



Validation Report

Calculator for Extrapolation of Net Weight in Conjunction with a Hypergeometric Sampling Plan

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1. INTRODUCTION

Forensic laboratories performing seized drug analysis often receive submissions comprised of numerous similar containers (i.e. envelopes, bags, vials) each purportedly containing a controlled substance. Forensic analysis is [performed](#) usually in accordance with statutory mandates [listing specific](#)~~requiring the controlled substance in a submission to exceed a~~ threshold weight [values](#).

By viewing the totality of items in a submission as a population, compliance with statutory mandates becomes a matter of the proportion of the population containing a particular controlled substance, by weight. A conventional approach to determine this proportion is to weigh and chemically identify the contents of all individual containers necessary to reach a threshold amount. For submissions with a large number of containers, i.e., 30 or more, this approach becomes very time consuming and laborious. Alternately, analysts can take the following steps¹:

1. weigh a sample of the population
2. calculate the average weight per unit
3. determine the proportion of the population that [would need to be inferred to](#) ~~must~~ contain a controlled substance to meet or exceed a statutory weight threshold
4. use a hypergeometric sampling plan to calculate the number of units to analyze [based on such inference](#)
5. ~~infer-determine and report~~ the weight and identity of ~~some-the larger~~ proportion of the population [inferred to be positive](#).

SWGDRUG has developed an Excel based calculator to aid in the performance of weight estimations in conjunction with a hypergeometric sampling plan. This document ~~s~~ validates the [accuracy of the correct](#) input and output ~~by the calculator for all needed~~ parameters [of the calculator](#).

¹ See SWGDRUG Supplemental Document SD-6 for discussion on measurement uncertainty for extrapolations of net weight and unit count.

2. DEFINITIONS

Symbols	Equations	Description	Reference Cell(s)	SD-6 Reference
N		Population size; number of total units	K1:L1	A.1
n		Sample size; number of units weighed	D28:E28	A.2
		Sample size; theoretical number of units analyzed	S (hidden)	B.2
X		Net weight of each individual unit	B12:C26,E12:F26, H12:I26,K12:L26	A.3
\bar{X}	$\frac{x_1 + x_2 + x_3 \dots}{n}$	Average weight of the <u>measured</u> units weighed using the arithmetic mean	D30:E30	A.4
s	$\sqrt{\frac{\sum (x - \bar{x})^2}{(n-1)}}$	<u>Sample Standard Deviation</u> - a measure of how widely values are dispersed from the average value (the mean)	D32:E32	A.4
RSD	S/\bar{X}	Relative Standard Deviation - ratio of the <u>sample</u> standard deviation (s) and the average weight (\bar{X})	D38D34:E38E34	A.4
u_w		Standard uncertainty (unexpanded) associated with the balance	J8:L8	A.5
$u_{\bar{x}}$	$\frac{s}{\sqrt{n}}$	Standard uncertainty (unexpanded) <u>associated with</u> of the calculated average weight (\bar{X}). Uncertainty encompasses the standard deviation as well as the number of measurements performed. The square root of the sample size is used to account for the standard deviation.	D34D36:E34E36	A.6
u_c	$\sqrt{u_x^2 + u_w^2}$	Combined uncertainty for the average weight per unit considering the uncertainty contribution from the weighing equipment. The root-sum-squared method is used to combine the uncertainties.	K34D38:L34E38	A.7
W	$N * \bar{X}$	Extrapolated net weight; <u>estimated</u> total weight from the average weight (\bar{X}) of the samples selected multiplied by the total numbers of samples (N)	K32K34:L32L34	A.8

