Operational Validation of E38 Shipping Container for the Purpose of Redistribution of Blood Components/Products between Ontario Hospitals

November 2017

Table of Contents

1.0. Executive Summary

In the fall of 2015, Canadian Blood Services (CBS) announced to its national and provincial customers Ontario Regional Blood Coordinating Network (ORBCoN) and the Factor Concentrate Redistribution Program (FCRP) that they were acquiring new insulated shipping containers (ISC's) for distribution of blood components and products to hospitals in Canada (excluding Quebec). The new ISC's have a pre-conditioning protocol which will not allow hospitals to utilize the new container. This change will have an impact on hospitals that presently use CBS boxes for shipping components/products to other facilities as part of their inventory management strategies, for redistribution or when transferring blood with patients to another facility. Hospitals were offered to continue to use the J82 and E38 shipping containers to facilitate redistribution and transfer of blood with a patient; however they would not provide ongoing verification that the containers are meeting the requirements set out by provincial and national standards for transporting blood. ORBCoN agreed to validate the shipping containers for the purposes of redistribution and transferring blood with a patient to maintain the established provincial redistribution programs. These programs have been successful in reducing waste of blood components/products and to help ensure patients 'needs are met.

The E38 shipping container was challenged at four temperature points to simulate temperature variations similar to the four seasons that the container could be exposed to during transit. Initial packing configurations that were provided by CBS were used to challenge the containers. After the initial first run the E38 container did not perform as expected using the recommended packing configuration of one gel pack on the bottom and one gel pack on top of the payload[1], so a modification was tested using two gel packs on the bottom and one gel pack on top of the payload. Each container was then tested in triplicate at each temperature point with a minimum and maximum payload for a total of 48 runs each using the revised packing configuration. Results were reviewed and the acceptable times in transit were established based on the results of each of the runs. Results below in table 1 illustrate how long the container maintained the acceptable shipping temperature of the products at the four different temperature points

Table 1 Shortest Time E38 Shipping Container Maintained Acceptable Temperature

Product/Acceptable Shipping Temperature	Target Extreme Winter Temperature (<-30°C)	Target Moderate Fall/Spring Temperature (1°C - 6°C)	Target Moderate Summer temperature (19°C to 25°C)	Target Extreme Summer temperature (> +30°C)
1 – 6 Plts (20°C -24°C)	2 hours	5 hours	24 hours	9 hours
1 – 8 PPP (19°C -25°C)	24 hours	24 hours	24 hours	6 hours

[1] Canadian Blood Services, Directive D30220, Revision2, Ottawa, ON:2011

2.0. Acknowledgments

Special thanks to the members of the two hospitals that performed the validation on behalf of ORBCoN and FCRP. ORBCoN and FCRP personnel appreciate the time taken by all staff that took part in this validation process.

Member	Affiliation
Amanda Pape	Halton Healthcare – Oakville Trafalgar Memorial Hospital
Laura Harrison	Trillium Health Partners – Credit Valley Hospital

3.0. Background, Purpose

3.1. Background:

CBS has implemented new shipping containers to support a national distribution system. The current J82 and E38 containers will be available for hospitals to use for redistribution and shipping blood with a patient. There have been some issues noted by CBS with the J82 and E38 container concerning temperature excursions (especially during the fall and spring months when temperature may vary more throughout the day), but containers perform well in a more controlled temperature shipping environment and will be validated to ensure they are suitable for redistribution purposes.

3.2. Purpose:

In order to confirm that these shipping containers would be suitable for hospitals to use, ORBCoN had to validate the manufacturer's claim that the shipping container labelled E38 will maintain the temperature of blood components (platelets) within the temperature range of 20°C to 24°C and Blood Products (PPPs) within the temperature range of 19°C to 25°C for a twenty-four (24) hour period using a standardized packing configuration (combination of gel packs). The shipping container validation was completed with the assistance of the staff at hospital transfusion medicine laboratories using equipment provided by their laboratory department. Temperatures were monitored and documented to determine the suitability of the shipping containers for the transfer of blood components and products within the Ontario hospital system.

