



QV TEST CO., LTD



Certification Number: CR3647

## CERTIFICATE OF COMPLIANCE

# VEM (Thailand) Co., Ltd.

## Clean room #1

## ISO Class 7 Cleanroom, In Operation

As per requirements of ISO 14644-1: 2015 (E), the designated area listed above has met the acceptance criteria for Class 7 at  $\geq 0.5 \mu\text{m}$ ,  $\geq 1.0 \mu\text{m}$ , and  $\geq 5.0 \mu\text{m}$ , under in operation condition. Testing was performed and was obtained in accordance with the current edition of the NEBB procedural standards for certified testing of cleanroom, and as outlined in the above standard and the results are attested to in the Report No: C230052.



Date of Certification:

12 March 2023

  
Mukdavan Prakobvaitayakit

NEBB Certified CPT Professional

QV TEST CO., LTD.

18/14 SOI NAWAMIN 111 YAK 4, NAWAMIN, BUENG KUM, BANGKOK, THAILAND 10230  
Tel: +66 2 060 3552. +669 4405 5599



QV TEST CO., LTD



Certification Number: CR3647

## CERTIFICATE OF COMPLIANCE

**VEM (Thailand) Co., Ltd.**

**Cleanroom#2**

**ISO Class 8 Cleanroom, In Operation**

As per requirements of ISO 14644-1: 2015 (E), the designated area listed above has met the acceptance criteria for Class 8 at  $\geq 0.5 \mu\text{m}$ ,  $\geq 1.0 \mu\text{m}$  and  $\geq 5.0 \mu\text{m}$ , under in operation condition. Testing was performed and was obtained in accordance with the current edition of the NEBB procedural standards for certified testing of cleanrooms, and as outlined in the above standard and the results are attested to in the Report No: C240130.



Date of Certification:

18 August 2024

Mukdavan Prakobvaitayakit

NEBB Certified CPT Professional

QV TEST CO., LTD.

18/14 SOI NAWAMIN 111 YAK 4, NAWAMIN, BUENG KUM, BANGKOK, THAILAND 10230  
Tel: +66 2 060 3552, +669 4405 5599



**QV TEST CO., LTD**  
18/14 Soi Nawamin 111 Yak 4, Nawamin  
Bueng Kum, Bangkok, 10230 Thailand  
Tel: +66 2 060 3552, +669 4405 5599



**NEBB Certified Firm**  
Certification No.: CR3647

## **CERTIFIED CLEANROOM TEST REPORT**

**For**

**VEM (Thailand) Co., Ltd.**

**427 Moo. 2 Mapyangporn, Pluakdaeng, Rayong 21140**

**Cleanroom#2**

**ISO Class 8 Cleanroom, In Operation**

**Report Number**



**C240130**

**Execution date:**

**15 August 2024**

## Table of Contents

Section	Contents	Page/Section No.
<b>1</b>	<b>Executive Summary</b>	2
<b>2</b>	<b>Abbreviations Used</b>	3
<b>3</b>	<b>Certification of Compliance</b>	4-5
<b>A</b>	<b>Introduction</b>	A1
	1. Purpose	
	2. Scope and Extent	
	3. Strategy of the qualification	
<b>B</b>	<b>References and Summary of Acceptance Criteria</b>	B1
<b>C</b>	<b>Instruments</b>	C1
<b>D</b>	<b>Test Procedures</b>	D1, D3-D5
<b>E</b>	<b>Test Results and Data</b>	E1, E3-E5, E22
<b>F</b>	<b>Layout Drawing</b>	F1
<b>G</b>	<b>Attachment</b>	
	1. Particle Count Raw Data	
	2. Calibration Certificate of Instruments	
	3. NEBB Certificates	
	- QV TEST CO., LTD. Certification No.: CR3647	
	- NEBB CPT Professional, Mrs. Mukdavan Prakobvaitayakit Certification No.: CP-24002	

	<b>CERTIFIED CLEANROOM TEST REPORT</b>	 Certification Number: CR3647
	Page 2	

## Executive Summary

Inspection and performance testing were concluded on **18 August 2024** for cleanrooms of **VEM (Thailand) Co., Ltd.** The following Cleanroom tests were performed and are reported:

- Airflow Volume and Uniformity Test / Flowhood Method
- Room Pressurization Test
- General Temperature and Humidity Uniformity Tests
- Airborne Particle Count Cleanliness Classification Test / ISO Class 8 @ 0.5, 1.0 and 5.0  $\mu\text{m}$

In addition to these tests result the following information and drawings were gathered and reported:

- Particle Count Location Drawing
- Supply Air Grilles and/or HEPA Filter Identification Layout Drawing
- Abbreviations
- Test Methods
- Test Equipment Calibrations

The following personnel of QV TEST tested, collected and reported the results found in this report:

- Mukdavan Prakobvaitayakit – Project Coordinator
- Tippawan Sae-Tung
- Wassika Jeamjanya
- Kantipa Jiamjittarom
- Kodchakorn Chimpalee
- Rattanachok Saysombut



### Abbreviations Used

<b>IEST</b>	Institute of Environmental Sciences and Technology
<b>NEBB</b>	National Environment Balancing Bureau
<b>ISO</b>	International Standard Organization
<b>ID</b>	Identification
<b>HEPA/H</b>	High Efficiency Particulate Air Filter
<b>m<sup>3</sup></b>	Cubic meters
<b>CMH or cmh</b>	Cubic meters per Hour
<b>CFM or cfm</b>	Cubic feet per minute
<b>Pa</b>	Pascal
<b>µm</b>	Micrometer
<b>°C</b>	Degrees Celsius
<b>AHU</b>	Air Handling Unit
<b>N/A</b>	Not Applicable
<b>RH</b>	Relative Humidity
<b>Max</b>	Maximum
<b>Min</b>	Minimum



QV TEST CO., LTD



Certification Number: CR3647

## CLEANROOM PERFORMANCE TESTING CERTIFICATE OF COMPLIANCE

**VEM (Thailand) Co., Ltd.**

**Cleanroom#2**

**ISO Class 8 Cleanroom, In Operation**

The data presented in this report is a record of cleanroom and system performance and was obtained in accordance with the current edition of the NEBB procedural standards for certified testing of cleanrooms and ISO14644-1: 2015 (E). Any variances from design, specified, or agreed to criteria are noted in the cleanroom report project summary.



Date of Certification:

18 August 2024

Mukdavan Prakobvaitayakit

NEBB Certified CPT Professional

Submitted & Certified By: QV TEST CO., LTD.  
18/14 SOI NAWAMIN 111 YAK 4, NAWAMIN, BUENG KUM, BANGKOK, THAILAND 10230  
Tel: +66 2 060 3552, +669 4405 5599



QV TEST CO., LTD





Certification Number:CR3647

The results shown and information given in this report are certified to be accurate and complete to the extent possible by equipment and procedures used on this date. QV Test Co., Ltd warrants that the equipment or system listed above and / or identified in this report is operating at the specified levels as shown, at and only at this time, and make no other warranties, stated or implied, concerning the continued performance, operation or safety in use of this equipment past this time.





	<b>CERTIFIED CLEANROOM TEST REPORT</b>		 Certification Number: CR3647
	Section: A1	Page 1 of 2	

## INTRODUCTION

### 1. PURPOSE

To provide documented evidence - i.e. this Testing Report, through appropriate performance testing, that the cleanroom, insulation room and operation room parameters are consistently within the established requirements.

### 2. SCOPE AND EXTENT

This protocol is applicable to qualification of the Cleanroom as per the drawing with specification details is attached document. The scope and extent of qualification will be as follows:

The Qualification aspect will be performed through reviewing and verifying the commissioning report **provided by VEM (Thailand) Co., Ltd.** for compliance with Qualification requirements as User Requirement Specifications (URS) with respect to Design Specifications (DS) and Functional Specifications (FS).

The verification will also include the inspection of the cleanroom's and HVAC system's as is conditions especially follow below test details (as built/ at rest or in operation conditions) using acceptance criteria and upper confidence limits (UCL) as appropriate.

Cleanroom Qualification Tests Responsibilities		
Page Code	Test Contents	QV Test
D1-1	Air Flow Volume and Uniformity Test / Flowhood Method	✓
D1-2	Air Flow Volume and Uniformity Test– Unidirectional/ Non-Unidirectional (Velocity Method)	
D2-1	Filter Installation Leak Tests / Aerosol Photometer Test Method	
D2-2	Filter Installation Leak Tests / Aerosol Photometer Test Method (Overall leak test: filters in ducts or AHUs)	
D2-6	Ulpa/Hepa Filter Installation Leak Test (Downstream Scan method with Ambient Air)	
D3	Room Pressurization Test	✓
D4	General Temperature and Humidity Uniformity Tests	✓
D5-1	Airborne Particle Count Cleanliness Classification Test / PICs	
D5-2	Airborne Particle Count Cleanliness Classification Test / ISO14644-1:2015(E)	✓
D6	Recovery Test	
D7	Air Flow Smoke Patterns Test	

### 3. STRATEGY OF THE QUALIFICATION

Each of the tests involved will comprise the following outline

- |    |                              |  |
|----|------------------------------|--|
| a) | <b>OBJECTIVE</b>             | to define the purpose of the test  |
| b) | <b>METHODOLOGY</b>           | to define the procedure to follow in test execution  |
| c) | <b>ACCEPTANCE CRITERIA</b>   | it details the expected result that are considered correct   |
| d) | <b>VERIFICATION REGISTER</b> | It details the verification to be done, checking the grade of compliance with the acceptance criteria.               |
| e) | <b>CONCLUSIONS</b>           | once the qualification of the test are made, the result of the test will be consigned with the appropriate comments. |

The result of the test could be

<b>PASS</b>	<b>FAIL</b>
When all verification results have been in accordance with the acceptance criteria, if non-conformities found but corrected and solved in time or considered as non-critical	When any verification does not fulfill the acceptance criteria because critical deviations are opened and it has not been possible to solve them in time. In the case, once the non-conformity has been solved. The verification must be repeated and the new result registered.

