

Procedure for Evaluating Accuracy and Precision of RAININ Pipettes

Factory-Approved Method for Using Gravimetric Analysis

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Foreword

Scope

This document describes the factory-approved method for determining pipette performance using gravimetric analysis. RAININ's Pipette Service Department uses this method thereby assuring conformity to the original manufacturer's conditions and specifications.

The document covers two methods:

- **2 Volumes x 4 Weighing Factory Method** confirms pipette accuracy and precision for new pipettes. It is also used for pipettes serviced following recalibration and repair through RAININ's CalPM™ and Express Repair™ programs.
- **3 Volumes x 10 Weighing Method** confirms pipette accuracy and precision for pipettes serviced through RAININ's CalPM program using CalPM Plan B with EMO (extended measurement option).

These procedures are applicable to all RAININ pipettes and most other manufacturer's pipettes.

Definitions

accuracy:	The closeness of a measured volume to the true volume as specified by the volume setting of the pipette. Also known as "mean error".
calibration:	The fine adjustment of the piston stroke length for mechanical pipettes.
evaporation rate:	An estimate of water loss due to evaporation during the weighing procedure. Evaporation rates are calculated when evaluating pipettes using 6- and 7-place balances. See Microvolume Procedures (page 7) for more information.
gravimetric analysis:	The general procedure based upon the determination of the weight of water samples as delivered by the pipette. Values are corrected for evaporation, then true mass and volumes are calculated simultaneously, based upon the knowledge of the density of water at specific temperatures with corrections for air buoyancy (Z-factor).
precision:	The closeness of agreement among the individual weighings. Also known as standard deviation, reproducibility and repeatability.
prerinse:	A double rinse of a pipette tip with testing medium. Repeat prerinse whenever a new tip is applied or weighing cycle time has been interrupted.
Z-factor:	Conversion factor ($\mu\text{L}/\text{mg}$) incorporating the density of water when buoyed in air as a function of temperature and pressure. For RAININ's laboratory conditions, the Z-factor is 1.0031 at 1 atm. (See table on page 4).

Calculations

MEAN WEIGHT:

Result expressed in mg.

$$\bar{w} = \frac{\sum_{i=1}^n w_i}{n}$$

\bar{w} = mean weight
 n = number of measurements
 w_i = individual weighings

MEAN VOLUME:

The mean weight result with corrections for evaporation and Z-factor. Expressed in μL .

$$\bar{v} = (\bar{w} + \bar{e}) \times Z$$

\bar{w} = mean weight (mg)
 \bar{v} = mean volume
 \bar{e} = evaporation rate (mg)
 Z = Z-factor

MEAN ERROR:

The difference between the mean volume of actual measurements and the true value as specified by the volume setting of the pipette. Expressed in μL .

$$E = \bar{v} - v_o$$

E = mean error
 \bar{v} = mean volume
 v_o = volume setting

As a percentage

$$E \% = \frac{\bar{v} - v_o}{v_o} \times 100$$

STANDARD DEVIATION:

Quantifies the magnitude of scatter due to random error.

$$s = \sqrt{\frac{\sum_{i=1}^n (\bar{w} - w_i)^2}{n - 1}}$$

s = standard deviation
 n = number of weighings
 \bar{w} = mean weighing
 w_i = individual weighings

As a percentage, also known as coefficient of variation (CV)

$$S \% = \frac{S}{\bar{v}} \times 100$$

Environment

Laboratory

Maintain the following laboratory conditions at least 2 hours before and throughout the evaluation procedure. Ensure balances, water, pipettes and tips are properly equilibrated to ambient conditions. Balances should be turned on a minimum of one hour before use.

- **Temperature** 21.5 ± 1.0°C
- **Relative Humidity** 45–75%
- **Conditioning** Keep the room circulating fan permanently on to prevent temperature surges. Drafts should be minimized.
- **Illumination** Use diffused light of sufficient intensity. Avoid direct sunlight.
- **Chronicle** Use a temperature and humidity data logging device for measuring conformity to specifications. Retain records for traceability.

Testing Medium

Distilled water with traceable density is used as the standard in gravimetric analysis.

Value for Z (µL/mg), as a Function of Temperature and Pressure, for Distilled Water at 1 atm

TEMP °C	ACTUAL Z-FACTOR	TEMP °C	ACTUAL Z-FACTOR	TEMP °C	ACTUAL Z-FACTOR
15.0	1.0020	20.0	1.0029	25.0	1.0040
15.5	1.0020	20.5	1.0030	25.5	1.0041
16.0	1.0021	21.0	1.0031	26.0	1.0043
16.5	1.0022	21.5	1.0032	26.5	1.0044
17.0	1.0023	22.0	1.0033	27.0	1.0045
17.5	1.0024	22.5	1.0034	27.5	1.0047
18.0	1.0025	23.0	1.0035	28.0	1.0048
18.5	1.0026	23.5	1.0036	28.5	1.0050
19.0	1.0027	24.0	1.0038	29.0	1.0051
19.5	1.0028	24.5	1.0039	29.5	1.0052
				30.0	1.0054

Fluctuation in room temperature and humidity will adversely affect balance stability and evaporation rates. A stringently-controlled environment assures reliable data.

