



Customer: FedEx Corporation  
Document Type: Qualification Report  
Product: 2-153985E-S  
Document Date: 03 May 2016  
Document Number: CQR-005-16 rev. 00

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# Qualification Report For the 2-153985E-S NanoCool Shipping System

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## Purpose

This report outlines testing for the qualification of the 2-153985E-S NanoCool shipping system. 2-153985E-S systems were tested in triplicate against the ISTA-7D summer and winter forty-eight hour profiles (Chart 1) and drop tested against a modified ISTA-3A drop procedure.

## Summary

Testing was conducted using the 2-153985E-S NanoCool shipping system. Three 2-153985E-S systems each were tested against the ISTA-7D summer and winter forty-eight hour profiles (Chart 1) and six systems were drop tested against a modified ISTA-3A drop procedure (Chart 2). Three systems were drop tested at room temperature and three systems were conditioned against the ISTA-7D 48 hour winter profile before drop testing. The systems tested had a product temperature range of 2.5°C to 7.4°C over both the summer and winter profiles. The systems drop tested passed with no significant damage to the outer box, VIPs, or cooler engine.

Chart 1 - ISTA-7D 48 Hour Summer and Winter Profiles

<b>Summer</b>		
<b>Temperature °C</b>	<b>Hours</b>	<b>Elapsed Time</b>
22	4	4
35	2	6
30	36	42
35	6	48
<b>Winter</b>		
<b>Temperature °C</b>	<b>Hours</b>	<b>Elapsed Time</b>
18	4	4
-10	2	6
10	36	42
-10	6	48

## Thermal Test Procedures

Testing was conducted using twelve 60mL Nalgene bottles as placebo product. All placebo products contain deionized water. A single 60mL Nalgene bottle was probed with a thermocouple to monitor the product temperature during testing.

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**Prepare for testing:**

- Precondition the 60mL Nalgene bottles at 3-5°C for 24 hours
- Prepare TIS (test information sheets), assign logger and chamber
- Prepare NanoCool shipping systems according to TIS sheet
- Obtain appropriate coolers for testing
- Assign coolers to boxes, documenting cooler and box numbers on TIS

When coolers, boxes, products and chambers are prepared start hook-up procedures.

**Hook-Up Procedure**

- Open box and remove cooler
- Place cooler upside down, dome up, and activate
- Obtain 60mL Nalgene bottles
- Tape the assigned thermocouple to the side of the triangle with the thermocouple end on the marked line 53mm from the top of the triangle.
- Insert the triangle into the chipboard box with the thermocouple facing the product, and then insert the product base first
- Place probed bottle in the payload cavity with the thermocouple to the center of the box
- Place cooler onto the box
- Close outer box
- Place systems in the chamber making sure that boxes are not touching
- Close chamber
- Turn on logger and chamber with correct testing profile

**Downloading and Autopsy Procedure**

- Download loggers according to download procedures
- Graph experiments according to graphing procedures and information on the test information sheet
- Analyze data to determine minimum and maximum temperature recorded during the test
- Chamber used for test FG98560-#139 was: ZP0453562; Logger: EL-8174
- Chamber used for test FG98560-#141 was: ZP0453561; Logger: EL-8173

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## Drop Test Procedures

The purpose of this test is to evaluate the durability of the 2-153985E-S NanoCool shipping system. Six total 2-153985E-S NanoCool shipping systems were drop tested against the ISTA-3A protocol (see Chart 2) with the addition of two 60" face one drops during the procedure. The two 60" drops on face one are to test the integrity of the NanoCool shipping system's engine. Three of the systems were drop tested at room temperature and three systems were conditioned against ISTA-7D 48hr winter profile before drop testing.

After the completion of the ISTA test sequence, the NanoCool shipping system is opened and inspected to see if it passes the acceptance criteria (see below). If the system passes the acceptance criteria guidelines the units are inspected again after twenty-four hours.

Chart 2: Drop Sequence

ISTA 3A Drop Sequence		
Drop Number	Drop Height (in)	Orientation
1	18"	Edge 3-4
2	18"	Edge 3-6
3	18"	Edge 4-6
4	18"	Corner 3-4-6
5	18"	Corner 2-3-5
6	18"	Edge 2-3
7	18"	Edge 1-2
8	36"	Face 3
9	18"	Face 3
10	60"	Face 1 on Hazard
11	18"	Edge 3-4
12	18"	Edge 3-6
13	18"	Edge 1-5
14	18"	Corner 3-4-6
15	18"	Corner 1-2-6
16	18"	Corner 1-4-5
17	36"	Face 1
18	60"	Face 1

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## Set-up

Each unit will be assembled in the following manner prior to the initiation of ISTA-3A.