Symbols	Equations	Description	Reference Cell(s)	SD-6 Reference
u_t	$N * u_c$	Extrapolated uncertainty (unexpanded) associated with the Extrapolated NW (W). This is obtained by multiplying the total number of samples (N) with the combined uncertainty (u_c).	n/a	A.8
α		<u>Significance level; Threshold index for evaluation of confidence</u> —a predefined <u>limit value</u> that represents the risk of being “wrong” in reaching a conclusion. This probability is a suitably small number between 0 and 1.	n/a	B.2
CL	(1- α)	<u>Threshold confidence level</u> —the predefined <u>limit threshold value</u> that represents the <u>confidence in the risk of being “correct” in reaching a</u> conclusion. This probability corresponds to α resulting in a number between 0 and 1 (i.e. a 0.99 CL has an α of 0.01).	K28:L28 <u>for weight extrapolations,</u> D41:E41 <u>for sampling</u>	<u>A.9</u> B.2
	(1- P_n)	The hypergeometric distribution is used to calculate the CL (1- P_n) for incremental sample sizes (n, n+1, etc.) until it is equal to or greater than the desired CL (1- α).	Q (hidden)	
	<u>Overall</u>	<u>The level of confidence associated with combining the weight extrapolation and sampling inference (identity) calculated via the Bonferroni correction or multiplication rule.</u>	<u>A57:M57</u>	<u>B.6</u>
P	$P_n = P_{sample\ 1} * P_{sample\ 2} * \dots * P_{sample\ n}$ $= \frac{N}{(Samples\ that\ must\ be\ +) - 1}$ $* \frac{N - 1}{(Samples\ that\ must\ be\ +) - 2} * \dots$ $* \frac{N - (n - 1)}{(Samples\ that\ must\ be\ +) - n}$	Probability of <u>a specific event occurring/achieving a positive result</u> for a specified sample sizes (n). As P_n decreases, confidence level increases. A P_n value of 0.01 is equal to a 0.99 CL. The hypergeometric distribution is used to calculate the minimum sample size that has to be analyzed by incrementally calculating the probability for each scenario until it is less than the threshold index for evaluation of confidence (α).	T (hidden)	B.2

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Symbols	Equations	Description	Reference Cell(s)	SD-6 Reference
k		Coverage factor obtained from a two tailed Student's t-distribution with n-1 degrees of freedom. As n increases with more samples, k decreases for a given confidence level.	K30:L30	A.9
<u>Lowest NW (sample)</u>	$\bar{X} - (k * u_c)$	<u>The lowest net weight estimated for a sample within a predefined confidence level. This is determined by subtracting the combined uncertainty for the average weight per unit (u_c) from the average weight of the measured units (\bar{X}).</u>	<u>D32:E32</u>	<u>B.1 (denominator)</u>
U_T	$= k * u_c$ $= k * N * u_c$ $= k * N * \sqrt{u_x^2 + u_w^2}$	Expanded extrapolated uncertainty; expands the extrapolated uncertainty (u_c) by the appropriate cover factor (k) to account for the desired confidence level in the uncertainty.	K36:L36	A.9
Lowest Extrapolated Net Weight	$W - U_T$	The lowest total net weight <u>that is possible</u> estimated for the total population within a predefined confidence level. This is determined by subtracting the expanded extrapolated uncertainty (U_T) from the extrapolated NW (W).	K38:L38	A.10
<u>Samples Units inferred to that must be (+)</u>	Statutory threshold weight / \bar{X} (round up to the nearest integer)	The number of units <u>that must be inferred to</u> contain a controlled substance in order to meet or exceed the threshold statutory weight. This becomes the population size (N) for reported net weight extrapolation.	D43:E43	B.1
>CL(1)/<CL(0)	GESTEP (Excel function)	Logical test to determine when the CL for incremental sample sizes is greater than the threshold <u>CL value</u> . The cell will return 1 when this condition is met.	R (hidden)	n/a
<u>Samples Units to that must be analyzed</u>	VLOOKUP (Excel function)	The minimum number of units to be analyzed is determined by returning the integer of n relating to a	K43:L43	B.2

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Symbols	Equations	Description	Reference Cell(s)	SD-6 Reference
		confidence level equal to or greater than the threshold CL <u>value</u> .		
Reported NW	Samples-Units inferred to that must be (+) * \bar{X} (truncate)	The total <u>reported</u> extrapolated net weight, in grams, of the samples-units inferred to that must be positive. In SD-6, this value is truncated to same level of significance (decimal places) as the reported U_T .	G46C49:H46E49	B.3
Reported U_T	$= (u_t * k)$ $= (n * uc * k)$ $= (n * \sqrt{u_x^2 + u_w^2} * k)$ (round)	Reported e Expanded extrapolated uncertainty <u>associated with the Reported NW of the units inferred to be positive and for the number of samples that are needed to meet the</u> minimum statutory requirement. In SD-6, this value is rounded up to 2 significant figures. It may be necessary to round to less significant figures if the rounded U_T exceeds the readability of the balance.	C48C51:D48E51	B.4
Reported NW <u>Ranges</u> <u>Lower Limit</u> <u>Upper Limit</u>	LL = (Reported NW) – (Reported U_T) UL = (Reported NW) + (Reported U_T)	The estimated-reported NW <u>net weight range</u> , in grams, that is within a certain <u>at the specified</u> level of confidence accounting for the total uncertainty .	G48C53:H48E53, J48C55:K48E55	B.5
ozs.	Reported NW / 28.3495 LL / 28.3495 UL / 28.3495	Conversion of the reported NW, <u>U_T</u> , lower limit (LL) and upper limit (UL), to ounces.	J46:K46 G50:H50,J50:K50 G49:H49,G51:H51 G53:H53,G55:H55	n/a
lbs.	LL / 28.3495 / 16 UL / 28.3495 / 16	Conversion of the <u>reported NW</u> , <u>U_T</u> , lower limit (LL) and upper limit (UL), to pounds.	J49:K49,J51:K51 J53:K53,J55:K55 G52:H52,J52:K52	n/a