Equipment

Balances

Appropriate 4-, 5-, 6-, and 7-place balances are selected to measure pipette performance. The sensitivity of the balance chosen must be equal to or less than one-tenth of the smallest deviation to be assessed.

<u>SENSITIVITY (G) DISPLAY</u>		<u>APPLICABLE MODELS BY NOMINAL VOLUME (µL)</u>
10 ⁻⁷	0.0000 mg	2, 10
10 ⁻⁶	0.000 mg	20, 25, 50
10 ⁻⁵	0.00 mg	100, 200, 250, 300
10 ⁻⁴	0.0 mg	1000, 1200, 2000, 2500, 5000, 10 mL, 20 mL

Work Stations

Balances are stationed on marble tables to minimize vibration. A black mat is positioned in front of the weighing chamber to expose droplets and create a cleaner environment. Each balance is directly coupled with a computer and RAININ software for data acquisition, statistical computation, and report production.

Balance Certification

Balances are regularly serviced and certified by METTLER-TOLEDO technicians using weights traceable to the National Institute of Standards and Technology (NIST). RAININ senior technicians qualify balances frequently using NIST-traceable weights and confirm balance parameters such as stability, integration time and levels.

Tips

RAININ pipettes are designed and calibrated using RAININ tips. Failing to use the original manufacturer's tips as recommended may result in poor pipette performance.

A note on Multichannel Pipettes

RAININ provides two distinct CalPM programs for multichannel pipettes: Multichannel One and Multichannel All. All the preceding information applies for Multichannel One, in which one channel is fully evaluated gravimetrically and the remaining channels are checked with one weighing at nominal volume.

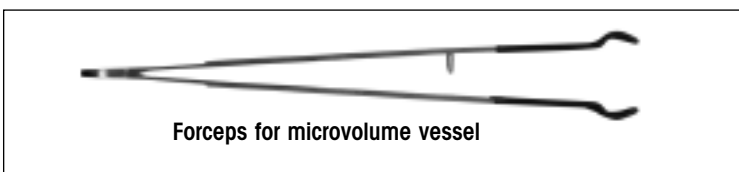
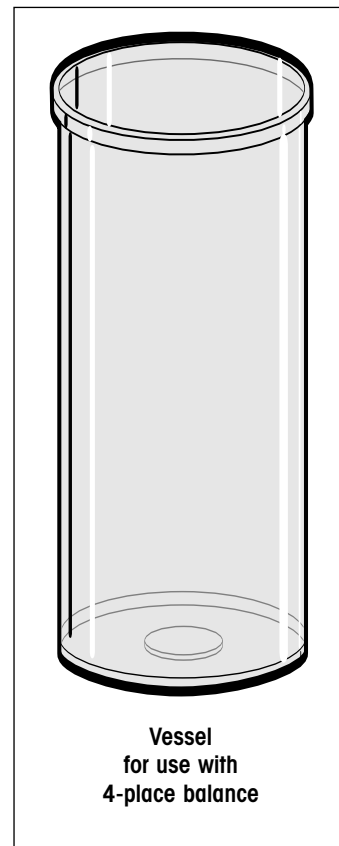
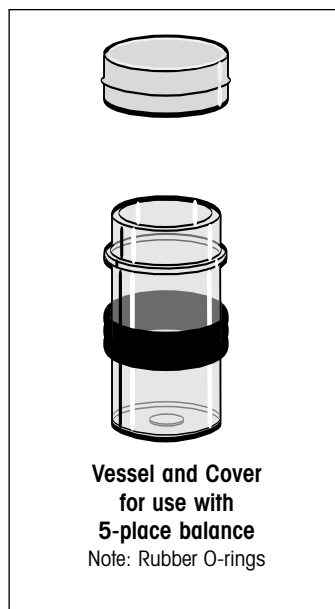
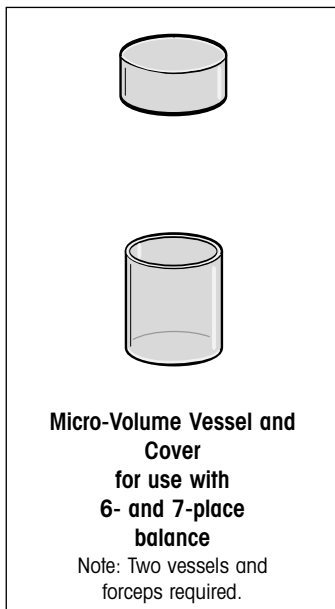
The Multichannel All program gravimetrically evaluates each channel (2 volumes x 4 weighings, 2 volumes x 10 weighings, or 3 volumes x 10 weighings) and is performed using special customized equipment and software for simultaneous 12-channel evaluation. For more information please call 800-543-4030.

<p>Using a 4-place balance to calibrate a 20 µL pipette can result in error 3x greater than the specification. Why? The 4-place balance inaccuracy is significantly larger than the inaccuracy of a 20 µL pipette . Always use the right balance for the job.</p>
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Accessories

Weighing Vessels

Cylindrical weighing vessels are constructed of non-porous plastic with flat bottoms. Some vessels have covers to minimize evaporation. Rubber o-rings prevent the transfer of heat from hands. The micro-volume vessel should be handled using forceps only. See page 7 for more information. A weighing kit consisting of all three vessel types and forceps is recommended.