- |    |                     |   |
|----|---------------------|---|
| f) | <b>OBSERVATIONS</b> | In this part will be any outstanding point to clarify any decision or just even during qualification process. It will be detailed when critical data should be registered |
|----|---------------------|---|

People that carry out the verification or review final data must put their signature and date where required.

Any deviation or non-conformity found during verification process would be registered and technical personnel in charge will carry out a revision and make appropriate comment, in order to classify the deviation according to the following categories.

<b>Critical</b>	<b>Non Critical</b>
It can effect to the product quality and therefore it must be correct. After correction, it must be done Again, a verification to demonstrate that it has been solve adequately	It does not affect the product quality and it can be left over without corrective action or with partial correction.

Deviation will be registered following the non-conformity model.

Once finished all test of the protocol, the model of the report that is shown in the next page will be complete, including

1. Performance result
2. A register of all non-conformities registered during the execution and its evaluation.
3. A list with all addition information used, which is used for supporting the qualification.

All signatures in the report confirm that the qualification has been carried and accepted.



# CERTIFIED CLEANROOM TEST REPORT



Certification Number: CR3647

Section: B1

Page 1 of 1



## REFERENCES AND SUMMARY OF ACCEPTANCE CRITERIA

### 1. REFERENCES

- [1] ISO 14644 series standards, International Organization of Standardization
- [2] ISO 14644-1:2015(E), Second edition 2015-12-15, Cleanrooms and associated controlled environments- Part 1: Classification of air cleanliness by particle concentration
- [3] Procedural Standards for Certified Testing of Cleanrooms, National Environmental Balancing Bureau (NEBB)
- [4] Operation and Maintenance Manuals for HVAC Systems
- [5] User Requirement Specifications (URS) and as-built drawing with specification detail.
- [6] Pharmaceutical Inspection Convention/Pharmaceutical Inspection Convention Scheme (PIC/S), Guide to Good Manufacturing Practice for Medical Products: Annexes, PE 009-12 (Annexes), 1 Oct 2015, [www.picscheme.org](http://www.picscheme.org).

### 2. SUMMARY OF ACCEPTANCE CRITERIA (1)

Item	Test Contents	User Requirement Specifications			Remark
1-1	Air Flow Volume and Uniformity Test / Flowhood Method	Air Change Rate: $\geq 5$ Cycle/hr			N/A
3	Room Pressurization Test	Pressure: $\geq 5$ Pa			N/A
4	General Temperature and Humidity Uniformity Tests	Temperature: 18 - 28 °C Humidity: 40 - 70 %RH			N/A
5-2	Airborne Particle Count Cleanliness Classification Test ISO 14644-1: 2015 (E)	ISO Class 8 (Particle/m <sup>3</sup> )			N/A
		$\geq 0.5 \mu\text{m}$	$\geq 1.0 \mu\text{m}$	$\geq 5.0 \mu\text{m}$	
		3,520,000	832,000	29,300	



	<b>CERTIFIED CLEANROOM TEST REPORT</b>		 <b>Certification Number: CR3647</b>
	Section: C1	Page 1 of 1	

### INSTRUMENTS

The instrument used in the execution of the verification tests will be registered in the verification table. A Calibration certification for the instrument used will be provided. The certificate will be issued by a competent authority.

EXECUTION INSTRUMENTS					
INSTRUMENT	SERIAL NUMBER	CERTIFICATE NUMBER	CALIBRATION DATE	NEXT CALIBRATION DATE	Used
<b>D1-1: Air Flow Volume and Uniformity Test / Flow hood Method</b>					
Air Flow Hood	T83801645011	23-AFM-133	4 Jul 2024	4 Jul 2025	
Air Flow Hood	T83801843016	24-AFM-046	4 Mar 2024	4 Mar 2025	✓
<b>D1-2: Air Flow Volume and Uniformity Test– Unidirectional/ Non-Unidirectional (Velocity Method)</b>					
Air Velocity Monitor	T83801843016	24-AVM-034	4 Mar 2024	4 Mar 2025	
Air Velocity with Matrix Probe	T83801843016	24-AFM-047	4 Mar 2024	4 Mar 2025	
Air Velocity Monitor	T83801645011	23-AVM-091	4 Mar 2024	4 Mar 2025	
Air Velocity with Matrix Probe	T83801645011	24-AFM-135	4 Mar 2024	4 Mar 2025	
Air Velocity Monitor	9535A1841010	24-AVM-033	1 Mar 2024	1 Mar 2025	
<b>D2-1: Filter Installation Leak Tests / Aerosol Photometer Test Method and D2-2: Filter Installation Leak Tests / Aerosol Photometer Test Method (Overall leak test: filters in ducts or AHUs) D2-3: HEPA Filter Efficiency Test D2-5: Filter Installation Leak Tests – Discrete Particle Counter Test Method D2-6: ULPA or HEPA Filter Installation Leak Test</b>					
Aerosol Photometer	24766	ST362/0724	16 Jul 2024	16 Jul 2025	
Aerosol Photometer	16438	ST556/0923	28 Sep 2023	28 Sep 2024	
Aerosol Particle Counter	91101842001	N/A	5 Dec 2023	5 Dec 2024	
Aerosol Generator ViCount 5000	1046436/ 1046437	-	-	-	
<b>D3: Room Pressurization Test</b>					
Pressure Measurement Function	T83801843016	24-DPM-060	4 Mar 2024	4 Mar 2025	✓
Pressure Measurement Function	T83801645011	24-DPM-18	4 Jun 2024	4 Jun 2025	
<b>D4: General Temperature and Humidity Tests / Uniformity Tests</b>					
Thermo-hygro-air quality meter HQ210 HT	2P211114529	551220085619002	16 Jan 2024	16 Jan 2025	
Thermo-hygro-air quality meter HQ210 HT	2P170305306	551220085797990	10 Apr 2024	10 Apr 2025	✓
<b>D5: Airborne Particle Count Cleanliness Classification Test D6: Recovery Test</b>					
Aerosol Particle Counter	95001352002	24-APC-058	14 May 2024	14 May 2025	
Aerosol Particle Counter	95002015023	24-APC-070	5 June 2024	5 June 2025	✓
Aerosol Particle Counter	91101842001	-	5 Dec 2023	5 Dec 2024	
<b>D7: Air Flow Smoke Pattern Test</b>					
Ultrasonic-Mist Generator	QV-002MG	-	-	-	
<b>D8: UV Measure Test</b>					
UV Light Meter	Q978124	WK2305-069-1	8 May 2023	8 May 2024	

All raw data obtained from the instrument will be attached in last section.

	<b>CERTIFIED CLEANROOM TEST REPORT</b>		 Certification Number: CR3647
	Section: D1-1	Page 1 of 1	

## TEST PROCEDURE

### AIR FLOW VOLUME AND UNIFORMITY TEST / FLOWHOOD METHOD

a) PURPOSE

- To lay down the procedure for testing the airflow volume and air change rate
- To verify uniformity at specified velocity
- Determine air change rates

b) EQUIPMENT AND INSTRUMENTATION

- Air flow Hood (attached in Execution instruments: Section C)

c) PROCEDURE



- Select the flow hood which adequately size to capture all the air exiting the supply air grille/HEPA filter being tested.
- Seat the flow hood firmly to the filter or supply frame to prevent air leakage.
- Measure the airflow volume of each filter in cubic meter per hour (CMH) or cubic feet per minute (CFM)
- Record the result in Airflow Volume And Uniformity Test – Flowhood Method Form
- Calculate the air change rate of each cleanroom

d) ACCEPTANCE CRITERIA

Criteria of acceptance will be as per the User Requirement Specification (URS)

(SECTION B)

Complete the verification data attached in SECTION E

	<b>CERTIFIED CLEANROOM TEST REPORT</b>		 Certification Number: CR3647
	Section: D3	Page 1 of 1	

## TEST PROCEDURE

### ROOM PRESSURIZATION TEST

a) PURPOSE

To lay down the procedure for validating the room pressurization test of the clean rooms or clean areas whether passes the specification

b) EQUIPMENT AND INSTRUMENTATION

- Micromanometer or Differential Pressure Indicator as attached in Execution instruments: Section C)



c) PROCEDURE

- Introduce the Micromanometer or Differential Pressure Indicator which is calibrated.
- Adjust zero the instrument before testing
- With all doors closed, measure and record the pressure differentials in Pa between the cleanroom and the exterior environment.
- Where the contract need to verify manometer gauge installed in cleanroom against the test instrument, read and record the value from both instruments. Compare the value as the contract specification.