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3. SOFTWARE

The validation has been performed with Excel® 2013 and 2016 via comparison with the European Network of Forensic Science Institutes (ENFSI) Drug Working Group (DWG) Calculator for Qualitative Sampling of Seized Drugs, version July 2017.

4. VALIDATION

The spreadsheet demonstrates the calculations in Examples 1 and 2 of SD-6 "Measurement Uncertainty for Extrapolations of Net Weight and Unit Count". It is designed to fit the vast majority of seized drug submissions allowing for use with multi-unit populations of 5000 or less and an input of 60 or less net weights.

For easier handling of the calculator, mandatory entry cells are highlighted yellow with the exception of the net weight entry fields. Formula cells are password protected to prohibit inadvertent changes to the spreadsheet. Additionally, data validation will alert the user when invalid entries are input in the population size, weight, uncertainty and confidence level cells. Lastly, the net weight entry cells are conditionally formatted to display the number of decimal places (0 to 6) corresponding to the balance readability (1 g to 0.001 mg).

The worksheet is divided into 3 sections:

- Estimation of Weight (SD-6 Example 1)
- Hypergeometric Sampling (SD-6 Example 2 B.1 to B.2)
- Reported Weight Extrapolation (SD-6 Example 3 B.3 to B.6)

Five datasets of various weights and population sizes were put into the calculator. The final output for each section was compared with the validated ENFSI calculator. See Appendix A for raw data entries and the corresponding ENFSI results in green.

4.1. **Estimation of Weight**

The first section of the calculator is titled "Extrapolation of Net Weight (NW)" and calculates the estimated net weight for the entire population based on the weight of a subset of units.

Case #:				Population Size (N):			
Unit #:							
Analyst:		Balance ID:		Total Gross Weight (g):			
<hr/>							
Extrapolation of Net Weight (NW)				Balance Readability:		u_w (unexpanded):	
Unit:	Net Weight (g):	Unit:	Net Weight (g):	Unit:	Net Weight (g):	Unit:	Net Weight (g):
Sample Size (n)	0			Confidence Level (1-α)			
Average NW (\bar{x})	#DIV/0!	grams		Student-t (k)	#NUM!		
Std. Dev. (s)	#DIV/0!	grams		Extrapolated NW (W)	#DIV/0! grams		
u\bar{x}	#DIV/0!	grams		u_c	#DIV/0! grams		
Lowest NW (sample)	#DIV/0!	grams		U_T	#NUM! grams		
RSD	#DIV/0!			Lowest Extrapolated NW	#DIV/0! grams		

The parameters in this section are calculated by using the following Excel formulas:

- Sample size (n) =COUNT(B12:C26,E12:F26,H12:I26,K12:L26)
- Average NW (\bar{x}) =AVERAGE(B12:C26,E12:F26,H12:I26,K12:L26)
- Standard deviation (s) =STDEV.S(B12:C26,E12:F26,H12:I26,K12:L26)
- ~~RSD =D34/D32=D32/D30 cell is formatted a percentage~~
- Standard uncertainty of the average NW (u \bar{x}) =D34/SQRT(D30)=D32/SQRT(D28)
- ~~Combined uncertainty of \bar{x} and balance (u_c) =SQRT(SUMSQ(D38,J10))~~
- ~~Student-t (k) =T.INV.2T((1-K28),D28-1)~~
- ~~=SQRT(SUMSQ(D34,J8))~~
- Lowest NW (sample) =D32-(K32*D40)=D30-(K30*K34)
- ~~RSD =D32/D30 cell is formatted a percentage~~

