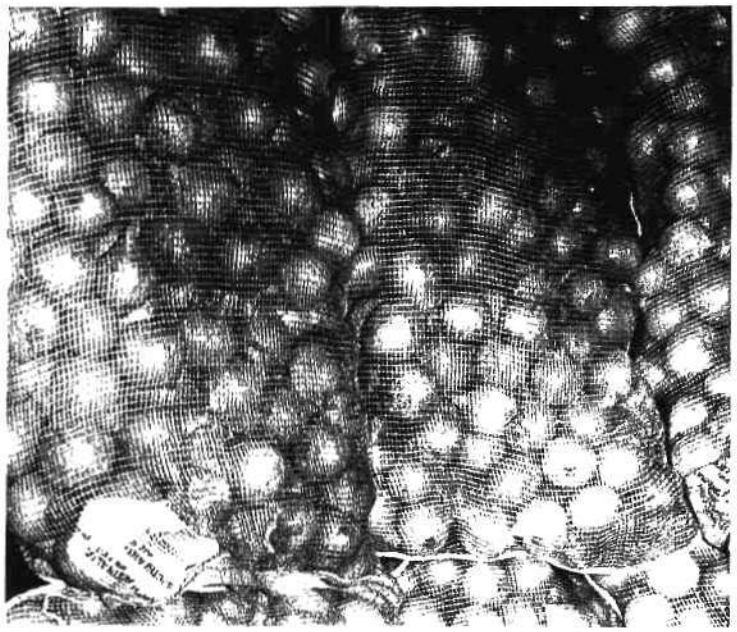
Notes: (1) Container numbers used here are the same as those used as references numbers in Appendix 4.
(2) All fantainers were fitted with 375mm diameter fans instead of the traditional 300mm fans. Fantainers on the Floriani were shipped with fans fitted in a rear bulkhead with doors held ajar. Fantainers on the Nelson Bay were constructed with a front bulkhead and fan/vent welded into the front of the container.

Containers were generally opened and inspected during unloading within 2 - 3 days of arrival. All inspections were undertaken at the importers premises. Appendix 2 contains all the details and assessment notes for each container. Summarised below are the results and discussion regarding key details on pre-shipment handling, storage methods, shipment methods etc.

3.1 Assessment and Commercial Acceptability

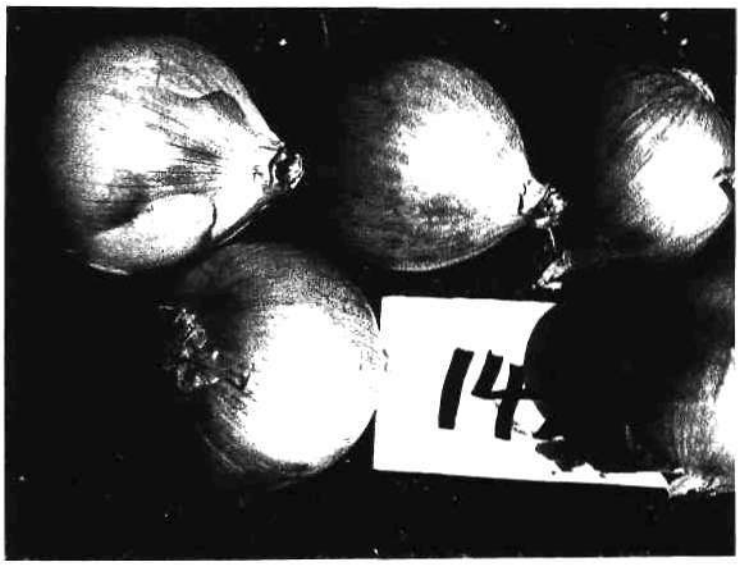
For each container inspected, a general assessment was made of the condition of the onions in the container. Where possible full assessments were made on bags from a range of positions within the stow. During the bag assessments all faults (staining, Aspergillus mould and rots) were counted and in many cases were of a minor nature and the onions were cleaned and packed into commercial packs. Hence commercial

packouts would be greater than the percentage of sound onions recorded for the bag assessments.



Increasing spoilage gradation in bags of onions from palletised fantainer stow.

Mild Aspergillus spoilage of white onions.



Skin staining and discoloration of white onions.

3.2 Varietal Variations

All codes ending in "Y" were for pallets of onions from one distinct cultivar and one production site. Although previously used for export with an acceptable performance, this season, its performance was very poor. This was also evident in the laboratory test (Table 4., sample 7.).

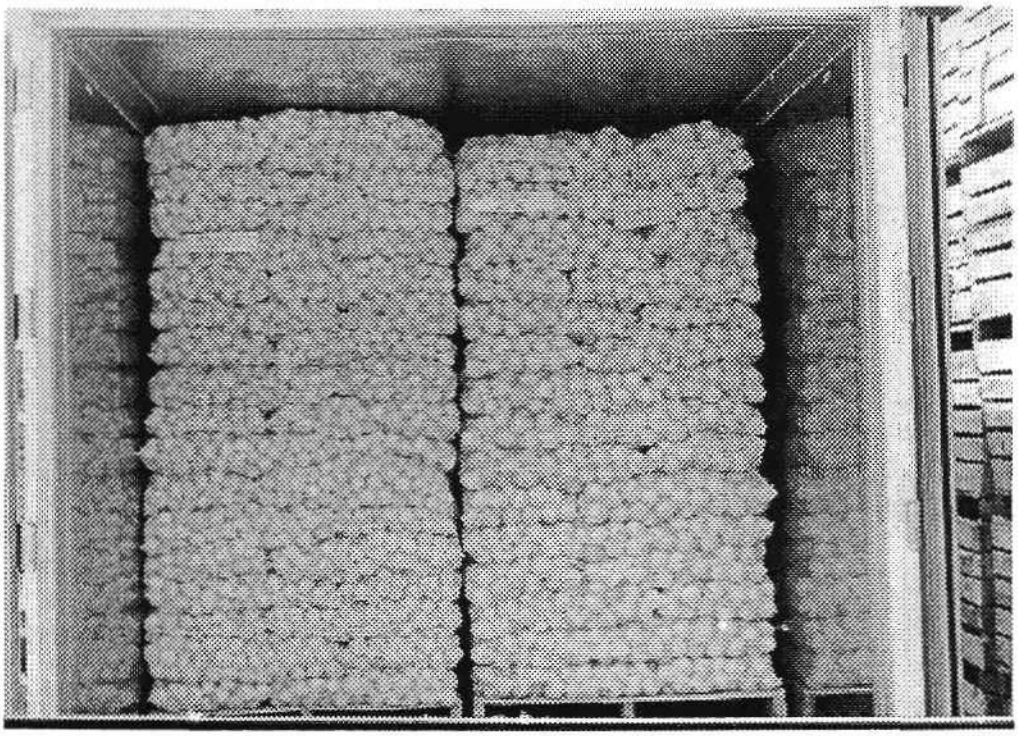
In assessing the performance of various container types and storage options, these pallets have been taken as atypical and a greater emphasis has been placed on the performance of the other lines (pallet codes) in that container in assessing the overall performance of that container.

3.3 Container Type

The best outturn results were obtained when using reefer containers with wastage levels at less than 5% with sound lines of onions (refer to Container Nos 4, 7, and 9). With Container 1. where there was an obvious problem with the temperature control the spoilage with the CNANS code onions was still low. Bag assessments of spoilage with palletised onions in fantainers ranged from more than 50% down to 28%.
Commercial rejection levels for these onions were in the 1 - 2% range for the reefer containers and 10 - 15% for the fantainers.

In addition to the better outturn from the reefer containers, the importers were impressed with the improved firmness and freshness of these onions compared to those from the fantainers.

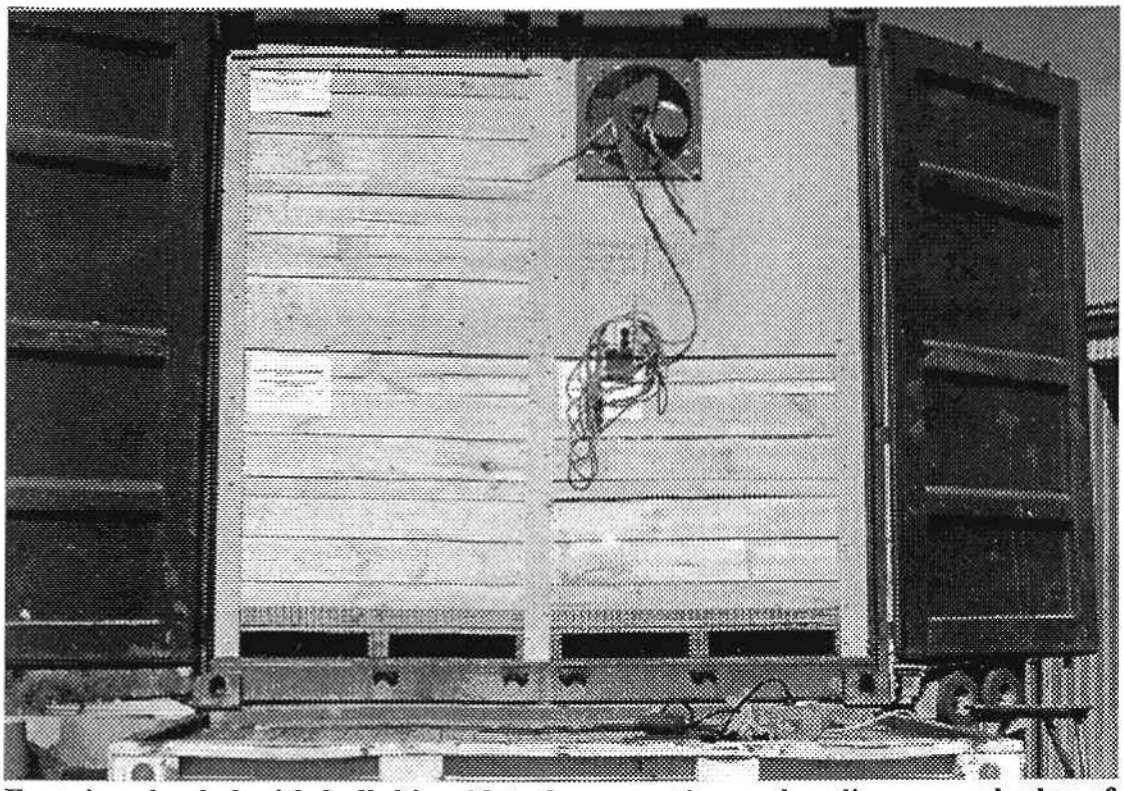
There was an observed difference in the outturn of the onions from the fantainers on the two different vessels with onions from the Floriani arriving in better condition. This could be due to a range of factors including weather conditiions encountered during the voyage, different shipping routes (see Section 6), vessel storage location and container configuration (ie integral fans with bulk head versus door ajar).



Palletised onions loaded into a reefer container.

3.4 Stowage Systems

Palletised, hand stowed and bulk bins were used as comparative treatments in fantainers (Containers 2, 2, 2 and 6). The onions shipped in bulk bins in a fantainer outturned in excellent condition with wastage levels less than 2%. There was no evidence of any dampness at any depth through the bins and outturn was comparable to that from the reefer containers, except for the better firmness and freshness of the latter.

