



Test Numbers: T2258-4,5,6,10,11 & 12	Creation Date: 23-Apr-2012
Document Type: Comparison Report	Issue No.: 1.1
Customer: BPF EPS Group	Issue Date: 01-May-2012
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Comparison of the EPS, Waxed-Corrugate & Corrugated Twin-Wall Polypropylene Large Shipping Systems for Temperature Sensitive Products by SCA Cool Logistics

BPF EPS Group

Associated Test Number(s): T2258-4,5,6,10,11 & 12
Test Description: Flat +5.0°C Profile
Flat +15.0°C Profile

01-May-2012

Prepared by: Matt Carroll

Position: Packaging Engineer

Signature:

Approved by: Richard Wood

Position: Design Manager

Signature:



1 Executive Summary

The EPS, Waxed-Corrugate & Corrugated Twin-Wall Polypropylene Large systems were tested to the predetermined criteria to confirm their comparability of maintaining a product temperature range of below +5.0°C for the required duration as outlined in Appendix A.

2 Results Summary

Shipper Type	Ambient Profile	Time to >+5.0°C	Test Iteration
EPS	Cold	>72:00hrs	T2258-4
	Warm	40:20hrs	T2258-10
Waxed-Corrugate	Cold	63:30hrs	T2258-5
	Warm	18:50hrs	T2258-11
Corrugated Twin-Wall Polypropylene	Cold	32:30hrs	T2258-6
	Warm	20:50hrs	T2258-12





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4 Revision Control

Issue	Date	Amendments	By
1.0	23-Apr-2012	Initial Issue	Matt Carroll
1.1	01-May-2012	Minor Cosmetic Adjustments	Matt Carroll



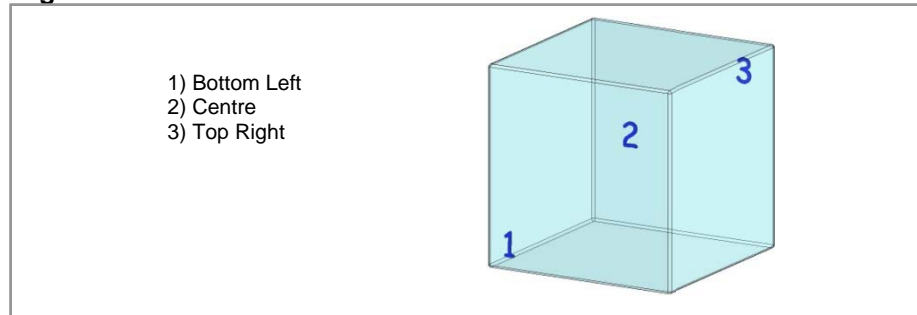
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5 Methodology

5.1 Product Preparation

Calibrated T type thermocouple probes were attached to the test product load in the locations referenced in figure A. This was done by taping the thermocouple wire to the individual product.

Figure A



5.2 Product Conditioning

The product load was placed into 0.0°C (±3.0°C) storage for a minimum period of 24 hours prior to the test start to allow its temperature to stabilise.

5.3 -18.0°C Component Conditioning

As referenced on the System Diagram, all components marked as -18.0°C were placed into -18.0°C (±3.0°C) storage for a minimum period of 24 hours prior to the test start to allow their temperature to stabilise. Conditioning times quoted are for individual components only, placed individually, allowing contact with air on a minimum of five faces (e.g. not stacked).

Prior to test initiation, these components were removed from storage and allowed to precondition at warehouse temperature (+20.0°C [±5.0°C]) until they had reached -4.0°C. At this temperature point they were added to the system packout. The temperatures were monitored using an infrared thermometer.

5.4 Other Component Conditioning

All other materials were maintained at warehouse temperature (+20.0°C [±5.0°C]) prior to testing.

5.5 Test Initiation

One hour prior to the start of testing, the environmental test chamber was programmed with the required ambient temperature profile and set to the starting temperature to stabilise.

All components were then assembled as illustrated on the system diagram.

With the shipper assembled and the lid secure, at least one (1) additional thermocouple was attached to the system exterior to measure the ambient temperature of the environmental chamber. All thermocouples were connected to a calibrated data logger and set to record at ten minute intervals. The tests were run for the required duration before the data logger was downloaded and a graph and table of readings produced.

5.6 Coolant

The coolant ice packs used contained a solution of 3% salt to 97% water.



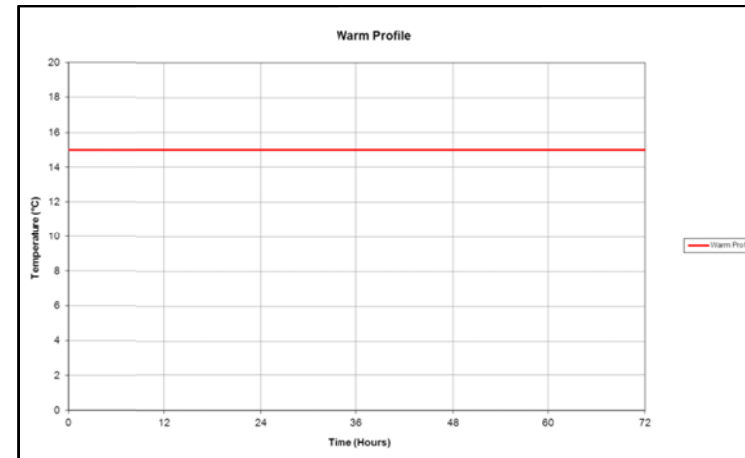
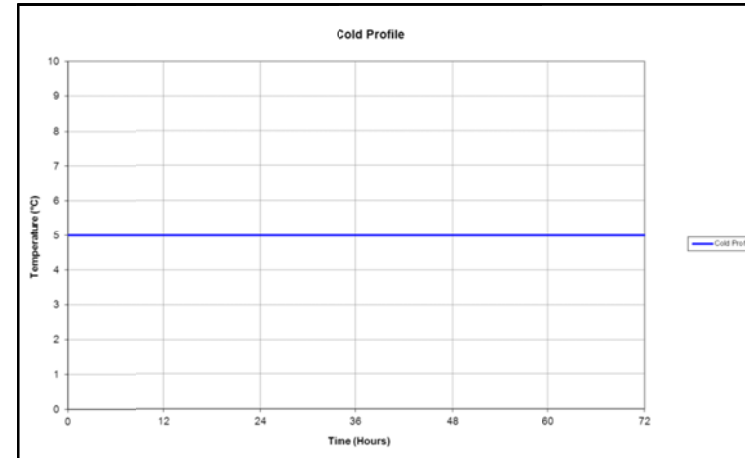
6 Ambient Temperature Profiles