Weighing Kit

Controlling evaporation is essential when evaluating micro-volume pipettes. RAININ uses a custom-designed micro-volume vessel to control this variable.

Micro-Volume Procedures

Evaluating micro-volume pipettes (i.e. less than 50 μL) requires special procedures and equipment. This procedure must be followed whenever 6- and 7-place balances are used for determining pipette performance. The goal is to minimize, control, and quantify evaporation loss during testing.

Two-vessel Method

Two micro-volume vessels with covers are used for each 6- and 7-place balance. Partially fill one vessel with approximately 100 μL of water. Set the other vessel aside. Water should cover the entire bottom surface of the first vessel. This vessel may now be used for weighings. During testing, droplets accumulating on the inner wall should be mixed into the 100 μL of water frequently.

When approximately 1/3 full, discard the entire contents of the first vessel, dry it with a lint-free material, and set it aside. Retrieve the unused vessel and partially fill with water as described above. Alternate vessels throughout the entire evaluation process or whenever sample is splashed on the cover.

Estimating the Evaporation Rate

Evaporation is estimated by running a series of four simulated weighings, only duplicating the weighing cycle without the addition of sample liquid to the vessel. Measure the total weight difference due to evaporation and divide by 4 to obtain an average. The rate is expressed in mg.

SIMULATED WEIGHING PROCEDURE

1. Fill the micro-volume vessel one-third full with water.
2. Cover the vessel and place in balance using forceps.
3. Using a pipette, aspirate a sample at full volume setting from the reservoir.
4. Tare the balance and remove the vessel.
5. Remove cover with forceps.
6. Dispense sample into the reservoir, not the micro-volume vessel.
7. Cover the micro-volume vessel and return it to the balance.
8. Record the result e_1 (negative value).
9. Repeat steps 3 through 8 three times to obtain e_2 , e_3 and e_4 .
10. Calculate the rate: $\bar{e} = -(e_1 + e_2 + e_3 + e_4)/4$
11. Round to the nearest 0.005 mg, and convert to a positive value.
12. The evaporation rate \bar{e} should be added when calculating the mean volume of each real sample weighing.

Evaporation rates usually range between 0.010 – 0.025 mg per weighing cycle. Recalculate the evaporation rate every 4 hours or whenever ambient conditions change.
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Qualifications

Qualifying a Technician

To qualify for assessing pipette performance a technician must first successfully complete three different proficiency trials in sequence for each pipette model.

- **Precision Trial:** Using an accurate pipette, take thirty weighings at each volume setting. Volume settings are generally 10, 50 and 100% of nominal. Calculate the standard deviation. If results are 1/3 less than precision specifications (min. 3 consecutive pipettes), continue to the next trial.
- **Accuracy Trial:** Take four weighings at each volume setting. Volume settings are generally 10, 50 and 100% of nominal. Calculate the mean volume. If comparative mean differences are consistently less than 1/3 of the accuracy specification (min. 3 consecutive pipettes), continue to the next trial.
- **Calibration Trial:** Using a number of purposely miscalibrated mechanical pipettes, the trainee calibrates each pipette according to RAININ's calibration procedure. A senior technician then re-verifies each unit for compliance to published specification. If a minimum of 14 consecutive pipettes pass, the trainee is qualified to evaluate and calibrate this model. Repeat procedure for other models/volume ranges.

Pipette Operation

Consistency in all aspects of a pipetting procedure will significantly contribute to reproducibility.

1. When picking up a sample, immerse the end of the disposable tip beneath the liquid surface within the following ranges:

IMMERSION DEPTH (mm)	PIPETTE VOLUMES
1-2	up to 10 µL
2-3	20 to 100 µL
3-6	200 to 2500 µL
6-10	5000 µL or more

2. Prerinse tips whenever critical reproducibility is required.
3. Maintain consistency in the following areas:
 - pipetting rhythm from sample to sample.
 - speed and smoothness when you press and release the push button.
 - push button pressure at the first stop.
 - angle and immersion depth.
4. Always operate a pipette in a vertical position.
5. Dispense sample by touching the tip end against the side wall of the receiving vessel to ensure complete sample flow.

Always wind the micrometer 1/3 revolution above the desired volume setting and then return clockwise. This will minimize errors in volume delivery due to mechanical backlash.

2 Volumes x 4 Weighing Factory Method

This method confirms pipette accuracy and precision for new pipettes and for pipettes serviced through RAININ's Calibration PM and Express Repair programs. Many customers consider this method satisfactory for periodically checking pipette performance. Conditions, procedures and qualifications previously described in this document should be implemented to assure validity of test results.

Description

After prerinsing the tip, record four individual weighings per volume setting. Use a new tip for each volume setting. Two volume settings should be tested for each model, beginning with the minimum setting first, as specified in the table below. (Testing at any one volume is not sufficient to assess proper calibration of a variable volume pipette.) Holding or hand warming the pipette shaft should be avoided throughout the test procedure.

