

APPENDIX A

Laboratory Report

Insulation Group

LAB REPORT # 2013092

Abridged ASTM C518 Test Report

Page 1 of 3

TITLE: Bally Foam C518 Testing With & Without Metal Skin

FILE: Foam

DATE: May 23, 2013

PROJECT NO.: 3200

TO: Guy Senter – Bally Refrigerated Boxes

REQUESTED BY: Gallagher, Kevin J.

CONDUCTED BY: Yuan, Sam

PRODUCT IDENTIFICATION:

Sample ID	Manufacturer	Product ID	Date Code	Product Description
15583	Bally	Foam Panel with 2 Skins, 810070-001	04/17/13	Metal skinned foam panel
15584	Bally	Foam Panel with 1 Skin, 810070-002	04/17/13	Metal skinned foam panel – one skin removed
15585	Bally	Foam Panel with no Skin, 810070-003	04/17/13	Metal skinned foam panel – both skins removed – 4" thick
15586	Bally	Foam Panel with 2 Skins, 810070-004	04/17/13	Metal skinned foam panel – both skins removed – 1" thick
15587	Bally	Foam Panel with 2 Skins, core 810070-005	04/17/13	Metal skinned foam panel – both skins removed – 1" thick core

PURPOSE OF TEST: Determine thermal conductivity of various closed cell foam insulation panels at 20 °F for Bally Refrigerated Boxes (PO P31895).

TEST SAMPLE: The Bally closed cell foam samples as received were 6 pieces of nominal 24 by 24 inches by 4 inches thick with metal skins on both top and bottom surfaces. The test samples were prepared using a horizontal band saw to achieve smooth and void free surfaces for thermal testing. They were also trimmed using a vertical band saw to the test specimen size of 12 by 12 inches. After cutting and planing*, the specimens were conditioned in a standard laboratory atmosphere for less than an hour before thermal testing. The laboratory atmospheric conditions were 20 ± 2°C (68 ± 3°F) and 45 ± 5% relative humidity. No other modifications were made to the samples during the conditioning and testing.

TEST METHOD AND EQUIPMENT: This testing conformed to all requirements of ASTM C 518 - 10, "Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus." Thermal transmission properties were determined at mean test temperatures of 20 °F within one hour using a Lasercomp Fox314 heat flow meter test apparatus after it had been calibrated at the same temperatures with a LaserComp 1 inch EPS foam standard. No deviations from the test method were made.

TEST RESULTS: Two 4" thick samples with and without metal skins were prepared and tested. However, the thermal test data were not valid since thermal equilibrium was not achieved during the 24-hour testing period. It was noted that a frost layer had accumulated on the outside of the bottom plate of the Fox 314 heat flow meter apparatus when the test chamber was opened after the test. The raw data from these aborted tests are presented in Appendix A, but these data could not be used to calculate the thermal performance of the tested specimens.

*foam samples without skins only

COORDINATED BY: _____

APPROVED BY: _____

Only the thermal test for a 1" thick core sample reached steady state in accordance with ASTM C518-10. The test results for the 1" thick core Bally closed cell refrigeration foam sample are listed in Table 1, while Table 2 shows the data for the calibration standard.

Table 1 – Thermal Test Data for 1 Inch Thick Core Bally Foam

Sample ID	15587	
Test Start Date / Time	05/02/13	13:29
Duration of Test	56	min.
Sample Thickness During Test	1.042	in
Hot Face Temperature	39.04	°F
Cold Face Temperature	1.06	°F
Mean Temperature	20.05	°F
Temperature Gradient	19.24	°F/in
Average Heat Flux (downward)	4.55	Btu/h·ft ²
Apparent Thermal Conductivity	0.1217	Btu·in/h·ft ² ·°F
Thermal Resistivity (R / in)	8.22	h·ft ² ·°F/Btu·in

The expanded uncertainty for the measurement of Apparent Conductivity for both samples is ± 0.0027 Btu·in/h·ft²·°F with a cover factor k=2, for a confidence level of approximately 95%.

Table 2 – Thermal Calibration Data for 1 inch EPS Foam

Specimen ID	Thickness (in.)	Hot Plate Temp. (°F)	Cold Plate Temp. (°F)	Density (pcf)	k-value (Btu·in/h·ft ² ·°F)	Assigned k-value (Btu·in/h·ft ² ·°F)	Difference (%)
LaserComp (04/26/2013) EPS STD 09010643	0.969	39.04	1.06	2.00	0.2042	0.2052	-0.5
LaserComp (05/01/2013) EPS STD 09010643	0.970	39.06	1.08	2.00	0.2044	0.2052	-0.4

CONCLUSION: The 1" thick Bally Closed Cell Foam core sample ID 15587 had a thermal conductivity (k) of 0.1217 Btu·in/h·ft²·°F with a measurement uncertainty of ± 0.0027 Btu·in/h·ft²·°F when tested at a mean temperature of 20 °F.

REFERENCES: K:\Labs\Glass & Thermal\thermal\TR Test Data\2013*.*

1. If during the process of a test requests, any method – ASTM or otherwise – differs from the procedure, any deviation shall be clearly stated under “Test Results”. For instance some ASTM procedures may specify different sampling protocol than generally used by the laboratory or in some cases samples may be conditioned differently.
2. This report must not be used to claim product certification, approval, or endorsement by NVLAP, NIST, or any agency of the Federal Government as a result of the use of the NVLAP name and/or symbol, NVLAP LAB CODE 100101-0.
3. Results in this report relate only to the items tested and, if appropriately sampled, to the lot, process, or plant from which the samples were taken.
4. Reports shall not be reproduced except in full and shall not be sent outside of the IG Research and Development Department without the consent of the Analytical Sciences Laboratory Manager.
5. For the uncertainty calculations for thermal measurements according to ASTM C518, C653, or C687 see Procedure 16 – Thermal Measurement Uncertainty.
6. If abbreviated or abridged thermal results are reported for samples tested by ASTM C518, a reference to the location of the complete data set will be given in the Reference Section of the Laboratory Report.

APPENDIX A – 2013092 Raw Data

Friday, April 26, 2013, Time 15:17

Wintherm32v3 Version 3.31.17

Instrument: F314

Instrument Program Version 72

Instrument Serial Number: 946

Sample Name: 2013092-15583

Thickness: 101.2507mm 3.986in

Thickness obtained : from instrument

TEST RUN

Calibration used : User Type

Calibration File Id: S0910643-09201116

User Type Parameters Table -- English Units

Point:1 19.99 0.205071

Upper Plate Calibration Constants : (English units)

Calibration Const: 0.004219 @39.20 °F

Lower Plate Calibration Constants : (English units)

Calibration Const: 0.004127 @1.40 °F

Number of transducers per plate: 1

Number of transducers used per plate: 1

Number of Setpoints: 1

Block Averages for setpoint 1 in English units

	Tupper	Tlower	Qupper	Qlower	Lambda	HeatFluxU	HeatFluxL
	[°F]	[°F]	[μV]	[μV]	[Btu in/ft²h°F]	[Btu/h/ft²]	[Btu/h/ft²]
-se-	39.24	1.24	-35	-927	0.2084	0.1486	3.827
-se-	39.23	1.24	-34	-929	0.2085	0.1440	3.833
-se-	39.23	1.24	-34	-929	0.2085	0.1420	3.835
-pe-	39.23	1.24	-36	-930	0.2092	0.1518	3.839
-se-	39.23	1.23	-35	-930	0.2089	0.1478	3.838
-se-	39.23	1.24	-32	-928	0.2079	0.1368	3.830
-se-	39.23	1.24	-33	-928	0.2081	0.1393	3.831
-pe-	39.23	1.24	-33	-928	0.2081	0.1402	3.830
-pe-	39.23	1.24	-33	-928	0.2080	0.1388	3.830
-pe-	39.23	1.23	-34	-930	0.2086	0.1427	3.837

APPENDIX A – 2013092 Raw Data

Saturday, April 27, 2013, Time 21:39

Setpoint No. 1

Setpoint Upper: 4.00 °C 39.20 °F
 Setpoint Lower: -17.11 °C 1.20 °F
 Temperature Upper: 4.02 °C 39.23 °F

CalibFactor Upper: 0.01330 W/m²μV 0.004219 Btu/h ft² μV
 Results Upper: 0.002125 W/mK 0.01474 Btu in/ft²h°F
 HeatFlux Upper: 0.4431 W/m² 0.1406 Btu/h/ft²
 Temperature Lower: -17.09 °C 1.24 °F
 CalibFactor Lower: 0.01301 W/m²μV 0.004127 Btu/h ft² μV
 Results Lower: 0.05795 W/mK 0.4018 Btu in/ft²h°F
 Percent Difference: 185.85%

HeatFlux Lower: 12.08 W/m² 3.832 Btu/h/ft²
 Temperature Average: -6.54 °C 20.23 °F
 Results Average: 0.03004 W/mK 0.2082 Btu in/ft²h°F
 Resistance Avg : 3.371 m²K/W 19.14 ft²h°F/Btu
 R/unit Avg : 33.29 mK/W 4.802 ft²h°F/Btu in

Thermal Equilibrium Criteria:

Temperature Equilibrium: 0.20
 Between Block HFM Equil.: 49
 HFM Percent Change: 2.00
 Min Number of Blocks: 4
 Calculation Blocks: 3

Results Table -- SI Units

Mean Temp	Upper Cond	Lower Cond	Average Cond
-6.54	0.002125	0.05795	0.03004

Results Table -- English Units

Mean Temp	Upper Cond	Lower Cond	Average Cond
20.23	0.01474	0.4018	0.2082

APPENDIX A – 2013092 Raw Data

Monday, April 29, 2013, Time 14:31

Wintherm32v3 Version 3.31.17

Instrument: F314

Instrument Program Version 72

Instrument Serial Number: 946

Sample Name: 2013092-15583_FLIPPED

Thickness: 100.9078mm 3.973in

Thickness obtained : from instrument

TEST RUN

Calibration used : User Type

Calibration File Id: S0910643-09201116

User Type Parameters Table -- English Units

Point:1 19.99 0.205071

Upper Plate Calibration Constants : (English units)

Calibration Const: 0.004219 @39.20 °F

Lower Plate Calibration Constants : (English units)

Calibration Const: 0.004127 @1.40 °F

Number of transducers per plate: 1

Number of transducers used per plate: 1

Number of Setpoints: 1

***OnButtonAbortClick::Stop button pressed ***

APPENDIX A – 2013092 Raw Data

Block Averages for setpoint 1 in English units

	Tupper	Tlower	Qupper	Qlower	Lambda	HeatFluxU	HeatFluxL
	[°F]	[°F]	[μV]	[μV]	[Btu in/ft²h°F]	[Btu/h/ft²]	[Btu/h/ft²]
-se-	39.02	1.04	-8	-943	0.2053	0.03420	3.894
-pe-	39.03	1.04	-8	-943	0.2050	0.03241	3.891
-pe-	39.02	1.04	-6	-942	0.2046	0.02616	3.888
-se-	39.03	1.05	-11	-945	0.2062	0.04623	3.900
-se-	39.02	1.05	-11	-947	0.2065	0.04440	3.907
-se-	39.02	1.04	-8	-945	0.2056	0.03390	3.901
-se-	39.02	1.04	-5	-941	0.2040	0.02004	3.884
-se-	39.03	1.05	-7	-943	0.2049	0.03070	3.891
-se-	39.03	1.04	-11	-946	0.2064	0.04670	3.904
-se-	39.02	1.04	-7	-945	0.2054	0.03122	3.900

***OnButtonAbort::Run Stopped ***

*** Run Stopped ***

***OnButtonAbortClick::Abort button pressed ***

APPENDIX A – 2013092 Raw Data

Tuesday, April 30, 2013, Time 16:03

Wintherm32v3 Version 3.31.17

Instrument: F314

Instrument Program Version 72

Instrument Serial Number: 946

Sample Name: 2013092-15585-A

Thickness: 99.6632mm 3.924in

[SAMPLE SURFACE WITH HOLES FACING UPPER PLATE]

Thickness obtained : from instrument

TEST RUN

Calibration used : User Type

Calibration File Id: S0910643-09201116

User Type Parameters Table -- English Units

Point:1 19.99 0.205071

Upper Plate Calibration Constants : (English units)

Calibration Const: 0.004219 @39.20 °F

Lower Plate Calibration Constants : (English units)

Calibration Const: 0.004127 @1.40 °F

Number of transducers per plate: 1

Number of transducers used per plate: 1

Number of Setpoints: 1

APPENDIX A – 2013092 Raw Data

Block Averages for setpoint 1 in English units

	Tupper	Tlower	Qupper	Qlower	Lambda	HeatFluxU	HeatFluxL
	[°F]	[°F]	[μV]	[μV]	[Btu in/ft²h°F]	[Btu/h/ft²]	[Btu/h/ft²]
-pe-	39.06	1.08	193	-409	0.1290	0.8123	1.687
-pe-	39.06	1.08	194	-407	0.1289	0.8173	1.680
-pe-	39.06	1.07	197	-405	0.1290	0.8292	1.671
-pe-	39.06	1.08	199	-402	0.1289	0.8376	1.660
-pe-	39.06	1.08	200	-400	0.1288	0.8449	1.652
-pe-	39.06	1.08	202	-399	0.1289	0.8508	1.647
-pe-	39.06	1.08	204	-398	0.1291	0.8590	1.641
-pe-	39.06	1.08	204	-396	0.1289	0.8619	1.635
-pe-	39.06	1.08	205	-396	0.1290	0.8652	1.634
-pe-	39.06	1.08	205	-396	0.1290	0.8665	1.633

Tuesday, April 30, 2013, Time 19:20

Setpoint No. 1

Setpoint Upper: 3.91 °C 39.04 °F
 Setpoint Lower: -17.20 °C 1.04 °F
 Temperature Upper: 3.92 °C 39.06 °F

CalibFactor Upper: 0.01330 W/m²μV 0.004219 Btu/h ft² μV
 Results Upper: 0.01287 W/mK 0.08924 Btu in/ft²h°F
 HeatFlux Upper: 2.725 W/m² 0.8645 Btu/h/ft²
 Temperature Lower: -17.18 °C 1.08 °F

CalibFactor Lower: 0.01301 W/m²μV 0.004127 Btu/h ft² μV
 Results Lower: 0.02433 W/mK 0.1687 Btu in/ft²h°F
 Percent Difference: 61.61%
 HeatFlux Lower: 5.152 W/m² 1.634 Btu/h/ft²
 Temperature Average: -6.63 °C 20.07 °F
 Results Average: 0.01860 W/mK 0.1290 Btu in/ft²h°F
 Resistance Avg : 5.357 m²K/W 30.42 ft²h°F/Btu
 R/unit Avg : 53.76 mK/W 7.754 ft²h°F/Btu in

Thermal Equilibrium Criteria:

Temperature Equilibrium: 0.20
 Between Block HFM Equil.: 150
 HFM Percent Change: 2.00

APPENDIX A – 2013092 Raw Data

Min Number of Blocks: 4

Calculation Blocks: 3

Results Table -- SI Units

Mean Temp	Upper Cond	Lower Cond	Average Cond	
-6.63	0.01287		0.02433	0.01860

Results Table -- English Units

Mean Temp	Upper Cond	Lower Cond	Average Cond	
20.07	0.08924		0.1687	0.1290

Wednesday, May 01, 2013, Time 08:15

Wintherm32v3 Version 3.31.17

Instrument: F314

Instrument Program Version 72

Instrument Serial Number: 946

Sample Name: 2013092-15585-A-FLIPPED

Thickness: 99.6950mm 3.925in

[SAMPLE SURFACE WITH HOLES FACING LOWER PLATE]