Cold Profile

Set Temperature	Duration
+5.0°C	72:00hrs

Warm Profile

Set Temperature	Duration
+15.0°C	72:00hrs





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7 System Diagram and Specification

7.1 T2258-4 & 10 BPF EPS Group EPS Large Shipper

Large EPS Lid



Large EPS Base

External Dimensions: 700x480x260mm
Internal Dimensions: 655x435x210mm
Internal Volume: 59.8L
Shipper Weight: 0.6kg
Volumetric Weight: 14.6kg



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T2258-5 & 11 Competitor Waxed-Corrugate Large Shipper

Large Waxed-Corrugate Lid



Large Waxed-Corrugate Base

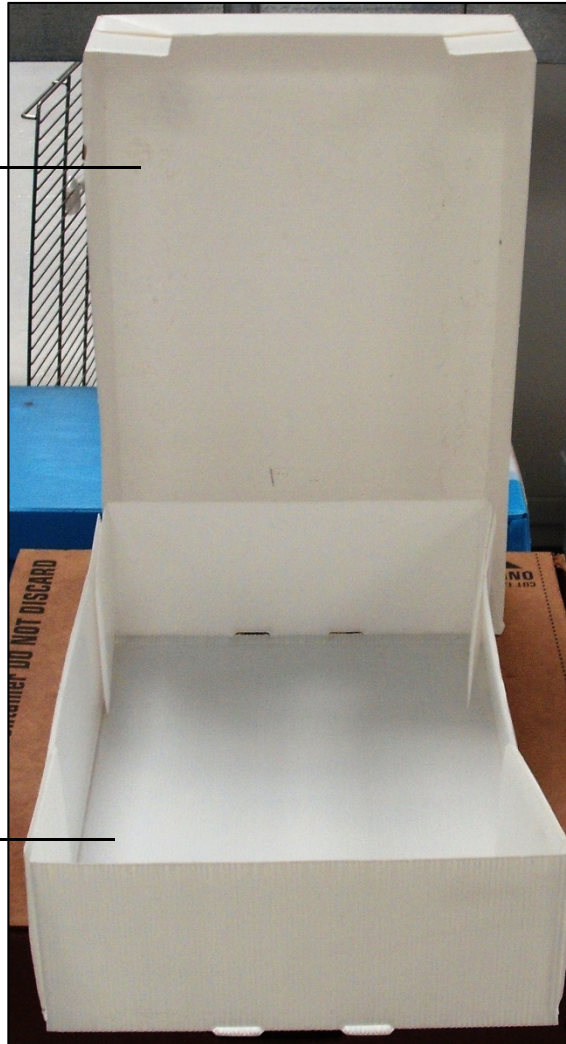
External Dimensions: 590x395x155mm
Internal Dimensions: 580x385x150mm
Internal Volume: 33.5L
Shipper Weight: 1.2kg
Volumetric Weight: 6.0kg



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7.2 T2258-5 & 12 Competitor Corrugated Twin-Wall Polypropylene Large Shipper

Large Corrugated Twin-Wall Polypropylene Lid



Large Corrugated Twin-Wall Polypropylene Base

External Dimensions: 495x325x130mm
Internal Dimensions: 475x310x125mm
Internal Volume: 18.4L
Shipper Weight: 0.3kg
Volumetric Weight: 3.5kg



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8 Packing Procedure

8.1 First Product Layer





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8.2 Middle Coolant Layer and Middle Product Layer