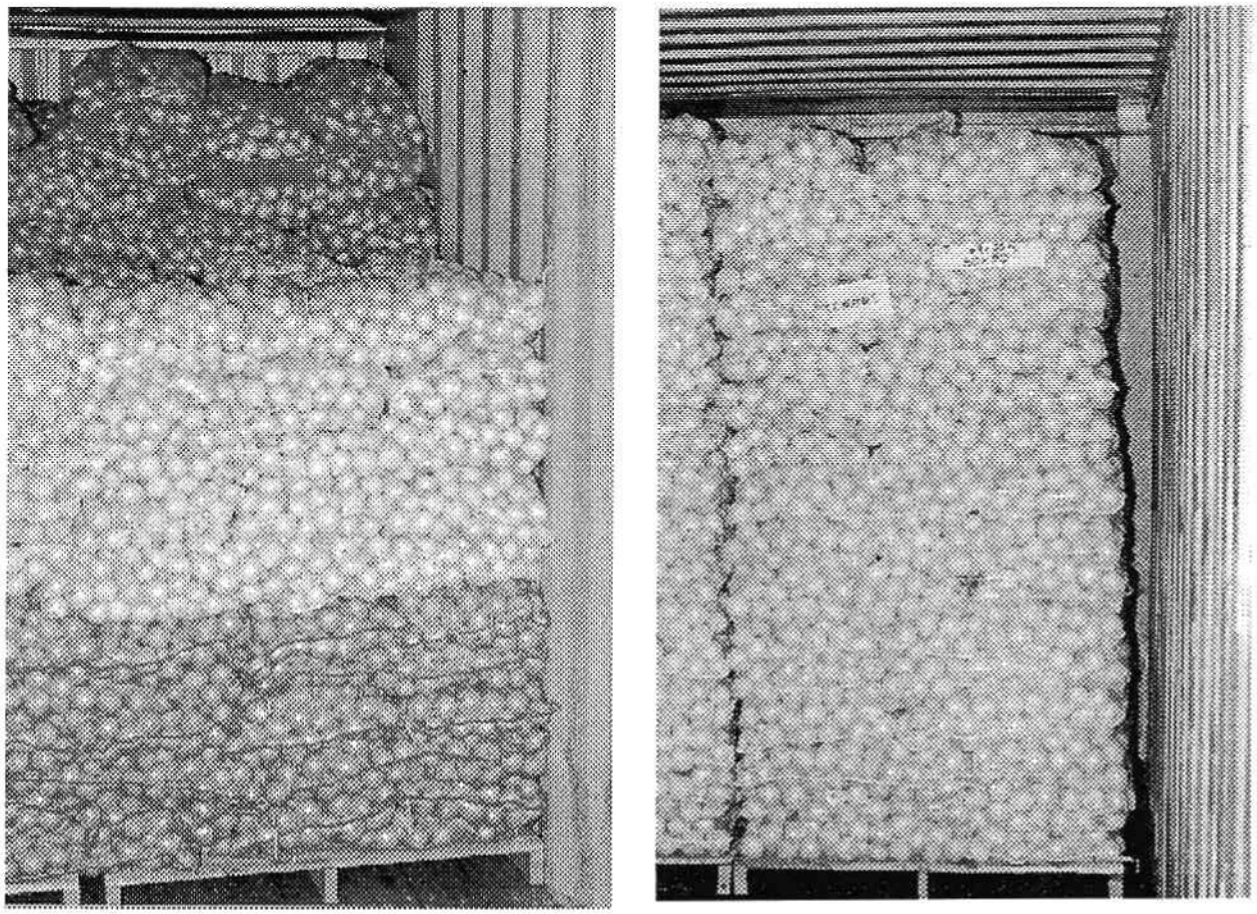


Fantainer loaded with bulk bins. Note fan mounting and sealing around edge of bins to create positive bottom to top air flow through the bins.

The individual bag assessments for the hand stowed and palletised fantainers (No. 2 and 3) indicate there was little difference in their performance. However in general observation, there were fewer bags with serious Aspergillus infections and skin staining in the hand stowed containers. As highlighted in the individual container reports, with the hand stowed there was evidence of condensation on the onions at some stage during the voyage, which at the time of unloading had diminished to a slightly damper band (with associated defects) running through the container at 1 - 3 layers down from the top of the stow. The minimal amount of damage and evenness throughout the stow is indicative of the evenly distributed airflow throughout the container. By contrast the palletised stow onions had a greater number of bags which showed significant skin staining and Aspergillus infections. Although the severity varied from pallet to pallet, the highest level of spoilage occurred in the centre of the pallets in the rows of bags from 2 - 8 down from the top of the pallet. The spoilage was always associated with increased moisture and dampness in the stow.

With both the hand and palletised stow, the zones of high moisture and spoilage are indicative of the load becoming wet from condensation during the voyage. This will

generally occur as the ship moves into the high temperature and high humidity conditions of the tropics from the cooler southern temperate zone. Condensation forms directly on the onions or on the roof of the container and drips down onto the onions. As the ship leaves the tropics, the air entering the fantainer is less humid and the free moisture will evaporate from the surface of the onions. The rate of the evaporation is dependent on the air flow over the onions. In stows where the air flow over the onions is forced to be even due to a uniform back pressure (ie bulk bins/ hand stow), the drying will be even and consistent across the stow. The length of time the onions will remain damp after the ambient air conditions improve is then dependent on the air exchange capacity of the fan used. It is evident that for the conditions encountered on this voyage of the Nelson Bay, a higher capacity fan may have been beneficial in reducing the spoilage in the hand stowed container.



Hand stowed (left) and palletised (right) stowage of fantainers. Note the large vertical gaps which occur with the palletised stow which reduces the air flow through the centre of the pallets.

With the palletised stow containers, large gaps exist between the pallets and the pallets and walls of the container throughout the voyage. These gaps allow the air to move easily and freely through these zones with much reduced air flow through the bags on the centre of the pallet. Hence the observed pattern of minimal spoilage on all the exposed surfaces of the pallet and a significantly increased level in the centre of the pallet.

3.5 Preshipment Handling

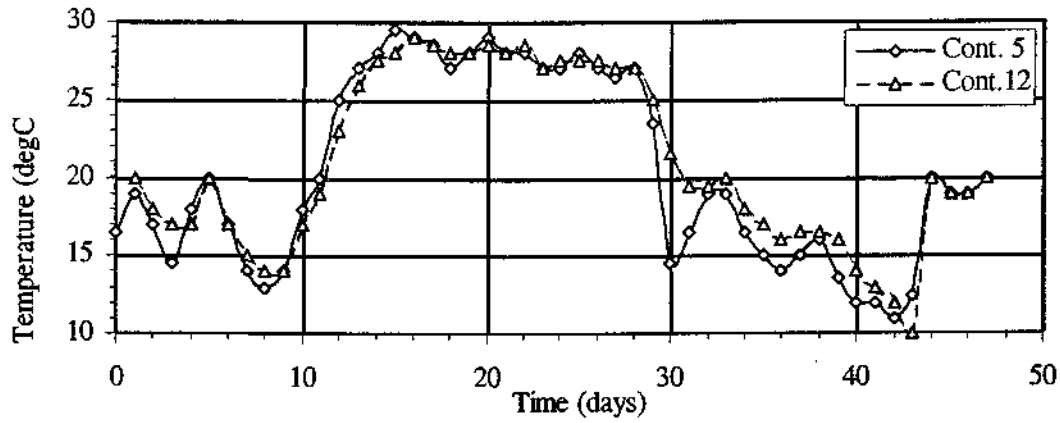
Time available at outturn inspection did not permit a detailed assessment which would have been necessary to make an accurate comparison of all the preshipment treatments. Other than poor performance of the "Y" coded variety described in section 2., there were no large differences in outturn observed. The second letter of the code was used to identify the forced air cured onions ("F") in comparison to natural field or shed cured onions ("N"). The outturn assessment indicates that the forced air cured onions performed at least as well and often better than the natural cured onions (See Containers 3 and 7.). No direct comparisons were made of onions stored post packing outside the temperature and humidity controlled room versus those stored inside.

3.6 Shipping Routes

From the temperature data collected, it is evident that the onions shipped via Durban on the Floriani and Aurora spent approximately 7 days above 25°C in the tropics (Container 2.) compared with approximately 14 days for the onions shipped on the Nelson Bay (Container 5., 12.: Figure 9.). This time difference could have a significant impact on the length of time the onions will remain moist and damp during the voyage and hence impacting the degree of staining and Aspergillus spoilage at outturn. This could have accounted for observed variation in outturn of the onions from the two ships, particularly if one assumes that the air flow through the containers is comparable with both systems.

From a commercial point of view, there are potential benefits with this routing option but this has to be weighed up against the risk associated with the container not being connected to power on the wharf during the transhipment at Durban.

Figure 9: Air temperatures for Containers 5 and 12 shipped on the Nelson Bay. Note tropical conditions exposure fron day 13 to 27.



3.7 Fantainer - Fan Size

A decision was made by the exporter to fit 375mm fans to all fantainers on both ships to increase the air exchange rate above that traditionally used with brown onions (300mm fan). The rated free air flow capacity of the 375mm fan is approximately 50% greater than that of the 300mm fan. However, the increased air flow will increase the back pressure and could reduce the actual volume of air to less than the anticipated 50% increase.

If Fantainers with larger fans for increased air flow through the stow are to be used in future shipments, then a thorough investigation of fan types and volume versus stable pressure characteristics needs to be made to ensure that improved air flow is being achieved.

3.8 Onion Handling Requirements for Reefer Shipments

Shipping onions in refrigerated containers requires additional specialised handling both pre and post shipment to ensure that the optimum quality is maintained. For shipment at 2°C, all onions have to be precooled prior to loading the container. During this project all onions were loaded into the containers with core temperatures less than 5°C.

When removed from the container by the importer, condensation will occur on the onions as their temperature will be below the dew point. Care has to be taken at this time to ensure that the onions are handled in a manner which will allow the onions to warm rapidly and allow this free moisture to dissipate. Storage under poor ventilation conditions could leave the onions moist and damp for many days which would encourage skin staining and Aspergillus growth.

Appendix 3. is a copy of the message which was translated into French and attached to the inside of each container so that it was clearly visible when the doors were opened. In addition, more detailed information on suggested post shipment handling procedures was forwarded by the exporter to each of the importers prior to the season. (See Appendix 4.).

Austrlian white onions in net bag prepacks ready for sale on European markets.

ACKNOWLEDGMENTS

The generous help, support and co-operation of the following organisations and persons for the successful completion of this project is acknowledged.

* Horticulture Research and Development Corporation
* Mypolonga Co-op - Kevin Prosser, Greg Fulwood
* Lower Murray Onion Producers
* French Importers and Agents
* SARDI staff - Maria Nechvoglod, Jamie Wilson, Barry Tugwell

APPENDICES

Appendix 1. EXPORT OF WHITE ONIONS HANDLING PROCEDURE

1.HARVESTING

1.1 Variety.

This handling procedure is for the handling of Whie Spanish the principle variety being exported at the present time.

1.2 Maturity.

Leaf fallover greater than 80 percent. Higher level with thick neck onions.

1.3 Soil Moisture.

No harvesting within 48 or 24 hours of moisture applications in excess of 10 and 5mm respectively. Soil moisture content should be low at the time of harvest to reduce soil adhesion and onion skin moisture. Apply no irrigation after slashing of the tops.

1.4 Weather Conditions.

No harvesting in wet or raining conditions or when bulb temperatures are greater than 30°C. (NOTE: Testing required to assess desirable max. temperature and whether core or surface temperatures will be more useful) Use average of 5 bulb core temperatures to determine accepatability for harvesting.

1.5 Containers.

Harvest directly into 1/2 tonne bulk bins with floor and side board gaps of at least 25mm.

1.6 Undercutting.

Undercutting of mature crops at 100-125mm below ground surface to encourage top drying. Light irrigations may be used during the infield drying period to reduce bulb and soil temperatures during hot weather conditions. Such irrigations should be light (less than 2mm and frequent) and not within 12 hours of harvesting.

1.7 Top Slashing.

For field dried onions with no green tops, slash tops at 50 to 80 mm above top of bulb at least 3 hours prior to lifting and not more than 24 hours prior to lifting. For onions harvested with some green tops, slash to leave at least 175mm of tops.

1.8 Harvesting.

Lift directly into bulk bins to minimise handling. Move bulk bins to curing/storage area within 2 hours of harvesting.

2.CURING

2.1 Natural Curing.

Cure onions with any green tops for a minimum of 10 days. Ensure that bins are placed in storage sheds in a manner to maximise wind exposure. Minimise as much as possible the depth of stack in the prevailing wind direction ie.the air moving through the shed on the prevailing wind should pass over/through/between the minimum number of bins. Leave air gaps between bins in the direction of the prevailing winds. Store to minimise direct sun exposure and greening.

2.2 Forced Air Curing.

Cure for a minimum of 5 days on forced air curing system.

Forced Air Curing System

* Minumum fan capacity of 300 litres/sec per bin at 10mm wg pressure.
* One or two rows of bins on each side of fan inlet.
* Gap between bins for air plenum chamber minimum of 600mm, preferably to match width of fan.
* Bin stacking with bin runners to prevent air flow into the plenum chamber and stacked as tightly as possible in rows.
* Cover for bins to be wide enough to cover full width of 2 bins and plenum chamber (3m with 600mm plenum width) and long enough to extend up and down both ends and accross the top.

2.2 Monitor Curing.

Monitor curing by recording weight of sample of onions placed in net bag stored in representative bin(s) of onions for that day of harvest. Minimum of 2 test samples per harvest day. Approx. 5 kg of onions per sample bag. Some bags to be stored in the centre of bins and recoverd and assessed when other bags indicate curing maybe adequate. Percent weight loss from harvest and rate of moisture loss under standard conditions will be assessed.

