ENVIRONMENTAL & OCCUPATIONAL HEALTH SCIENCES
SCHOOL OF PUBLIC HEALTH · UNIVERSITY of WASHINGTON

Field Research and Consultation Group

10/26/17

Tamas Ugrai
University of Washington
Oceanography, Box 355351
Seattle, WA 98195-5351

FRCG #: 2017-54

Dear Tamas,

Enclosed within this document are the results of our 10/25/17 clean room evaluation of the Rm 443A Laboratory located in at the University of Washington in the Oceanography Building in Seattle, WA.

According to ISO 14644, we have concluded that at the time and conditions of the measurements, the lab complies with the ISO Class 6 @ 0.3 µm classification. This is equivalent to the now obsolete Federal Standard 209e Class 1000 @ 0.3 µm. Classification is based on each location passing the designated criteria independently (In contrast to Fed Standard 209e, which assesses the overall cleanliness of the room). Therefore, the overall classification was determined by the location with the highest concentration (Sample 4).

At the time of the evaluation, the laminar flow hood and flow bench were operating. Two individuals were present: a laboratory employee, conducting typical work near the sink and fume hood; and the industrial hygienist responsible for monitoring. Please see the attached report and Table 1 and Figure 1 for details.

For comparison, the results of the 04/02/14 evaluation are included with this report (Table 2). This evaluation found that the laboratory complied with ISO Class 6 @ 0.5 µm (Fed Standard 209e Class 1000 @ 0.5 µm).

Lastly, Table 3 provides a comparison of the ISO 14644 and Federal Standard 209e criteria.

Please feel free to contact me with any questions at (206) 616-7689.

Sincerely,

Marc Beaudreau, MS
Industrial Hygienist

Clean Room Test Report

Date and time of testing: October 26, 2017

Laboratory:	UW Oceanography Building Room 443A	**Applicable Standard:**	ISO 14644
Instrument:	TSI AeroTrak 9306-V2	**Target Criteria:**	ISO 6 (@ 0.3 µm)
Room Dimensions:	5.5m x 3.0m x 2.7m	**Minimum sample volume:**	2 Liters
Room Area:	16.7 m^2	**Minimum sample number:**	25
Flow Regime:	Non-unidirectional	**Flow rate:**	2.83 LPM
State of Room:	Operational	**Sample duration:**	2:00 min
		Volume/sample:	0.01 m^3
		Number of locations:	5
		Replicates/location:	5

Table 1. Particle concentration in Oceanography lab 443A on 10/25/17

	Particle Concentrations (particles/m^3)				
	>0.3 um		**>0.5 um**		
Location*	**Average**	**Std Dev**	**Average**	**Std Dev**	**# of Samples**
Sample 1	8,525	5,492	6,979	4,755	5
Sample 2	4,735	3,853	3,993	3,703	5
Sample 3	495	521	283	387	5
Sample 4	19,364	18,846	6,961	5,344	5
Sample 5	177	395	71	158	5
ISO Class 5	10,200		3,520		
ISO Class 6	102,000		35,200		
ISO Class 7	1,020,000		352,000		