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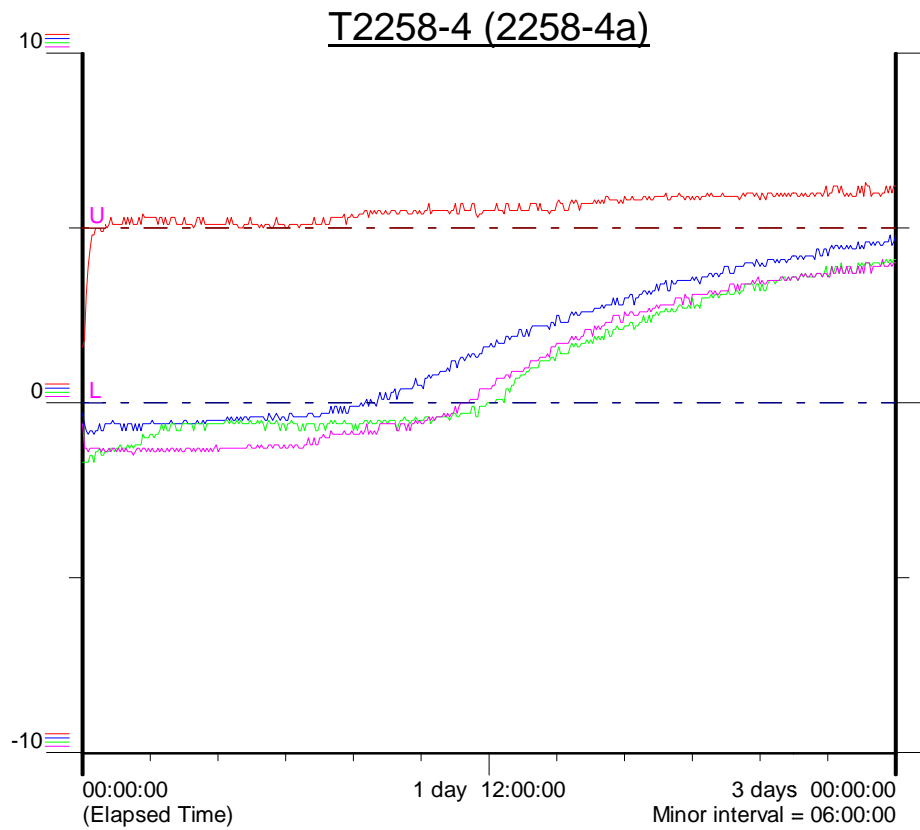
8.3 Final Coolant Layer in Corrugated Twin-Wall Polypropylene & Waxed-Corrugate Shippers, Penultimate Coolant & Product Layer in EPS Shipper





9 Test Result

9.1 T2258-4: Cold Profile, EPS Large Shipper (13.5kg of product, 6.0kg of coolant)



Ch:2	Ambient 2
Ch:3	Btm L
Ch:4	Ctr
Ch:5	Top R

Results

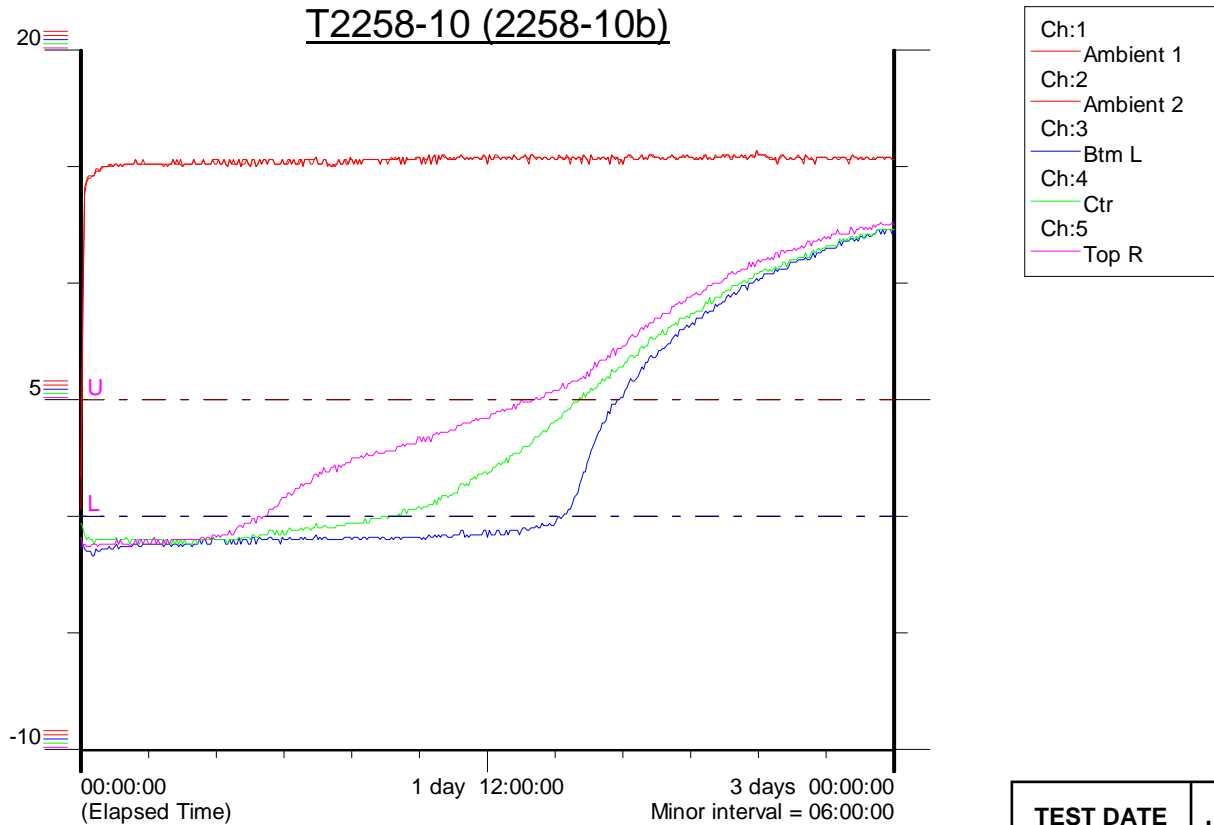
	TIME / TEMPERATURE	CHANNEL
>+5.0°C @	N/A	N/A
Maximum Temperature	+4.8°C 72:00hrs	3
Minimum Temperature	-1.7°C 00:00hrs	4