~~Student t (k) = T.INV.2T((1 - K28), D28 - 1)~~

~~Extrapolated NW (W) = D32 * K3 = D30 * K1~~

~~Combined uncertainty of \bar{x} and balance (u_e) = SQRT(SUMSQ(D34, J8))~~

Expanded combined uncertainty (U_T)

~~= K3 * K32 * SQRT(SUMSQ(D38, J10)) = K1 * K30 * SQRT(SUMSQ(D34, J8))~~

Lowest Extrapolated NW = K36 - K38

~~= K32 - K36~~

The extrapolated net weight (W) and associated expanded combined uncertainty (U_T) was compared with the ENFSI estimations for each dataset. It should be noted that the ENFSI calculator applies a finite correction factor, Q_{corr}, if n/N > 0.1 which lessens the total uncertainty. Thus, the SWGDRUG calculator results in more conservative uncertainties for Datasets 2, 4 and 5. Because the terminal output is in agreement, Excel formulas are valid and correct for this section of the calculator.

4.2. Hypergeometric Sampling

The second section of the calculator is titled "Hypergeometric Sampling" and uses the NW estimation from the first section to determine the number of samples-units that *must be demonstrated (inferred) to contain a controlled substance* in order to meet a minimum statutory weight. Subsequently, this section statistically determines the minimum number of samples-units that *must be analyzed to allow such an inference, infer* that the amount of material containing a controlled substance is present in enough material to exceed the statutory weight.

Hypergeometric Sampling			
Confidence Level (1-α)	<input type="text"/>	Units inferred to be (+)	<input type="text" value="#DIV/0!"/>
Minimum Statutory Wt.	<input type="text"/> grams	Units to be analyzed	<input type="text" value="#N/A"/>

Hypergeometric Sampling			
		Samples that must be (+)	<input type="text" value="#DIV/0!"/>
Minimum Statutory Wt.	<input type="text"/> grams	Samples to be analyzed	<input type="text" value="#N/A"/>

The parameters in this section are calculated by using the following Excel formulas:

~~Samples~~ ~~Units~~ ~~that~~ ~~must~~ ~~inferred~~ ~~to~~ be (+)
~~=ROUNDUP(D45/K34,0)=ROUNDUP(D43/D36,0)~~

~~Samples~~ ~~Units~~ to be analyzed
~~=VLOOKUP(1,R4:S1044,2,FALSE)=VLOOKUP(1,R2:S1041,2,FALSE)~~

*Theoretical number of items tested (n) =IF(\$K\$13-(\$K\$13-1)<\$K\$13,\$K\$13-(\$K\$13-1),\$K\$13) ; =IF(\$K\$13-(\$K\$13-1-S#)<\$K\$13, \$K\$13-(\$K\$13-1-S#), \$K\$13)

*Probability that fewer than the '~~Samples-Units inferred to~~that must be (+)' exists given various theoretical sample sizes (P) =HYPGEOM.DIST(S#,S#,\$K\$4143-1,\$K\$13,FALSE)

*Level of confidence that at least the '~~Samples-Units inferred to~~that must be (+)' exists given various theoretical sample sizes (CL) =1-HYPGEOM.DIST(~~S2S#~~,~~S2S#~~,\$K\$4143-1,\$K\$13,FALSE)

*Logical test that returns 0 when the theoretical confidence level is less than the threshold confidence level and 1 when it is met or exceeded (>CL(1)/<CL(0))
=GESTEP(Q#,\$KD\$2843)

**indicated hidden column*

"#" denotes incremental row number(s)

The number of samples that must be analyzed agrees with the ENFSI estimations for each dataset. Because this terminal output has been verified, Excel formulas are valid and correct for this section of the calculator.

4.3. Reported Weight Extrapolation

The third section of the calculator is titled "Reported Weight Extrapolation" and ~~extrapolates~~ ~~produces~~ the reported NW and uncertainty ~~resulting from~~ of the hypergeometric sampling ~~plan~~ ~~procedure~~ ~~and~~ using the ~~average~~ net weights ~~per unit determined~~ ~~sampled~~ in the first section.