d) ACCEPTANCE CRITERIA

Criteria of acceptance will be as per the User Requirement specification (URS) in SECTION B

Complete the verification data attached in SECTION E

	<b>CERTIFIED CLEANROOM TEST REPORT</b>		 Certification Number: CR3647
	Section: D4	Page 1 of 1	

## TEST PROCEDURE

### GENERAL TEMPERATURE AND HUMIDITY UNIFORMITY TESTS

a) PURPOSE

- To document the temperature and humidity levels in the cleanroom or clean space.
- To lay down the procedure for validating the temperature and humidity test of the clean rooms or clean areas whether passes the specification.

b) EQUIPMENT AND INSTRUMENTATION

- Temperature and relative humidity meter (attached in Execution instruments: Section C)

c) PROCEDURE

Procedure for the general temperature uniformity test

- Verify completion of HVAC system testing, adjusting and balancing (TAB) work prior to performing these tests
- Allow the HVAC system to operate under automatic control for 24 hours prior to tests
- Measure the temperature at a minimum of one location for each temperature control zone.
- Place each thermometer or each sensor at the designated location at work level height
- Allow time for the sensor to stabilize sufficiently for accurate readings.
- Record the time and temperature reading at each location for each temperature control work zone in General Temperature and Humidity Uniformity Tests form
- Calculate the average of reading

Procedure for the general humidity uniformity test

- Verify completion of HVAC system testing, adjusting and balancing (TAB) work prior to performing these tests.
- Allow the HVAC system to operate under automatic control for 24 hours prior to tests.
- The relative humidity is to be measured at a minimum of one location for each humidity (temperature) control zone.
- Place the humidity device or sensor at the designated location and height, allowing the sensor to stabilize.
- Measure and record the humidity readings simultaneously with temperature readings
- Record the time and humidity reading at each location for each temperature control work zone in General Temperature and Humidity Uniformity Tests form
- Calculate the average of reading

d) ACCEPTANCE CRITERIA

Criteria of acceptance will be as per the User Requirement Specification (URS) (SECTION B)

Complete the verification data attached in SECTION E

### TEST PROCEDURE

<b>AIRBORNE PARTICLE COUNT CLEANLINESS CLASSIFICATION TEST/ ISO STANDARD 14644-1: 2015(E)</b>
---

a) PURPOSE

- To lay down the procedure for testing the airborne particulate level in the cleanroom and to determine the room Cleanliness Classification as per ISO 14644-1: 2015(E).

b) EQUIPMENT AND INSTRUMENTATION

- Particle Counter (attached in Execution instruments: Section C)

c) PROCEDURE

- Verify that all aspects of the cleanroom system which contribute to its operational integrity (air handling, filtration systems, walls, ceilings, floors, etc.) are complete and functioning. The following primary tests shall be completed prior to performing the cleanliness classification tests:
  - a. Room pressurization tests
  - b. Airflow tests
  - c. Filter Leak tests
- The minimum number of locations,  $N_L$  shall be determined as in Table D5-2.1.

**Table D5-2. 1 Sampling location related to cleanroom area**

Area of cleanroom (m <sup>2</sup> ) less than or equal to	Minimum number of sampling location to be tested ( $N_L$ )
2	1
4	2
6	3
8	4
10	5
24	6
28	7
32	8
36	9
52	10
56	11
64	12
68	13
72	14
76	15
104	16
108	17
116	18
148	19
156	20
192	21
232	22
276	23
352	24
436	25
636	26
1,000	27
> 1,000	See formula D5-2.1

Note 1: If considered area falls between two values in the table, the greater of two should be selected.

Note 2: In the case of unidirectional airflow, the area may be considered as the cross section of moving air perpendicular to the direction of the airflow. In all other cases the area may be considered as the horizontal plan area of the cleanroom or clean zone.



- Sampling location for large cleanroom or clean zones

**Formula D5-2.1:**

$$N_L = 27 \times \left[ \frac{A}{1000} \right]$$

Where

$N_L$  is the minimum number of sampling location to be evaluated, rounded up to the next whole number;  
 $A$  is the area of the cleanroom in m<sup>2</sup>.

- Divide the whole cleanroom or clean zone in to  $N_L$  section of equal area.
- Select within each section a sampling location considered to be representative of the characteristics of the section, taken at a height of 1.5 meter above the floor. When an obstruction was encountered, the sample was taken at 12" above the obstruction.
- Additional sampling location may be selected for location considered critical and also additional sections and associated sampling locations may be included to facilitate subdivision into equal section.
- The single sample volume per location for ISO 14644-1:2015(E) classified room shall be using the formula D5-2.2. The minimum sample volume shall be 2 liters with a minimum sample time of 1 minute.

**Formula D5-2.2:**

$$V_s = \left[ \frac{20}{C_{n,m}} \right] \times 1000$$

where

$V_s$  is the minimum single sample volume per location, expressed in liters

$C_{n,m}$  is the class limit (number of particle per cubic meter) for the large considered particle size specified for the relevant class.

20 is the number of particles that could be counted if the particle concentration were at the class limit.

- The size of particles to be measured for room class certification shall be as specified in the contract documents or as agreed to between the Owner / Buyer and the QV Test Co., Ltd. Particle counts limits for an ISO classified room according to their Cleanliness Class as per ISO 14644-1:2015(E) as shown in Table D5-2.2.
- Air born particle concentration for cleanrooms and clean zones are designated as

ISO Class Number; Occupancy state; Considered particle size(s)

Example      ISO Class 4; at rest; 0.2µm, 0.5 µm.

**Table D5-2.2: ISO Classes of air cleanliness by particle concentration**

ISO Class number (N)	Maximum allowable concentration (particle/m <sup>3</sup> ) for particle equal to and greater than the considered sizes, shown below <sup>a</sup>					
	≥ 0.1 μm	≥ 0.2 μm	≥ 0.3 μm	≥ 0.5 μm	≥ 1 μm	≥ 5 μm
1	10	d	d	d	d	e
2	100	24 <sup>b</sup>	10 <sup>b</sup>	d	d	e
3	1,000	237	102	35 <sup>b</sup>	d	e
4	10,000	2,370	1,020	352	83 <sup>b</sup>	e
5	100,000	23,700	10,200	3,520	832	d, e, f
6	1,000,000	237,000	102,000	35,200	8,320	293
7	c	c	c	352,000	83,200	2,930
8	c	c	c	3,520,000	832,000	29,300
9 <sup>g</sup>	c	c	c	35,200,000	8,320,000	293,000

a All concentration in the table are cumulative, e.g. for ISO Class 5, the 10,200 particles shown at 0.3 μm include all particle equal to and greater than this size.  
 b These concentrations will lead to large air sample volumes for classification.  
 c Concentration limits are not applicable in this region of the table due to very high particle concentration.  
 d Sampling and statistical limitation for particle in low concentration make classification inappropriate.  
 e Sampling collection limitations for both particles in low concentration and sizes greater than 1 μm make classification at this particle size inappropriate, due to potential particle losses in the sampling system.  
 f In order to specify this particle size in association with ISO Class 5, the macroparticle descriptor M may be adapted and used in conjunction with at least one other particle size. To express an air particle concentration of 20 or 29 particle/m<sup>3</sup> in the particle size rang ≥ 5μm based on the use of light scattering (discrete) airborne particle counters (LSAPC), the designation would be; “ISO M (20; ≥ 5 μm); LSAPC” or “ISO M (29; ≥ 5 μm); LSAPC”, respectively.  
 g This class is only applicable for the in-operation state.

- If and out- of- specification count founded at a location due to and identified abnormal occurrence, then that count can be discarded and noted as such on the test report and a new sample taken.
- If an out- of- specification count founded at a location is attributed to a technical failure of the cleanroom or equipment, the cause should be identified, remedial action taken and retesting performed of the failed sampling location and documented in non-conformance report.
- Record the result in Airborne particle count cleanliness classification test form.
- When two or more single sample volume are taken at a location, calculate and record the average number of particles per location at each considered particle size from the individual sample particle concentrations, according to Formula D5-2.3.

**Formula D5-2.3:**



$$\bar{C} = \frac{\sum_{i=1}^n C_i}{n}$$

where

$\bar{C}$  is the average number of particle at location I, representing any location



$C_i$  is the number of particles in individual samples.

$n$  is number of sampling take at location  $i$ .