Equipment

TEST DATE	DATA LOGGER	PROBE SET	PROBE EXTENSION	ENVIRONMENTAL CHAMBER
30-Mar-2012	AK	AK	AK	13



9.2 T2258-10: Warm Profile, EPS Large Shipper
(13.5kg of product, 6.0kg of coolant)



Results

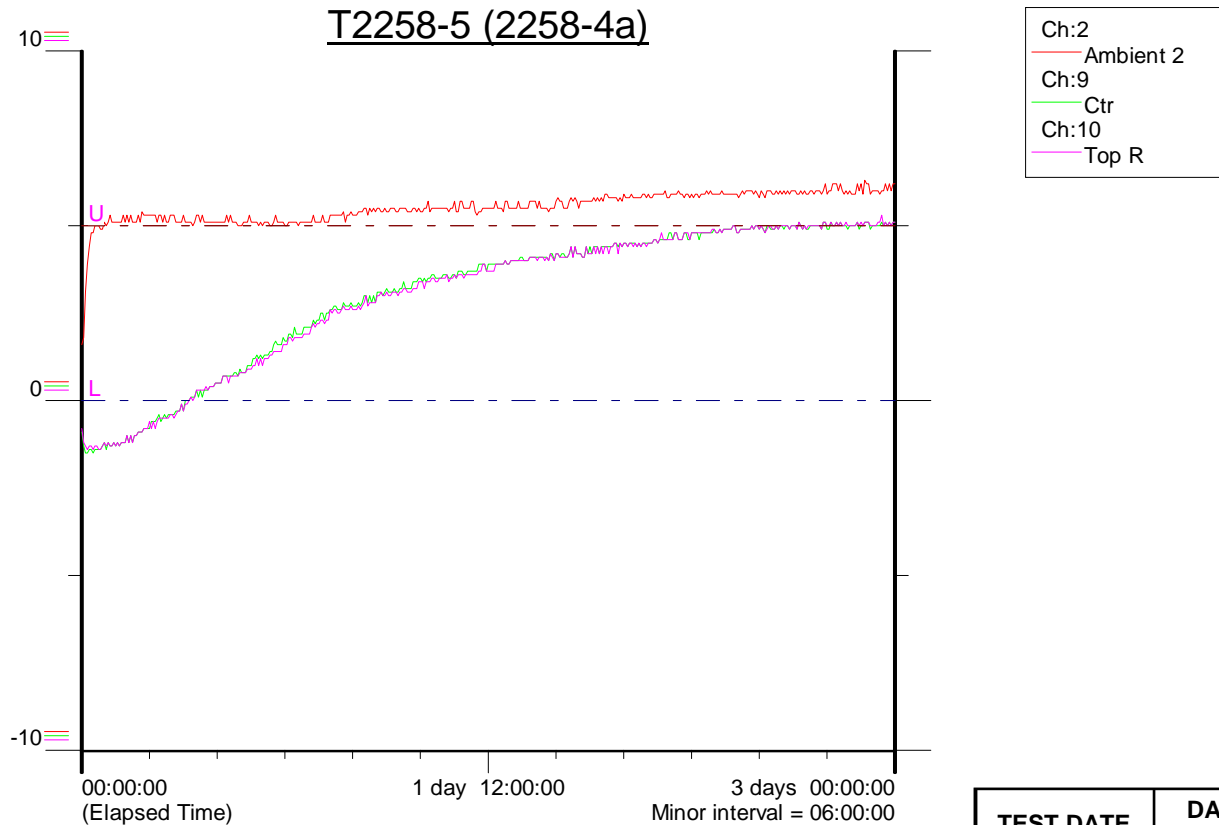
	TIME / TEMPERATURE	CHANNEL
>+5.0°C @	40:20hrs	5
Maximum Temperature	+12.6°C 70:50hrs	5
Minimum Temperature	-1.7°C 01:00hrs	3

Equipment

TEST DATE	DATA LOGGER	PROBE SET	PROBE EXTENSION	ENVIRONMENTAL CHAMBER
12-Apr-2012	AK	AK	AK	13



9.3 T2258-5: Cold Profile, Waxed-Corrugate Large Shipper (9.0kg of product, 6.0kg of coolant)



Results

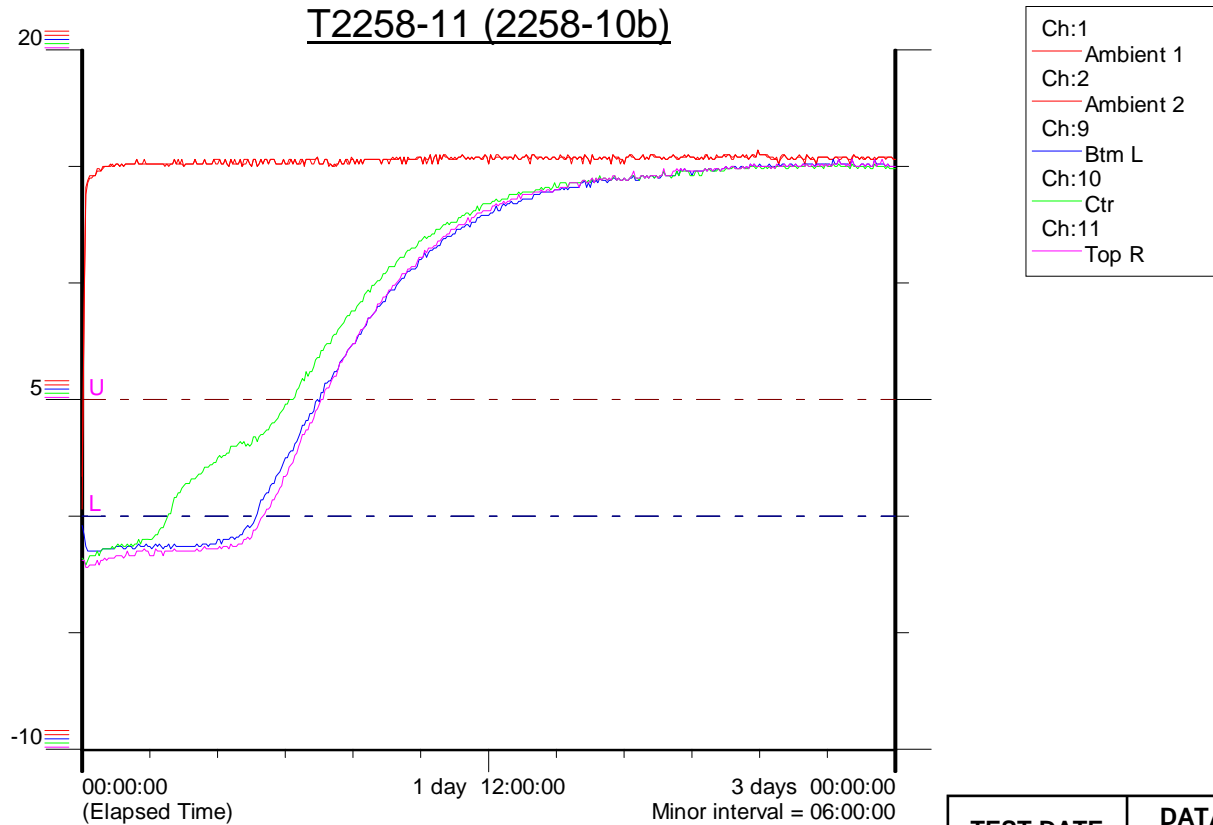
	TIME / TEMPERATURE	CHANNEL
>+5.0°C @	63:30hrs	9,10
Maximum Temperature	+5.3°C 70:50hrs	10
Minimum Temperature	-1.5°C 00:20hrs	9