Thickness obtained : from instrument

TEST RUN

Calibration used : User Type

Calibration File Id: S0910643-09201116

User Type Parameters Table -- English Units

Point:1 19.99 0.205071

Upper Plate Calibration Constants : (English units)

Calibration Const: 0.004219 @39.20 °F

Lower Plate Calibration Constants : (English units)

Calibration Const: 0.004127 @1.40 °F

Number of transducers per plate: 1

Number of transducers used per plate: 1

Number of Setpoints: 1

APPENDIX A – 2013092 Raw Data

Block Averages for setpoint 1 in English units

	Tupper	Tlower	Qupper	Qlower	Lambda	HeatFluxU	HeatFluxL
	[°F]	[°F]	[μV]	[μV]	[Btu in/ft²h°F]	[Btu/h/ft²]	[Btu/h/ft²]
-se-	39.06	1.08	173	-430	0.1293	0.7305	1.773
-se-	39.06	1.08	173	-430	0.1295	0.7317	1.776
-pe-	39.05	1.07	180	-424	0.1296	0.7583	1.751
-se-	39.06	1.08	183	-420	0.1294	0.7724	1.734
-se-	39.06	1.08	183	-419	0.1291	0.7725	1.729
-pe-	39.06	1.07	187	-416	0.1293	0.7889	1.716
-se-	39.06	1.08	190	-413	0.1294	0.8013	1.704
-pe-	39.06	1.08	191	-411	0.1292	0.8051	1.698
-pe-	39.06	1.08	193	-411	0.1298	0.8154	1.698
-pe-	39.06	1.08	194	-409	0.1294	0.8205	1.687

APPENDIX A – 2013092 Raw Data

Wednesday, May 01, 2013, Time 11:14

Setpoint No. 1

Setpoint Upper: 3.91 °C 39.04 °F
 Setpoint Lower: -17.20 °C 1.04 °F
 Temperature Upper: 3.92 °C 39.06 °F
 CalibFactor Upper: 0.01330 W/m²μV 0.004219 Btu/h ft² μV
 Results Upper: 0.01212 W/mK 0.08402 Btu in/ft²h°F
 HeatFlux Upper: 2.565 W/m² 0.8137 Btu/h/ft²

 Temperature Lower: -17.18 °C 1.08 °F
 CalibFactor Lower: 0.01301 W/m²μV 0.004127 Btu/h ft² μV
 Results Lower: 0.02523 W/mK 0.1749 Btu in/ft²h°F
 Percent Difference: 70.22%
 HeatFlux Lower: 5.341 W/m² 1.694 Btu/h/ft²
 Temperature Average: -6.63 °C 20.07 °F
 Results Average: 0.01868 W/mK 0.1295 Btu in/ft²h°F
 Resistance Avg : 5.338 m²K/W 30.31 ft²h°F/Btu
 R/unit Avg : 53.55 mK/W 7.723 ft²h°F/Btu in

Thermal Equilibrium Criteria:

Temperature Equilibrium: 0.20
 Between Block HFM Equil.: 50
 HFM Percent Change: 2.00
 Min Number of Blocks: 4
 Calculation Blocks: 3

Results Table -- SI Units

Mean Temp	Upper Cond	Lower Cond	Average Cond
-6.63	0.01212	0.02523	0.01868

Results Table -- English Units

Mean Temp	Upper Cond	Lower Cond	Average Cond
20.07	0.08402	0.1749	0.1295

APPENDIX A – 2013092 Raw Data

Friday, May 03, 2013, Time 10:32

Wintherm32v3 Version 3.31.17

Instrument: F314

Instrument Program Version 72

Instrument Serial Number: 946

Sample Name: 2013092-15585-RETEST

Thickness: 99.7775mm 3.928in

Thickness obtained : from instrument

TEST RUN

Calibration used : User Type

Calibration File Id: S0910643-09201116

User Type Parameters Table -- English Units

Point:1 19.99 0.205071

Upper Plate Calibration Constants : (English units)

Calibration Const: 0.004219 @39.20 °F

Lower Plate Calibration Constants : (English units)

Calibration Const: 0.004127 @1.40 °F

Number of transducers per plate: 1

Number of transducers used per plate: 1

Number of Setpoints: 1

APPENDIX A – 2013092 Raw Data

Block Averages for setpoint 1 in English units

	Tupper	Tlower	Qupper	Qlower	Lambda	HeatFluxU	HeatFluxL
	[°F]	[°F]	[μV]	[μV]	[Btu in/ft²h°F]	[Btu/h/ft²]	[Btu/h/ft²]
-pe-	39.04	1.06	209	-393	0.1295	0.8835	1.623
-pe-	39.04	1.06	210	-394	0.1297	0.8865	1.624
-pe-	39.05	1.07	211	-394	0.1299	0.8896	1.625
-pe-	39.05	1.07	208	-395	0.1298	0.8796	1.631
-pe-	39.04	1.06	209	-395	0.1298	0.8804	1.632
-pe-	39.04	1.06	213	-393	0.1301	0.8977	1.620
-pe-	39.05	1.07	210	-393	0.1297	0.8869	1.623
-pe-	39.04	1.06	210	-393	0.1295	0.8852	1.622
-pe-	39.04	1.06	210	-394	0.1297	0.8860	1.625
-pe-	39.04	1.06	212	-393	0.1301	0.8964	1.622

Friday, May 03, 2013, Time 15:36

Setpoint No. 1

Setpoint Upper: 3.90 °C 39.02 °F

Setpoint Lower: -17.21 °C 1.02 °F

Temperature Upper: 3.91 °C 39.04 °F

CalibFactor Upper: 0.01330 W/m²μV 0.004219 Btu/h ft² μV

Results Upper: 0.01327 W/mK 0.09202 Btu in/ft²h°F

HeatFlux Upper: 2.807 W/m² 0.8904 Btu/h/ft²

Temperature Lower: -17.19 °C 1.06 °F

CalibFactor Lower: 0.01301 W/m²μV 0.004127 Btu/h ft² μV

Results Lower: 0.02418 W/mK 0.1677 Btu in/ft²h°F

Percent Difference: 58.26%

HeatFlux Lower: 5.114 W/m² 1.622 Btu/h/ft²

Temperature Average: -6.64 °C 20.05 °F

Results Average: 0.01873 W/mK 0.1298 Btu in/ft²h°F

Resistance Avg : 5.328 m²K/W 30.25 ft²h°F/Btu

R/unit Avg : 53.40 mK/W 7.702 ft²h°F/Btu in

APPENDIX A – 2013092 Raw Data

Thermal Equilibrium Criteria:

Temperature Equilibrium: 0.20
Between Block HFM Equil.: 50
HFM Percent Change: 3.00
Min Number of Blocks: 35
Calculation Blocks: 5

Results Table -- SI Units

Mean Temp	Upper Cond	Lower Cond	Average Cond
-6.64	0.01327	0.02418	0.01873

Results Table -- English Units

Mean Temp	Upper Cond	Lower Cond	Average Cond
20.05	0.09202	0.1677	0.1298

APPENDIX A – 2013092 Raw Data

Thursday, May 02, 2013, Time 13:29

Wintherm32v3 Version 3.31.17

Instrument: F314

Instrument Program Version 72

Instrument Serial Number: 946

Sample Name: 2013092-15587

Thickness: 26.4604mm 1.042in

Thickness obtained : from instrument

TEST RUN

Calibration used : User Type

Calibration File Id: S0910643-09201116

User Type Parameters Table -- English Units

Point:1 19.99 0.205071

Upper Plate Calibration Constants : (English units)

Calibration Const: 0.004219 @39.20 °F

Lower Plate Calibration Constants : (English units)

Calibration Const: 0.004127 @1.40 °F

Number of transducers per plate: 1

Number of transducers used per plate: 1

Number of Setpoints: 1

Block Averages for setpoint 1 in English units

	Tupper	Tlower	Qupper	Qlower	Lambda	HeatFluxU	HeatFluxL
	[°F]	[°F]	[μV]	[μV]	[Btu in/ft ² h°F]	[Btu/h/ft ²]	[Btu/h/ft ²]
-ne-	39.03	2.85	662	-2481	0.1874	2.792	10.24
-ne-	39.03	1.04	917	-1257	0.1241	3.868	5.188
-te-	39.04	1.05	1006	-1126	0.1218	4.244	4.646
-te-	39.03	1.06	1022	-1109	0.1218	4.312	4.576
-pe-	39.03	1.05	1029	-1101	0.1217	4.341	4.544
-pe-	39.04	1.06	1031	-1098	0.1217	4.352	4.533
-pe-	39.04	1.06	1031	-1098	0.1217	4.350	4.531
-pe-	39.04	1.06	1032	-1097	0.1217	4.353	4.528
-pe-	39.04	1.06	1032	-1096	0.1216	4.353	4.525
-pe-	39.04	1.06	1031	-1096	0.1216	4.350	4.525

APPENDIX A – 2013092 Raw Data

Thursday, May 02, 2013, Time 14:25

Setpoint No. 1

Setpoint Upper: 3.90 °C 39.02 °F
 Setpoint Lower: -17.21 °C 1.02 °F
 Temperature Upper: 3.91 °C 39.04 °F
 CalibFactor Upper: 0.01330 W/m²μV 0.004219 Btu/h ft² μV
 Results Upper: 0.01720 W/mK 0.1193 Btu in/ft²h°F
 HeatFlux Upper: 13.72 W/m² 4.352 Btu/h/ft²
 Temperature Lower: -17.19 °C 1.06 °F
 CalibFactor Lower: 0.01301 W/m²μV 0.004127 Btu/h ft² μV
 Results Lower: 0.01789 W/mK 0.1240 Btu in/ft²h°F
 Percent Difference: 3.93%
 HeatFlux Lower: 14.27 W/m² 4.526 Btu/h/ft²
 Temperature Average: -6.64 °C 20.05 °F
 Results Average: 0.01755 W/mK 0.1217 Btu in/ft²h°F
 Resistance Avg : 1.508 m²K/W 8.563 ft²h°F/Btu
 R/unit Avg : 56.99 mK/W 8.220 ft²h°F/Btu in

Thermal Equilibrium Criteria:

Temperature Equilibrium: 0.20
 Between Block HFM Equil.: 50
 HFM Percent Change: 2.00
 Min Number of Blocks: 4
 Calculation Blocks: 3

Results Table -- SI Units

Mean Temp	Upper Cond	Lower Cond	Average Cond
-6.64	0.01720	0.01789	0.01755

Results Table -- English Units

Mean Temp	Upper Cond	Lower Cond	Average Cond
20.05	0.1193	0.1240	0.1217

APPENDIX A – 2013092 Raw Data

Tuesday, April 30, 2013, Time 07:35

Wintherm32v3 Version 3.31.17

Instrument: F314

Instrument Program Version 72

Instrument Serial Number: 946

Sample Name: DRYING

Thickness: 25.4063mm 1.000in

Thickness obtained : user entered

TEST RUN

Calibration used : 1450b

Calibration read from instrument

Upper Plate Calibration Constants : (English units)

Calibration Const: 0.004301	@-3.93 °F	
Calibration Const: 0.004259	@14.07 °F	
Calibration Const: 0.004225	@32.00 °F	
Calibration Const: 0.004181	@50.00 °F	
Calibration Const: 0.004135	@68.00 °F	
Calibration Const: 0.004086	@86.05 °F	
Calibration Const: 0.004037	@104.09 °F	
Calibration Const: 0.003989	@122.05 °F	
A0=1.432159e-002	A1=5.653817e-006	A2=-3.426657e-008

Lower Plate Calibration Constants : (English units)

Calibration Const: 0.004166	@41.00 °F	
Calibration Const: 0.004088	@59.00 °F	
Calibration Const: 0.004020	@77.05 °F	
Calibration Const: 0.003945	@95.05 °F	
Calibration Const: 0.003873	@113.05 °F	
Calibration Const: 0.003799	@131.05 °F	
Calibration Const: 0.003729	@149.05 °F	
Calibration Const: 0.003664	@167.05 °F	
A0=2.083844e-002	A1=-3.170839e-005	A2=1.438789e-008

Number of transducers per plate: 1

APPENDIX A – 2013092 Raw Data

Number of transducers used per plate: 1

Number of Setpoints: 1

***OnButtonAbortClick::Stop button pressed ***

Block Averages for setpoint 1 in English units

	Tupper	Tlower	Qupper	Qlower	Lambda	HeatFluxU	HeatFluxL
	[°F]	[°F]	[μV]	[μV]	[Btu in/ft²h°F]	[Btu/h/ft²]	[Btu/h/ft²]
-te-	125.02	125.02	2802	4916	17029	11.15	18.80
-te-	125.02	125.02	2941	4995	4246	11.70	19.11
-te-	125.02	125.01	2854	5011	2923	11.35	19.17
-te-	125.01	125.02	2951	5036	5322	11.74	19.26
-te-	125.02	125.02	3167	5269	7449	12.60	20.15
-te-	125.02	125.03	2765	4795	5803	11.00	18.34
-te-	125.02	125.02	2710	4717	43702	10.78	18.04
-te-	125.02	125.02	2601	4565	5622	10.35	17.46
-te-	125.02	125.02	2566	4507	5096	10.21	17.24
-te-	125.02	125.01	2453	4253	1668	9.761	16.27

***OnButtonAbort::Run Stopped ***

*** Run Stopped ***

***OnButtonAbortClick::Abort button pressed ***

Monday, May 06, 2013, Time 09:04

APPENDIX A – 2013092 Raw Data

Wintherm32v3 Version 3.31.17
Instrument: F314
Instrument Program Version 72
Instrument Serial Number: 946
Sample Name: Low e
Thickness: 24.8856mm 0.980in
Thickness obtained : user entered

TEST RUN

Calibration used : User Type Multiple Thickness
Calibration File Id: S19X
User Type Parameters Table -- English Units

Point:1 75.00 0.233351

Calibration Constants calculated: using test sample thickness at test temperatures

Upper Plate Calibration Constants : (English units)

Calibration Const: 0.004014 @95.00 °F

Lower Plate Calibration Constants : (English units)

Calibration Const: 0.004096 @55.00 °F

Number of transducers per plate: 1

Number of transducers used per plate: 1

Number of Setpoints: 1

Block Averages for setpoint 1 in English units

Tupper Tlower Qupper Qlower Lambda HeatFluxU HeatFluxL

APPENDIX A – 2013092 Raw Data

	[°F]	[°F]	[μV]	[μV]	[Btu in/ft ² h°F]	[Btu/h/ft ²]	[Btu/h/ft ²]
-te-	95.02	55.02	2488	-2383	0.2417	9.986	9.764
-pe-	95.03	55.03	2488	-2384	0.2417	9.985	9.766
-pe-	95.04	55.04	2483	-2388	0.2417	9.967	9.784
-pe-	95.03	55.03	2480	-2390	0.2416	9.955	9.791
-pe-	95.03	55.03	2481	-2389	0.2416	9.959	9.787
-pe-	95.03	55.03	2481	-2389	0.2416	9.959	9.788
-pe-	95.03	55.03	2483	-2389	0.2417	9.968	9.784
-pe-	95.04	55.03	2480	-2390	0.2416	9.954	9.790
-pe-	95.03	55.03	2480	-2389	0.2416	9.954	9.788
-pe-	95.03	55.03	2482	-2389	0.2416	9.961	9.787