2.3 Storage.

Postcuring storage only in well exposed curing/storage sheds away from irrigated and green crops.

3.TRANSPORT (BINS/PALETTISED BAGS)

3.1 Load Protection.

All loads must be covered under all weather conditions.

3.2 Weather Restrictions.

No transport under wet or damp conditions.

4.GRADING AND PACKING

4.1 Onion Condition.

No processing of onions with moist neck tissue.

4.2 Machinery Adjustment.

Proper adjustment of machines to reduce damage and injury.

4.3 Grade Standard.

Uniform grade standards between packing sheds.

4.4 Packages.

Packing into net bags without labels.

4.5 Palletisation.
Palletisation of bags at packing onto pallets ready for loading into container.

4.6 Quality Check.
Use standard Mypolonga Coop procedures for quality checking prior to stowage.

4.7 Trace Back.
Label all pallets to permit onion source identification and trace back.

5.POST PACKING STORAGE

5.1 Curing.
All onions to receive at least 24 hours of heated air forced air curing prior to containerisation.

5.2 Storage Conditions.
Storage prior to containerisation at all times in conditions of greater than 25°C, less than 50% relative humidity and airflow greater than 0.5 airchanges/min.

6.CONTAINERISATION

6.1 Condition of Container.
Check container for water leaks, and general cleanliness and condition.

6.2 Container Modification.
Install fan(s) to provide at least 0.5 m^3/sec airflow through the container at 70 Pa pressure. Check operation prior to loading.

6.3 Sample Bags.
Retain sample bags of onions for each container.

6.4 Quality Check.
Check sample bags for quality control before stowing.

6.5 Stowage System.
Stowage strictly in accordance with the stowage plan (to be developed).

6.6 Weather Restrictions. Avoid containerisation under damp and high RH conditions.

6.7 Loading Location. Load containers directly from storage area.

6.8 Loading Time. Load containers after 10am.

6.9 Power Connection. Connect power to containers not being immediately transported to freight terminal.

7.WHARF STORAGE

7.1 Power Connection.
Ensure rapid connection to power.

7.2 Handling Procedure.

Provide handling instructions to cargo handlers/company

HANDLING AND STOWAGE OF REEFER CONTAINERS.

1. Onions for loading into the container should be cooled to as close as possible to the proposed carriage temperature prior to stowage. Minimum of 2 days storage in coolstore prior to loading container.

2. Load containers only under conditions which will minimise the chances of condensation ie. no loading under damp or high humidity conditions.

3. Check container operatioin and clean thoroughly prior to loading.

4. Set air exchange rate on container to maximum available.

5. Ensure container is connectted to power while waiting at the packingshed and/or wharf prior to loading on the ship.

6 Instruct importers regarding the importance of unloading and handling to reduce the amount of condensation occuring on the onions. Suggestted actions should include :

* Unload under warm dry conditions. Avoid damp and humid conditions if possible.
* Ventilate and provide high volumes of air movement over the onions for at least 24 hours after unloading. Must be maintained until all onions are dry. Check centres of palletts. Forced air system as per curing is recommended.
* Gradual warming of the container over 3-4 days to ambient tempearture conditions prior to opening.

Appendix 2: SHIPPING CONTAINER DETAILS

REFERENCE No.: 1

CONTAINER No:
MSCU 361 037 0

Container Type
Reefer

Packing Date
7/3/95

Packing Method
Palletised

Vessel
Floriani

Buyer

Arrival / Inspection Date
5/5/95 (59 days)

Bag Assessments

CONTAINER CONTENTS
Sample Code
(Pallet No.)

Front

(50)	(51)
CNANS (64)	CNANS (76)
RNAD (45)	CNADY (22)
CNANS (75)	RNAD (41)
RFAD (38)	CNANY (70)

Doors

Pallet No.	Code	Bag Location	Sound %	Stain %	Asp. %	Rots %
22	CNADY	2 rows down	59	3	-	38
75	CNANS	2 rows down	86	3	11	0
-	*	3 rows up	97	3	0	0

Notes: * Red bag from up near the front of the container.

General Comments

Outturn was variable for this container as there was obviously a problem with temperature control and sweating. In moving from the front of the container to the rear, there was a significant increase in wastage from both staining and fungal attack. All of the onions in the bags on the pallets at the rear of the container were quite wet and had been so for some considerable time as saprophytic type moulds were growing on many of the onions from these pallets. Wastage from some these pallets could have been greater than 50%, depending on how well the bags were dried out over the next few days. The onions stowed near the front of

the container (red bag above) outturned better and were equivalent in quality to most of the other reefer containers.

It was recommended to the importers that the bags of wet onions be placed outside as single bags (not palletised) in a location were there would be some natural breeze or airflow over the onions.

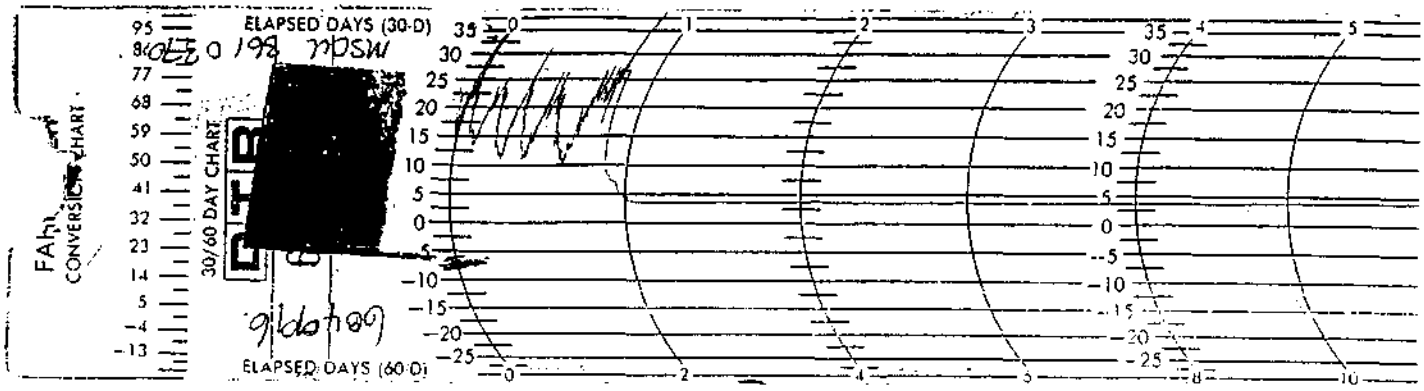
Likely contributing factors for the poor outturn could be:

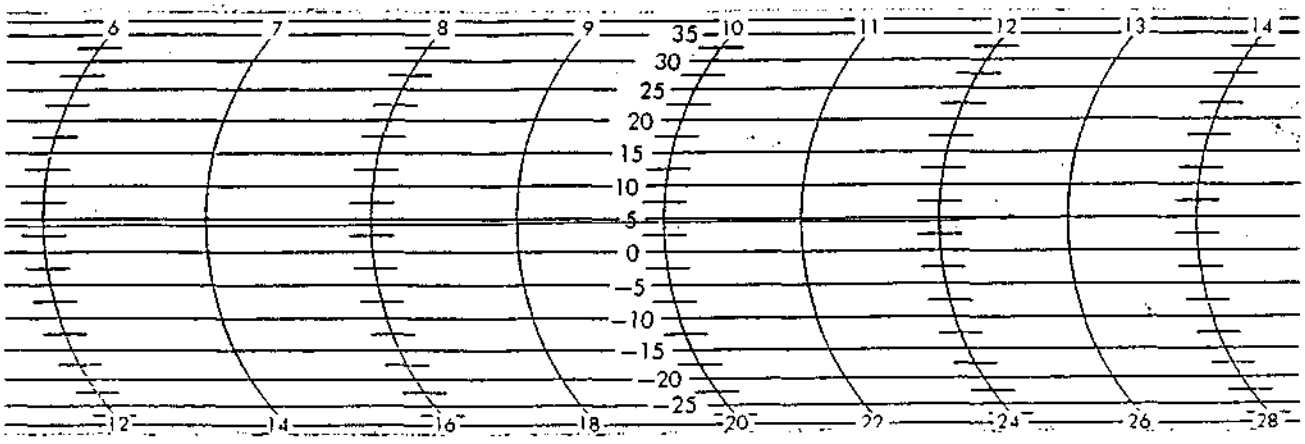
1) No ventilation in the container. The ventilation setting on the container was checked on arrival and was found to be set at 25-30% which would have been adequate if this was the setting for the whole voyage.

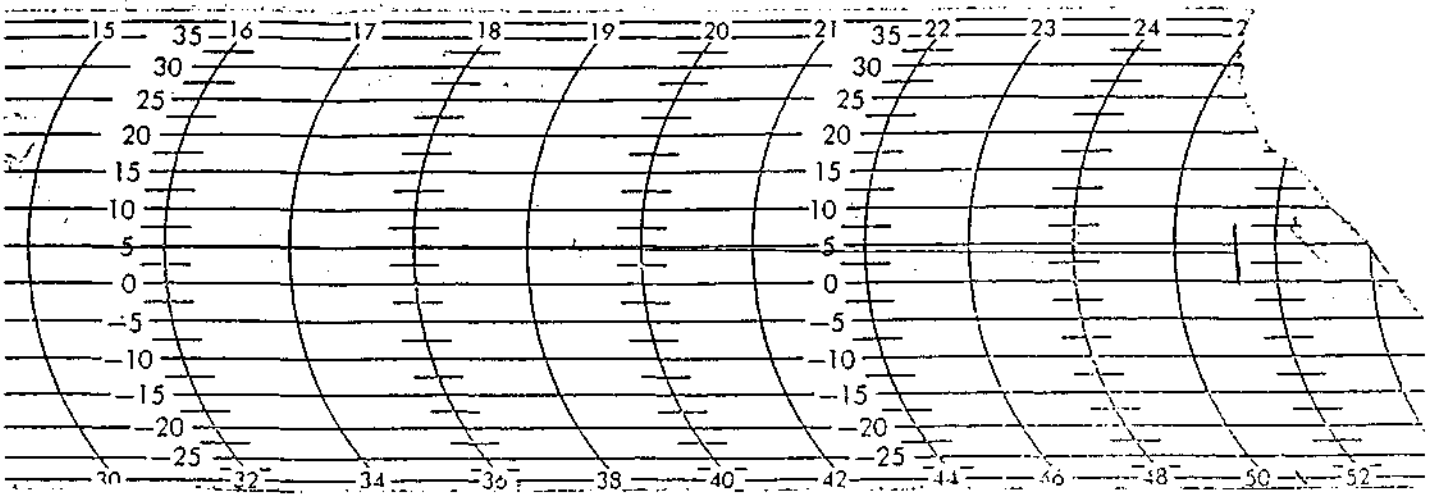
2 Improper temperature control. Shipping container charts were not sighted. DTR chart recorder line indicates temperature for most of the voyage was closer to 4 - 5°C than the requested 2°C but this is not likely to have caused the problem. However, there is evidence from the chart that the container spent the first 5-7 days not operating with temperatures on one day exceeding 40°C and more than 25°C on all days. The onions were precooled prior to loading and condensation would have occurred from any air entering the container during that period and the air exchange rate when the cooling was operating would not have been capable of rapidly drying out the product. The fact that pallets at the front of the container were dry and had significantly less damage is also indicative of the problem occurring early in the shipment rather than later. The non cooling period corresponds approx. with the time spent on the wharf at Pt. Adelaide prior to loading onto the ship.

Although the problems with the other reefer container (No. 7) shipped on the Floriani were much less, many of the same problems were evident and the DTR chart again reflected the same lack of cooling at the commencement of the voyage.

Temperature Chart







SHIPPING CONTAINER DETAILS

REFERENCE No.: 2

CONTAINER No:
CLOU 242 094 0

Container Type
Fan (15"), Door Ajar

Packing Date
1/3/95

Packing Method
Hand Stowed

Vessel
Floriani

Buyer

Arrival Date
5/5/95 (65 days)

CONTAINER CONTENTS
Sample Code
(Pallet No.)