Equipment

TEST DATE	DATA LOGGER	PROBE SET	PROBE EXTENSION	ENVIRONMENTAL CHAMBER
30-Mar-2012	AK	AK	AK	13



9.4 T2258-11: Warm Profile, Waxed-Corrugate Large Shipper
 (9.0kg of product, 6.0kg of coolant)



Results

	TIME / TEMPERATURE	CHANNEL
>+5.0°C @	18:50hrs	10
Maximum Temperature	+15.3°C 66:30hrs	9
Minimum Temperature	-2.2°C 00:20hrs	11

Equipment

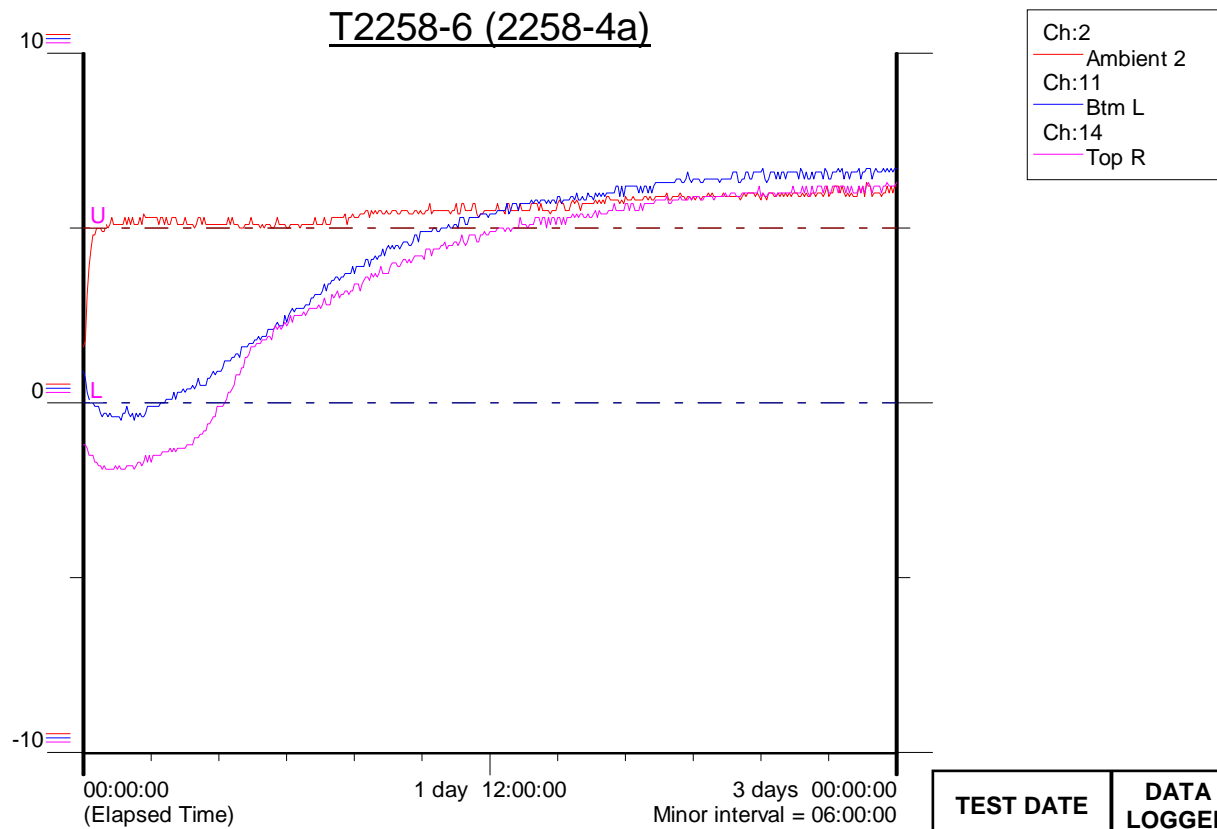
TEST DATE	DATA LOGGER	PROBE SET	PROBE EXTENSION	ENVIRONMENTAL CHAMBER
12-Apr-2012	AK	AK	AK	13



