Cokebusters

DEMO INSPECTION REPORT

F-101

01/10/18

Merlin

SMART PIGGING
INSPECTION TECHNOLOGY

TABLE OF CONTENTS

1 EXECUTIVE SUMMARY 3
2 SUMMARY OF OPERATIONS 6
3 PROCESS OVERVIEW 6
4 Pass 4 ANALYSIS 7
4.1 Pass 4, Convection: Wall Thickness Data Table 7
4.2 Pass 4 Convection: Internal Diameter Data Table 8
4.3 Pass 4 Convection: External Diameter Data Table 9
4.4 Pass 4 Convection: Summary Graphs 10
4.5 Pass 4 Convection 3D Imagery (Wall Thickness, Front View) 11
4.6 Pass 4 Convection 3D Imagery (Wall Thickness, Rear View) 12
4.7 Pass 4 Convection 3D Imagery (Internal Radius, Front View) 13
4.8 Pass 4 Convection 3D Imagery (Internal Radius, Rear View) 14
4.9 Pass 4 Crossover: Wall Thickness Data Table 15
4.10 Pass 4 Crossover: Internal Diameter Data Table 15
4.11 Pass 4 Crossover: External Diameter Data Table 15
4.12 Pass 4 Crossover: Summary Graphs 16
4.13 Pass 4 Radiant: Wall Thickness Data Table 17
4.14 Pass 4 Radiant: Internal Diameter Data Table 18
4.15 Pass 4 Radiant: External Diameter Data Table 19
4.16 Pass 4 Radiant: Summary Graphs 20
4.17 Pass 4 Radiant 3D Imagery (Wall Thickness, Front View) 21
4.18 Pass 4 Radiant 3D Imagery (Wall Thickness, Rear View) 22
4.19 Pass 4 Radiant 3D Imagery (Internal Radius, Front View) 23
4.20 Pass 4 Radiant 3D Imagery (Internal Radius, Rear View) 24
4.21 Pass 4 Radiant 3D Imagery (Wall Thickness, Las Point Classification) 25
5 APPENDIX A: MERLIN MARK IV SPECIFICATION 26
6 APPENDIX B: INTERPRETING THE DATA 27
7 APPENDIX C: CALIBRATION 30
8 APPENDIX D: DATA MAPPING 31
9 APPENDIX E: GENERAL CONTRACTUAL CONDITIONS 32
10 APPENDIX F: INDIVIDUAL SECTION GRAPHS 35

1 EXECUTIVE SUMMARY

Non-destructive in-line testing in the form of ultrasonic smartpigging was carried out on Pass 4 of the coker heater F-101. The inspection was carried out strictly as a demonstration of technology. Wall thickness and internal radius data was obtained from both the convection and radiant coils within the pass. The extensive amount of data recovered was judged to be accurate and consistent, from which a detailed evaluation of the mechanical and physical properties of the heater tubes could be made. The quantity of data obtained was in the region of 4800 wall thickness measurements per axial foot of tubing. It should be noted that as a demonstration inspection, no analysis of bend data was carried out. Typically, data coverage greater than 70% would be expected in these short radius return bends.

Convection Tubing

In general, the data obtained from the convection coil indicated minimal deviation from the nominal tube geometry. The minimum measured wall thickness was seen to be 0.394" in Tube 9, representing a wall loss of 0.043" from the nominal wall thickness. Some patterns of minor wall loss were evident in close proximity to some of the girth welds towards the middle of each tube. It's theorized that this has been caused by a chromium depletion around the heat-affected zone of the weld, making the area more susceptible to intergranular attack when exposed to elevated temperatures. Figure 1 shows an example of internal metal loss (taken from Pass 4, Convection Tube 4). There was no evidence of internal fouling remaining within the coil.

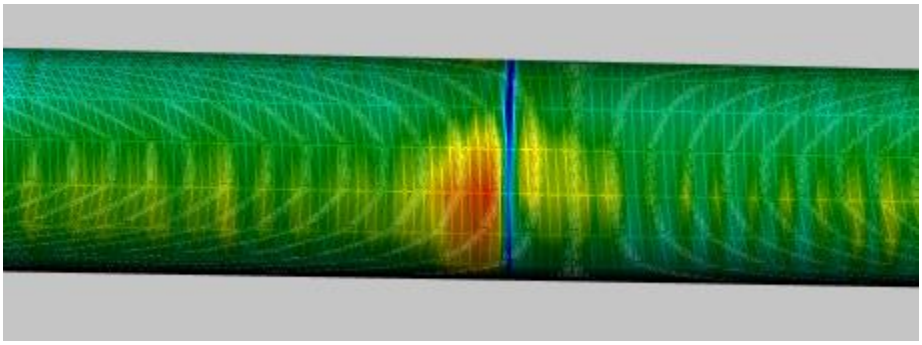


Figure 1: Internal wall loss in close proximity to girth weld (Convection Tube 4)

Radiant Tubing

During this particular inspection run, it was evident that the radiant coil contained some minor areas of internal fouling, predominantly in isolated patches towards the lower section of the coil. Figure 2 shows a "coke scan" of the coil, where the fouling patches can be clearly identified. It should be noted that tubes 23 and 24 have historically been replaced, resulting in the lower internal diameter and subsequent darker shaded areas within Figure 2.

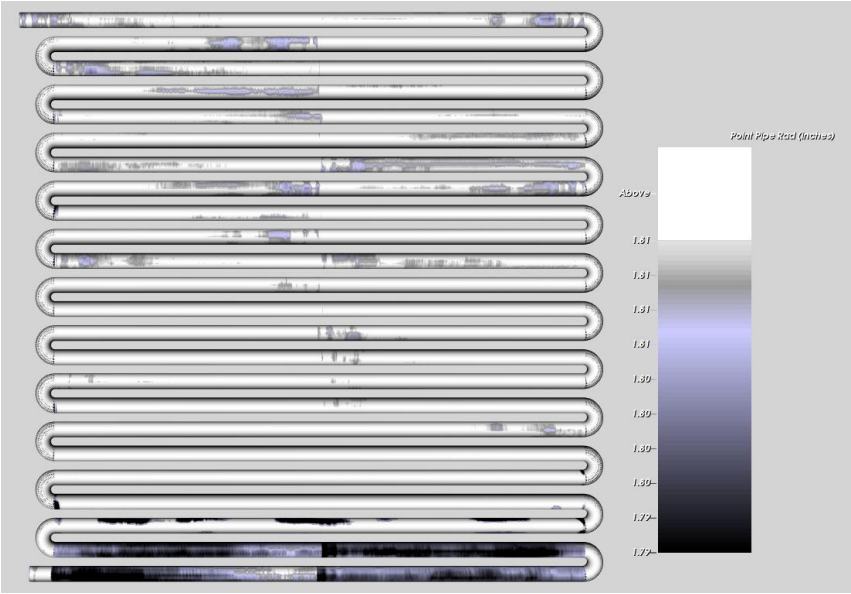


Figure 2: Pass 4 Radiant Coke Scan.

The most significant levels of internal fouling were identified in Tube 22, primarily towards the 12 o clock position. Areas of internal wall loss were also identified within this tube, in opposite circumferential patches to the fouling. It's suggested that this wall loss has been caused either by scraper pig abrasion, or intergranular attack where historic coke was adhered to the tube wall. The most severe area of wall loss is detailed within Figure 3.

Various wall thickness measurements which were thicker than the nominal values were observed at various locations throughout both the convection and radiant coils, most notably on the girth welds. At these points, an apparent "growth" within the outside diameter is measured due to the increased wall thickness.

In general, the mechanical integrity of the pass was in satisfactory condition with the minor wall loss observed being consistent with a process of this type and age. It's recommended that Radiant Tube 22 is closely monitored for future wall loss and degradation.

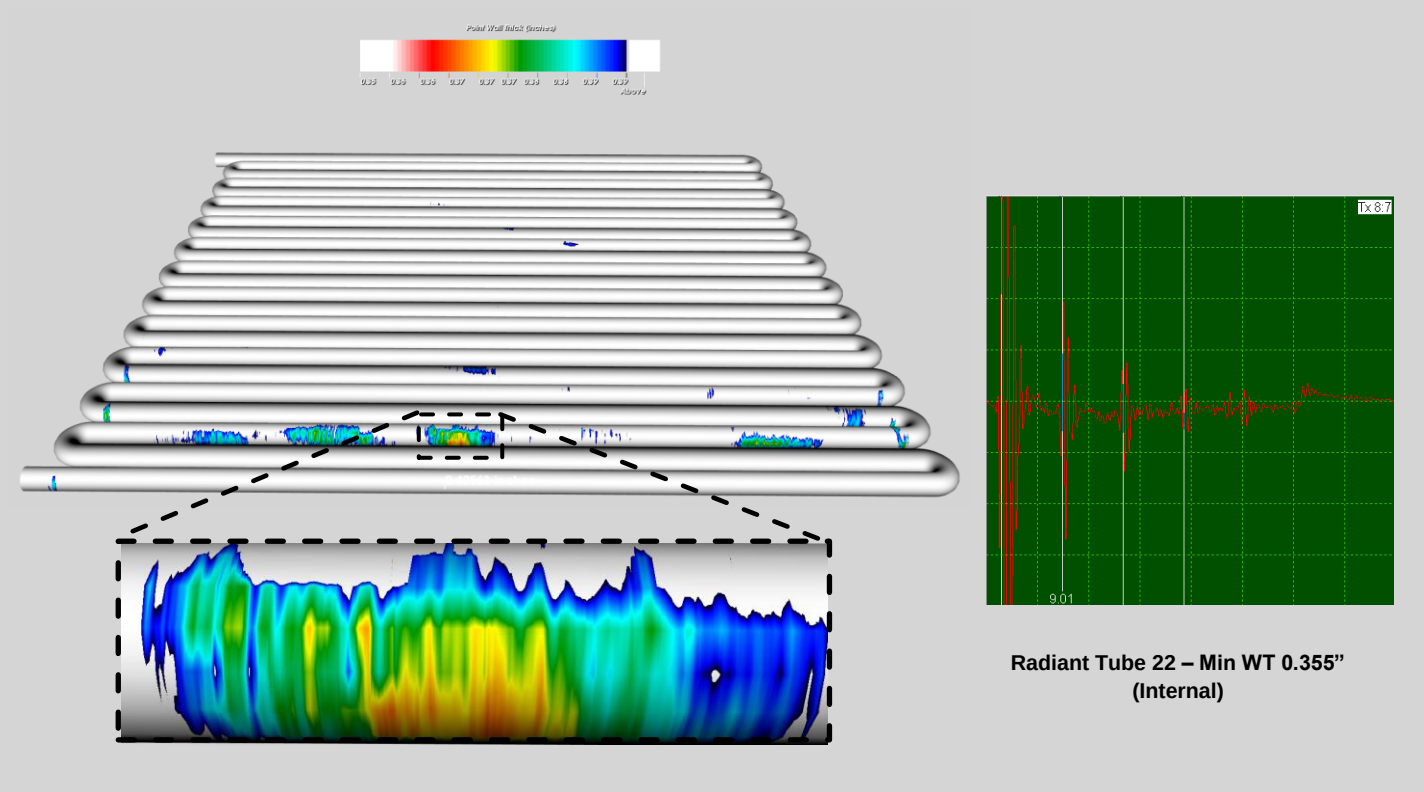


Figure 3: Pass 4 Radiant Tube 22 Defect Classification.

Measurement details including locations are provided within the data tables and graphs throughout this report. Raw Rf A-scans for every measurement obtained were recorded for verification purposes. For a full commercial inspection, interactive 3D display software would usually be provided. If further data or information is required, this can be provided at the request of the client.

Dr David Thewsey PhD, CEng, BEng (Hons), MWeldI
Chief Technology Officer
Cokebusters USA
01/10/18

2 SUMMARY OF OPERATIONS	
Client:	Client X Petroleum
Address:	Client X Refinery USA
Inspection Start:	09/26/18
Inspection Completion:	09/26/18
Inspectors:	Trent Teague (ASNT UT II)
Report Author:	Dr David Thewsey
Report ID:	Demo Report
Approval:	*Dr David Thewsey* *CTO – Cokebusters USA* 01/10/18
3 PROCESS OVERVIEW	
Furnace ID:	70H1
Process:	Coker
Passes Inspected:	Pass 4
Nominal OD:	4.5”
Nominal Wall Thickness:	0.437” - Convection 0.384” – Radiant
Minimum Allowable Wall Thickness:	Not Provided
Growth Allowance:	Not Provided

4 PASS 4 ANALYSIS

4.1 Pass 4, Convection: Wall Thickness Data Table

4.1.1 Nominal Wall Thickness: 0.437inches

Tube Identity Number	Average Wall Thickness (inches)	Minimum Wall Thickness (inches)	Minimum WT Location (x'x")	Maximum Wall Loss (inches)	Comments
1	0.443	0.420	31'8"	0.017	
2	0.439	0.411	49'11"	0.026	
3	0.435	0.414	20'7"	0.023	
4	0.433	0.397	Multiple	0.040	
5	0.436	0.410	11'1"	0.027	
6	0.437	0.414	1'5"	0.023	
7	0.434	0.410	26'6"	0.027	
8	0.434	0.413	4'8"	0.024	
9	0.433	0.394	26'4"	0.043	MINIMUM MEASURED WALL THICKNESS
10	0.432	0.398	48'4"	0.039	
11	0.434	0.407	9'7"	0.030	
12	0.435	0.400	48'4"	0.037	
13	0.429	0.405	21'2"	0.032	
14	0.427	0.409	34'6"	0.028	
15	0.431	0.409	40'1"	0.028	
16	0.431	0.409	52'3"	0.028	
17	0.433	0.415	Multiple	0.022	
18	0.432	0.397	61'4"	0.040	

4.2 Pass 4 Convection: Internal Diameter Data Table

4.2.1 Nominal ID: 3.63inches

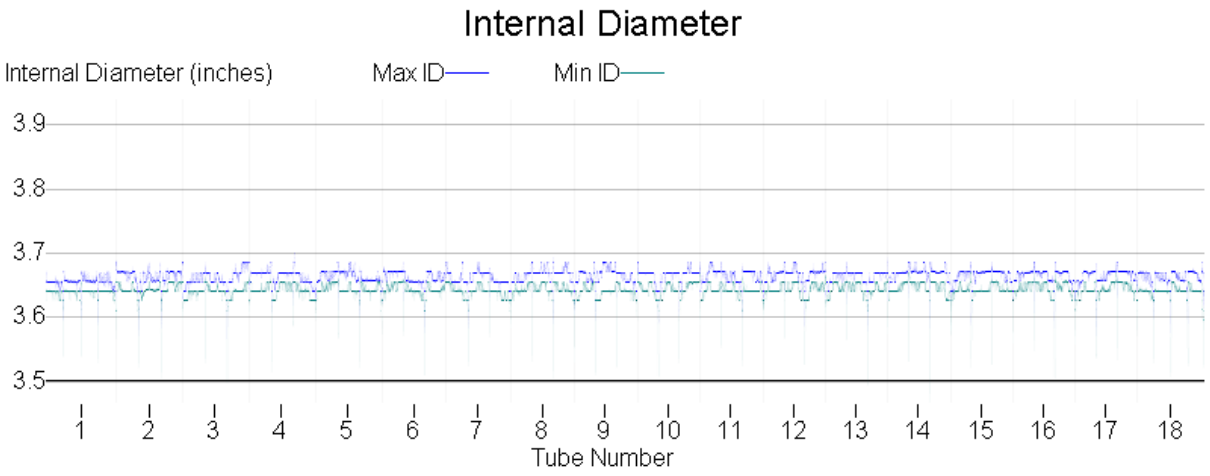
Tube Identity Number	Average ID (inches)	Minimum ID (inches)	Minimum ID Location (x'x")	Maximum ID (inches)	Maximum ID Location (x'x")	Comments
1	3.65	3.53	47'5"	3.67	16'4"	
2	3.65	3.50	40'1"	3.69	0'1"	
3	3.65	3.50	40'2"	3.68	55'3"	
4	3.65	3.51	20'2"	3.70	40'5"	MAXIMUM MEASURED ID
5	3.65	3.52	40'3"	3.69	31'2"	
6	3.65	3.51	40'2"	3.69	19'11"	
7	3.65	3.52	20'2"	3.69	0'1"	
8	3.65	3.51	40'1"	3.69	40'5"	
9	3.65	3.51	19'11"	3.68	29'12"	
10	3.65	3.51	20'2"	3.69	0'4"	
11	3.65	3.53	40'1"	3.69	19'7"	
12	3.65	3.53	40'1"	3.69	57'8"	
13	3.65	3.49	40'1"	3.69	59'10"	
14	3.66	3.46	40'0"	3.68	Multiple	
15	3.65	3.52	20'0"	3.69	19'9"	
16	3.65	3.51	40'1"	3.69	20'5"	
17	3.65	3.53	40'0"	3.69	39'9"	
18	3.65	3.51	31'2"	3.68	Multiple	

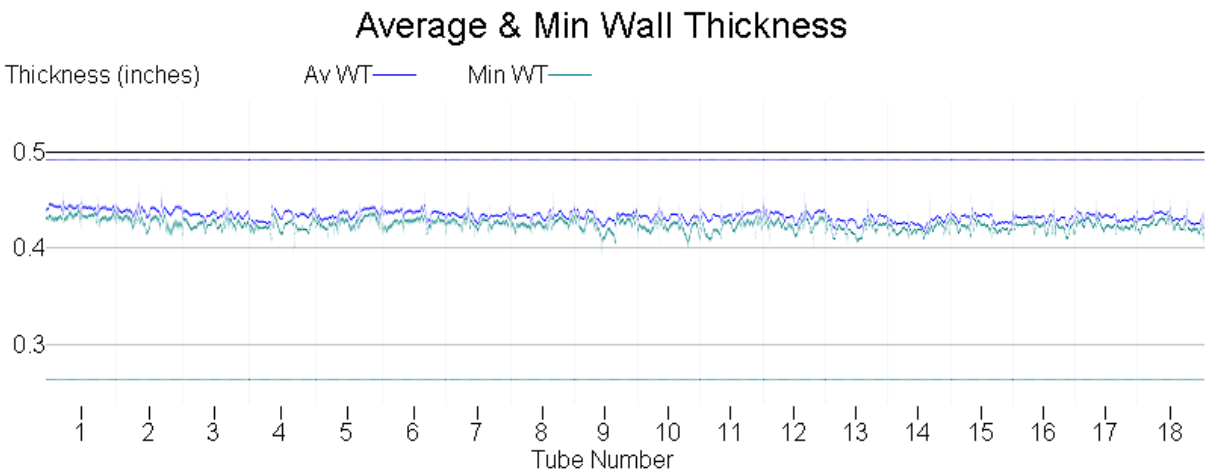
4.3 Pass 4 Convection: External Diameter Data Table

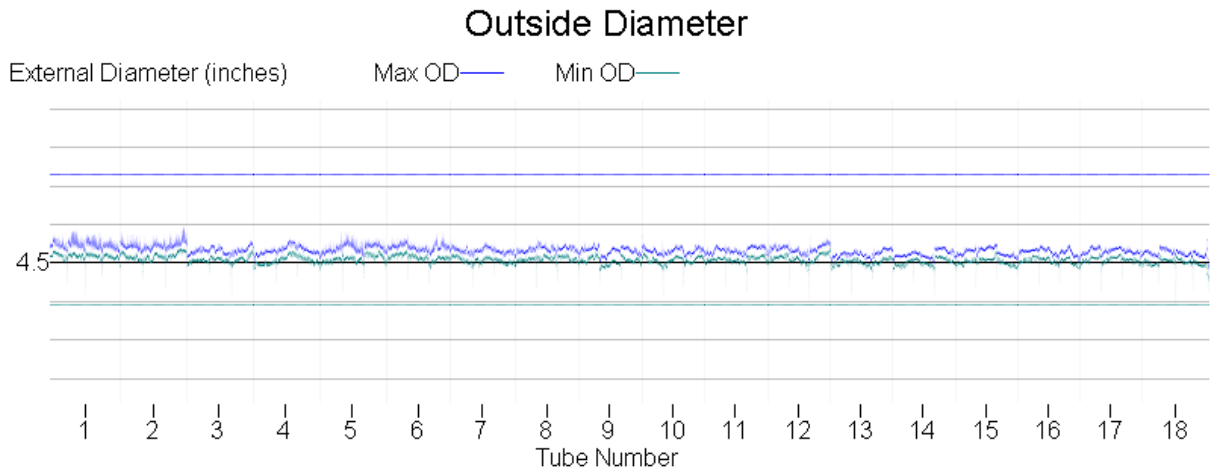
4.3.1 Nominal OD: 4.50inches

Tube Identity Number	Average OD (inches)	Minimum OD (inches)	Maximum OD (inches)	Maximum OD Location (x'x")	Maximum OD % Increase	Comments
1	4.53	4.42	4.58	24'3"	1.9 %	
2	4.53	4.44	4.60	57'2"	2.2 %	MAXIMUM MEASURED OD
3	4.52	4.42	4.56	57'10"	1.4 %	
4	4.52	4.45	4.56	32'11"	1.4 %	
5	4.52	4.43	4.58	23'5"	1.8 %	
6	4.53	4.45	4.58	53'1"	1.8 %	
7	4.52	4.44	4.57	0'0"	1.5 %	
8	4.52	4.44	4.56	20'1"	1.4 %	
9	4.52	4.45	4.56	5'5"	1.3 %	
10	4.52	4.42	4.57	0'0"	1.6 %	
11	4.52	4.43	4.56	19'11"	1.2 %	
12	4.52	4.40	4.58	0'0"	1.8 %	
13	4.51	4.42	4.55	59'11"	1.0 %	
14	4.51	4.42	4.54	40'4"	1.0 %	
15	4.52	4.44	4.55	38'8"	1.2 %	
16	4.52	4.44	4.55	22'7"	1.1 %	
17	4.52	4.43	4.55	38'8"	1.2 %	
18	4.51	4.40	4.56	59'11"	1.4 %	

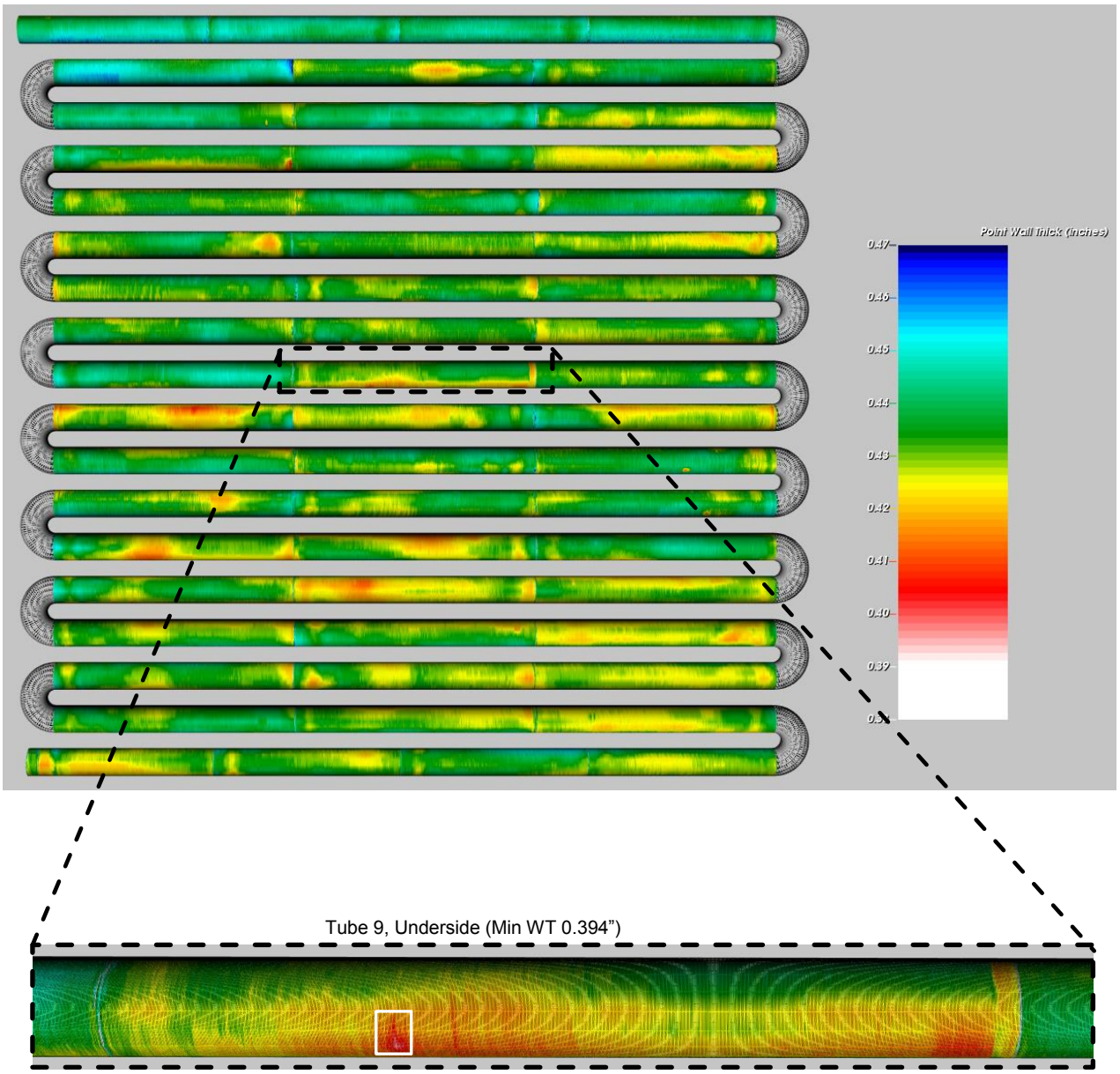
4.4 Pass 4 Convection: Summary Graphs



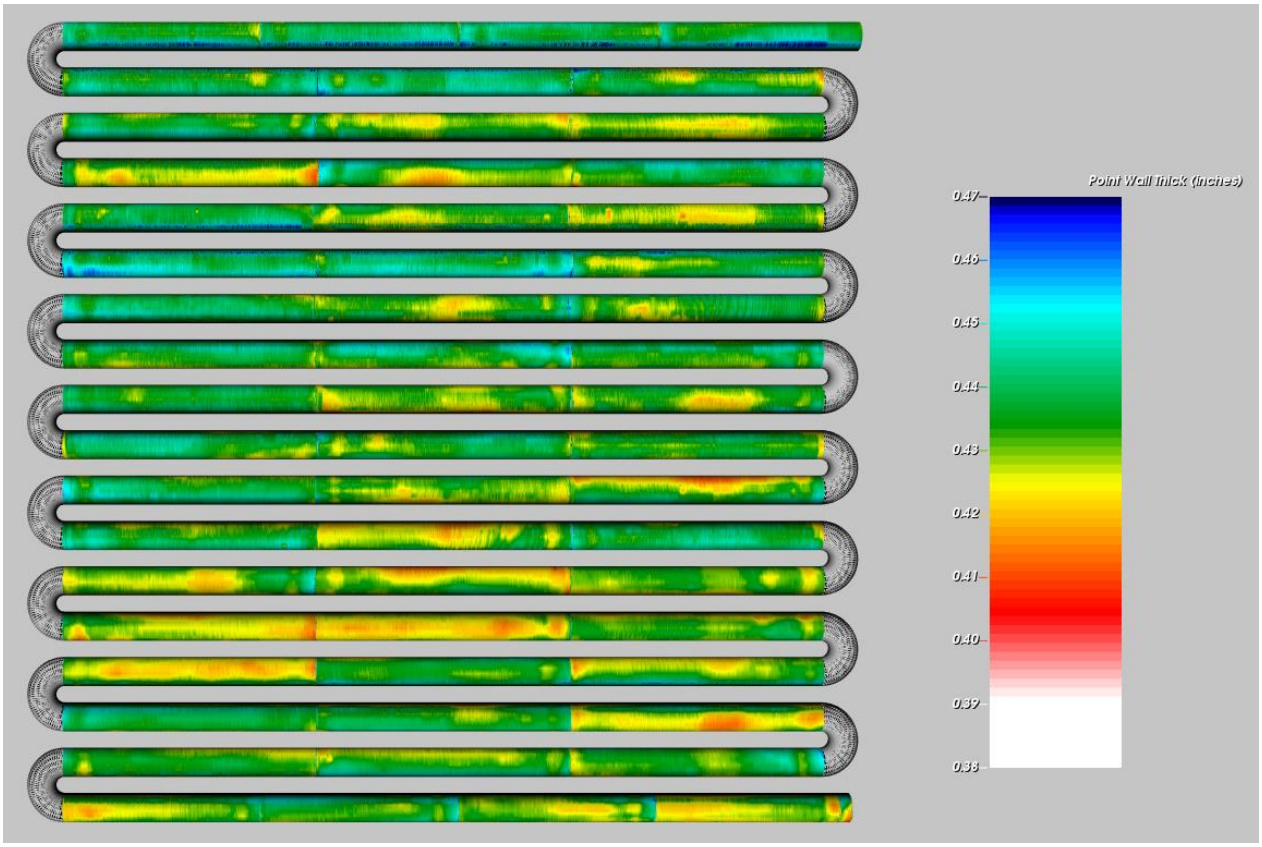




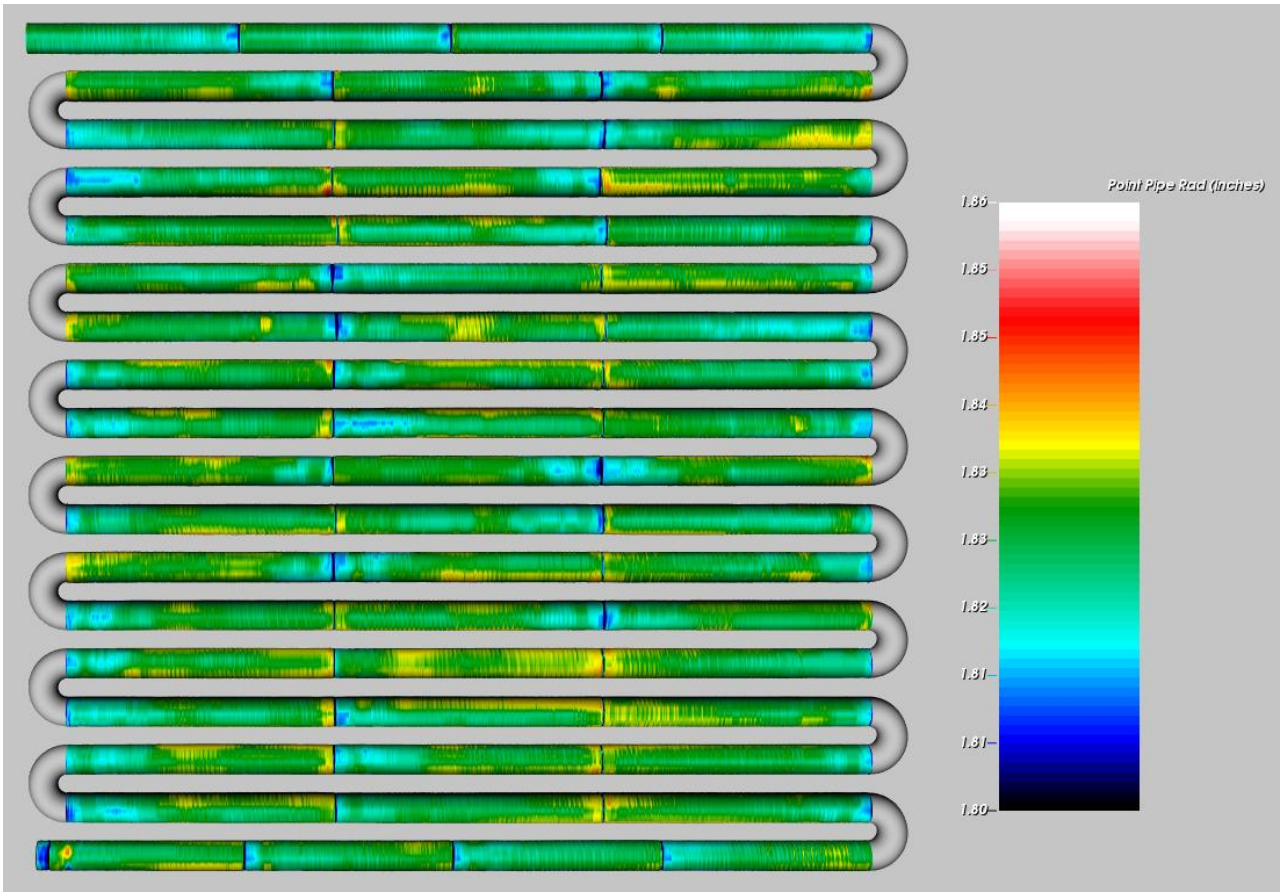
4.5 Pass 4 Convection 3D Imagery (Wall Thickness, Front View)



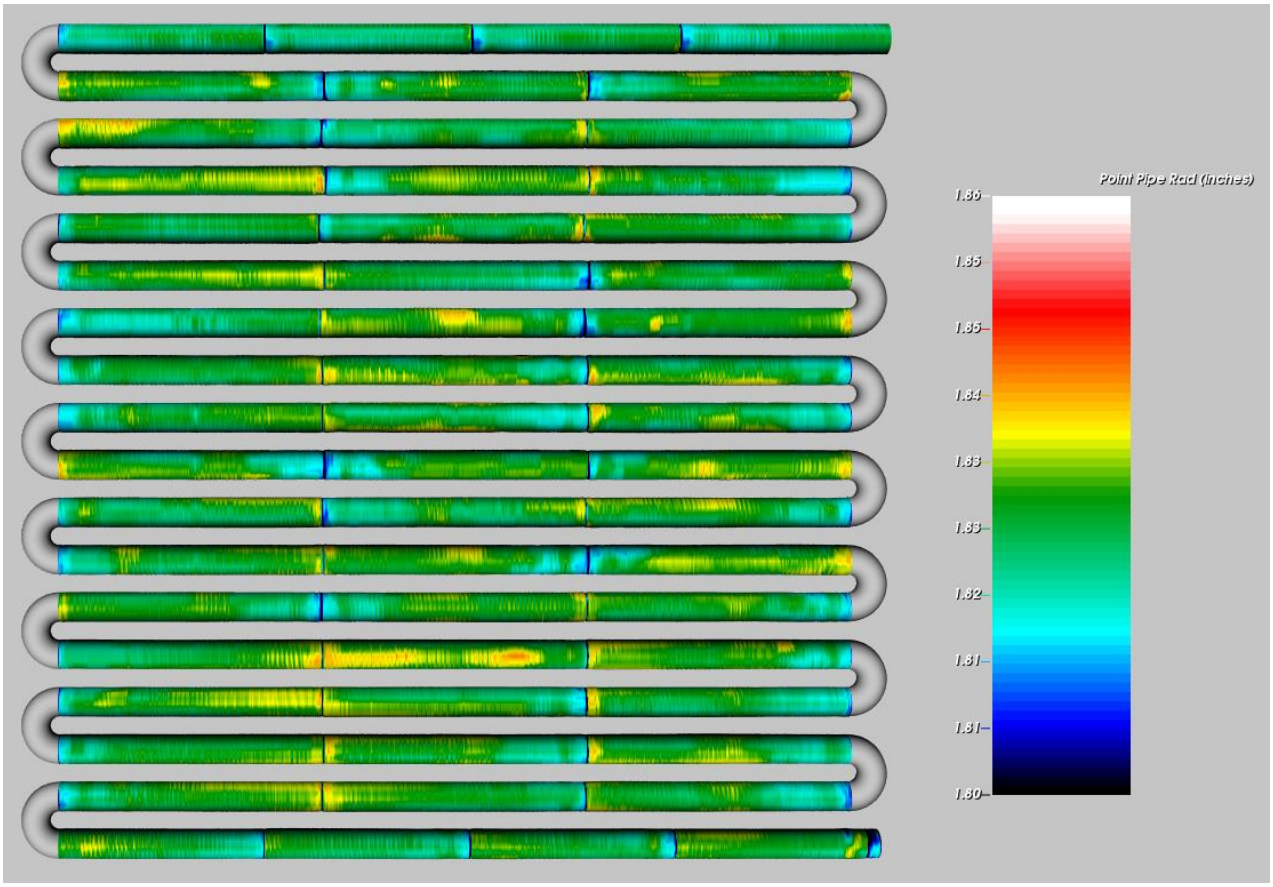
4.6 Pass 4 Convection 3D Imagery (Wall Thickness, Rear View)



4.7 Pass 4 Convection 3D Imagery (Internal Radius, Front View)



4.8 Pass 4 Convection 3D Imagery (Internal Radius, Rear View)



4.9 Pass 4 Crossover: Wall Thickness Data Table

4.9.1 Nominal Wall Thickness: 0.437inches

Tube Identity Number	Average Wall Thickness (inches)	Minimum Wall Thickness (inches)	Minimum WT Location (x'x")	Maximum Wall Loss (inches)	Comments
1	0.414	0.387	9'11"	0.050	

4.10 Pass 4 Crossover: Internal Diameter Data Table

4.10.1 Nominal ID: 3.63inches

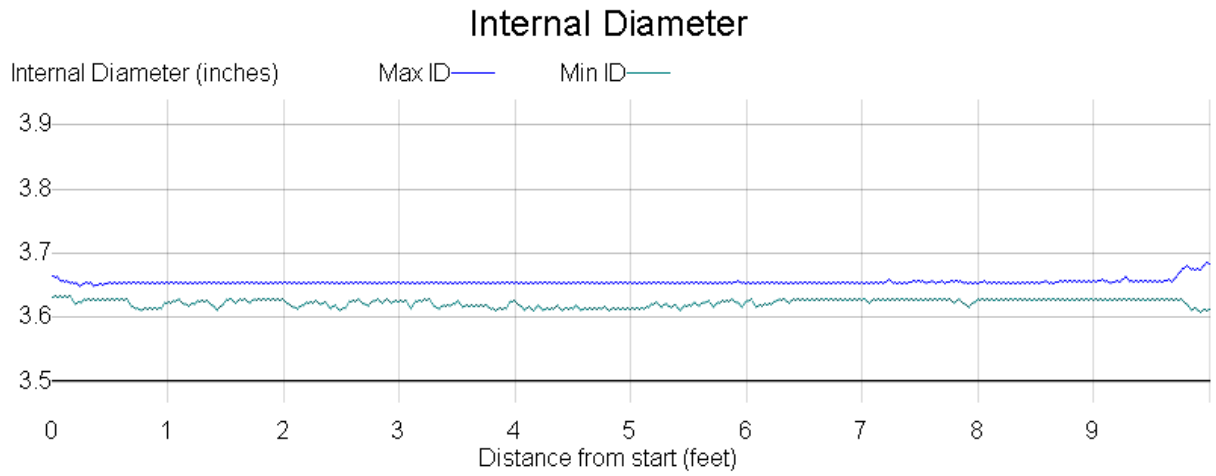
Tube Identity Number	Average ID (inches)	Minimum ID (inches)	Minimum ID Location (x'x")	Maximum ID (inches)	Maximum ID Location (x'x")	Comments
1	3.64	3.61	9'12"	3.69	9'11"	