4.0. Design and Methodology:

4.1. Validation Objectives:

To evaluate the thermal performance of the E38 shipping container during the following ambient temperatures for a period of 24 hours:

1. -30°C and -35°C
2. 1°C and 6°C
3. 19°C and 25°C
4. 30°C and 40°C

4.2. Method

Two hospital laboratories agreed to work with ORBCoN to challenge the two types of shipping containers that will continue to be supplied to hospitals through CBS. Four different temperature points were selected to simulate temperature variations similar to the four seasons that the containers could be exposed to during transit. To simulate extreme winter temperatures the first lab used a freezer with a temperature range of -30°C to -35°C and to simulate Fall/Spring temperatures they used a refrigerator with a temperature range of 1°C to 6°C. To simulate temperatures that would simulate moderate summer temperatures, the second lab incubated the containers at room temperature (19°C to 25°C), and to simulate extreme summer temperatures they used an incubator with a temperature range of 30°C to 40°C. Each container was tested in triplicate at each

temperature point with minimum and maximum payloads. Each test was assigned an expected payload, the acceptable temperature range and the target time in the testing environment. Table 2 shows the test protocol for payloads, temperature and duration of testing.

Table 2: Test Protocol

TEST#	PAYLOAD	TESTING TEMP	DURATION OF TEST	Acceptable Product Temperature Range
Test #1	Minimum 1 unit PLT	30-40°C	24 hours	20-24°C
Test #2	Maximum 6 units PLT	30-40°C	24 hours	20-24°C
Test#3	Minimum 1 vial PPP	30-40°C	24 hours	2-25°C
Test #4	Maximum # vials PPP	30-40°C	24 hours	2-25°C
Test #5	Minimum 1 unit PLT	19-25°C	24 hours	20-24°C
Test #6	Maximum 6 units PLT	19-25°C	24 hours	20-24°C
Test #7	Minimum 1 vial PPP	19-25°C	24 hours	2-25°C
Test# 8	Maximum # vials PPP	19-25°C	24 hours	2-25°C
Test #9	Minimum 1 unit PLT	-30-35°C	24 hours	20-24°C
Test #10	Maximum 6 units PLT	-30-35°C	24 hours	20-24°C
Test#11	Minimum 1 vial PPP	-30-35°C	24 hours	2-25°C
Test #12	Maximum # vials PPP	-30-35°C	24 hours	2-25°C
Test #13	Minimum 1 unit PLT	1-6°C	24 hours	20-24°C
Test #14	Maximum 6 units PLT	1-6°C	24 hours	20-24°C
Test #15	Minimum 1 vial PPP	1-6°C	24 hours	2-25°C
Test# 16	Maximum # vials PPP	1-6°C	24 hours	2-25°C

4.3. Acceptance Criteria:

1. E38 shipping containers will be considered acceptable for use only if the temperature within the shipping container is maintained between 20°C and 24°C for platelets (PLT) as well as between 19°C and 25°C for plasma protein products (PPP) based on a determined amount of time required to support redistribution of products within Ontario using the maximum and the minimum payload for each product tested.
2. The determined amount of time will be 24 hours or the minimum duration the container maintains acceptable temperature.
3. Three runs in each test sequence must meet the acceptance criteria without any major deficiencies.
4. Major deficiencies will result in repeat testing of the particular test or run or may result in repeating all test and runs upon review of the deficiency and implementation of any corrective action.

4.4. Equipment Used in the Validation Process:

Each testing location used their own equipment to challenge the containers. Each testing site was provided Log-ic data logging tags and corresponding software to collect the temperature during each challenge. The temperature was logged every 15 minutes for each run on the data logger and then the data was downloaded to the Log-ic software where a Log-ic Tag report was generated. Please see tables 3 and 4 for a list of equipment used by each testing location.