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9.5 T2258-6: Cold Profile, Corrugated Twin-Wall Polypropylene Large Shipper
 (3.0kg of product, 6.8kg of coolant)

9.6



Results

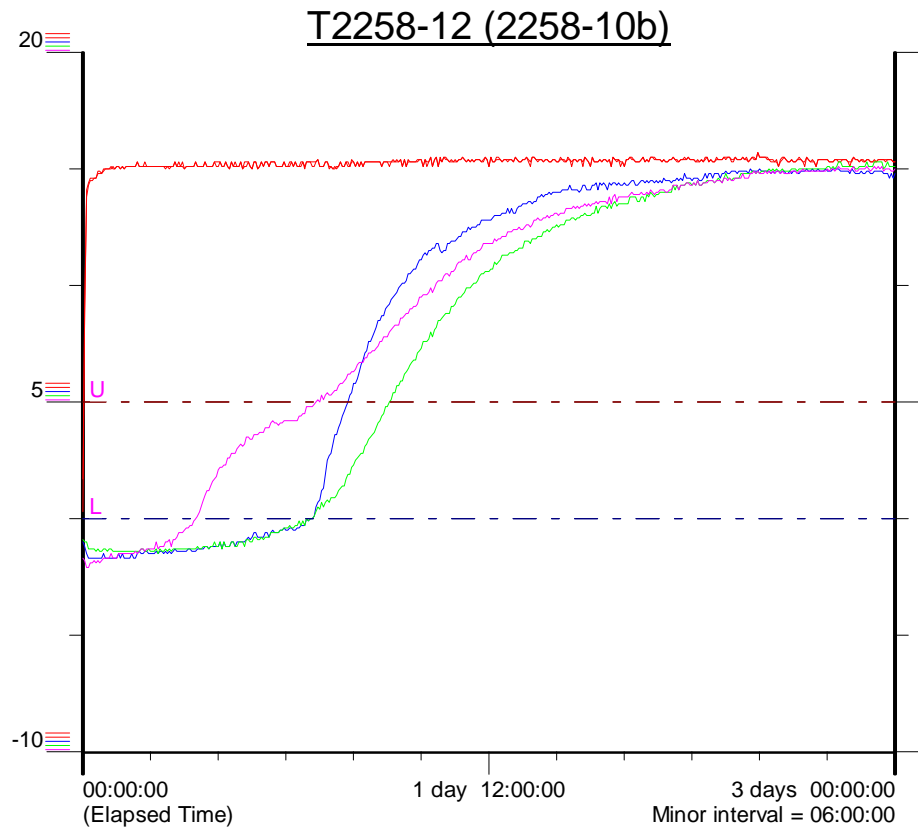
	TIME / TEMPERATURE	CHANNEL
>+5.0°C @	32:30hrs	11
Maximum Temperature	+6.7°C 65:40hrs	11
Minimum Temperature	-1.9°C 01:40hrs	14

Equipment

TEST DATE	DATA LOGGER	PROBE SET	PROBE EXTENSION	ENVIRONMENTAL CHAMBER
30-Mar-2012	AK	AK	AK	13



**T2258-12: Warm Profile, Corrugated Twin-Wall Polypropylene
Large Shipper
(3.0kg of product, 6.8kg of coolant)**



- Ch:1 Ambient 1
- Ch:2 Ambient 2
- Ch:12 Btm L
- Ch:13 Ctr
- Ch:14 Top R

Results

	TIME / TEMPERATURE	CHANNEL
>+5.0°C @	20:50hrs	14
Maximum Temperature	+15.3°C 67:00hrs	13
Minimum Temperature	-2.1°C 00:20hrs	14

Equipment

TEST DATE	DATA LOGGER	PROBE SET	PROBE EXTENSION	ENVIRONMENTAL CHAMBER
12-Apr-2012	AK	AK	AK	13



10 Deviations and Discussion

Shipper Type	Ambient Profile	Time to >+5.0°C	Test Iteration
EPS	Cold	>72:00hrs	T2258-4
	Warm	40:20hrs	T2258-10
Waxed-Corrugate	Cold	63:30hrs	T2258-5
	Warm	18:50hrs	T2258-11
Corrugated Twin-Wall Polypropylene	Cold	32:30hrs	T2258-6
	Warm	20:50hrs	T2258-12

The EPS Large shipper maintained a product temperature of below +5.0°C for the full 72:00hrs duration when tested to the Cold Profile, significantly outperforming the Waxed-Corrugate and Corrugated Twin-Wall Polypropylene Large shippers. While the EPS Large shipper did not pass the full required duration when tested to the Warm Profile it still managed to outperform both the Waxed-Corrugate and Corrugated Twin-Wall Polypropylene Large shippers by more than 20:00hrs. The EPS Large shipper can be considered a more effective choice for shipping fish products through cold and warm ambient conditions than either the Waxed-Corrugate or Corrugated Twin-Wall Polypropylene Large shippers. It is worth noting that during the T2258-5 (Waxed-Corrugate Large, Cold Profile) and the T2258-6 (Corrugated Twin-Wall Polypropylene Large, Cold Profile) tests one probe failed to record and as such is not included in the results displayed above. According to ASTM D3103 guidelines the failure of a single probe to read during a test is considered acceptable.

11 Conclusion

The tests have shown that the EPS Large system outperforms the Waxed-Corrugate and Corrugated Twin-Wall Polypropylene Large systems in terms of thermal performance.