Volume Settings

For RAININ pipettes, the same volume settings are used for calibration in Manufacturing, in Calibration PM, and in Express Repair.*

1. For new RAININ pipettes.	VOLUME SET % OF NOMINAL
	<u>MIN</u> <u>MAX</u>
All air-displacement models and MR-10, MR-100, MR-1000**	10% 100%
2. For RAININ pipettes serviced through the CalPM program.	VOLUME SET % OF NOMINAL
	<u>MIN</u> <u>MAX</u>
All air-displacement models and MR-10, MR-100, MR-1000**	10% 100%
3. For RAININ pipettes serviced through Express Repair.	VOLUME SET % OF NOMINAL
	<u>MIN</u> <u>MAX</u>
All air-displacement models and MR-10, MR-100, MR-1000**	10% 100%

Results

Calculate the mean volume and standard deviation for each volume setting using the formulae on page 2. Compare results to specifications on pages 14-16 to determine conformity.

* Custom test volumes within the published operating volume range are also available.

** For specified volume ranges for MR-25, MR-50, and MR-250 Pos-D positive-displacement pipettes, see page 16.

Individual weighings are calculated by subtracting the balance tare reading from the sample reading. Consistent rhythm during weighing operations should be maintained.

3 Volumes x 10 Weighing Method

This method confirms pipette accuracy and precision for pipettes serviced through RAININ Calibration PM program: Cal PM Plan B with EMO (extended measurement option). Customers requiring higher confidence levels of measured results prefer this method. Conditions, procedures, and qualifications previously described in this document should be implemented to assure validity of test results.

Description

After prerinsing the tip, record ten individual weighings per volume setting. Change tips between each volume setting. Three volume settings are selected per pipette model based on the pipette's working range, as specified in the table below. Holding or hand warming of the pipette shaft should be avoided throughout the procedure.

Volume Settings

RAININ pipettes serviced through the Calibration PM Plan B with EMO program.	VOLUME SET* % OF NOMINAL		
	<u>MIN</u>	<u>MID</u>	<u>MAX</u>
All air-displacement models and MR-10, MR-100, MR-1000**	10%	50%	100%

Results

Calculate the mean volume and standard deviation for each volume setting using the formulae on page 2. Compare results to specifications on pages 14-16 to determine conformity.

* Custom test volumes within the published operating volume range are also available.

** For specified volume ranges for MR-25, MR-50, and MR-250 Pos-D positive-displacement pipettes, see page 16.

While the 3 volumes x 10 weighing method provides a higher confidence level of measured results, the cost in time and money is often unwarranted when a pipette receives preventive maintenance, a standard feature of RAININ's Cal PM program. To learn more, request Technical Report 9804, Comparison of Ten vs Four Weighing Method, or download from the RAININ website: www.rainin.com/pdf/tr9804.pdf.

Sample Reports

3 Volumes x 10 Weighing Method

Cal PM Pipette, Plan B with EMO (also with ISO 17025 certification)

RAININ Pipetting 360°	ISO 9001:2000 CERTIFIED	Calibration PM™	ISO 17025:1999 REGISTERED	NVLAP NVLAP LAB 2004 200690		
PLAN B CERTIFICATE						
INSTITUTION	PROTEIN TECHNOLOGIES INC	PIPETTE MODEL	PIPET LITE 200			
ADDRESS	1665 E. 18TH STREET	SERIAL #	B0301920A			
CITY, STATE, ZIP	TUCSON, AZ 85719	INTERNAL ID	PIP01647			
CONDITIONS AND EQUIPMENT						
TEMPERATURE	21.5 °C (±1.0)	BALANCE SERIAL #	1121121502			
HUMIDITY	60% (±15)	SENSITIVITY (g)	0.0001			
EVAPORATION RATE (mg)	N/A	BALANCE CALIBRATION DUE:	11/3/2006			
CERTIFIED TIPS	LTS-250	MASS TRACEABILITY	NIST			
		DENSITY TRACEABILITY	SI UNITS			
AS FOUND						
	20 µl	100 µl	200 µl			
MEAN (µl)	20.16	100	199.97			
PRECISION	.09	.08	.15			
UNCERTAINTY (µl)*	±.39	±.22	±.35			
STATUS	PASS	PASS	PASS			
REPAIR	NO					
PREVENTIVE MAINTENANCE	Seal replaced, cleaned piston					
CALIBRATION	Confirmed					
AS RETURNED						
	20 µl	100 µl	200 µl			
WEIGHINGS (mg)	19.80 19.83 19.9 19.89 19.88 19.9 19.81 19.89 19.9 19.9	99.72 99.8 99.57 99.6 99.61 99.43 99.5 99.45 99.4 99.36	199.15 199.29 199.29 199.24 199.2 199.45 199.58 199.61 199.43 199.43			
RESULTS	ACTUAL	SPECIFICATIONS	ACTUAL	SPECIFICATIONS	ACTUAL	SPECIFICATIONS
MEAN (µl)	19.84	19.5 to 20.5	99.84	99.2 to 100.8	199.99	198.4 to 201.6
ERROR (%)	-0.31%	±1.25	-0.16%	±1.8	-0.01%	±1.8
PRECISION	.09	0.2	.11	.25	.16	0.3
CV (%)	0.15%	1	0.11%	.25	0.08%	.15
UNCERTAINTY (µl)*	±.16		±.39		±.5	
STATUS	PASS		PASS		PASS	
PIPETTE HISTORY						
	AS FOUND		AS RETURNED			
200 µl						
100 µl						
20 µl						
ACCURACY	PASS PASS PASS PASS PASS PASS PASS PASS		PASS PASS PASS PASS PASS PASS PASS PASS			
PRECISION	PASS PASS PASS PASS PASS PASS PASS PASS		PASS PASS PASS PASS PASS PASS PASS PASS			
RAININ SERVICE CENTER	7500 Edgewater Dr. Oakland, CA 94621		PLAN B EXTENDED			
800-952-7027	Rainin Certificate # 24064HL-8					
This certificate is issued in accordance with Rainin standard operating procedure A9-10 and the conditions of accreditation granted by NVLAP. This laboratory has been assessed for measurement capability and confidence and is in compliance with ISO 17025:1999, ISO 9001:2000, and ANSI/ISO 9241-5:1998, Part 1. The above results refer only to the pipette calibrated. Statements of compliance does not include the measurement of uncertainty. Do not reproduce this document unless initial.			DATE: 11/2/2005 Next Due: 2/2/2006			
			* Uncertainty of mean at 95% Confidence Interval			
			Page 1 of 1			