Test Location #1 (Tests 1 – 8): Trillium Health Partners – Credit Valley Hospital
2200 Eglinton Avenue West, Mississauga, ON L5M 2N1

Test Location #2 (Tests 9 – 16): Halton Healthcare – Oakville Trafalgar Memorial Hospital
3001 Hospital Gate, Oakville, ON L6M 0L8

Table 3: Test Location #1 Equipment List

Equipment	Name Model	Serial Number	Calibration Date
Freezer	HEMAPRO-JEWETT BPL425	N31R119122	Jan 2017
Incubator	SANYO MCO-17A1	50704107	Feb 2017
Fridge	JEWETT BBR55	G1324-198	Feb 2017
Data logger A *(outside container)*	LOG-IC USB255	3000373701	June 2016
Data logger B *(inside bottom of container)*	LOG-IC USB255	3000365884	June 2016
Data logger C *(inside top of container)*	LOG-IC USB255	300365952	June 2016
Platelet Incubator	HELMER PC900i	971936	Jan 2017
Platelet Agitator	HELMER PF48i	971855	Jan 2017

Table 4: Test Location #2 Equipment List

Equipment	Name and Model	Serial Number	Calibration Date
Freezer	Helmer IPF125-8	993689	Sept 2016
Refrigerator	Helmer IB245	968528	Sept 2016
Data Logger A (outside shipping container - Ambient)	AeroScout Wireless Temperature Monitoring Software	Freezer: 000CCC751DE9 Refrigerator: 000CCC751BC4	Sept 2016
Data Logger B (bottom inside shipping container)	Logic USB 255 Use Logger	Set A: 3000373720 Set B: 3000216028 Set C: 3000365876	June 2016
Data Logger C (top inside shipping container)	Logic USB 255 Use Logger	Set A: 3000365833 Set B: 3000373712 Set C: 3000365952	June 2016

Equipment	Name and Model	Serial Number	Calibration Date
Thermometer	Traceable Infrared Thermometer Gun 12777-846	160631891	July 2016

4.5. Packing Configuration Tested

CBS procedures state that three gel packs are to be preconditioned in a temperature range of 20°C to 24°C for at least eight hours to replicate the acceptable temperature range as per their validation protocol[2]. Figures 1 and 2 show the packing configuration used for challenging the E38 containers for both PLT and PPP.

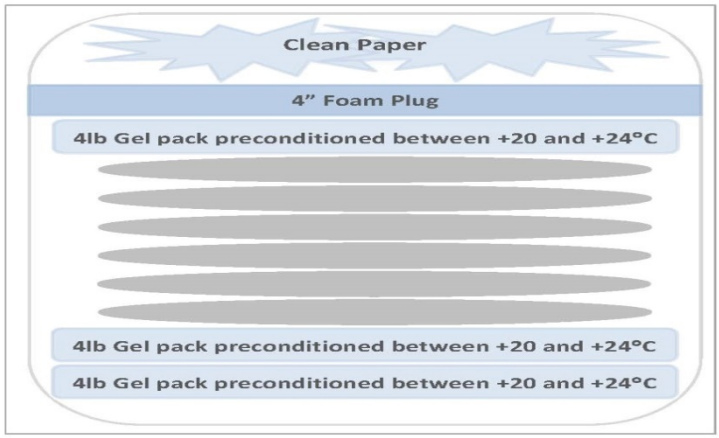


Figure 1 Packing configurations for PLT using E38 Container

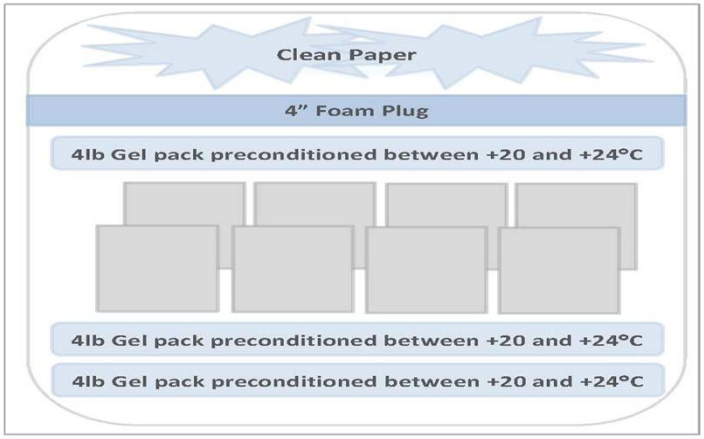


Figure 2 Packing configuration for PPP using E38 Container

4.6. E38 Container Components used for Validation Testing:

Outside corrugated sleeve
4" Foam plug
Strap
4lb gel pack stabilized between 20°C and 24°C (x3)
Plastic zip-lock bag for gel packs
Clear plastic over-wrap bag for components/products
Tamper proof device
Clean packing paper *(if required)*
Data loggers (x3)

Figure 3 E38 container outer side

Figure 4 E38 container with payload

[2] Canadian Blood Services , Directive D30220,Revision2, Ottawa, ON;2011

4.7. Validation Procedure:

STEP | **ACTION**

1.0 Pre-condition the Gel Packs

1.1.