	<b>Test Results and Data</b>		
	Section: E1-1	Page 1 of 1	

AIR FLOW VOLUME AND UNIFORMITY TEST / FLOWHOOD METHOD												
AHU No.	Room No.	Room Name	SPEC.				RESULT				Air Change (Cycle/hr)	Conclusion
			Room Volume (m <sup>3</sup> )	Air Change (Cycle/hr)	SAG and HEPA		Supply Air Flow		Air Change (Cycle/hr)			
					Item	Size	SAG/HEPA	Total		SAG/HEPA		
-	-	Cleanroom#2	715.88	≥ 5	H1	2'x4'	388	4,182	228	2,460	5.84	PASS
					H2	2'x4'	360		212			
					H3	2'x4'	368		216			
					H4	2'x4'	319		188			
					H5	2'x4'	308		181			
					H6	2'x4'	314		185			
					H7	2'x4'	316		186			
					H8	2'x4'	302		178			
					H9	2'x4'	313		184			
					H10	2'x4'	319		188			
					H11	2'x4'	305		179			
					H12	2'x4'	289		170			
					H13	2'x4'	281		165			

Remark:

Prepared by: Rattanachok Saysombut	Signature: 	Date: 18 Aug 2024
Reviewed by: Mukdavan Prakobvaitayakit	Signature: 	Date: 18 Aug 2024



### Test Results and Data



Section: E3

Page 1 of 1

Certification Number : CR3647

#### Room Pressurization Test

Acceptance Criteria: Follow design of each room

AHU No.	Room No.	Room Name	SPEC.	RESULT		Test Result
			Room Pressure difference	Room Manometer Reading	Standard Manometer Reading	
			Pa	Pa	Pa	
-	-	Cleanroom#2	$\geq 5$	11	10.0	PASS

Remark:

Prepared by: Rattanachok Saysombut

Signature:

Date: 18 Aug 2024

Reviewed by: Mukdavan Prakobvaitayakit

Signature:

Date: 18 Aug 2024



### Test Results and Data



Section: E4

Page 1 of 1

Certification Number : CR3647

#### General Temperature And Humidity Uniformity Tests

Acceptance Criteria: Follow design of each room

AHU No.	Room No.	Room Name	SPECIFICATION				RESULT		Test Result
			Temperature (°C)		Humidity (%RH)		Temperature (°C)	Humidity (%RH)	
			Min	Max	Min	Max			
-	-	Cleanroom#2	18	28	40	70	23.0	47.8	PASS

Remark:

Prepared by: Rattanachok Saysombut

Signature:

Date: 19 Aug 2024

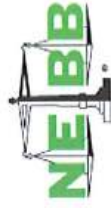
Reviewed by: Mukdavan Prakobvaitayakit

Signature:

Date: 18 Aug 2024



## Test Results and Data



Section: E5-2

Page 1 of 3

Certification Number : CR3647

### AIRBORNE PARTICLE COUNT CLEANLINESS CLASSIFICATION TEST

Occupancy State:		In Operation		Number of Personnel:		9						
Particle counter Used:		TSI 9500-01										
Classification Standard		Cleanroom Classification:										
ISO 14644-1:2015 (E)		ISO Class 8										
Particle Size		Acceptance Criteria (particles/m <sup>3</sup> ):										
0.5 µm		≤ 3,520,000										
Room		Particle Count										
Room No.	Room	Pos 1	Pos 2	Pos 3	Pos 4	Pos 5	Pos 6	Pos 7	Pos 8	Pos 9	Pos 10	Result
-	Cleanroom#2	141,530	116,900	103,540	115,980	99,660	79,020	71,530	78,220	63,150	53,890	PASS
		Pos 11	Pos 12	Pos 13	Pos 14	Pos 15	Pos 16	Pos 17	Pos 18	Pos 19	Pos 20	
		50,590	39,450	70,560	52,660	63,580	164,730	113,190	76,510	83,430	70,090	
		Pos 21	Pos 22	Pos 23	Pos 24	Pos 25	Pos 26	Pos 27	Pos 28	Pos 29	Pos 30	
		79,700	69,850									

Remark: Each sampling location is less than the acceptance criteria.

Prepared by: Rattanachok Saysombut

Signature: *Rattana*

Date: 18 Aug 2024

Reviewed by: Mukdavan Prakobvattayakit

Signature: *Mukdavan*

Date: 18 Aug 2024



## Test Results and Data



Section: E5-2

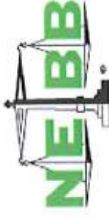
Page 2 of 3

Certification Number : CR3647

AIRBORNE PARTICLE COUNT CLEANLINESS CLASSIFICATION TEST														
Occupancy State:		In Operation		Number of Personnel:										
						9								
Particle Size		Classification Standard		Cleanroom Classification:		Acceptance Criteria (particles/m <sup>3</sup> ): Particle Cleanliness Class Limit								
1.0 µm		ISO 14644-1:2015 (E)		ISO Class 8		≤ 832,000								
Room No.	Room	Particle Count												Result
		Pos 1	Pos 2	Pos 3	Pos 4	Pos 5	Pos 6	Pos 7	Pos 8	Pos 9	Pos 10	Pos 11	Pos 12	
-	Cleanroom#2	36,430	27,490	24,390	34,270	26,410	20,570	18,290	26,690	18,670	15,460			
		15,150	11,250	23,570	15,110	17,780	45,290	30,380	20,130	24,930	17,900			
		18,920	16,970											
Remark: Each sampling location is less than the acceptance criteria.														
Prepared by: Rattanachok Saysombut		Signature:				Date: 18 Aug 2024								
Reviewed by: Mukdavan Prakobvattayakit		Signature:				Date: 18 Aug 2024								



### Test Results and Data



Section: E5-2

Page 3 of 3

Certification Number : CR3647

AIRBORNE PARTICLE COUNT CLEANLINESS CLASSIFICATION TEST																						
Occupancy State:		In Operation		Particle counter Used:																		
				Particle counter Standard		Cleanroom Classification:		Acceptance Criteria (particles/m <sup>3</sup> ):		Particle Cleanliness Class Limit												
				ISO 14644-1:2015 (E)		ISO Class 8		≤ 29,300														
Room No.	Room	Particle Count												Result								
		Pos 1	Pos 2	Pos 3	Pos 4	Pos 5	Pos 6	Pos 7	Pos 8	Pos 9	Pos 10	Pos 11	Pos 12									
-	Cleanroom#2	1,880	860	890	2,140	1,670	760	1,020	1,810	1,080	1,100	1,250	1,050	2,210	940	820	1,480	880	600	1,950	550	PASS
		740	830																			

Remark: Each sampling location is less than the acceptance criteria.

Prepared by: Rattanachok Saysombut

*Rattana*

Signature:

Date: 17 Aug 2024



Reviewed by: Mukdavan Prakobvattayakit

*ml*

Signature:

Date: 18 Aug 2024



	<b>Test Results and Data</b>		
	Section: E22	Page 1 of 1	

**QUALIFICATION RESULT**

**Conclusions:**  
 According to the test result discussion, it could be concluded that the cleanroom has met the acceptance criteria of following tests:

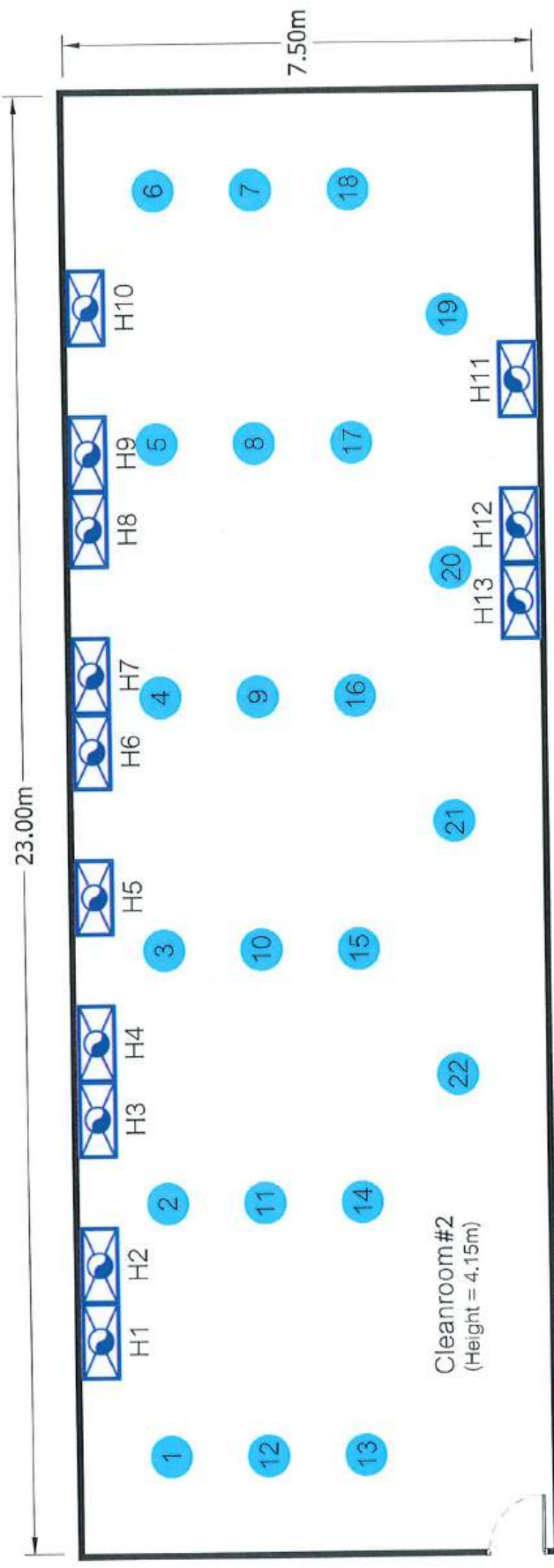
1. Airflow Volume and Uniformity Test / Flowhood Method
2. Room Pressurization Test
3. General Temperature and Humidity Uniformity Tests
4. Airborne Particle Count Cleanliness Classification Test

**Additional information attached:**

- Particle Sampling Raw Data
- Room and position tests layout
- Instrument certificate

The signature of the present document implies the complete revision of the protocol and the revision of all data that support the test.