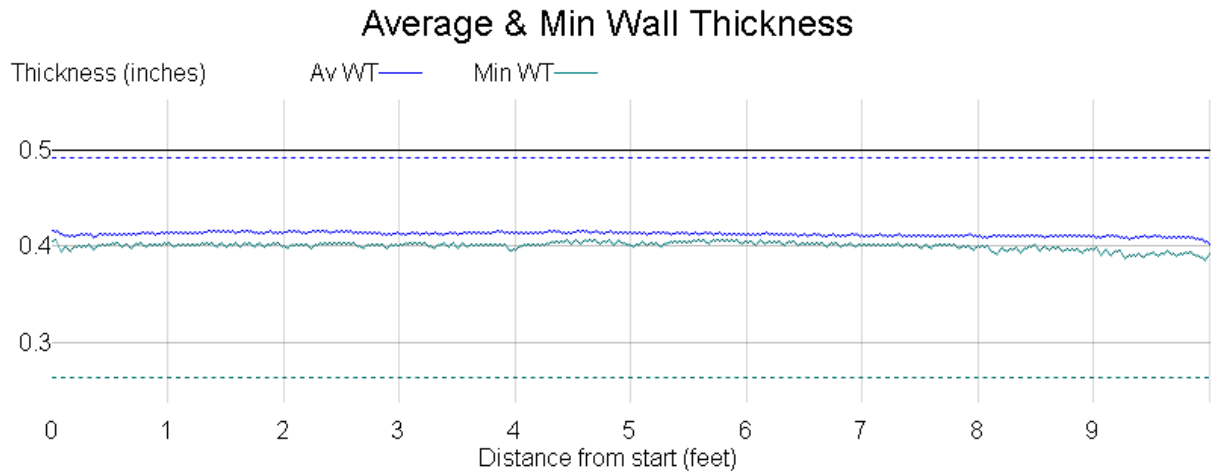
4.11 Pass 4 Crossover: External Diameter Data Table

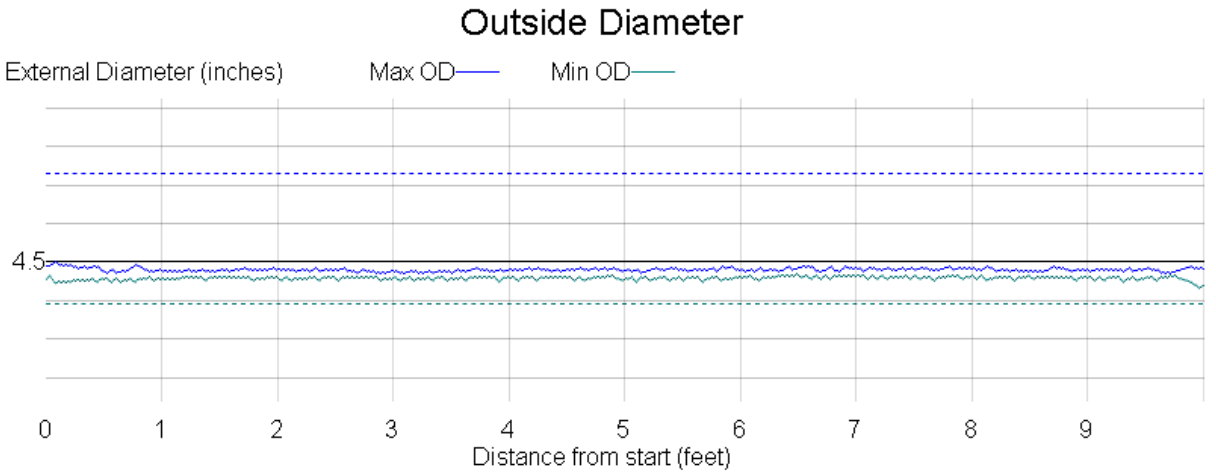
4.11.1 Nominal OD: 4.50inches

Tube Identity Number	Average OD (inches)	Minimum OD (inches)	Maximum OD (inches)	Maximum OD Location (x'x")	Maximum OD % Increase	Comments
1	4.47	4.43	4.50	0'1"	0.0 %	

4.12 Pass 4 Crossover: Summary Graphs







4.13 Pass 4 Radiant: Wall Thickness Data Table

4.13.1 Nominal Wall Thickness: 0.384inches

Tube Identity Number	Average Wall Thickness (inches)	Minimum Wall Thickness (inches)	Minimum WT Location (x'x")	Maximum Wall Loss (inches)	Comments
1	0.418	0.392	Multiple	-0.008	
2	0.412	0.378	59'12"	0.006	
3	0.414	0.381	53'11"	0.003	
4	0.412	0.387	Multiple	-0.004	
5	0.413	0.386	35'7"	-0.002	
6	0.412	0.386	36'1"	-0.002	
7	0.416	0.387	54'2"	-0.004	
8	0.417	0.394	28'8"	-0.010	
9	0.409	0.383	31'3"	0.001	
10	0.413	0.383	22'7"	0.001	
11	0.416	0.391	0'3"	-0.007	
12	0.412	0.378	Multiple	0.006	
13	0.406	0.383	Multiple	0.001	
14	0.411	0.380	59'11"	0.004	
15	0.409	0.376	Multiple	0.008	
16	0.411	0.377	40'3"	0.007	
17	0.410	0.378	Multiple	0.006	
18	0.410	0.380	Multiple	0.003	
19	0.407	0.375	0'2"	0.009	
20	0.411	0.373	Multiple	0.010	
21	0.410	0.369	Multiple	0.015	
22	0.410	0.355	Multiple	0.029	MINIMUM MEASURED WALL THICKNESS
23	0.443	0.411	26'10"	-0.028	
24	0.437	0.373	Multiple	0.010	

4.14 Pass 4 Radiant: Internal Diameter Data Table

4.14.1 Nominal ID: 3.73inches

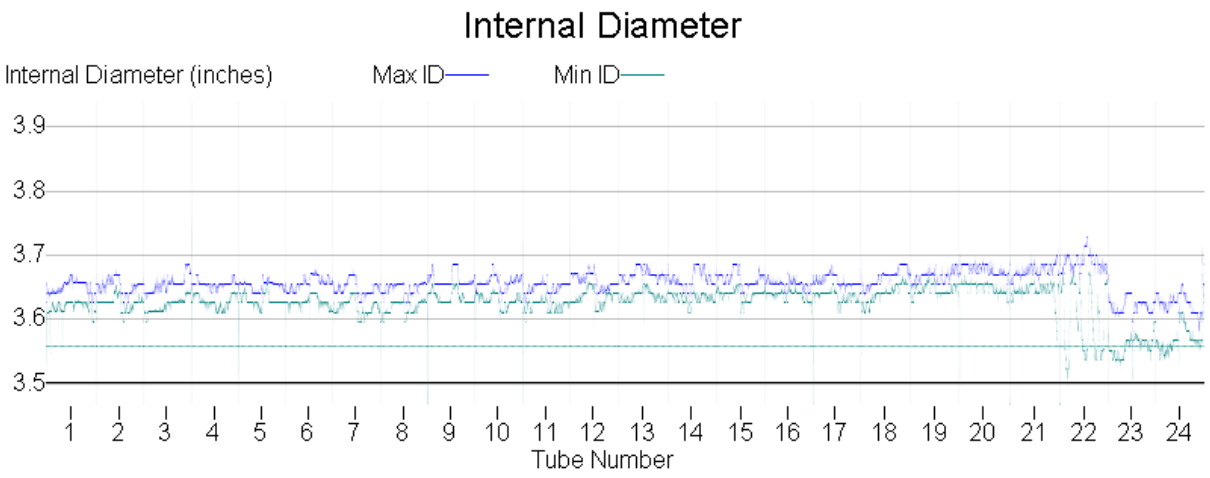
Tube Identity Number	Average ID (inches)	Minimum ID (inches)	Minimum ID Location (x'x")	Maximum ID (inches)	Maximum ID Location (x'x")	Comments
1	3.63	3.51	0'0"	3.67	38'4"	
2	3.64	3.60	33'11"	3.68	24'10"	
3	3.64	3.60	0'6"	3.68	57'1"	
4	3.64	3.55	0'2"	3.76	0'1"	MAXIMUM MEASURED ID
5	3.64	3.51	0'5"	3.67	37'7"	
6	3.64	3.59	0'1"	3.68	36'6"	
7	3.63	3.59	0'2"	3.68	24'10"	
8	3.63	3.54	0'2"	3.67	59'11"	
9	3.65	3.39	0'4"	3.68	6'7"	
10	3.64	3.57	0'4"	3.68	23'5"	
11	3.63	3.44	0'3"	3.72	0'2"	
12	3.65	3.59	30'1"	3.75	0'2"	
13	3.65	3.59	30'3"	3.69	0'2"	
14	3.65	3.61	30'2"	3.68	37'5"	
15	3.65	3.60	30'2"	3.68	25'10"	
16	3.65	3.61	58'2"	3.67	30'5"	
17	3.65	3.39	0'2"	3.68	24'6"	
18	3.65	3.54	0'2"	3.70	0'0"	
19	3.66	3.61	0'4"	3.70	59'11"	
20	3.66	3.49	0'2"	3.70	0'2"	
21	3.66	3.36	0'0"	3.71	59'10"	
22	3.65	3.33	0'1"	3.73	34'1"	
23	3.59	3.50	30'3"	3.65	29'3"	
24	3.60	3.53	30'4"	3.71	60'7"	

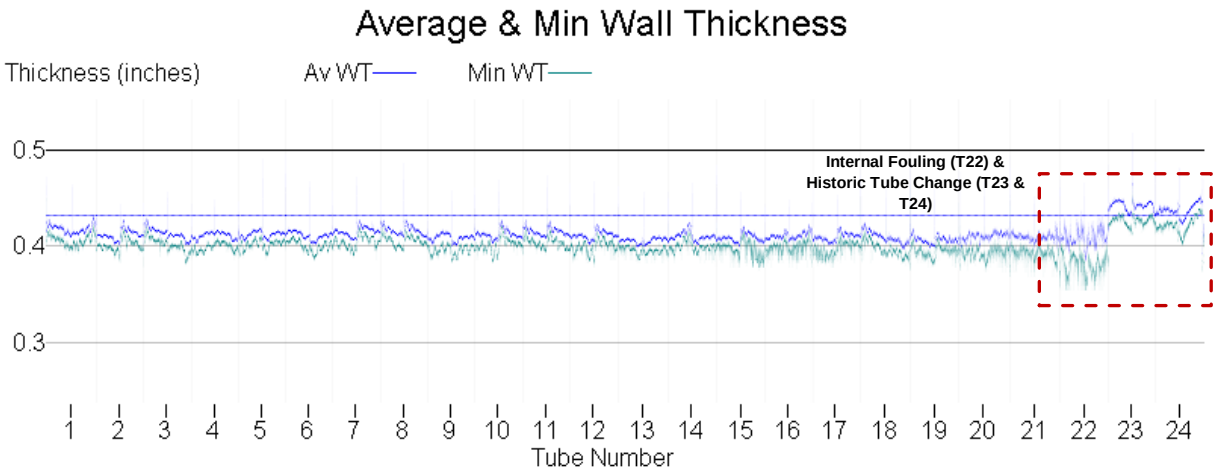
4.15 Pass 4 Radiant: External Diameter Data Table

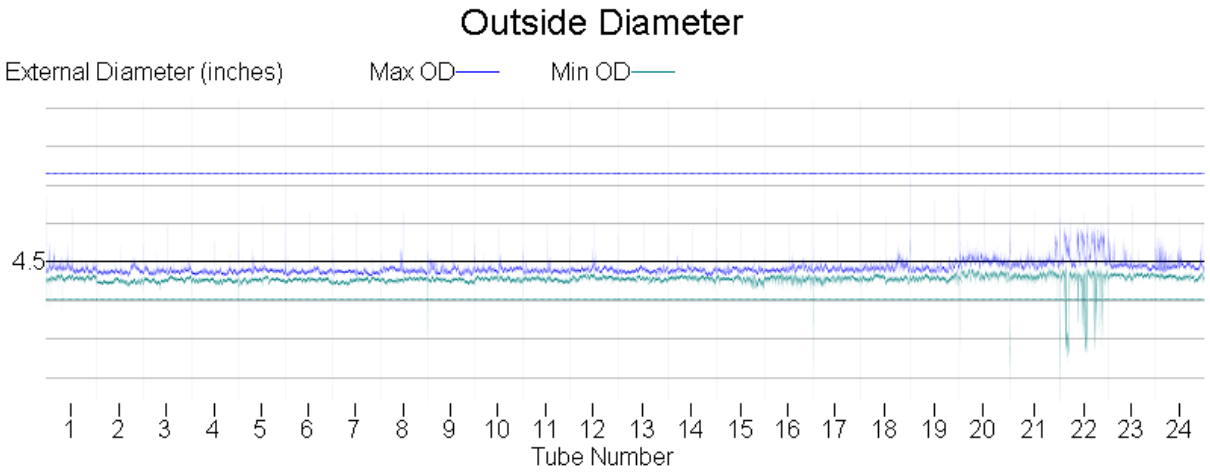
4.15.1 Nominal OD: 4.50inches

Tube Identity Number	Average OD (inches)	Minimum OD (inches)	Maximum OD (inches)	Maximum OD Location (x'x")	Maximum OD % Increase	Comments
1	4.47	4.38	4.67	0'1"	3.8 %	
2	4.46	4.41	4.54	30'4"	0.9 %	
3	4.47	4.43	4.61	0'0"	2.5 %	
4	4.46	4.38	4.56	30'1"	1.3 %	
5	4.47	4.36	4.68	59'12"	4.1 %	
6	4.46	4.44	4.64	0'0"	3.1 %	
7	4.46	4.44	4.63	30'2"	2.8 %	
8	4.47	4.37	4.63	30'1"	3.0 %	
9	4.46	4.29	4.60	30'2"	2.2 %	
10	4.47	4.44	4.60	0'0"	2.3 %	
11	4.47	4.28	4.60	30'2"	2.2 %	
12	4.47	4.44	4.64	0'0"	3.2 %	
13	4.47	4.44	4.61	59'12"	2.6 %	
14	4.47	4.42	4.66	0'0"	3.5 %	
15	4.47	4.43	4.65	0'0"	3.3 %	
16	4.47	4.42	4.62	59'12"	2.6 %	
17	4.47	4.22	4.67	59'12"	3.9 %	
18	4.47	4.40	4.64	59'12"	3.2 %	
19	4.47	4.43	4.77	0'0"	6.1 %	MAXIMUM MEASURED OD
20	4.48	4.28	4.69	30'2"	4.1 %	
21	4.48	4.18	4.66	59'12"	3.6 %	
22	4.47	4.14	4.65	59'12"	3.4 %	
23	4.48	4.44	4.68	59'12"	4.0 %	
24	4.47	4.44	4.64	62'10"	3.0 %	

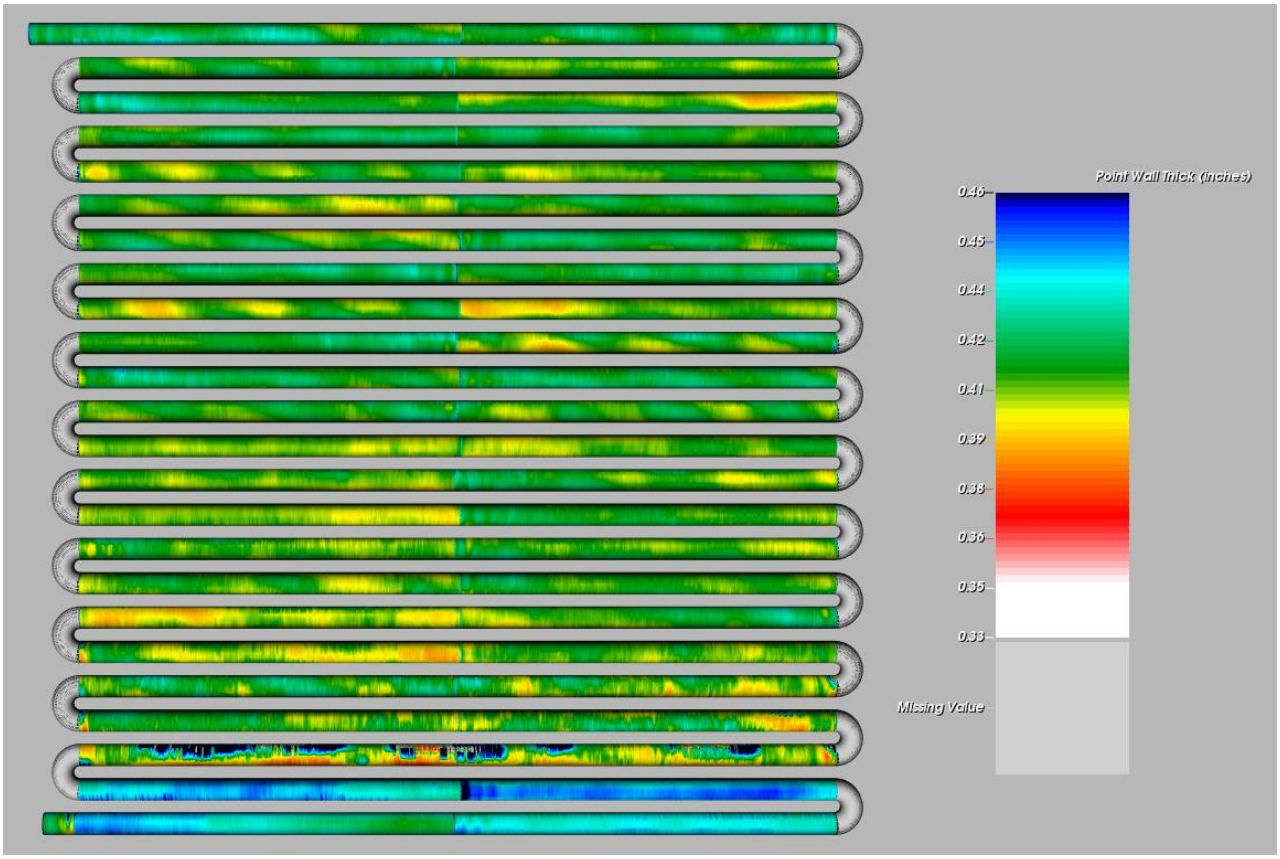
4.16 Pass 4 Radiant: Summary Graphs



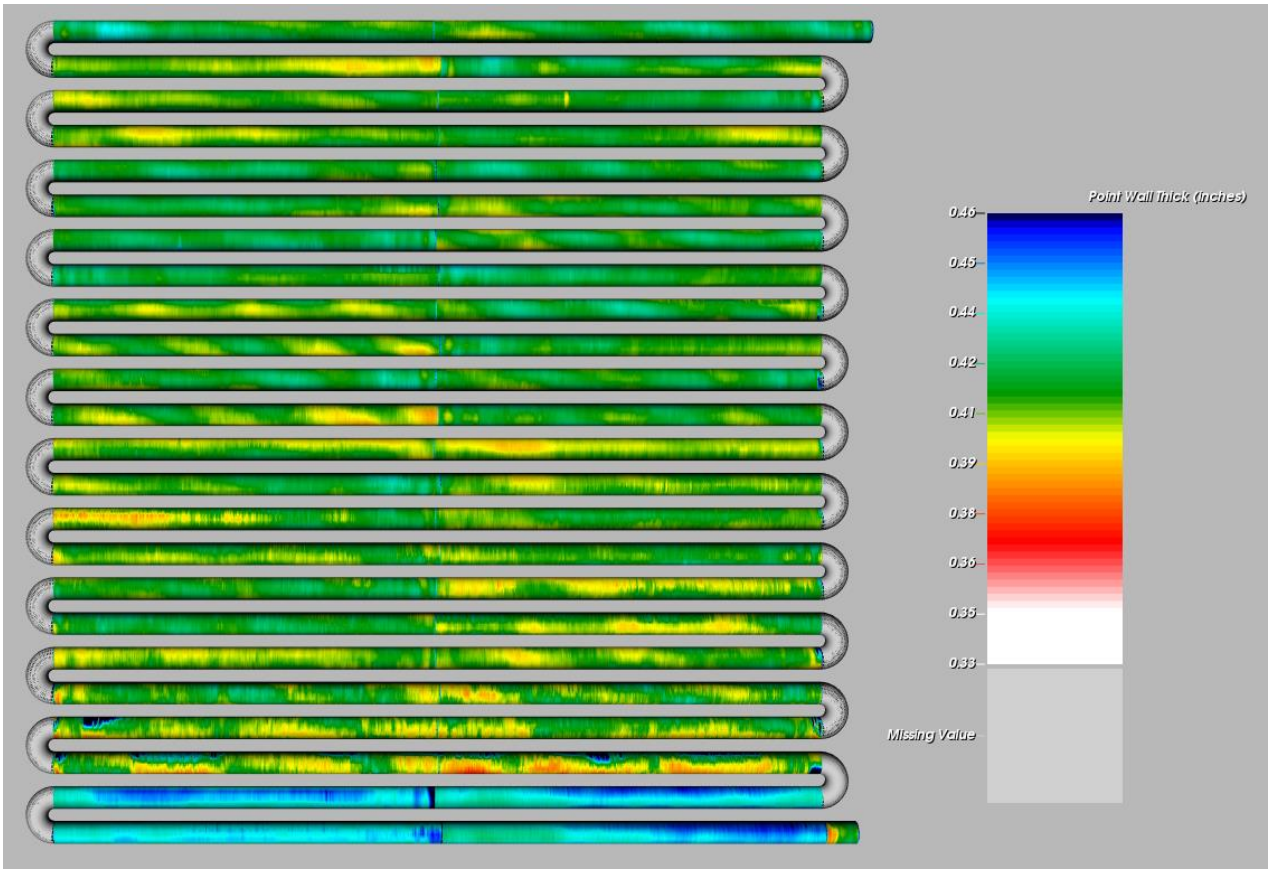




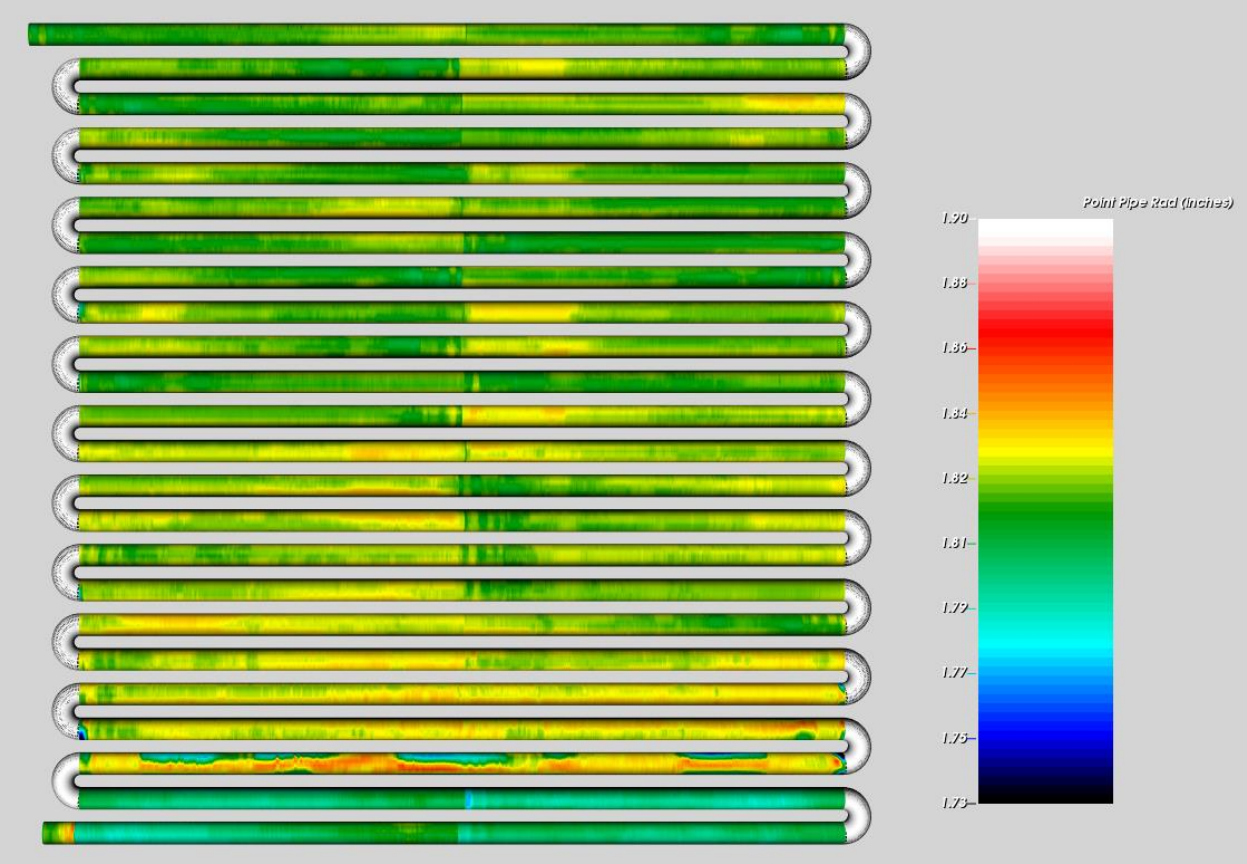
4.17 Pass 4 Radiant 3D Imagery (Wall Thickness, Front View)



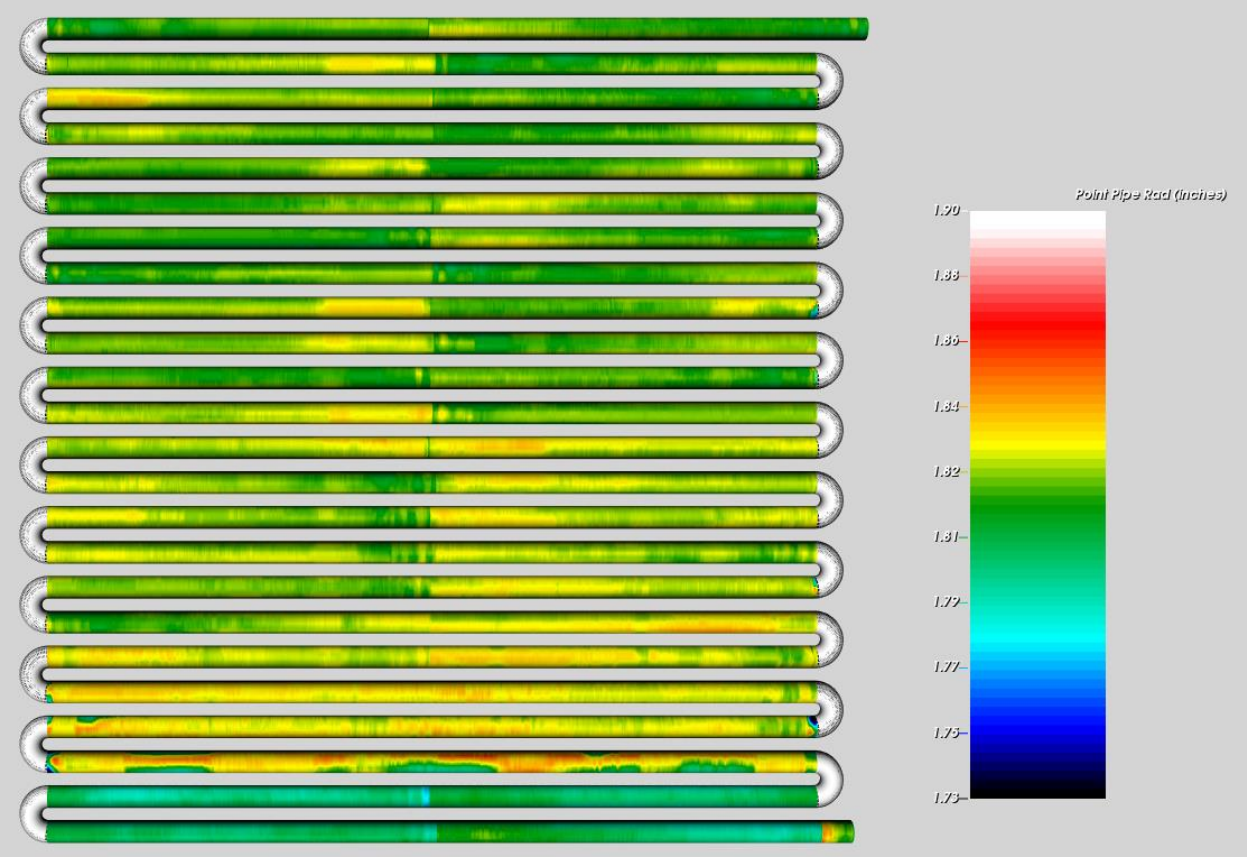
4.18 Pass 4 Radiant 3D Imagery (Wall Thickness, Rear View)



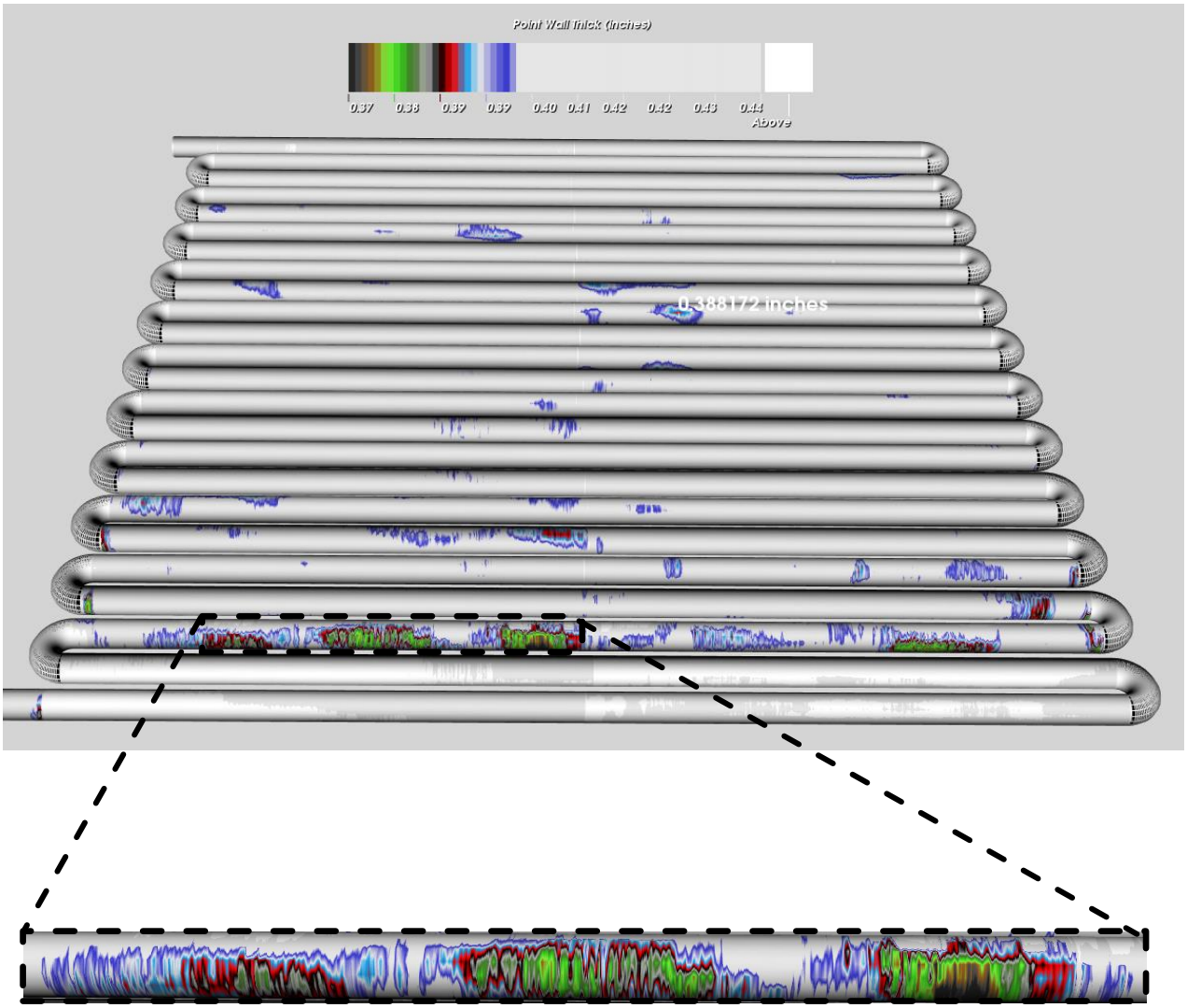
4.19 Pass 4 Radiant 3D Imagery (Internal Radius, Front View)



4.20 Pass 4 Radiant 3D Imagery (Internal Radius, Rear View)



4.21 Pass 4 Radiant 3D Imagery (Wall Thickness, Las Point Classification)



5 APPENDIX A: MERLIN MARK IV SPECIFICATION

Inherent static accuracy	±0.1mm / 0.004”
Wall Thickness dynamic accuracy	±0.2mm / 0.008”
Internal Diameter accuracy	±0.75% (full scale)
Axial location accuracy	±60mm / 2.4”
Resolution	0.3” (axial) x 0.5” (circumferential) Typical
Pig speed	0.5ms-1 / 1.6ft/s Typical
Data sampling rate	60Hz
Transducer centre frequency	5MHz
Tube Diameter Range	2.6” – 12”

6 APPENDIX B: INTERPRETING THE DATA

The axial location of each measurement is referenced from the “start” of each tube at the bend/tube weld (0.00m datum). The “end” of each tube is defined as the bend/tube weld farthest away from the process flow. Figures B1, B2 & B3 demonstrate the axial location referencing against three typical process coil arrangement.

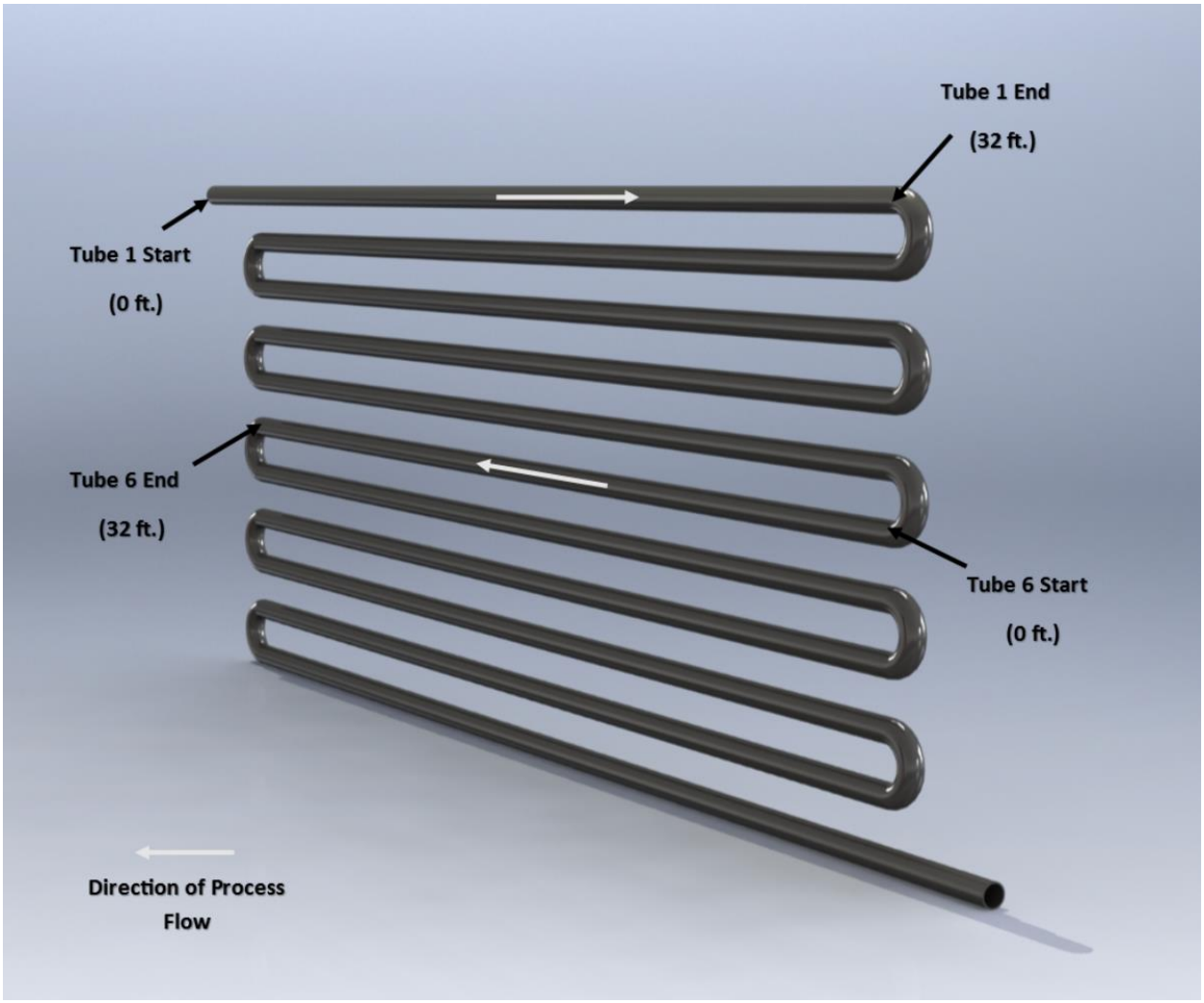


Figure B1: Axial location referencing within a typical horizontal convection coil.

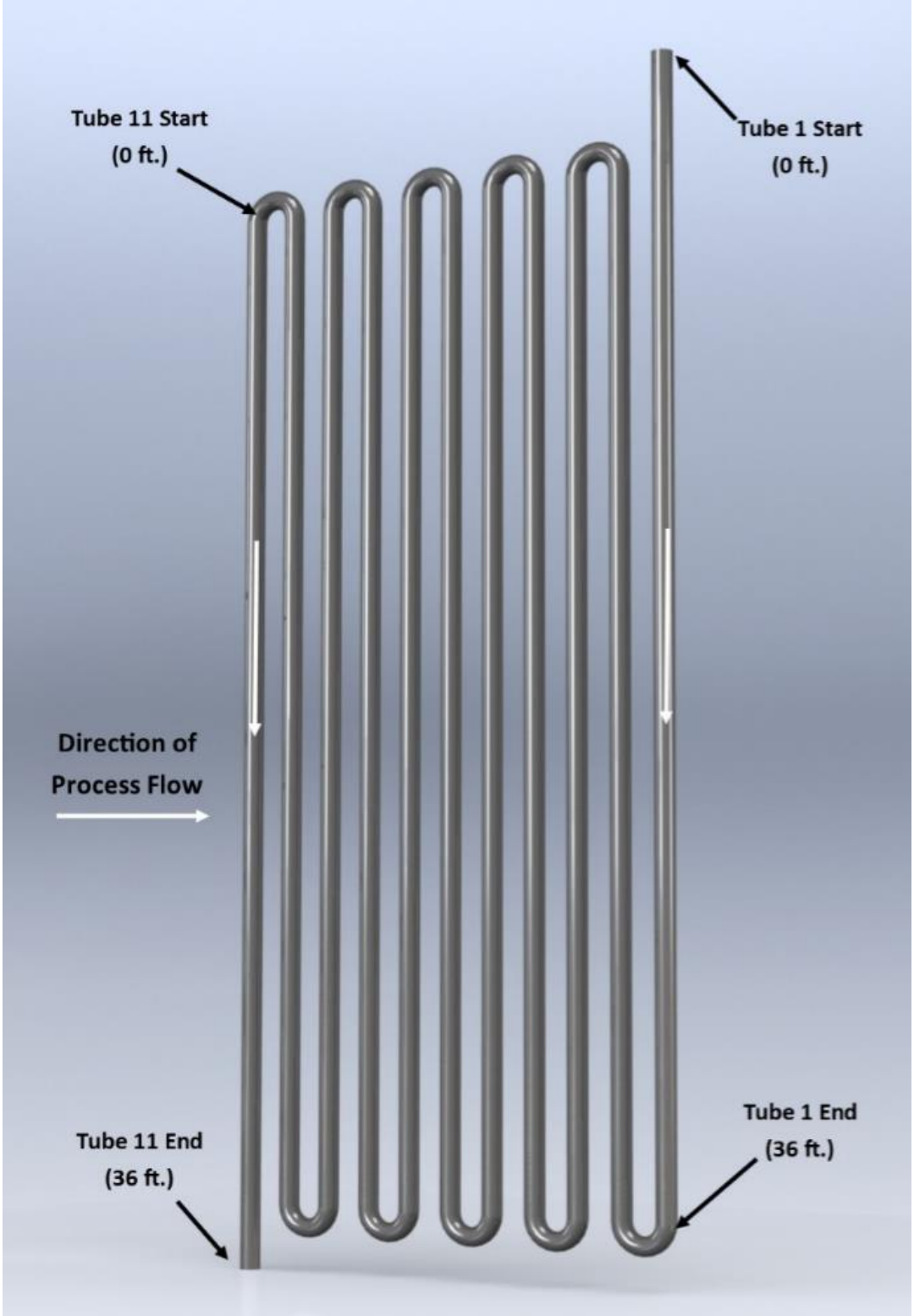


Figure B2: Axial location referencing within a typical vertical radiant coil.