Monday, May 06, 2013, Time 10:00

Setpoint No. 1

Setpoint Upper:	35.00 °C	95.00 °F
Setpoint Lower:	12.78 °C	55.00 °F
Temperature Upper:	35.02 °C	95.03 °F
CalibFactor Upper:	0.01265 W/m ² μV	0.004014 Btu/h ft ² μV
Results Upper:	0.03515 W/mK	0.2437 Btu in/ft ² h°F
HeatFlux Upper:	31.39 W/m ²	9.959 Btu/h/ft ²
Temperature Lower:	12.80 °C	55.03 °F
CalibFactor Lower:	0.01291 W/m ² μV	0.004096 Btu/h ft ² μV
Results Lower:	0.03455 W/mK	0.2395 Btu in/ft ² h°F
Percent Difference:	1.74%	
HeatFlux Lower:	30.85 W/m ²	9.787 Btu/h/ft ²
Temperature Average:	23.91 °C	75.03 °F
Results Average:	0.03485 W/mK	0.2416 Btu in/ft ² h°F
Resistance Avg :	0.7141 m ² K/W	4.055 ft ² h°F/Btu
R/unit Avg :	28.69 mK/W	4.139 ft ² h°F/Btu in

Thermal Equilibrium Criteria:

Temperature Equilibrium:	0.20
Between Block HFM Equil.:	50
HFM Percent Change:	2.00
Min Number of Blocks:	10
Calculation Blocks:	5

Results Table -- SI Units

APPENDIX A – 2013092 Raw Data

Mean Temp	Upper Cond	Lower Cond	Average Cond
23.91	0.03515	0.03455	0.03485

Results Table -- English Units

Mean Temp	Upper Cond	Lower Cond	Average Cond
75.03	0.2437	0.2395	0.2416

Friday, April 26, 2013, Time 10:30

Wintherm32v3 Version 3.31.17

Instrument: F314

Instrument Program Version 72

Instrument Serial Number: 946

Sample Name: S09010643_04261310

Thickness: 24.6189mm 0.969in

Thickness obtained : from instrument

TEST RUN

Calibration used : User Type

Calibration File Id: S0910643-09201116

Calibration File Info :

File Name: S0910643-09201116

Thickness: 24.7330mm 0.974in

User Type Parameters Table -- English Units

Point:1 19.99 0.205071

Upper Plate Calibration Constants : (English units)

Calibration Const: 0.004219 @39.20 °F

Lower Plate Calibration Constants : (English units)

Calibration Const: 0.004127 @1.40 °F

Number of transducers per plate: 1

APPENDIX A – 2013092 Raw Data

Number of transducers used per plate: 1

Number of Setpoints: 1

Block Averages for setpoint 1 in English units

	Tupper	Tlower	Qupper	Qlower	Lambda	HeatFluxU	HeatFluxL
	[°F]	[°F]	[μV]	[μV]	[Btu in/ft ² h°F]	[Btu/h/ft ²]	[Btu/h/ft ²]
-ne-	39.03	3.09	1493	-3315	0.2692	6.300	13.68
-ne-	39.03	1.04	1829	-2065	0.2070	7.719	8.522
-te-	39.03	1.05	1893	-1949	0.2044	7.988	8.044
-te-	39.03	1.05	1899	-1940	0.2042	8.012	8.006
-pe-	39.04	1.06	1901	-1939	0.2043	8.019	8.004
-pe-	39.05	1.07	1900	-1941	0.2044	8.016	8.011
-pe-	39.05	1.07	1897	-1942	0.2042	8.003	8.017
-pe-	39.04	1.06	1898	-1941	0.2042	8.009	8.011
-pe-	39.04	1.06	1900	-1939	0.2043	8.018	8.004
-pe-	39.05	1.07	1898	-1940	0.2042	8.007	8.008

Friday, April 26, 2013, Time 11:26

Setpoint No. 1

Setpoint Upper: 3.90 °C 39.02 °F

Setpoint Lower: -17.21 °C 1.02 °F

Temperature Upper: 3.91 °C 39.04 °F

CalibFactor Upper: 0.01330 W/m²μV 0.004219 Btu/h ft² μV

Results Upper: 0.02946 W/mK 0.2042 Btu in/ft²h°F

HeatFlux Upper: 25.25 W/m² 8.010 Btu/h/ft²

Temperature Lower: -17.19 °C 1.06 °F

CalibFactor Lower: 0.01301 W/m²μV 0.004127 Btu/h ft² μV

Results Lower: 0.02946 W/mK 0.2042 Btu in/ft²h°F

Percent Difference: 0.01%

HeatFlux Lower: 25.25 W/m² 8.010 Btu/h/ft²

Temperature Average: -6.64 °C 20.05 °F

Results Average: 0.02946 W/mK 0.2042 Btu in/ft²h°F

Resistance Avg : 0.8357 m²K/W 4.746 ft²h°F/Btu

R/unit Avg : 33.95 mK/W 4.896 ft²h°F/Btu in

Thermal Equilibrium Criteria:

Temperature Equilibrium: 0.20

Between Block HFM Equil.: 49

HFM Percent Change: 2.00

Min Number of Blocks: 7

APPENDIX A – 2013092 Raw Data

Calculation Blocks: 4

Results Table -- SI Units

Mean Temp	Upper Cond	Lower Cond	Average Cond
-6.64	0.02946	0.02946	0.02946

Results Table -- English Units

Mean Temp	Upper Cond	Lower Cond	Average Cond
20.05	0.2042	0.2042	0.2042

Wednesday, May 01, 2013, Time 14:18

Wintherm32v3 Version 3.31.17

Instrument: F314

Instrument Program Version 72

Instrument Serial Number: 946

Sample Name: S09010643_05011314

Thickness: 24.6253mm 0.970in

Thickness obtained : from instrument

TEST RUN

Calibration used : User Type

Calibration File Id: S0910643-09201116

User Type Parameters Table -- English Units

Point:1 19.99 0.205071

Upper Plate Calibration Constants : (English units)

Calibration Const: 0.004219 @39.20 °F

Lower Plate Calibration Constants : (English units)

Calibration Const: 0.004127 @1.40 °F

Number of transducers per plate: 1

Number of transducers used per plate: 1

Number of Setpoints: 1

APPENDIX A – 2013092 Raw Data

Block Averages for setpoint 1 in English units

	Tupper	Tlower	Qupper	Qlower	Lambda	HeatFluxU	HeatFluxL
	[°F]	[°F]	[μV]	[μV]	[Btu in/ft²h°F]	[Btu/h/ft²]	[Btu/h/ft²]
-ne-	49.79	49.55	-7422	-7756	128.7	31.32	32.01
-ne-	39.06	26.78	-982	-5663	1.085	4.145	23.37
-ne-	39.05	11.94	804	-4266	0.3752	3.393	17.61
-ne-	39.05	3.22	1484	-3343	0.2711	6.259	13.80
-ne-	39.05	1.06	1826	-2074	0.2073	7.704	8.561
-te-	39.05	1.09	1893	-1944	0.2043	7.986	8.024
-te-	39.06	1.08	1899	-1943	0.2045	8.013	8.021
-pe-	39.06	1.08	1900	-1943	0.2044	8.015	8.018
-pe-	39.06	1.08	1900	-1941	0.2044	8.016	8.010
-pe-	39.07	1.09	1898	-1944	0.2044	8.007	8.023

Wednesday, May 01, 2013, Time 15:00

Setpoint No. 1

Setpoint Upper: 3.91 °C 39.04 °F

Setpoint Lower: -17.20 °C 1.04 °F

Temperature Upper: 3.92 °C 39.06 °F

CalibFactor Upper: 0.01330 W/m²μV 0.004219 Btu/h ft² μV

Results Upper: 0.02948 W/mK 0.2044 Btu in/ft²h°F

HeatFlux Upper: 25.26 W/m² 8.012 Btu/h/ft²

Temperature Lower: -17.18 °C 1.08 °F

CalibFactor Lower: 0.01301 W/m²μV 0.004127 Btu/h ft² μV

Results Lower: 0.02949 W/mK 0.2045 Btu in/ft²h°F

Percent Difference: 0.06%

HeatFlux Lower: 25.27 W/m² 8.017 Btu/h/ft²

Temperature Average: -6.63 °C 20.07 °F

Results Average: 0.02948 W/mK 0.2044 Btu in/ft²h°F

Resistance Avg : 0.8352 m²K/W 4.743 ft²h°F/Btu

R/unit Avg : 33.92 mK/W 4.892 ft²h°F/Btu in

APPENDIX A – 2013092 Raw Data

Thermal Equilibrium Criteria:

Temperature Equilibrium: 0.20
Between Block HFM Equil.: 50
HFM Percent Change: 2.00
Min Number of Blocks: 4
Calculation Blocks: 3

Results Table -- SI Units

Mean Temp	Upper Cond	Lower Cond	Average Cond
-6.63	0.02948	0.02949	0.02948

Results Table -- English Units

Mean Temp	Upper Cond	Lower Cond	Average Cond
20.07	0.2044	0.2045	0.2044

Thursday, May 16, 2013, Time 13:46

Wintherm32v3 Version 3.31.17

Instrument: F314

Instrument Program Version 72

Instrument Serial Number: 946

Sample Name: S09010643_05161313

Thickness: 24.6444mm 0.970in

Thickness obtained : from instrument

TEST RUN

Calibration used : User Type

Calibration File Id: S0910643-09201116

Calibration File Info :

File Name: S0910643-09201116

Thickness: 24.7330mm 0.974in

User Type Parameters Table -- English Units

Point:1 19.99 0.205071

APPENDIX A – 2013092 Raw Data

Upper Plate Calibration Constants : (English units)

Calibration Const: 0.004219 @39.20 °F

Lower Plate Calibration Constants : (English units)

Calibration Const: 0.004127 @1.40 °F

Number of transducers per plate: 1

Number of transducers used per plate: 1

Number of Setpoints: 1

Raw Thermal Data

APPENDIX B

Thermal Conductivity Measurements Conducted on Insulated Panels Supplied by Bally Refrigerated Boxes, Inc.

R & D Services, Inc. has completed thermal conductivity measurements on foam specimens submitted by Bally Refrigerated Boxes, Inc. Measurements were conducted according to the method outlined in ASTM C518. Ten specimens were received by R&D Services, Inc. on August 12, 2013. The specimens consisted of foam insulation panels with approximately 0.03 inch metal skins attached to the top and bottom surfaces. Each specimen was approximately 18 by 18 inches with approximately 4 inches of foam between the metal skins. R&D Services, Inc. was requested to perform thermal conductivity measurements in accordance with ASTM C518 on the following specimens:

- 1. 1 inch thick core foam specimen (two specimens)**
- 2. 2 inch thick core foam specimen (two specimens)**
- 3. 3 inch thick core foam specimen (two specimens)**
- 4. 4 inch thick core foam specimen (two specimens)**
- 5. Full thickness insulation panel with skins attached (two specimens)**

Each specimen was prepared to 12 by 12 inches prior to measurement. Core specimens were prepared by removing the metal skins and taking specimens from the center of the foam. Core specimens were sliced using a high speed fine-tooth band saw. Four inch core specimens were prepared by removing a minimum amount of foam to create flat surfaces. All measurements were conducted within 30 minutes of preparing the core specimens.

All thermal conductivity measurements were conducted using a Lasercomp Fox 300 model heat-flow meter apparatus. All tests were conducted at 20 °F mean temperature. Thermal conductivity results are summarized in Table 1.

Table 1: Thermal Conductivity Measurements of Specimens

Specimen ID	Thickness (inch)	Density (lb/ft³)	Thermal Conductivity (Btu in / hr ft² F)	Thermal Resistance (hr ft² F / Btu)
1" thick core (1 of 2)	0.989	1.93	0.126	7.85
1" thick core (2 of 2)	0.999	1.88	0.125	7.99
2" thick core (1 of 2)	1.992	1.96	0.126	15.8
2" thick core (2 of 2)	2.012	1.91	0.127	15.8
3" thick core (1 of 2)	2.977	1.99	0.133	22.4
3" thick core (2 of 2)	2.859	1.89	0.135	21.2
4" thick core (1 of 2)	3.529	1.93	0.140	25.2
4" thick core (2 of 2)	3.637	2.03	0.137	26.5
4" thick with skin (1 of 2)	3.968	NA	0.205	19.4
4" thick with skin (2 of 2)	3.933	NA	0.199	19.8

Prior to measuring the specimens, calibration of the heat flow meter was verified at 20 °F for up to two inch thickness. Specimens exceeding two inches in thickness may produce inaccurate results. The client was notified of this issue prior to the project.

The following observations were made during the tests:

- Heat flow meter plates were dried prior to each test to prevent moisture accumulation in the heat flux transducers.
- Specimens exceeding two inches in thickness experienced a noticeable percent difference between the upper and lower transducer outputs. These specimens are outside of the calibration of the heat flow meter.
- Specimens tested with metal skins were not homogenous and are outside of the scope of ASTM C518.
- Three and four inch specimens (no metal skins) had uneven surfaces. Voids and low spots in the surface were observed. Best attempt was made to optimize contact between specimens and the isothermal plates of the heat flow meter.

Individual thermal resistance test reports for each specimen are included in this report. All results are reported in accordance with ASTM C518 requirements. Specimens outside the scope of ASTM C518 or outside of the instrument calibration are noted.

The results of the four inch thick specimens with metal skins are not representative of the thermal resistance of the specimen. The metal skins cause excessive heat loss to the edges of the test specimen, which results in falsely increased thermal conductivity.

APPENDIX C

APPENDIX C-1

SPECIMEN 4 WITH FACERS

TEST REPORT

REPORT NUMBER: 100888391MID-001.3

ORIGINAL ISSUE DATE: April 30, 2013

REVISED DATE: NA

EVALUATION CENTER

Intertek

8431 Murphy Drive

Middleton, WI 53562

Rendered To:

Department of Energy

PRODUCTS EVALUATED: Specimen 4

EVALUATION PROPERTY: ASTM C518: *Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Apparatus in accordance with 10 CFR Subpart R Part 431.304(b)*

Report of Testing of Department of Energy for Specimen 4 for compliance with the applicable requirements of the following criteria: ASTM C518, 2004, Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Apparatus in accordance with 10 CFR Subpart R Part 431.304(b) Uniform test method for the measurement of energy consumption of walk-in coolers and walk-in freezers.

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2 Introduction

Intertek has conducted testing for Department of Energy Specimen 4 to evaluate the thermal transmission properties. Testing was conducted in accordance with ASTM, following the standard methods of C518 (2004) Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus in accordance with 10 CFR Subpart R Part 431.304(b). This evaluation began April 22, 2013 and was completed April 29, 2013.

3 Test Samples

3.1. SAMPLE SELECTION

Samples were received directly from the client. Samples were received at the Intertek Middleton Evaluation Center April 17, 2013 in good condition.

One about 12 inch by 12 inch section was cut from the center of one sample are 46" x 96" metal clad foam filled panels with a total thickness of about 4 inches from Bally Refrigeration Boxes Inc.

3.2. SAMPLE AND ASSEMBLY DESCRIPTION

The samples stored at 73 +/-4 °F and 50 +/- 5% relative humidity for minimum of 24 hours prior to starting the test.

4 Testing and Evaluation Methods

4.1. Thermal Conductivity

The heat flow meter apparatus establishes steady state unidirectional heat flux through a test specimen between two parallel plates at constant but different temperatures. By appropriate calibration of the heat flux transducer(s) with calibration standards and by measurement of the plate temperatures and plate separation, Fourier's law of heat conduction is used to calculate thermal conductivity, thermal resistance, or resistivity.

The accurate use of the test method is limited by the capability of the apparatus to reproduce unidirectional constant heat flux density in the specimens, and by the precision in the measurement of temperature, thickness, EMF produced by the heat flux transducer, etc.