Reported Weight Extrapolation			
Reported NW	#DIV/0!	grams	#DIV/0!
	#DIV/0!	ozs.	#DIV/0!
	#DIV/0!	lbs.	
Reported U _T	#DIV/0!	grams	#DIV/0!
	#DIV/0!	ozs.	#DIV/0!
	#DIV/0!	lbs.	
Lower Limit	#DIV/0!	grams	#DIV/0!
	#DIV/0!	ozs.	#DIV/0!
	#DIV/0!	lbs.	
Upper Limit	#DIV/0!	grams	#DIV/0!
	#DIV/0!	ozs.	#DIV/0!
	#DIV/0!	lbs.	
The overall level of confidence for weight and identity is at least 0%.			

Reported Weight Extrapolation	Reported NW	#DIV/0!	grams	#DIV/0!	ozs.
Reported U _T	#DIV/0!	grams	Ranges	#DIV/0!	grams
				#DIV/0!	ozs.
				#DIV/0!	lbs.

The parameters in this section are calculated by the following Excel formulas:

Reported NW =K41*D30 grams; =G46/28.3495 ounces

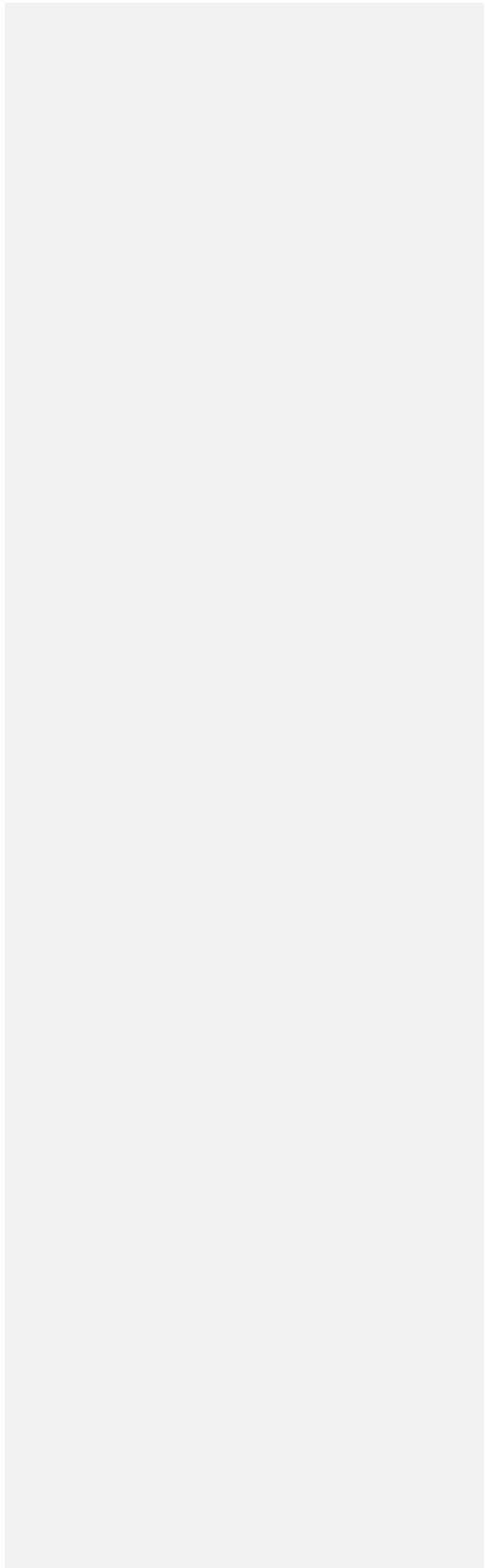
Reported U_T =K41*K30*SQRT(SUMSQ(D34,J8))

~~Range~~ Lower Limit =G46-C48 grams; =G48/28.3495 ounces; =G48/28.3495/16 pounds

~~Range~~ Upper Limit =G46+C48 grams; =J48/28.3495 ounces; =J48/28.3495/16 pounds

The reported net weight (NW) and associated uncertainty (U_T) was compared to the ENFSI estimations for each dataset. It should be noted that the ENFSI calculator applies a finite correction factor, Q_{corr}, if n/N > 0.1 which ~~lessens~~ ~~decreases~~ the total uncertainty. Thus, the SWGDRUG calculator results in a more conservative uncertainty for Dataset 2. For Reported Weight Extrapolations, the sample size (n) is considered the number of units weighed and the population (N) is adjusted to the number of units inferred to be positive as denoted with an asterisk (*) for each dataset in Appendix A. The ENFSI calculator is unable to calculate the uncertainty associated with Datasets 4 and 5 due to ~~the number of units weighed (n) exceeding number of units that must be positive (N)~~. The Q_{corr} returns a negative value for Dataset 4 (N = 6 and n = 40) and 5 (N = 21 and n = 45). Thus, comparison to ENFSI is not possible. These values were calculated by hand to be 2.50 and 136 for Datasets 4 and 5 respectively. Because this terminal

output is in agreement, Excel formulas are valid and correct for this section of the calculator.