Sample Reports

3 Volumes x 10 Weighing Method - Multichannel All

Cal PM Multichannel Pipette

RAININ Pipetting 360°		ISO 9001:2000 — CERTIFIED —		Calibration PM™								
MULTICHANNEL ALL												
INSTITUTION	PROTEIN TECHNOLOGIES INC			PIPETTE MODEL			PIPET LITE L12-200					
NAME	DAN MALONE			SERIAL #			E0001995					
DEPT	SALES / MARKETING			INTERNAL ID			755-A					
CONDITIONS AND EQUIPMENT												
TEMPERATURE	21.5 °C (±1.0)			BALANCE SERIAL #			425.00.00					
HUMIDITY	60% (±1%)			SENSITIVITY (g)			0.0001					
EVAPORATION RATE (mg)				MASS TRACEABILITY			NIST					
CERTIFIED TIPS	LTS-250			WATER TRACEABILITY			SI UNITS					
REPAIR	PASS											
PREVENTIVE MAINTENANCE	Piston(s) cleaned & regreased											
CALIBRATION	Confirmed											
As Found Summary												
SETTING 20 µl												
CHANNEL	1	2	3	4	5	6	7	8	9	10	11	12
MEAN (µl)	20.15	20.16	20.16	20.17	20.12	20.15	20.12	20.16	20.14	20.16	20.12	20.14
ERROR (%)	0.75%	0.80%	0.79%	0.82%	0.61%	0.74%	0.61%	0.82%	0.69%	0.79%	0.60%	0.70%
PRECISION (µl)	0.03	0.06	0.02	0.04	0.07	0.08	0.05	0.08	0.05	0.03	0.05	0.03
CV (%)	0.15%	0.30%	0.10%	0.20%	0.35%	0.38%	0.29%	0.40%	0.29%	0.15%	0.25%	0.18%
STATUS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS
SETTING 100 µl												
MEAN (µl)	100.03	100.18	100.04	100.07	100.07	100.00	99.96	99.97	100.04	99.93	99.86	99.92
ERROR (%)	0.03%	0.18%	0.04%	0.07%	0.07%	-0.00%	-0.04%	-0.03%	0.04%	-0.07%	-0.14%	-0.08%
PRECISION (µl)	0.07	0.03	0.05	0.05	0.03	0.04	0.04	0.04	0.05	0.06	0.07	0.07
CV (%)	0.07%	0.03%	0.05%	0.05%	0.03%	0.04%	0.04%	0.04%	0.05%	0.06%	0.07%	0.07%
STATUS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS
SETTING 200 µl												
MEAN (µl)	200.14	200.28	200.13	200.28	200.28	200.20	200.09	200.18	200.33	200.09	200.01	200.18
ERROR (%)	0.07%	0.13%	0.06%	0.13%	0.14%	0.10%	0.05%	0.09%	0.16%	0.05%	0.01%	0.09%
PRECISION (µl)	0.05	0.06	0.06	0.05	0.10	0.09	0.22	0.10	0.12	0.11	0.11	0.13
CV (%)	0.02%	0.03%	0.03%	0.02%	0.05%	0.04%	0.11%	0.05%	0.06%	0.05%	0.05%	0.06%
STATUS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS
As Returned Summary												
SETTING 20 µl												
CHANNEL	1	2	3	4	5	6	7	8	9	10	11	12
MEAN (µl)	20.02	20.01	20.06	20.06	20.15	20.16	20.20	20.16	20.15	20.12	20.13	20.07
ERROR (%)	0.11%	0.05%	0.32%	0.49%	0.77%	0.82%	1.02%	0.80%	0.74%	0.59%	0.52%	0.33%
PRECISION (µl)	0.07	0.07	0.06	0.08	0.10	0.11	0.12	0.11	0.10	0.11	0.10	0.10
CV (%)	0.35%	0.36%	0.40%	0.40%	0.50%	0.55%	0.59%	0.55%	0.50%	0.55%	0.50%	0.50%
STATUS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS
SETTING 100 µl												
MEAN (µl)	99.97	99.91	100.00	100.08	100.14	100.09	100.18	100.15	100.12	100.04	100.05	99.99
ERROR (%)	-0.03%	-0.09%	-0.00%	0.08%	0.14%	0.09%	0.18%	0.16%	0.12%	0.04%	0.05%	-0.01%
PRECISION (µl)	0.18	0.17	0.18	0.17	0.17	0.17	0.18	0.16	0.16	0.18	0.16	0.19
CV (%)	0.18%	0.17%	0.18%	0.17%	0.17%	0.17%	0.18%	0.16%	0.16%	0.18%	0.16%	0.19%
STATUS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS
SETTING 200 µl												
MEAN (µl)	200.37	200.22	200.19	200.45	200.45	200.25	200.45	200.49	200.41	200.28	200.32	200.28
ERROR (%)	0.14%	0.11%	0.09%	0.23%	0.22%	0.14%	0.23%	0.25%	0.21%	0.19%	0.16%	0.13%
PRECISION (µl)	0.14	0.15	0.12	0.13	0.14	0.15	0.17	0.14	0.15	0.14	0.14	0.13
CV (%)	0.07%	0.07%	0.06%	0.06%	0.07%	0.07%	0.08%	0.07%	0.07%	0.07%	0.07%	0.06%
STATUS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS
PIPETTE HISTORY												
AS FOUND												
200.0	1											
100.0	1											
20.0	1											
10.0	1											
5.0	1											
2.0	1											
1.0	1											
0.5	1											
0.2	1											
0.1	1											
AS RETURNED												
200.0												
100.0												
20.0												
10.0												
5.0												
2.0												
1.0												
0.5												
0.2												
0.1												
PLAN B EXTENDED												
RAININ SERVICE CENTER 7500 Edgewater Drive, Oakland CA 94621 800-662-7027 Rainin Certificate # 05555E8-2												
DATE: 7/11/2005 Next Due: 7/11/2006 <i>Cristy Tunod</i> CRISTY TUNOD, TECHNICIAN												
Page 1 of 2												