6

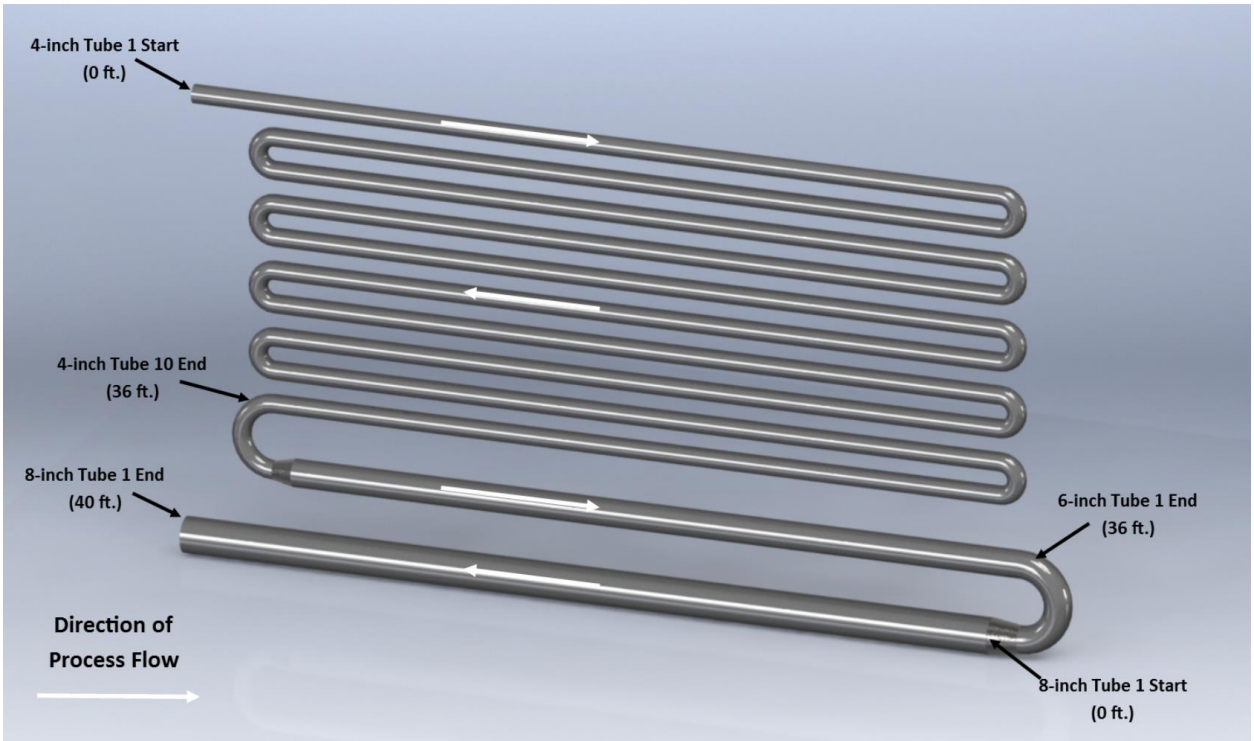
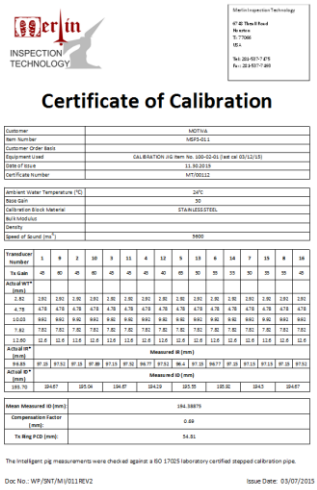


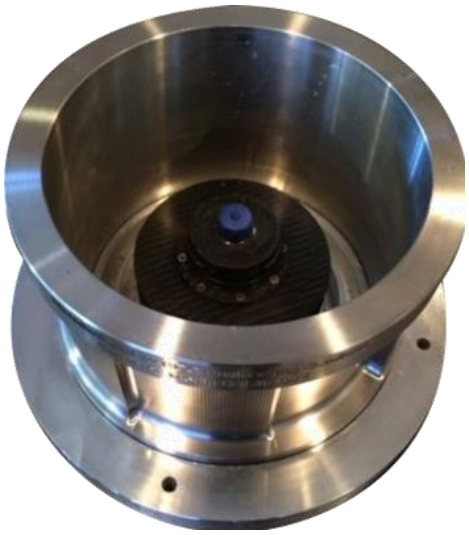
Figure B3: Axial location referencing within a typical radiant coil from a vacuum furnace.

7 APPENDIX C: CALIBRATION

It is standard MERLIN™ procedure that each MIT inspection device is calibrated immediately prior to any MIT inspection operation. The calibration is performed at the COKEBUSTERS Technology Centre, UK, by a PCN/ASNT qualified MIT Technician. During this procedure, each ultrasonic transducer is calibrated independently to a stainless steel calibration block/step that itself has been measured and certified by a third party ISO 9001 accredited laboratory. Velocity of sound is then adjusted to the correct value for the furnace tube material that is being inspected and final checks are carried out on a sample that is of equal geometry and material to the furnace tube material. All water temperatures are measured using a Fluke 566 Infrared Thermometer, which has an accuracy of ±1%, to allow for the effect of temperature on the velocity of sound. A calibration block is also available on each Cokebusters pumping unit should technicians need to carry out any further checks whilst on-site. All MIT Technicians are examined and certified to ASNT UT II standards in the Merlin Inspection Procedure and certificates of calibration are available to clients upon request.

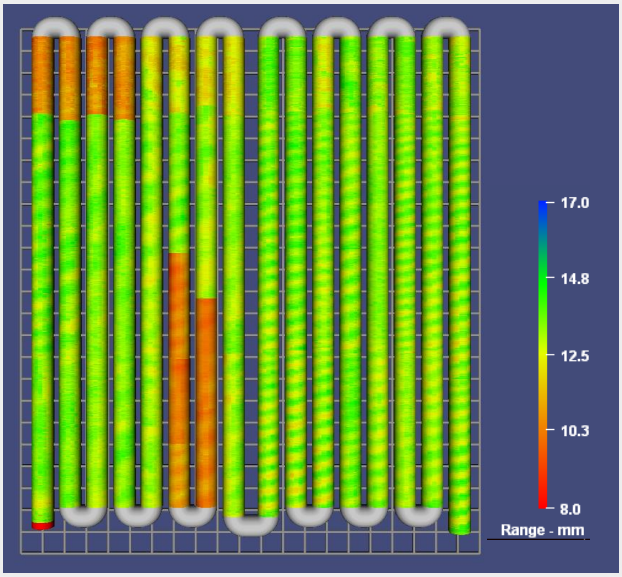


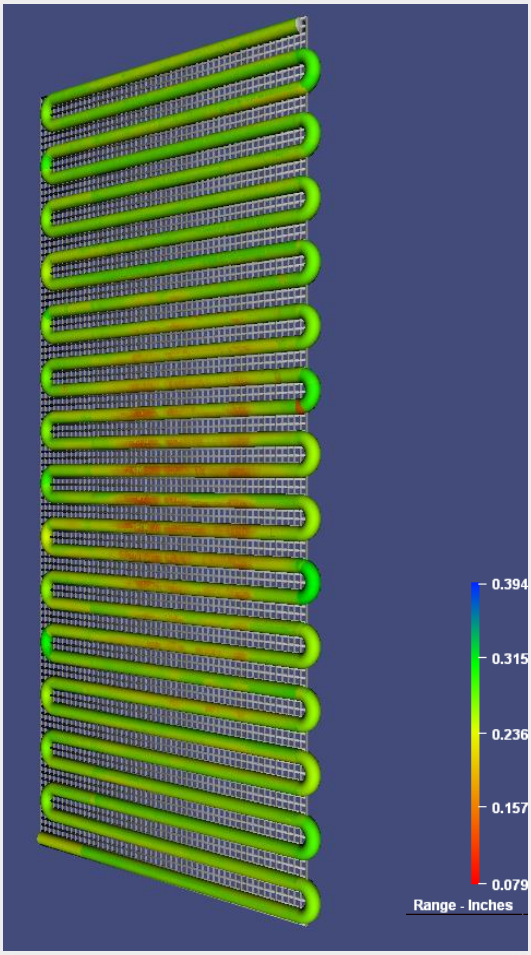
Certificate of Calibration

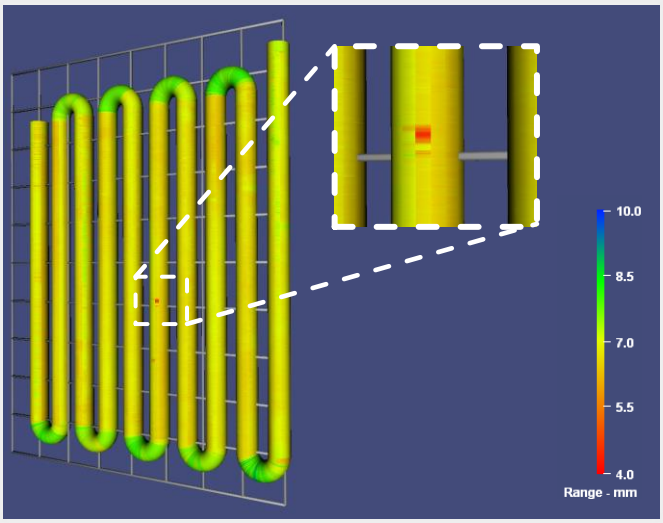


8 APPENDIX D: DATA MAPPING

In order to optimize data interpretation and analysis, the MERLIN system uses powerful, bespoke 3D meshing software to map every wall thickness, internal and outside radius measurement to a model of the heater pass. The software is fully interactive, featuring colour scaling, aspect ratio adjustment, zoom functions, grid referencing and rotation/panning in 3 dimensions. This software is able to quickly highlight any problematic areas, typically within 20 minutes of an inspection run. A copy of the viewing software, together with individual interactive viewing files is supplied to the client with every Inspection Final Inspection Report.







9 APPENDIX E: GENERAL CONTRACTUAL CONDITIONS

1.0 The Inspection Contract

In addition to the terms and conditions detailed in the Quotation Template (Document Number: Demo Report), the following contractual terms which are specific to the Merlin Inspection service shall be adhered to.

The Inspection Company shall during the Contract Period subject to earlier termination provide the Client with an in-line inspection service, referred to as "Intelligent Pigging" or "Smart Pigging". For the avoidance of doubt the Client acknowledges that:

Cokebusters Limited have been requested by the client to undertake an in-line inspection service. The provision of the Inspection Service does not relieve the Client of this responsibility. The Client acknowledges that it is the Client's legal responsibility to have the relevant equipment inspected in accordance with all applicable legislation and the Inspection Company shall have no liability to the Client for any fines or other penalties incurred by the Client in this regard (including without limitation any fees for intervention levied against the Client by the Health and Safety Executive);

The Inspection Service will not include any services not specifically detailed within the Contract including without limitation the following services (although such services may be available subject to additional charges and the conclusion of a separate agreement between the parties):

Neither the Inspection Company nor the Client shall be liable to the other party in contract, tort, negligence or breach of statutory duty or otherwise for any:

- **Loss of profits**
- **Economic loss**
- **Loss of turnover**
- **Loss of business**
- **Loss of data**
- **Loss of goodwill**
- **Indirect, special or consequential losses**

The Inspection Company shall have no liability under the Contract for any failure or delay in the provision of an Inspection to the extent that the same is contributed to by the acts or omissions of the Client (including without limitation where Plant is not made available for Inspection), even if the same results in Plant becoming overdue for Inspection and in such circumstances it shall be the Client's responsibility to rearrange Inspection of such Plant or take it out of service.

Where any Plant is overdue for Inspection at the time it is added to the Contract (including at commencement of the Contract), or where Plant becomes overdue for Inspection as a result of the acts and omissions of the Client, the Inspection Company will seek to agree a timetable with the Client for the Inspection of such Plant. However, the Client acknowledges that the Inspection Company shall have no liability in respect of such overdue Plant and the Client indemnifies and shall keep the Inspection Company indemnified in respect of any claims of any nature made against any and all damages, costs and expenses suffered or incurred by the Inspection Company in connection with such Plant being overdue for Inspection.

Nothing in this Contract shall operate to limit or exclude the liability of either party for fraud, fraudulent misrepresentation, death or personal injury caused by its negligence, or any other liability which cannot be limited or excluded by law.

2.0 Deliverables

Upon completion of the in-line inspection, it is understood that Cokebusters will provide the client with the following within 24-hours of completing the final inspection run:

- **A written Field Report, providing the client with an overview of the process coil(s) metallurgic and geometric condition in tabulated and graphical form.**
- **Details of any metallurgic/geometric flaws contained within the process coil(s). It should be noted that all data contained within the Field Report will not be fully validated until submission of the Final Report.**
- **A close out meeting with the client to discuss the inspection results (if requested).**

Upon completion of the in-line inspection, it is understood that Cokebusters will provide the client with the following within 7 days of completing the final inspection run:

- **A written Final Inspection Report, providing the client with comprehensive details of the process coil(s) condition. In addition to the data tables and graphs provided within the Field Report, the Final Report shall include written evaluations, descriptions and recommendations from a Senior Merlin Inspector (Internal Level III Technician).**
- **Interactive colour coded 3D models of the process coil(s).**
- **A separate document containing individual section graphs for each process tube (If requested)**

It is understood by the client that:

Cokebusters Limited will not accept responsibility for any metallurgic flaw, defect or anomaly contained within the process coil(s) tubing and/or return bends.

Merlin Technology Inspection Service provided by Cokebusters Limited is for advisory purposes only. Cokebusters Limited will not accept responsibility for any geometric anomaly, flaw or defect which may have gone undetected from the inspection procedure.

The accuracy, resolution and technical capabilities of the Merlin Mark IV In-line Inspection Tool are described within Appendix A of the Field and Final Inspection Reports. Cokebusters Limited will not accept responsibility for any misinterpretation of data or reporting.

Cokebusters Limited will not accept responsibility for any process anomalies, accidents or disruptions following the inspection service.

3.0 Confidentiality

Unless otherwise agreed, each party shall keep confidential the terms of the Contract and all information of a confidential nature that it may acquire in relation to the business or affairs of the other party (Confidential Information). Neither party shall use the other party's confidential information for any purpose other than to perform its obligations under this Contract, unless otherwise required by law or the confidential information has entered the public domain other than through the fault of the party which received such Confidential Information. The obligations in this clause shall continue for a period of three (3) years from the date of expiry or termination of the Contract.

The Inspection Company shall be entitled to:

Share Confidential Information with other members of its Group; and

Retain a copy of any Confidential Information as required for regulatory purposes and/or to show evidence of compliance with this.

4.0 Liability

In substitution for all rights which the Client would or might have but for the Contracts, the Inspection Company undertakes that if an Inspection is performed in a defective or erroneous manner then the Inspection Company will at its discretion either credit to the Client the Fee paid by the Client and attributable to the Inspection or re-perform the Inspection (save as to the time of performance).

5.0 Data Protection

The Inspection Company, together with its Group, may use the personal and business details the Client provides (or which are supplied by third parties) including any details of directors, officers, partners and employees (whose consent the Client must obtain) to:

1. Provide the Client with a quotation and to deal with the associated administration of the Contract;

2. Search credit reference, credit scoring and fraud agencies who may keep a record of the search;

3. Support the development of the Inspection Company's business by including the Client's details in customer surveys, for market research and business reviews which may be carried out by third parties acting on the Inspection Company's behalf.

Under the Data Protection Act 1998 individuals are entitled to request a copy of all the personal information the Inspection Company holds about them.

Personal details may be transferred to countries outside the EEA. They will at all times be held securely and handled with the utmost care in accordance with all principles of English law.

By applying for and/or entering into this Contract the Client is deemed to specifically consent to the use of any personal data supplied by the Client and the Client's contract data in the ways and for the purposes set out.

6.0 Indemnity

The Client indemnifies and shall keep the Inspection Company indemnified in respect of any claims of any nature made against any and all damages, costs and expenses suffered or incurred by the Inspection Company as a result of any third party claim arising out of the Client's failure to comply with its obligations under the Contract.

7.0 General

Relationship of the parties

Nothing in the Contract is intended to, or shall be deemed to, establish any partnership or joint venture between any of the parties, constitute any party the agent of another party, or authorise any party to make or enter into any commitments for or on behalf of any other party.

Variations to the Contract

No variation of the Contract shall be effective unless it is in writing and signed by the parties (or their authorised representatives).

Notices

Any notice given to a party under or in connection with this Contract shall be in writing and shall be delivered by hand or sent by recorded delivery or pre-paid first-class post or other next working day delivery service to the Cokebusters Head Office address or its principal place of business (in any other case) (and in the case of notices to the Company, a copy shall be required to be sent for the attention of the Company Secretary at the same address).

Entire Agreement

The Contract constitutes the entire agreement between the parties and supersedes and extinguishes all previous agreements, promises, assurances, warranties, representations and understandings between them, whether written or oral, relating to its subject matter.

Each party agrees that it shall have no remedies in respect of any statement, representation, assurance or warranty (whether made innocently or negligently) that is not set out in the Contract. Each party agrees that it shall have no claim for innocent or negligent misrepresentation or negligent misstatement based on any statement in the Contract.

No Waiver

No failure or delay by a party to exercise any right or remedy provided under the Contract or by law shall constitute a waiver of that or any other right or remedy, nor shall it prevent or restrict the further exercise of that or any other right or remedy. No single or partial exercise of such right or remedy shall prevent or restrict the further exercise of that or any other right or remedy.

Rights of Third Parties

No one other than a party to the Contract shall have any right to enforce any of its terms.

Unenforceable Terms

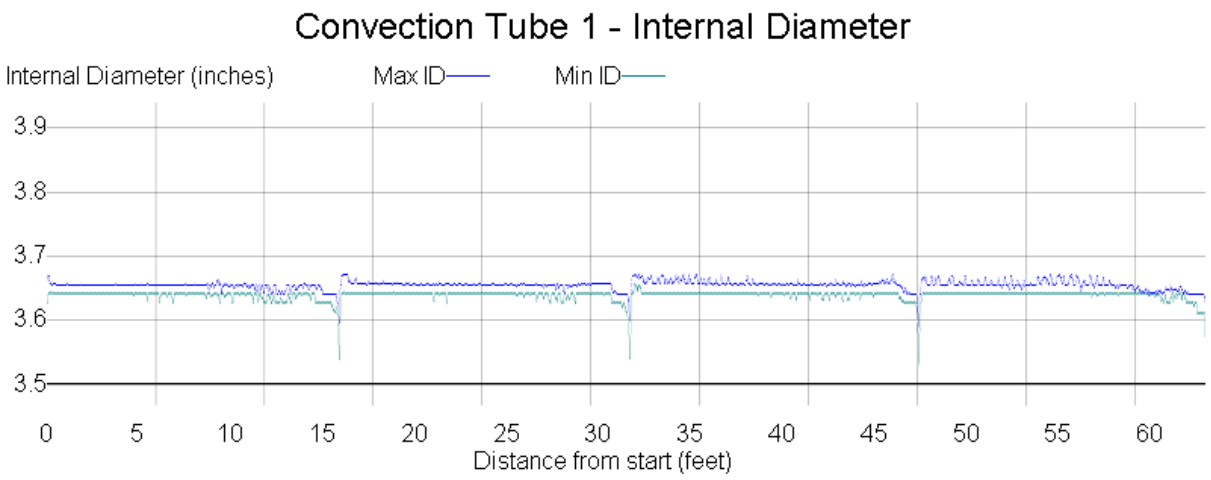
If any provision in the Contract is held by any competent court to be unenforceable in whole or in part, the validity of the other provisions and the remainder of the provision in question shall not be affected.

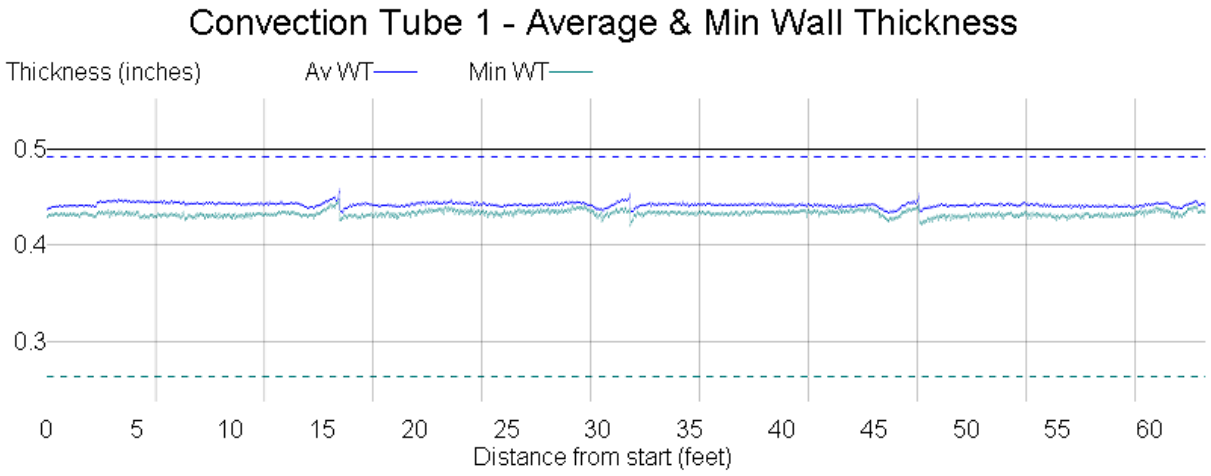
Language, Governing Law and Jurisdiction

The language of the Contract and all communications relating to it will be in English.

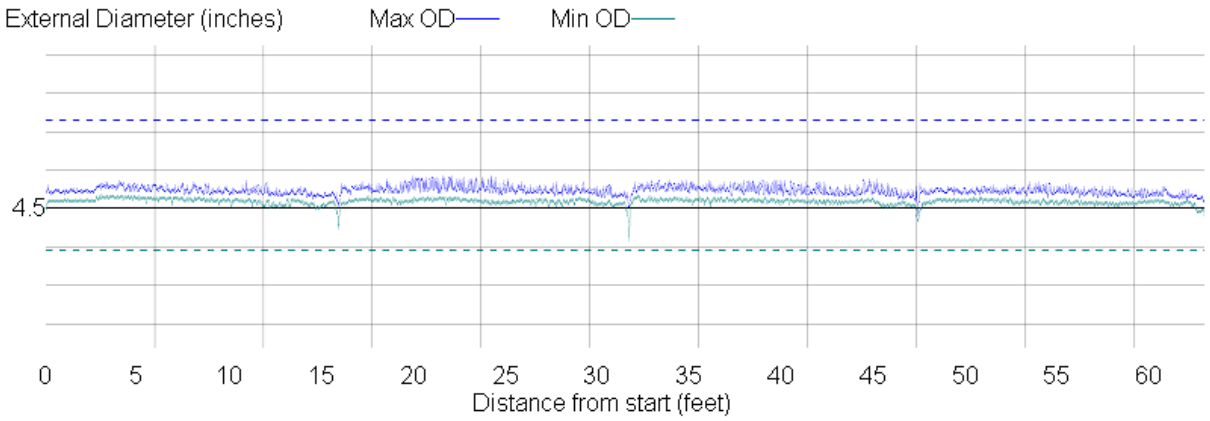
English law shall apply to the Contract and the parties agree to submit to the exclusive jurisdiction of the English Courts in respect of all disputes arising out of or in connection with the Contract (whether of a contractual or tortious nature or otherwise).

10 APPENDIX F: INDIVIDUAL SECTION GRAPHS

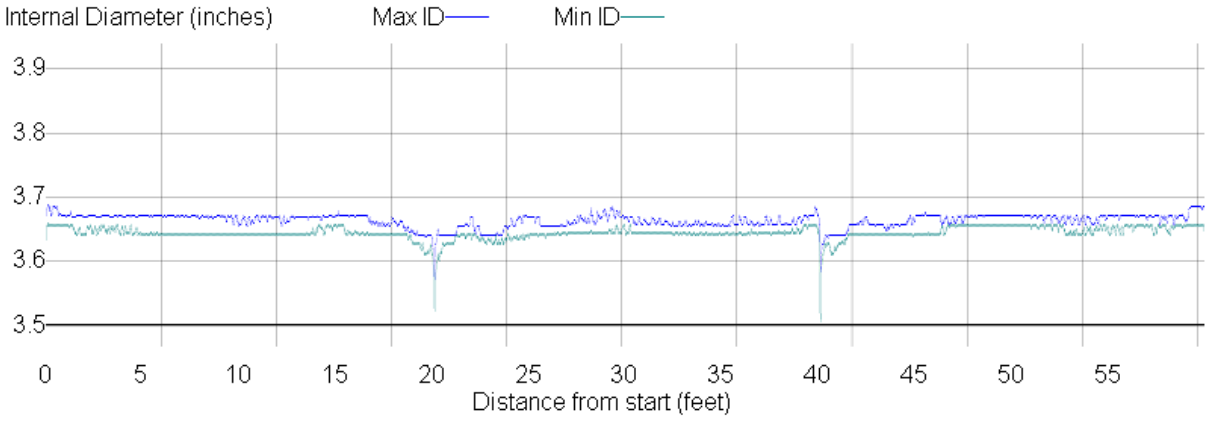




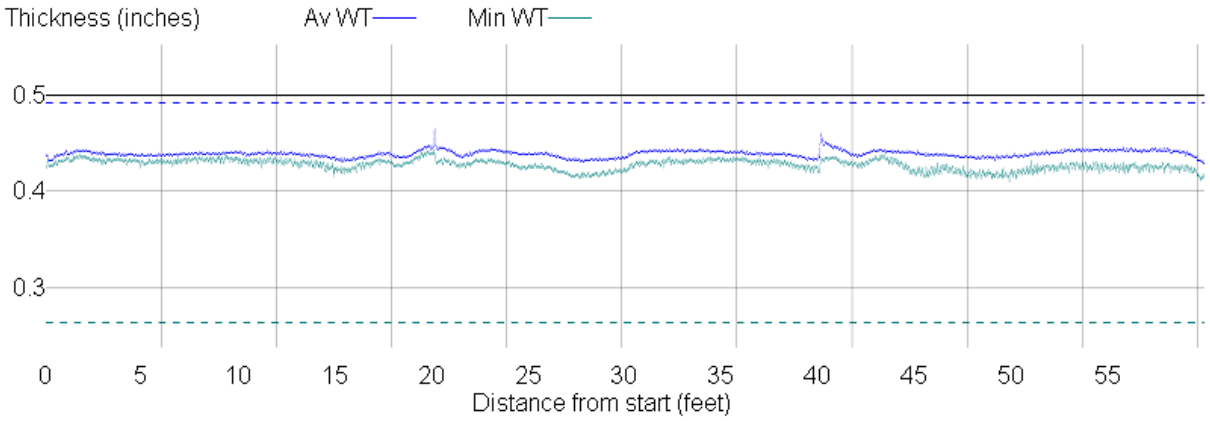
Convection Tube 1 - Outside Diameter



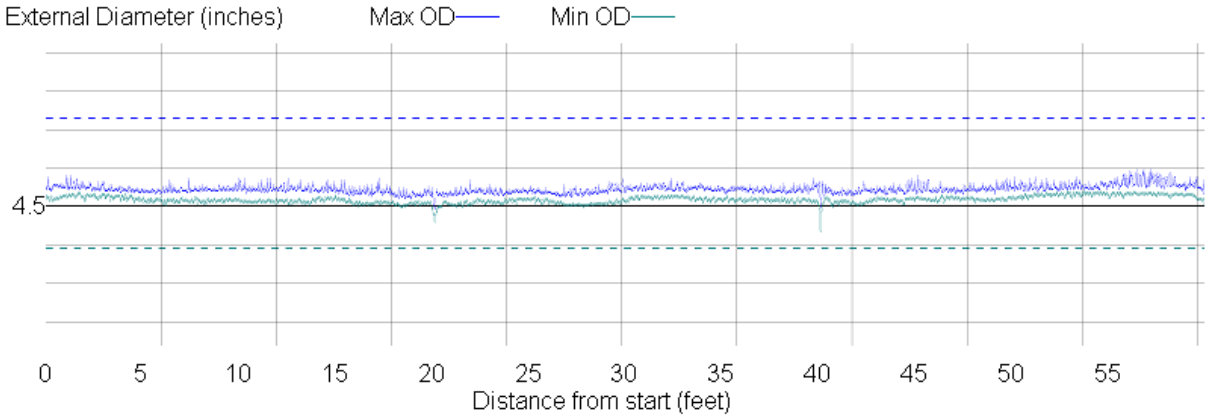
Convection Tube 2 - Internal Diameter



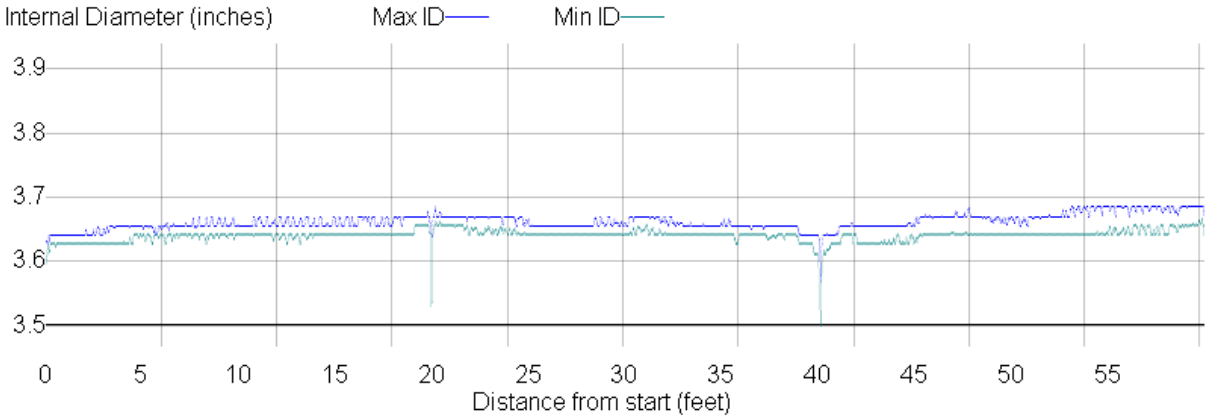
Convection Tube 2 - Average & Min Wall Thickness



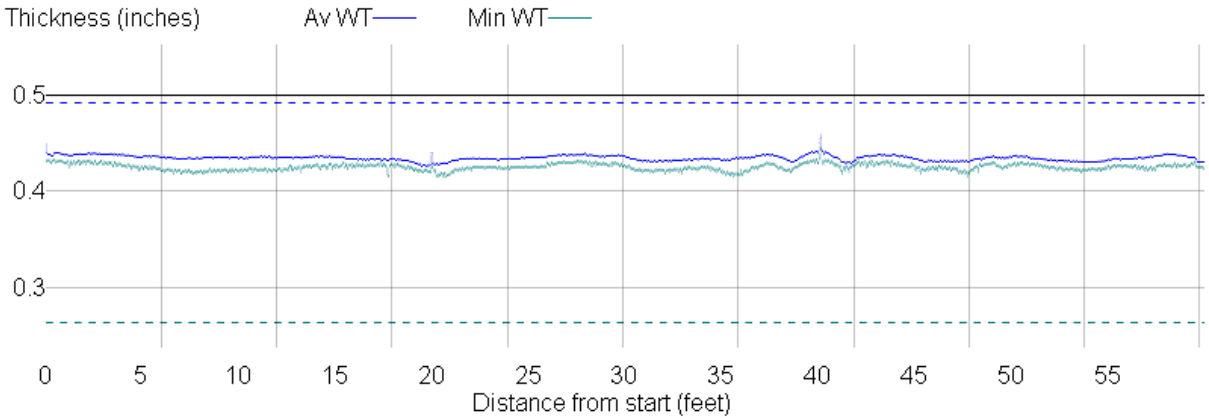
Convection Tube 2 - Outside Diameter



Convection Tube 3 - Internal Diameter



Convection Tube 3 - Average & Min Wall Thickness



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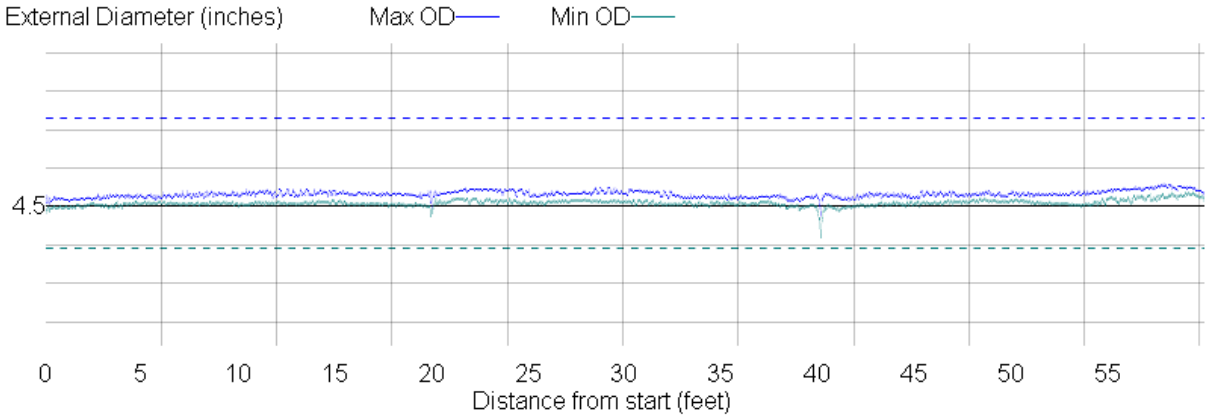
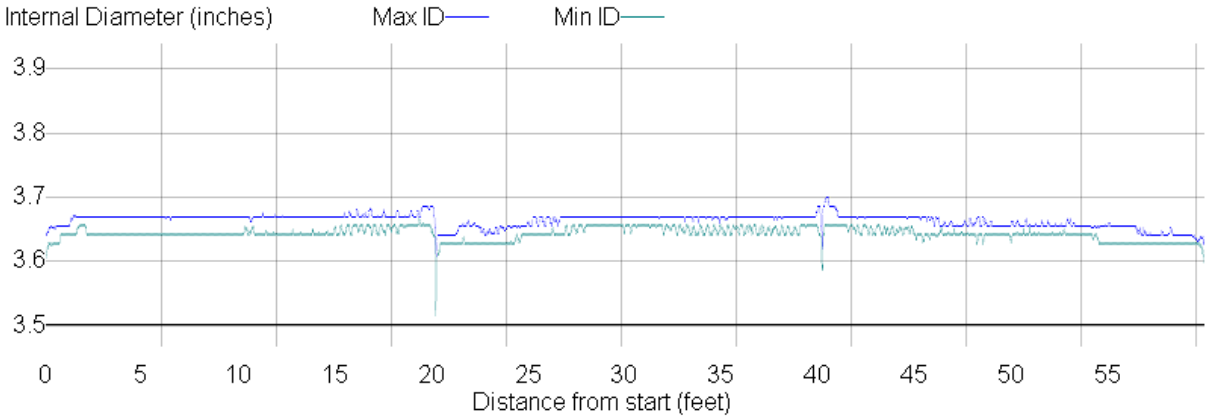
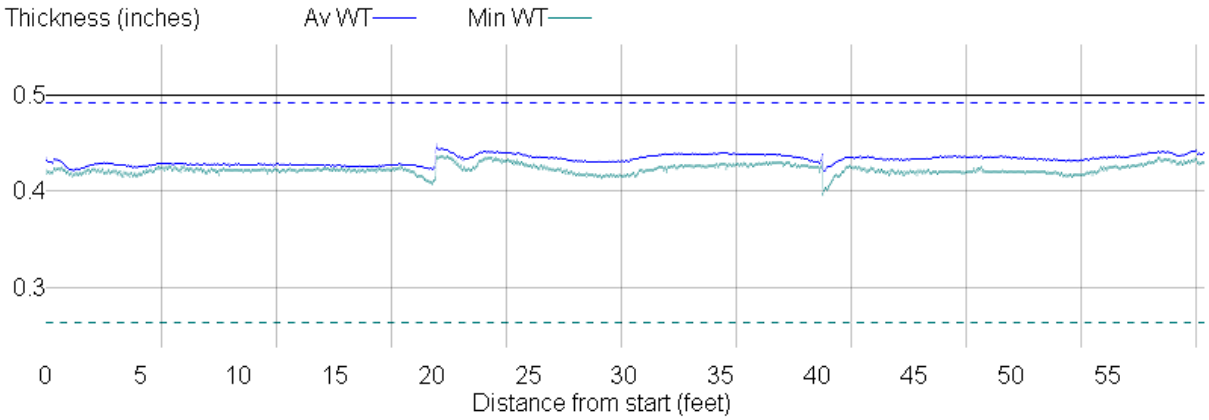


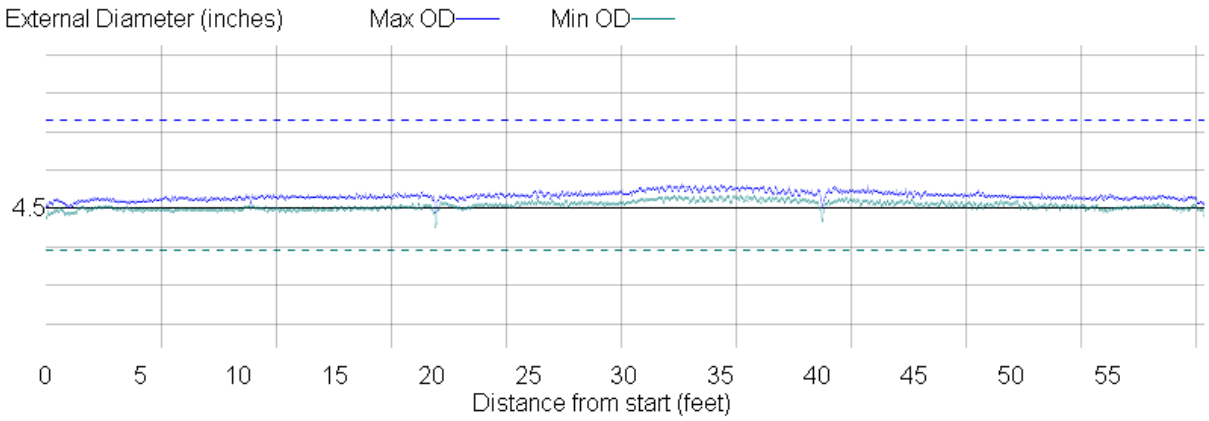
Convection Tube 4 - Internal Diameter



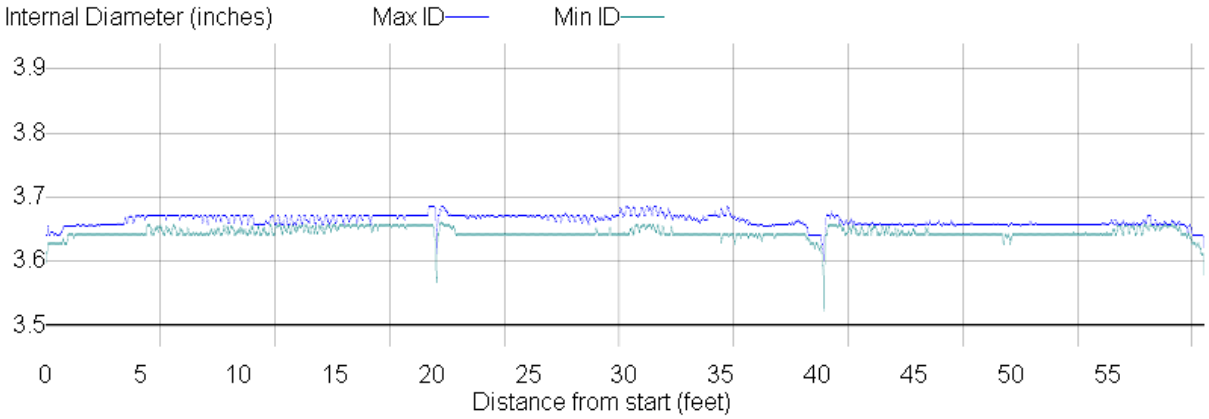
Convection Tube 4 - Average & Min Wall Thickness