5. CONCLUSION

The SWGDRUG Calculator for Extrapolation of Net Weight in Conjunction with a Hypergeometric Sampling Plan version 1.0 is valid and fit for purpose.

6. CONTACT

Please address questions, report errors and/or bugs found in the Excel software or within this document to swgdrug@hotmail.com.

7. APPENDIX A

Scientific Working Group for the Analysis of Seized Drugs							
Case #: Dataset 1		Population Size (N): 500					
Unit #: 1-500							
Analyst: MB		Balance ID:		Total Gross Weight (g):			
		B509638893		170.42			
Extrapolation of Net Weight (NW)							
		Balance Readability:		u_w (unexpanded):			
		0.1 mg		0.003100537			
Unit:	Net Weight (g):	Unit:	Net Weight (g):	Unit:	Net Weight (g):	Unit:	Net Weight (g):
1	0.0490	16	0.0433				
2	0.0333	17	0.0543				
3	0.0394	18	0.0455				
4	0.0499	19	0.0400				
5	0.0466	20	0.0534				
6	0.0385	21	0.0424				
7	0.0553	22	0.0534				
8	0.0468	23	0.0448				
9	0.0475	24	0.0503				
10	0.0693	25	0.0409				
11	0.0511	26	0.0467				
12	0.0415	27	0.0341				
13	0.0445	28	0.0494				
14	0.0492	29	0.0469				
15	0.0512	30	0.0421				
Sample Size (n)	30			Confidence Level (1-α)	0.99		
Average NW (\bar{X})	0.046686667	grams		Student-t (k)	2.756385904		
Std. Dev. (s)	0.007046923	grams		Lowest NW (sample)	0.037433814	grams	
RSD	15.1%			Extrapolated NW (W)	23.34333333	grams	
u_{x̄}	0.001286586	grams		U_T	4.62642642	grams	
u_c	0.003356879	grams		Lowest Extrapolated NW	18.71690691	grams	
Hypergeometric Sampling							
Confidence Level (1-α)		0.99		Units inferred to be (+)		401	
Minimum Statutory Wt.		15		Units to be analyzed		21	
						21	
Reported Weight Extrapolation *Adjusted N = Units inferred to be (+) = 401 and n = Sample Size = 30							
Reported NW	18.72135333	grams	0.660376844	ozs.	0.041273553	lbs.	
	18.721*						
Reported U_T	3.710393989	grams	0.130880403	ozs.	0.008180025	lbs.	
	3.710*						
Lower Limit	15.01095934	grams	0.529496441	ozs.	0.033093528	lbs.	
Upper Limit	22.43174732	grams	0.791257247	ozs.	0.049453578	lbs.	
7. The overall level of confidence for weight and identity is at least 98.01%.							