The apparatus shall not be used at temperatures, thickness or resistances, other than those within the range of the calibration; unless it can be shown that there is no difference in accuracy.

The apparatus must be capable of maintaining at least a 10°C temperature difference across the specimen for the duration of the test, unless a smaller LT is a requirement of a particular test. The specimens tested may also limit the use of the test method and these limitations are outlined in Practice C1045.

This evaluation was accomplished using a HFM436/3/1 ER Heat Flow Meter Thermal Conductivity Instrument, manufactured by Netzsch. The HFM436/3/1 ER determines thermal conductivity in accordance with ASTM C 518.

Heat flow through a solid, results from having a temperature gradient in the material. Thermal conductivity is a material property, which determines how much heat flows through a given thickness of the material when there is a temperature difference. The Fourier linear heat flow equation defines thermal conductivity under steady state conditions as:

$$I = \varnothing \frac{DX}{DT}$$

where:

I = thermal conductivity, $\frac{W}{m \cdot K}$

$\varnothing$ = heat flux, $\frac{W}{m^2}$

DT = temperature difference across distance LX , K

DX = distance between hot and cold plates, m

Prior to each series of tests, the HFM436/3/1 ER was calibrated using a sample whose thermal conductivity is known and traceable to national standards.

To perform the test, the specimens are placed in the HFM436/3/1 ER instrument, the top (hot) plate is brought downwards creating contact of both plates with the test specimen. The hot and cold plates were then allowed to equilibrate to the required temperatures and their exact temperatures were read from the instrument.

The mean temperature for testing is 20°F with a temperature difference between plates at 35°F.

Density Measurements were taken using standard ASTM D1622.

4.2. Testing and Calculation for 10 CFR Subpart R Part 431.304(b)

1. The R value shall be 1/K factor multiplied by the thickness of the panel
 2. The K factor shall be based on ASTM C518
 3. For Calculating the R value for freezers, the K factor for the foam at 20 degrees Fahrenheit (average foam temperature) shall be used.
 4. For Calculating the R value for coolers, the K factor for the foam at 55 degrees Fahrenheit (average foam temperature) shall be used
-

5 Results and Observations

Testing was performed at 20 degrees Fahrenheit and 55 degrees Fahrenheit.

Density Measurements Results for ASTM D1622:

Specimen	Length (in)	Width (in)	Depth (in)	Weight	Density	
	Avg.	Avg.	Avg.	(g)	(kg/m ³)	(lbs/ft ³)
4	11.97	11.97	4.03	1045.40	113.19	7.07

Please note: The density measurements were taken to include the metal exterior.

Results tables for ASTM C518:

Test Information	Thermal Conductivity	Thermal Conductivity	Thermal Resistance	Thermal Resistance	Thermal Resistance per inch	Thermal Resistance per meter	Thermal Transmittance
	K Value	K Value	R Value	R Value	R/in	R/m	U
Units:	Btu-in/hr-ft ² -°F	W/m-K	Hr-ft ² -°F/Btu	m ² -K/W	Hr-ft ² -°F/Btu/in	m ² -K/W/m	W/m ² -K
Target Mean 20 F	0.200758	0.02895	20.06485	3.5336	4.98	34.5	0.28
Target Mean 55 F	0.224662	0.03240	17.85552	3.1445	4.45	30.9	0.32

Test Information	Duration of the measurement	Instrument Measured Thickness	Instrument Measured Thickness	Mean Temperature	Mean Temperature	Temperature Gradient	
	min	(in)	(m)	°F	°C	°F/in	°C/m
Target Mean 20 F	4:16:58	4.0283	0.102319	23.34	-4.81	8.68	-190.39
Target Mean 55 F	1:22:31	4.0117	0.101897	55.29	12.94	9.25	-174.29

5.1.1. Statement of Measurement Uncertainty

The uncertainty of the Netzsch Thermal Conductivity Instrument HFM436/3/1 ER is estimated to be 1-3%.

6 Conclusion

Intertek has conducted testing for Department of Energy, on Specimen 4 to evaluate the thermal transmission properties. Testing was conducted in accordance with ASTM, following the standard methods of C518 (2004) Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.

These results are listed as is and there are no pass fail criteria for this testing.

The conclusions of this test report may not be used as part of the requirements for Intertek product certification. Authority to Mark must be issued for a product to become certified.

INTERTEK



Reported by:

Bryan Bowman
Chemist



Reviewed by:

Mark Crawford
Chemist

7 Calibration

Equipment:	Equipment Number	Calibration Due Date
Thermal Conductivity Instrument	1266	Calibrated before testing
Scale	1045	March 2014
Calipers	1076	Sept 2013
Calipers	1248	May 2014

8 Appendix



Above: Cut samples



Above: Final sample for testing

9 Revision Summary

DATE	SUMMARY
April 30, 2013	Original Issue Date

22Apr13 088099-2												
Time k(t)	K(avg)	SP # Status	dx(cm)	TUpper	TLower	TMean	TDelta	QUpper	QLower	StdDev	pk/avg	N(t)
1:37:03	p	1	4.0281	45.35	12.12	28.74	33.23	-28807	35270	0.00005	0.00093	0.00589
0.18587	0.18556	Rough										
1:38:07	p	1	4.0275	45.37	10.09	27.73	35.28	-7748	33575	0.00000	0.00000	0.00593
2.09137	2.09137	Rough										
1:39:11	p	1	4.0264	45.31	9.09	27.20	36.23	-4506	20069	0.02521	0.05579	0.00593
2.33850	2.21493	Rough										
1:40:15	p	1	4.0255	45.26	8.55	26.91	36.71	-3708	13505	0.06933	0.27550	0.00592
1.41044	1.94677	Rough										
1:41:19	p	1	4.0252	45.24	8.36	26.80	36.88	-3277	10253	0.09229	0.44744	0.00592
0.93610	1.69410	Rough										
1:42:23	p	1	4.0250	45.27	8.33	26.80	36.94	-2692	7950	0.10353	0.56938	0.00592
0.67398	1.49008	Rough										
1:43:26	p	1	4.0238	45.36	8.41	26.89	36.95	-2131	6508	0.10859	0.75889	0.00592
0.52678	1.32953	Rough										
1:44:30	p	1	4.0243	45.50	8.56	27.03	36.95	-1566	5380	0.11022	1.12376	0.00592
0.39036	1.10111	Rough										
1:45:34	p	1	4.0234	45.68	8.74	27.21	36.94	-1097	4650	0.10908	1.29539	0.00592
0.36011	1.01878	Rough										
1:46:38	p	1	4.0237	45.89	8.95	27.42	36.94	-765	4052	0.10743	1.45974	0.00593
0.33809	0.95071	Rough										
1:47:41	p	1	4.0234	46.13	9.19	27.66	36.94	-489	3607	0.09336	2.02080	0.00593
0.32560	0.77413	Rough										
1:48:45	p	1	4.0230	46.35	9.41	27.88	36.93	-302	3315	0.05099	1.46705	0.00593
0.31429	0.57171	Rough										
1:49:49	p	1	4.0229	46.60	9.65	28.12	36.94	-154	3078	0.02928	1.03082	0.00593
0.30278	0.46095	Rough										
1:50:53	p	1	4.0231	46.84	9.88	28.36	36.96	-64	2915	0.01746	0.69885	0.00593
0.29393	0.39673	Rough										
1:51:57	p	1	4.0233	47.07	10.09	28.58	36.97	-3	2781	0.01097	0.47125	0.00593
0.28716	0.35805	Rough										
1:53:01	p	1	4.0228	47.31	10.32	28.81	36.99	26	2692	0.00734	0.32312	0.00593
0.28215	0.33358	Rough										
1:54:04	p	1	4.0228	47.50	10.50	29.00	37.00	40	2625	0.00535	0.23157	0.00594
0.27513	0.31696	Rough										
1:55:08	p	1	4.0229	47.72	10.69	29.21	37.02	39	2575	0.00423	0.18104	0.00594
0.26987	0.30491	Rough										
1:56:12	p	1	4.0227	47.89	10.86	29.38	37.03	25	2535	0.00351	0.14420	0.00594
0.26580	0.29548	Rough										
1:57:16	p	1	4.0228	48.08	11.03	29.55	37.05	5	2508	0.00306	0.13100	0.00594
0.26219	0.28789	Rough										
1:58:20	p	1	4.0226	48.25	11.17	29.71	37.09	-16	2499	0.00269	0.11848	0.00594
0.25669	0.28100	Rough										
1:59:24	p	1	4.0227	48.39	11.31	29.85	37.08	-36	2489	0.00237	0.10159	0.00594
0.25285	0.27485	Rough										
2:00:27	p	1	4.0228	48.54	11.44	29.99	37.10	-61	2473	0.00214	0.09021	0.00594
0.25035	0.26961	Rough										
2:01:31	p	1	4.0229	48.67	11.55	30.11	37.11	-86	2466	0.00184	0.08308	0.00594
0.24334	0.26050	Rough										
2:02:35	p	1	4.0228	48.80	11.68	30.24	37.12	-111	2464	0.00167	0.07311	0.00594
0.24097	0.25639	Rough										
2:03:39	p	1	4.0226	48.91	11.77	30.34	37.14	-127	2459	0.00156	0.06798	0.00595
0.23818	0.25269	Rough										
2:04:43	p	1	4.0228	49.02	11.88	30.45	37.15	-155	2446	0.00149	0.06678	0.00595
0.23454	0.24916	Rough										
2:05:46	p	1	4.0228	49.12	11.96	30.54	37.15	-168	2442	0.00139	0.06620	0.00595
0.23327	0.24591	Rough										
2:06:50	p	1	4.0227	49.22	12.05	30.63	37.17	-178	2435	0.00124	0.05678	0.00595
0.23206	0.24289	Rough										
2:07:54	p	1	4.0226	49.31	12.14	30.73	37.17	-185	2429	0.00117	0.05294	0.00595
0.22917	0.24014	Rough										
2:08:58	p	1	4.0227	49.39	12.21	30.80	37.19	-200	2418	0.00110	0.05360	0.00595
0.22757	0.23761	Rough										
2:10:02	p	1	4.0227	49.47	12.28	30.88	37.19	-209	2413	0.00099	0.04870	0.00595
0.22650	0.23523	Rough										
2:11:06	p	1	4.0227	49.54	12.34	30.94	37.20	-212	2409	0.00090	0.04408	0.00595
0.22503	0.23306	Rough										
2:12:09	p	1	4.0226	49.61	12.41	31.01	37.20	-209	2400	0.00084	0.04314	0.00595
0.22280	0.23101	Rough										
2:13:13	p	1	4.0225	49.67	12.46	31.06	37.21	-219	2381	0.00075	0.03917	0.00595
0.22285	0.22920	Rough										
2:14:17	p	1	4.0227	49.73	12.51	31.12	37.22	-228	2374	0.00068	0.03110	0.00595
0.22091	0.22747	Rough										
2:15:21	p	1	4.0227	49.78	12.56	31.17	37.22	-228	2373	0.00069	0.03272	0.00595
0.21865	0.22588	Rough										
2:16:25	p	1	4.0227	49.83	12.60	31.21	37.23	-218	2368	0.00065	0.03420	0.00595
0.21832	0.22439	Rough										
2:17:28	p	1	4.0227	49.89	12.66	31.27	37.23	-225	2348	0.00056	0.02733	0.00595

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0.21892	0.22307	Rough											
2:18:32	p	1	4.0227	49.91	12.68	31.30	37.23	-225	2340	0.00051	0.02654	0.00595	
0.21584	0.22065	Rough											
2:19:36	p	1	4.0227	49.96	12.72	31.34	37.24	-222	2337	0.00046	0.02472	0.00595	
0.21603	0.21960	Rough											
2:20:40	p	1	4.0227	49.99	12.75	31.37	37.25	-212	2330	0.00039	0.01896	0.00595	
0.21610	0.21871	Rough											
2:21:44	p	1	4.0222	50.02	12.77	31.40	37.25	-201	2316	0.00036	0.02257	0.00595	
0.21507	0.21793	Rough											
2:22:48	p	1	4.0225	50.04	12.79	31.42	37.25	-209	2303	0.00029	0.01746	0.00595	
0.21466	0.21712	Rough											
2:23:51	p	1	4.0225	50.07	12.81	31.44	37.26	-211	2306	0.00024	0.01141	0.00595	
0.21421	0.21645	Rough											
2:24:55	p	1	4.0225	50.10	12.84	31.47	37.26	-209	2299	0.00027	0.01535	0.00595	
0.21252	0.21583	Rough											
2:25:59	p	1	4.0225	50.12	12.86	31.49	37.26	-211	2291	0.00030	0.01741	0.00595	
0.21169	0.21517	Rough											
2:27:03	p	1	4.0225	50.13	12.87	31.50	37.26	-212	2289	0.00024	0.01356	0.00595	
0.21319	0.21460	Rough											
2:28:07	p	1	4.0225	50.15	12.88	31.52	37.27	-210	2285	0.00024	0.01158	0.00595	
0.21237	0.21417	Rough											
2:29:10	p	1	4.0225	50.17	12.90	31.53	37.27	-201	2278	0.00026	0.01242	0.00595	
0.21103	0.21369	Rough											
2:30:14	p	1	4.0225	50.19	12.93	31.56	37.26	-191	2264	0.00024	0.01324	0.00595	
0.21194	0.21328	Rough											
2:31:18	p	1	4.0225	50.20	12.93	31.56	37.26	-187	2255	0.00020	0.01035	0.00595	
0.21195	0.21286	Rough											
2:32:22	p	1	4.0225	50.22	12.95	31.58	37.27	-177	2249	0.00018	0.01040	0.00595	
0.21095	0.21245	Rough											
2:33:26	p	1	4.0225	50.24	12.97	31.60	37.27	-165	2239	0.00016	0.01014	0.00595	
0.21072	0.21206	Rough											
2:34:29	p	1	4.0225	50.25	12.99	31.62	37.27	-163	2219	0.00011	0.00658	0.00595	
0.21165	0.21180	Fine											
2:35:33	p	1	4.0222	49.66	13.47	31.56	36.20	-2905	359	0.02204	0.12892	0.00595	
-0.27154		0.18742	Rough										
2:36:37	p	1	4.0223	49.46	13.56	31.51	35.90	-1929	1185	0.02491	3.06272	0.00595	
-0.10294		0.13164	Rough										
2:37:41	p	1	4.0224	49.35	13.58	31.46	35.77	-1363	1769	0.02498	3.40715	0.00595	
0.02401	0.11281	Rough											