Preconditioning for:	***Then***
PLTs and PPP(room temp)	• 3 Gel packs need to be conditioned in a 20°C to 24°C environment for at least 6 hours prior to use • Ensure each is enclosed in a sealed zip lock bag

2.0. Pack Out Preparations

2.1. Select shipping container

If	***Then***
Preparing for 1 to 6 PLTs or 1 to 8 PPP	• Apply data-logger to outside of shipping container • Place 2 room temperature gel packs *(in zip lock bags)* on the bottom of the container • Apply data-logger on top of gel packs and press 'start' button to initiate data monitoring

3.0. Load Payload

3.1. Ensure payload is preconditioned before loading into the assembled shipping container. Do not over pack.

If payload is	***Then***
PLTs	Products must be preconditioned between 20°C and 24°C for at least 6 hours before being placed in shipping container
PPP	Products must be preconditioned between 2°C and 25°C for at least 6 hours before being placed in shipping container

3.2. Place the payload (required number of PLT or PPP depending on the Test Protocol number in step 6.1) into a clear plastic over-wrap bag and place into the E38 shipping container on top of the gel pack.

3.3. Place a second data logger on top of the payload and press the start button to initiate data monitoring.

4.0. Close and Secure Container

4.1. Minimize empty air space in the container.

If	***Then***
Shipping PLTs or Shipping PPPs	• Place one room temperature gel pack *(in a zip lock bag)* on the top of the data-logger • Place the 4" foam plug on top of the gel pack

4.2. Place the Styrofoam lid on top of shipping container.

4.3. Close and secure the outer corrugated plastic container with the strap.

4.4. Loop a tamper proof device through the buckle to ensure the container is not opened during the test.

4.5. Press the 'start' button on the data logger attached to the outside of the container to begin monitoring the outside ambient temperature.

5.0. Label Container

5.1. Affix a label on the outside of the container to indicate Test#, Run# and payload for the applicable temperature/time.

6.0.

6.1. Place container in the desired temperature environment for the indicated time. Refer to

Perform Test

the table below:

TEST#	PAYLOAD	TESTING TEMP	DURATION OF TEST	Acceptable Product Temperature Range
Test #1	Minimum 1 unit PLT	30-40°C	24 hours	20-24°C
Test #2	Maximum 6 units PLT	30-40°C	24 hours	20-24°C
Test#3	Minimum 1 vial PPP	30-40°C	24 hours	2-25°C
Test #4	Maximum # vials PPP	30-40°C	24 hours	2-25°C
Test #5	Minimum 1 unit PLT	19-25°C	24 hours	20-24°C
Test #6	Maximum 6 units PLT	19-25°C	24 hours	20-24°C
Test #7	Minimum 1 vial PPP	19-25°C	24 hours	2-25°C
Test# 8	Maximum # vials PPP	19-25°C	24 hours	2-25°C
Test #9	Minimum 1 unit PLT	-30-35°C	24 hours	20-24°C
Test #10	Maximum 6 units PLT	-30-35°C	24 hours	20-24°C
Test#11	Minimum 1 vial PPP	-30-35°C	24 hours	2-25°C
Test #12	Maximum # vials PPP	-30-35°C	24 hours	2-25°C
Test #13	Minimum 1 unit PLT	1-6°C	24 hours	20-24°C
Test #14	Maximum 6 units PLT	1-6°C	24 hours	20-24°C
Test #15	Minimum 1 vial PPP	1-6°C	24 hours	2-25°C
Test# 16	Maximum # vials PPP	1-6°C	24 hours	2-25°C

6.2. Run each test a minimum of three times.

6.3. At completion of each test run, stop the data loggers, return the packing materials and component/product to temperature conditioning environment.