Specifications - Single-Channel Pipettes

PIPET-LITE, PIPET-PLUS, E-MAN HYBRID, EDP1 AND EDP3-PLUS

MODEL VOLUME	INCREMENT μL MANUAL	INCREMENT μL ELECTRONIC	VOLUME SET μL	ACCURACY		PRECISION	
				%	$\mu\text{L}(\pm)$	%	$\mu\text{L}(\leq)$
2 μL 0.1–2 μL recommended range*	0.002	n/a	0.2	12.0	0.024	6.0	0.012
			1	2.7	0.027	1.3	0.013
			2	1.5	0.030	0.7	0.014
10 μL 0.5–10 μL recommended range*	0.02	0.01	1	2.5	0.025	1.2	0.012
			5	1.5	0.075	0.6	0.03
			10	1.0	0.1	0.4	0.04
20 μL 2–20 μL recommended range	0.02	0.02	2	7.5	0.15	2.0	0.04
			10	1.5	0.15	0.5	0.05
			20	1.0	0.2	0.3	0.06
100 μL 10–100 μL recommended range	0.2	0.1	10	3.5	0.35	1.0	0.1
			50	0.8	0.4	0.24	0.12
			100	0.8	0.8	0.15	0.15
200 μL 20–200 μL recommended range	0.2	0.2	20	2.5	0.5	1.0	0.2
			100	0.8	0.8	0.25	0.25
			200	0.8	1.6	0.15	0.3
300 μL 20–300 μL recommended range*	0.5	0.2	30	2.5	0.75	1.0	0.3
			150	0.8	1.2	0.25	0.375
			300	0.8	2.4	0.15	0.45
1000 μL 100–1000 μL recommended range	2	1.0	100	3.0	3.0	0.6	0.6
			500	0.8	4.0	0.2	1.0
			1000	0.8	8.0	0.15	1.5
2000 μL 200–2000 μL recommended range	2	2.0	200	3.0	6.0	0.6	1.2
			1000	0.8	8.0	0.2	2.0
			2000	0.8	16.0	0.12	2.4
5000 μL 500–5000 μL recommended range	5	5.0* (*E1-5000: 10)	500	2.4	12.0	0.6	3.0
			2500	0.6	15.0	0.2	5.0
			5000	0.6	30.0	0.16	8.0
10 mL 1 mL–10 mL recommended range	20	10	1 mL	5.0	50.0	0.6	6.0
			5 mL	1.0	50.0	0.2	10.0
			10 mL	0.6	60.0	0.16	16.0
20 mL 2 mL–20 mL recommended range	20	20	2 mL	5.0	100.0	0.6	12.0
			10 mL	1.0	100.0	0.2	20.0
			20 mL	0.6	120.0	0.16	32.0