** Refer to Figure 1 for sample locations*

Figure 1. Lab schematic and sample locations

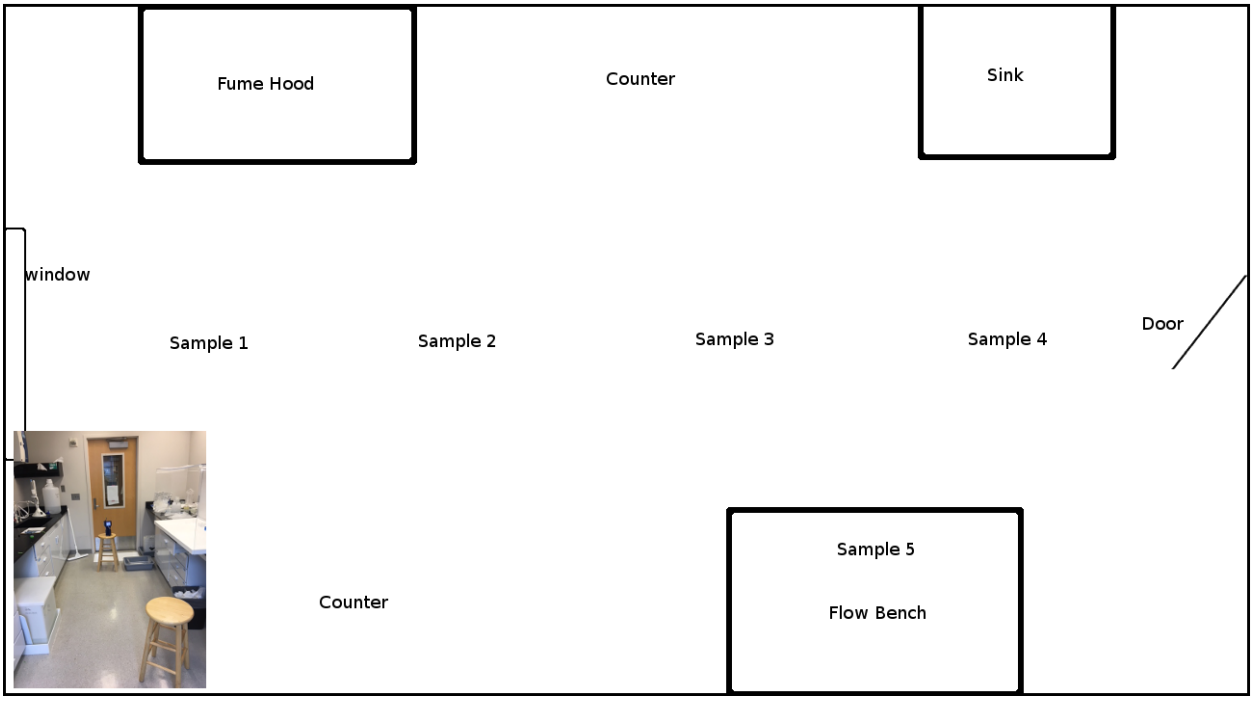
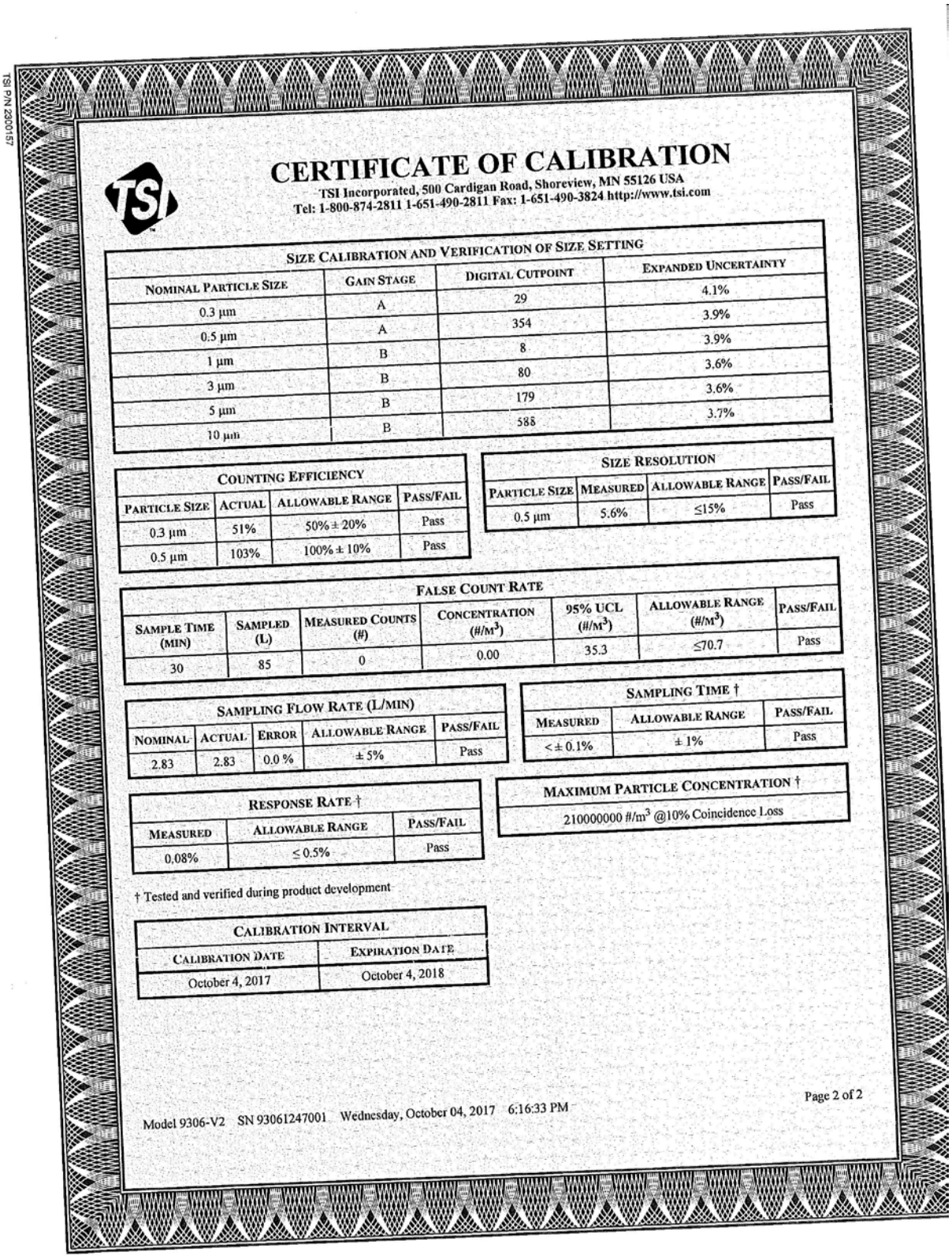