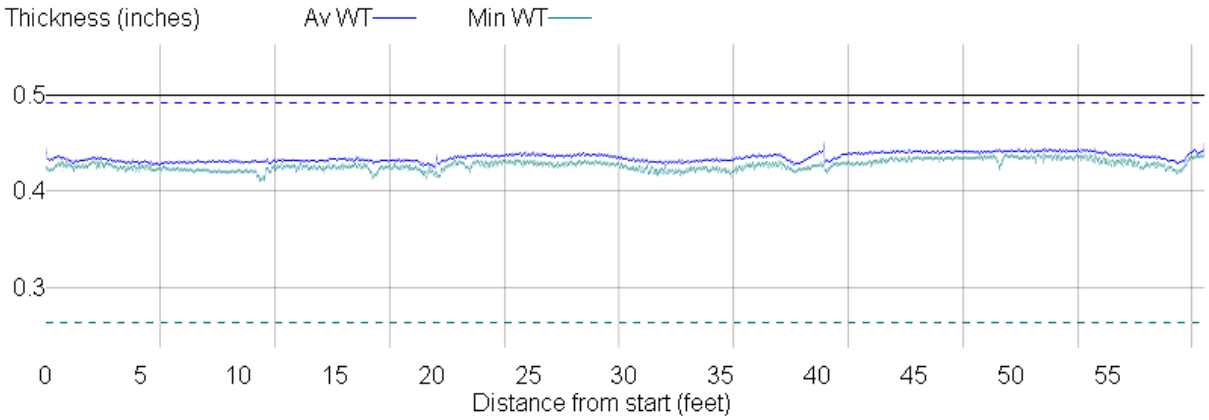
Convection Tube 4 - Outside Diameter



Convection Tube 5 - Internal Diameter



Convection Tube 5 - Average & Min Wall Thickness



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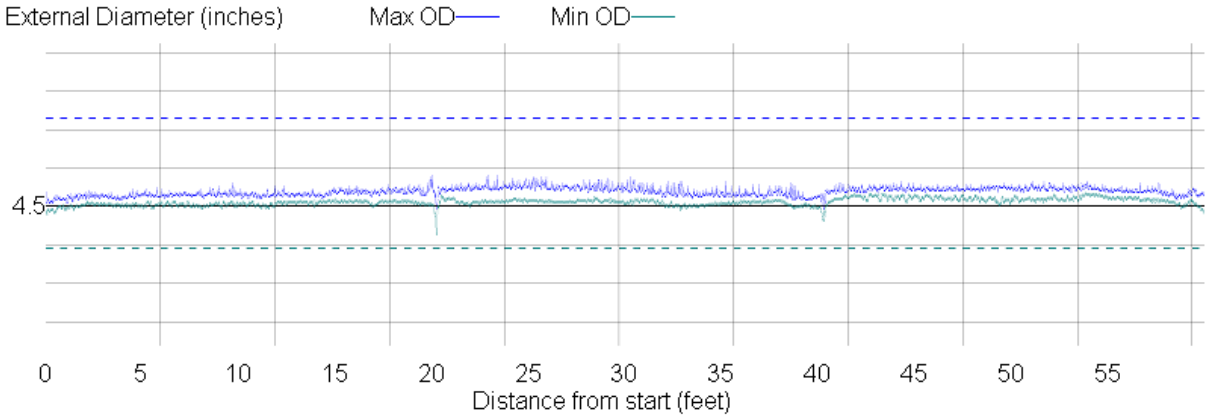

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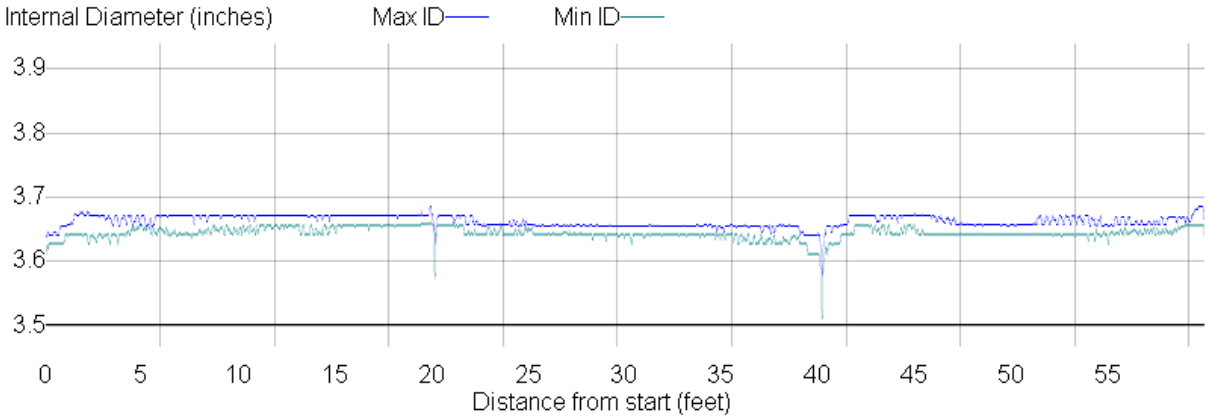
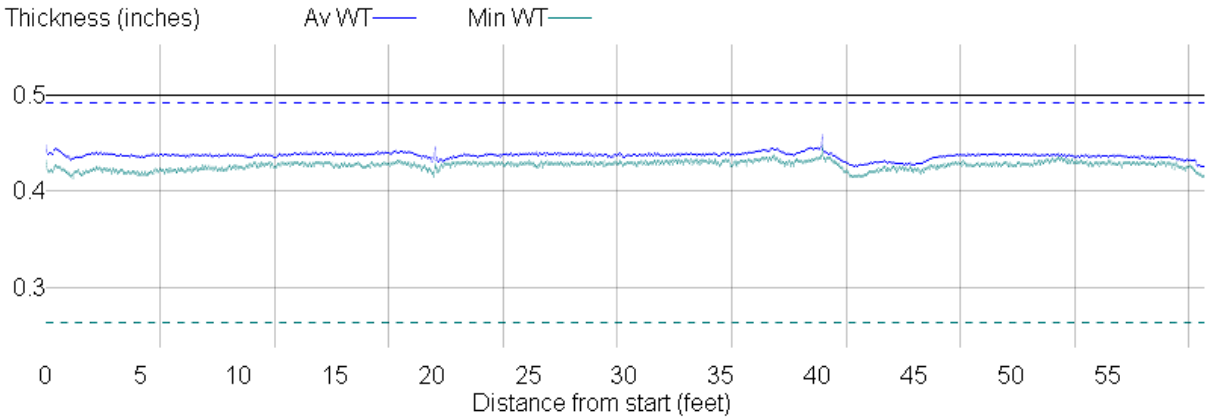


Convection Tube 6 - Average & Min Wall Thickness



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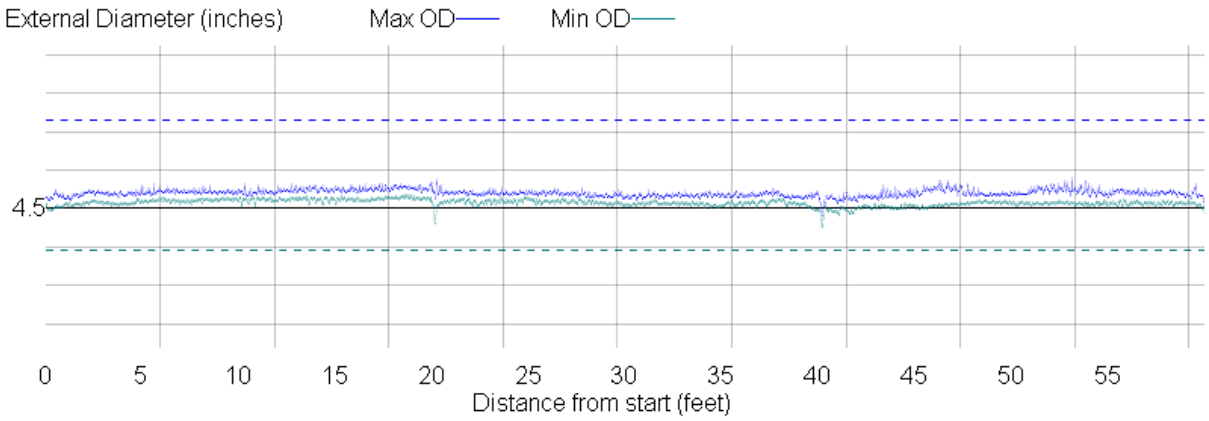
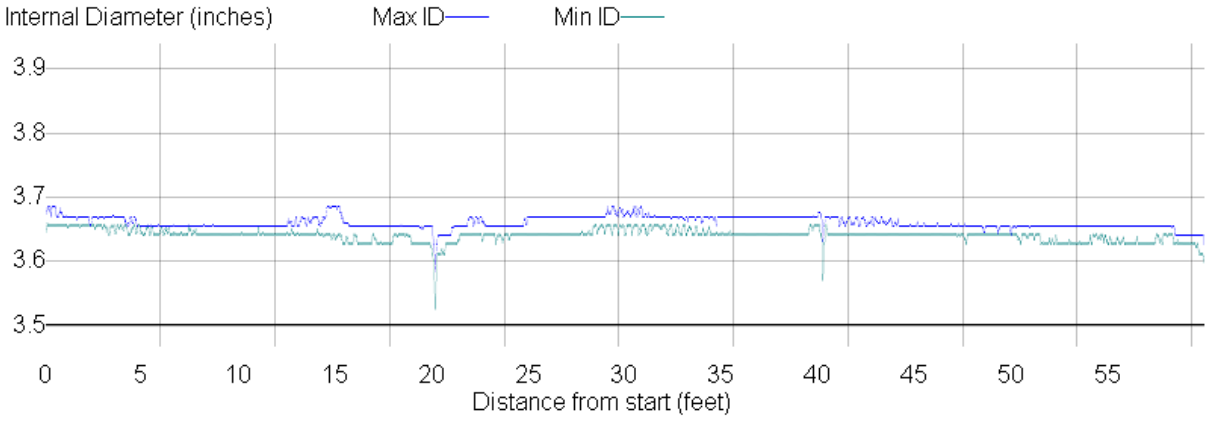
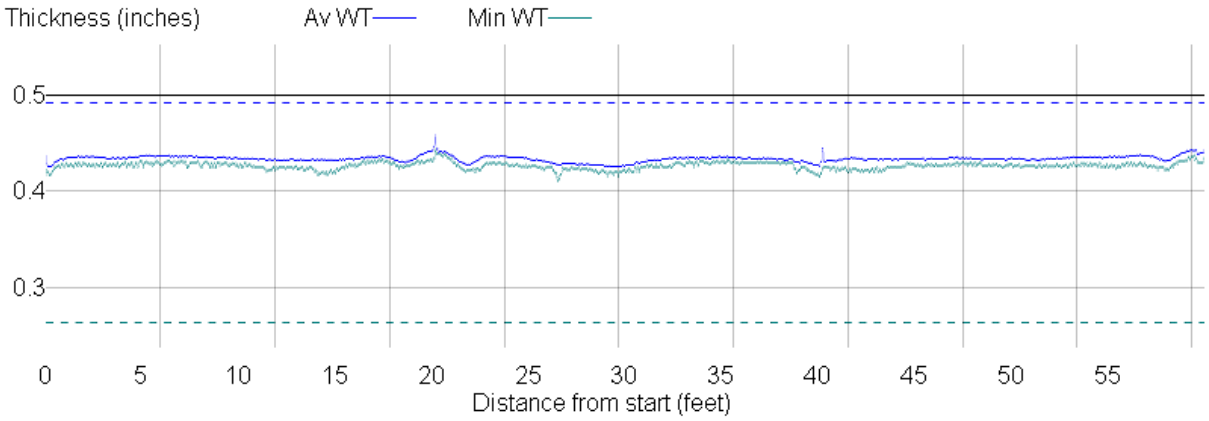


Convection Tube 7 - Internal Diameter



Convection Tube 7 - Average & Min Wall Thickness



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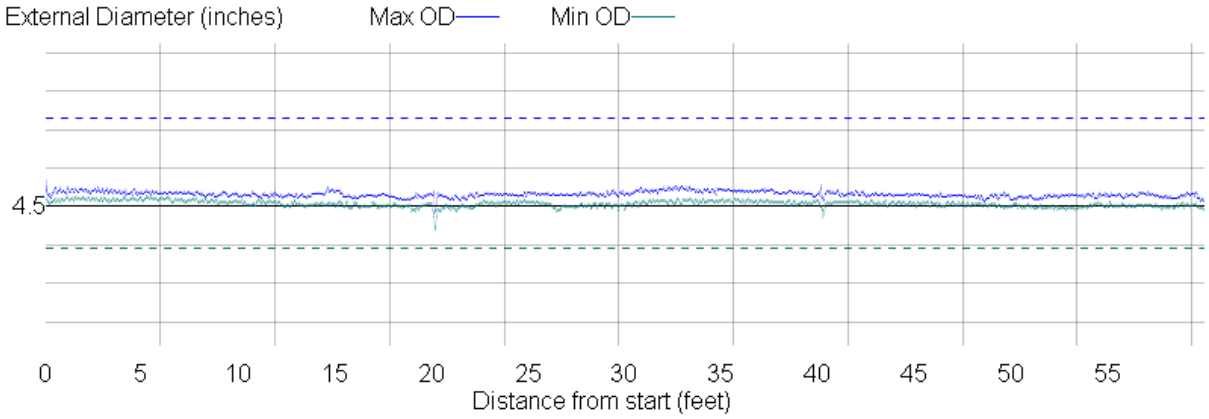
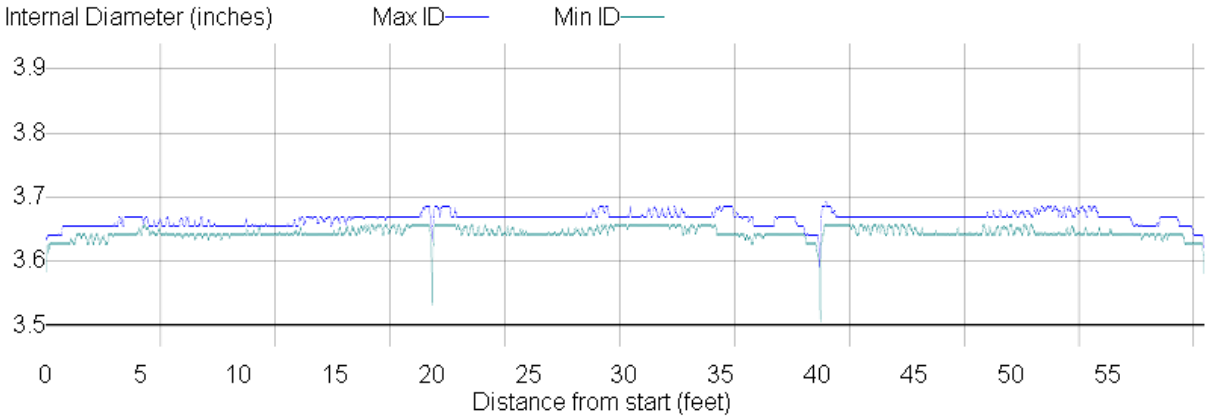
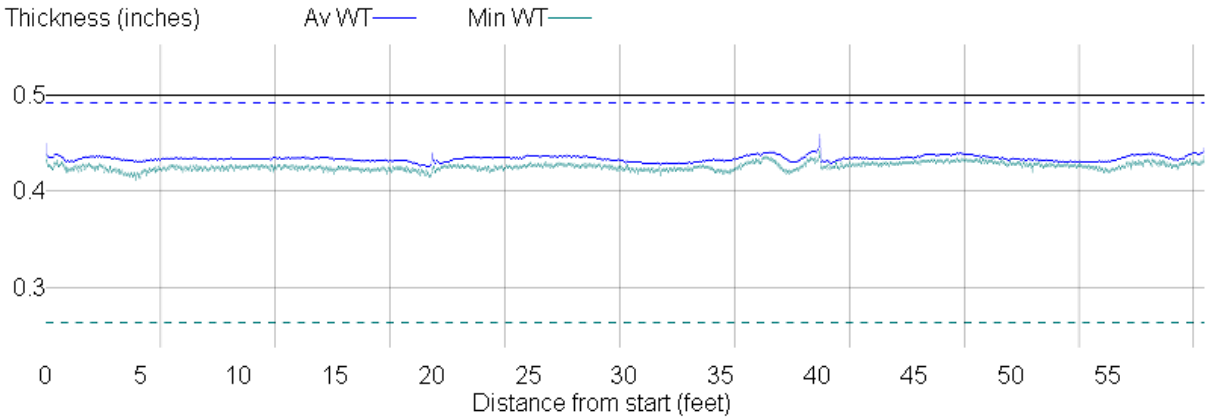


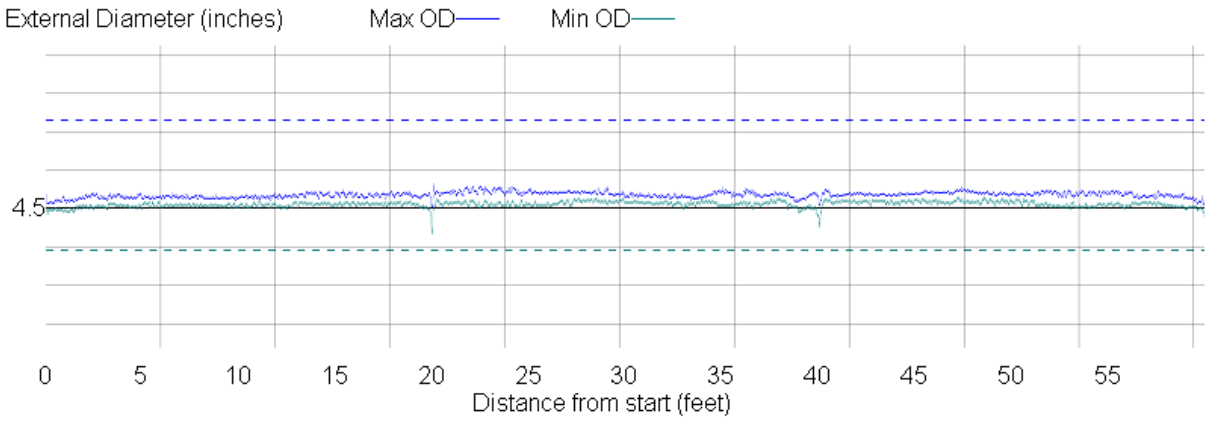
Convection Tube 8 - Internal Diameter



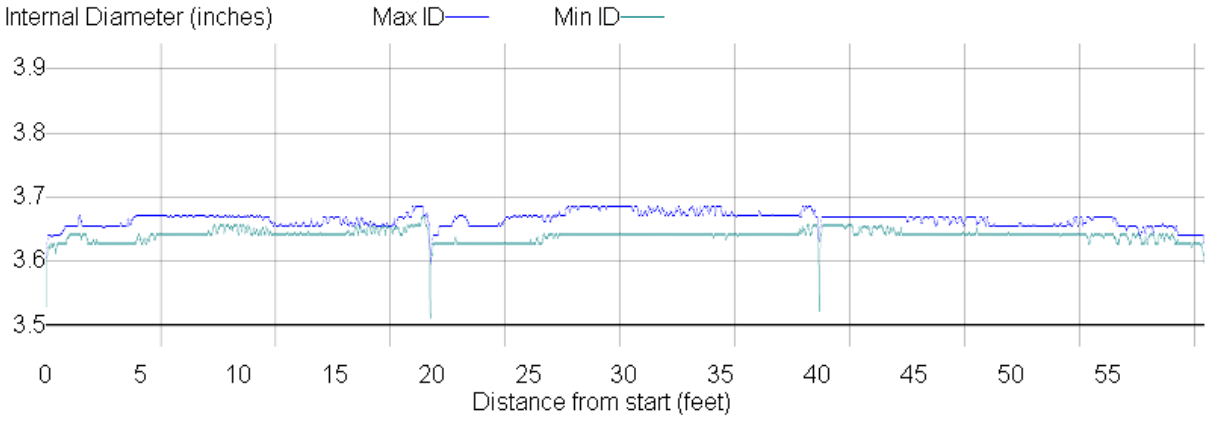
Convection Tube 8 - Average & Min Wall Thickness



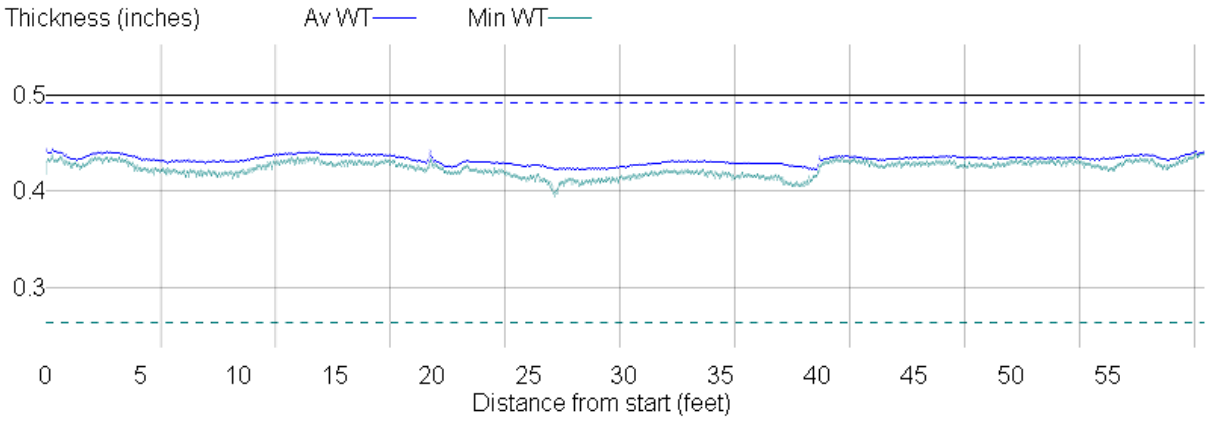
Convection Tube 8 - Outside Diameter



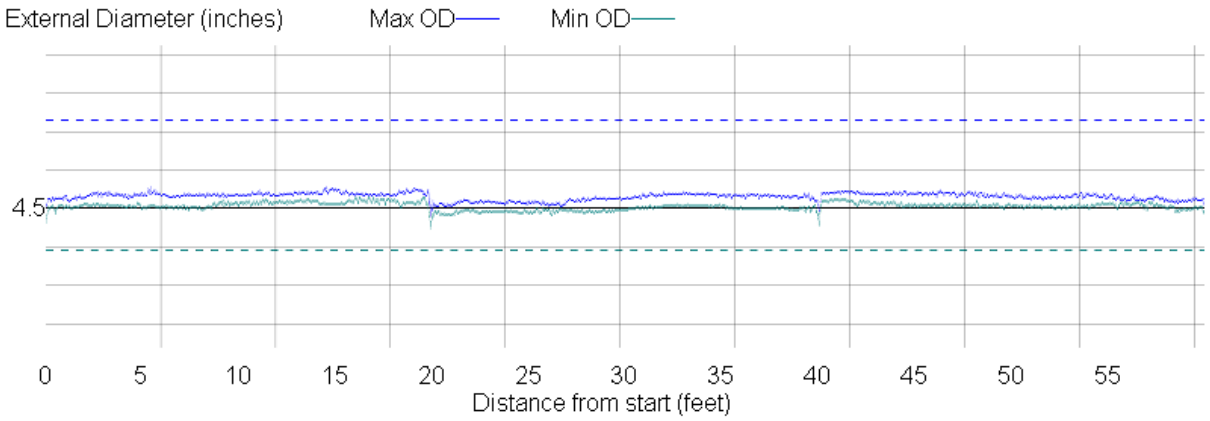
Convection Tube 9 - Internal Diameter



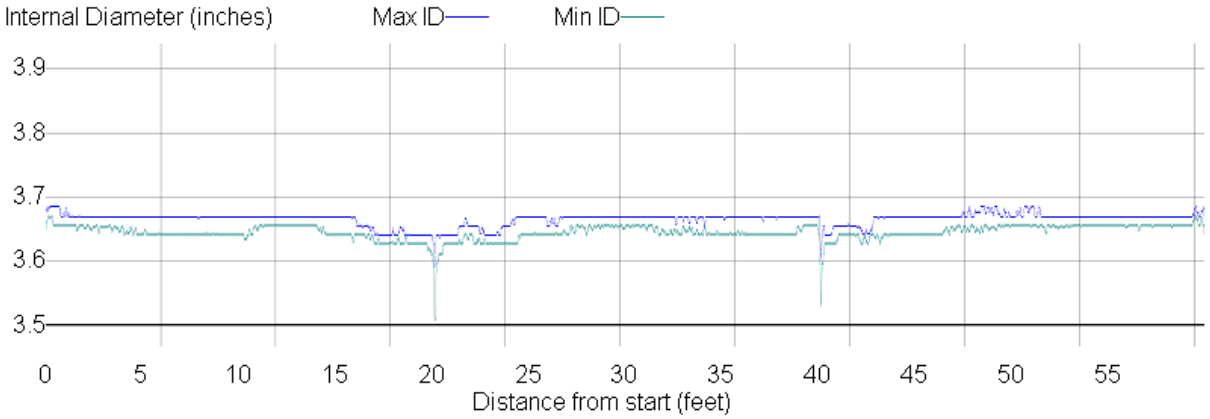
Convection Tube 9 - Average & Min Wall Thickness



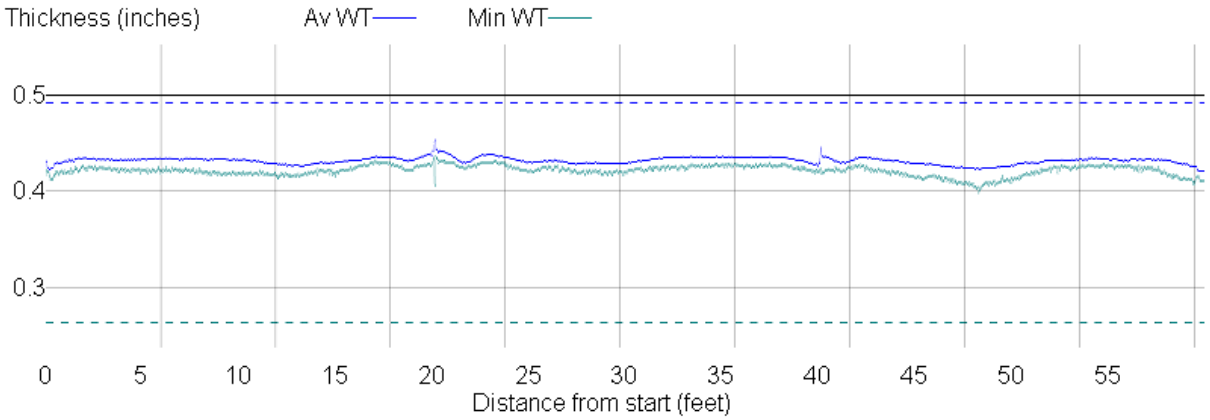
Convection Tube 9 - Outside Diameter



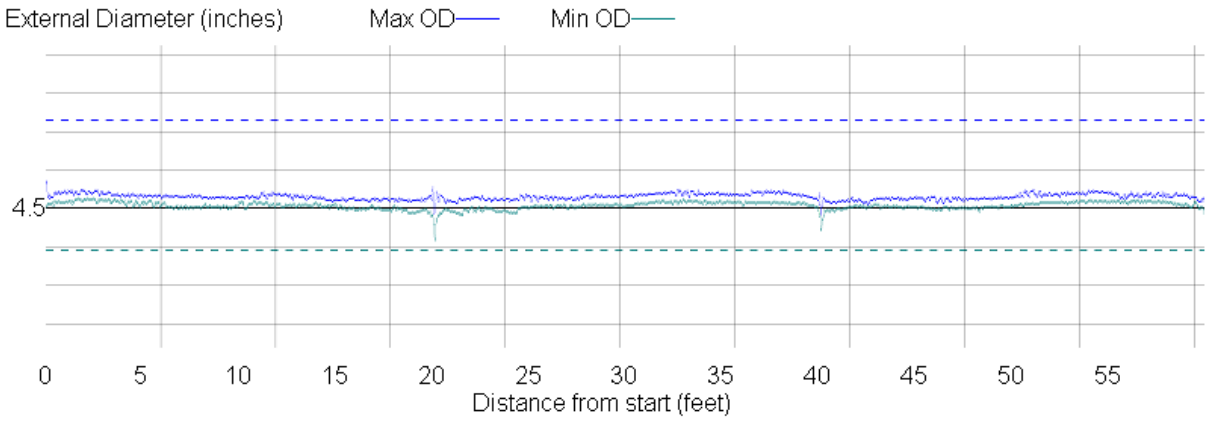
Convection Tube 10 - Internal Diameter



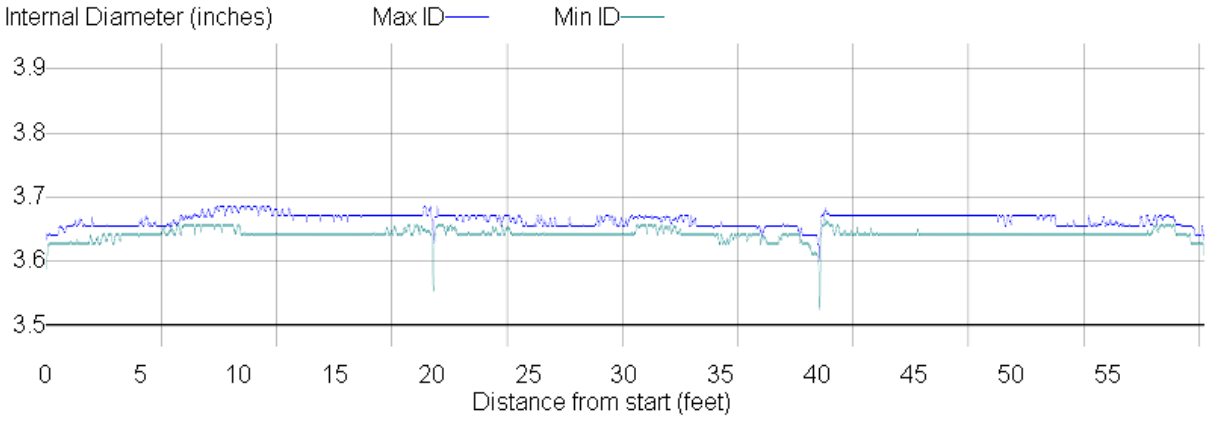
Convection Tube 10 - Average & Min Wall Thickness



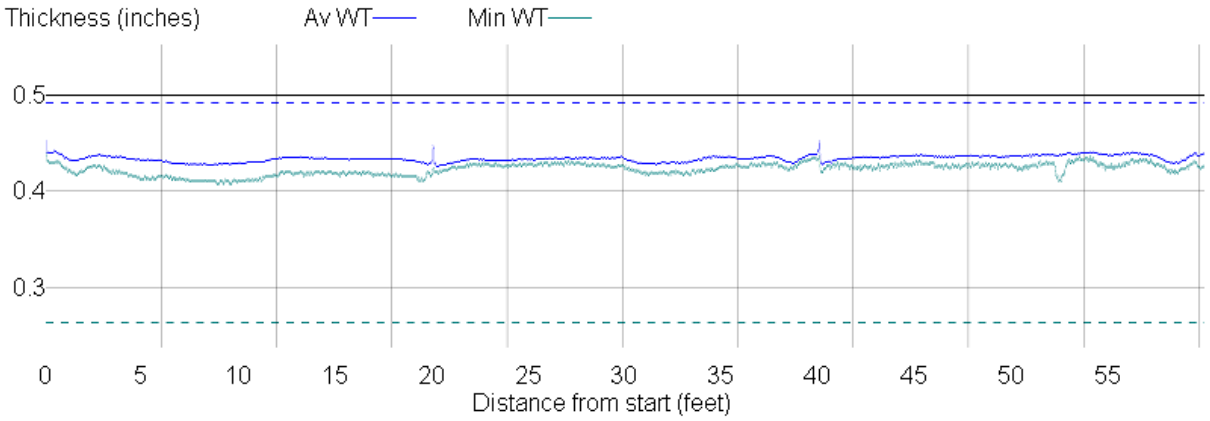
Convection Tube 10 - Outside Diameter



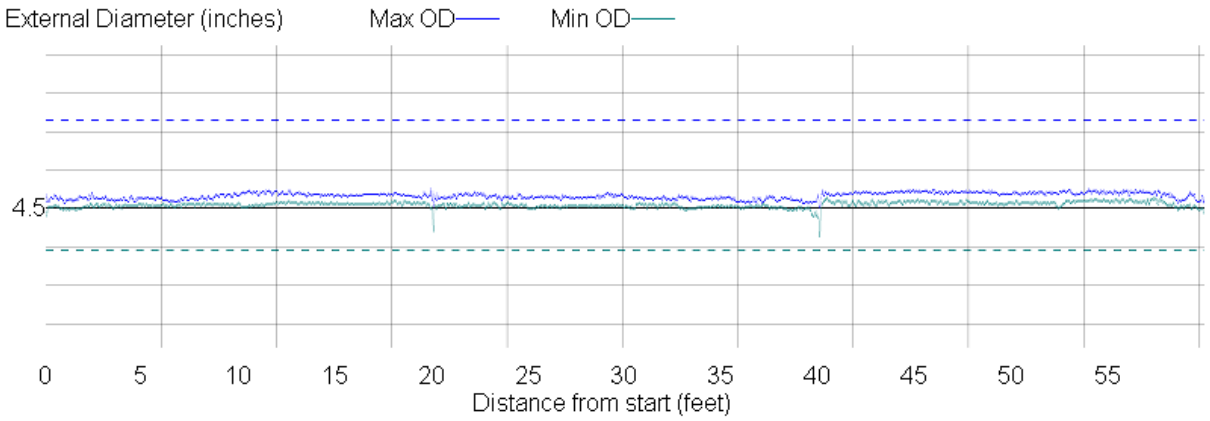
Convection Tube 11 - Internal Diameter



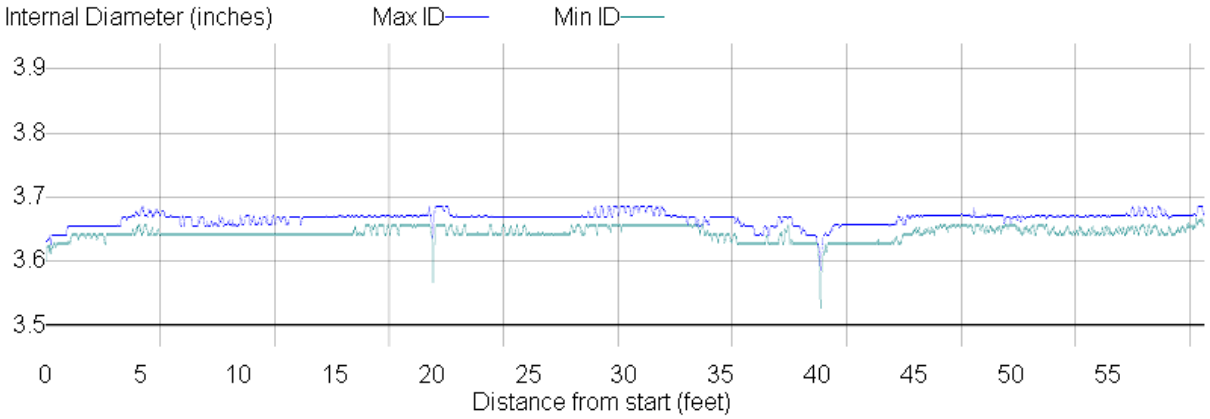
Convection Tube 11 - Average & Min Wall Thickness



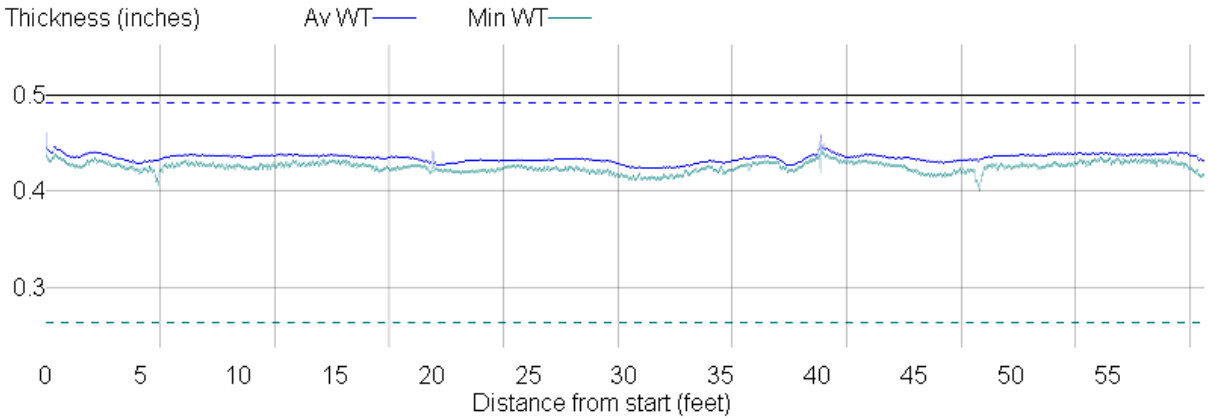
Convection Tube 11 - Outside Diameter



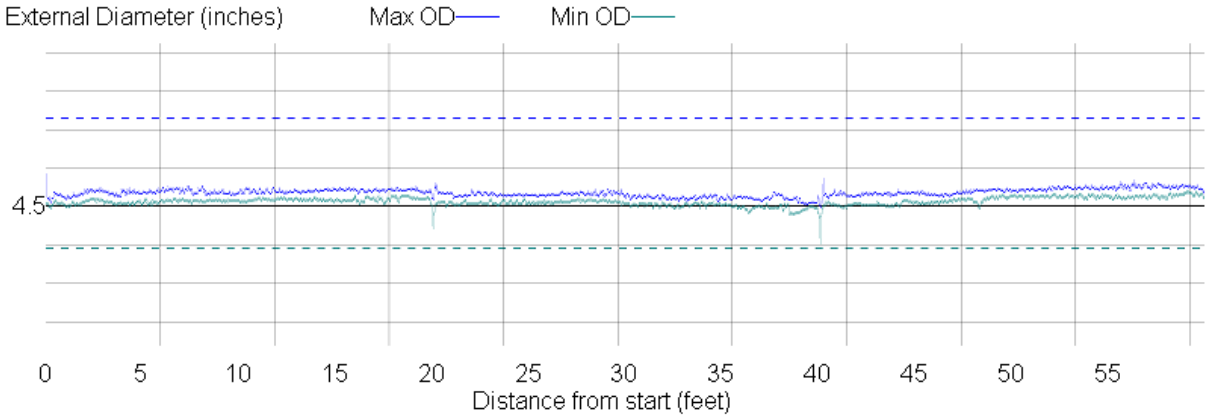
Convection Tube 12 - Internal Diameter



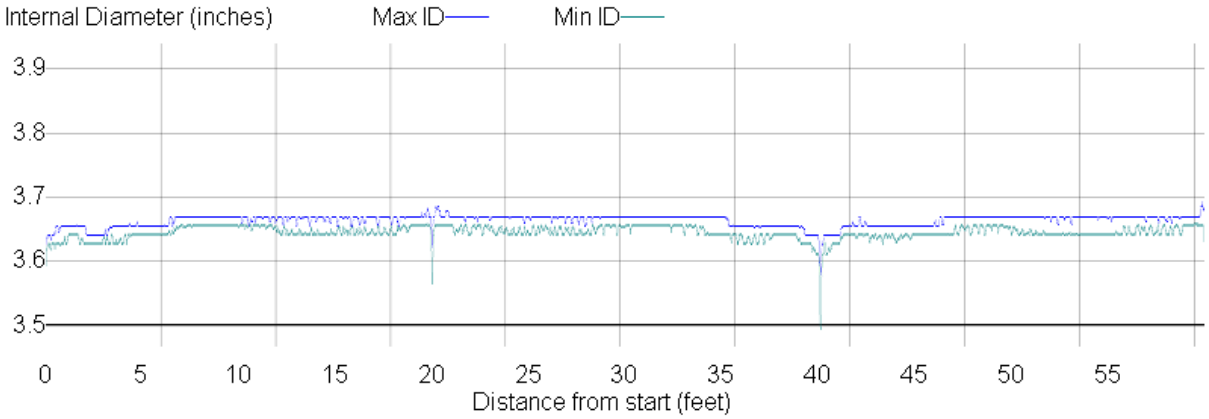
Convection Tube 12 - Average & Min Wall Thickness