Front

All RNAN ex P66,68 CNANS	Pallet Loading Sequence
1 - 55 2 - 54	9 - 56 10 - 68
3 - 53 4 - 52	11 - 66 12 - 65
5 - 60 6 - 59	13 - 63 14 - 62
7 - 58 8 - 57	15 - 5

Doors

Bag Assessments

Pallet No.	Code	Bag Location	Sound %	Stain %	Asp. %	Rots %
?	RNAN	1st stack, near top	83	3	14	0
?	RNAN	1st stack, bottom row	86	3	10	1
?	CNANS	2nd stack, 2 rows up	73	3	22	2
65	RNAN	2nd stack, half height	69	3	25	3

General Comments

Good general outturn for a fantainer. Only slight dampness evident at opening and restricted to the top 1 to 3 layers of bags. Staining and Aspergillus infections found are evidence of high level of moisture at some stage during the voyage. There were a lot of dry skins on the floor of

the container at the completion of unloading, further evidence of the dry crisp nature of most of the skins from the onions in this container.

There was no evidence of the damp wet zones near the Centre of pallets and extending down from layers 2-8 as evident on many of the palletised loads.

String tied bag of Purple Onions

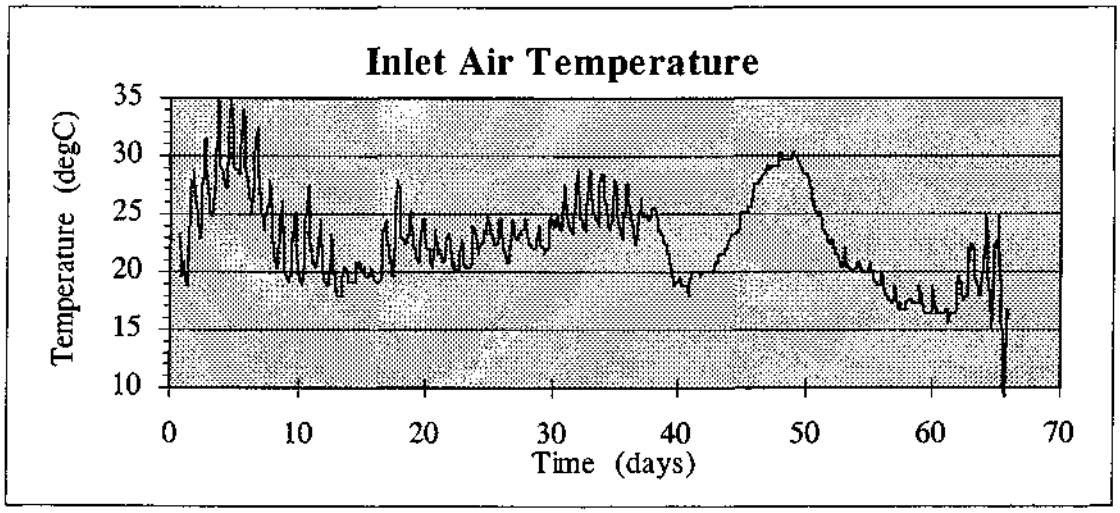
Fairly good condition with some Aspergillus (similar to whites). Softening more than the whites was evident.

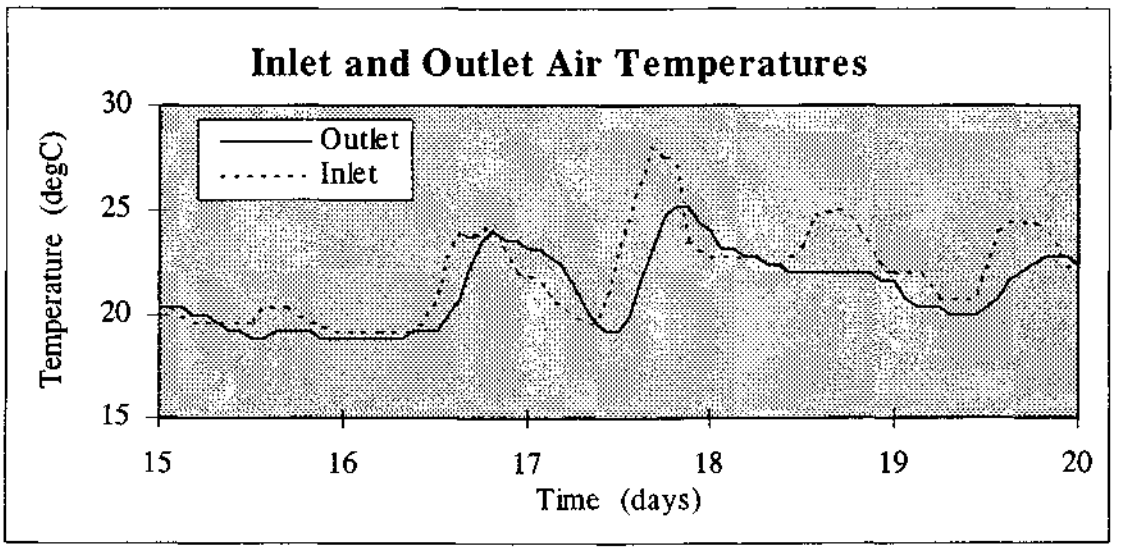
Red string tied bags of Whites.

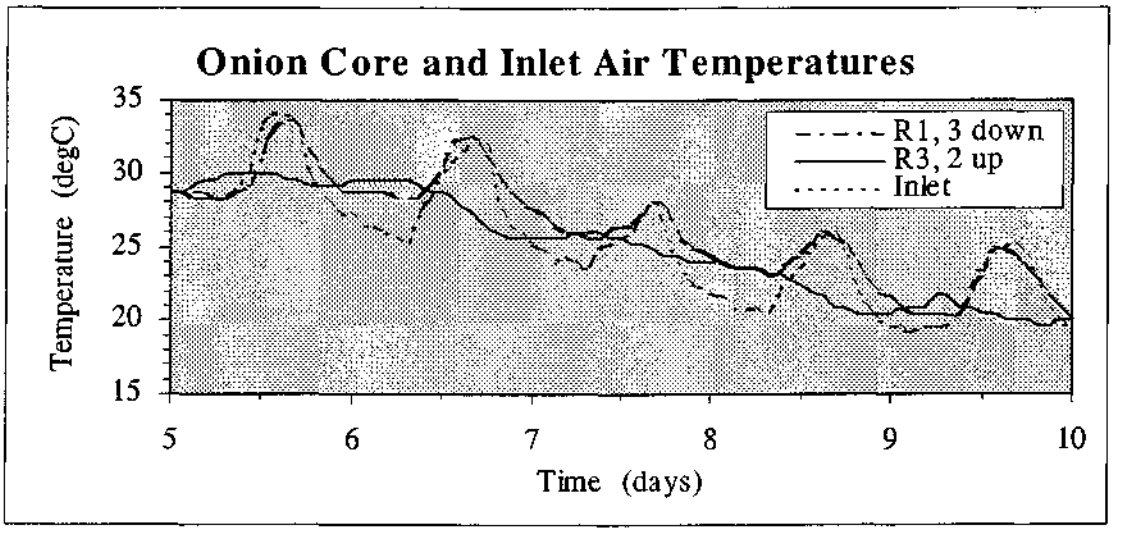
Outturn condition the same as other whites in the container.

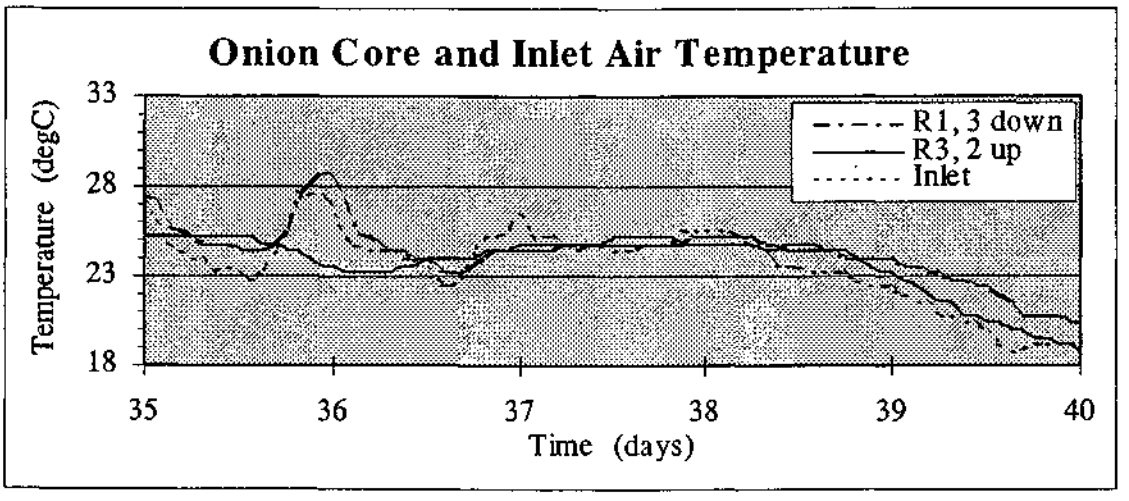
Temperature Data

Good temperature data which clearly shows the shorter duration of high tropical temperatures associated with this transport system. Daily temperature fluctuations evident throughout the voyage except while moving through the tropics.




Inlet and Outlet Air Temperatures
Outlet
Inlet
Temperature (degC)
30
25
20
15
15
16
17
18
19
20
Time (days)


Onion Core and Inlet Air Temperatures
R1, 3 down
R3, 2 up
Inlet
Temperature (degC)
35
30
25
20
15
5
6
7
8
9
10
Time (days)


Onion Core and Inlet Air Temperature
R1, 3 down
R3, 2 up
Inlet
Temperature (degC)
33
28
23
18
35
36
37
38
39
40
Time (days)

SHIPPING CONTAINER DETAILS

REFERENCE No.: 3

CONTAINER No:
MSCU 232 374 7

Container Type
Fan (15"), Door Ajar

Packing Date
8/3/95

Packing Method
Palletised

Vessel
Floriani

Buyer

Arrival Date
5/5/95 (58 days)

CONTAINER CONTENTS
Sample Code
(Pallet No.)

Front

CNAS (74)	RNAD (47)
RNAD (35)	CNADS (23)
RNAD (42)	CNADY (21)
RFAD (37)	RNAD (43)
RNAD (44)	CNADS (8)

Doors

Bag Assessments

Pallet No.	Code	Bag Location	Sound %	Stain %	Asp. %	Rots %
37	RFAD	5/6 rows down	88	3	9	0
42	RNAD	5/6 rows down	78	9	11	2
35	RNAD	5/6 rows down	63	11	23	3
21	CNADY	2 rows down	Approx. 5	Approx. 95		
74	CNADS	5/6 rows down	27	8	60	5