Prepared by	Title	Signature	Date
Rattanachok Saysombut	Validation Document Support		19 Aug 2024
Reviewed by	Title	Signature	Date
Mukdavan Prakobvaitayakit	CPT Supervisor		18 Aug 2024
Approved by	Title	Signature	Date



Cleanroom #2  
(Height = 4.15m)

Validation Plan  
(Scale 1: 100)

-  = HEPA Filter Size 2' x 4'
-  = Particle Sampling Point



QV Test Co., Ltd.  
18/14 Soi Nawamin 111 Yak 4, Nawamin, Buengkum,  
Bangkok 10230, Tel: +662 060 3552, +669 4405 5599



Certification Number: CR3647

Customer

VEM (Thailand) Co., Ltd.

Section F1

DWG. Shown

- HEPA Filter Layout
- Particle Sampling Point

Certified Cleanroom.

Cleanroom #2

Prepared By *Samson* 18 Aug 2024

Reviewed By *Sam*, 18 Aug 2024

DWG. Scale 1 : 100

Date:



# CERTIFIED CLEANROOM TEST REPORT



Certification Number: CR3647

## AIRBORNE PARTICLE COUNT TEST RAW DATA

AHU No.	Room No.	Room Name	ISO Class
-	-	Cleanroom#2 (1 of 3)	8

Inst Model 9500-01  
Serial # 95002015023

Sample 1 of \*\*  
Sample # 3001  
Start Time 8/15/2024, 11:11:50  
End Time 8/15/2024, 11:12:50  
Zone VEH  
Location Cleanroom#2  
Recipe 1m/1p  
Sample Time 00:01:00  
Volume 100.0 L  
Instrument Status: OK

Particulates / m3:	Size	Diff	Cumul Alarm
0.5	105100	141530	
1.0	34550	36430	
5.0	1880	1880	

Inst Model 9500-01  
Serial # 95002015023

Sample 4 of \*\*  
Sample # 3004  
Start Time 8/15/2024, 11:15:05  
End Time 8/15/2024, 11:16:05  
Zone VEH  
Location Cleanroom#2  
Recipe 1m/1p  
Sample Time 00:01:00  
Volume 100.0 L  
Instrument Status: OK

Particulates / m3:	Size	Diff	Cumul Alarm
0.5	81710	115980	
1.0	32130	34270	
5.0	2140	2140	

Inst Model 9500-01  
Serial # 95002015023

Sample 7 of \*\*  
Sample # 3007  
Start Time 8/15/2024, 11:18:20  
End Time 8/15/2024, 11:19:20  
Zone VEH  
Location Cleanroom#2  
Recipe 1m/1p  
Sample Time 00:01:00  
Volume 100.0 L  
Instrument Status: OK

Particulates / m3:	Size	Diff	Cumul Alarm
0.5	53240	71530	
1.0	17270	18290	
5.0	1020	1020	

Inst Model 9500-01  
Serial # 95002015023

Sample 2 of \*\*  
Sample # 3002  
Start Time 8/15/2024, 11:12:55  
End Time 8/15/2024, 11:13:55  
Zone VEH  
Location Cleanroom#2  
Recipe 1m/1p  
Sample Time 00:01:00  
Volume 100.0 L  
Instrument Status: OK

Particulates / m3:	Size	Diff	Cumul Alarm
0.5	89410	116900	
1.0	26630	27490	
5.0	860	860	

Inst Model 9500-01  
Serial # 95002015023

Sample 5 of \*\*  
Sample # 3005  
Start Time 8/15/2024, 11:16:10  
End Time 8/15/2024, 11:17:10  
Zone VEH  
Location Cleanroom#2  
Recipe 1m/1p  
Sample Time 00:01:00  
Volume 100.0 L  
Instrument Status: OK

Particulates / m3:	Size	Diff	Cumul Alarm
0.5	73250	99660	
1.0	24740	26410	
5.0	1670	1670	

Inst Model 9500-01  
Serial # 95002015023

Sample 8 of \*\*  
Sample # 3008  
Start Time 8/15/2024, 11:19:25  
End Time 8/15/2024, 11:20:25  
Zone VEH  
Location Cleanroom#2  
Recipe 1m/1p  
Sample Time 00:01:00  
Volume 100.0 L  
Instrument Status: OK

Particulates / m3:	Size	Diff	Cumul Alarm
0.5	51530	78220	
1.0	24880	26690	
5.0	1810	1810	

Inst Model 9500-01  
Serial # 95002015023

Sample 3 of \*\*  
Sample # 3003  
Start Time 8/15/2024, 11:14:00  
End Time 8/15/2024, 11:15:00  
Zone VEH  
Location Cleanroom#2  
Recipe 1m/1p  
Sample Time 00:01:00  
Volume 100.0 L  
Instrument Status: OK

Particulates / m3:	Size	Diff	Cumul Alarm
0.5	79150	103540	
1.0	23500	24390	
5.0	890	890	

Inst Model 9500-01  
Serial # 95002015023

Sample 6 of \*\*  
Sample # 3006  
Start Time 8/15/2024, 11:17:15  
End Time 8/15/2024, 11:18:15  
Zone VEH  
Location Cleanroom#2  
Recipe 1m/1p  
Sample Time 00:01:00  
Volume 100.0 L  
Instrument Status: OK

Particulates / m3:	Size	Diff	Cumul Alarm
0.5	58450	79020	
1.0	19810	20570	
5.0	760	760	

Inst Model 9500-01  
Serial # 95002015023

Sample 9 of \*\*  
Sample # 3009  
Start Time 8/15/2024, 11:20:30  
End Time 8/15/2024, 11:21:30  
Zone VEH  
Location Cleanroom#2  
Recipe 1m/1p  
Sample Time 00:01:00  
Volume 100.0 L  
Instrument Status: OK

Particulates / m3:	Size	Diff	Cumul Alarm
0.5	44480	63150	
1.0	17590	18670	
5.0	1080	1080	

Completed by: Rattanachok Saysombut      Signature: Smsorn      Date: 18 Aug 2024



# CERTIFIED CLEANROOM TEST REPORT



Certification Number: CR3647

## AIRBORNE PARTICLE COUNT TEST RAW DATA

AHU No.	Room No.	Room Name	ISO Class
-	-	Cleanroom#2 (2 of 3)	8

Inst Model 9500-01  
Serial # 95002015023

Sample 10 of ∞  
Sample # 3010  
Start Time 8/15/2024, 11:21:35  
End Time 8/15/2024, 11:22:35  
Zone VEH  
Location Cleanroom#2  
Recipe 1m/1p  
Sample Time 00:01:00  
Volume 100.0 L  
Instrument Status: OK

Particles / m3:	Diff	Cumul Alarm
Size		
0.5	38430	53890
1.0	14360	15460
5.0	1100	1100

Inst Model 9500-01  
Serial # 95002015023

Sample 13 of ∞  
Sample # 3013  
Start Time 8/15/2024, 11:24:50  
End Time 8/15/2024, 11:25:50  
Zone VEH  
Location Cleanroom#2  
Recipe 1m/1p  
Sample Time 00:01:00  
Volume 100.0 L  
Instrument Status: OK

Particles / m3:	Diff	Cumul Alarm
Size		
0.5	46990	70560
1.0	21360	23570
5.0	2210	2210

Inst Model 9500-01  
Serial # 95002015023

Sample 16 of ∞  
Sample # 3016  
Start Time 8/15/2024, 11:28:05  
End Time 8/15/2024, 11:29:05  
Zone VEH  
Location Cleanroom#2  
Recipe 1m/1p  
Sample Time 00:01:00  
Volume 100.0 L  
Instrument Status: OK

Particles / m3:	Diff	Cumul Alarm
Size		
0.5	119440	164730
1.0	43810	45290
5.0	1480	1480

Inst Model 9500-01  
Serial # 95002015023

Sample 11 of ∞  
Sample # 3011  
Start Time 8/15/2024, 11:22:40  
End Time 8/15/2024, 11:23:40  
Zone VEH  
Location Cleanroom#2  
Recipe 1m/1p  
Sample Time 00:01:00  
Volume 100.0 L  
Instrument Status: OK

Particles / m3:	Diff	Cumul Alarm
Size		
0.5	35440	50590
1.0	13900	15150
5.0	1250	1250

Inst Model 9500-01  
Serial # 95002015023

Sample 14 of ∞  
Sample # 3014  
Start Time 8/15/2024, 11:25:55  
End Time 8/15/2024, 11:26:55  
Zone VEH  
Location Cleanroom#2  
Recipe 1m/1p  
Sample Time 00:01:00  
Volume 100.0 L  
Instrument Status: OK