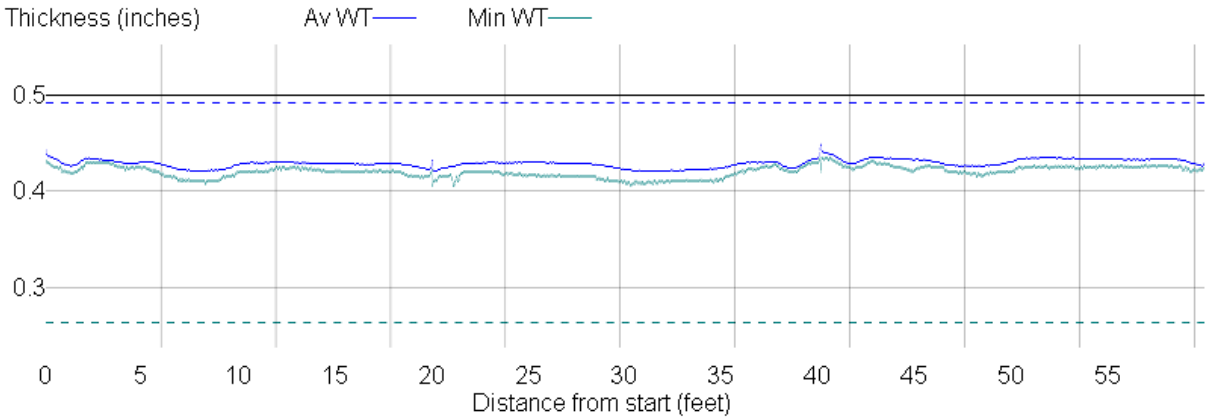
Convection Tube 12 - Outside Diameter



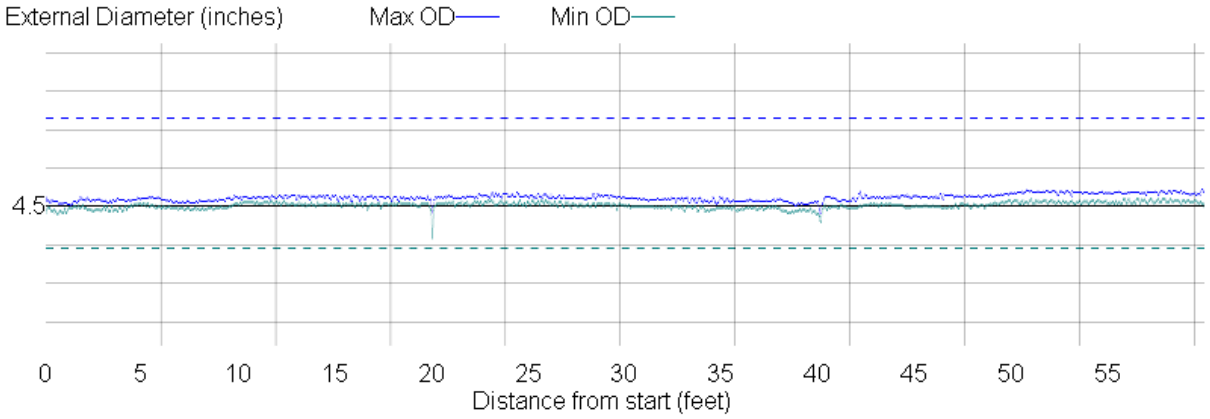
Convection Tube 13 - Internal Diameter



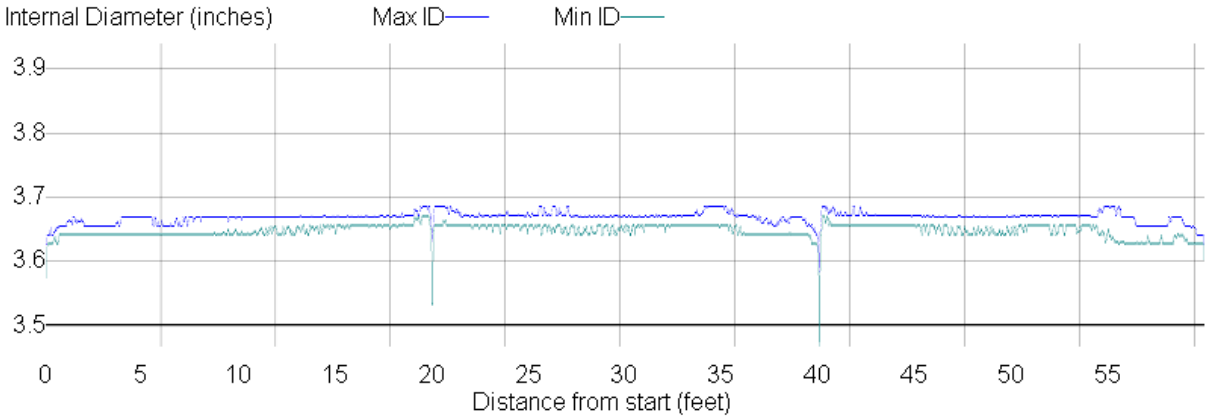
Convection Tube 13 - Average & Min Wall Thickness



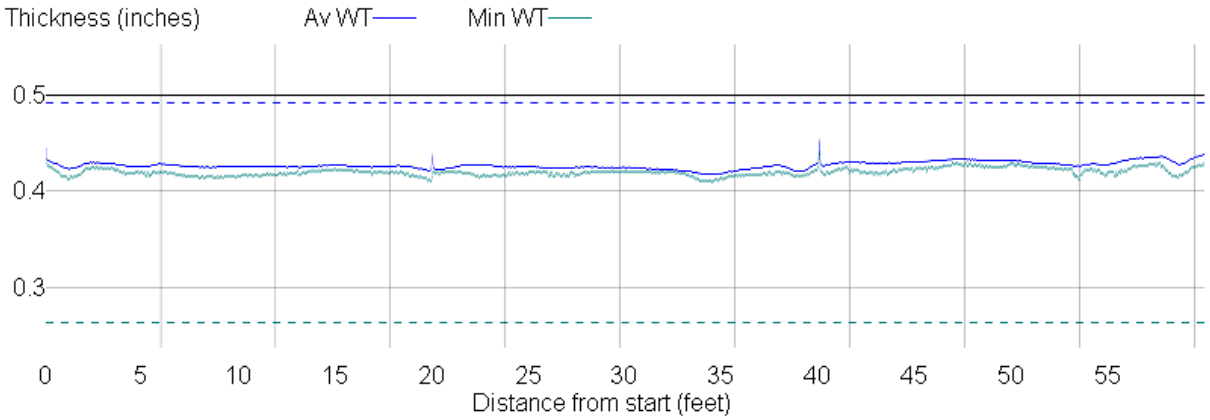
Convection Tube 13 - Outside Diameter



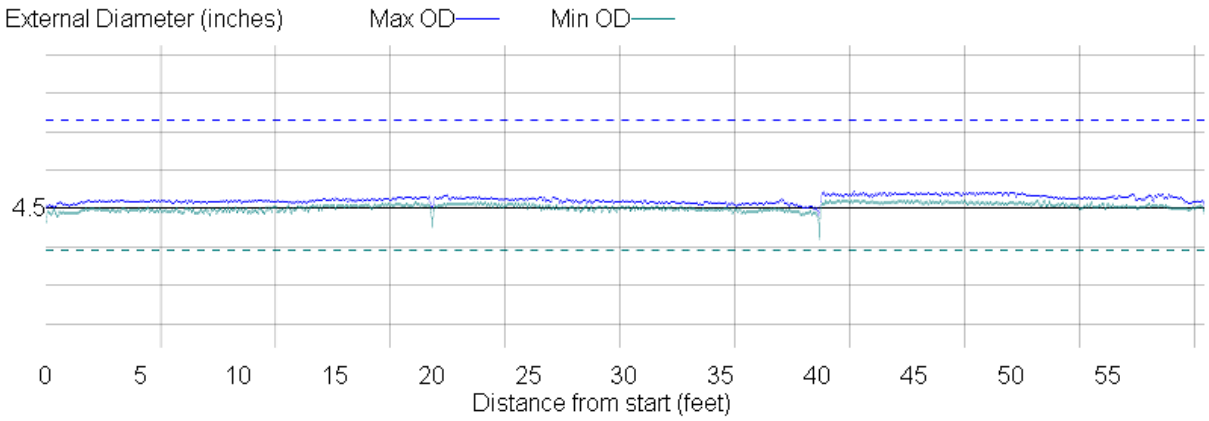
Convection Tube 14 - Internal Diameter



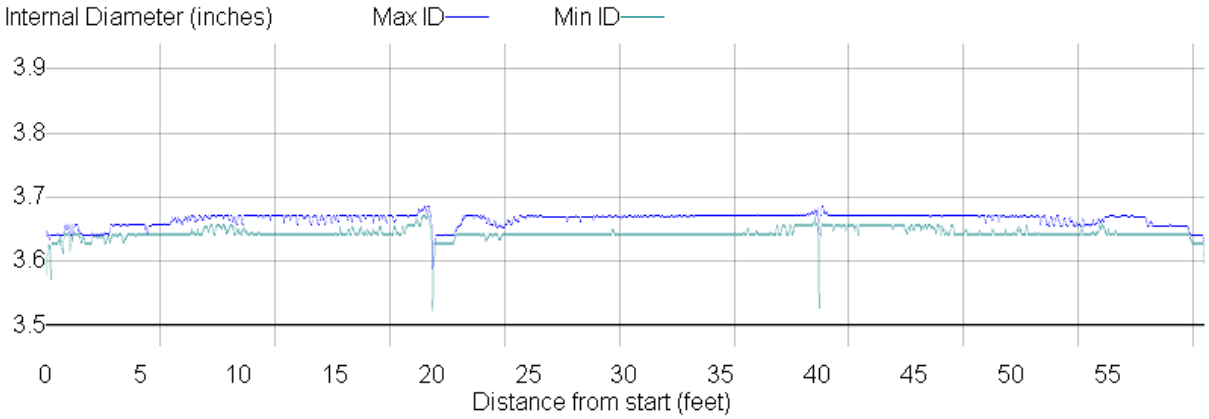
Convection Tube 14 - Average & Min Wall Thickness



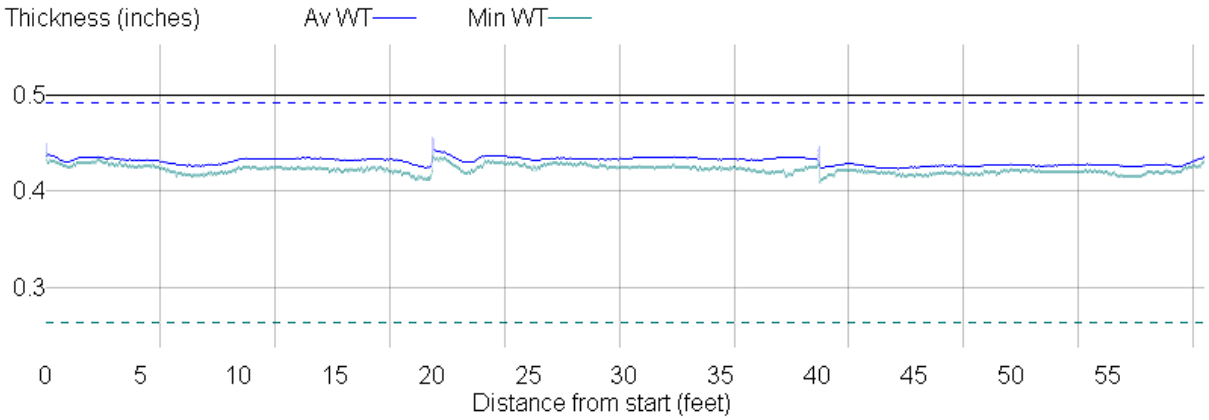
Convection Tube 14 - Outside Diameter



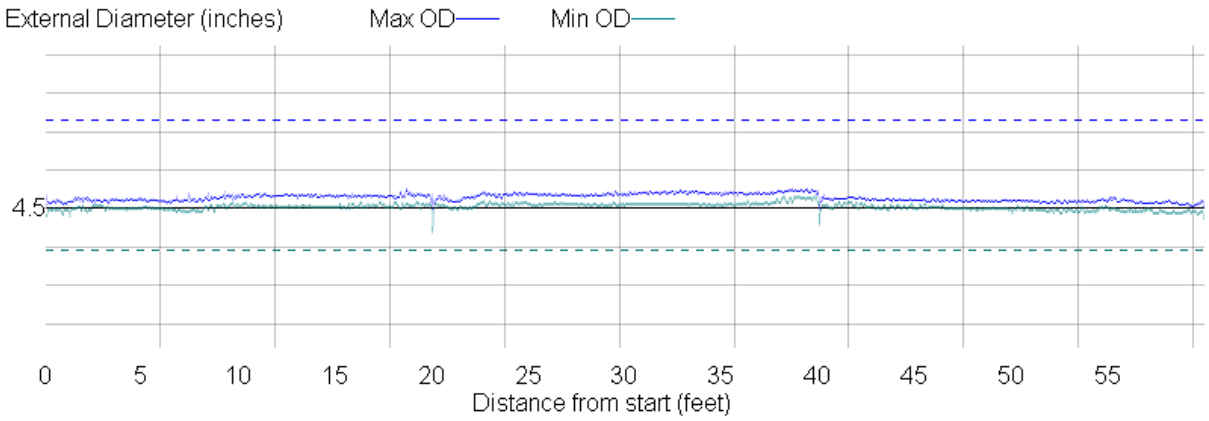
Convection Tube 15 - Internal Diameter



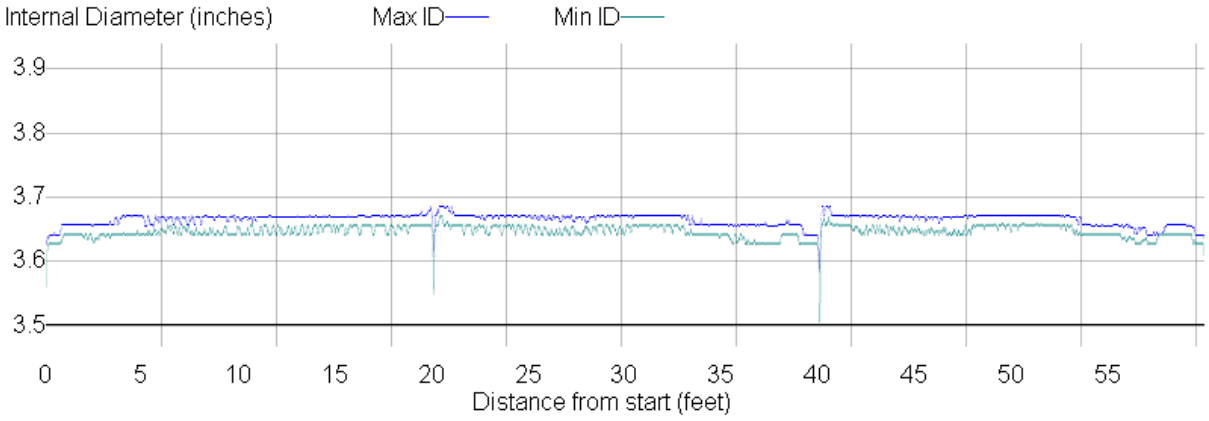
Convection Tube 15 - Average & Min Wall Thickness



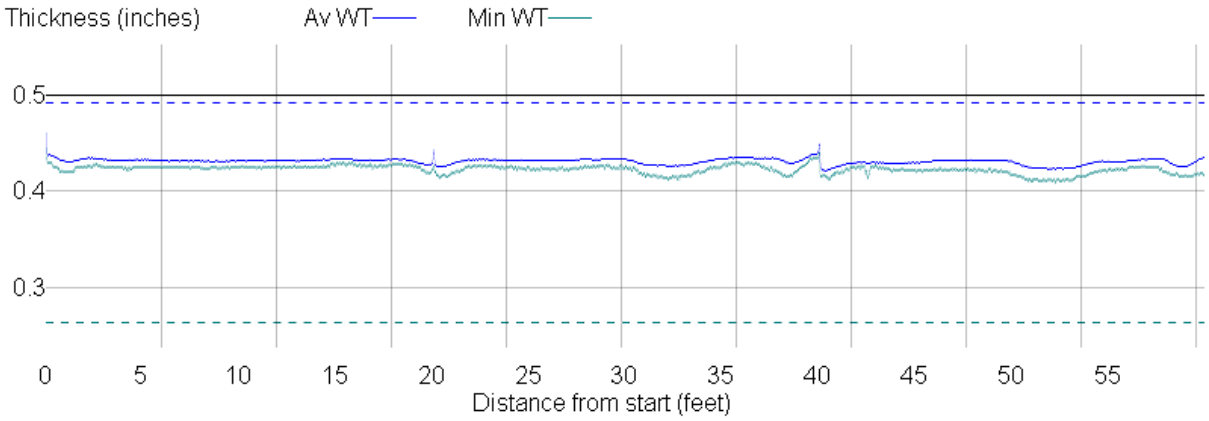
Convection Tube 15 - Outside Diameter



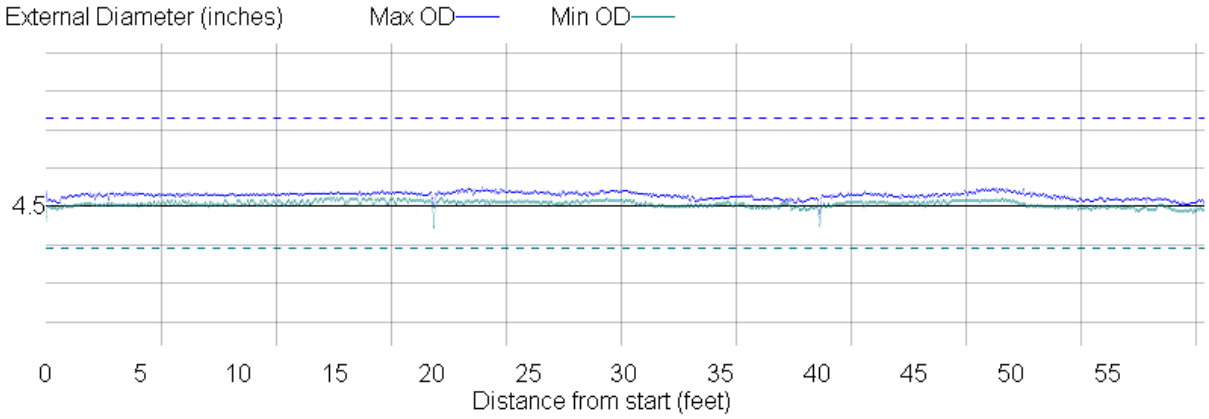
Convection Tube 16 - Internal Diameter



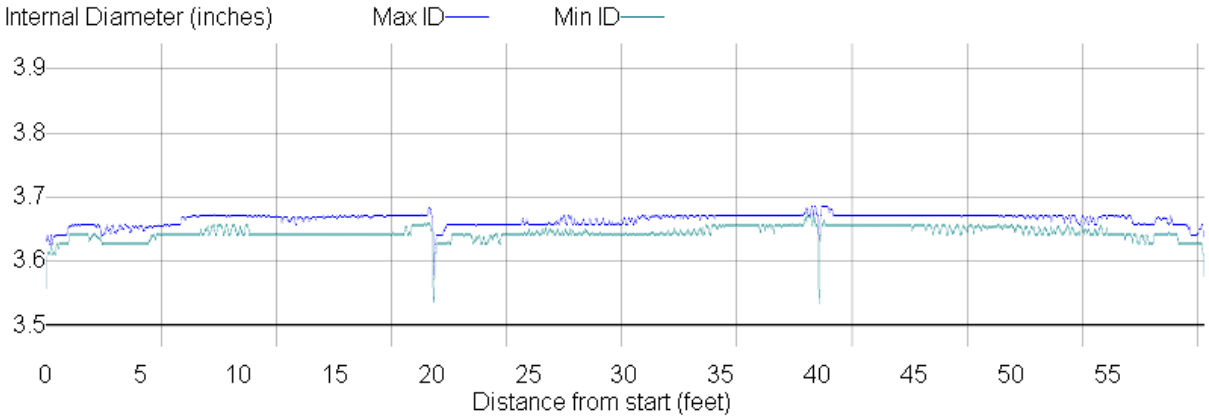
Convection Tube 16 - Average & Min Wall Thickness



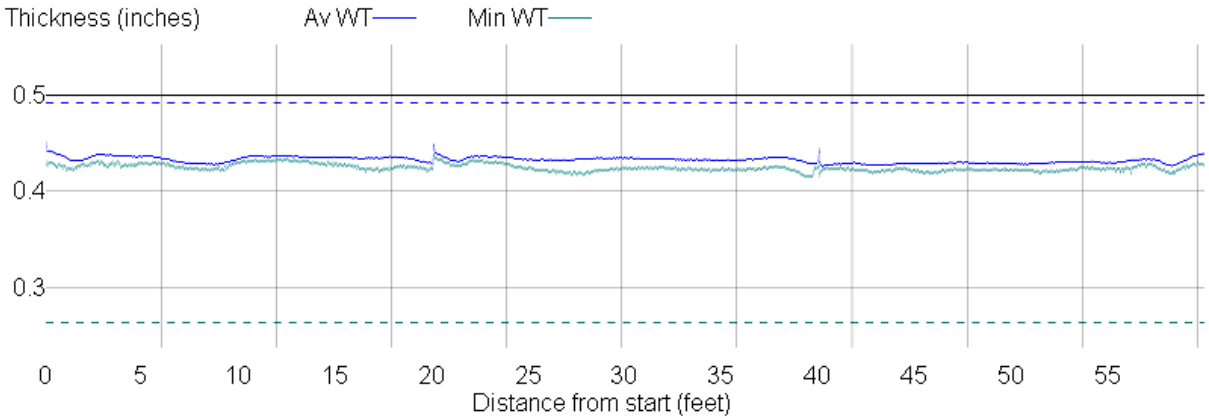
Convection Tube 16 - Outside Diameter



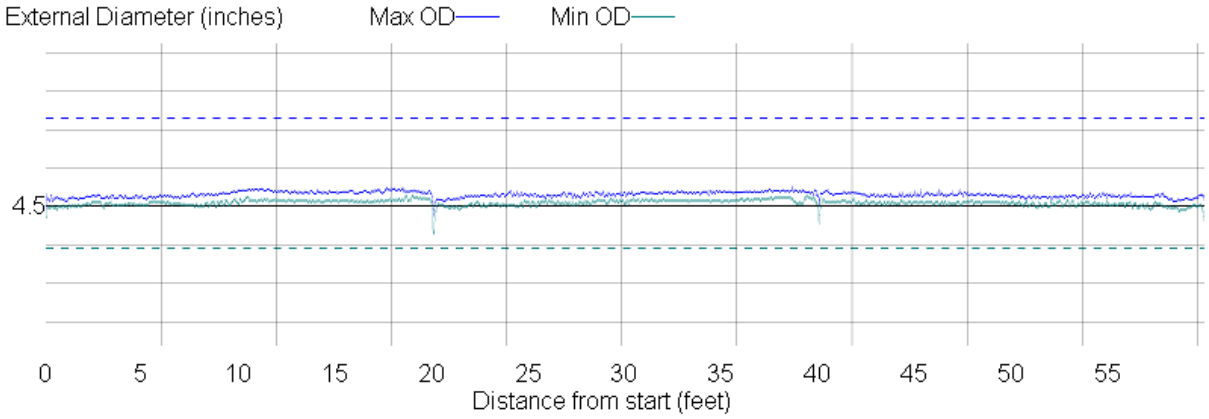
Convection Tube 17 - Internal Diameter



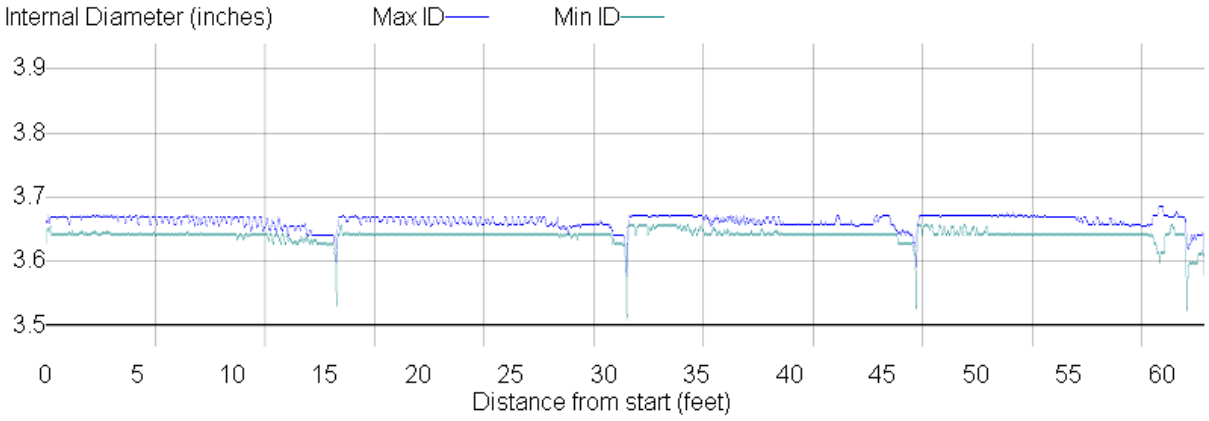
Convection Tube 17 - Average & Min Wall Thickness



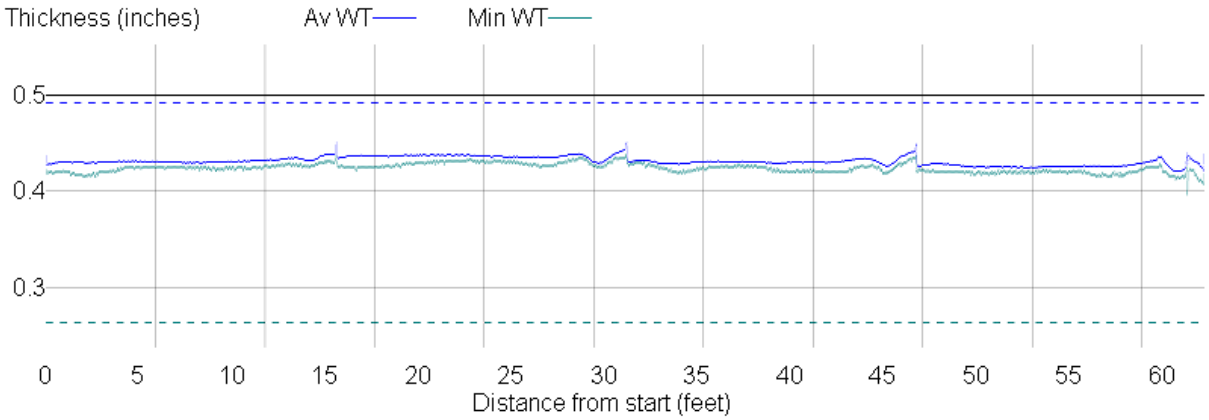
Convection Tube 17 - Outside Diameter



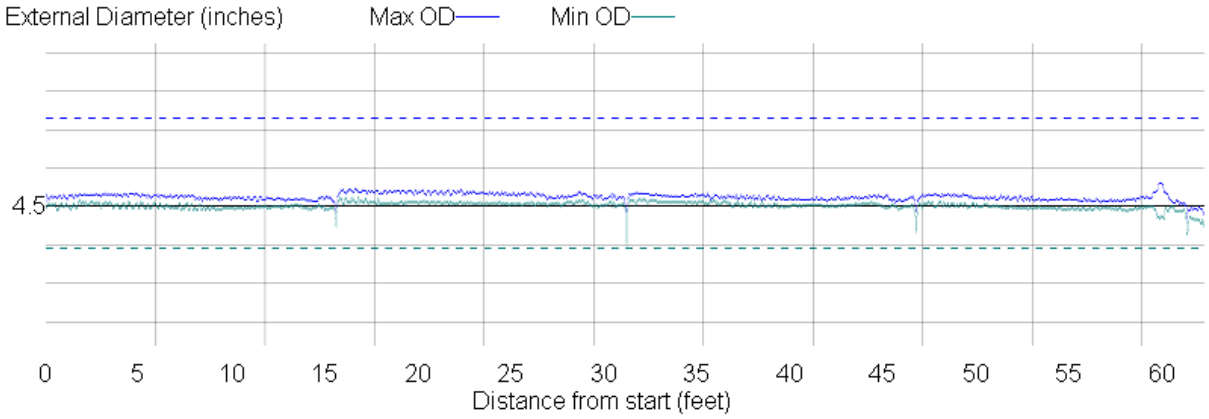
Convection Tube 18 - Internal Diameter



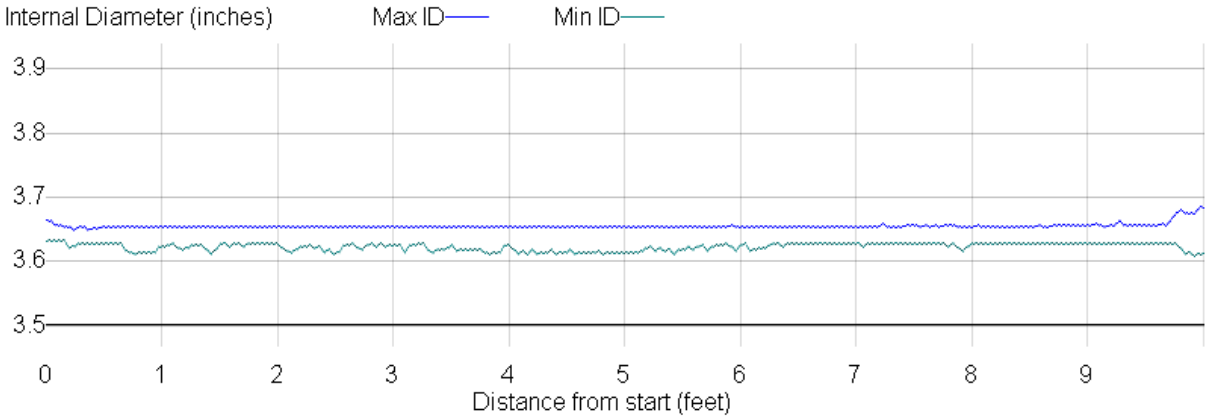
Convection Tube 18 - Average & Min Wall Thickness



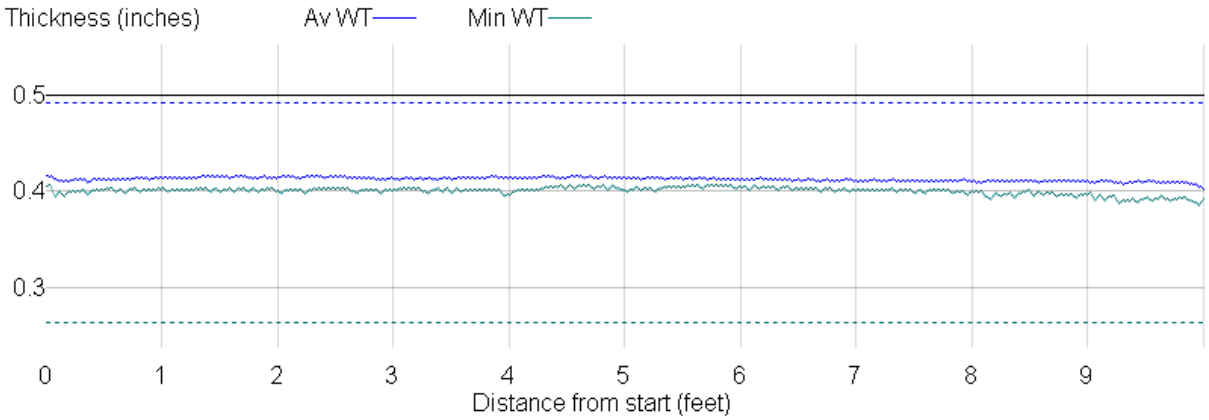
Convection Tube 18 - Outside Diameter



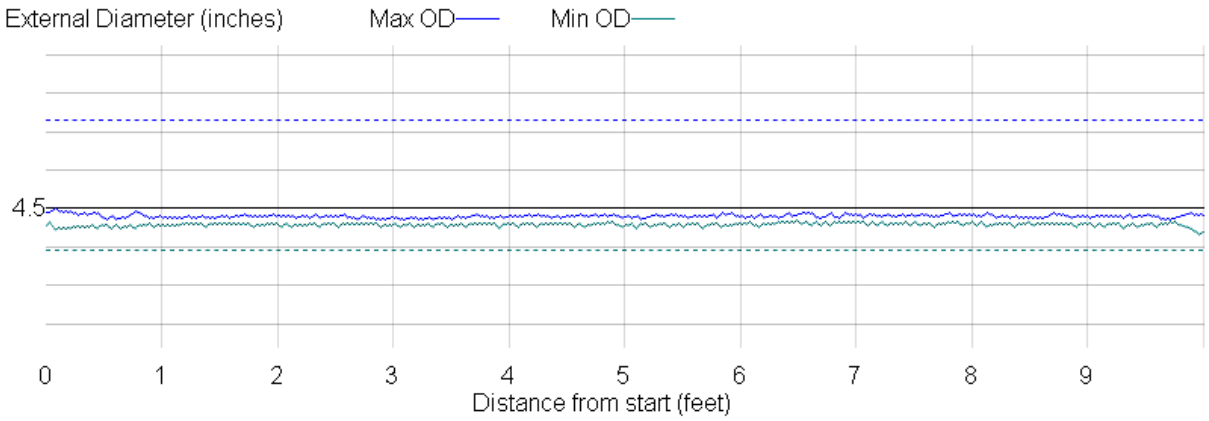
Crossover Tube 1 - Internal Diameter



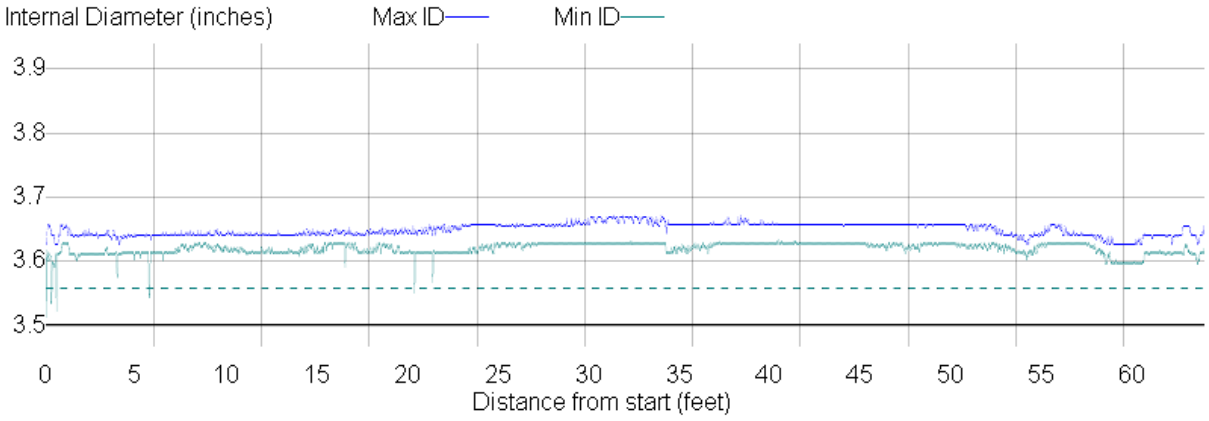
Crossover Tube 1 - Average & Min Wall Thickness



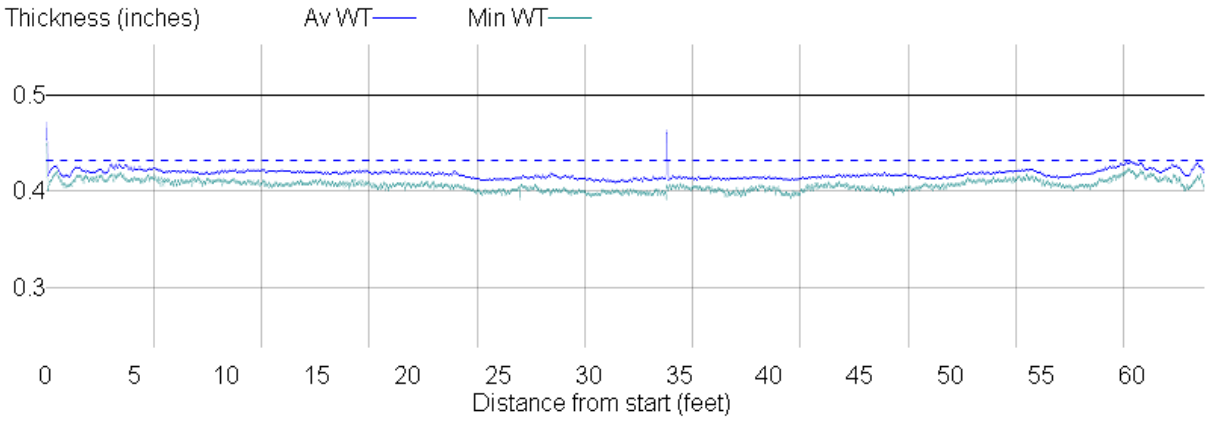
Crossover Tube 1 - Outside Diameter



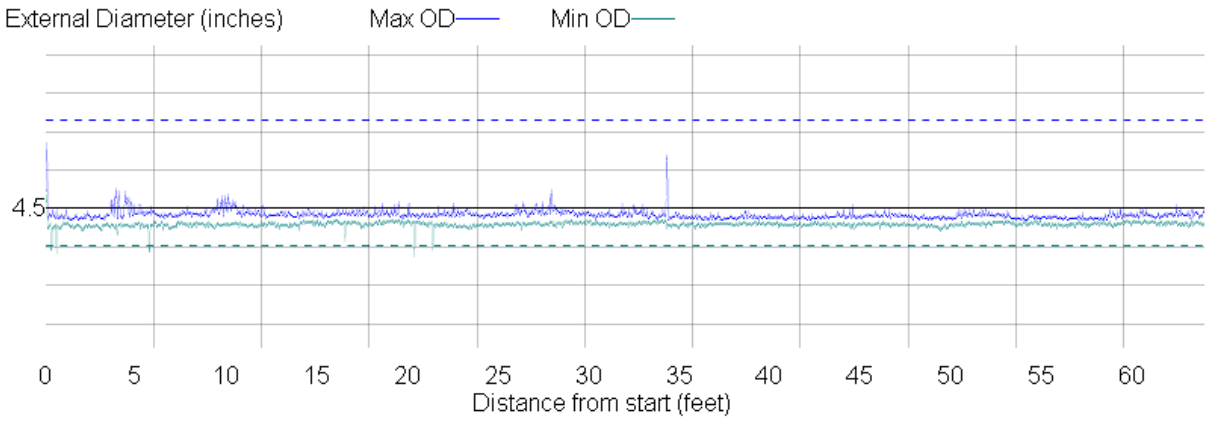
Radiant Tube 1 - Internal Diameter



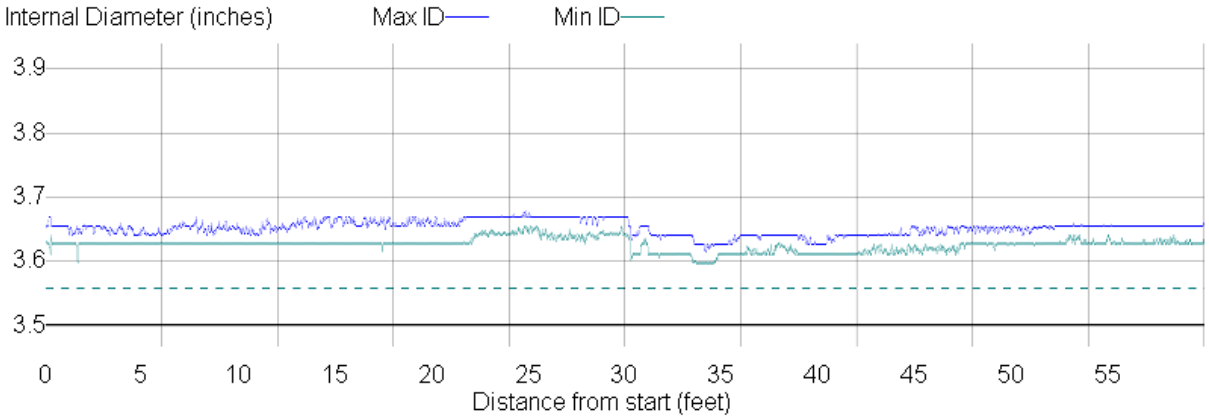
Radiant Tube 1 - Average & Min Wall Thickness