7.0. Download Temperature Data

7.1. Download data from data loggers and print reports.

8.0. Complete Documentation

8.1. Complete all worksheets and deficiency reports

8.2. Attach all documentation to the protocol. Title each attachment with the corresponding test number and run number.
e.g. Test#1: Test at 30-40°C Ambient Temperature with 1 unit PLT Run #1 attachment #1

5.0. Validation Results

The validation process was completed for all temperature challenges in a controlled environment in the laboratory setting. The project team evaluated each of the test runs and identified and were able to troubleshoot any deficiencies identified during the testing. Each test run that demonstrated deficiencies was repeated. Data was downloaded for all three runs for each test and then a minimum and maximum temperature was established for each data logger as well as the average temperature outside of the container as well as inside the container. The time intervals were recorded and reviewed to see how long each container held the acceptable temperature range inside the container. The shortest acceptable

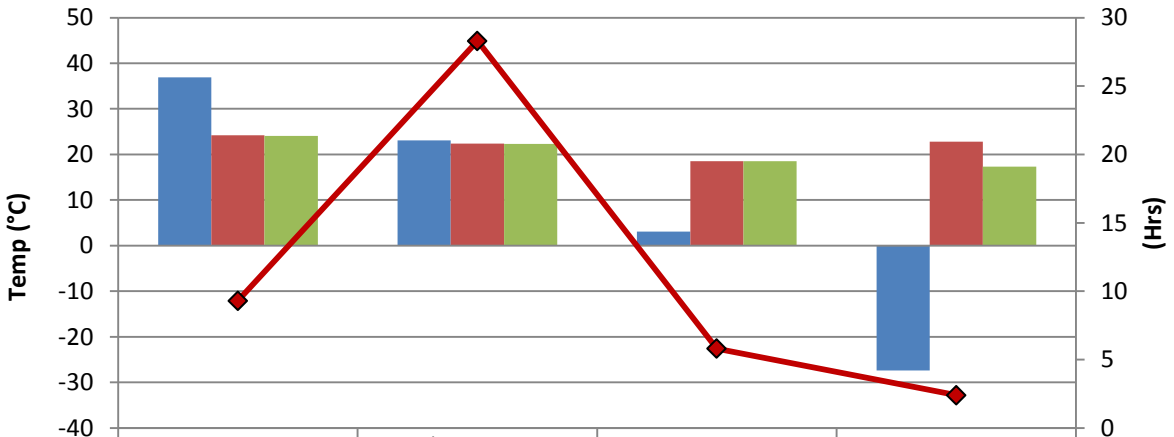
temperature (Table 5) provides the data for the RBC payload tested at each temperature point. Table 6 provides data for the PPP payload tested at each temperature point.

Table 5: E38 maintaining payload of 1-6 PLT at 20°C - 24°C

	Data Logger	Min Temp (°C)	Max Temp (°C)	Average Temp (°C)	Shortest Acceptable Time (hrs.)
Extreme Summer Temp 30 to 40°C	A (Ambient)	32.2	40.6	36.9	8.0
	B (Bottom)	20.7	27.4	24.2	
	C (Top)	20.5	27.6	24.1	
Moderate Summer Temp 19 to25°C	A (Ambient)	21.7	24.5	23.1	23.0
	B (Bottom)	21.7	23.3	22.4	
	C (Top)	21.4	23.1	22.3	
Fall/Spring Temp 1 to 6°C	A (Ambient)	2.3	3.9	3.1	4.0
	B (Bottom)	13.8	21.9	18.5	
	C (Top)	13.6	22.2	18.5	
Extreme Winter Temp -30 to -35°C	A (Ambient)	-28.2	-24.4	-27.4	0.3
	B (Bottom)	5.2	22.6	22.8	
	C (Top)	5.0	17.4	17.3	