- Obtain correct systems
- Condition systems if specified
- Check package component integrity prior to testing and note any damage or markings
- Remove cooler and activate if specified
- Replace cooler engine
- Close NanoCool shipping unit
- Using packing-style adhesive tape, seal the shipping units in the manner indicated by the shipping unit graphics, sealing face 2 to face 5, face 2 to face 6, and face 2 to face 3
- Number outer shipping box according to ISTA-3A drop testing procedures
- Establish 18", 36" and 60" drop testing height

## Inspection and Acceptance Criteria

Visually inspect the NanoCool shipping systems for the following:

- Rips in the corrugate shipping case material
- Adhesion of the foam pad to the inside of Face 1
- Cooler engine integrity
  - Burst bladder
  - Loss of vacuum
- Integrity of the vacuum insulation panel (VIP)
  - Loss of vacuum
  - Structure maintained
- Integrity of XPS foam
  - Cover shifting significantly
  - Breaks in the XPS foam (surface cracks are allowed)

Failure: loss of cooler or VIP integrity or foam cover breaking as listed above.  
Document all other observations related to above criteria.

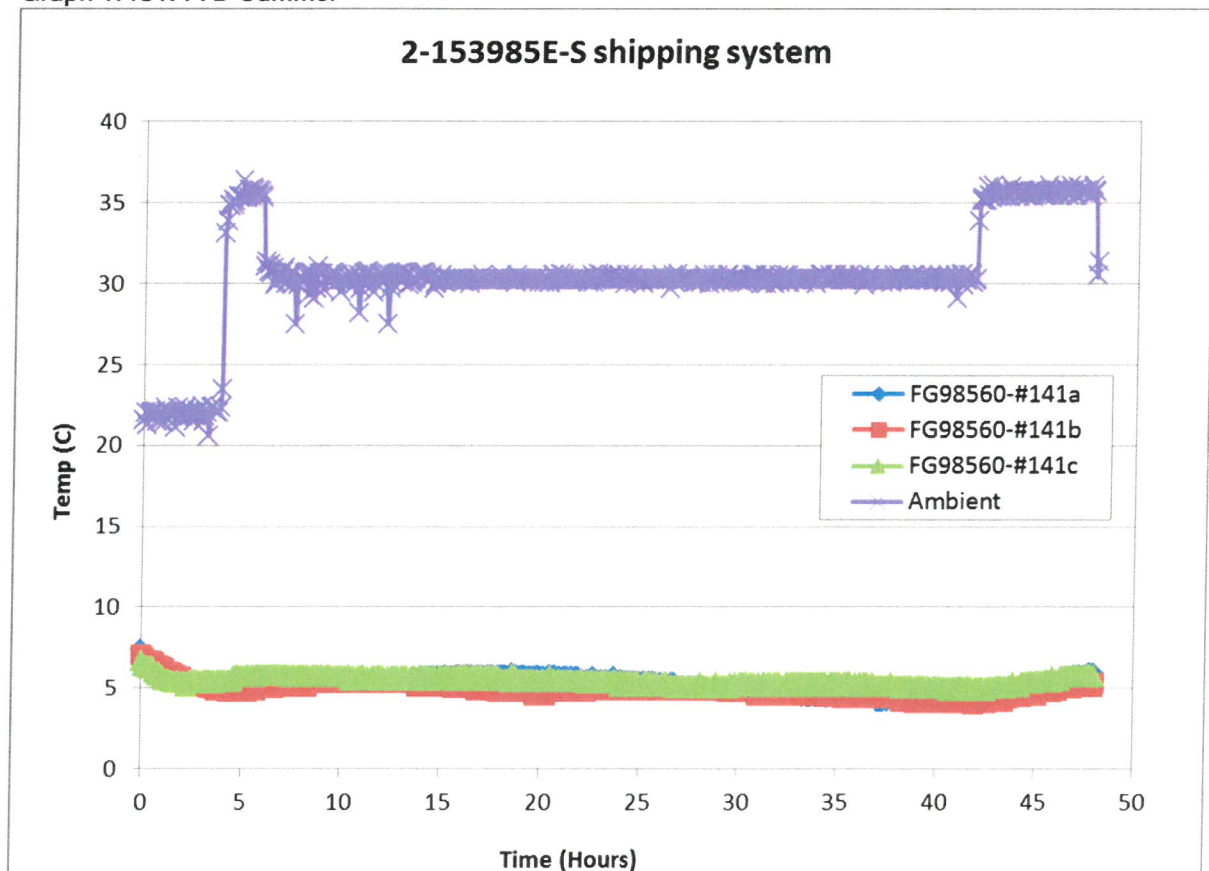
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## Summary of Results