Table 2. Particle concentrations in Oceanography lab 443A on 04/02/14

	Particle Concentrations (particles/m^3)				
	>0.3 um		>0.5 um		
Location	**Average**	**Std Dev**	**Average**	**Std Dev**	**# of Samples**
A (near window)	27,220	14,577	20,760	10,557	3
B	11,318	8,292	8,834	6,356	3
C	12,478	9,277	10,380	8,040	3
D	11,926	5,697	9,386	4,194	3
E (near entrance	9,441	1,791	7,067	1,675	3
Overall	14,477	10,109	11,285	7,689	15
Criteria for M4.5 (Class 1000 or ISO 6)			35,300		
Criteria for M4	30,900		10,000		
Criteria for M3.5 (Class 100 or ISO 5)	10,600		3,530		

Table 3. ISO 14644 comparison to Federal Standard 209e

	Max particles/m^3						Fed STD 209e equivalent
Class	**≥0.1**	**≥0.2**	**≥0.3**	**≥0.5**	**≥1**	**≥5**	
ISO1	10	2.37					
ISO2	100	23.7	10.2	3.5			
ISO3	1000	237	102	35	8.3		Class 1
ISO4	10000	2370	1020	352	83		Class 10
ISO5	100000	23700	10200	3520	832	29	Class 100
ISO6	1000000	237000	102000	35200	8320	293	Class 1000
ISO7				352000	83200	2930	Class 10000
ISO8				3520000	832000	29300	Class 100000
ISO9				35200000	8320000	293000	Room Air



TSI P/N 2300157

CERTIFICATE OF CALIBRATION

TSI Incorporated, 500 Cardigan Road, Shoreview, MN 55126 USA
Tel: 1-800-874-2811 1-651-490-2811 Fax: 1-651-490-3824 http://www.tsi.com