Particles / m3:	Diff	Cumul Alarm
Size		
0.5	37550	52660
1.0	14170	15110
5.0	940	940

Inst Model 9500-01  
Serial # 95002015023

Sample 17 of ∞  
Sample # 3017  
Start Time 8/15/2024, 11:29:10  
End Time 8/15/2024, 11:30:10  
Zone VEH  
Location Cleanroom#2  
Recipe 1m/1p  
Sample Time 00:01:00  
Volume 100.0 L  
Instrument Status: OK

Particles / m3:	Diff	Cumul Alarm
Size		
0.5	82810	113190
1.0	29500	30360
5.0	880	880

Inst Model 9500-01  
Serial # 95002015023

Sample 12 of ∞  
Sample # 3012  
Start Time 8/15/2024, 11:23:45  
End Time 8/15/2024, 11:24:45  
Zone VEH  
Location Cleanroom#2  
Recipe 1m/1p  
Sample Time 00:01:00  
Volume 100.0 L  
Instrument Status: OK

Particles / m3:	Diff	Cumul Alarm
Size		
0.5	28200	39450
1.0	10200	11250
5.0	1050	1050

Inst Model 9500-01  
Serial # 95002015023

Sample 15 of ∞  
Sample # 3015  
Start Time 8/15/2024, 11:27:00  
End Time 8/15/2024, 11:28:00  
Zone VEH  
Location Cleanroom#2  
Recipe 1m/1p  
Sample Time 00:01:00  
Volume 100.0 L  
Instrument Status: OK

Particles / m3:	Diff	Cumul Alarm
Size		
0.5	45800	63580
1.0	16960	17780
5.0	820	820

Inst Model 9500-01  
Serial # 95002015023

Sample 18 of ∞  
Sample # 3018  
Start Time 8/15/2024, 11:30:15  
End Time 8/15/2024, 11:31:15  
Zone VEH  
Location Cleanroom#2  
Recipe 1m/1p  
Sample Time 00:01:00  
Volume 100.0 L  
Instrument Status: OK

Particles / m3:	Diff	Cumul Alarm
Size		
0.5	56380	76510
1.0	19530	20130
5.0	600	600

Completed by: Rattanachok Saysombut

Signature: Samson

Date: 19 Aug 2024



CERTIFIED CLEANROOM TEST REPORT



Certification Number: CR3647

AIRBORNE PARTICLE COUNT TEST RAW DATA

AHU No.	Room No.	Room Name	ISO Class
-	-	Cleanroom#2 (3 of 3)	8

Inst Model 9500-01  
Serial # 95002015023

Sample 19 of ∞  
Sample # 3019  
Start Time 8/15/2024, 11:31:20  
End Time 8/15/2024, 11:32:20  
Zone VEH  
Location Cleanroom#2  
Recipe 1m/1p  
Sample Time 00:01:00  
Volume 100.0 L  
Instrument Status: OK

Particles / m3:	Size	Diff	Cumul Alarm
0.5	58500	83430	
1.0	22980	24930	
5.0	1950	1950	

Inst Model 9500-01  
Serial # 95002015023

Sample 20 of ∞  
Sample # 3020  
Start Time 8/15/2024, 11:32:25  
End Time 8/15/2024, 11:33:25  
Zone VEH  
Location Cleanroom#2  
Recipe 1m/1p  
Sample Time 00:01:00  
Volume 100.0 L  
Instrument Status: OK

Particles / m3:	Size	Diff	Cumul Alarm
0.5	52190	70090	
1.0	17350	17900	
5.0	550	550	

Inst Model 9500-01  
Serial # 95002015023

Sample 21 of ∞  
Sample # 3021  
Start Time 8/15/2024, 11:33:30  
End Time 8/15/2024, 11:34:30  
Zone VEH  
Location Cleanroom#2  
Recipe 1m/1p  
Sample Time 00:01:00  
Volume 100.0 L  
Instrument Status: OK

Particles / m3:	Size	Diff	Cumul Alarm
0.5	60780	79700	
1.0	18180	18920	
5.0	740	740	

Inst Model 9500-01  
Serial # 95002015023

Sample 22 of ∞  
Sample # 3022  
Start Time 8/15/2024, 11:34:35  
End Time 8/15/2024, 11:35:35  
Zone VEH  
Location Cleanroom#2  
Recipe 1m/1p  
Sample Time 00:01:00  
Volume 100.0 L  
Instrument Status: OK

Particles / m3:	Size	Diff	Cumul Alarm
0.5	52860	69830	
1.0	16140	16970	
5.0	830	830	

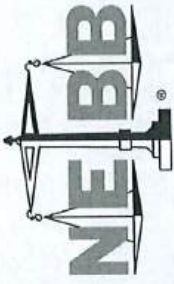
Completed by: Rattanachok Saysombut

Signature:

*Signature*

Date:

17 Aug 2024



# Firm Certification

## QV TEST CO. LTD.

HAS MET ALL REQUIREMENTS FOR NEBB CERTIFIED  
STATUS IN THE FOLLOWING DISCIPLINE

### Cleanroom Performance Testing

3647

NEBB Certification Number

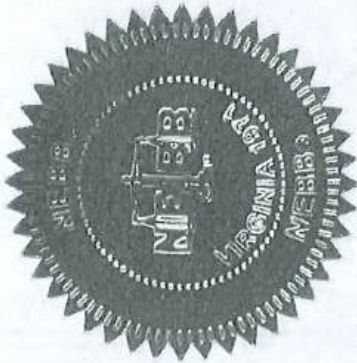
December 31, 2024

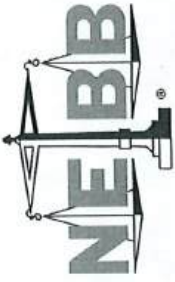
Expiration Date

NEBB President

NEBB President-Elect

5074110  
17 Aug 2024





# Certification

**MUKDAVAN PRAKOBVAITAYAKIT**

**HAS MET ALL REQUIREMENTS FOR NEBB CERTIFIED PROFESSIONAL  
STATUS IN THE FOLLOWING DISCIPLINE**

## ***Cleanroom Performance Testing***

This Certificate, as well as individual affiliation with a NEBB Certified Firm and associated NEBB Certification Stamp are REQUIRED to provide a NEBB Certified Report. Participation in the NEBB Quality Assurance Program requires the Certificant be affiliated with a NEBB Certified Firm

**CP-24002**

NEBB Certification Number

**December 31, 2024**

Expiration Date

NEBB President

NEBB President-Elect

5/12/2004  
17 Aug 2024



# CERTIFICATE OF CALIBRATION

Particle Measuring Technique Co., Ltd.

48/53 Floor3 Moo7 Boonkum Road, Kukot, Lumlokka, Pathumtani 12130 Thailand. Tel # (662) 536-5316-8

CUSTOMER: QV Test Co., Ltd.

ENVIRONMENTAL CONDITIONS			Certificate No.	ST362/0724
TEMPERATURE	24.1	°C	MODEL	ZI
AMBIENT PRESSURE	101	kPa	SERIAL No.	24766

CALIBRATION EQUIPMENT				
	THERMOMETER	AEROSOL GENERATOR	BAROMETER	FLOWMETER
MODEL	Definer 220	ARS	Definer 220	Definer 220
SERIAL	133021	24486	133021	133021
NIST CAL DATE	22-Aug-23	18-Aug-23	22-Aug-23	22-Aug-23
CAL DUE DATE	22-Aug-24	18-Aug-24	22-Aug-24	22-Aug-24

CALIBRATION DATA					
Volumetric Flow: L/min ± 5% of Reading					
TEST POINT	MEASUREMENT	ZI OUTPUT	ABS ERROR	ALLOWED ERROR	CAL STATUS
AS FOUND	28.3	28.4	0.1	1.4	Pass
AS LEFT	28.3	28.4	0.1	1.4	Pass
Stray Light: Volts					
	AS FOUND			AS LEFT	
STRAY LIGHT	0.000389			0.000374	
DOP Concentration: 100 µg/L +/- 10% Of Reading*					
TEST POINT	GENERATOR	ZI OUTPUT	ABS ERROR	ALLOWED ERROR	CAL STATUS
AS FOUND	100.0	106.7	6.7	10	Pass
AS LEFT	100.0	102.3	2.3	10	Pass
PAO Concentration: 100 µg/L +/- 10% Of Reading*					
TEST POINT	GENERATOR	ZI OUTPUT	ABS ERROR	ALLOWED ERROR	CAL STATUS
AS FOUND	100.0	106.7	6.7	10	Pass
AS LEFT	100.0	102.2	2.2	10	Pass
High Concentration: 100 µg/L +/- 30 µg/L					
TEST POINT	GENERATOR	ZI OUTPUT	ABS ERROR	ALLOWED ERROR	CAL STATUS
AS FOUND	100.0	107.2	7.2	30	Pass
AS LEFT	100.0	102.8	2.8	30	Pass

\* TUR 2.6:1

CONDITION OF UNIT							
AS FOUND							
<input checked="" type="checkbox"/>	In tolerance	<input type="checkbox"/>	Inoperable	<input checked="" type="checkbox"/>	Calibrated as left	<input type="checkbox"/>	New Instrument, NA
<input type="checkbox"/>	Out of tolerance	<input type="checkbox"/>		<input type="checkbox"/>	No calibration performed		