### ISTA-7D 48 Hour Summer Profile

Test FG98560-#141 tested 2-153985E-S NanoCool shipping systems in triplicate. The test was performed against the ISTA-7D summer forty-eight hour profile (Graph 1). Twelve 60mL Nalgene bottles were used as placebo product. The product temperature ranged from 4.0 to 7.4°C over the forty-eight hour test and the average product temperature at forty-eight hours was 5.7°C.

Graph 1: ISTA-7D Summer

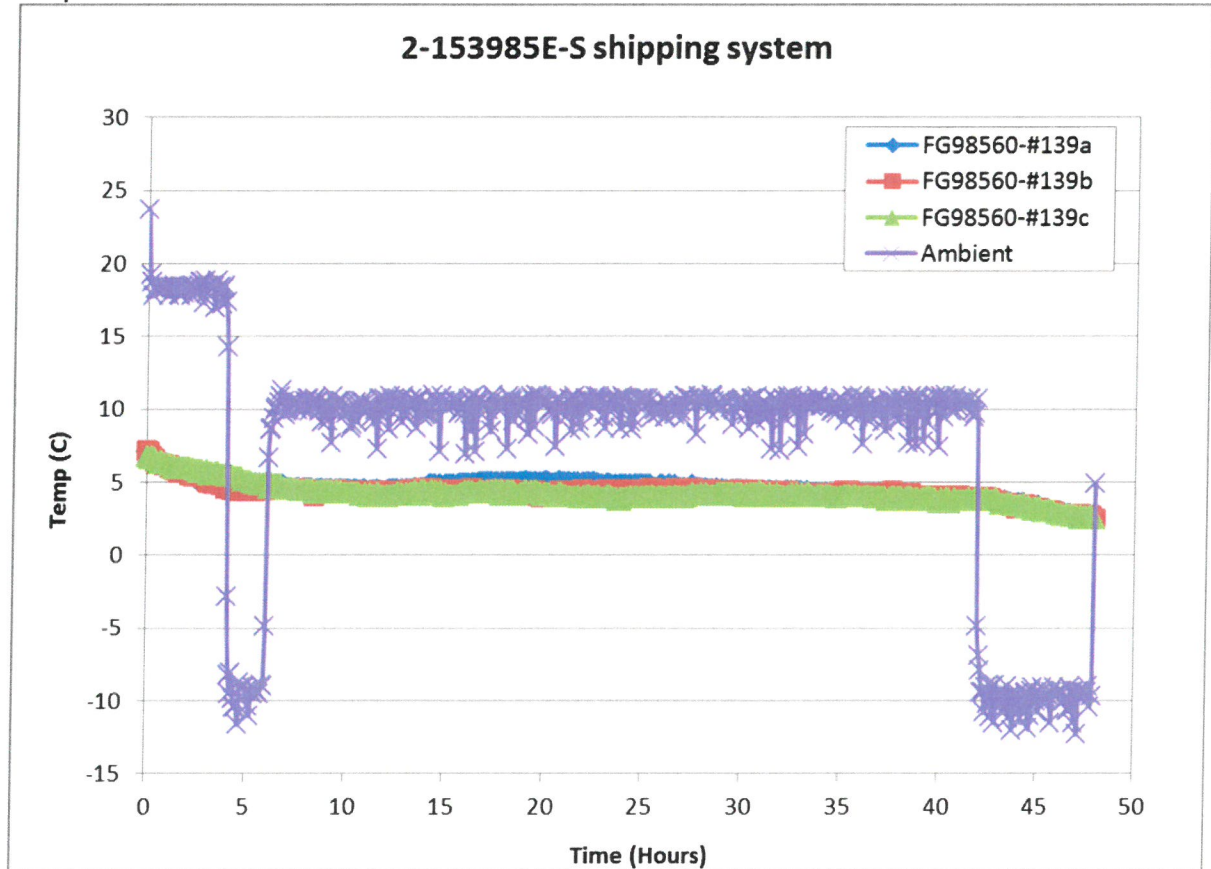


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## ISTA-7D 48 Hour Winter Profile