General Comments

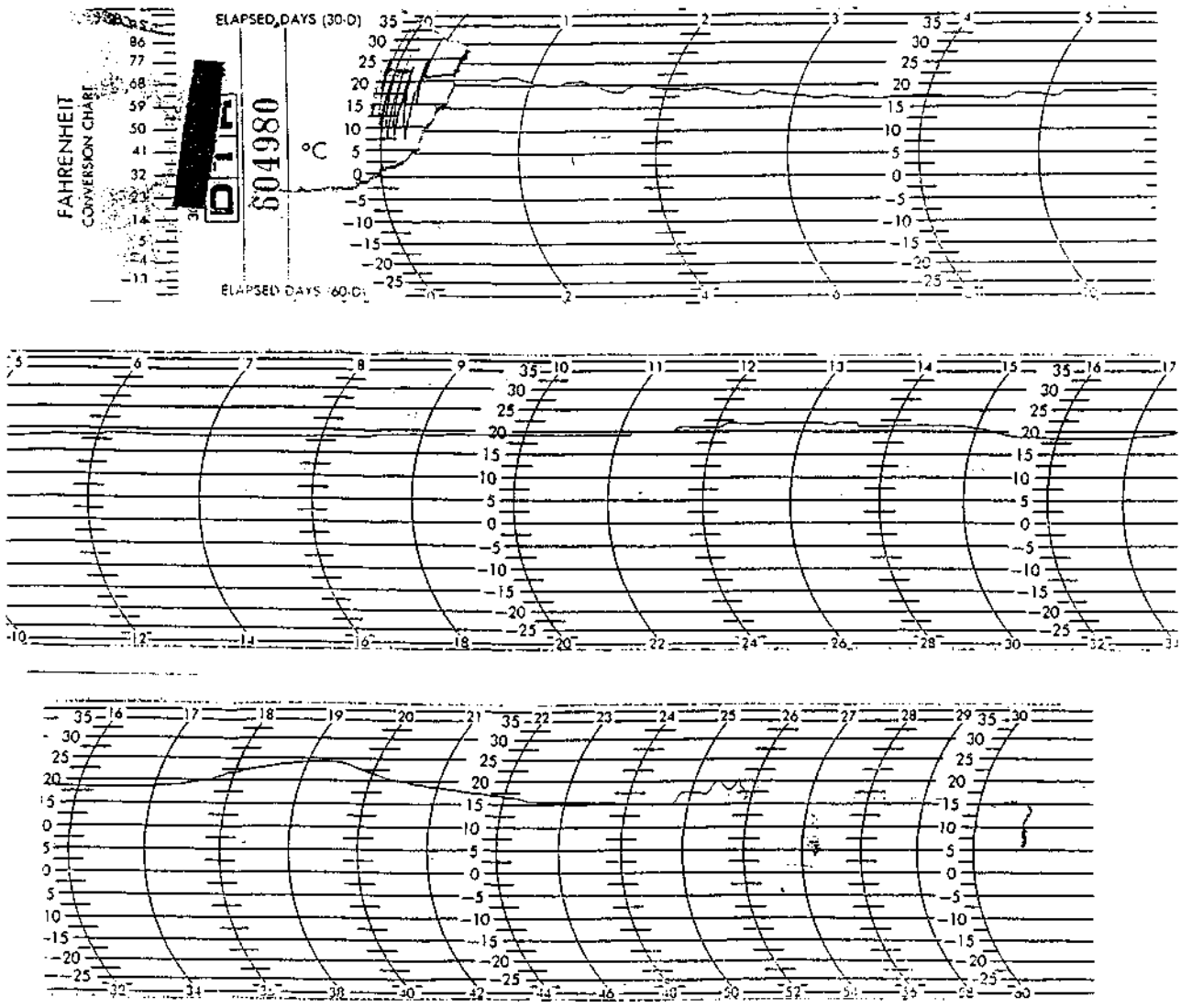
Very variable outturn from this container with no clear patterns of moulds or wastage in relation to pre shipment treatment or position in the stow. Typical moist wet spots in the stow on various pallets at 2-8 rows down form the top of the pallet and towards the centre of the pallets. This did not occur with all pallets and possibly occurs only in locations were the stow receives additional free moisture from condensation dripping off from low points on the container ceiling.

Comments and quick visual assessments of the condition of each pallet (without pulling down) were:

Pallet	Score	Comment
74	5/10	Lot of rots and Aspergillus showing.
47	6.5/10	-
35	7/10	-
23	5/10	-
42	7/10	Rot spoiling and staining a few adjacent onions.
21	1/10	Pallet height down 200-300mm, collapsing with lot of rots.
37	7.5/10	Feel dry, good condition.
43	7/10	Fairly good condition.
44		-
8	6.5/10	-

Temperature Chart

DTR temperature recorder chart inaccurate. First 4-5 days compressed onto start of chart with diurnal fluctuations evident. Temperatures mainly between 15 and 20°C for most of the voyage with little evidence of daily fluctuations. Five days above 20°C with peak of 25°C while moving through the tropics.



SHIPPING CONTAINER DETAILS

REFERENCE No.: 4

CONTAINER No:
TRLU 102 195 7

Container Type
Reefer

Packing Date
16/3/95

Packing Method
Palletised

Vessel
Nelson Bay

Buyer

Arrival Date
28/4/95, pm.

Inspection Date
2/5/95, 10:30am
(47 days)

CONTAINER CONTENTS
Sample Code
(Pallet No.)

Front

CNADS (124)	(126)
CNADS (90)	CNADS (127)
CNAD (85)	CNADS (83)
CNADS (71)	CNADS (67)
CNADS (107)	CNADS (69)

Doors

Bag Assessments

Pallet No.	Code	Bag Location	Sound %	Stain %	Asp. %	Rots %
?	?	?	83	10	6	1
?	?	?	87	8	4	1

General Comments

Container was opened and unloaded on Friday 28/4/95 and inspection was on Tuesday 2/5/95 at 10:30am. The onions had been left in the closed shed on original shipping pallets with no appreciable ventilation throughout this period. The shipping pallets were repacked onto other pallets on a 2 for 1 basis on the Tuesday morning and many bags from the centre of the pallets

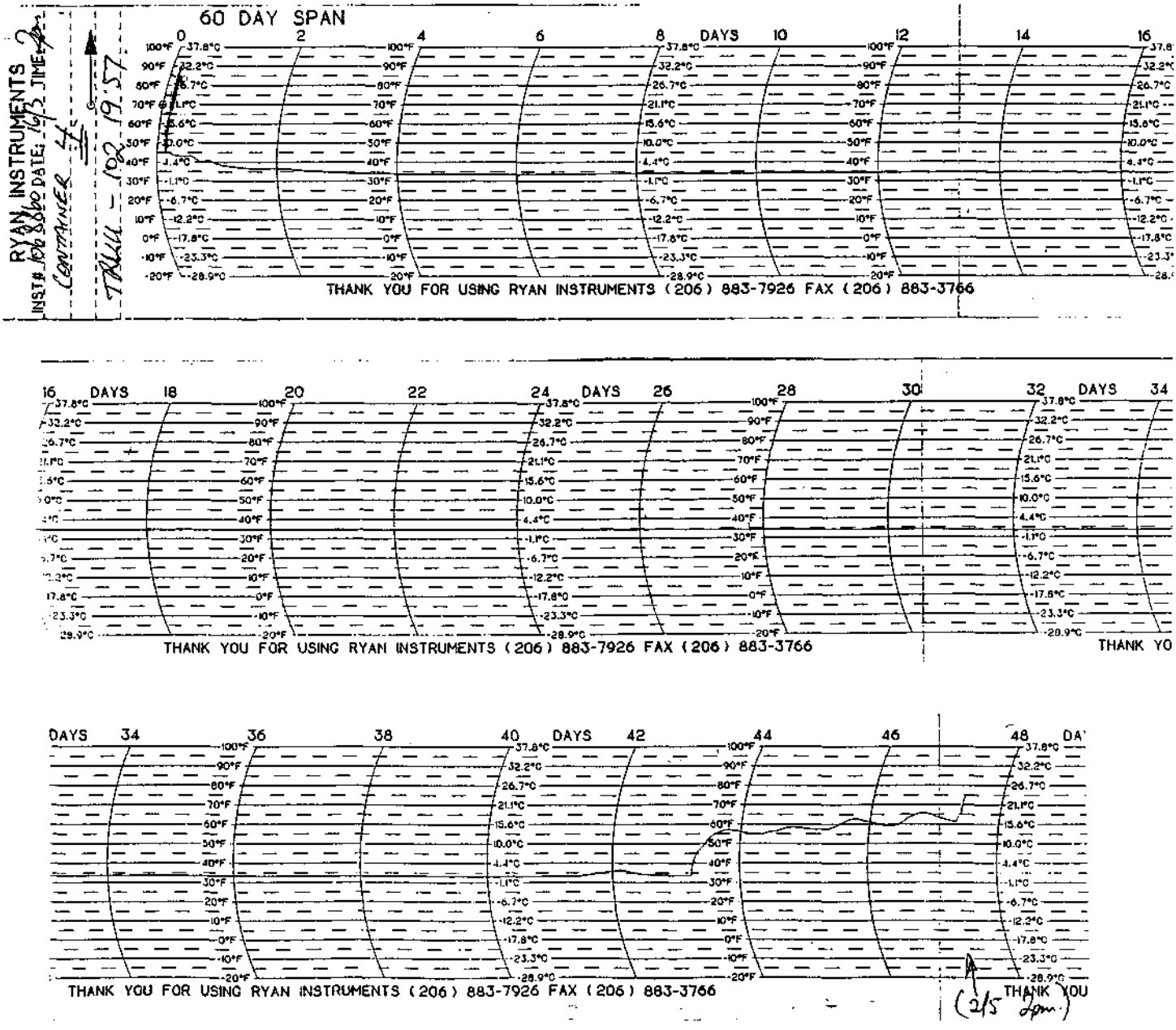
were still moist. Repacked onion pallets were moved outside to an area were there was better ventilation and by early afternoon most bags were fairly dry.

This container had no obvious vents open on loading and there was no free moisture in the container when opened. However, there was evidence of some staining and Aspergillus development which means there must have been some moisture around at some stage during the shipment. This could have occurred in the 3 days shed storage but this is probably to short for Aspergillus development.

All pallet labels and identification lost. Inspection of 2 random bags from the shipment. Both bags inspected were dry.

Temperature Chart

Temperature chart shows cooling operative almost immediately after packing and slow cooling of load from around 7°C to constant transit temperature of 1.5°C over the first 4 days of the voyage.



SHIPPING CONTAINER DETAILS

REFERENCE No.: 5

CONTAINER No:
ACTF 101 447 0

Container Type
Fantainer, 15" fan.

Packing Method
Palletised

Packing Date
15/3/95

Vessel
Nelson Bay

Buyer

Arrival Date
28/4/95, pm.

Inspection
2/5/95, 10:30am
(48 days)

CONTAINER CONTENTS
Sample Code
(Pallet No.)

Front

(131)	(134)
CNADS (122)	CNADS (130)
CNADS (113)	CNADS (111)
CNADS (82)	CNADS (119)
CNADS (116)	CNADS (110)

Doors

Bag Assessments

Pallet No.	Code	Bag Location	Sound %	Stain %	Asp. %	Rots %
111?	CNADS	near top of pallet	48	28	24	0
?	?	?	41	32	27	0
?	?	?	59	20	21	0

General Comments

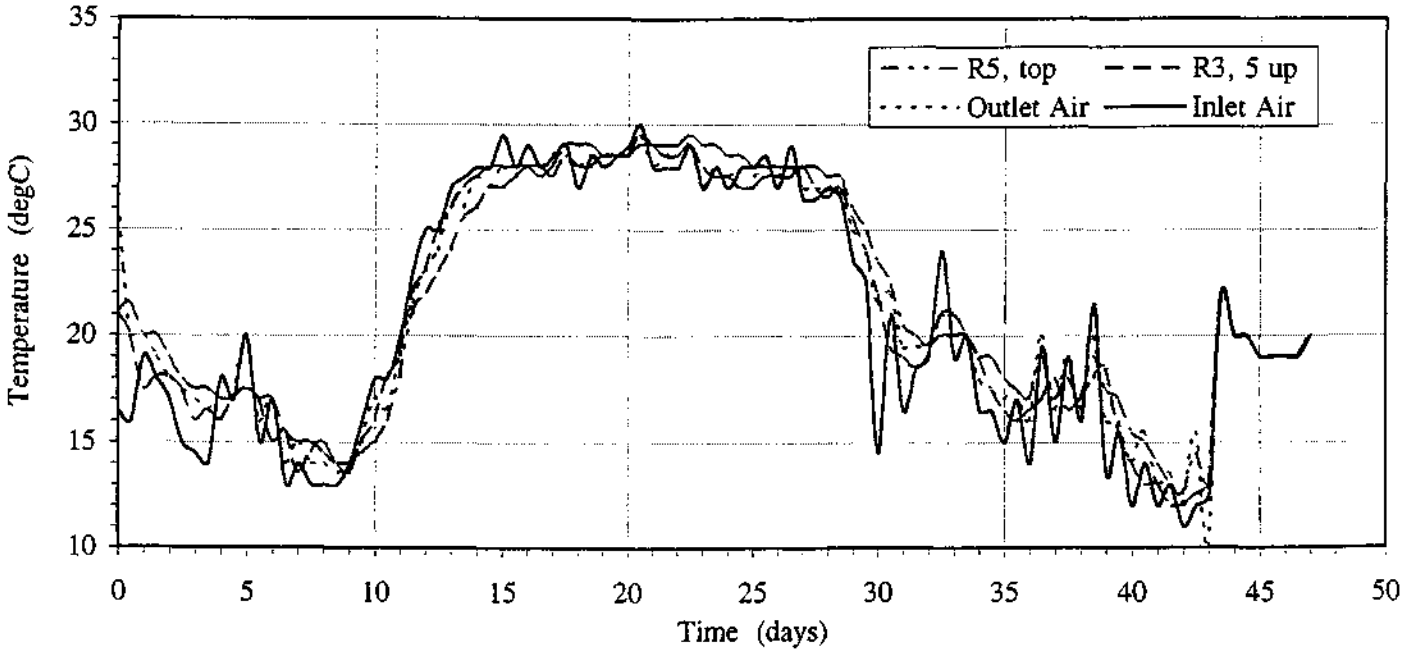
Handling procedure same as container 4 in regard to receival times, unpacking and inspection. Three bags randomly selected for inspection. Many bags were already packed for sale from this container and at the time of inspection around half to 2/3 of the container had been

prepacked into small net bags. The **apparent** amount of rejects at the packing line was estimated at 6 x 15kg. Only the most severe Aspergillus infections were being rejected and much of the staining is removed in the packing process due to the loss of the outer skins.