12 Liability Restriction

It should be noted that this report represents test results carried out by SCA Cool Logistics in good faith. As such we cannot be responsible for the handling and usage of the systems tested; we restrict our liability to the replacement of any components supplied which are not to agreed specification. Customers are advised to check the appropriateness of the testing parameters for their shipping conditions.



13 Appendix A: Test Criteria

Product	Name	Rainbow Trout
	Temperature Range	Below +5.0°C
	Primary Packaging	Vacuum Sealed Bag
	Weight	750g
	Quantity Within Presentation Packaging	2
Product Load	EPS Shipper Load Quantity	18
	EPS Shipper Load Weight	13.5kg
	Waxed-Corrugate Shipper Load Quantity	12
	Waxed-Corrugate Shipper Load Weight	9.0kg
	Corrugated Twin-Wall Polypropylene Shipper Load Quantity	9
	Corrugated Twin-Wall Polypropylene Shipper Load Weight	6.8kg
Shipping	Required Minimum Pass Duration	72:00hrs
	Test Run Duration	72:00hrs
	Ambient Profile A	Cold Profile
	Ambient Profile B	Warm Profile
Other		



14 Appendix B: Calibration Documents

14.1 Environmental Chamber

Calibration Report of Environmental Test Chambers

Test Chamber Reference: 13 Serial Number: 222/18852 Model Number: SB111/1000
 Logger Reference: Z Probe Set Reference: Z Extension Lead Set Reference: Z

Ambient Temperature Profile

Temperature (°C)	Duration (hours)
+20	4
+50	4
-20	4
+50	4
+5	4
+20	4

Results

Thermocouple Positioning

Calibration performed by: Matt Carroll
 Date: 19-Dec-2011



14.2 Data Logger

CALIBRATION REPORT
Squirrel Data Logger and T-Type Thermocouple Probes

Revision 5
19/12/2008

RESULTS
All of the following equipment has been calibrated against the NIST traceable standard

DATA LOGGER REFERENCE	PROBE SET REFERENCE	EXTENSION PROBE REFERENCE	LOGGER SERIAL NUMBER
AK	AK	AK	EL-8805

Reference Dotsmann Serial Number: 65505020361 Reference Calibrated Probe Serial No: 60997

Calibration at +65°C

Initial Calibrator Reading: 65.00°C Average Calibrator Reading: 65.000°C
Final Calibrator Reading: 65.00°C (Channels must read +/- 0.5°C of average calibrator reading)

Thermocouple Readings

Channel 1	65.0°C	Channel 5	65.3°C	Channel 9	65.3°C	Channel 13	65.1°C
Channel 2	65.1°C	Channel 6	65.4°C	Channel 10	65.3°C	Channel 14	65.1°C
Channel 3	64.9°C	Channel 7	65.4°C	Channel 11	65.2°C	Channel 15	65.1°C
Channel 4	65.3°C	Channel 8	65.0°C	Channel 12	65.3°C	Channel 16	N/A

Calibration at +5°C

Initial Calibrator Reading: 5.10°C Average Calibrator Reading: 5.100°C
Final Calibrator Reading: 5.10°C (Channels must read +/- 0.5°C of average calibrator reading)

Thermocouple Readings

Channel 1	5.1°C	Channel 5	5.3°C	Channel 9	5.0°C	Channel 13	5.0°C
Channel 2	5.1°C	Channel 6	5.1°C	Channel 10	5.0°C	Channel 14	5.0°C
Channel 3	5.3°C	Channel 7	5.1°C	Channel 11	5.0°C	Channel 15	5.0°C
Channel 4	5.1°C	Channel 8	5.3°C	Channel 12	5.0°C	Channel 16	4.9°C

Calibration at -30°C

Initial Calibrator Reading: -35.10°C Average Calibrator Reading: -35.150°C
Final Calibrator Reading: -35.20°C (Channels must read +/- 0.5°C of average calibrator reading)

Thermocouple Readings

Channel 1	-35.0°C	Channel 5	-35.0°C	Channel 9	-35.0°C	Channel 13	-35.0°C
Channel 2	-35.2°C	Channel 6	-35.0°C	Channel 10	-35.0°C	Channel 14	-35.0°C
Channel 3	-34.7°C	Channel 7	-35.0°C	Channel 11	-35.0°C	Channel 15	-35.2°C
Channel 4	-35.2°C	Channel 8	-34.8°C	Channel 12	-35.0°C	Channel 16	-35.2°C

CALIBRATION PERFORMED BY: Matt Carroll
NAME: _____ SIGNATURE: _____
DATE: 19 December 2011

CALIBRATION REPORT
Squirrel Data Logger and T-Type Thermocouple Probes

Revision 5
19/12/2008

RESULTS
All of the following equipment has been calibrated against the NIST traceable standard

DATA LOGGER REFERENCE	PROBE SET REFERENCE	EXTENSION PROBE REFERENCE	LOGGER SERIAL NUMBER
Z	Z	Z	EL-8190

Reference Dotsmann Serial Number: 65505020361 Reference Calibrated Probe Serial No: 60997

Calibration at +65°C

Initial Calibrator Reading: 65.20°C Average Calibrator Reading: 65.200°C
Final Calibrator Reading: 65.20°C (Channels must read +/- 0.5°C of average calibrator reading)

Thermocouple Readings

Channel 1	65.2°C	Channel 5	65.3°C	Channel 9	65.2°C	Channel 13	65.3°C
Channel 2	65.0°C	Channel 6	65.2°C	Channel 10	65.3°C	Channel 14	65.2°C
Channel 3	65.2°C	Channel 7	65.3°C	Channel 11	65.2°C	Channel 15	65.1°C
Channel 4	65.0°C	Channel 8	65.3°C	Channel 12	65.2°C	Channel 16	65.2°C