3:00:01	p	1	4.0224	46.20	10.38	28.29	35.82	-1245	3126	0.00044	0.02765	0.00593
0.19804	0.20146	Rough										
3:01:05	p	1	4.0225	46.07	10.26	28.17	35.81	-1201	3076	0.00034	0.02000	0.00593
0.19887	0.20065	Rough										
3:02:09	p	1	4.0224	45.97	10.16	28.07	35.81	-1157	3033	0.00029	0.02030	0.00593
0.19838	0.20002	Rough										
3:03:13	p	1	4.0223	45.85	10.06	27.95	35.80	-1107	2979	0.00022	0.01675	0.00593
0.19782	0.19939	Rough										
3:04:16	p	1	4.0224	45.76	9.97	27.86	35.79	-1064	2934	0.00014	0.01039	0.00593
0.19828	0.19895	Rough										
3:05:20	p	1	4.0224	45.66	9.87	27.77	35.79	-1016	2897	0.00009	0.00685	0.00593
0.19857	0.19870	Fine										
3:06:24	p	1	4.0224	45.38	9.95	27.66	35.42	-1927	2195	0.00006	0.00000	0.00593
0.19883	0.19858	Fine										
3:07:28	p	1	4.0224	45.23	9.91	27.57	35.33	-1606	2415	0.00762	0.04403	0.00593
0.03152	0.19021	Rough										
3:08:32	p	1	4.0224	45.10	9.83	27.46	35.27	-1335	2608	0.00859	0.80888	0.00593
0.13848	0.16491	Rough										
3:09:35	p	1	4.0224	45.00	9.75	27.37	35.25	-1175	2748	0.00843	0.80514	0.00593
0.16644	0.16175	Rough										
3:10:39	p	1	4.0224	44.90	9.66	27.28	35.24	-1101	2835	0.00831	0.80344	0.00592
0.18488	0.16035	Rough										
3:11:43	p	1	4.0224	44.80	9.56	27.18	35.25	-1076	2909	0.00828	0.80307	0.00592
0.19534	0.16005	Rough										
3:12:47	p	1	4.0224	44.71	9.44	27.08	35.26	-1064	2965	0.00833	0.80361	0.00592
0.20227	0.16050	Rough										
3:13:51	p	1	4.0224	44.61	9.33	26.97	35.28	-1058	3003	0.00843	0.80471	0.00592
0.20728	0.16140	Rough										
3:14:54	p	1	4.0224	44.51	9.21	26.86	35.31	-1055	3043	0.00858	0.80628	0.00592
0.21168	0.16271	Rough										
3:15:58	p	1	4.0224	44.41	9.08	26.74	35.33	-1060	3068	0.00876	0.80808	0.00592
0.21407	0.16423	Rough										
3:17:02	p	1	4.0224	44.31	8.96	26.63	35.35	-1080	3090	0.00585	0.50544	0.00592
0.21555	0.18263	Rough										
3:18:06	p	1	4.0224	44.20	8.83	26.51	35.37	-1099	3105	0.00365	0.29014	0.00592
0.21485	0.19509	Rough										
3:19:10	p	1	4.0224	44.09	8.71	26.40	35.38	-1102	3088	0.00233	0.17844	0.00592
0.21354	0.20259	Rough										
3:20:14	p	1	4.0224	43.98	8.59	26.28	35.40	-1101	3080	0.00147	0.10776	0.00592
0.21258	0.20721	Rough										
3:21:17	p	1	4.0223	43.88	8.47	26.18	35.40	-1095	3053	0.00093	0.06888	0.00592
0.21074	0.20979	Rough										
3:22:21	p	1	4.0209	43.77	8.35	26.06	35.42	-1086	3035	0.00059	0.04197	0.00592
0.20877	0.21114	Rough										
3:23:25	p	1	4.0216	43.66	8.24	25.95	35.41	-1071	2998	0.00044	0.02143	0.00592
0.20708	0.21162	Rough										
3:24:29	p	1	4.0224	43.57	8.13	25.85	35.43	-1055	2964	0.00049	0.02780	0.00592
0.20557	0.21145	Rough										
3:25:33	p	1	4.0224	43.46	8.03	25.74	35.43	-1027	2932	0.00066	0.03122	0.00591
0.20302	0.20956	Rough										
3:26:37	p	1	4.0225	43.37	7.93	25.65	35.44	-999	2894	0.00066	0.03183	0.00591
0.20215	0.20822	Rough										
3:27:40	p	1	4.0224	43.28	7.85	25.56	35.43	-971	2866	0.00063	0.03211	0.00591
0.20163	0.20690	Rough										
3:28:44	p	1	4.0224	43.20	7.76	25.48	35.44	-946	2827	0.00058	0.03376	0.00591
0.20098	0.20564	Rough										
3:29:48	p	1	4.0224	43.11	7.67	25.39	35.44	-919	2797	0.00051	0.03095	0.00591
0.20034	0.20442	Rough										
3:30:52	p	1	4.0223	43.03	7.59	25.31	35.44	-896	2766	0.00046	0.02737	0.00591
0.19864	0.20321	Rough										
3:31:56	p	1	4.0224	42.95	7.52	25.23	35.43	-874	2742	0.00039	0.02396	0.00591
0.19905	0.20224	Rough										
3:32:59	p	1	4.0224	42.87	7.44	25.16	35.43	-850	2712	0.00034	0.02079	0.00591
0.19853	0.20138	Rough										
3:34:03	p	1	4.0225	42.81	7.38	25.10	35.43	-825	2691	0.00028	0.01576	0.00591
0.19915	0.20074	Rough										
3:35:07	p	1	4.0225	42.75	7.32	25.04	35.42	-796	2664	0.00025	0.01440	0.00591
0.19789	0.20014	Rough										
3:36:11	p	1	4.0226	42.68	7.26	24.97	35.42	-775	2638	0.00021	0.01209	0.00591
0.19904	0.19974	Rough										
3:37:15	p	1	4.0219	42.63	7.21	24.92	35.42	-739	2613	0.00018	0.01144	0.00591
0.19821	0.19934	Rough										
3:38:18	p	1	4.0204	42.58	7.16	24.87	35.42	-726	2582	0.00014	0.00950	0.00591
0.19907	0.19909	Fine										
3:39:22	p	1	4.0202	42.42	7.19	24.81	35.23	-1213	2216	0.00011	0.00000	0.00591
0.19768	0.19876	Fine										
3:40:26	p	1	4.0201	42.34	7.18	24.76	35.16	-1049	2304	0.00414	0.02382	0.00591
0.10787	0.19414	Rough										
3:41:30	p	1	4.0202	42.27	7.14	24.71	35.13	-870	2382	0.00467	0.41254	0.00591

0.13978	0.18363	Rough											
3:42:34	p	1	4.0205	42.22	7.11	24.67	35.11	-757	2422	0.00460	0.39393	0.00591	
0.17886	0.17799	Rough											
3:43:38	p	1	4.0206	42.19	7.08	24.63	35.11	-683	2443	0.00451	0.39004	0.00591	
0.18779	0.17685	Rough											
3:44:41	p	1	4.0207	42.14	7.03	24.59	35.11	-626	2455	0.00448	0.38924	0.00591	
0.19558	0.17662	Rough											
3:45:45	p	1	4.0207	42.11	7.00	24.56	35.11	-602	2463	0.00449	0.38937	0.00591	
0.19942	0.17666	Rough											
3:46:49	p	1	4.0209	42.07	6.96	24.51	35.12	-568	2461	0.00454	0.39077	0.00591	
0.20226	0.17706	Rough											
3:47:53	p	1	4.0207	42.05	6.92	24.48	35.12	-559	2454	0.00459	0.39237	0.00591	
0.20373	0.17753	Rough											
3:48:57	p	1	4.0204	42.02	6.88	24.45	35.14	-539	2449	0.00467	0.39475	0.00591	
0.20466	0.17823	Rough											
3:50:00	p	1	4.0207	41.98	6.84	24.41	35.15	-538	2445	0.00315	0.25637	0.00591	
0.20523	0.18796	Rough											
3:51:04	p	1	4.0207	41.95	6.80	24.37	35.15	-536	2438	0.00204	0.16495	0.00590	
0.20412	0.19440	Rough											
3:52:08	p	1	4.0198	41.90	6.75	24.33	35.16	-530	2429	0.00126	0.09896	0.00590	
0.20335	0.19850	Rough											
3:53:12	p	1	4.0198	41.87	6.71	24.29	35.16	-525	2424	0.00079	0.06544	0.00590	
0.20329	0.20094	Rough											
3:54:16	p	1	4.0197	41.84	6.67	24.25	35.17	-519	2407	0.00042	0.03412	0.00590	
0.20328	0.20249	Rough											
3:55:19	p	1	4.0197	41.80	6.63	24.22	35.17	-517	2400	0.00024	0.01817	0.00590	
0.20173	0.20311	Rough											
3:56:23	p	1	4.0196	41.77	6.60	24.18	35.17	-506	2384	0.00018	0.00948	0.00590	
0.20138	0.20330	Fine											
3:57:27	p	1	4.0195	41.68	6.59	24.14	35.09	-718	2226	0.00019	0.00000	0.00590	
0.20156	0.20323	Fine											
3:58:31	p	1	4.0196	41.64	6.57	24.10	35.07	-649	2265	0.00191	0.01048	0.00590	
0.16156	0.20112	Rough											
3:59:35	p	1	4.0195	41.59	6.54	24.07	35.05	-576	2295	0.00219	0.16668	0.00590	
0.18479	0.19388	Rough											
4:00:39	p	1	4.0197	41.56	6.52	24.04	35.04	-532	2295	0.00214	0.16020	0.00590	
0.18915	0.19238	Rough											
4:01:42	p	1	4.0197	41.52	6.48	24.00	35.04	-500	2296	0.00207	0.15544	0.00590	
0.19250	0.19130	Rough											
4:02:46	p	1	4.0196	41.50	6.46	23.98	35.04	-477	2286	0.00198	0.15109	0.00590	
0.19350	0.19032	Rough											
4:03:50	p	1	4.0195	41.46	6.43	23.95	35.03	-461	2277	0.00189	0.14739	0.00590	
0.19502	0.18949	Rough											
4:04:54	p	1	4.0195	41.45	6.42	23.94	35.02	-445	2264	0.00181	0.14441	0.00590	
0.19513	0.18883	Rough											
4:05:58	p	1	4.0214	41.42	6.40	23.91	35.02	-437	2248	0.00173	0.14159	0.00590	
0.19517	0.18821	Rough											
4:07:02	p	1	4.0211	41.40	6.38	23.89	35.02	-422	2246	0.00165	0.13900	0.00590	
0.19590	0.18764	Rough											
4:08:05	p	1	4.0207	41.38	6.36	23.87	35.01	-401	2228	0.00102	0.09112	0.00590	
0.19655	0.19114	Rough											
4:09:09	p	1	4.0209	41.37	6.35	23.86	35.02	-393	2224	0.00055	0.04480	0.00590	
0.19690	0.19346	Rough											
4:10:13	p	1	4.0209	41.34	6.33	23.84	35.01	-387	2205	0.00034	0.02782	0.00590	
0.19585	0.19457	Rough											
4:11:17	p	1	4.0210	41.32	6.32	23.82	35.01	-376	2204	0.00020	0.01402	0.00590	
0.19586	0.19524	Rough											
4:12:21	p	1	4.0213	41.31	6.31	23.81	35.00	-374	2196	0.00014	0.01089	0.00590	
0.19641	0.19563	Rough											
4:13:25	p	1	4.0213	41.29	6.29	23.79	35.00	-371	2205	0.00010	0.00491	0.00590	
0.19656	0.19593	Fine											
4:14:28	p	1	4.0209	41.28	6.28	23.78	35.00	-377	2195	0.00011	0.00000	0.00590	
0.19751	0.19618	Fine											
4:15:32	p	1	4.0209	41.26	6.27	23.77	34.99	-367	2197	0.00010	0.00018	0.00590	
0.19581	0.19622	Fine											
4:16:36	p	1	4.0209	41.25	6.26	23.75	34.99	-353	2184	0.00009	0.00103	0.00590	
0.19714	0.19636	Fine											
4:17:40	p	1	4.0209	41.23	6.25	23.74	34.99	-336	2174	0.00011	0.00147	0.00590	
0.19814	0.19643	Fine											
4:18:43	p	1	4.0209	41.23	6.24	23.74	34.99	-312	2158	0.00014	0.00197	0.00590	
0.19866	0.19651	Fine											
4:19:47	p	1	4.0209	41.22	6.24	23.73	34.98	-298	2139	0.00015	0.00281	0.00590	
0.19842	0.19660	Fine											
4:20:51	p	1	4.0209	41.21	6.22	23.72	34.99	-285	2131	0.00014	0.00360	0.00590	
0.19843	0.19670	Fine											
4:21:55	p	1	4.0209	41.20	6.22	23.71	34.98	-284	2123	0.00014	0.00407	0.00590	
0.19833	0.19680	Fine											
4:22:59	p	1	4.0209	41.18	6.20	23.69	34.98	-281	2126	0.00014	0.00476	0.00590	
0.19896	0.19690	Rough											

				22Apr13 088099-2									
4:24:03	p	1	4.0209	41.18	6.19	23.69	34.98	-274	2119	0.00014	0.01060	0.00590	
0.19822	0.19791	Rough											
4:25:06	p	1	4.0209	41.16	6.18	23.67	34.99	-275	2124	0.00009	0.00594	0.00590	
0.19854	0.19819	Fine											
4:26:10	p	1	4.0209	41.15	6.16	23.65	34.99	-273	2123	0.00008	0.00000	0.00590	
0.19906	0.19839	Fine											
4:27:14	p	1	4.0209	41.14	6.15	23.64	34.99	-273	2123	0.00004	0.00040	0.00590	
0.19873	0.19847	Fine											
4:28:18	p	1	4.0209	41.12	6.14	23.63	34.99	-272	2116	0.00004	0.00066	0.00590	
0.19886	0.19852	Fine											
4:29:22	p	1	4.0209	41.11	6.12	23.61	34.99	-267	2112	0.00004	0.00080	0.00590	
0.19874	0.19855	Fine											
4:30:26	p	1	4.0209	41.09	6.11	23.60	34.98	-251	2107	0.00004	0.00094	0.00590	
0.19905	0.19858	Fine											
4:31:29	p	1	4.0209	41.08	6.09	23.59	34.99	-248	2097	0.00006	0.00115	0.00590	
0.19972	0.19862	Fine											
4:32:33	p	1	4.0209	41.07	6.09	23.58	34.99	-230	2081	0.00006	0.00135	0.00590	
0.19905	0.19866	Fine											
4:33:37	p	1	4.0209	41.07	6.08	23.57	34.98	-221	2071	0.00005	0.00170	0.00590	
0.19918	0.19873	Fine											
4:34:41	p	1	4.0209	41.06	6.08	23.57	34.98	-218	2064	0.00004	0.00187	0.00590	
0.19904	0.19876	Fine											
4:35:45	p	1	4.0209	41.05	6.07	23.56	34.98	-221	2060	0.00008	0.00133	0.00590	
0.19755	0.19881	Fine											
4:36:48	p	1	4.0209	41.04	6.06	23.55	34.98	-231	2067	0.00009	0.00114	0.00590	
0.19799	0.19884	Fine											
4:37:52	p	1	4.0209	41.03	6.05	23.54	34.98	-234	2069	0.00012	0.00111	0.00590	
0.19714	0.19885	Fine											
4:38:56	p	1	4.0209	41.02	6.03	23.53	34.98	-238	2080	0.00013	0.00139	0.00590	
0.19768	0.19884	Fine											
4:40:00	p	1	4.0209	41.00	6.02	23.51	34.98	-248	2079	0.00014	0.00218	0.00590	
0.19716	0.19881	Fine											
4:41:04	p	1	4.0209	40.98	6.01	23.50	34.97	-246	2091	0.00012	0.00258	0.00590	
0.19834	0.19875	Fine											
4:42:07	p	1	4.0209	40.98	6.01	23.49	34.97	-240	2084	0.00012	0.00272	0.00590	
0.19802	0.19868	Fine											
4:43:11	p	1	4.0209	40.97	5.99	23.48	34.98	-231	2082	0.00011	0.00241	0.00590	
0.19908	0.19860	Fine											
4:44:15	p	1	4.0193	40.96	5.98	23.47	34.98	-211	2074	0.00014	0.00278	0.00590	
0.20028	0.19852	Rough											
4:45:19	p	1	4.0197	40.96	5.98	23.47	34.98	-210	2070	0.00019	0.01314	0.00590	
0.20104	0.19843	Rough											
4:46:23	p	1	4.0196	40.95	5.98	23.47	34.98	-208	2061	0.00020	0.01191	0.00590	
0.19997	0.19867	Rough											
4:47:27	p	1	4.0198	40.96	5.98	23.47	34.97	-203	2053	0.00020	0.01081	0.00590	
0.20015	0.19889	Rough											
4:48:30	p	1	4.0199	40.96	5.98	23.47	34.97	-192	2051	0.00018	0.00973	0.00590	
0.19927	0.19910	Fine											
4:49:34	p	1	4.0199	40.96	5.98	23.47	34.98	-186	2051	0.00018	0.00000	0.00590	
0.20040	0.19937	Rough											
4:50:38	p	1	4.0199	40.95	5.98	23.47	34.98	-166	2043	0.00016	0.00000	0.00590	
0.20209	0.20011	Rough											
4:51:42	p	1	4.0199	40.96	5.98	23.47	34.98	-158	2023	0.00013	0.00829	0.00590	
0.20122	0.20043	Fine											
4:52:46	p	1	4.0199	40.96	5.98	23.47	34.98	-157	2019	0.00011	0.00000	0.00590	
0.20025	0.20054	Fine											
4:53:50	p	1	4.0199	40.96	5.97	23.47	34.98	-156	2015	0.00011	0.00006	0.00590	
0.20004	0.20053	Fine											
4:54:53	p	1	4.0199	40.95	5.97	23.46	34.98	-166	2024	0.00011	0.00034	0.00590	
0.20013	0.20050	Fine											
4:55:57	p	1	4.0199	40.94	5.96	23.45	34.98	-172	2028	0.00011	0.00033	0.00590	
0.20055	0.20050	Fine											
4:57:01	p	1	4.0199	40.93	5.95	23.44	34.98	-181	2031	0.00011	0.00030	0.00590	
0.19990	0.20049	Fine											
4:58:05	p	1	4.0199	40.92	5.94	23.43	34.99	-179	2034	0.00012	0.00032	0.00590	
0.19894	0.20048	Fine											
4:59:08	p	1	4.0199	40.91	5.93	23.42	34.98	-187	2031	0.00013	0.00055	0.00590	
0.19960	0.20046	Fine											
5:00:12	p	1	4.0199	40.90	5.92	23.41	34.98	-186	2030	0.00016	0.00170	0.00590	
0.19798	0.20041	Rough											
5:01:16	p	1	4.0199	40.88	5.91	23.40	34.97	-191	2027	0.00015	0.00847	0.00590	
0.19809	0.19967	Fine											
5:02:20	p	1	4.0199	40.88	5.90	23.39	34.97	-190	2025	0.00015	0.00000	0.00590	
0.19767	0.19932	Fine											
5:03:24	p	1	4.0199	40.86	5.90	23.38	34.97	-178	2014	0.00016	0.00059	0.00590	
0.19791	0.19920	Fine											
5:04:28	p	1	4.0199	40.86	5.89	23.38	34.97	-165	2002	0.00016	0.00118	0.00590	
0.19771	0.19908	Fine											
5:05:31	p	1	4.0199	40.86	5.89	23.37	34.96	-152	1990	0.00015	0.00179	0.00590	