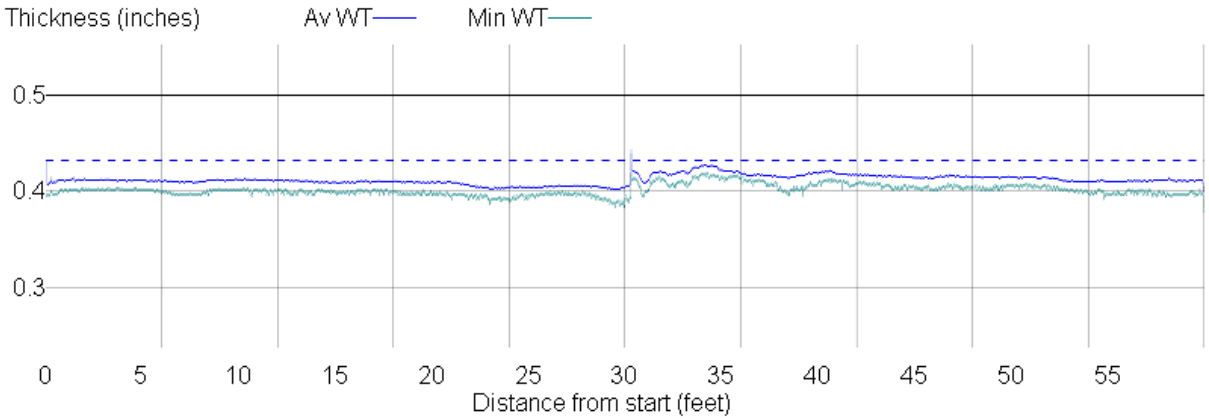
Radiant Tube 1 - Outside Diameter



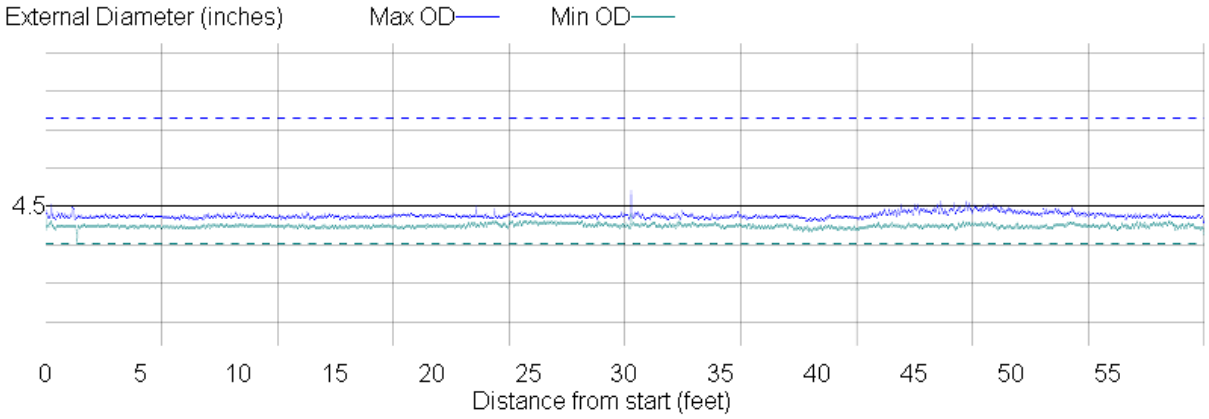
Radiant Tube 2 - Internal Diameter



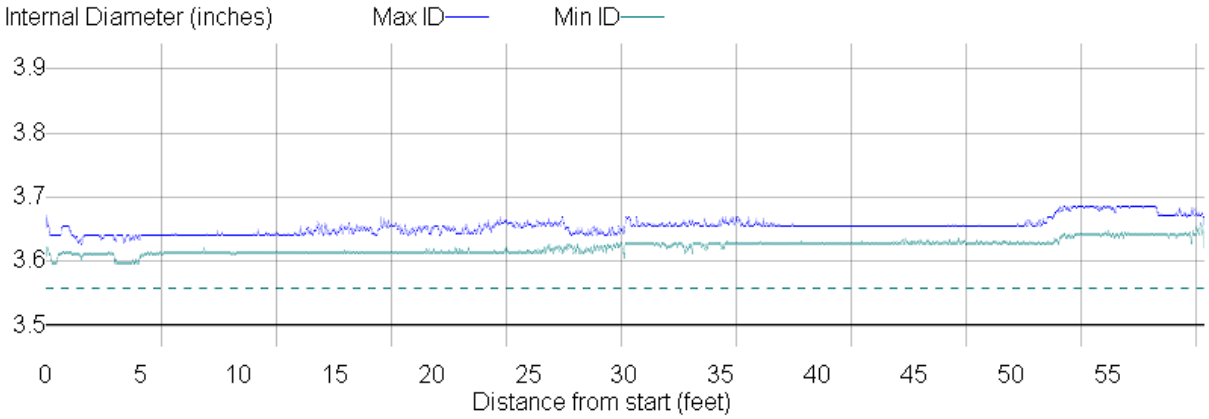
Radiant Tube 2 - Average & Min Wall Thickness



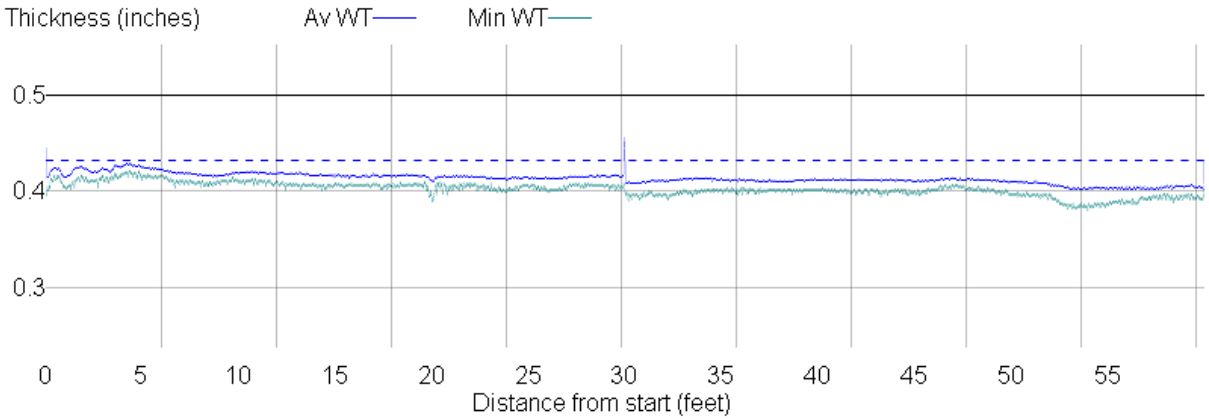
Radiant Tube 2 - Outside Diameter



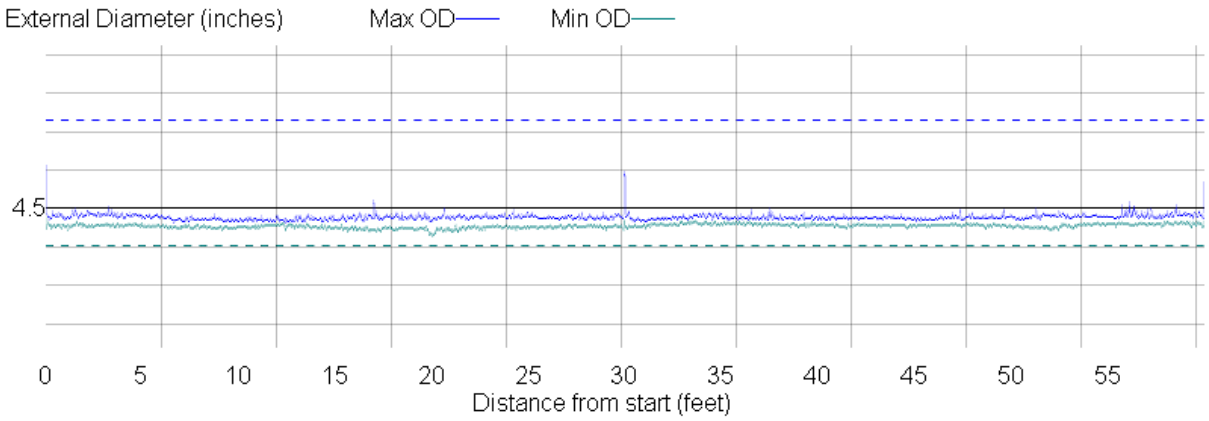
Radiant Tube 3 - Internal Diameter



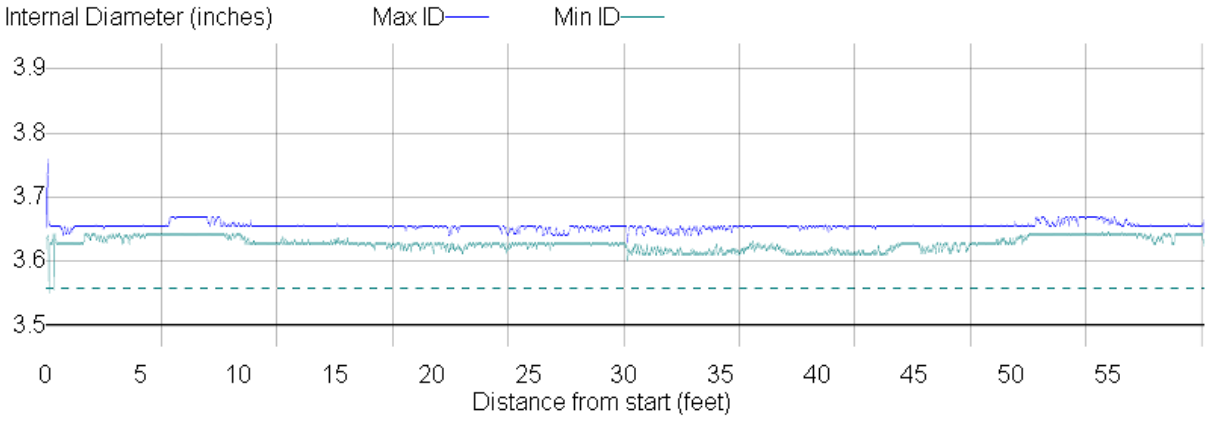
Radiant Tube 3 - Average & Min Wall Thickness



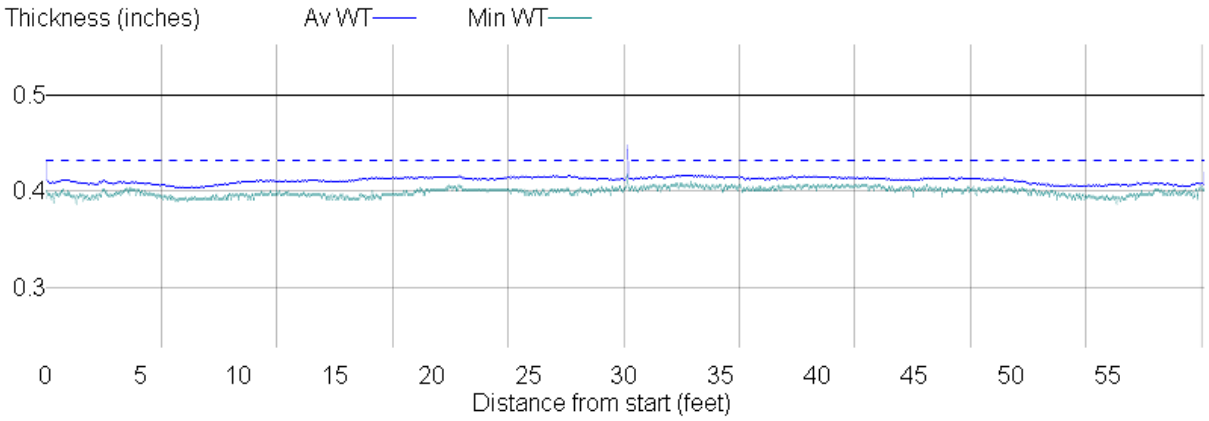
Radiant Tube 3 - Outside Diameter



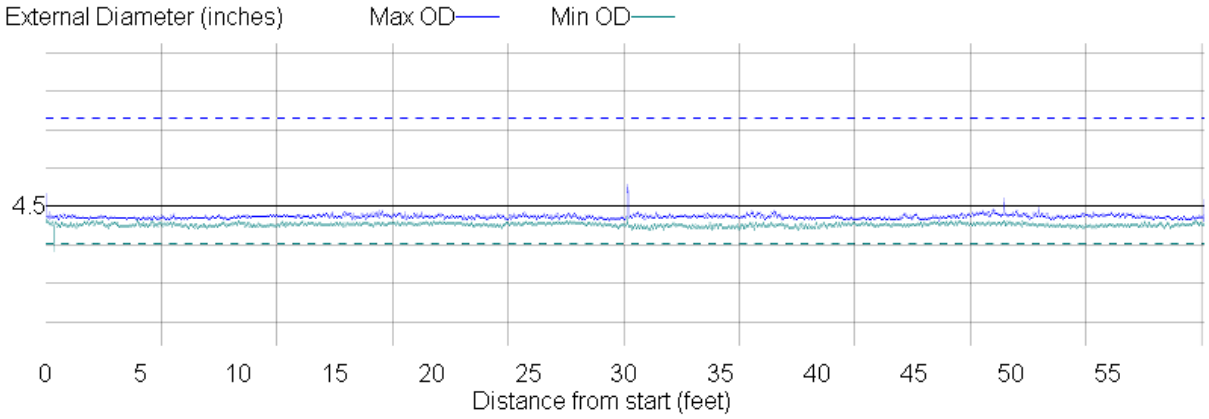
Radiant Tube 4 - Internal Diameter



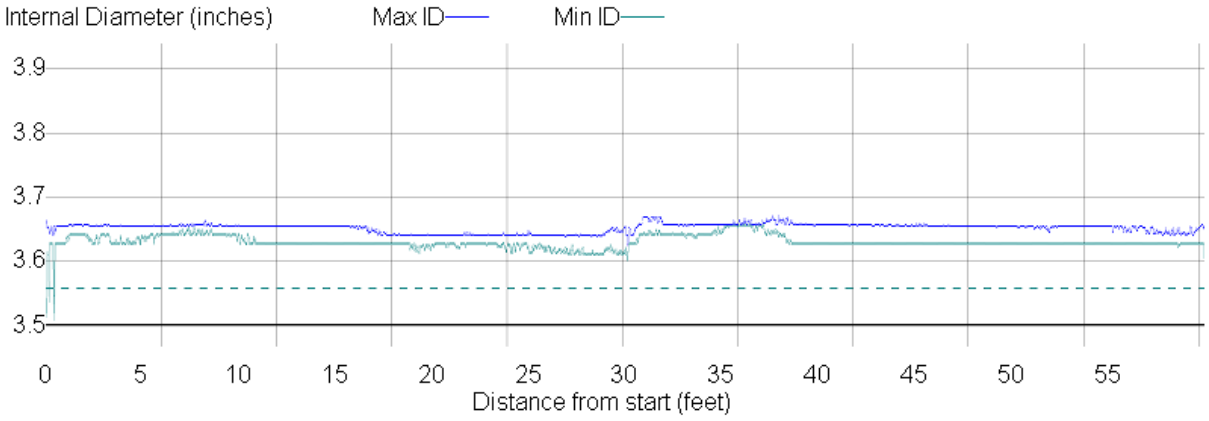
Radiant Tube 4 - Average & Min Wall Thickness



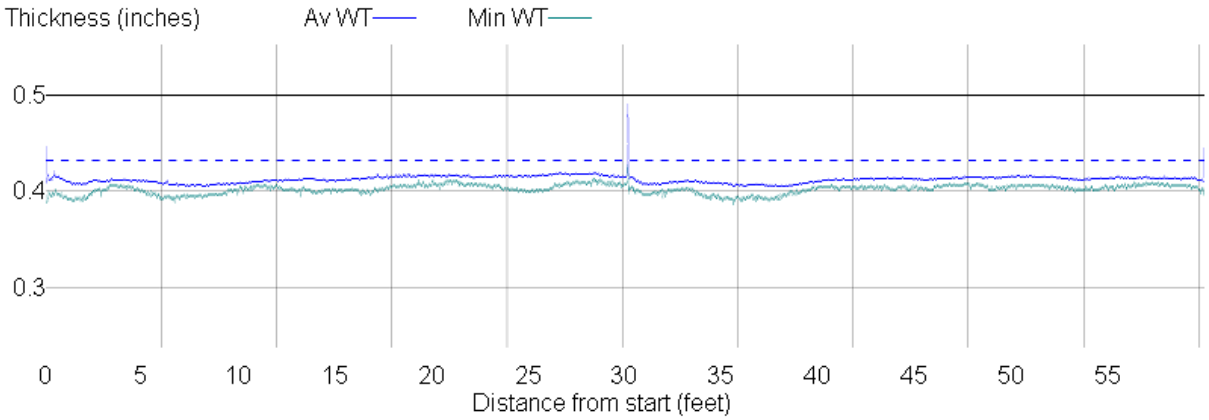
Radiant Tube 4 - Outside Diameter



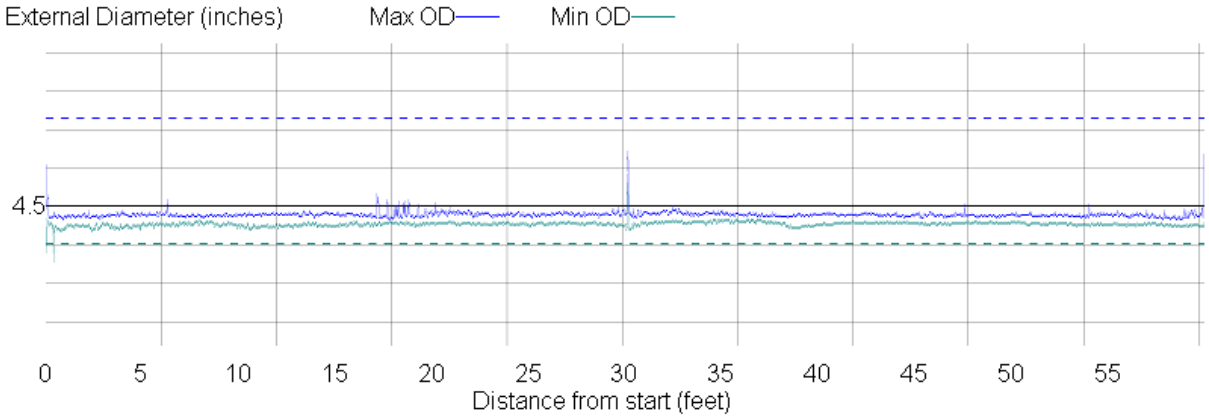
Radiant Tube 5 - Internal Diameter



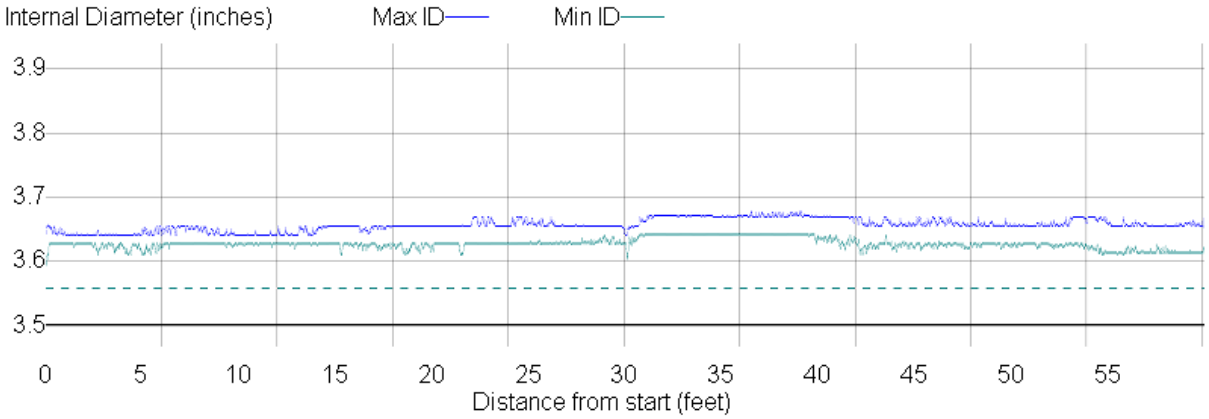
Radiant Tube 5 - Average & Min Wall Thickness



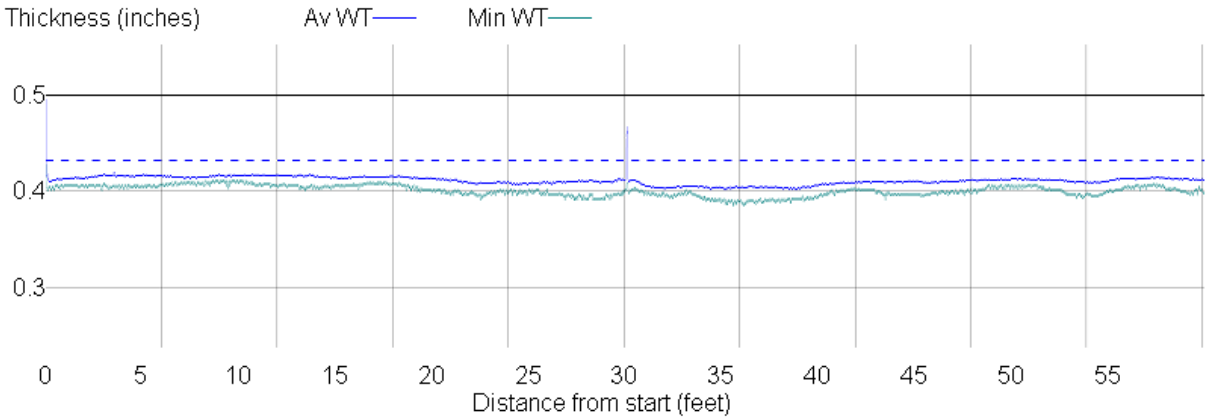
Radiant Tube 5 - Outside Diameter



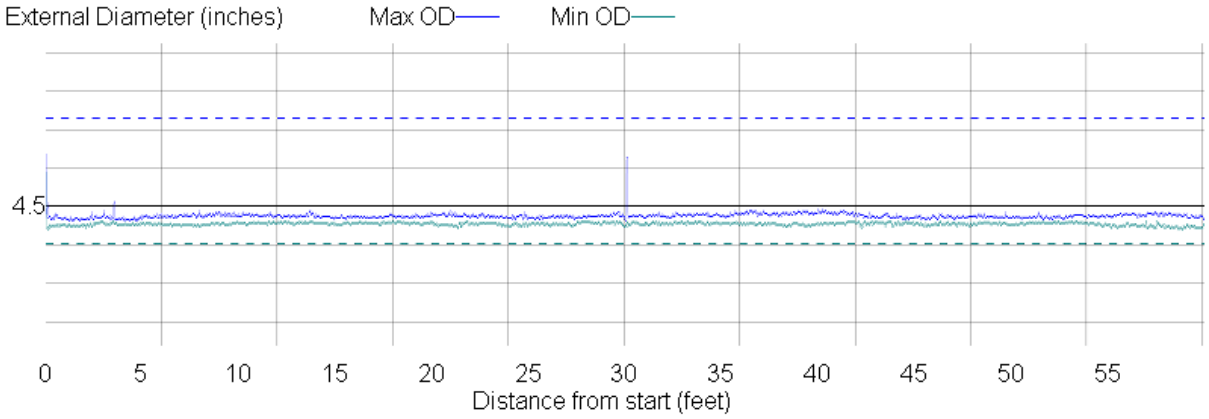
Radiant Tube 6 - Internal Diameter



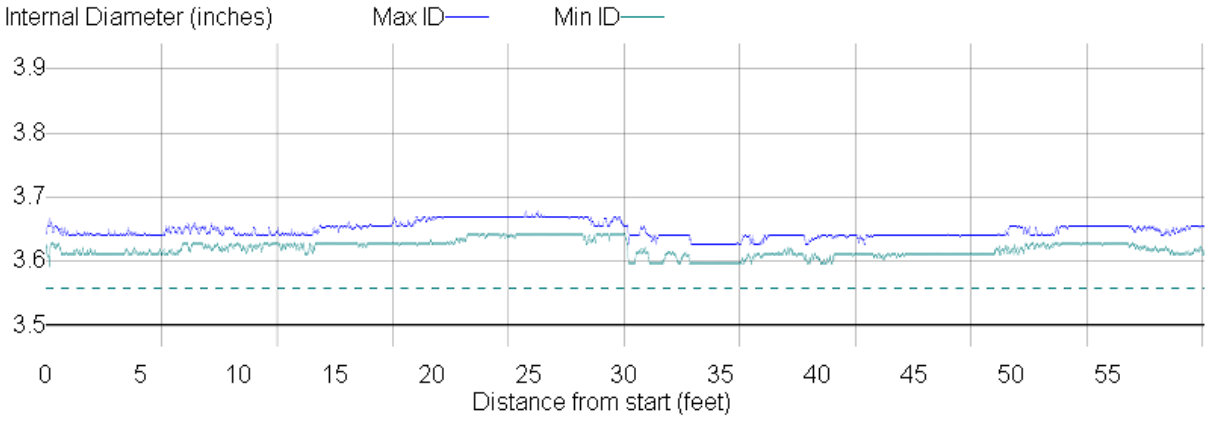
Radiant Tube 6 - Average & Min Wall Thickness



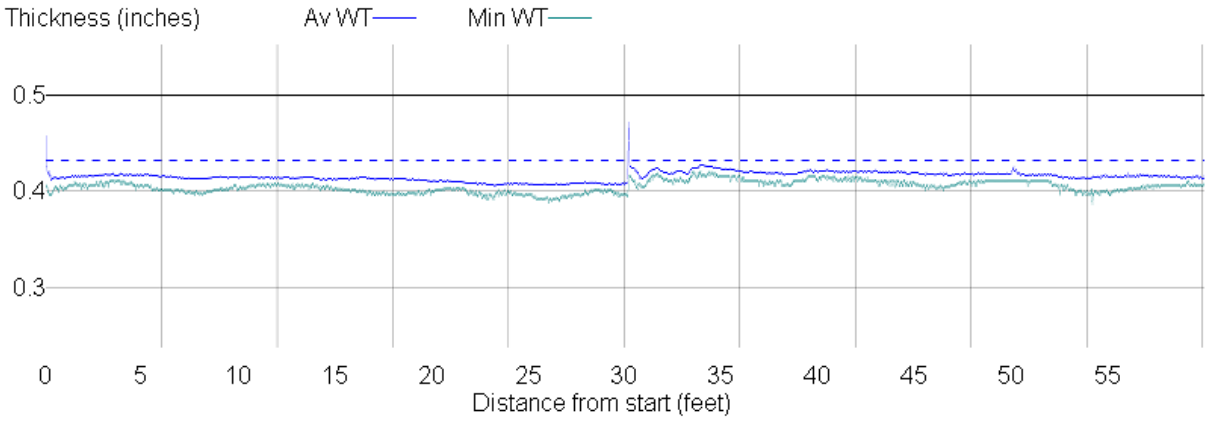
Radiant Tube 6 - Outside Diameter



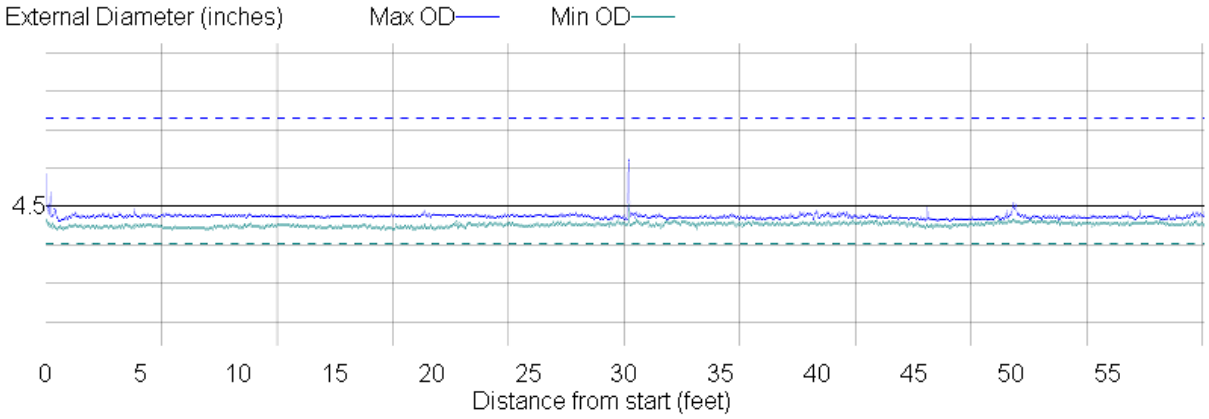
Radiant Tube 7 - Internal Diameter



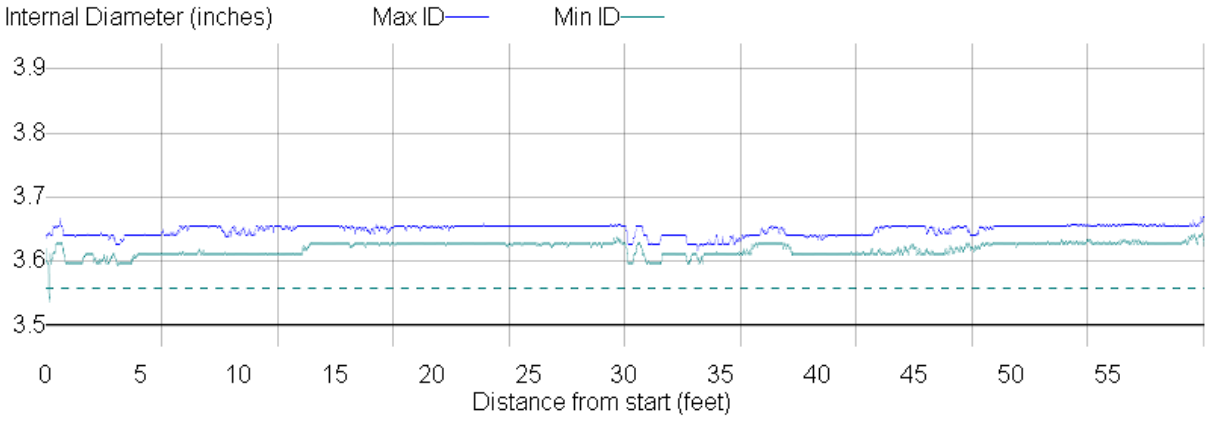
Radiant Tube 7 - Average & Min Wall Thickness



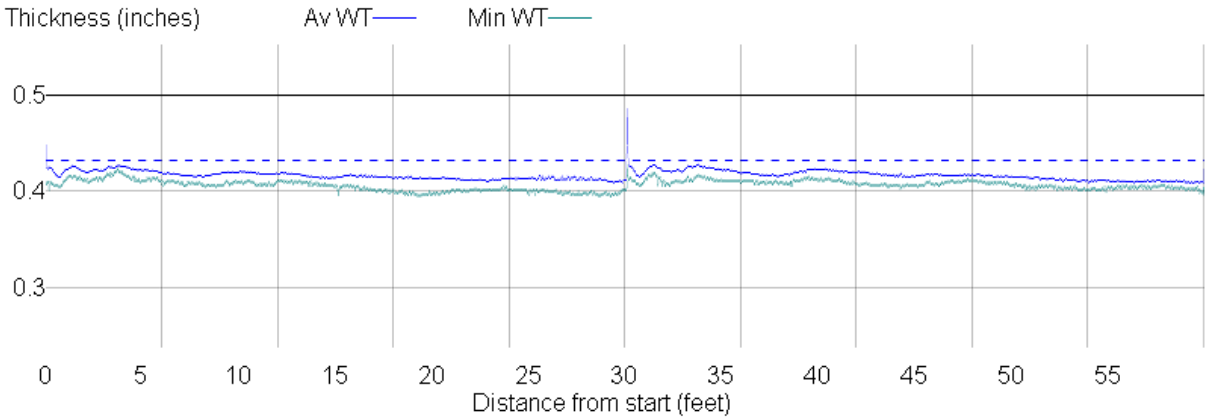
Radiant Tube 7 - Outside Diameter



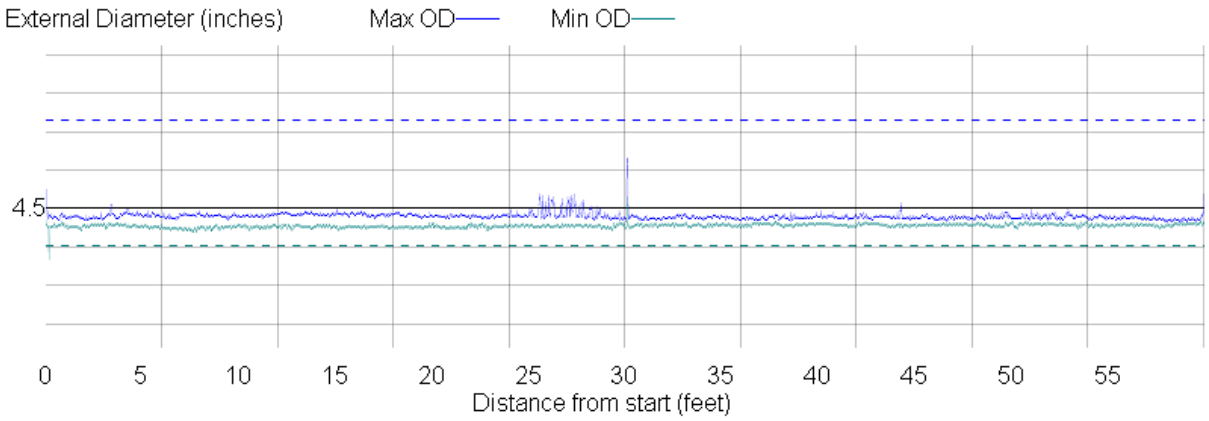
Radiant Tube 8 - Internal Diameter



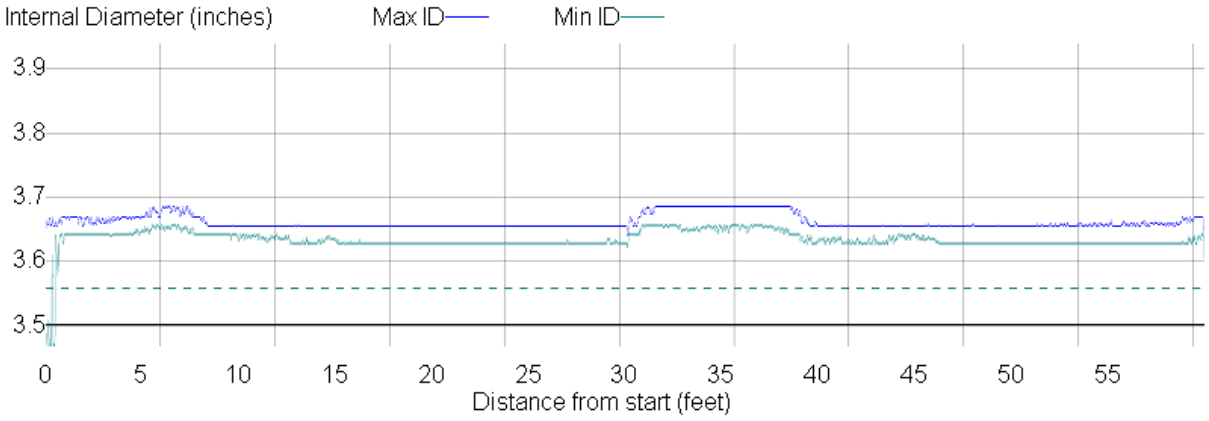
Radiant Tube 8 - Average & Min Wall Thickness