MAINTENANCE PERFORMED							
<input type="checkbox"/>	Rework Scattering Chamber	<input checked="" type="checkbox"/>	Test Scanning Probe	<input checked="" type="checkbox"/>	Leak Check	<input checked="" type="checkbox"/>	Voltage Checks
<input checked="" type="checkbox"/>	Clean Sampling System	<input checked="" type="checkbox"/>	Test Absolute Filter	<input type="checkbox"/>	Printer	<input type="checkbox"/>	
<input type="checkbox"/>	Replace Cell Lamp	<input type="checkbox"/>	Replace Gaskets	<input checked="" type="checkbox"/>	Final Test	<input type="checkbox"/>	
<input type="checkbox"/>	Align Optics	<input checked="" type="checkbox"/>	Tighten Loose Hardware	<input type="checkbox"/>		<input type="checkbox"/>	

**CALIBRATION STATEMENT**

The instrument listed on this certificate has been calibrated against standards traceable to NIST or other recognized national metrology institutes, derived from ratio type measurements, or compared to nationally recognized consensus standards. A test uncertainty ratio of 4:1 (k=2, approx. 95% confidence level) was maintained unless otherwise stated. The quality management system of ATI is registered to ISO 9001:2008. All results contained within this certificate relate only to the item(s) calibrated. Any number of factors may cause the calibrated item to drift out of calibration before the instruments calibration interval has expired. This certificate shall not be reproduced except in full and with written consent of ATI. This unit has been calibrated to the most recent revision of PCL-173-WI.

Calibrated By		Cal Date	16 July 2024
Final Inspection			

Samitua  
18 Aug 2024





Certificate of Calibration

Customer

Name : QV TEST CO., LTD  
Address : 18/14 Soi Nawamin 111 Yak 4, Nawamin, Buengkum, Bangkok 10230

Certificate No : 24-AFM-046

Request No : Req-2024-0407

Unit Under Calibration Details

Calibration Parameter : Air Flow  
Manufacturer : TSI  
Model : 8380  
Serial Number : T83801843016  
ID : -

Calibration Result : Without Adjustment

Instrument Status : Used

Calibration Environment and Details

Temperature : (23 ± 3)°C  
Humidity : (55 ± 15)%RH  
Barometric Pressure : (1010 ± 10)hPa  
Received Date : 19 February 2024  
Calibration Date : 4 March 2024  
Calibration By : Mr. Sittichok Jirapukdeesakul  
Location of Calibration : LAB 4 Air Velocity  
Calibration Procedure : In-house method CP-ACH-01 based on Comparison technique

Reference Standard	Model	Serial Number	Traceable	Due
Air Capture Hood	8380	T83801746003	CIH	14 April 2024

Traceability : This Certificate is traceable to International System of Unit (SI) Unit through CIH Equipment Company Inc.

Note : The reported uncertainty is based on standard uncertainty multiplied by the Coverage Factor  $k=2$ , providing a level of confidence approximately 95 %.

Calibrated By : [Signature]  
Service Calibration Engineer

Approved By : [Signature]  
Mr. Pacit Mathavorn  
Calibration Engineer Supervisor

Issue Date : 4 March 2024

[Signature]

18 Aug 2024



Certificate No : 24-AFM-046

Request No : Req-2024-0407

Measurement results : Air Capture Hood/Flow

Calibration Range	Supply Measured			Uncertainty
	STD	UUC	Error	
CFM	CFM	CFM	CFM	CFM
*100	100	100	0	12
*400	404	404	0	23
600	606	611	5	58
900	904	909	5	63
1100	1112	1115	3	63

Calibration Range	Return Measured			Uncertainty
	STD	UUC	Error	
CFM	CFM	CFM	CFM	CFM
*100	100	103	3	12
*400	404	406	2	23
600	608	611	3	33
900	909	901	-8	45
1100	1118	1110	-8	53

Note

\* Indicates non accredited

End of Certificate

Signature  
 18 Aug 2024

The results related only to the item calibrated. The certificate shall not be reproduced except in full, without written approval of the Innovative Instrument Co., Ltd.



## Certificate of Calibration

### Customer

Name : QV TEST CO., LTD  
Address : 18/14 Soi Nawamin 111 Yak 4, Nawamin, Buengkum,  
Bangkok 10230

Certificate No : 24-TPM-118

Request No : Req-2024-0407

Page : 1/2

### Unit Under Calibration Details

Calibration Parameter : Temperature

Instrument Name : Air Capture Hood

Manufacturer : TSI

Model : 8380

Serial Number : T83801843016

Resolution : 0.1 °C

ID Number : -

Range Calibration : 20 °C to 50 °C

Type of Sensor : RTD

Sensor Diameter (mm) : 4.5

Calibration Position (mm) : 67.5

Instrument Status : Used

### Calibration Environment and Details

Temperature : 23 °C ± 3 °C

Humidity : 55 %RH ± 15 %RH

Received Date : 19 February 2024

Calibrated Date : 4 March 2024

Calibration Procedure : In-house method CP-TPM-01 by Comparison with Standard Thermometer.

Reference Standard : Digital Thermometer with Sensor, Manufacturer: GINGO/GINGO, Model: GT1 I/ RTD100, SN: 08000057, ID: 02-TPM Which was calibrated on 27 February 2023, Calibration Certificate No. : QR23-0494

Traceability : This Certificate is traceable to SI Unit through Quality Reborn Co., Ltd., NSC-ONSC Accreditation No.: Calibration 0292

### Note

The reported uncertainty is based on standard uncertainty multiplied by the Coverage Factor  $k=2$ , providing a level of confidence approximately 95 %.

Approved By :

*me*

Mr. Noppadon Luangart

Technical Manager

Issue Date :

4 March 2024

*สมิต*  
18 Aug 2024

INNOVATIVE INSTRUMENT CALIBRATION LAB  
INNOVATIVE INSTRUMENT CO., LTD. HEAD OFFICE  
7/139 MOO 13, SOI SUNTINAKORN 11 TAMBON BANG KAEO,  
AMPHOE BANG PHEI SAMUT PRAKAN PROVINCE 10540 THAILAND  
TEL: (66)0-2116-5860-1 FAX: (66)0-2116-7140



**Calibration Note**

UUC Adjustment : Not Adjust

Certificate No : 24-TPM-118

Request No : Req-2024-0407


Page : 2/2

**Result of Calibration :**

UUC Sensor	Standard Temperature (°C)	UUC Reading (°C)	Correction (°C)	Uncertainty (±°C)
SENSOR 1	20.032	20.1	- 0.1	0.13
	60.046	60.0	0.0	0.13

End of Certificate

Calibrated By :

  
Mr. Sittichok Jirapukdeesakul

5/12/2024  
17 Aug 2024

## Certificate of Calibration

### Customer

Name : QV TEST CO., LTD  
Address : 18/14 Soi Nawamin 111 Yak 4, Nawamin, Buengkum,  
Bangkok 10230

Certificate No : 24-DPM-060

Request No : Req-2024-0407

Page : 1 of 2

### Unit Under Calibration Details

Calibration Parameter : Differential Pressure  
Measurement Item : Air Capture Hood  
Manufacturer : TSI  
Model : 8380  
Serial Number : T83801843016  
ID : -

Resolution : 0.001 (Pa)  
Accuracy : 2% of Reading  
Instrument Status : Used  
Reference level : Center of UUC's Display  
Mounting Position : Vertical  
Pressure Medium : Air

### Calibration Environment and Details

Temperature : 23 °C ±2 °C  
Humidity : 55 %RH ±20 %RH  
Received Date : 19 February 2024  
Calibration Date : 4 March 2024  
Calibration By : Mr. Sittichok Jirapukdeesakul  
Location of Calibration : LAB 4 Differential Pressure  
Calibration Procedure : In-house method CP-DPM-01 based on DKD-R 6-1:03/2014 Calibration of Pressure Gauges


Reference Standard : Digital Pressure Calibrator, Model: ADT672-05-DP20-MBAR, S/N: 273160C0023, Which was calibration due date on 12 July 2024, Calibration Certificate No. : MP-0144-23

Traceability : This Certification is traceable to the International System of Units (SI) maintained at National Institute of Metrology (NIMT)


### Note

The reported uncertainty is based on standard uncertainty multiplied by the Coverage Factor  $k = 2$ , providing a level of confidence approximately 95 %.