Some bag to bag variation evident but could not be related to position in container and external appearances of bags is very deceiving. Comments made on inspection bags above prior to opening were contrary to the objective assessments. The assumed pallet 111 bag was rated as good but had a lower content of sound onions than the third bag which was rated visually as fair.

General comment from the packer was that the 50-70mm onions had a better outturn than the 60-80mm size.

Temperature Data



SHIPPING CONTAINER DETAILS

REFERENCE No.: 6

CONTAINER No:
TECU 385 150 3

Container Type
Fan (15"),Door Ajar

Packing Method
Bulk Bins

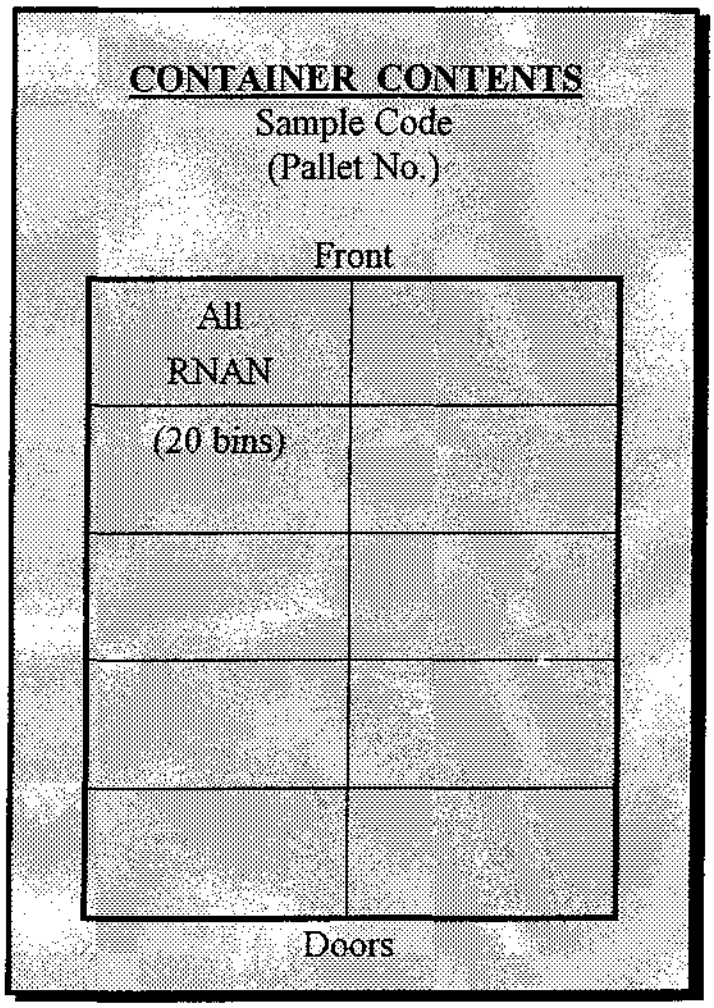
Packing Date
2/3/95

Vessel
Floriani

Buyer

Arrival / Inspection Date
5/5/95 (65 days)

General Comments

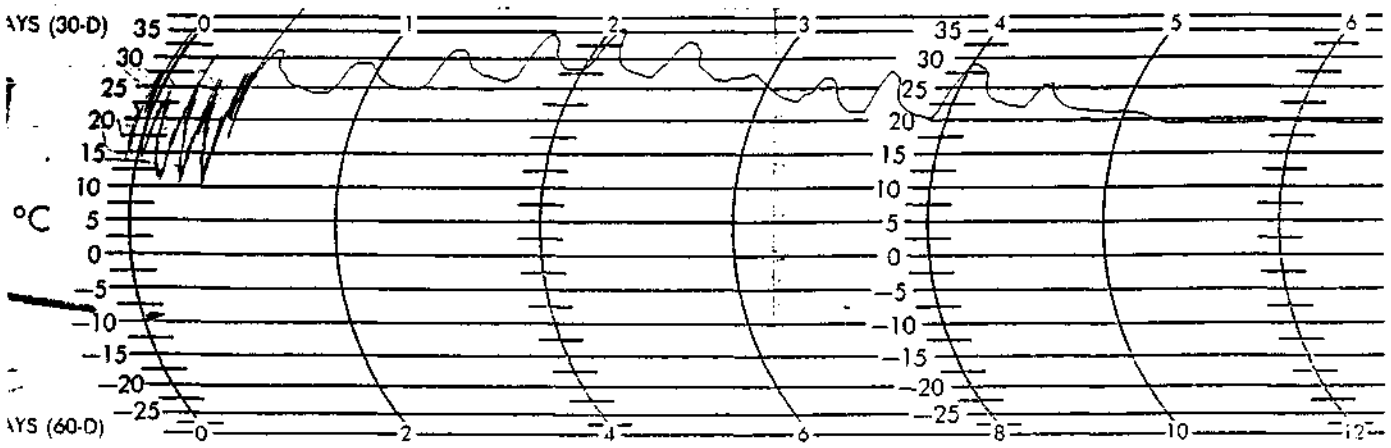


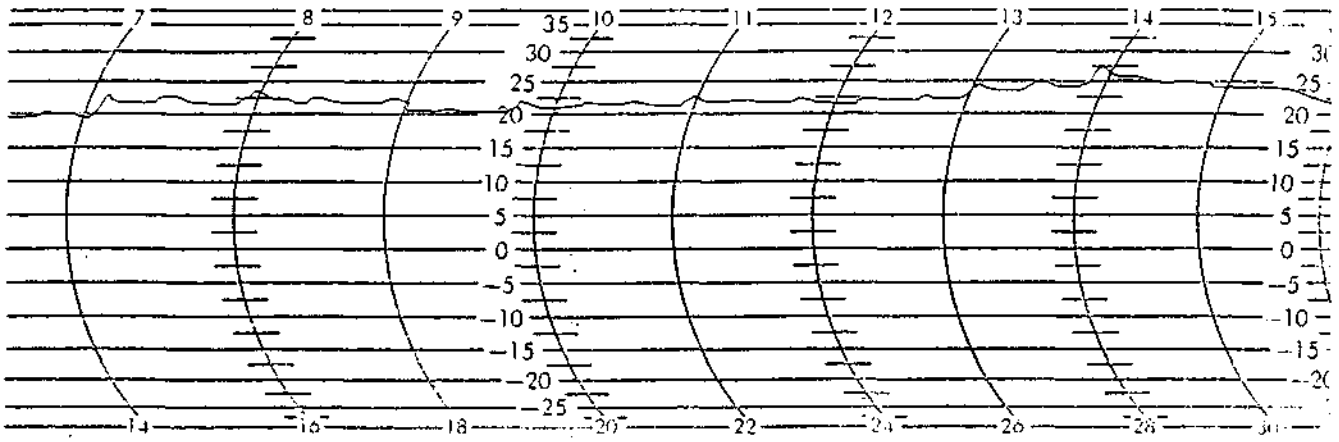
Outturn of both sizes was excellent with an estimated less than 2% wastage, 0.5-1% as rots and 1-2% as Aspergillus. The onions throughout the bins were crisp and dry.

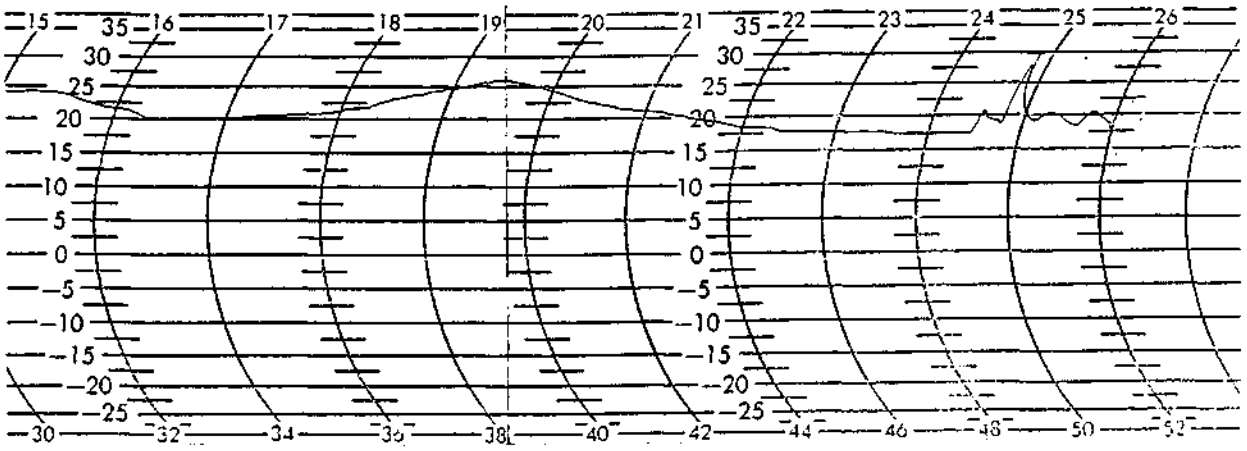
Bulk bins are very suitable for the importers handling system and shipment with this method would suit their packing operations. However, the bins used on this occasion were much stronger than necessary and had features which are not required eg. corner supports and chamfered edges to the floor boards in the bins.

Temperature Chart

In accurate DTR chart. Temperatures throughout the voyage generally greater than 20oC with most of the early part of the voyage having daily fluctuations in the 25-35°C range.







SHIPPING CONTAINER DETAILS

REFERENCE No.: 7

CONTAINER No:
MSCU 361 176 1

Container Type
Reefer

Packing Date
6/3/95

Packing Method
Palletised

Vessel
Floriani

Buyer

Arrival / Inspection Date
5/5/95 (60 days)

Bag Assessments

CONTAINER CONTENTS
Sample Code
(Pallet No.)

Front

CNANS (48)	RNAD (51)
CNANS (73)	CNANS (79)
CNADY (25)	CNANS (72)
CNANS (78)	CNANS (61)
RNAD (46)	RFAD (40)

Doors

Pallet No.	Code	Bag Location	Sound %	Stain %	Asp. %	Rots %
46	RNAD	2 rows down	94	2	4	0
46	RNAD	half way	94	2	4	0
46	RNAD	2 rows up	97	1	2	0
78	CNANS	2 rows down	97	1	2	0
78	CNANS	half way	97	1	2	0
40	RFAD	2 rows down	96	2	2	0
40	RFAD	5 rows up	99	0	1	0
25	CNADY	2 rows down	73	4	23	
25	CNADY	8 rows up	77	2	21	