0.19773	0.19896	Fine	4.0199	40.85	5.89	23.37	34.96	-148	1986	0.00012	0.00243	0.00590
5:06:35	p	1										
0.19807	0.19884	Fine	4.0199	40.85	5.89	23.37	34.96	-135	1989	0.00011	0.00330	0.00590
5:07:39	p	1										
0.19966	0.19866	Fine	4.0199	40.85	5.89	23.37	34.96	-128	1991	0.00014	0.00350	0.00590
5:08:43	p	1										
0.20063	0.19862	Rough	4.0199	40.85	5.89	23.37	34.96	-117	1980	0.00017	0.01025	0.00590
5:09:47	p	1										
0.20051	0.19860	Rough	4.0199	40.85	5.89	23.37	34.97	-114	1982	0.00021	0.01135	0.00590
5:10:51	p	1										
0.20116	0.19890	Rough	4.0199	40.85	5.88	23.37	34.97	-116	1985	0.00023	0.01148	0.00590
5:11:54	p	1										
0.20158	0.19929	Rough	4.0198	40.85	5.89	23.37	34.97	-123	1989	0.00023	0.00973	0.00590
5:12:58	p	1										
0.20136	0.19964	Fine	4.0198	40.87	5.90	23.38	34.97	-121	1988	0.00022	0.00000	0.00590
5:14:02	p	1										
0.20104	0.19997	Rough	4.0197	40.87	5.90	23.39	34.96	-118	1981	0.00019	0.01169	0.00590
5:15:06	p	1										
0.20115	0.20031	Rough	4.0199	40.88	5.91	23.39	34.97	-120	1986	0.00015	0.01273	0.00590
5:16:10	p	1										
0.20019	0.20052	Rough	4.0198	40.88	5.91	23.39	34.97	-117	1984	0.00008	0.00573	0.00590
5:17:13	p	1										
0.20082	0.20081	Fine	4.0198	40.88	5.91	23.40	34.97	-127	1996	0.00006	0.00000	0.00590
5:18:17	p	1										
0.20128	0.20097	Fine	4.0198	40.88	5.91	23.39	34.97	-131	1994	0.00006	0.00002	0.00590
5:19:21	p	1										
0.20073	0.20098	Fine	4.0198	40.87	5.90	23.39	34.97	-132	1987	0.00006	0.00003	0.00590
5:20:25	p	1										
0.20047	0.20098	Fine	4.0198	40.87	5.90	23.38	34.97	-129	1975	0.00008	0.00049	0.00590
5:21:29	p	1										
0.19985	0.20094	Fine	4.0198	40.87	5.90	23.38	34.97	-130	1982	0.00011	0.00141	0.00590
5:22:33	p	1										
0.19902	0.20087	Fine	4.0199	40.87	5.90	23.38	34.97	-132	1985	0.00011	0.00206	0.00590
5:23:36	p	1										
0.19922	0.20079	Fine	4.0199	40.86	5.89	23.37	34.97	-135	1987	0.00011	0.00287	0.00590
5:24:40	p	1										
0.19942	0.20063	Fine	4.0199	40.86	5.89	23.37	34.97	-125	1981	0.00011	0.00255	0.00590
5:25:44	p	1										
0.20019	0.20056	Fine	4.0199	40.85	5.88	23.36	34.97	-126	1972	0.00011	0.00316	0.00590
5:26:48	p	1										
0.19890	0.20049	Fine	4.0199	40.84	5.88	23.36	34.96	-119	1971	0.00009	0.00362	0.00590
5:27:52	p	1										
0.19903	0.20036	Fine	4.0199	40.83	5.87	23.35	34.96	-124	1971	0.00008	0.00386	0.00590
5:28:55	p	1										
0.19869	0.20020	Fine	4.0199	40.83	5.87	23.35	34.96	-127	1972	0.00007	0.00405	0.00590
5:29:59	p	1										
0.19914	0.20004	Fine	4.0200	40.82	5.86	23.34	34.96	-129	1971	0.00007	0.00360	0.00590
5:31:03	p	1										
0.19860	0.19987	Fine	4.0199	40.82	5.86	23.34	34.96	-129	1974	0.00007	0.00326	0.00590
5:32:07	p	1										
0.19881	0.19973	Fine	4.0199	40.82	5.86	23.34	34.96	-126	1968	0.00007	0.00315	0.00590
5:33:11	p	1										
0.19861	0.19960	Fine	4.0199	40.81	5.85	23.33	34.95	-130	1979	0.00007	0.00288	0.00590
5:34:15	p	1										
0.19885	0.19948	Fine	4.0199	40.80	5.85	23.33	34.96	-127	1983	0.00007	0.00342	0.00590
5:35:18	p	1										
0.19897	0.19937	Fine	4.0199	40.81	5.85	23.33	34.95	-123	1987	0.00006	0.00301	0.00590
5:36:22	p	1										
0.20006	0.19926	Fine	4.0198	40.81	5.85	23.33	34.96	-119	1982	0.00010	0.00223	0.00590
5:37:26	p	1										
0.20080	0.19919	Fine	4.0198	40.81	5.86	23.33	34.95	-118	1974	0.00013	0.00135	0.00590
5:38:30	p	1										
0.20103	0.19916	Fine	4.0198	40.81	5.86	23.33	34.96	-107	1973	0.00013	0.00167	0.00590
5:39:34	p	1										
0.20016	0.19917	Fine	4.0198	40.81	5.86	23.34	34.95	-97	1969	0.00015	0.00242	0.00590
5:40:37	p	1										
0.20103	0.19921	Fine	4.0198	40.81	5.86	23.34	34.95	-92	1956	0.00015	0.00402	0.00590
5:41:41	p	1										
0.20080	0.19940	Fine	4.0198	40.82	5.87	23.35	34.96	-85	1944	0.00013	0.00430	0.00590
5:42:45	p	1										
0.20048	0.19953	Fine	4.0198	40.82	5.87	23.35	34.95	-76	1944	0.00011	0.00464	0.00590
5:43:49	p	1										
0.20112	0.19968	Fine	4.0198	40.82	5.87	23.35	34.95	-72	1932	0.00007	0.00448	0.00590
5:44:53	p	1										
0.20038	0.19986	Fine	4.0198	40.83	5.87	23.35	34.96	-71	1935	0.00007	0.00442	0.00590
5:45:56	p	1										
0.20014	0.20004	Fine	4.0198	40.83	5.87	23.35	34.96	-71	1939	0.00007	0.00421	0.00590
5:47:00	p	1										
0.20048	0.20020	Fine										

5:48:04	p	1	4.0197	40.83	5.87	23.35	34.96	-83	1947	0.00008	0.00419	0.00590
0.20165	0.20034	Fine										
5:49:08	p	1	4.0198	40.83	5.87	23.35	34.95	-86	1947	0.00008	0.00391	0.00590
0.20067	0.20047	Fine										
5:50:12	p	1	4.0198	40.83	5.87	23.35	34.96	-89	1945	0.00008	0.00292	0.00590
0.20037	0.20058	Fine										
5:51:16	p	1	4.0198	40.82	5.87	23.34	34.95	-79	1944	0.00008	0.00221	0.00590
0.19968	0.20064	Fine										
5:52:19	p	1	4.0197	40.82	5.87	23.34	34.95	-84	1946	0.00008	0.00147	0.00590
0.20079	0.20068	Fine										
5:53:23	p	1	4.0198	40.82	5.86	23.34	34.96	-89	1954	0.00008	0.00072	0.00590
0.20024	0.20070	Point										

APPENDIX C-2

SPECIMEN 4 WITHOUT FACERS

TEST REPORT

REPORT NUMBER: 100888391MID-001.7

ORIGINAL ISSUE DATE: July 22, 2013

REVISED DATE: NA

EVALUATION CENTER

Intertek

8431 Murphy Drive

Middleton, WI 53562

Rendered To:

Department of Energy

PRODUCTS EVALUATED: Specimen 4 (without metal)

EVALUATION PROPERTY: ASTM C518: *Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Apparatus in accordance with 10 CFR Subpart R Part 431.304(b)*

Report of Testing of Department of Energy for Specimen 4 (without metal) for compliance with the applicable requirements of the following criteria: ASTM C518, 2004, Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Apparatus in accordance with 10 CFR Subpart R Part 431.304(b) Uniform test method for the measurement of energy consumption of walk-in coolers and walk –in freezers.

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2 Introduction

Intertek has conducted testing for Department of Energy on Specimen 4 (without metal) to evaluate the thermal transmission properties. Testing was conducted in accordance with ASTM, following the standard methods of C518 (2004) Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus in accordance with 10 CFR Subpart R Part 431.304(b). This evaluation began July 22, 2013 and was completed July 22, 2013.

3 Test Samples

3.1. SAMPLE SELECTION

Samples were received directly from the client. Samples were received at the Intertek Middleton Evaluation Center April 17, 2013 in good condition.

One about 12 inch by 12 inch section was cut from the center of one sample are 46" x 96" metal clad foam filled panels with a total thickness of about 4 inches from Bally Refrigeration Boxes Inc. The metal clad was removed by prying it from the foam (see attached photo in appendix)

3.2. SAMPLE AND ASSEMBLY DESCRIPTION

The samples stored at 73 +/-4 °F and 50 +/- 5% relative humidity for minimum of 24 hours prior to starting the test.

4 Testing and Evaluation Methods

4.1. Thermal Conductivity

The heat flow meter apparatus establishes steady state unidirectional heat flux through a test specimen between two parallel plates at constant but different temperatures. By appropriate calibration of the heat flux transducer(s) with calibration standards and by measurement of the plate temperatures and plate separation, Fourier's law of heat conduction is used to calculate thermal conductivity, thermal resistance, or resistivity.

The accurate use of the test method is limited by the capability of the apparatus to reproduce unidirectional constant heat flux density in the specimens, and by the precision in the measurement of temperature, thickness, EMF produced by the heat flux transducer, etc.

The apparatus shall not be used at temperatures, thickness or resistances, other than those within the range of the calibration; unless it can be shown that there is no difference in accuracy.

The apparatus must be capable of maintaining at least a 10°C temperature difference across the specimen for the duration of the test, unless a smaller LT is a requirement of a particular test. The specimens tested may also limit the use of the test method and these limitations are outlined in Practice C1045.

This evaluation was accomplished using a HFM436/3/1 ER Heat Flow Meter Thermal Conductivity Instrument, manufactured by Netzsch. The HFM436/3/1 ER determines thermal conductivity in accordance with ASTM C 518.

Heat flow through a solid, results from having a temperature gradient in the material. Thermal conductivity is a material property, which determines how much heat flows through a given thickness of the material when there is a temperature difference. The Fourier linear heat flow equation defines thermal conductivity under steady state conditions as:

$$I = \frac{Q}{DT}$$

where:

$$I = \text{thermal conductivity, } \frac{W}{m \cdot K}$$

$$Q = \text{heat flux, } \frac{W}{m^2}$$

DT = temperature difference across distance LX, K

DX = distance between hot and cold plates, m

Prior to each series of tests, the HFM436/3/1 ER was calibrated using a sample whose thermal conductivity is known and traceable to national standards.

To perform the test, the specimens are placed in the HFM436/3/1 ER instrument, the top (hot) plate is brought downwards creating contact of both plates with the test specimen. The hot and cold plates were then allowed to equilibrate to the required temperatures and their exact temperatures were read from the instrument.

The mean temperature for testing is 20°F with a temperature difference between plates at 30°F.

Density Measurements were taken using standard ASTM D1622.

4.2. Testing and Calculation for 10 CFR Subpart R Part 431.304(b)

1. The R value shall be 1/K factor multiplied by the thickness of the panel
 2. The K factor shall be based on ASTM C518
 3. For Calculating the R value for freezers, the K factor for the foam at 20 degrees Fahrenheit (average foam temperature) shall be used.
 4. For Calculating the R value for coolers, the K factor for the foam at 55 degrees Fahrenheit (average foam temperature) shall be used
-

5 Results and Observations

Testing was performed at 20 degrees Fahrenheit only.