SIZE CALIBRATION AND VERIFICATION OF SIZE SETTING

NOMINAL PARTICLE SIZE	GAIN STAGE	DIGITAL CUTPOINT	EXPANDED UNCERTAINTY
0.3 µm	A	29	4.1%
0.5 µm	A	354	3.9%
1 µm	B	8	3.9%
3 µm	B	80	3.6%
5 µm	B	179	3.6%
10 µm	B	588	3.7%

COUNTING EFFICIENCY

PARTICLE SIZE	ACTUAL	ALLOWABLE RANGE	PASS/FAIL
0.3 µm	51%	50% ± 20%	Pass
0.5 µm	103%	100% ± 10%	Pass

SIZE RESOLUTION

PARTICLE SIZE	MEASURED	ALLOWABLE RANGE	PASS/FAIL
0.5 µm	5.6%	≤15%	Pass

FALSE COUNT RATE

SAMPLE TIME (MIN)	SAMPLED (L)	MEASURED COUNTS (#)	CONCENTRATION (#/M^3)	95% UCL (#/M^3)	ALLOWABLE RANGE (#/M^3)	PASS/FAIL
30	85	0	0.00	35.3	≤70.7	Pass

SAMPLING FLOW RATE (L/MIN)

NOMINAL	ACTUAL	ERROR	ALLOWABLE RANGE	PASS/FAIL
2.83	2.83	0.0 %	± 5%	Pass

SAMPLING TIME †

MEASURED	ALLOWABLE RANGE	PASS/FAIL
< ± 0.1%	± 1%	Pass

RESPONSE RATE †

MEASURED	ALLOWABLE RANGE	PASS/FAIL
0.08%	≤ 0.5%	Pass

MAXIMUM PARTICLE CONCENTRATION †

210000000 #/m^3 @10% Coincidence Loss

† Tested and verified during product development

CALIBRATION INTERVAL

CALIBRATION DATE	EXPIRATION DATE
October 4, 2017	October 4, 2018

Page 2 of 2

Model 9306-V2 SN 93061247001 Wednesday, October 04, 2017 6:16:33 PM

TSI P/N 2930157

CERTIFICATE OF CALIBRATION

TSI Incorporated, 500 Cardigan Road, Shoreview, MN 55126 USA
Tel: 1-800-874-2811 1-651-490-2811 Fax: 1-651-490-3824 http://www.tsi.com

Environment Condition		
Temperature	74.6 (23.7)	°F (°C)
Relative Humidity	31	%RH
Barometric Pressure	29.26 (990.9)	inHg (hPa)

Model	9306-V2
Serial Number	93061247001
Customer Inst ID	

☒ As Left ☐ As Found

☒ In Tolerance ☐ Out of Tolerance

AeroTrak Calibration Kit

Measurement Variable	System ID	Date Last Calibrated	Calibration Due Date
Flow Meter	E003739	6/30/2017	12/31/2017
7201-02F	E005520	9/18/2017	3/31/2018
Flow Meter	E005633	7/12/2017	1/31/2018

Particle Standards

Particle Size	Standard Uncertainty	Standard Deviation	Lot No.	Expiration Date
0.303 µm	0.003 µm	0.0047 µm	174664	10/31/2019
0.508 µm	0.004 µm	0.0085 µm	168223	4/30/2019
0.994 µm	0.0075 µm	0.010 µm	171667	7/31/2019
3.000 µm	0.01 µm	0.03 µm	167683	3/31/2019
5.020 µm	0.015 µm	0.06 µm	179268	1/31/2020
9.850 µm	0.04 µm	0.13 µm	172685	8/31/2019

TSI does hereby certify that the calibration performed on the above described instrument meets the requirements of ISO 21501-4. TSI does hereby certify that the above described instrument conforms to the original manufacturer's specification (not applicable to As Found data) and has been calibrated using standards whose accuracies are traceable to the United States National Institute of Standards and Technology (NIST) or has been verified with respect to instrumentation whose accuracy is traceable to NIST, or is derived from accepted values of physical constants. TSI is registered to ISO-9001:2015.