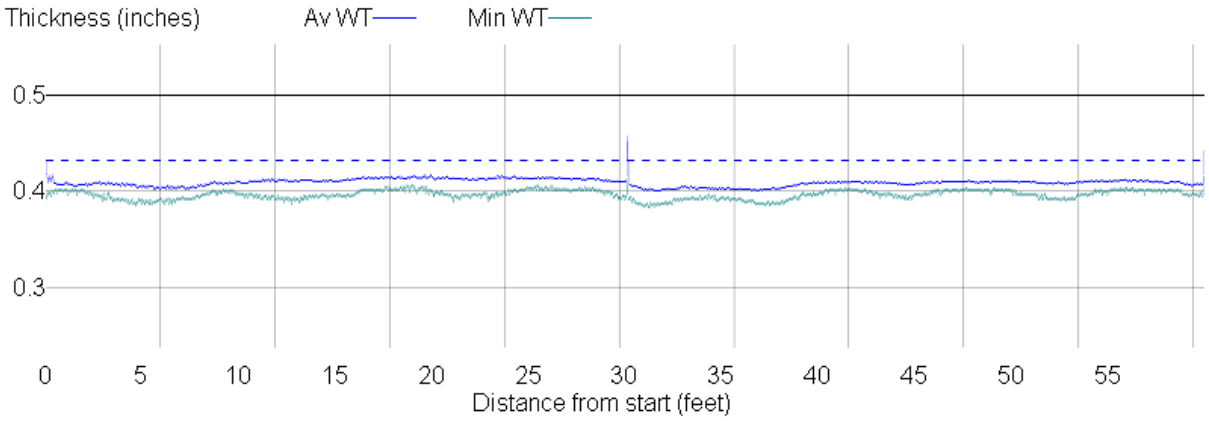
Radiant Tube 8 - Outside Diameter



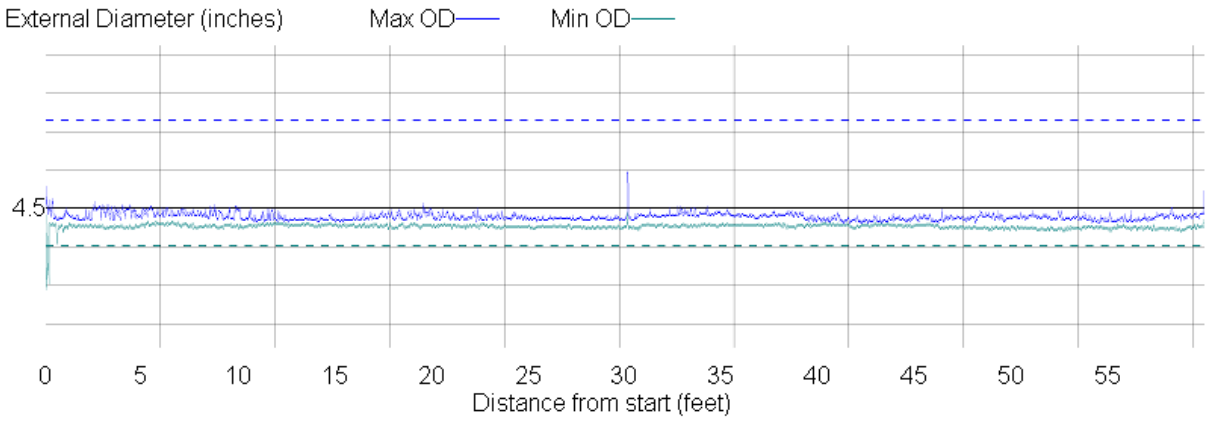
Radiant Tube 9 - Internal Diameter



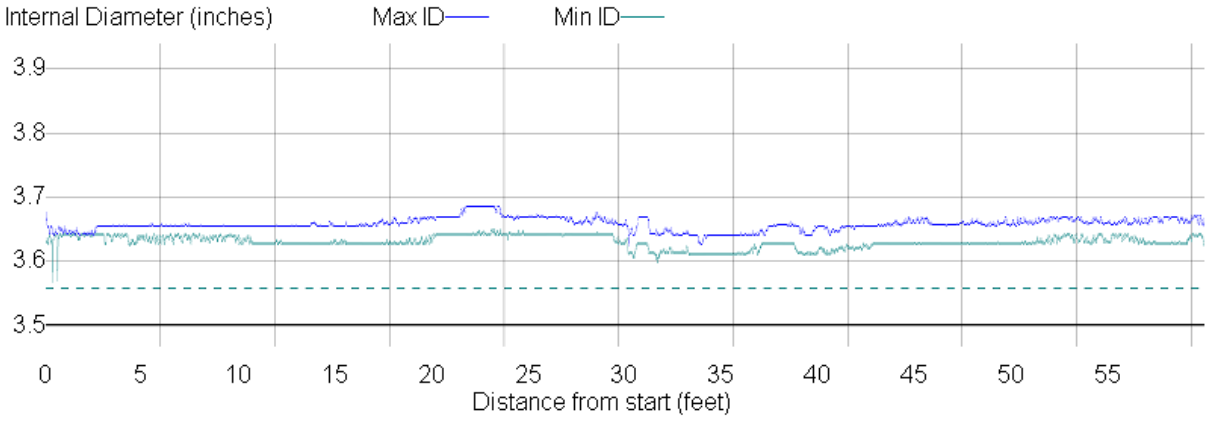
Radiant Tube 9 - Average & Min Wall Thickness



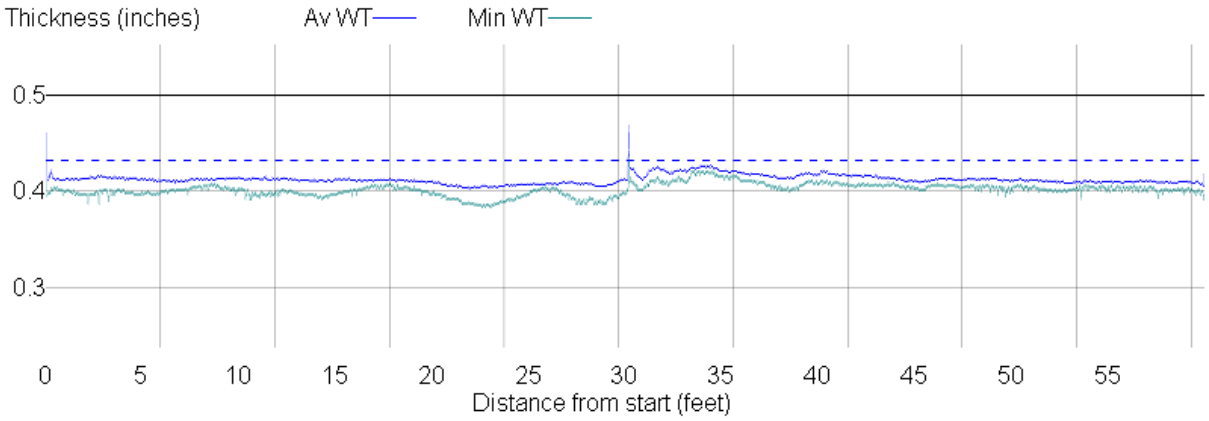
Radiant Tube 9 - Outside Diameter



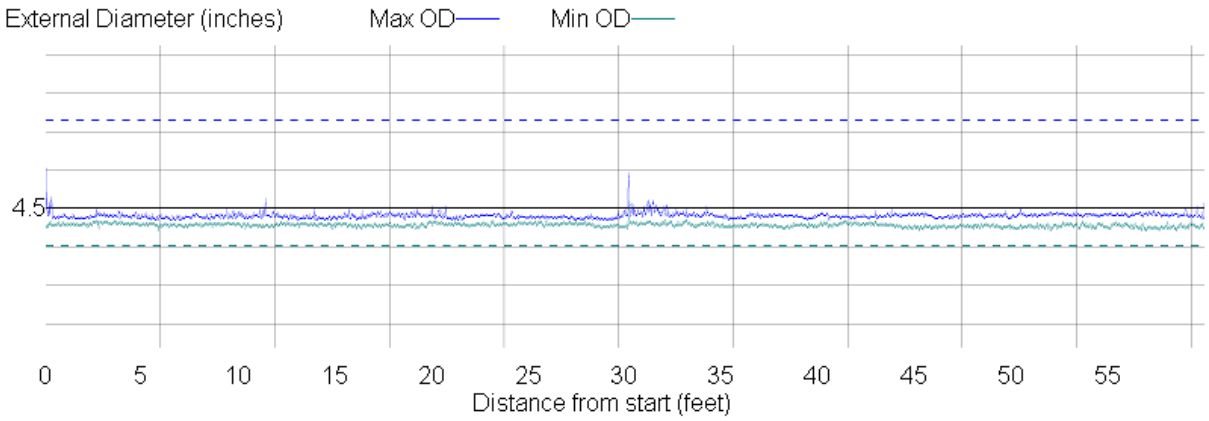
Radiant Tube 10 - Internal Diameter



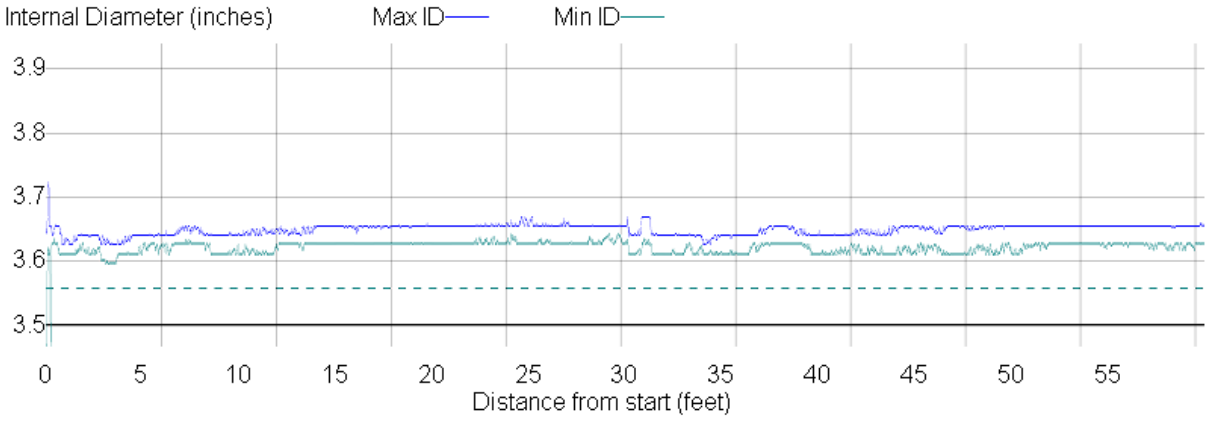
Radiant Tube 10 - Average & Min Wall Thickness



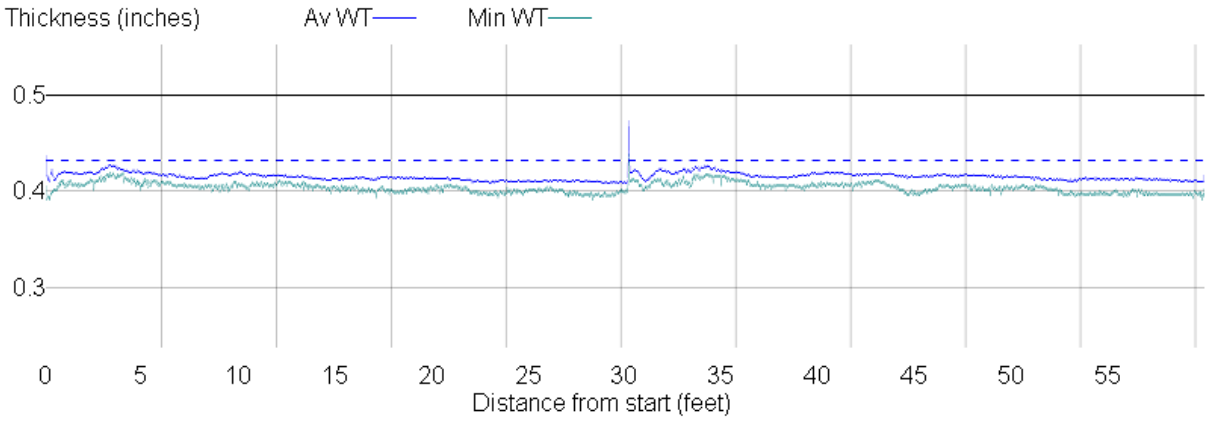
Radiant Tube 10 - Outside Diameter



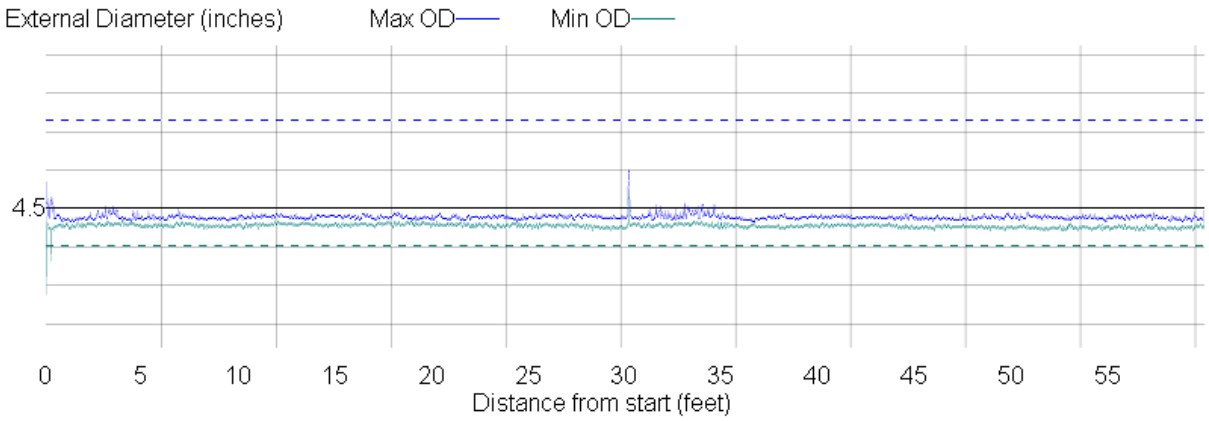
Radiant Tube 11 - Internal Diameter



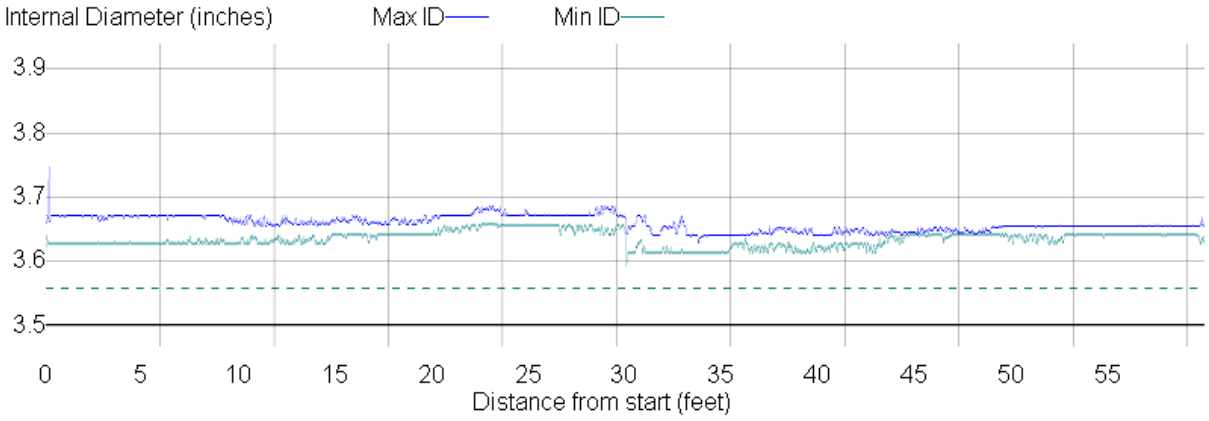
Radiant Tube 11 - Average & Min Wall Thickness



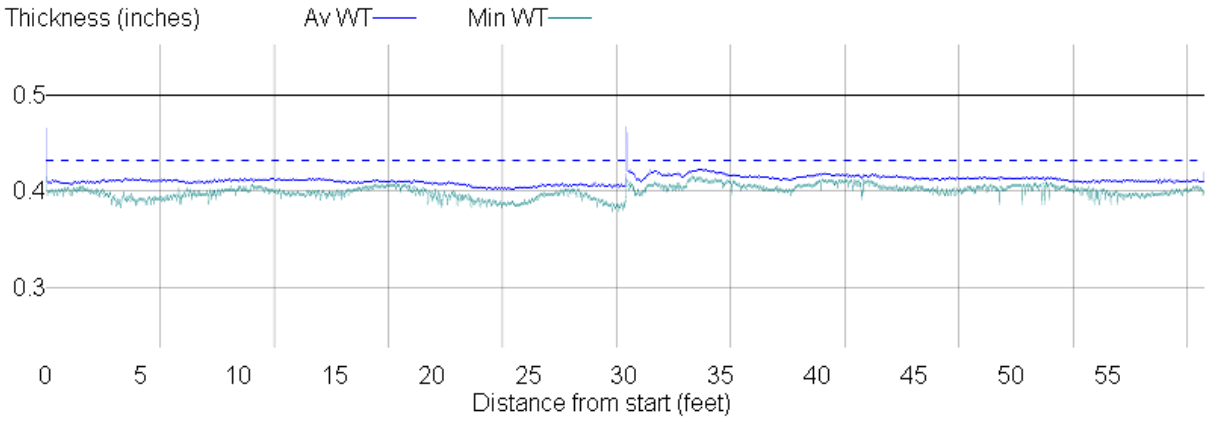
Radiant Tube 11 - Outside Diameter



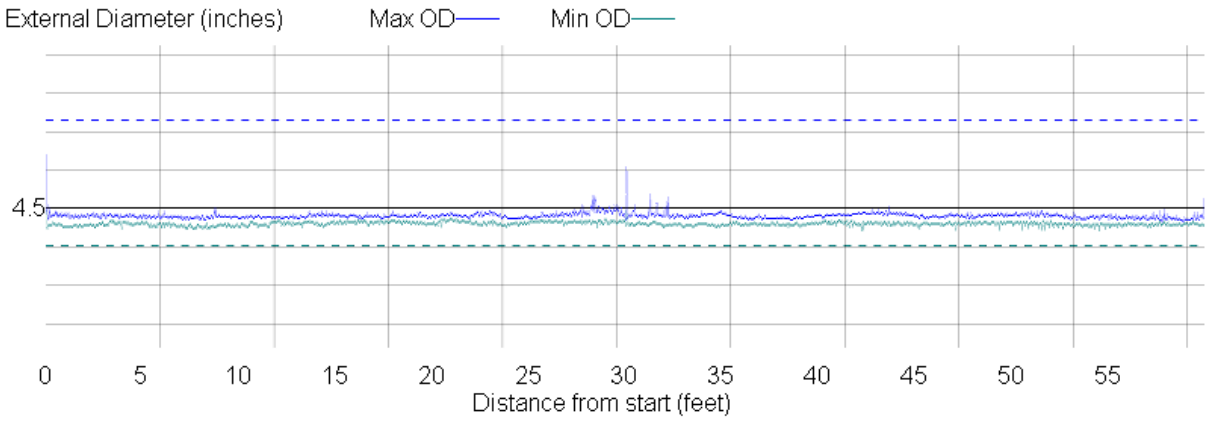
Radiant Tube 12 - Internal Diameter



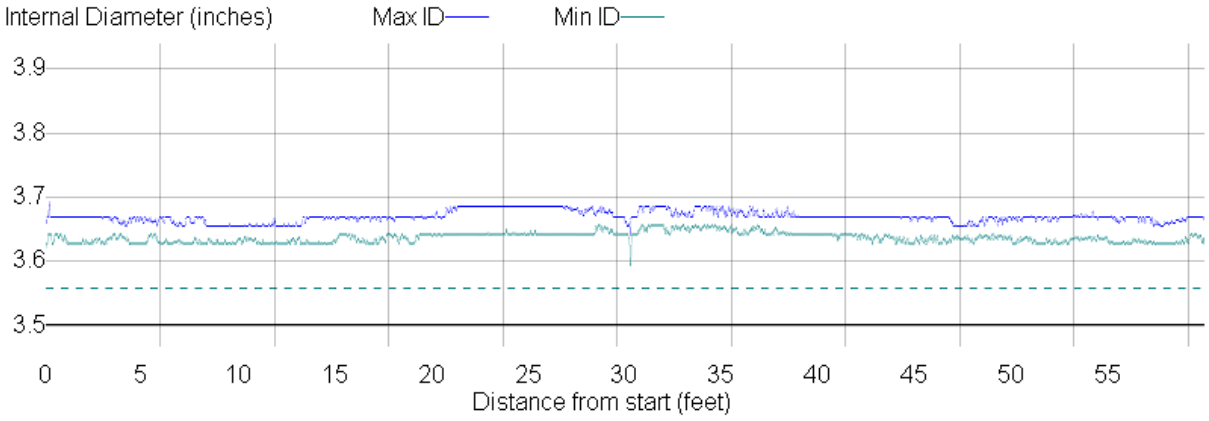
Radiant Tube 12 - Average & Min Wall Thickness



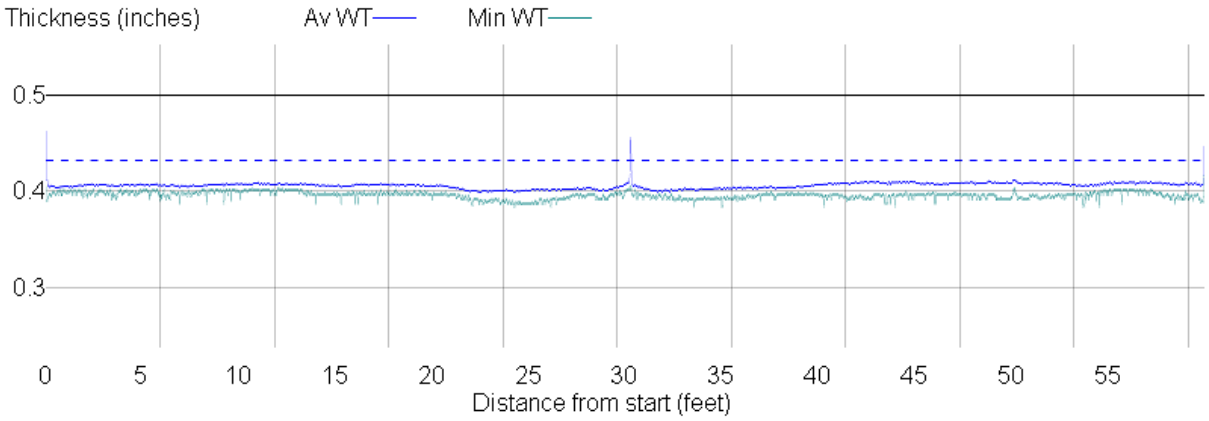
Radiant Tube 12 - Outside Diameter



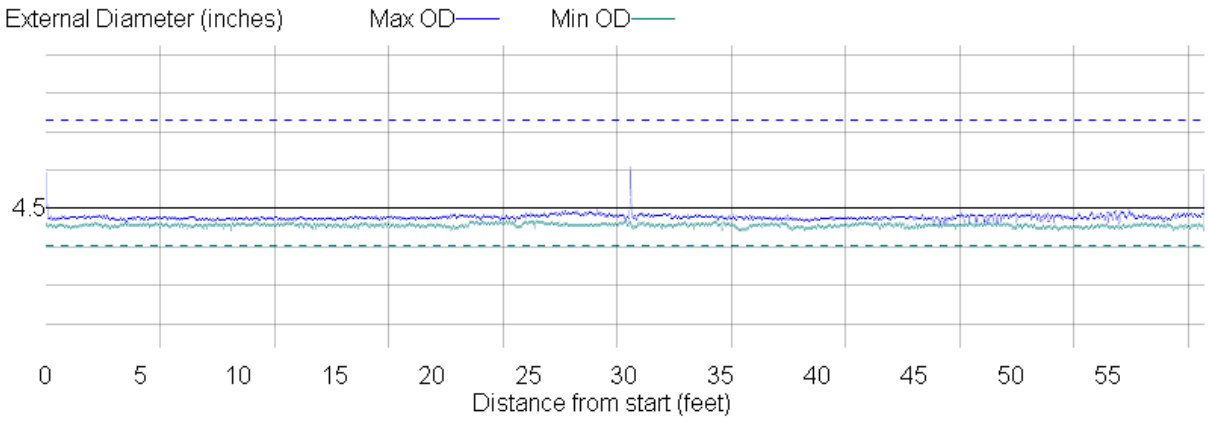
Radiant Tube 13 - Internal Diameter



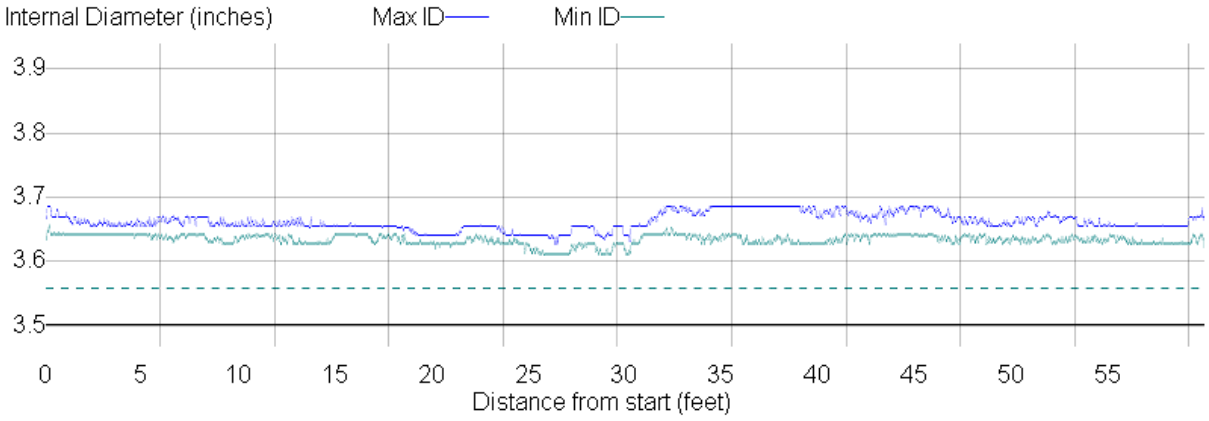
Radiant Tube 13 - Average & Min Wall Thickness



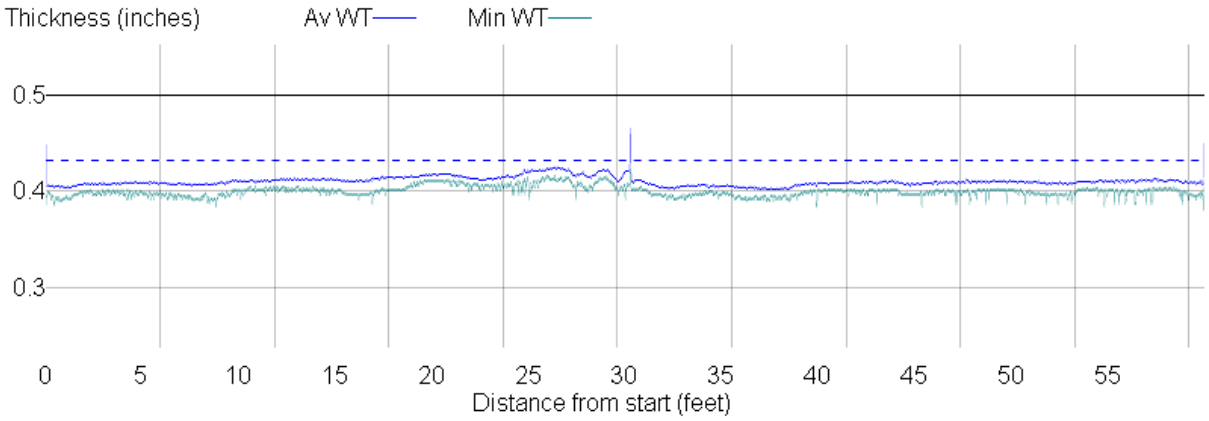
Radiant Tube 13 - Outside Diameter



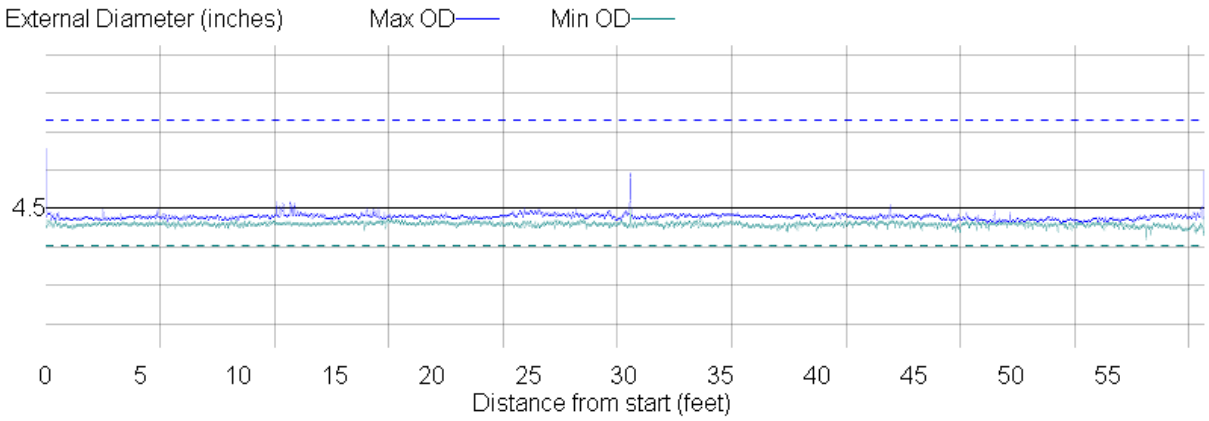
Radiant Tube 14 - Internal Diameter



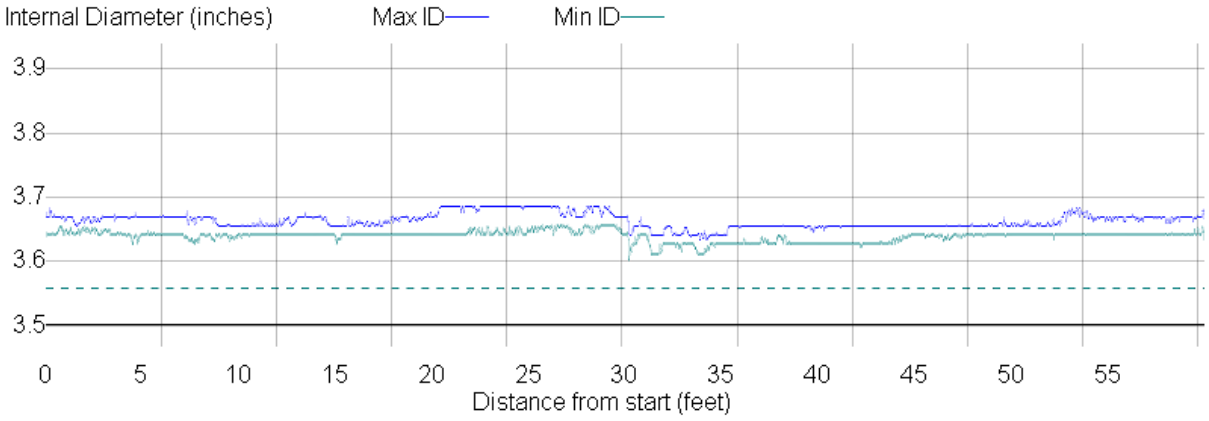
Radiant Tube 14 - Average & Min Wall Thickness



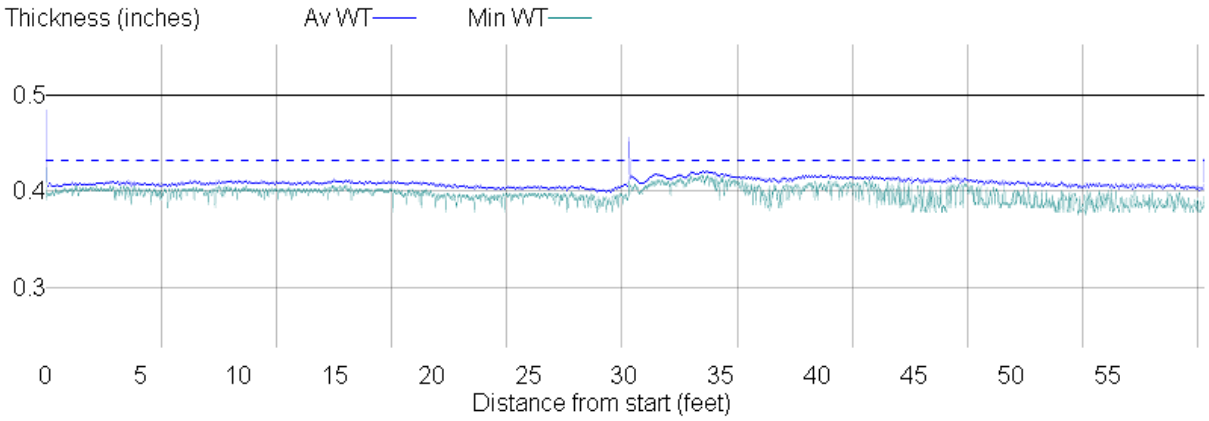
Radiant Tube 14 - Outside Diameter



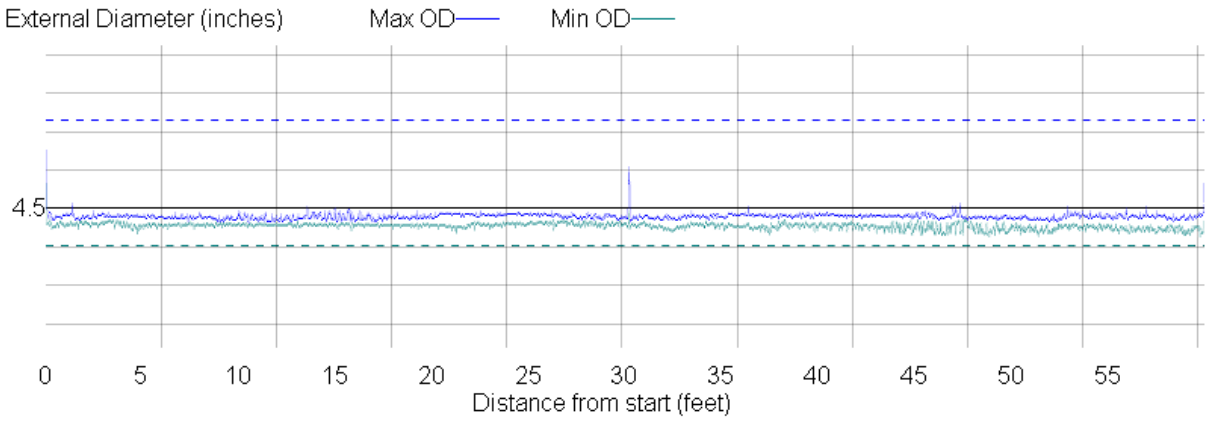
Radiant Tube 15 - Internal Diameter



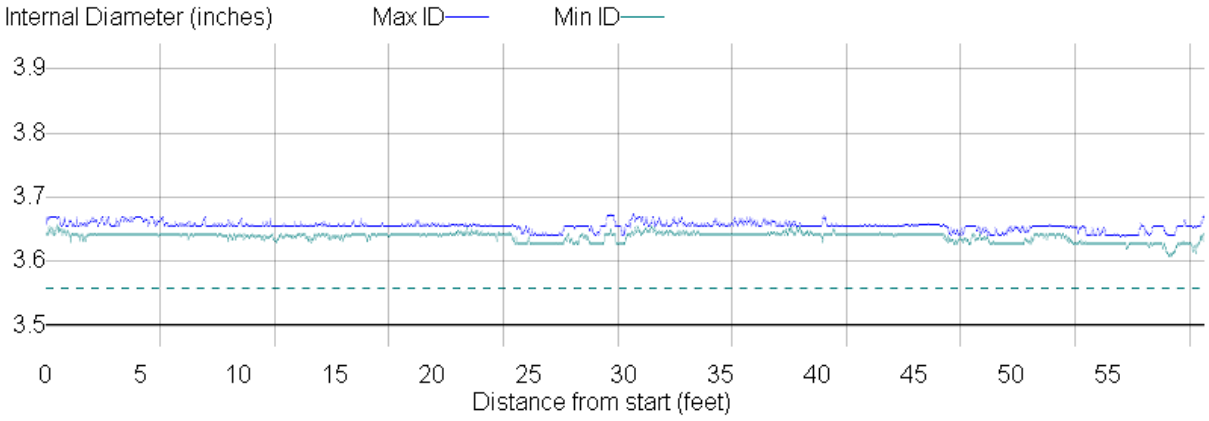
Radiant Tube 15 - Average & Min Wall Thickness



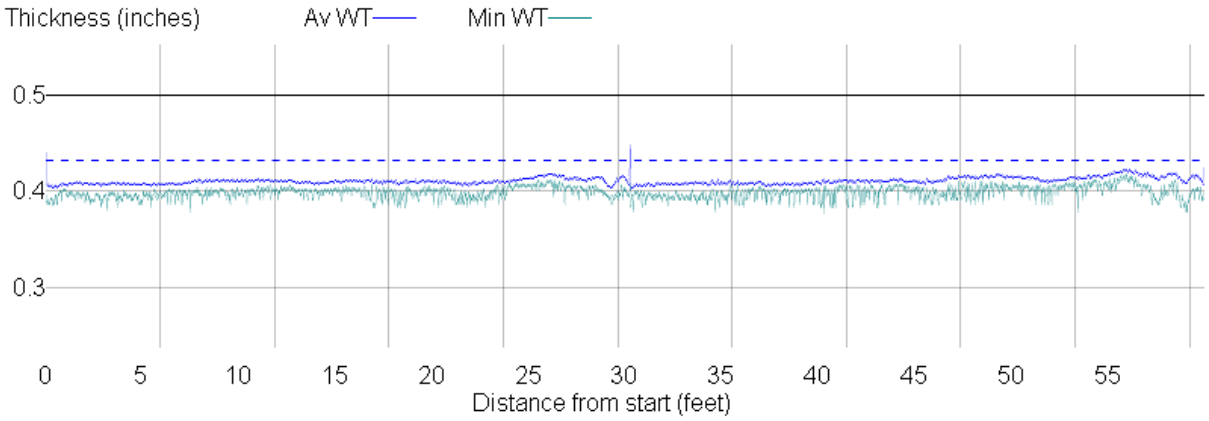
Radiant Tube 15 - Outside Diameter



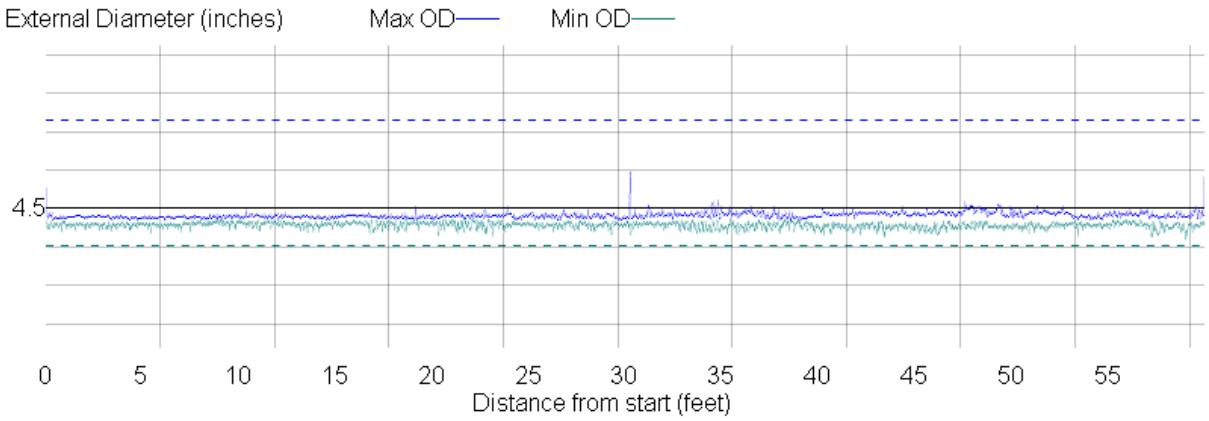
Radiant Tube 16 - Internal Diameter



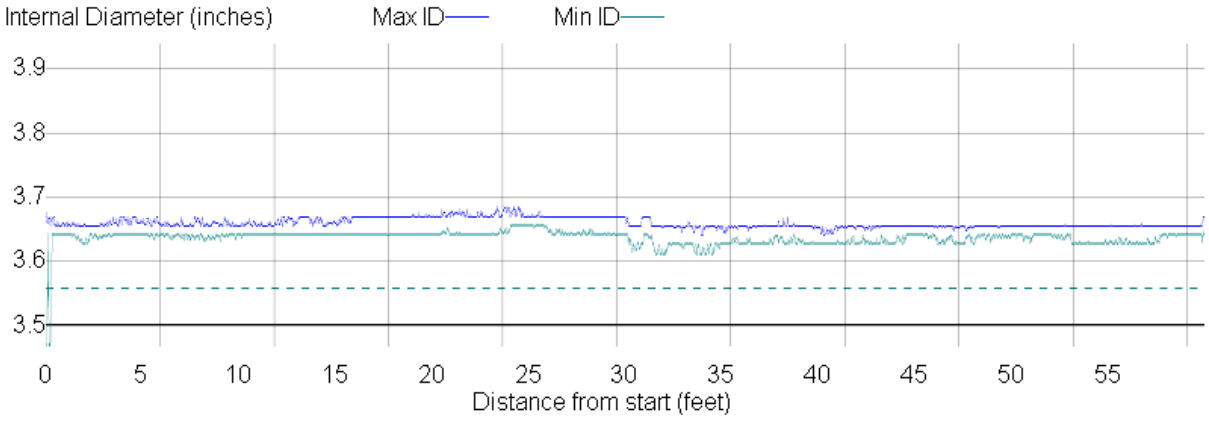
Radiant Tube 16 - Average & Min Wall Thickness