Test FG98560-#139 tested 2-153985E-S NanoCool shipping systems in triplicate. The test was performed against the ISTA-7D winter forty-eight hour profile (Graph 2). Twelve 60mL Nalgene bottles were used as placebo product. The product temperature ranged from 2.5 to 7.2°C over the forty-eight hour test and the average product temperature at forty-eight hours was 2.5°C.

Graph 2: ISTA-7D Winter



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Chart 3 lists the maximum and minimum temperature recorded during testing. The forty-eight hour end product temperature is also noted. When a reading occurs more than once, the time of the first occurrence is shown.

**Chart 3: Minimum and Maximum Temperatures**

Test #	Profile	Minimum product temperature recorded		Maximum product temperature recorded		Temp. @ 48 Hours, °C
		Temp., °C	Time, Hours	Temp., °C	Time, Hours	
FG98560-#141a	summer	4.0	41.6	7.4	0.0	5.9
FG98560-#141b	summer	4.0	41.9	7.1	0.0	5.3
FG98560-#141c	summer	4.9	40.7	6.7	0.0	5.8
FG98560-#139a	winter	2.5	47.6	7.1	0.0	2.5
FG98560-#139b	winter	2.5	47.9	7.2	0.0	2.5
FG98560-#139c	winter	2.5	47.2	6.8	0.0	2.5

### ISTA-3A Drop Test

Six 2-153985E-S NanoCool shipping systems were tested against a modified ISTA-3A drop sequence (Chart 2). All of the systems passed when checked against the acceptance criteria outlined earlier in the report. The NanoCool cooler engines maintained vacuum and cooling properties. The units were still functioning after twenty four hours. All three insulation systems remained under vacuum and there was no significant damage to the VIPs or XPS foam.



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## **Conclusion**

The tests have shown that this system maintains 2 to 8°C when tested against the ISTA-7D forty-eight summer and winter profiles. The system also passes drop testing against the modified ISTA-3A drop sequence, which shows that the system meets NanoCool's requirements for durability. These results are reported in good faith and the customer should use their judgment as to whether the system is appropriate for their application.

### **Liability Restriction:**

It should be noted that this report represents test results carried out by NanoCool LLC 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. As with any cool shipping system used in normal warehouse conditions some condensation will occur, we advise that the effect of this condensation on the product to be shipped is checked prior to usage.


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### Final QMOC/Protocol Approval

The signatures listed below indicate that these representatives have reviewed this document and approve of the QMOC/Protocol activities and data documented herein. When all approval signatures have been obtained, the QMOC/Protocol is considered complete.

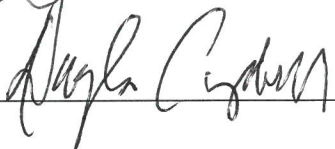
#### Written By

Signature:  Date: 5/5/16  
Product Development/Tech Services

#### Approved By

Signature:  Date: 5/5/16  
Operations

Signature:  Date: 05/05/16  
Quality

Signature:  Date: 5/5/16  
Sales

## Environmental Test Chamber Register

Description	Dimensions	Model #	Serial #	Calibrated	Manufacturer	Range
Test Chamber #2 Everette	38" x 38" x 38"	Z-Plus 32	ZP0453561	Annually	Cincinnati Sub-Zero	-20 °C to +50 °C
Test Chamber #3 Gordon	38" x 38" x 38"	Z-Plus 32	ZP0453562	Annually	Cincinnati Sub-Zero	-20 °C to +50 °C
Register approved	Wendy White			November 2013		
Name .....				Date .....		

## Data Logger Register

Description	Note	Model #	Serial #	Calibrated	Manufacturer	Range
Data Logger Bubba	16 temp. channels, 1 pulse channel, 1 event channel	1025	EL-8174	Annually	Eltek Instruments	-200 °C to +200 °C
Data Logger Rene	16 temp. channels, 1 pulse channel, 1 event channel	1025	EL-8173	Annually	Eltek Instruments	-200 °C to +200 °C
Register approved	Wendy White			February 2013		
Name .....				Date .....		