Case #: Dataset 1				Population Size (N):		500	
Unit #: 1-500							
Analyst: MB				Balance ID:		Total Gross Weight (g):	
						170.42	
Extrapolation of Net Weight (NW)				Balance Readability:		u_w (unexpanded):	
				0.1 mg		0.003100537	
Unit:	Net Weight (g):	Unit:	Net Weight (g):	Unit:	Net Weight (g):	Unit:	Net Weight (g):
1	0.0490	16	0.0433	31		46	
2	0.0333	17	0.0543	32		47	
3	0.0394	18	0.0455	33		48	
4	0.0499	19	0.0400	34		49	
5	0.0466	20	0.0534	35		50	
6	0.0385	21	0.0424	36		51	
7	0.0553	22	0.0534	37		52	
8	0.0468	23	0.0448	38		53	
9	0.0475	24	0.0503	39		54	
10	0.0693	25	0.0409	40		55	
11	0.0511	26	0.0467	41		56	
12	0.0415	27	0.0341	42		57	
13	0.0445	28	0.0494	43		58	
14	0.0492	29	0.0469	44		59	
15	0.0512	30	0.0421	45		60	
Sample Size (n)	30		Confidence Level (1-α)	0.99			
Average NW (\bar{X})	0.046686667	grams	Student-t (k)	2.756385904			
Std. Dev. (s)	0.007046923	grams	Extrapolated NW (W)	23.34333333	grams		
				23.343			
$u_{\bar{x}}$	0.001286586	grams	u_c	0.003356879		grams	
Lowest NW (sample)	0.037433814	grams	U_T	4.62642642	grams		
				4.626			
RSD	15.1%		Lowest Extrapolated NW	18.71690691		grams	
Hypergeometric Sampling				Samples that must be (+)		401	
Minimum Statutory Wt.				15		grams	
				Samples to be analyzed		21	
						21	
Reported Weight Extrapolation		Reported NW	18.72135333	grams	0.660376844	ozs.	
			18.721*				
Reported U_T	3.710393989	grams	Ranges	15.01095934	-	22.43174732	grams
	3.710*						
	*(N = 401, n = 30)			0.529496441	-	0.791257247	ozs.
				0.033093528	-	0.049453578	lbs.

8.

Scientific Working Group for the Analysis of Seized Drugs

Case #: Dataset 2 **Population Size (N):** 50
Unit #: 1-50
Analyst: TR **Balance ID:** B746999853 **Total Gross Weight (g):** 170.42

Extrapolation of Net Weight (NW)

Balance Readability: 0.001 g **u_w (unexpanded):** 0.001496364

Unit:	Net Weight (g):	Unit:	Net Weight (g):	Unit:	Net Weight (g):	Unit:	Net Weight (g):
1	0.490	16	0.433				
2	0.333	17	0.543				
3	0.394	18	0.455				
4	0.499	19	0.400				
5	0.466	20	0.534				
6	0.385	21	0.424				
7	0.553	22	0.534				
8	0.468	23	0.448				
9	0.475	24	0.503				
10	0.693	25	0.409				
11	0.511	26	0.467				
12	0.415	27	0.341				
13	0.445	28	0.494				
14	0.492	29	0.469				
15	0.512	30	0.421				

Sample Size (n)	30	Confidence Level (1-α)	0.99
Average NW (\bar{X})	0.46686667 grams	Student-t (k)	2.756385904
Std. Dev. (s)	0.070469232 grams	Lowest NW (sample)	0.431164337 grams
RSD	15.1%	Extrapolated NW (W)	23.34333333 grams
u_{x̄}	0.012865863 grams	U_T	1.7851165 grams
u_c	0.012952588 grams	Lowest Extrapolated NW	21.55821683 grams

Hypergeometric Sampling

Confidence Level (1-α)	0.99	Units inferred to be (+)	35
Minimum Statutory Wt.	15 grams	Units to be analyzed	11

Reported Weight Extrapolation *Adjusted N = Units inferred to be (+) = 35 and n = Sample Size = 30

Reported NW	16.34033333 grams	0.576388766 ozs.	0.036024298 lbs.
Reported U_T	1.24958155 grams	0.044077728 ozs.	0.002754858 lbs.
Lower Limit	15.09075178 grams	0.532311038 ozs.	0.03326944 lbs.
Upper Limit	17.58991488 grams	0.620466494 ozs.	0.038779156 lbs.

The overall level of confidence for weight and identity is at least 98.01%.