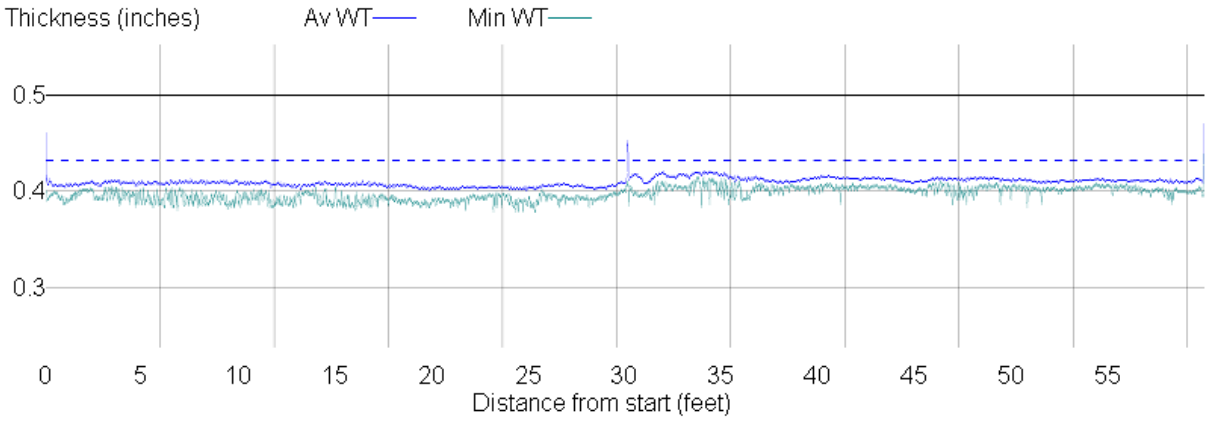
Radiant Tube 16 - Outside Diameter



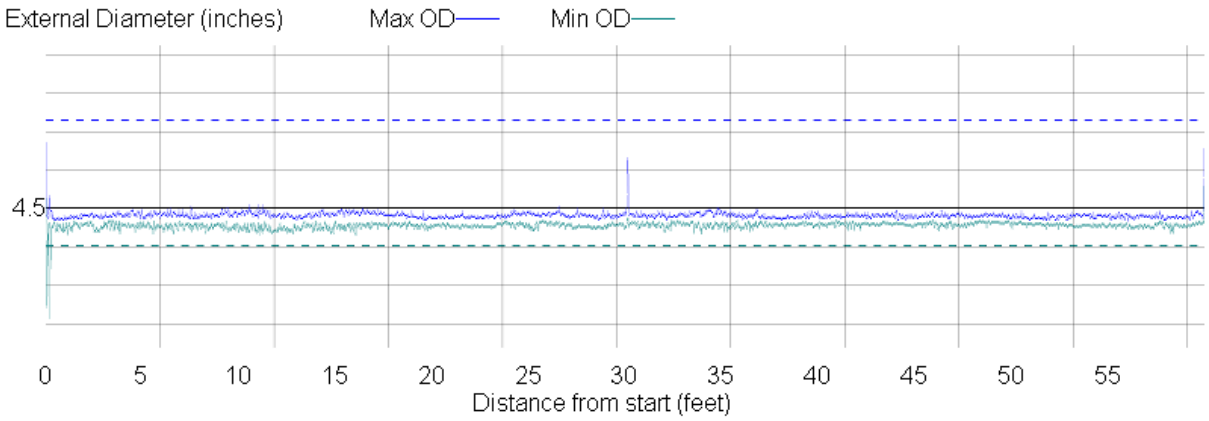
Radiant Tube 17 - Internal Diameter



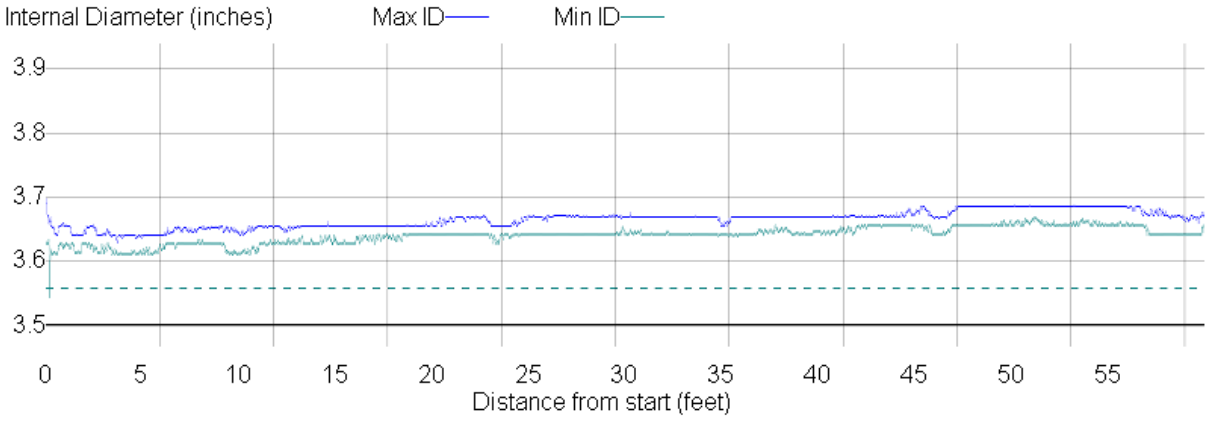
Radiant Tube 17 - Average & Min Wall Thickness



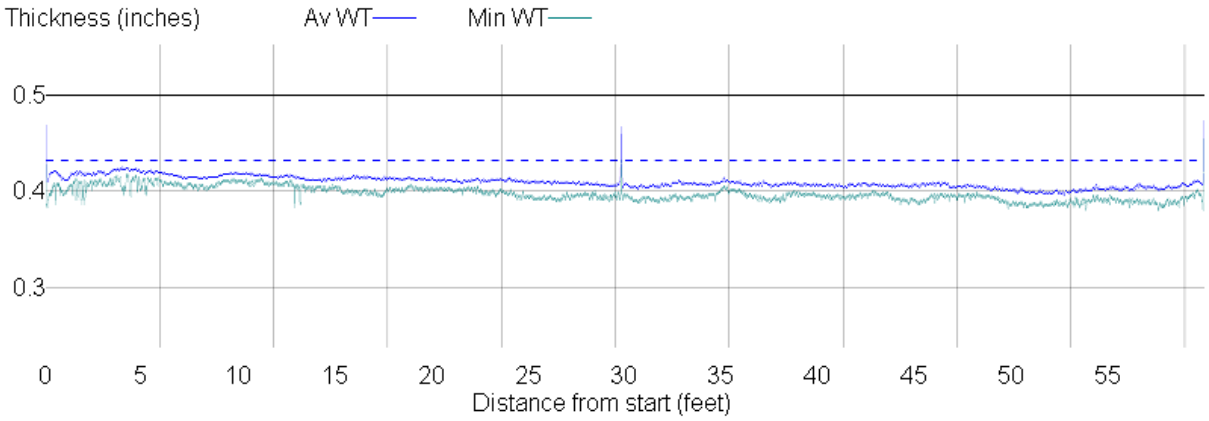
Radiant Tube 17 - Outside Diameter



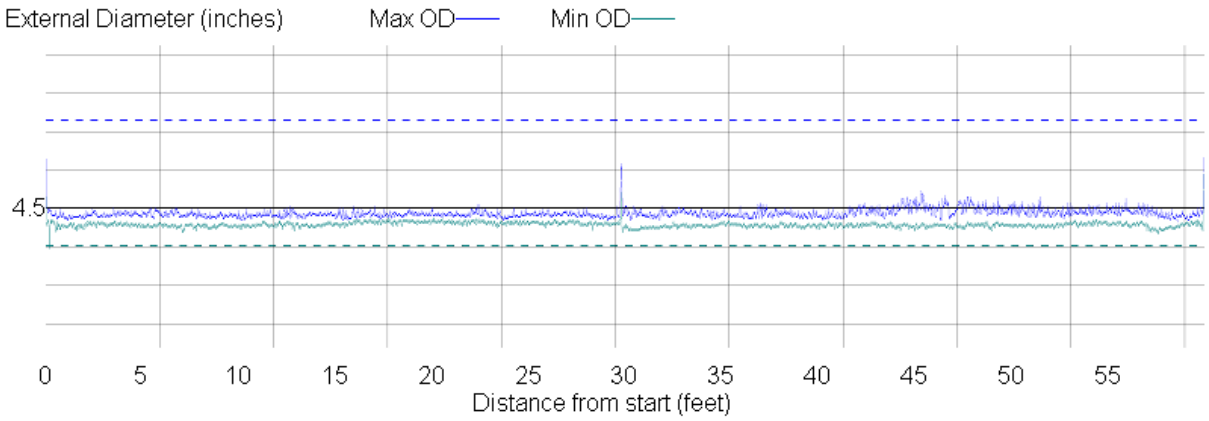
Radiant Tube 18 - Internal Diameter



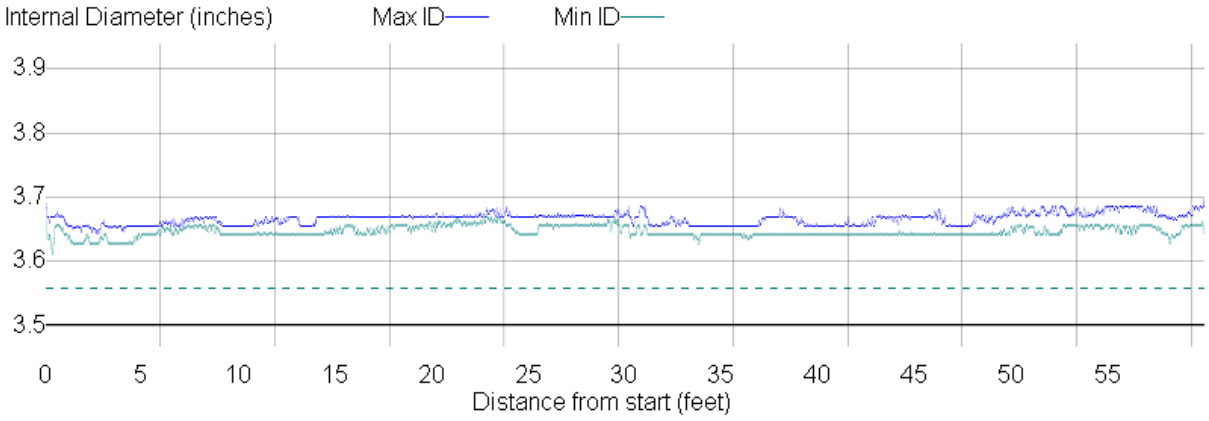
Radiant Tube 18 - Average & Min Wall Thickness



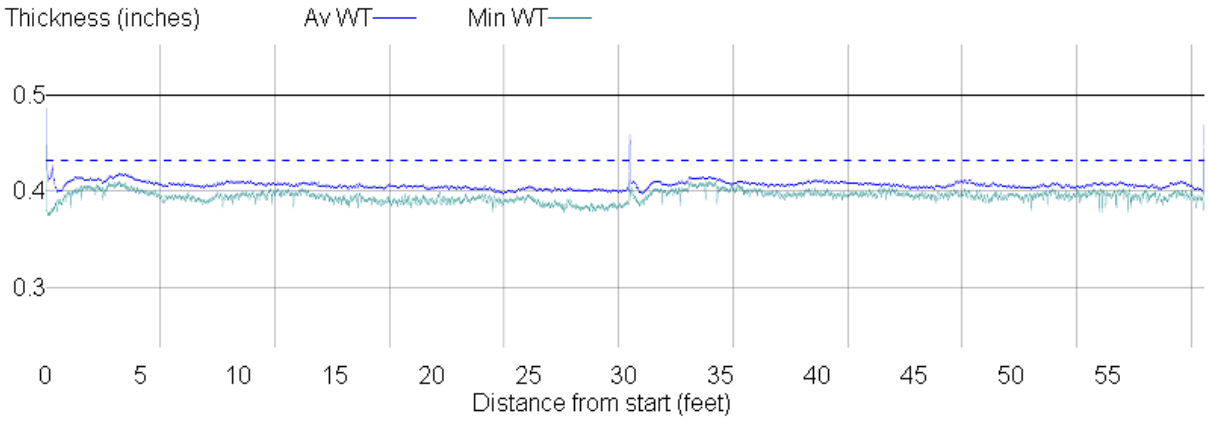
Radiant Tube 18 - Outside Diameter



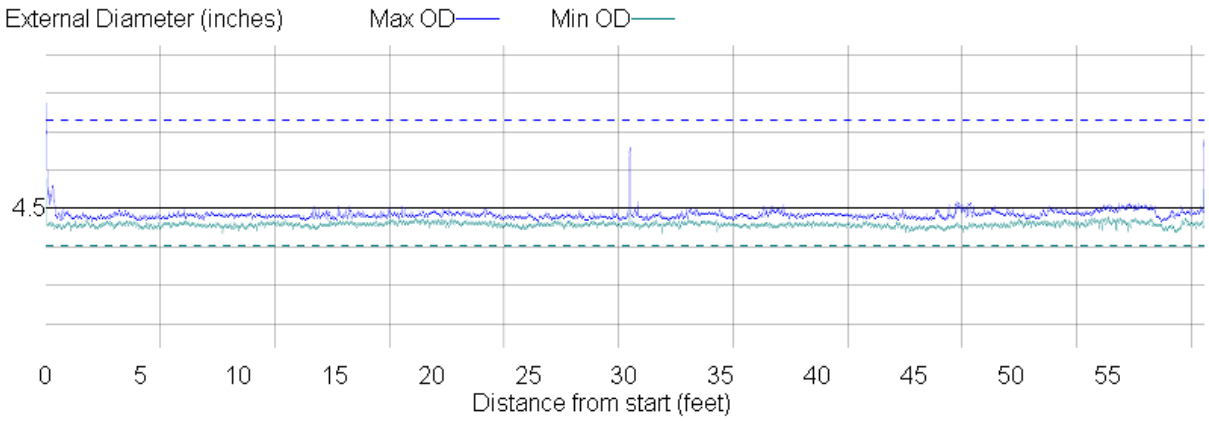
Radiant Tube 19 - Internal Diameter



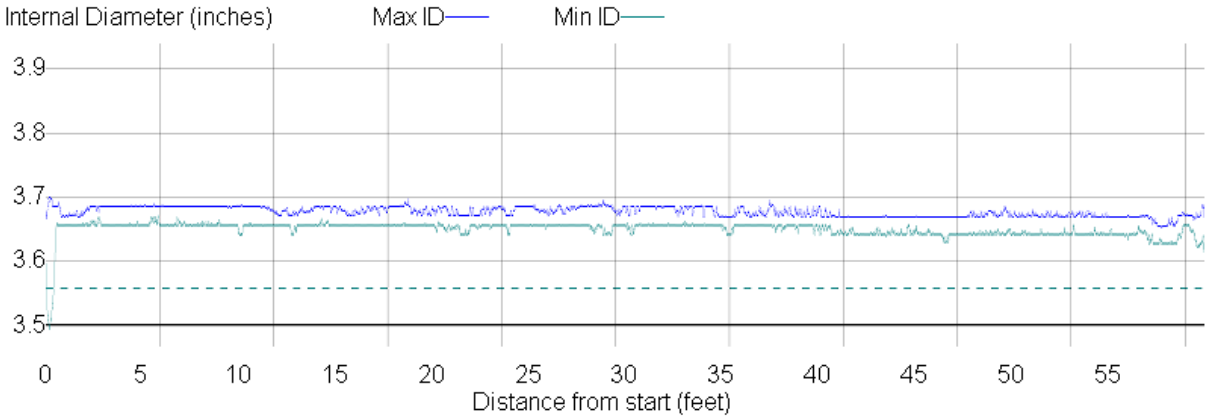
Radiant Tube 19 - Average & Min Wall Thickness



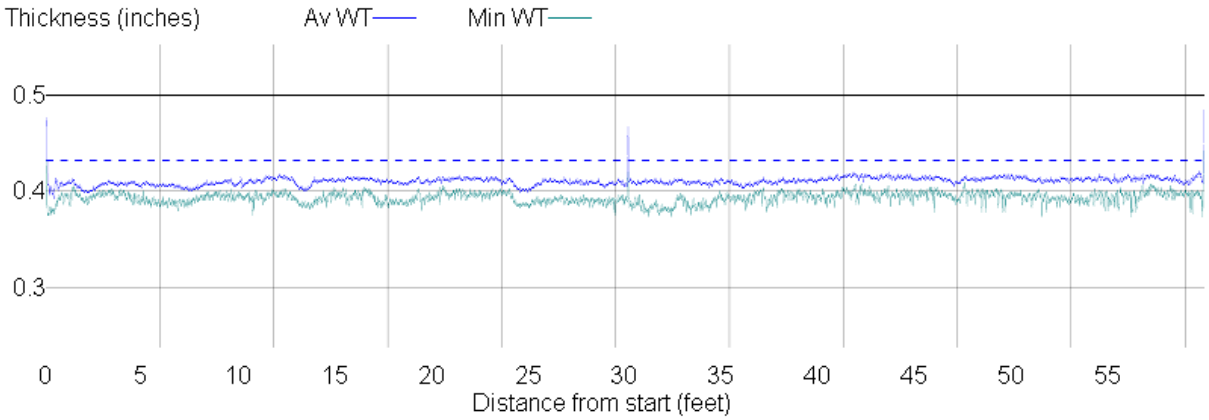
Radiant Tube 19 - Outside Diameter



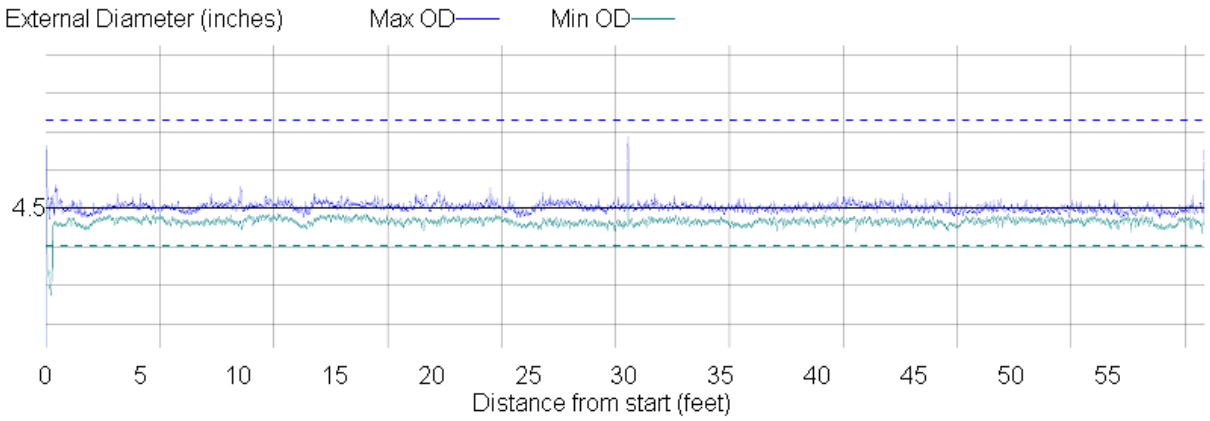
Radiant Tube 20 - Internal Diameter



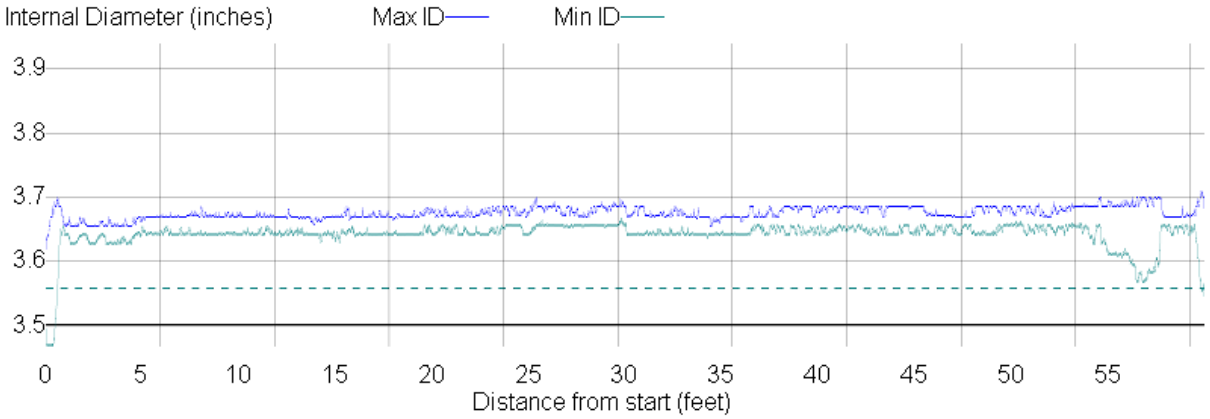
Radiant Tube 20 - Average & Min Wall Thickness



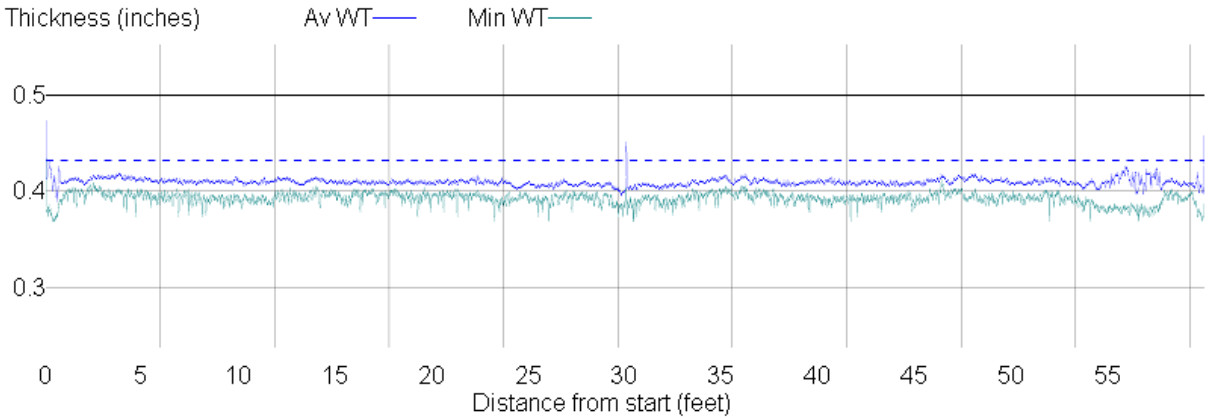
Radiant Tube 20 - Outside Diameter



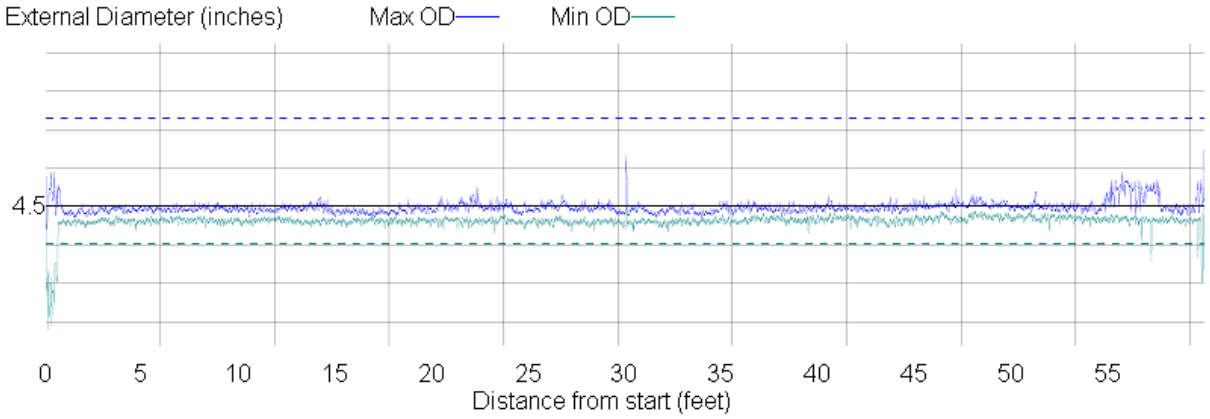
Radiant Tube 21 - Internal Diameter



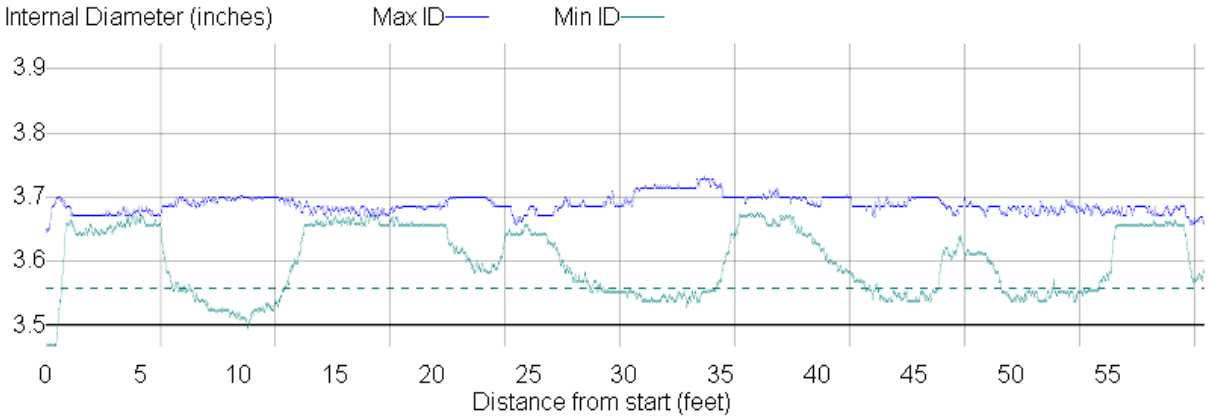
Radiant Tube 21 - Average & Min Wall Thickness



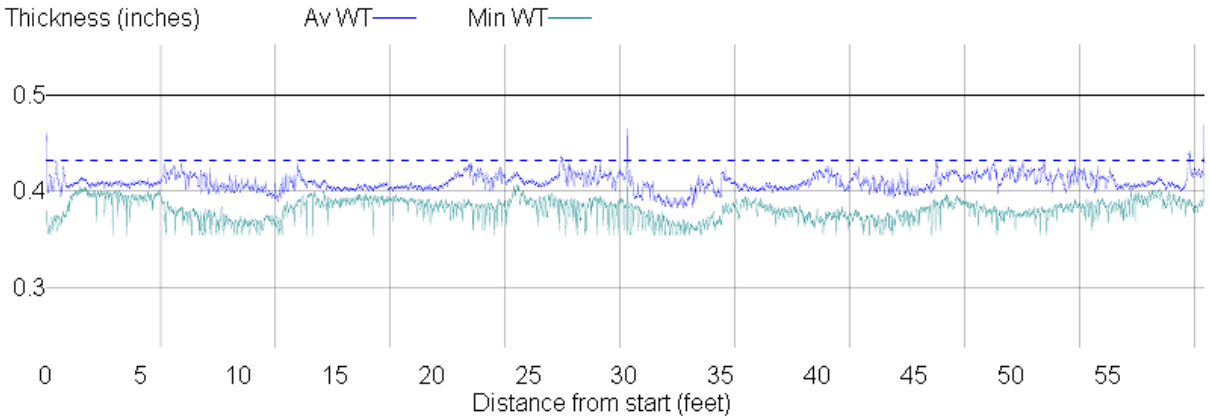
Radiant Tube 21 - Outside Diameter



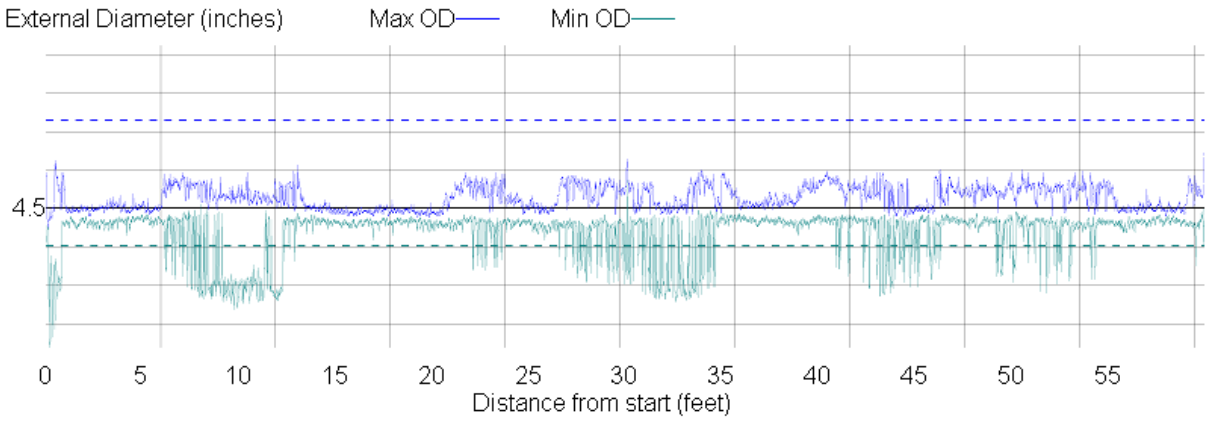
Radiant Tube 22 - Internal Diameter



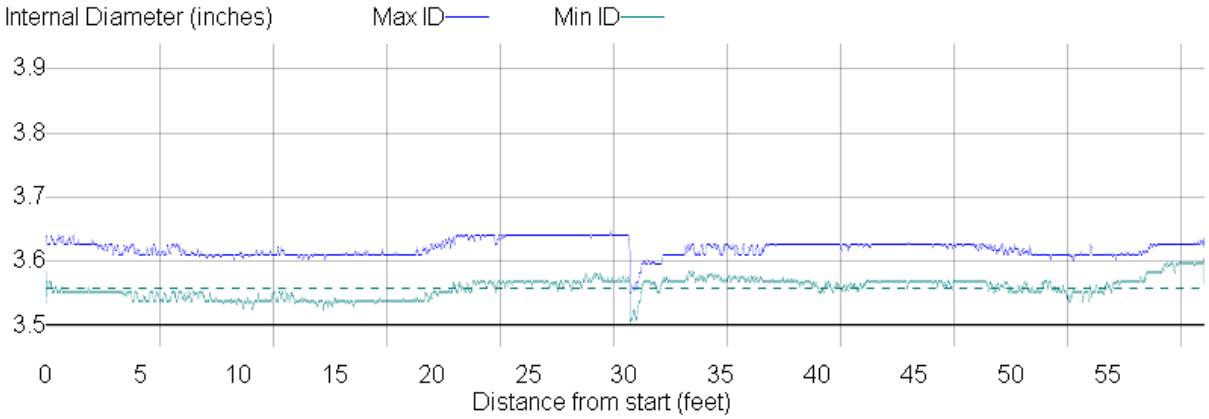
Radiant Tube 22 - Average & Min Wall Thickness



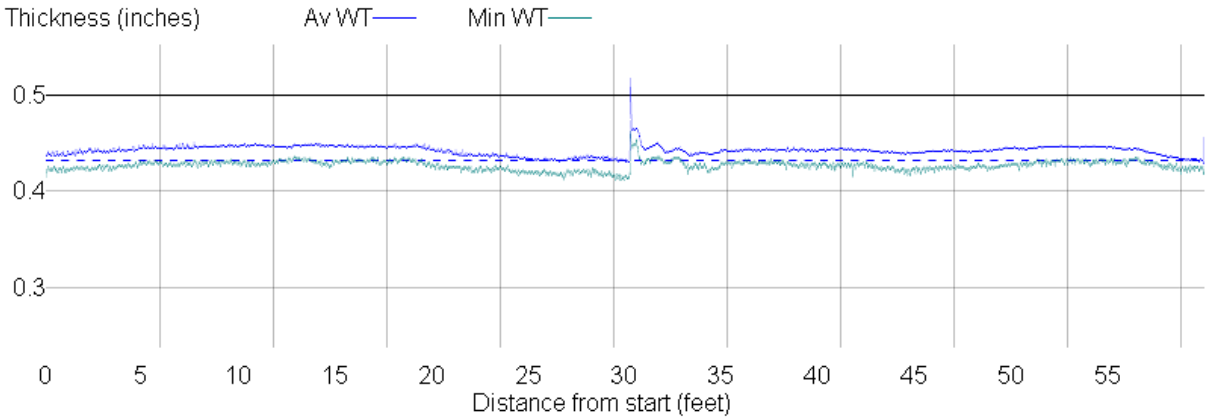
Radiant Tube 22 - Outside Diameter



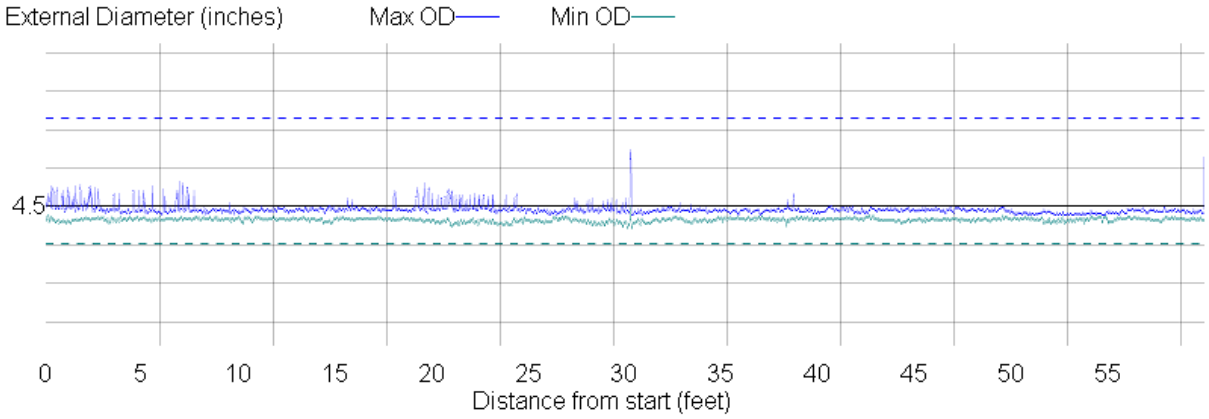
Radiant Tube 23 - Internal Diameter



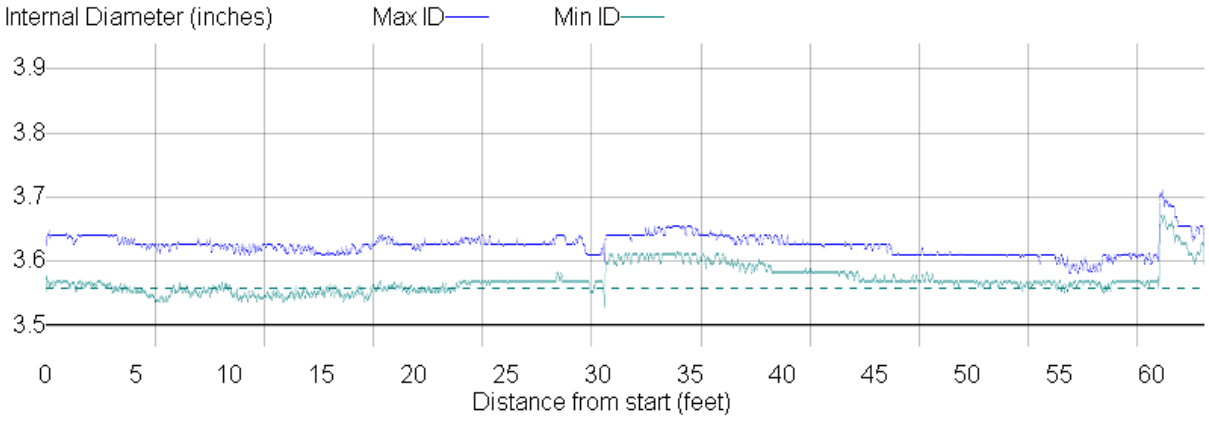
Radiant Tube 23 - Average & Min Wall Thickness



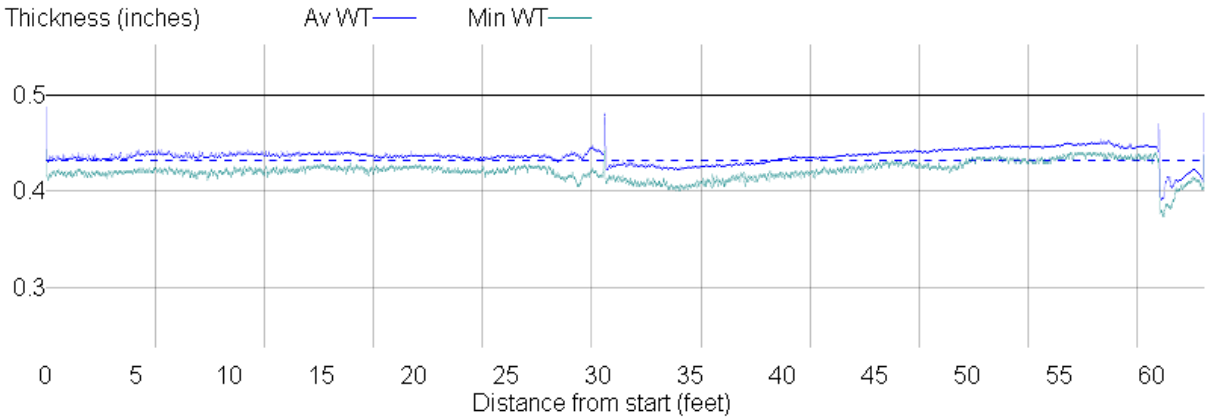
Radiant Tube 23 - Outside Diameter

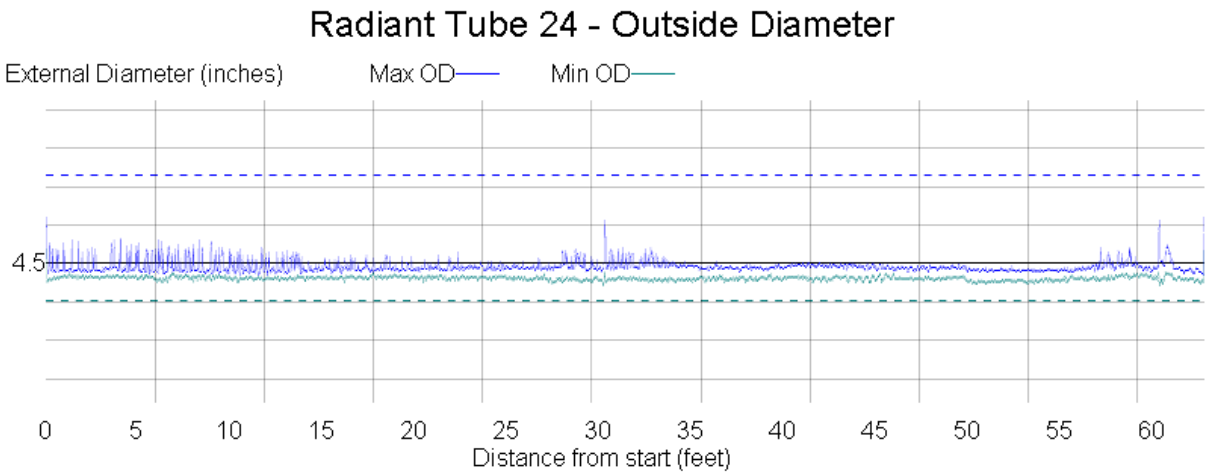


Radiant Tube 24 - Internal Diameter



Radiant Tube 24 - Average & Min Wall Thickness




Radiant Tube 24 - Outside Diameter
External Diameter (inches)
Max OD
Min OD
4.5
0
5
10
15
20
25
30
35
40
45
50
55
60
Distance from start (feet)