Density Measurements Results for ASTM D1622:

Specimen	Length (mm)	Width (mm)	Depth (mm)	Weight	Density	
	Avg.	Avg.	Avg.	(kg)	(kg/m ³)	(lbs/ft ³)
Specimen 4 Foam Only Bally 4 inch	303.57	303.94	101.74	0.3403	36.25	2.26

Results tables for ASTM C518 on Bally 4" foam only:

Test Information	Thermal Conductivity	Thermal Conductivity	Thermal Resistance	Thermal Resistance	Thermal Resistance per inch	Thermal Resistance per meter	Thermal Transmittance
	K Value	K Value	R Value	R Value	R/in	R/m	U
Units:	Btu-in/hr-ft ² -°F	W/m-K	Hr-ft ² -°F/Btu	m ² -K/W	Hr-ft ² -°F/Btu/in	m ² -K/W/m	W/m ² -K
Specimen 4 Foam Only	0.124016	0.01789	32.29811	5.6880	8.06	55.9	0.18

Test Information	Duration of the measurement	Instrument Measured Thickness	Instrument Measured Thickness	Mean Temperature	Mean Temperature	Temperature Gradient	
	min	(in)	(m)	°F	°C	°F/in	°C/m
Specimen 4 Foam Only	3:02:00	4.0059	0.101750	23.08	-4.96	7.62	-226.73

5.1.1. Statement of Measurement Uncertainty

The uncertainty of the Netzsch Thermal Conductivity Instrument HFM436/3/1 ER is estimated to be 1-3%.

6 Conclusion

Intertek has conducted testing for Department of Energy, on Specimen 4 (without metal) to evaluate the thermal transmission properties. Testing was conducted in accordance with ASTM, following the standard methods of C518 (2004) Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.

These results are listed as is and there are no pass fail criteria for this testing.

The conclusions of this test report may not be used as part of the requirements for Intertek product certification. Authority to Mark must be issued for a product to become certified.

INTERTEK



Reported by:

Bryan Bowman
Chemist



Reviewed by:

Mark Crawford
Chemist

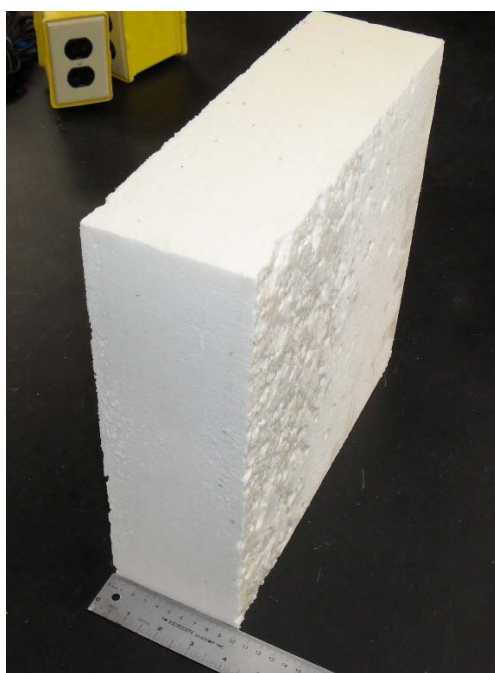
7 Calibration

Equipment:	Equipment Number	Calibration Due Date
Thermal Conductivity Instrument	1266	Calibrated before testing
Scale	1045	March 2014
Calipers	1077	Sept 2013

8 Appendix



Above: Cut samples



Above: Final sample for testing

9 Revision Summary

DATE	SUMMARY
July 22, 2013	Original Issue Date

Time Status	SP #	dX(cm)	TUpper	TLower	Bally TMean	4 in no TDelta	metal 1 QUpper	20 F data QLower	StdDev	pk/avg	N(t)	k(t)	K(avg)
9:17:05 a	1	4.0063	91.92	53.82	72.87	38.09	-3315	-2467	0.00003	0.00094	0.00619	0.23693	0.23734
Rough													
9:18:09 a	1	4.0065	90.25	54.67	72.46	35.58	-5132	-2095	0.00000	0.00000	0.00619	-1.2291	-1.2291
Rough													
9:19:13 a	1	4.0064	89.02	54.50	71.76	34.52	-3138	1228	0.06631	0.35959	0.00618	-0.5789	-0.9040
Rough													
9:20:17 a	1	4.0059	88.00	53.85	70.93	34.15	-3089	3347	0.07986	0.90482	0.00618	-0.1277	-0.6452
Rough													
9:21:21 a	1	4.0055	86.82	52.85	69.84	33.97	-3677	4723	0.08240	1.61174	0.00618	0.05335	-0.4706
Rough													
9:22:25 a	1	4.0058	85.51	51.76	68.63	33.75	-4310	5668	0.08107	2.49803	0.00617	0.12558	-0.3513
Rough													
9:23:29 a	1	4.0057	84.21	50.36	67.29	33.85	-4970	6469	0.07556	5.04091	0.00616	0.17326	-0.2034
Rough													
9:24:33 a	1	4.0054	82.68	48.82	65.75	33.86	-5503	7042	0.07260	6.88738	0.00615	0.17759	-0.1558
Rough													
9:25:37 a	1	4.0050	81.22	47.34	64.28	33.88	-6013	7537	0.06976	9.32827	0.00614	0.17562	-0.1190
Rough													
9:26:40 a	1	4.0047	79.55	45.65	62.60	33.89	-6438	7889	0.06708	12.6561	0.00613	0.17099	-0.0900
Rough													
9:27:44 a	1	4.0044	77.98	44.07	61.02	33.91	-6751	8193	0.03468	12.6871	0.00612	0.16629	0.04954
Rough													
9:28:48 a	1	4.0050	76.24	42.31	59.27	33.93	-7024	8408	0.01384	2.03458	0.00612	0.16021	0.12345
Rough													
9:29:52 a	1	4.0047	74.63	40.70	57.67	33.94	-7212	8543	0.00544	0.64784	0.00611	0.15259	0.15148
Rough													
9:30:56 a	1	4.0037	72.87	38.92	55.90	33.95	-7361	8648	0.00229	0.21963	0.00610	0.14776	0.16092
Rough													
9:31:59 a	1	4.0032	71.11	37.16	54.14	33.95	-7457	8697	0.00174	0.11937	0.00609	0.14327	0.16269
Rough													
9:33:03 a	1	4.0028	69.53	35.58	52.56	33.95	-7519	8703	0.00206	0.13782	0.00608	0.13847	0.16061
Rough													
9:34:07 a	1	4.0028	67.81	33.87	50.84	33.94	-7534	8668	0.00231	0.15365	0.00607	0.13248	0.15653
Rough													
9:35:11 a	1	4.0018	66.29	32.36	49.32	33.93	-7496	8585	0.00241	0.16737	0.00606	0.12604	0.15137
Rough													
9:36:15 a	1	4.0018	64.64	30.74	47.69	33.90	-7408	8456	0.00242	0.17152	0.00605	0.12149	0.14596
Rough													
9:37:18 a	1	4.0012	63.19	29.31	46.25	33.88	-7303	8316	0.00236	0.18216	0.00604	0.11804	0.14066
Rough													
9:38:22 a	1	4.0011	61.66	27.81	44.73	33.85	-7168	8151	0.00226	0.18347	0.00604	0.11339	0.13538
Rough													
9:39:26 a	1	4.0009	60.18	26.48	43.33	33.70	-7023	7981	0.00212	0.16961	0.00603	0.11112	0.13047
Rough													
9:40:30 a	1	4.0007	58.89	25.10	41.99	33.79	-6833	7785	0.00183	0.17385	0.00602	0.10773	0.12205
Rough													
9:41:34 a	1	3.9999	57.55	23.86	40.70	33.70	-6579	6839	0.00437	0.73384	0.00602	0.02946	0.11067
Rough													
9:42:38 a	1	3.9996	56.51	22.97	39.74	33.53	-5908	5969	0.00638	0.98827	0.00601	0.00114	0.09694
Rough													
9:43:42 a	1	3.9995	55.45	22.01	38.73	33.44	-5599	6382	0.00618	0.98752	0.00600	0.07441	0.09113
Rough													
9:44:45 a	1	3.9992	54.50	21.08	37.79	33.41	-5535	6634	0.00612	0.98746	0.00600	0.12156	0.09068
Rough													
9:45:49 a	1	3.9990	53.48	20.06	36.77	33.42	-5422	6603	0.00633	0.98766	0.00599	0.13635	0.09217
Rough													
9:46:53 a	1	3.9988	52.50	19.17	35.84	33.33	-5228	6371	0.00654	0.98789	0.00598	0.13497	0.09386
Rough													
9:47:57 a	1	3.9981	51.68	18.28	34.98	33.40	-4952	6062	0.00667	0.98808	0.00598	0.12849	0.09537
Rough													
9:49:01 a	1	3.9978	50.85	17.46	34.16	33.39	-4683	5742	0.00676	0.98823	0.00597	0.12314	0.09658
Rough													
9:50:05 a	1	3.9974	50.20	16.97	33.58	33.22	-4267	4702	0.00684	0.98838	0.00597	0.12090	0.09781
Rough													
9:51:08 a	1	3.9974	49.53	16.17	32.85	33.36	-4062	5317	0.00707	0.98873	0.00597	0.13813	0.10085
Rough													
9:52:12 a	1	3.9969	48.97	15.59	32.28	33.38	-3827	4883	0.00613	0.98971	0.00596	0.12629	0.11054
Rough													
9:53:16 a	1	3.9971	48.41	15.05	31.73	33.36	-3613	4455	0.00272	0.38537	0.00596	0.10641	0.12106
Rough													
9:54:20 a	1	3.9967	47.94	14.60	31.27	33.34	-3372	4346	0.00151	0.14672	0.00595	0.11085	0.12471
Rough													
9:55:24 a	1	3.9960	47.49	14.17	30.83	33.32	-3126	4158	0.00186	0.17654	0.00595	0.10100	0.12265
Rough													
9:56:28 a	1	3.9959	47.07	13.79	30.43	33.29	-2950	3963	0.00174	0.16318	0.00595	0.11678	0.12070
Rough													
9:57:32 a	1	3.9964	46.74	13.47	30.10	33.27	-2755	3773	0.00152	0.17663	0.00594	0.11546	0.11739
Rough													
9:58:36 a	1	3.9956	46.40	13.15	29.78	33.26	-2580	3596	0.00149	0.18439	0.00594	0.11545	0.11662
Rough													
9:59:40 a	1	3.9947	46.14	13.09	29.62	33.04	-2424	3455	0.00148	0.18758	0.00594	0.11777	0.11631
Rough													
10:00:44 a	1	3.9948	45.87	12.74	29.31	33.13	-2266	3323	0.00100	0.11698	0.00594	0.11881	0.11438
Rough													
10:01:47 a	1	3.9945	45.63	12.51	29.07	33.12	-2147	3196	0.00087	0.11244	0.00594	0.12044	0.11380
Rough													
10:02:51 a	1	3.9945	45.42	12.28	28.85	33.14	-2016	3071	0.00084	0.12392	0.00594	0.12132	0.11529
Rough													
10:03:55 a	1	3.9939	45.23	12.09	28.66	33.14	-1900	2989	0.00083	0.13035	0.00593	0.11937	0.11614

Bally 4 in no metal 1 20 F data														
Rough														
10:05:00 a	1	3.9939	45.06	11.92	28.49	33.14	-1794	2861	0.00039	0.03723	0.00593	0.12271	0.11831	
Rough														
10:06:03 a	1	3.9941	44.89	11.77	28.33	33.13	-1681	2747	0.00040	0.03352	0.00593	0.12102	0.11873	
Rough														
10:07:07 a	1	3.9941	44.75	11.64	28.19	33.11	-1588	2654	0.00035	0.03201	0.00593	0.12036	0.11927	
Rough														
10:08:11 a	1	3.9940	44.63	11.50	28.07	33.13	-1493	2566	0.00031	0.03715	0.00593	0.12182	0.11991	
Rough														
10:09:15 a	1	3.9945	44.51	11.38	27.94	33.12	-1416	2491	0.00022	0.02292	0.00593	0.12171	0.12053	
Rough														
10:10:19 a	1	3.9949	44.41	11.29	27.85	33.12	-1338	2416	0.00018	0.01794	0.00593	0.12228	0.12098	
Rough														
10:11:23 a	1	3.9940	44.30	11.19	27.75	33.11	-1267	2346	0.00015	0.01601	0.00593	0.12206	0.12131	
Rough														
10:12:28 a	1	3.9942	44.22	11.11	27.66	33.11	-1200	2283	0.00015	0.01767	0.00593	0.12249	0.12151	
Rough														
10:13:32 a	1	3.9940	44.14	11.03	27.59	33.11	-1132	2221	0.00015	0.01473	0.00593	0.12374	0.12216	
Rough														
10:14:36 a	1	3.9942	44.07	10.96	27.51	33.11	-1073	2159	0.00016	0.01527	0.00593	0.12339	0.12223	
Rough														
10:15:40 a	1	3.9938	44.01	10.90	27.46	33.11	-1012	2098	0.00015	0.01709	0.00593	0.12328	0.12245	
Rough														
10:16:43 a	1	3.9936	43.95	10.85	27.40	33.10	-956	2045	0.00012	0.00883	0.00593	0.12374	0.12279	
Fine														
10:17:47 a	1	3.9932	43.73	11.08	27.41	32.65	-1876	1166	0.00014	0.00000	0.00592	0.12487	0.12310	
Rough														
10:18:51 a	1	3.9932	42.89	11.50	27.19	31.39	-3103	511	0.02466	7.03356	0.00592	-0.4174	0.06918	
Rough														
10:19:55 a	1	3.9936	42.54	11.52	27.03	31.02	-2078	1427	0.02638	10.9602	0.00592	-0.1504	0.04191	
Rough														
10:20:59 a	1	3.9935	42.31	11.43	26.87	30.88	-1710	1908	0.02615	15.6096	0.00592	-0.0113	0.02857	
Rough														
10:22:03 a	1	3.9938	42.09	11.27	26.68	30.81	-1629	2169	0.02574	20.8135	0.00592	0.04745	0.02107	
Rough														
10:23:07 a	1	3.9934	41.88	11.09	26.49	30.78	-1640	2314	0.02539	26.9119	0.00592	0.07383	0.01611	
Rough														
10:24:12 a	1	3.9936	41.64	10.87	26.25	30.77	-1663	2424	0.02508	34.4586	0.00592	0.08741	0.01248	
Rough														
10:25:16 a	1	3.9934	41.38	10.63	26.00	30.75	-1683	2496	0.02483	44.2091	0.00592	0.09524	0.00966	
Rough														
10:26:20 a	1	3.9934	41.14	10.38	25.76	30.75	-1690	2539	0.02461	57.2722	0.00592	0.10085	0.00742	
Rough														
10:27:24 a	1	3.9931	40.88	10.12	25.50	30.75	-1688	2554	0.02442	76.3130	0.00591	0.10499	0.00554	
Rough														
10:28:28 a	1	3.9932	40.64	9.90	25.27	30.74	-1659	2521	0.02421	116.500	0.00591	0.10559	0.00361	
Rough														
10:29:32 a	1	3.9932	40.39	9.66	25.03	30.72	-1589	2453	0.00542	1.13890	0.00591	0.10549	0.08144	
Rough														
10:30:35 a	1	3.9930	40.16	9.47	24.82	30.69	-1505	2373	0.00277	0.49073	0.00591	0.10602	0.09317	
Rough														
10:31:39 a	1	3.9926	39.97	9.28	24.63	30.69	-1401	2278	0.00156	0.25504	0.00591	0.10678	0.09911	
Rough														
10:32:43 a	1	3.9921	39.79	9.12	24.45	30.67	-1297	2190	0.00093	0.14735	0.00591	0.10790	0.10251	
Rough														
10:33:48 a	1	3.9926	39.64	8.98	24.31	30.67	-1213	2108	0.00059	0.09110	0.00590	0.11014	0.10479	
Rough														
10:34:51 a	1	3.9924	39.50	8.85	24.17	30.65	-1132	2041	0.00043	0.05236	0.00590	0.11164	0.10643	
Rough														
10:35:55 a	1	3.9921	39.35	8.73	24.04	30.62	-1069	1982	0.00041	0.04672	0.00590	0.11263	0.10760	
Rough														
10:37:00 a	1	3.9916	39.25	8.61	23.93	30.63	-993	1923	0.00046	0.04493	0.00590	0.11331	0.10844	
Rough														
10:38:04 a	1	3.9915	39.14	8.51	23.82	30.62	-920	1856	0.00049	0.03998	0.00590	0.11344	0.10922	
Rough														
10:39:07 a	1	3.9917	39.05	8.43	23.74	30.62	-863	1811	0.00049	0.04247	0.00590	0.11438	0.11017	
Rough														
10:40:11 a	1	3.9918	38.95	8.35	23.65	30.60	-812	1756	0.00047	0.04583	0.00590	0.11490	0.11111	
Rough														
10:41:15 a	1	3.9916	38.88	8.28	23.58	30.60	-758	1717	0.00043	0.04726	0.00590	0.11564	0.11208	
Rough														
10:42:19 a	1	3.9913	38.80	8.20	23.50	30.60	-712	1675	0.00040	0.04650	0.00590	0.11761	0.11316	
Rough														
10:43:23 a	1	3.9915	38.73	8.15	23.44	30.58	-674	1633	0.00036	0.03526	0.00590	0.11799	0.11417	
Rough														
10:44:27 a	1	3.9911	38.68	8.09	23.39	30.58	-630	1596	0.00032	0.02831	0.00590	0.11739	0.11489	
Rough														
10:45:30 a	1	3.9914	38.62	8.04	23.33	30.58	-588	1562	0.00030	0.02511	0.00590	0.11802	0.11553	
Rough														
10:46:34 a	1	3.9915	38.57	7.99	23.28	30.58	-552	1531	0.00031	0.02899	0.00590	0.11986	0.11682	
Rough														
10:47:38 a	1	3.9911	38.52	7.95	23.24	30.58	-512	1494	0.00028	0.02604	0.00590	0.11963	0.11744	
Rough														
10:48:42 a	1	3.9908	38.48	7.91	23.20	30.57	-475	1460	0.00025	0.02647	0.00590	0.12024	0.11803	
Rough														
10:49:46 a	1	3.9910	38.45	7.88	23.16	30.57	-436	1413	0.00021	0.02452	0.00590	0.12012	0.11855	
Rough														
10:50:49 a	1	3.9914	38.42	7.86	23.14	30.57	-405	1374	0.00016	0.01284	0.00590	0.11929	0.11891	
Rough														
10:51:53 a	1	3.9910	38.40	7.83	23.11	30.57	-370	1356	0.00016	0.01545	0.00590	0.12076	0.11923	
Rough														