General Comments

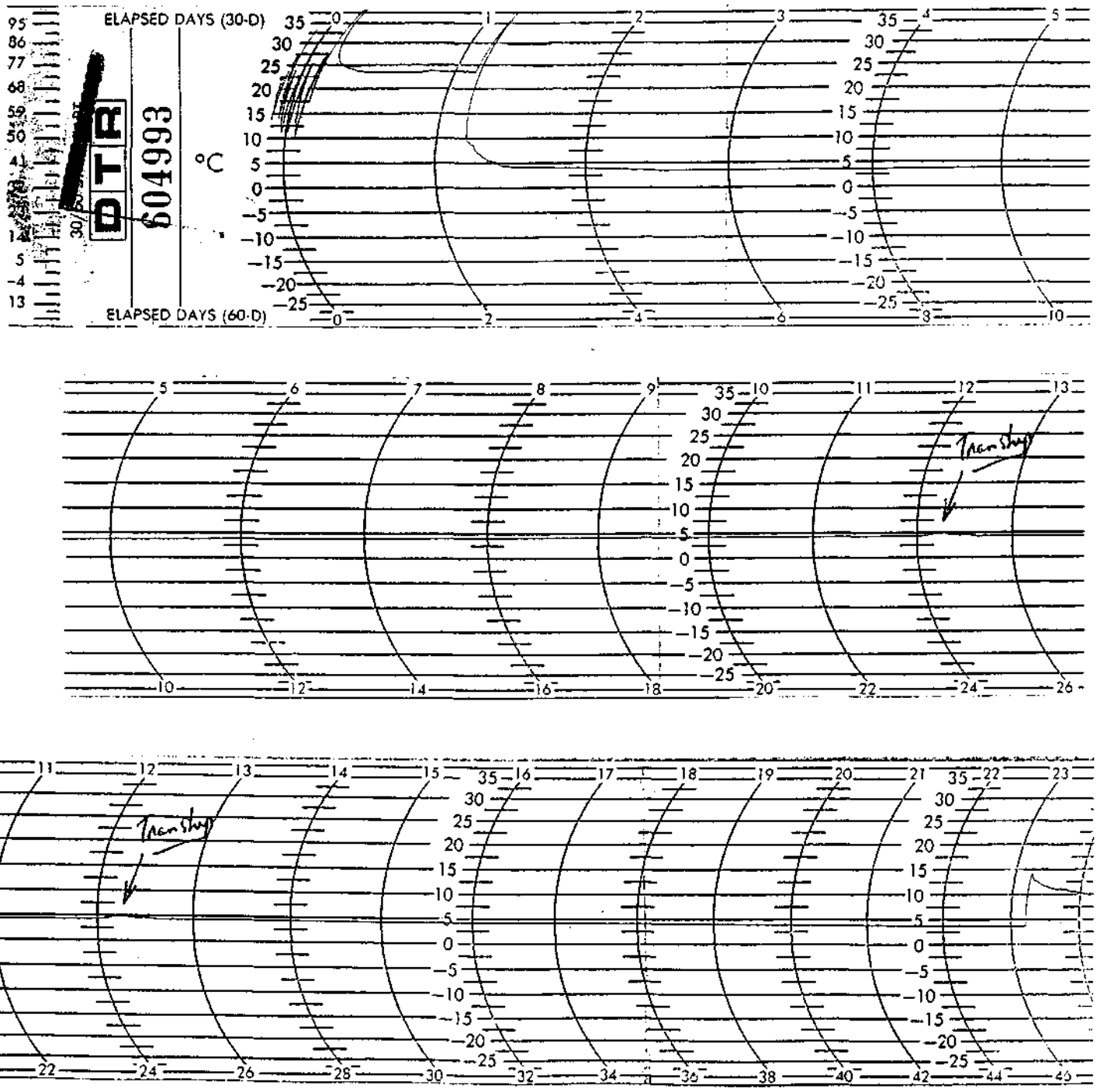
All pallets except No. 25 by external inspection appeared to be in good condition with most bags being dry and crisp. Onions being held in 10°C coolstore after unloading from container.

Onion bags stacked into centre space in the pallets and onions adjacent to this space were usually slightly damp on those pallets broken down.

The saprophytic type moulds found on the onions on pallets 25 and 40 is evidence of a period of prolonged high humidity and possibly free moisture during some part of the voyage (see also Container No 1 notes).

Temperature Chart

Faulty DTR chart. The diurnal type fluctuations on the early part of the chart could be indicative of the container not being on power for some time on the wharf or early part of the voyage. While operating, temperature was maintained at around 4°C.



SHIPPING CONTAINER DETAILS

REFERENCE No.: 8

CONTAINER No:
ACTF 101 941 9

Container Type
Fantainer (15" fan)

Packing Date
15/3/95

Packing Method
Palletised

Vessel
Nelson Bay

Buyer

Arrival / Inspection Date
28/4/95 (44 days)

CONTAINER CONTENTS
Sample Code
(Pallet No.)

Front

CNADS (141)	CNADS (137)
CNADS (139)	CNADS (132)
CNADS (133)	CNADS (135)
CNADS (112)	CNADS (98)
CNADS (91)	CNADS (120)

Doors

Bag Assessments

Pallet No.	Code	Bag Location	Sound %	Stain %	Asp. %	Rots %
135	CNADS	top layer	63	10	25	3
135	CNADS	centre	63	12	23	2
135	CNADS	2 rows up	70	8	20	2

General Comments

Comments on individual pallets:

Pallet 135: Severe Aspergillus infection (60-70% infected) at 3-4 rows down in the centre of the pallet Increased staining also in this area which is indicative of extended time of dampness.

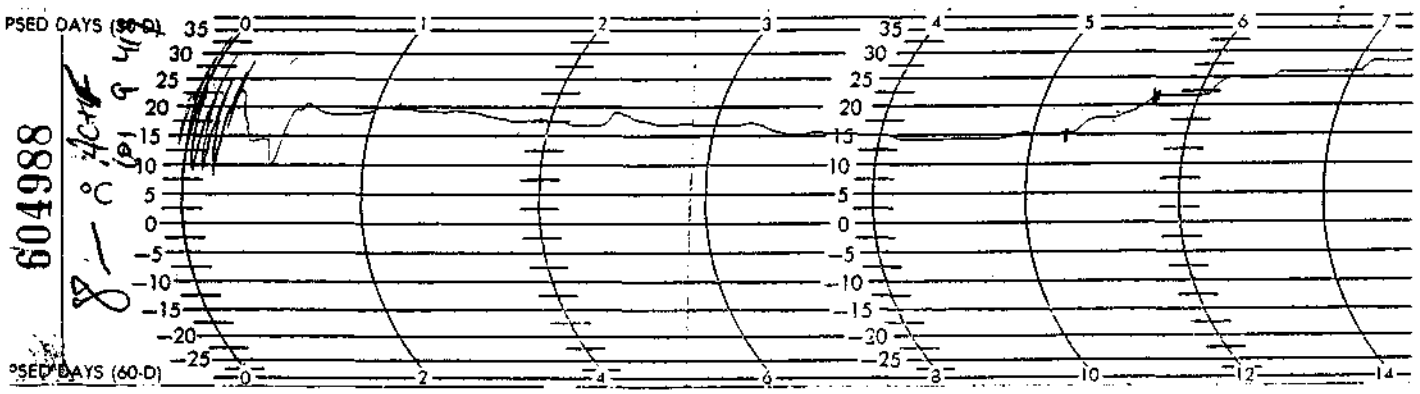
Pallet 137: Ten to 15 bags badly affected with Aspergillus in rows 2-6 down from the top of the pallet. Rest of pallet okay and probably better than pallet 135.

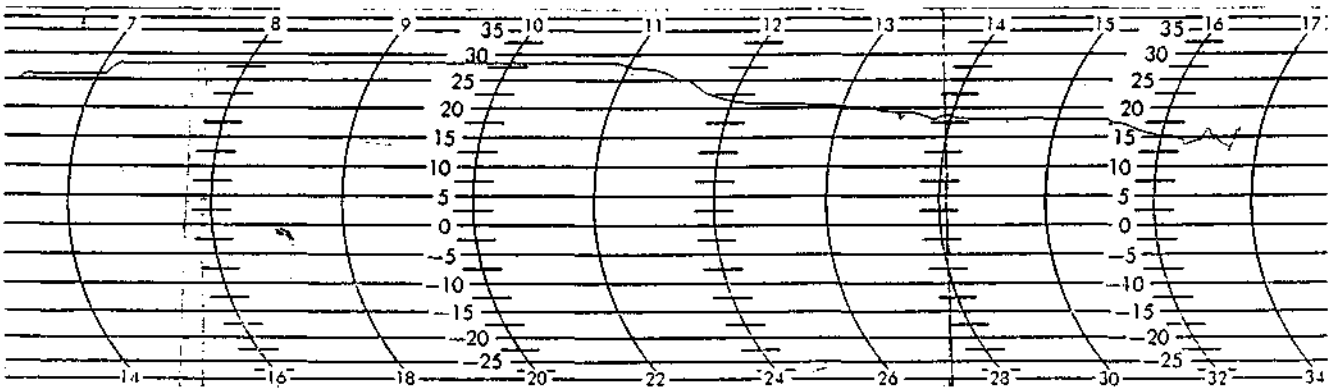
Pallet 112: Visually the worst affected pallet in the container. Few bags in top row okay, then next 20 bags or more badly affected with Aspergillus (30-80%) and then reducing towards the bottom of the pallet.

Five bags randomly weighed at 20.54, 20.46,20.57,20.58,20.50 kg.

Temperature Chart

Failed DTR recorder chart. Some day temps up to 33°C in the first few days. Temperatures during the tropical phase of the voyage were fairly constant at 28°C. Fastest temperature rise during the voyage was 7°C in one day.





SHIPPING CONTAINER DETAILS

REFERENCE No.: 9

CONTAINER No:
AJCU 293 336 1

Container Type
Reefer

Packing Date
16/3/95

Packing Method
Palletised

Vessel
Nelson Bay

Buyer

Arrival / Inspection Date
27/4/95 (42 days)

CONTAINER CONTENTS
Sample Code
(Pallet No.)

Front

	CNADS (80)
CNADS (128)	CNADS (86)
RFAD (39)	CNADS (81)
CNADS (89)	CNADS (97)
CNADS (84)	CNADS (87)

Doors

General Comments

There was no condensation in the container at opening and no off odours from rotting onions. All onions appeared firm and dry, only found one onion in whole shipment with black mould. Pallet 39 (RFAD) appeared to be in the same condition as all other pallets. Some black rub marks on some of the onions which had been in contact with the side walls of the container.

Core temperatures at the time of unloading were :
Rear pallet, half height - 1.2°C
Centre of Stow, Half Height - 0.9°C.

Temperature datalogger failed to work. No data available.

SHIPPING CONTAINER DETAILS

REFERENCE No.: **10**

CONTAINER No:
ITLU 781 8 940

Container Type
Reefer

Packing Date
16/3/95

Packing Method
Palletised

Vessel
Nelson Bay

Buyer

Arrival Date
2/5/95 ??

Inspection
No Inspection

CONTAINER CONTENTS
Sample Code
(Pallet No.)

Front

CNADS (118)	CNADS (124)
CNADS (94)	RNADS (102)
CNADS (92)	CNADS (51)
CNADS (114)	CNADS (96)
CNADS (109)	CNADS (104)

Doors

General Comments

Loading temperature was 2.3 - 3°C.

Unloaded in Central France location on 2/5/95. Instructions were given on the best handling procedure for these onions and they were being transferred from the container directly to a 10°C coolstore with continuously running fans.

SHIPPING CONTAINER DETAILS

REFERENCE No.: **11**

CONTAINER No:
UFCU 608 554 9

Container Type
Fan (15"), Door Ajar

Packing Date
9/3/95

Packing Method
Palletised

Vessel
Floriani

Buyer

Arrival Date
Approx. 6/5/95
(58 days)

Inspection
No Inspection

CONTAINER CONTENTS
Sample Code
(Pallet No.)

Front

RFAD (31)	RFAD (26)
RFAD (33)	RFAD (28)
RFAD (32)	RFAD (34)
RFAD (36)	RFAD (30)
RFAD (27)	RFAD (29)

Doors

SHIPPING CONTAINER DETAILS

REFERENCE No.: 12

CONTAINER No:
ACTF(U???)101 533 1

Container Type
Fantainer (15" fan)

Packing Date

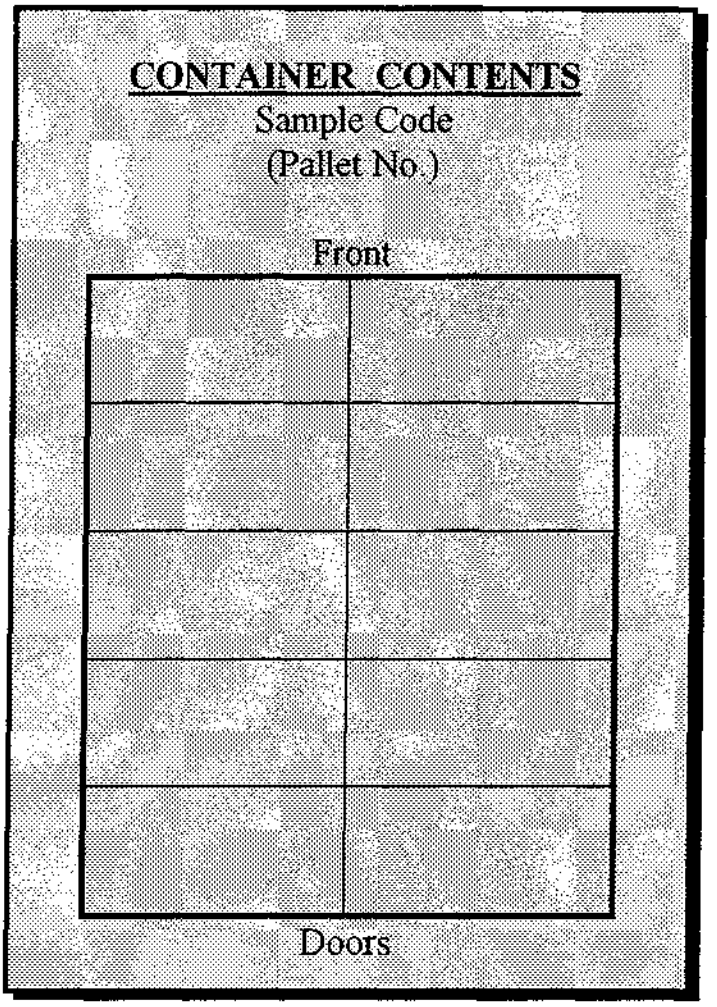
Vessel
Nelson Bay

Buyer

Arrival Date
28/4/95

Inspection
2/5/95 (days)