Calibration at +5°C

Initial Calibrator Reading: 5.30°C Average Calibrator Reading: 5.300°C
Final Calibrator Reading: 5.30°C (Channels must read +/- 0.5°C of average calibrator reading)

Thermocouple Readings

Channel 1	5.4°C	Channel 5	5.7°C	Channel 9	5.6°C	Channel 13	5.5°C
Channel 2	5.5°C	Channel 6	5.5°C	Channel 10	5.4°C	Channel 14	5.5°C
Channel 3	5.4°C	Channel 7	5.5°C	Channel 11	5.4°C	Channel 15	5.5°C
Channel 4	5.5°C	Channel 8	5.7°C	Channel 12	5.4°C	Channel 16	5.5°C

Calibration at -30°C

Initial Calibrator Reading: -35.60°C Average Calibrator Reading: -35.600°C
Final Calibrator Reading: -35.60°C (Channels must read +/- 0.5°C of average calibrator reading)

Thermocouple Readings

Channel 1	-35.2°C	Channel 5	-35.1°C	Channel 9	-35.1°C	Channel 13	-35.2°C
Channel 2	-35.1°C	Channel 6	-35.1°C	Channel 10	-35.1°C	Channel 14	-35.2°C
Channel 3	-35.3°C	Channel 7	-35.1°C	Channel 11	-35.2°C	Channel 15	-35.3°C
Channel 4	-35.2°C	Channel 8	-35.1°C	Channel 12	-35.2°C	Channel 16	-35.2°C

CALIBRATION PERFORMED BY: Matt Carroll
NAME: _____ SIGNATURE: _____
DATE: 12 December 2011



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14.3 Master Calibrator - Dostmann P600

CERTIFICATE OF CALIBRATION
ISSUED BY **ANTECH**

DATE OF ISSUE 12 October 2011 CERTIFICATE NUMBER : U50648-11

UKAS CALIBRATION
0489

Antech Calibration Services
Hewett Road
Capton Hall Industrial Estate
Great Yarmouth
Norfolk NR31 0NN
Telephone: +44 (0) 1493 440600 Facsimile: +44 (0) 1493 440606
e-mail: sales@antech.org.uk

APPROVED SIGNATORY

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CUSTOMER DETAILS ANTECH REF: 11979-1.11/A

Company : Cool Logistics
Address : Celsius House
The Stanbridge Building
Stanbridge Road
Leighton Buzzard
Bedfordshire
LU7 4QQ

Order Number : TBA

UNIT CALIBRATED

Manufacturer : Dostmann
Model : P655 Digital Thermometer C/w Pt100 Temperature Probe
Serial No. Indicator : 65505020361
Probe : 060997
Date Inst. Received : 07 October 2011
Date Calibrated : 10 October 2011 to 11 October 2011

AMBIENT TEMPERATURE : 20°C ± 5°C

CALIBRATION PROCEDURE : PROC30400

Approved Signatory : A. Oxborough () M. Gunn (✓)

U:\ohc\2011\1901-12000\1979.11.A\Certificates\U50648-11.doc

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CERTIFICATE OF CALIBRATION
ANTECH

UKAS ACCREDITED CALIBRATION LABORATORY No. 0489

CERTIFICATE NUMBER
U50648-11
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Calibration details:

The UUT was calibrated as a system by inter-comparison with working standard PRT's using a high accuracy switched DC resistance bridge and temperature indicator, with the UUT probe inserted in a series of stirred liquid baths.

The UUT temperature indicator resolution is 0.01°C.

The results reported were taken with the 'CAL/OPI' function enabled and are as found, no adjustments made.

The uncertainties of measurement quoted are true at the time of calibration and are not indicative of the UUT to maintain its calibration with time.

TEMPERATURE MEASUREMENT RESULTS

Probe Serial No. 060997
Insertion depth 200mm

Standard Mean Temperature °C	UUT Indicated Temperature °C	Deviation from Standard Mean °C	Uncertainty Of Measurement °C
-79.999	-80.04	-0.041	± 0.04
-20.001	-20.03	-0.029	± 0.04
-0.002	-0.03	-0.028	± 0.04
10.001	9.98	-0.021	± 0.04
37.003	36.99	-0.013	± 0.04

The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor k=2, providing a level of confidence of approximately 95%. The uncertainty evaluation has been carried out in accordance with UKAS requirements.

END OF CERTIFICATE

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15 Appendix C: Glossary of Terms

Conditioning: The period (minimum of 48 hours) in which product or components are stored in order for them to stabilise at their relevant temperature.

Deviation: Any unexpected outcomes during testing are included in 'Deviations and Discussion', and can include things such as failed probes, temperature excursions or any changes made to the system or test process which differs from the original protocol.

Excursion: Refers only to temperatures recorded above or below threshold during testing.

Preconditioning: It is sometimes recommended that frozen components are left at factory ambient for a specified duration prior to their use within a system in order to avoid cold shock. This never applies to chilled or warm components and differs from standard conditioning which is required for all components. Preconditioning times are stated on the Methodology and System Diagram pages.

System Name: As a system configuration may require multiple tests to prove suitability, a single system name is used for identification for reporting, traceability and ordering purposes. The system name applied will always relate to the earliest approved test number. For example, a report contains results from two tests, T1111-11 and T1111-12, and so would be named the T1111-11 system.

Temperature Readings: All temperature readings throughout the report are presented in °C (degrees Celsius).

Test Number: Each Technical project is given a unique project number e.g. T1111. Each individual test is given a different identification number, which is the suffix to the unique project number e.g. T1111-13.