RAININ CLASSIC

MODEL VOLUME	INCREMENT μL	VOLUME SET μL	ACCURACY		PRECISION	
			%	$\mu\text{L}(\pm)$	%	$\mu\text{L}(\leq)$
PR-2 0.1–2 μL recommended range*	0.002	0.2	12.0	0.024	6.0	0.012
		1	2.7	0.027	1.3	0.013
		2	1.5	0.030	0.7	0.014
PR-10 0.5–10 μL recommended range*	0.02	1	2.5	0.025	1.2	0.012
		5	1.5	0.075	0.6	0.03
		10	1.0	0.1	0.4	0.04
PR-20 2–20 μL recommended range	0.02	2	7.5	0.15	2.0	0.04
		10	1.5	0.15	0.5	0.05
		20	1.0	0.2	0.3	0.06
PR-100 10–100 μL recommended range	0.2	10	3.5	0.35	1.0	0.1
		50	0.8	0.4	0.24	0.12
		100	0.8	0.8	0.15	0.15
PR-200 20–200 μL recommended range	0.2	20	2.5	0.5	1.0	0.2
		100	0.8	0.8	0.25	0.25
		200	0.8	1.6	0.15	0.3
PR-1000 100–1000 μL recommended range	2	100	3.0	3.0	0.6	0.6
		500	0.8	4.0	0.2	1.0
		1000	0.8	8.0	0.15	1.5
PR-5000 500–5000 μL recommended range	2	500	2.4	12.0	0.6	3.0
		2500	0.6	15.0	0.2	5.0
		5000	0.6	30.0	0.16	8.0
PR-10ML 1 mL–10 mL recommended range	20	1 mL	5.0	50.0	0.6	6.0
		5 mL	1.0	50.0	0.2	10.0
		10 mL	0.6	60.0	0.16	16.0

* When pipetting volumes less than the minimum specified, results depend upon the skill of the operator.

Specifications - Single-Channel & Multichannel Pipettes

EDP, EDP2, AND EDP-PLUS SINGLE-CHANNEL PIPETTES

MODEL VOLUME	INCREMENT EDP (µL)	INCREMENT EDP2 (µL)	INCREMENT EDP-PLUS (µL)	VOLUME SET (µL)	ACCURACY		PRECISION	
					%	µL(±)	%	µL(≤)
10 µL E2-MIC, EP 0.5–10 µL recommended range*	n/a	0.02	0.01	1	2.5	0.025	1.2	0.012
				5	1.5	0.075	0.6	0.03
				10	1.0	0.1	0.4	0.04
10 µL E2, EDP 1–10 µL recommended range	0.01	0.02	n/a	1	10.0	0.1	4.0	0.04
				5	2.0	0.1	0.8	0.04
				10	1.0	0.1	0.5	0.05
25 µL 2.5–25 µL recommended range	0.05	0.1	0.05	2.5	6.0	0.15	2.0	0.05
				12.5	1.2	0.15	0.4	0.05
				25	1.0	0.25	0.3	0.075
100 µL 10–100 µL recommended range	0.1	0.2	0.1	10	3.0	0.3	1.0	0.1
				50	0.8	0.4	0.2	0.1
				100	0.8	0.8	0.2	0.2
250 µL 25–250 µL recommended range	0.5	1	0.5	25	2.0	0.5	0.6	0.15
				125	0.8	1.0	0.15	0.19
				250	0.8	2.0	0.15	0.38
1000 µL 100–1000 µL recommended range	1	2	1	100	3.0	3.0	0.6	0.6
				500	0.8	4.0	0.13	0.65
				1000	0.8	8.0	0.13	1.3
2500 µL 250–2500 µL recommended range	5	10	5	250	3.2	8.0	0.8	2.0
				1250	0.8	10.0	0.16	2.0
				2500	0.8	20.0	0.12	3.0
10 mL 1–10 mL recommended range	10	n/a	10	1 mL	5.0	50.0	0.6	6.0
				5 mL	1.0	50.0	0.2	10.0
				10 mL	0.6	60.0	0.16	16.0

PIPET-LITE, EDP1 AND EDP3 MULTICHANNEL PIPETTES, PIPET-LITE AND EDP3 ADJUSTABLE-SPACER MULTICHANNEL PIPETTES

MODEL VOLUME	INCREMENT µL MANUAL	INCREMENT µL ELECTRONIC	VOLUME SET µL	ACCURACY		PRECISION	
				%	µL(±)	%	µL(≤)
10 µL 0.5–10 µL recommended range*	0.02	0.01	1	2.5	0.025	1.2	0.012
			5	1.5	0.075	0.6	0.03
			10	1.0	0.1	0.4	0.04
20 µL 2–20 µL recommended range	0.02	0.02	2	7.5	0.15	2.0	0.04
			10	1.5	0.15	0.5	0.05
			20	1.0	0.2	0.3	0.06
50 µL 5–50 µL recommended range	0.05	0.05	5	3.5	0.18	1.5	0.075
			25	1.2	0.3	0.4	0.1
			50	0.8	0.4	0.2	0.1
100 µL 10–100 µL recommended range	0.2	0.1	10	3.5	0.35	1.0	0.1
			50	0.8	0.4	0.24	0.12
			100	0.8	0.8	0.15	0.15
200 µL 20–200 µL recommended range	0.2	0.2	20	2.5	0.5	1.0	0.2
			100	0.8	0.8	0.25	0.25
			200	0.8	1.6	0.15	0.3
300 µL 20–300 µL recommended range*	0.5	0.2	30	2.5	0.75	1.0	0.3
			150	0.8	1.2	0.25	0.375
			300	0.8	2.4	0.15	0.45
1200 µL 100–1200 µL recommended range	2	1.0	100	3.6	3.6	0.6	0.6
			600	0.8	4.8	0.2	1.2
			1200	0.8	9.6	0.15	1.8