Bag Assessments



Pallet No.	Code	Bag Location	Sound %	Stain %	Asp. %	Rots %
142	CNADS	3 rows down	72	10	15	3
Adj 103		half way	72	12	13	3

General Comments

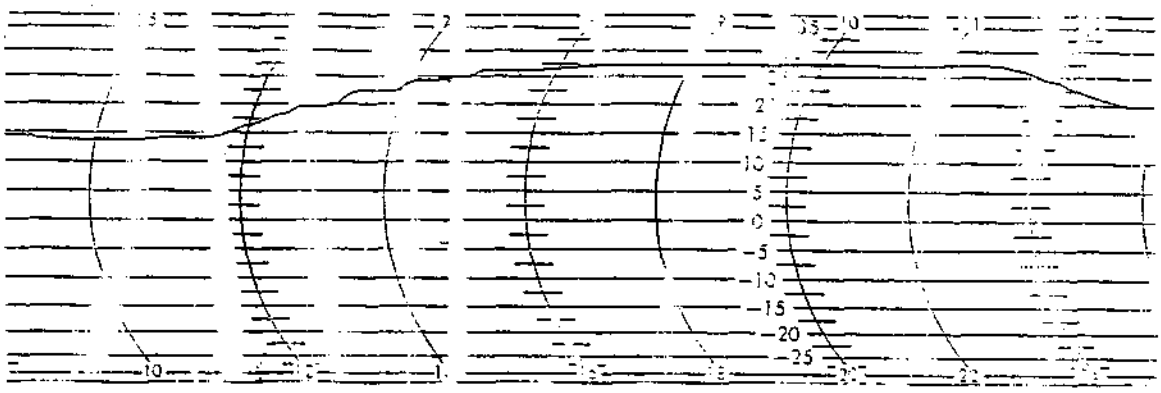
Similar to other fantainers with pockets of increased levels of Aspergillus and staining in the 2/3 to 5/7 rows down in the centre of pallets. These pockets are not evident from the outside of the pallet and vary considerably in size. Consistent with the slow drying of patches of heavy condensation.

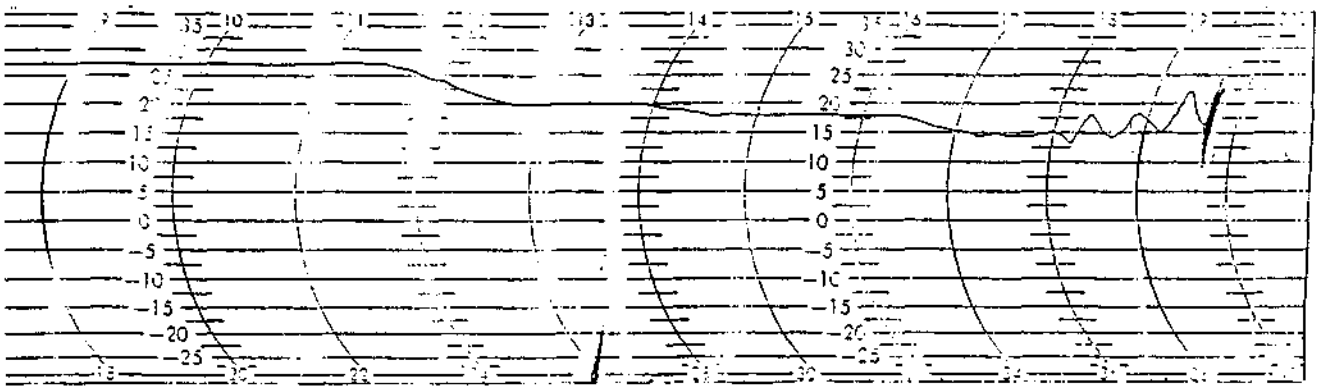
This container was delivered to the importers premises on 28/4 but not placed on power and only unloaded on 2/5. No apparent adverse effects from this incident.

The importer insisted that this container had no inlet vents for the air to circulate through the load. The boards for the inlet air were reported to have extended right down to the floor.

Temperature Chart

Inaccurate speed DTR recorder used in this shipment Temperature patterns consistent with other fantainers on the Nelson Bay.





SHIPPING CONTAINER DETAILS

REFERENCE No.: 13

CONTAINER No:
ACTF 101 007 3

Container Type
Fantainer (15" fan)

Packing Date

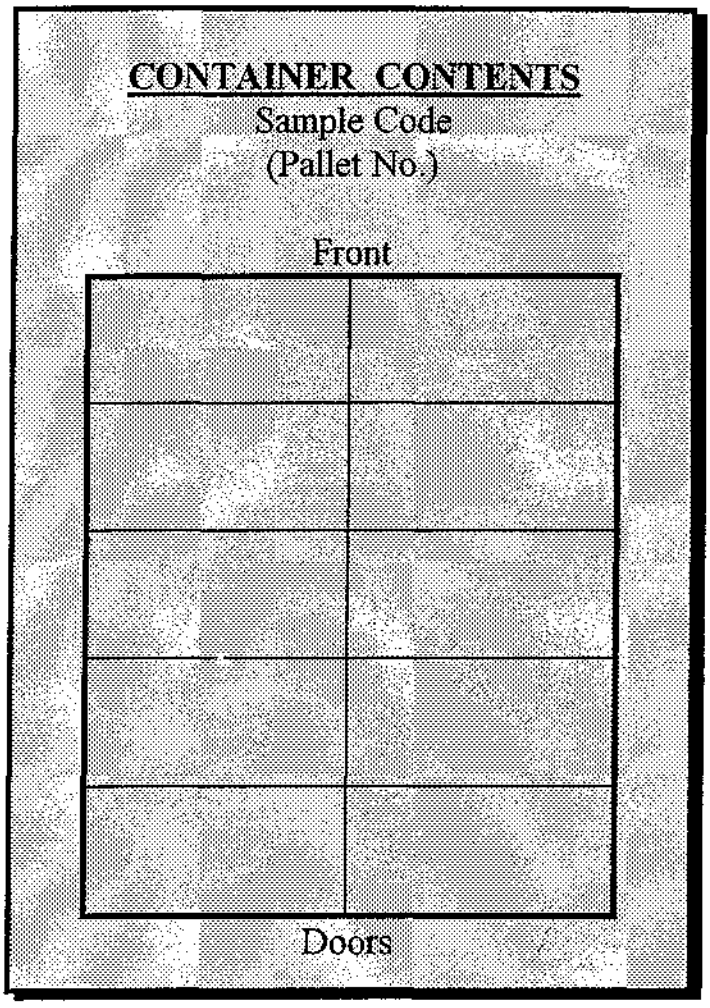
Vessel
Nelson Bay

Destination

Buyer

Arrival Date
28/4/95

Inspection
2/5/95 (days)



General Comments

At least equivalent to the best outturn from a fantainer on the Nelson Bay. Skins very dry on the outside of pallet, with low levels of staining and Aspergillus evident. . However, no pallets pulled down from this container.

Three days standing without power and no inlet vent comments from importer the same as for Container 12.

Appendix 3. NOTICE ATTACHED TO REEFER CONTAINERS

ATTENTION

HANDLING RECOMMENDATIONS FOR ONIONS AFTER REMOVAL FROM CONTAINER.

These onions have been shipped in a refrigerated container to maintain there quality and freshness. After removal from the container, moisture can condense onto the cold onions and lead to a reduction in quality. The amount of moisture condensation can be minimised with no effect on quality if one of the following recommended handling procedures are adopted:

Place onions on a forced air drying system which will provide a positive flow of ambient air over the onions for at least 24 hours.

OR

Transfer onions to a coolstore operating between 5 and 10°C. Ensure that cooling fans in the room are continuously operating for the following 36 hours. Stack pallets with a minimum of 15cm air gap around each pallet.

OR

Place pallets of onions outside of buildings in a shaded and sheltered location where any natural wind will blow over and through the pallets. Preferably stack pallets in a single row or a least with air gaps greater than 30cm around each pallet.

IF IN DOUBT ABOUT HOW TO TREAT THESE ONIONS, PLEASE SEE YOUR SUPERVISOR.

Appendix 4. HANDLING PROCEDURE FOR ONIONS FROM REFRIGERATED CONTAINERS

Introduction

Onions shipped in refrigerated containers will arrive in a firm sound condition if there have been no failures in the container refrigeration system. The quality of the onions will be high with little or no spoilage from sweating or mould growth. It is important that the handling procedure of the importers will be such that the high quality of the onions is preserved.

Moisture condensation on the cold onions as they are removed from the container is the main danger in regard to spoilage and loss of quality. Suggested handling procedures for the onions on removal from the container will either minimise the amount of condensation or rapidly remove any condensation before it can do any damage.

Forced Air Warming Method (Highly recommended)

Pallets of onions are stacked in 2 rows with the pallet runners in the same direction as the rows and with a gap of 50-70cm between the 2 rows. With the use of a fan and plastic cover to place over the gap between the rows of pallets ambient air is forced to flow over and through the bags of onions on the pallets. Attached is a diagrammatic representation of the forced air principle as applied to bulk bins and pallets of cartons and the same principle is applied to the pallets of onions (Note variation required in 4. below). The ambient air should be drawn over the onions until all onions have a temperature equal to the air temperature and have no moisture on the surface. This will normally take 24-36 hours and is dependant on the ambient air temperature and relative humidity. Important considerations in the design and operation of the system are:

1. The fan must have a capacity of not less than 14,500 cubic feet per minute (6,850 litres per second) for each container of onions. The fan has to be able to deliver the rated air volume against a pressure of 3/8 inch water gauge (100 Pascals). This generally means that only vane axial and centrifugal type fans will be suitable.
2. The curtain should be of light flexible material such that it will easily suck down onto the sides (end pallets) and top of the pallets of onions.
3. Timber battens will have to be placed across the top of the gap between the pallets to prevent the curtain from being sucked into the gap between the pallets. These battens can be attached to the curtain at regular intervals for easier handling if convenient.
4. The curtain for the onion warming should extend out the full width of the 2 rows of pallets so that air can only enter through the sides of the pallets. The full outside face of the end pallets should also be covered with the curtain.
5. This system can be operated inside a well ventilated enclosed shed as the air is forced over the onions by the fan.

Cool Storage Method.

Transfer the onions from the container directly to a coolstore operating at between 5 and 10 degrees C. This will reduce the temperature difference between the onions and the air temperature and consequently the chance of heavy condensation forming on the onions. Only coolstores with forced draught coils providing air exchange rates greater than 1 air change per minute should be used. Fans in these rooms should be operated continuously during the first 36-48 hours that the onions are in the coolstore.

Care has to be exercised in removing the onions from the coolstore as condensation can still occur if high ambient temperature and/or humidity conditions are present when the onions are removed. Removal of the onions to a well ventilated location up to 24 hours prior to packing would be beneficial

to ensure they have equilibrated to the ambient temperature and the chance of condensation during and after packing has disappeared.

Natural Ventilation Method.

This technique relies on using natural air movement and ambient conditions to warm the onions and remove any moisture condensed on the surface of the onions. This technique is reliant on warm to hot and dry weather conditions and as such cannot be relied upon to be effective at all times.

The pallets of onions on removal from the container should be placed outside of buildings in a shaded location where any natural wind/air movement will blow over and through the pallets. Do not block stack the pallets, the best configuration is to place them in a long single row at 90 degrees to the direction of the wind. This will ensure that each pallet receives the maximum exposure to the natural air movement. If stacking in a single row is not possible leave gaps of at least 30cm around each pallet. Ensure that none of the onions are exposed to direct sunlight as sunburn can occur.

Illustrations of the principle of forced air ventilation.

For the palletised onions, use one row of pallets each side of the fan and ensure that the curtain is wide enough to extent across both rows of pallets and the central air space.