Charles Traas
Calibrated

October 4, 2017
Date

Model 9306-V2 SN 93061247001 Wednesday, October 04, 2017 6:16:33 PM

Page 1 of 2

Instrument	TSI AeroTrak 9306-V2 Particle Counter
Date	10/25/2017
Start Time	11:40
End Time	14:22

	Minimum	Average	Maximum	Std. Dev.	Std. Err.
Channel 1	0	14843.09	315548	53990.64	9259.32
Channel 2	0	7458.91	144170	24512.33	4203.83
Channel 3	0	5186	105477	17927.47	3074.54
Channel 4	0	2390.35	48410	8268.6	1418.05
Channel 5	0	1584.88	33216	5681.39	974.35
Channel 6	0	732.68	13781	2376.45	407.56

						Cumulative					
Record #	**Location**	**Instrument Status**	**Sample Time**	**Laser Status**	**0.3µm**		**0.5µm**		**Flow Status**	**Volume(m3)**
1	Purge	(ok)	0:05:00	OK	71		71		OK	0.01
2	Zero	(ok)	0:05:00	OK	0		0		OK	0.01
4	Near Window	(ok)	0:02:00	OK	6184		4770		OK	0.01
5	Near Window	(ok)	0:02:00	OK	12014		9187		OK	0.01
6	Near Window	(ok)	0:02:00	OK	13958		12367		OK	0.01
8	Near Window	(ok)	0:02:00	OK	1943		1590		OK	0.01
	Avg				*8525*	*5492*	*6979*	*4755*		
9	Near Fume Hood	(ok)	0:02:00	OK	707		177		OK	0.01
10	Near Fume Hood	(ok)	0:02:00	OK	2297		1590		OK	0.01
11	Near Fume Hood	(ok)	0:02:00	OK	6184		5654		OK	0.01
12	Near Fume Hood	(ok)	0:02:00	OK	10601		9541		OK	0.01
13	Near Fume Hood	(ok)	0:02:00	OK	3887		3004		OK	0.01
	Avg				*4735*	*3853*	*3993*	*3703*		
14	Center of Lab	(ok)	0:02:00	OK	530		0		OK	0.01
15	Center of Lab	(ok)	0:02:00	OK	707		707		OK	0.01
16	Center of Lab	(ok)	0:02:00	OK	1237		707		OK	0.01
17	Center of Lab	(ok)	0:02:00	OK	0		0		OK	0.01
18	Center of Lab	(ok)	0:02:00	OK	0		0		OK	0.01
	Avg				*495*	*521*	*283*	*387*		
24	In Flow Bench	(ok)	0:02:00	OK	883		353		OK	0.01
25	In Flow Bench	(ok)	0:02:00	OK	0		0		OK	0.01
26	In Flow Bench	(ok)	0:02:00	OK	0		0		OK	0.01
27	In Flow Bench	(ok)	0:02:00	OK	0		0		OK	0.01
28	In Flow Bench	(ok)	0:02:00	OK	0		0		OK	0.01
	Avg				*177*	*395*	*71*	*158*		
29	Near Entrance	(ok)	0:02:00	OK	45053		14488		OK	0.01
30	Near Entrance	(ok)	0:02:00	OK	32509		9541		OK	0.01
31	Near Entrance	(ok)	0:02:00	OK	13958		6890		OK	0.01
32	Near Entrance	(ok)	0:02:00	OK	2827		2473		OK	0.01
33	Near Entrance	(ok)	0:02:00	OK	2473		1413		OK	0.01
	Avg				*19364*	*18846*	*6961*	*5344*		
34	Changing Zone	(ok)	0:02:00	OK	315548		144170		OK	0.01