Calibrated By :   
Service Calibration Engineer

Approved By :   
Mr. Pacit Mathavorn  
Calibration Engineer Supervisor

Issue Date : 4 March 2024

  
17 Aug 2024



Certificate No : 24-DPM-060

Request No : Req-2024-0407

Page : 2 of 2

Result of Calibration : Not Adjustment

Measurement results : Air Capture Hood

Calibration Range Pa	STD Reading		UUC Reading		Correction Value	
	Pa		Pa		Pa	
	Up	Down	Up	Down	Up	Down
0	0.1	0.1	0.000	0.000	0.1	0.1
500	499.4	499.4	502	502	-2.6	-2.6
2000	1997.0	1997.0	2007	2007	-10.0	-10.0
3500	3494.2	3494.2	3516	3516	-21.8	-21.8

The Uncertainty of measurement was  $\pm 3$  Pa

Calibration Range Pa	STD Reading		UUC Reading		Correction Value	
	Pa		Pa		Pa	
	Up	Down	Up	Down	Up	Down
0	-0.1	-0.1	0.000	0.000	-0.1	-0.1
-1000	-997.0	-997.0	-1002	-1002	5.0	5.0

The Uncertainty of measurement was  $\pm 3$  Pa

End of Certificate

Signature  
 17 Aug 2024

# CERTIFICATE OF CALIBRATION

Date of Issue : 23 April 2024  
Order Item No.: 2404021

Certificate Number : QR24-0850  
Page : 1 of 2



## REBORN

www.qreborn.com



Quality Reborn Co., Ltd.  
42/266-267 Soi Liap Khlong Phasi Charoen Fang Nuea 8/1,  
Nongkham, Bangkok 10160  
Tel: +66 2444 7382 - 3, Fax: +66 2444 7383



NSC-TISI-TIS 17025  
CALIBRATION 0292

Customer : QV Test Co., Ltd.  
18/14 Soi Nawamin 111 Yak 4, Nawamin, Buengkum, Bangkok 10230 Thailand

Date Received : 08 April 2024

Date of Calibration : 10 April 2024

Instrument : Description : Digital Thermo Hygrometer with Probe  
Model : HQ 210  
Serial Number : 2P170305306  
ID Number : -  
Manufacturer : KIMO  
Site : Quality Reborn Co., Ltd.  
Location : Calibration Room 1

### Environmental Conditions

Temperature :  $25\text{ }^{\circ}\text{C} \pm 3\text{ }^{\circ}\text{C}$   
Relative Humidity :  $55\% \pm 25\%$

### Calibration Method Used

This instrument was calibrated by comparison of indication with the dew point hygrometer with chilled mirror sensor and standard thermometer with PRT in humidity/temperature chamber according to calibration procedure no. CP-H03-01.

### Traceability of Measurement

This certificate of calibration documents the traceability to national standards, which realize the units of measurement according to the International System of Units (SI).

Calibrated By : Ms. Nisalak Buranaset

Approved By : 

[  ] Mr. Thanat Sutthinate  
[  ] Mr. Jatuporn Juijai-ngam

**Details of Calibration**

## 1. Reference Standard Equipment Used :

Description	Certificate No.	Due Date
Dew Point Hygrometer Model : 1211Optidew S/N : 172778	M-22H032	01 June 2024
Connected with Sensor Model : OPT-STD-2 S/N : 169510	M-22H032	01 June 2024
Reference Thermometer 1524 S/N 1923168 connected with	H05-24-01	15 February 2025
Fast Response RTD NR-351 S/N 4606903-002 (Channel T1)	H05-24-01	15 February 2025
Fast Response RTD NR-351 S/N 4506346-001 (Channel T2)	H05-24-01	15 February 2025

2. The results reported in this certificate refer to the condition of the instrument on the date of calibration and carry no implication regarding the long-term stability of the instrument.

3. Condition of calibration item : normal condition, no indication find for any damage or malfunction.

4. The results reported herein relate only to the item calibrated.

5. Uncertainty of humidity measurement was include temperature dependency test at 25 °C ± 0.50 °C

6. This instrument connected with Humidity & Temperature Probe "KIMO" Model : SHR 300,  
 S/N : 4P170318634 for Channel C1

**Result of Calibration :. (Without Adjustment)**

Function :. Humidity Measurement at Reference Temperature 25 °C

Standard Humidity (%RH)	UUC* Reading (%RH)	Humidity Correction (%RH)	Uncertainty of Measurement (±%RH)
9.91	11.1	-1.19	0.59
30.13	30.8	-0.67	0.84
50.13	48.7	1.43	1.1
69.79	66.5	3.29	1.6
85.07	81.1	3.97	1.8

**Result of Calibration :. (Without Adjustment)**

Function :. Temperature Measurement

Standard Temperature (°C)	UUC* Reading (°C)	Temperature Correction (°C)	Uncertainty of Measurement (±°C)
-20.010	-20.2	0.190	0.33
0.059	-0.2	0.259	0.33
20.015	19.6	0.415	0.19
39.944	39.4	0.544	0.19
59.997	59.3	0.697	0.33

UUC\* : Unit Under Calibration

This reported uncertainty of measurement was based on a standard uncertainty multiplied by a coverage factor  $k = 2$ , providing a level of confidence of approximately 95%.

*Sum Jsa*  
 18 Aug 2024





Certificate No : 24-APC-070

Request No : Req-2024-1212

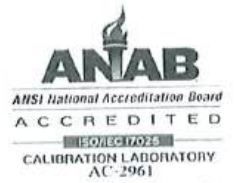
* Size Calibration and Verification of Size Setting								
Nominal Particle Size ( $\mu\text{m}$ )	Previous Digital Cutpoint	As Found Digital Cutpoint	Gain Stage	Measured Particle Size ( $\mu\text{m}$ )	Size Error (%)	MPE $\pm$ (%)	Expanded Uncertainty (%)	Result
0.5	275	275	A	0.500	0.0	10	3.9	Pass
0.7	530	530	A	0.700	0.0	10	3.7	Pass
1.0	770	770	A	1.000	0.0	10	4.0	Pass
3.0	450	450	B	3.000	0.0	10	4.1	Pass
5.0	1320	1320	B	5.000	0.0	10	6.6	Pass
10.0	3800	3800	B	10.000	0.0	10	6.3	Pass

Counting Efficiency				
Particle Size ( $\mu\text{m}$ )	Deviation %	MPE $\pm$ %	Uncertainty %	Result
0.5	-1.6	20	15	Pass
1.0	-3.3	10	5.7	Pass

* Size Resolution				
Particle Size ( $\mu\text{m}$ )	Measured %	Uncertainty %	MPE %	Result
0.5	6.9	3.9	15	Pass

* False Count Rate						
Sample Time (min)	Sampled (L)	Measured Counts (#)	Concentration (#/M <sup>3</sup> )	95% UCL (#/M <sup>3</sup> )	MPE (#/M <sup>3</sup> )	Result
15	1520	0	0.00	4.0	$\leq 4$	Pass

*Imrisa*  
 18 Aug 2024



Certificate No : 24-APC-070

Request No : Req-2024-1212

Sampling Flow Rate							
Temperature (°C)	Pressure (kPa)	UUC (Fixed Flow) (l/min)	STD (l/min)	Error %	MPE ± %	Uncertainty (L/min)	Result
24.90	99.20	100.0	101.4	1.4	5	2.5	Pass

Note : - UUC Reference Condition : At atmospheric and room temperature condition

- Flow Rate was corrected for non-standard operating condition by using equation :

$$Q_{\text{meas}} = Q_{\text{ref}} \times \frac{P_{\text{ref}}}{P_{\text{meas}}} \times \frac{T_{\text{meas}}}{T_{\text{ref}}}$$

where Q = Flow Rate P = Absolute Pressure T = Absolute Temperature  
 Meas = Measurement Condition ref = Standard Condition

*Calibration Interval	
Calibration Date	Expiration Date
5 June 2024	<= 1 Year

\* Indicates non accredited

MPE = Maximum Permissible Error (Specified in ISO 21501-4)

### Decision Rule for Statements of Conformity

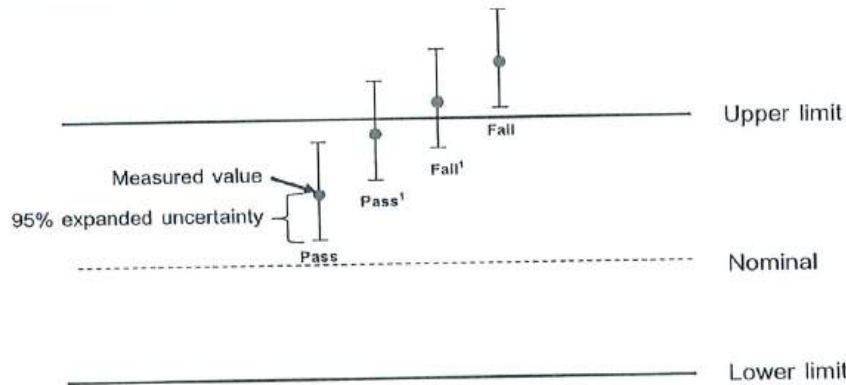
The standard decision rule employed for the statements of conformity to each calibration result will be applied using ILAC-G8:09/2019; Guidelines on the Reporting of Compliance with Specification as following Fig. and statements

Pass = The measurement result plus the expanded uncertainty with a 95% coverage probability were within the limit.

Pass<sup>1</sup> = The measurement result was within the limit. However, a portion of the expanded uncertainty of measurement at 95% exceeds the limit.

Fail<sup>1</sup> = The measurement result was out of the limit. However, a portion of the expanded uncertainty of measurement at 95% is within the limit.

Fail = The measurement result plus the expanded uncertainty with a 95% coverage probability were outside the limit.



End of Certificate

Signature  
 18 Aug 2024