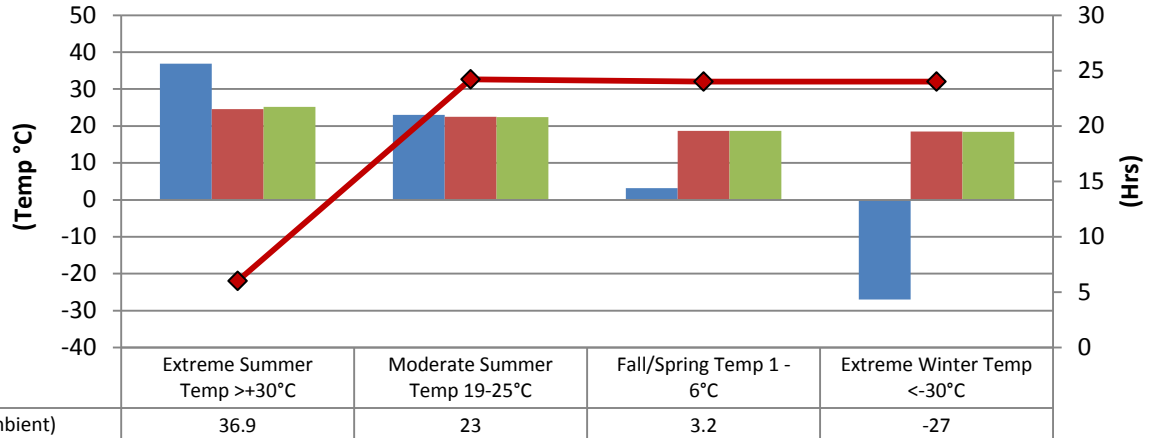
Table 6: E38 maintaining payload of 1-8 PPP vials at 2°C - 25°C

	Data Logger	Min Temp (°C)	Max Temp (°C)	Average Temp (°C)	Shortest Acceptable Time (hrs.)
Extreme Summer Temp 30 to 40°C	A (Ambient)	33.0	40.1	36.9	5.0
	B (Bottom)	21.1	27.3	24.6	
	C (Top)	21.2	29.5	25.2	
Moderate Summer Temp 19 to25°C	A (Ambient)	21.7	24.7	23.0	24.0
	B (Bottom)	21.7	23.1	22.5	
	C (Top)	21.5	22.9	22.4	
Fall/Spring Temp 1 to 6°C	A (Ambient)	2.3	3.9	3.2	24.0
	B (Bottom)	14.3	22.7	18.7	
	C (Top)	14.1	22.8	18.7	
Extreme Winter Temp -30 to -35°C	A (Ambient)	-29.4	-24.4	-27.0	24.0
	B (Bottom)	2.5	22.4	18.5	
	C (Top)	3.4	22.6	18.4	



	Extreme Summer Temp >+30°C	Moderate Summer Temp 19-25°C	Fall/Spring Temp 1 - 6°C	Extreme Winter Temp <-30°C
Data Logger A (Ambient)	36.9	23.1	3.1	-27.4
Data Logger B (Insided Bottom)	24.2	22.4	18.5	22.8
Data Logger C (Inside Top)	24.1	22.3	18.5	17.3
Average Acceptable Time	9.3	28.3	5.8	2.4

Figure 6: Average temperature recorded for E38 container with PLT payload and average acceptable time



	Extreme Summer Temp >+30°C	Moderate Summer Temp 19-25°C	Fall/Spring Temp 1 - 6°C	Extreme Winter Temp <-30°C
Data Logger A (Ambient)	36.9	23	3.2	-27
Data Logger B (Insided Bottom)	24.6	22.5	18.7	18.5
Data Logger C (Inside Top)	25.2	22.4	18.7	18.4
Average Acceptable Time	6	24.2	24	24

Figure 6: Average temperature recorded for E38 container with PPP payload and average acceptable time

The above graphs illustrate the minimum and maximum temperatures of the data loggers inside the container and the average time that the container maintained the acceptable temperatures.

5.1. Deficiencies Reported

Three deficiencies were reported during the validation of the E38 shipping containers.

Deficiency 1: The first deficiency was noted after the first run for Test 1. Data loggers were placed incorrectly inside the E38 shipping container for Test#1 Run #1. The bottom data logger was placed underneath the gel packs instead of on top of the gel packs on the bottom of the container. Test #1 Run#1 was rerun and the bottom data logger was placed on top of the two gel packs but underneath the payload and the second data-logger was placed on top of the payload prior to adding the third gel pack and the foam insert.