EDP-PLUS EP-M8 MULTICHANNEL PIPETTE

MODEL VOLUME	INCREMENT µL	VOLUME SET µL	ACCURACY		PRECISION	
			%	µL(±)	%	µL(≤)
10 µL 0.5–10 µL recommended range*	0.01	1	2.5	0.025	1.2	0.012
		5	1.5	0.075	0.6	0.03
		10	1.0	0.1	0.4	0.04
250 µL 10–250 µL recommended range	0.5	25	2.0	0.5	0.6	0.15
		125	0.8	1.0	0.15	0.19
		250	0.8	2.0	0.15	0.38

RAININ CLASSIC PR-200-M8 MULTICHANNEL PIPETTE

MODEL VOLUME	INCREMENT µL	VOLUME SET µL	ACCURACY		PRECISION	
			%	µL(±)	%	µL(≤)
200 µL 20–200 µL recommended range	0.2	20	2.5	0.5	1.25	0.25
		100	1.0	1.0	0.5	0.5
		200	1.0	2.0	0.5	1.0

* When pipetting volumes less than the minimum specified, results depend upon the skill of the operator.

Specifications - Specialty Pipettes

POS-D POSITIVE-DISPLACEMENT

MODEL VOLUME	INCREMENT μL	VOLUME SET μL	ACCURACY		PRECISION	
			%	$\mu\text{L}(\pm)$	%	$\mu\text{L}(\leq)$
MR-10 0.5–10 μL recommended range*	0.02	1	9.0	0.09	3.0	0.03
		5	2.0	0.10	0.6	0.03
		10	1.5	0.15	0.6	0.06
MR-25 3–25 μL recommended range	0.02	3	8.3	0.25	2.6	0.08
		10	2.7	0.27	0.8	0.08
		25	1.2	0.30	0.4	0.10
MR-50 20–50 μL recommended range	0.02	20	1.7	0.34	1.0	0.20
		50	1.4	0.70	0.6	0.30
MR-100 10–100 μL recommended range	0.2	10	5.0	0.50	2.0	0.20
		50	1.5	0.75	0.6	0.30
		100	1.0	1.00	0.4	0.40
MR-250 50–250 μL recommended range	0.2	50	3.0	1.50	0.6	0.30
		100	1.7	1.70	0.3	0.30
		250	1.0	2.50	0.2	0.50
MR-1000 100–1000 μL recommended range	2	100	3.0	3.00	1.6	1.60
		500	1.0	5.00	0.5	2.50
		1000	0.8	8.00	0.4	4.00

* When pipetting volumes less than the minimum specified, results depend upon the skill of the operator.

AR-E1 AUTOREP ELECTRONIC

SYRINGE CAPACITY	VOLUME RANGE OF SYRINGE	INCREMENTAL ADJUSTMENT	RELATIVE ACCURACY % % OF NOMINAL VOLUME				RELATIVE PRECISION % % OF NOMINAL VOLUME			
			100%	50%	10%	1%	100%	50%	10%	1%
0.1 mL	1-100 μL	0.1 μL	1.0	1.2	1.6	16.0	0.50	1.0	2.0	12.0
0.5 mL	5-100 μL	0.1 μL	0.9	0.9	0.9	9.0	0.25	0.5	1.0	6.0
	100-500 μL	1 μL								
1.25 mL	12.5-100 μL	0.5 μL	0.6	0.6	0.9	8.0	0.15	0.3	0.6	3.5
	100-1000 μL	1 μL								
	1-1.25 mL	10 μL								
2.5 mL	25-1000 μL	1 μL	0.5	0.5	0.8	8.0	0.1	0.2	0.4	2.5
	1-2.5 mL	10 μL								
5 mL	50-1000 μL	1 μL	0.5	0.5	0.8	8.0	0.08	0.15	0.3	1.5
	1-5 mL	10 μL								
12.5 mL	125-1000 μL	5 μL	0.4	0.4	0.5	5.0	0.08	0.15	0.25	1.25
	1-10 mL	10 μL								
	10-12.5 mL	100 μL								
25 mL	250 μL -10 mL	10 μL	0.3	0.3	0.3	3.0	0.08	0.15	0.25	1.25
	10-25 mL	100 μL								
50 mL	500 μL - 10 mL	10 μL	0.3	0.3	0.3	3.0	0.08	0.15	0.25	1.25
	10-50 mL	100 μL								

AR-M2 AUTOREP MANUAL

SYRINGE CAPACITY	VOLUME RANGE OF SYRINGE	RELATIVE ACCURACY %	RELATIVE PRECISION %
0.5 mL	10-50 μL	0.8	≤ 1.4 to ≤ 0.6
1.25 mL	25-125 μL	0.8	≤ 0.8 to ≤ 0.3
2.5 mL	50-250 μL	0.7	≤ 0.8 to ≤ 0.2
5 mL	100-500 μL	0.5	≤ 0.6 to ≤ 0.2
12.5 mL	250-1250 μL	0.3	≤ 0.4 to ≤ 0.2
25 mL	500-2500 μL	0.3	≤ 0.4 to ≤ 0.2
50 mL	1-5 mL	0.3	≤ 0.4 to ≤ 0.15

Specifications - Liquidator 96

Inaccuracy (average over multiple full plates):

200 μL :	$\pm 1.0\%$
100 μL :	$\pm 1.0\%$
20 μL :	$\pm 2.0\%$
5 μL :	$\pm 5.0\%$

Precision:

200 μL :	0.5%
100 μL :	0.8%
20 μL :	1.5%
5 μL :	3.5%

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