10:52:57 a	1	3.9911	38.37	7.81	23.09	30.56	-350	1336	0.00018	0.01834	0.00590	0.12150	0.11958
Rough													
10:54:01 a	1	3.9913	38.35	7.79	23.07	30.57	-321	1316	0.00016	0.01636	0.00590	0.12140	0.11998
Rough													
10:55:05 a	1	3.9915	38.33	7.77	23.05	30.56	-300	1302	0.00014	0.01322	0.00590	0.12197	0.12038
Rough													
10:56:08 a	1	3.9913	38.31	7.75	23.03	30.56	-276	1280	0.00018	0.02187	0.00590	0.12347	0.12082
Rough													
10:57:12 a	1	3.9913	38.29	7.74	23.02	30.55	-256	1257	0.00018	0.02016	0.00590	0.12188	0.12103
Rough													
10:58:16 a	1	3.9914	38.28	7.72	23.00	30.56	-235	1237	0.00019	0.01726	0.00590	0.12322	0.12139
Rough													
10:59:20 a	1	3.9913	38.26	7.71	22.99	30.56	-216	1218	0.00020	0.01946	0.00590	0.12296	0.12166
Rough													
11:00:24 a	1	3.9913	38.25	7.70	22.98	30.56	-200	1188	0.00019	0.02166	0.00590	0.12286	0.12193
Rough													
11:01:28 a	1	3.9913	38.24	7.69	22.97	30.55	-177	1154	0.00014	0.01123	0.00590	0.12092	0.12209
Rough													
11:02:31 a	1	3.9912	38.23	7.68	22.96	30.54	-156	1151	0.00016	0.01615	0.00590	0.12005	0.12202
Rough													
11:03:35 a	1	3.9911	38.22	7.67	22.95	30.55	-130	1141	0.00017	0.01846	0.00590	0.12386	0.12231
Rough													
11:04:39 a	1	3.9913	38.22	7.67	22.94	30.55	-114	1125	0.00019	0.01998	0.00590	0.12386	0.12250
Rough													
11:05:43 a	1	3.9902	38.21	7.66	22.93	30.55	-95	1109	0.00018	0.01991	0.00590	0.12337	0.12249
Rough													
11:06:47 a	1	3.9909	38.20	7.65	22.92	30.55	-83	1095	0.00019	0.02136	0.00590	0.12370	0.12267
Rough													
11:07:50 a	1	3.9910	38.19	7.64	22.92	30.55	-69	1075	0.00019	0.02156	0.00589	0.12348	0.12270
Rough													
11:08:54 a	1	3.9909	38.19	7.64	22.92	30.55	-52	1062	0.00020	0.02264	0.00589	0.12432	0.12283
Rough													
11:09:58 a	1	3.9908	38.19	7.64	22.92	30.55	-42	1056	0.00022	0.02411	0.00589	0.12471	0.12302
Rough													
11:11:02 a	1	3.9910	38.18	7.63	22.91	30.55	-31	1048	0.00020	0.02673	0.00589	0.12423	0.12335
Rough													
11:12:06 a	1	3.9910	38.18	7.63	22.90	30.55	-22	1040	0.00011	0.01397	0.00589	0.12300	0.12364
Rough													
11:13:10 a	1	3.9908	38.18	7.63	22.91	30.55	-11	1028	0.00007	0.00705	0.00589	0.12384	0.12384
Fine													
11:14:13 a	1	3.9909	38.18	7.63	22.90	30.55	2	1009	0.00007	0.00000	0.00589	0.12371	0.12382
Fine													
11:15:17 a	1	3.9912	38.18	7.62	22.90	30.55	14	991	0.00007	0.00001	0.00589	0.12383	0.12382
Fine													
11:16:21 a	1	3.9912	38.18	7.63	22.91	30.55	21	982	0.00007	0.00024	0.00589	0.12383	0.12384
Fine													
11:17:25 a	1	3.9911	38.17	7.62	22.90	30.55	35	975	0.00007	0.00022	0.00589	0.12349	0.12384
Fine													
11:18:29 a	1	3.9911	38.18	7.62	22.90	30.55	43	970	0.00007	0.00019	0.00589	0.12359	0.12384
Fine													
11:19:32 a	1	3.9912	38.17	7.63	22.90	30.55	47	961	0.00007	0.00055	0.00589	0.12335	0.12383
Fine													
11:20:36 a	1	3.9912	38.18	7.62	22.90	30.55	64	947	0.00004	0.00143	0.00589	0.12384	0.12377
Fine													
11:21:40 a	1	3.9913	38.18	7.63	22.91	30.55	78	934	0.00003	0.00136	0.00589	0.12397	0.12377
Fine													
11:22:44 a	1	3.9911	38.18	7.63	22.90	30.55	85	922	0.00003	0.00132	0.00589	0.12398	0.12376
Fine													
11:23:48 a	1	3.9912	38.19	7.64	22.91	30.55	96	916	0.00003	0.00124	0.00589	0.12397	0.12375
Fine													
11:24:52 a	1	3.9911	38.19	7.64	22.91	30.55	99	909	0.00005	0.00123	0.00589	0.12445	0.12375
Fine													
11:25:55 a	1	3.9911	38.19	7.64	22.91	30.55	105	907	0.00005	0.00118	0.00589	0.12396	0.12374
Fine													
11:26:59 a	1	3.9912	38.19	7.63	22.91	30.56	113	900	0.00005	0.00122	0.00589	0.12434	0.12375
Fine													
11:28:03 a	1	3.9913	38.19	7.64	22.91	30.55	120	888	0.00007	0.00121	0.00589	0.12287	0.12374
Fine													
11:29:07 a	1	3.9912	38.18	7.63	22.91	30.55	130	873	0.00010	0.00124	0.00589	0.12224	0.12374
Rough													
11:30:11 a	1	3.9912	38.19	7.64	22.91	30.55	142	855	0.00012	0.01095	0.00589	0.12228	0.12359
Rough													
11:31:14 a	1	3.9912	38.19	7.64	22.91	30.55	149	845	0.00014	0.01122	0.00589	0.12202	0.12341
Rough													
11:32:18 a	1	3.9912	38.19	7.64	22.92	30.54	163	844	0.00014	0.00986	0.00589	0.12228	0.12324
Fine													
11:33:22 a	1	3.9912	38.19	7.65	22.92	30.54	179	826	0.00014	0.00000	0.00589	0.12350	0.12319
Rough													
11:34:26 a	1	3.9911	38.20	7.66	22.93	30.54	191	823	0.00013	0.01121	0.00590	0.12279	0.12307
Rough													
11:35:30 a	1	3.9912	38.22	7.67	22.94	30.54	197	818	0.00012	0.01095	0.00590	0.12364	0.12299
Rough													
11:36:33 a	1	3.9911	38.23	7.68	22.95	30.55	206	815	0.00012	0.01080	0.00590	0.12413	0.12301
Rough													
11:37:37 a	1	3.9912	38.24	7.69	22.96	30.54	207	804	0.00015	0.01549	0.00590	0.12388	0.12319
Rough													
11:38:41 a	1	3.9911	38.24	7.70	22.97	30.54	208	807	0.00015	0.01364	0.00590	0.12448	0.12341
Rough													
11:39:45 a	1	3.9912	38.25	7.71	22.98	30.54	204	799	0.00014	0.01302	0.00590	0.12304	0.12349
Rough													
11:40:49 a	1	3.9913	38.25	7.71	22.98	30.54	198	804	0.00012	0.01218	0.00590	0.12305	0.12359

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Rough														
11:41:53 a	1	3.9913	38.24	7.71	22.97	30.54	197	810	0.00010	0.01096	0.00590	0.12377	0.12374	
Rough														
11:42:56 a	1	3.9912	38.25	7.70	22.97	30.55	202	813	0.00010	0.01114	0.00590	0.12328	0.12372	
Rough														
11:44:00 a	1	3.9912	38.24	7.70	22.97	30.54	203	812	0.00010	0.01073	0.00590	0.12329	0.12377	
Rough														
11:45:04 a	1	3.9912	38.24	7.70	22.97	30.54	206	809	0.00010	0.01043	0.00590	0.12402	0.12380	
Rough														
11:46:08 a	1	3.9912	38.24	7.70	22.97	30.54	213	800	0.00010	0.01053	0.00590	0.12401	0.12379	
Rough														
11:47:12 a	1	3.9912	38.25	7.71	22.98	30.54	220	792	0.00007	0.00653	0.00590	0.12390	0.12367	
Fine														
11:48:15 a	1	3.9913	38.25	7.71	22.98	30.54	224	787	0.00008	0.00000	0.00590	0.12461	0.12374	
Fine														
11:49:19 a	1	3.9912	38.25	7.70	22.98	30.54	234	781	0.00007	0.00029	0.00590	0.12376	0.12371	
Fine														
11:50:23 a	1	3.9911	38.26	7.72	22.99	30.54	239	775	0.00007	0.00039	0.00590	0.12377	0.12372	
Fine														
11:51:27 a	1	3.9911	38.26	7.72	22.99	30.54	242	774	0.00007	0.00118	0.00590	0.12475	0.12377	
Fine														
11:52:31 a	1	3.9912	38.27	7.73	23.00	30.54	249	765	0.00007	0.00118	0.00590	0.12413	0.12381	
Fine														
11:53:35 a	1	3.9912	38.27	7.73	23.00	30.54	257	760	0.00006	0.00164	0.00590	0.12425	0.12385	
Fine														
11:54:38 a	1	3.9911	38.28	7.73	23.01	30.54	258	748	0.00007	0.00217	0.00590	0.12340	0.12393	
Fine														
11:55:42 a	1	3.9911	38.29	7.75	23.02	30.55	266	749	0.00007	0.00222	0.00590	0.12391	0.12395	
Fine														
11:56:46 a	1	3.9911	38.29	7.75	23.02	30.54	261	751	0.00007	0.00240	0.00590	0.12438	0.12397	
Fine														
11:57:50 a	1	3.9911	38.30	7.75	23.02	30.54	259	753	0.00008	0.00279	0.00590	0.12533	0.12402	
Fine														
11:58:54 a	1	3.9911	38.30	7.76	23.03	30.55	262	750	0.00008	0.00273	0.00590	0.12460	0.12408	
Fine														
11:59:57 a	1	3.9911	38.31	7.76	23.04	30.55	272	747	0.00008	0.00186	0.00590	0.12414	0.12415	
Fine														
12:01:01 p	1	3.9911	38.32	7.77	23.04	30.55	279	742	0.00008	0.00183	0.00590	0.12364	0.12418	
Fine														
12:02:05 p	1	3.9911	38.32	7.78	23.05	30.54	274	735	0.00009	0.00128	0.00590	0.12351	0.12420	
Fine														
12:03:09 p	1	3.9911	38.33	7.78	23.06	30.55	275	736	0.00009	0.00118	0.00590	0.12401	0.12421	
Fine														
12:04:13 p	1	3.9911	38.33	7.79	23.06	30.55	272	730	0.00008	0.00129	0.00590	0.12376	0.12420	
Rough														
12:05:17 p	1	3.9911	38.33	7.78	23.06	30.55	276	733	0.00008	0.00999	0.00590	0.12363	0.12409	
Fine														
12:06:20 p	1	3.9911	38.33	7.79	23.06	30.55	276	732	0.00008	0.00000	0.00590	0.12449	0.12415	
Fine														
12:07:24 p	1	3.9911	38.34	7.79	23.07	30.54	278	729	0.00009	0.00035	0.00590	0.12352	0.12410	
Rough														
12:08:28 p	1	3.9910	38.33	7.79	23.06	30.54	280	729	0.00006	0.00583	0.00590	0.12352	0.12388	
Fine														
12:09:32 p	1	3.9910	38.34	7.80	23.07	30.55	282	731	0.00005	0.00000	0.00590	0.12389	0.12381	
Fine														
12:10:36 p	1	3.9910	38.34	7.80	23.07	30.54	282	727	0.00005	0.00006	0.00590	0.12353	0.12381	
Fine														
12:11:39 p	1	3.9910	38.34	7.80	23.07	30.55	286	725	0.00006	0.00024	0.00590	0.12315	0.12380	
Fine														
12:12:43 p	1	3.9910	38.35	7.80	23.07	30.55	290	721	0.00006	0.00041	0.00590	0.12366	0.12379	
Fine														
12:13:47 p	1	3.9910	38.35	7.80	23.07	30.54	292	719	0.00006	0.00042	0.00590	0.12435	0.12379	
Fine														
12:14:51 p	1	3.9910	38.35	7.80	23.08	30.55	290	717	0.00006	0.00049	0.00590	0.12413	0.12380	
Fine														
12:15:55 p	1	3.9911	38.34	7.80	23.07	30.55	295	713	0.00006	0.00046	0.00590	0.12376	0.12380	
Fine														
12:16:58 p	1	3.9911	38.35	7.80	23.08	30.55	305	711	0.00005	0.00049	0.00590	0.12401	0.12380	
Fine														
12:18:02 p	1	3.9911	38.35	7.80	23.08	30.54	306	705	0.00005	0.00054	0.00590	0.12390	0.12381	
Point														