Deficiency 2: After the first run it was noticed that the E38 box did not last the 24hrs as previously thought to maintain appropriate temperatures. Test 1 Run#1 was repeated and failed to demonstrate that the box could meet the required minimum of 24hrs to maintain the appropriate temperatures. The redistribution group agreed to continue the challenge to 24hrs and, using the data collected, assign the acceptable time based on the results.

Deficiency 3: After review of Test#9 Run#1 temperature data it was noted that the box was lasting less than 3 hours at the -30°C to -35°C range. Test #9 Run #2 lasted less than three hours as well. It was not meeting the required time of 24 hours and group felt it was not prudent to continue the validation test runs passed six hours. Because the performance of the containers in previous runs were showing that it was not meeting the 24 hour requirement (see Deficiency 1) the group agreed that to continue to the 24 hour mark was not providing useful data. The group agreed to limit the time in incubation to 6 hours. All runs for test #9, 10, 11 and 12 failed to maintain the acceptable temperature in the container for 6 hours.

6.0. Discussion

The thermal performance of the E38 shipping container in the extreme cold ambient temperatures as well as the extreme hot ambient temperature did not maintain the acceptable shipping temperature range of 20°C to 24°C as expected for shipping platelets. In the extreme heat (>30°C) the container only maintained the acceptable temperature for eight (8) and only 0.3 hours in extreme cold (<-30°C).

The thermal performance of the E38 shipping container when shipping PPP in extreme cold or extreme hot ambient temperatures showed variation from shipping PLT because most PPP have a wider acceptable shipping temperature range compared to platelets. Most PPP can be shipped in a temperature environment of 2°C to 25°C within a 24hr period[3]. There are exceptions that some products can only be shipped between 2°C and 8°C which is the same as their storage temperature.

[3] Plasma Protein Product Acceptable shipping/Storage Requirements by Product as Per Manufacturer

The E38 shipping container maintained the acceptable temperature for the PPP for an average of 24 hours in the extreme cold temperatures but only an average of five (5) hours in extreme hot temperatures.

In most cases the container will not be exposed to these extreme temperatures for prolonged periods of time due to being shipped inside vehicles that are temperature controlled by couriers and most of the shipments will be short distances (less than6 hours).

7.0. Recommendation:

As most facilities are using a courier system to ship products between facilities, and shipping products with a patient are in most cases inside a temperature controlled vehicle, the likelihood of products being exposed to a constant extreme temperature over a prolonged period of time is very small. The E38 shipping container can continue to be used for redistributing (or transferring) platelets and blood products within the hospital system based on the validation completed. It is suggested that hospitals delay redistributing blood components and PPP when extreme temperatures are forecast to avoid the possibility of the shipping containers being exposed to the temperatures that may exceed the shortest acceptable time *(see table 7 below)*.

Table 7 Shortest Time E38 Shipping Container Maintained Acceptable Temperature

Product/Acceptable Shipping Temperature	Target Extreme Winter Temperature (<-30°C)	Target Moderate Fall/Spring Temperature (1°C - 6°C)	Target Moderate Summer temperature (19°C to 25°C)	Target Extreme Summer temperature (> +30°C)
1 – 6 Plts (20°C -24°C)	0.3 hours	4 hours	23 hours	8 hours
1 – 8 PPP (19°C -25°C)	24 hours	24 hours	24 hours	5 hours

All hospitals that will participate in the redistribution program should ensure that the pre conditioning of gel packs are in accordance to the validation parameters.

Due to the shortened time containers maintain acceptable temperatures in extreme ambient temperatures, it is recommended that transporting components and products should be done in a vehicle that allows placing the shipping container inside the passenger area of the vehicle where ambient temperatures are maintained closer to room temperatures. Facilities should confirm with their couriers that the shipping container can be placed inside the vehicle's passenger area. This confirmation should be documented.

Annual random checks will be conducted on the shipping containers to ensure that they are continuing to meet the expected requirements to ship blood components and products between facilities. ORBCoN will facilitate this with the help of FCRP and provincial hospitals.

The validation protocol along with the data results will be made available for facilities that are implementing redistribution using the E38 shipping containers.