Case #: Dataset 2				Population Size (N):		50	
Unit #: 1-50							
Analyst: TR				Balance ID:		Total Gross Weight (g):	
						170.42	
Extrapolation of Net Weight (NW)				Balance Readability:		u_w (unexpanded):	
				0.001 g		0.001496364	
Unit:	Net Weight (g):	Unit:	Net Weight (g):	Unit:	Net Weight (g):	Unit:	Net Weight (g):
1	0.490	16	0.433	31		46	
2	0.333	17	0.543	32		47	
3	0.394	18	0.455	33		48	
4	0.499	19	0.400	34		49	
5	0.466	20	0.534	35		50	
6	0.385	21	0.424	36		51	
7	0.553	22	0.534	37		52	
8	0.468	23	0.448	38		53	
9	0.475	24	0.503	39		54	
10	0.693	25	0.409	40		55	
11	0.511	26	0.467	41		56	
12	0.415	27	0.341	42		57	
13	0.445	28	0.494	43		58	
14	0.492	29	0.469	44		59	
15	0.512	30	0.421	45		60	
Sample Size (n)	30			Confidence Level (1-α)	0.99		
Average NW (X̄)	0.46686667 grams			Student-t (k)	2.756385904		
Std. Dev. (s)	0.070469232 grams			Extrapolated NW (W)	23.34333333 grams		
					23.343		
u_{x̄}	0.012865863 grams			u_c	0.012952588 grams		
Lowest NW (sample)	0.431164337 grams			U_T	1.7851165 grams		
					1.129		
RSD	15.1%			Lowest Extrapolated NW	21.55821683 grams		
Hypergeometric Sampling				Samples that must be (+)		35	
Minimum Statutory Wt.				15 grams		Samples to be analyzed	
						11	
Reported Weight Extrapolation				Reported NW	16.34033333 grams		0.576388766 ozs.
					16.340*		
Reported U_T	1.24958155	grams	Ranges	15.09075178	-	17.58991488	grams
	0.472*						
	*(N = 35, n = 30)			0.532311038	-	0.620466494	ozs.
				0.03326944	-	0.038779156	lbs.

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Case #: Dataset 3 **Population Size (N):** 1512
Unit #: 1-1512
Analyst: MB **Balance ID:** 6656 **Total Gross Weight (g):** 448.65

Extrapolation of Net Weight (NW)

Balance Readability: 0.1 mg **u_w (unexpanded):** 0.003100537

Unit:	Net Weight (g):	Unit:	Net Weight (g):	Unit:	Net Weight (g):	Unit:	Net Weight (g):
1	0.0387	16	0.0418	31	0.0310	46	0.0257
2	0.0278	17	0.0266	32	0.0237	47	0.0242
3	0.0191	18	0.0248	33	0.0472	48	0.0282
4	0.0267	19	0.0412	34	0.0275	49	0.0237
5	0.0511	20	0.0190	35	0.0320	50	0.0331
6	0.0227	21	0.0275	36	0.0244	51	0.0243
7	0.0391	22	0.0378	37	0.0387	52	0.0276
8	0.0303	23	0.0209	38	0.0366	53	0.0295
9	0.0239	24	0.0272	39	0.0249	54	0.033
10	0.0223	25	0.0415	40	0.0227	55	0.0273
11	0.0241	26	0.0327	41	0.0323	56	0.025
12	0.0314	27	0.0291	42	0.0277	57	0.0292
13	0.0283	28	0.0552	43	0.0340	58	0.0278
14	0.0304	29	0.0260	44	0.0257	59	0.0498
15	0.0334	30	0.0273	45	0.0320	60	0.0358

Sample Size (n)	60	Confidence Level (1-α)	0.95
Average NW (\bar{X})	0.030541667 grams	Student-t (k)	2.000995378
Std. Dev. (s)	0.007750326 grams	Lowest NW (sample)	0.024022457 grams
RSD	25.4%	Extrapolated NW (W)	46.179 grams
u\bar{x}	0.001000563 grams	U_T	9.85704501 grams
u_c	0.003257983 grams	Lowest Extrapolated NW	36.32195499 grams

Hypergeometric Sampling

Confidence Level (1-α) 0.95 **Units inferred to be (+)** 625
Minimum Statutory Wt. 15 grams **Units to be analyzed** 4

Reported Weight Extrapolation *Adjusted N = Units inferred to be (+) = 625 and n = Sample Size = 60

Reported NW	19.08854167 grams	0.673329042 ozs.	0.042083065 lbs.
Reported U_T	4.074506039 grams	0.143724088 ozs.	0.008982756 lbs.
Lower Limit	15.01403563 grams	0.529604953 ozs.	0.03310031 lbs.
Upper Limit	23.16304771 grams	0.81705313 ozs.	0.051065821 lbs.

The overall level of confidence for weight and identity is at least 90.25%.

Case #: Dataset 3				Population Size (N):		1512	
Unit #: 1-1512							
Analyst: MB				Balance ID:		Total Gross Weight (g):	
						448.65	
Extrapolation of Net Weight (NW)				Balance Readability:		u_w (unexpanded):	
				0.1 mg		0.003100537	
Unit:	Net Weight (g):	Unit:	Net Weight (g):	Unit:	Net Weight (g):	Unit:	Net Weight (g):
1	0.0387	16	0.0418	31	0.0310	46	0.0257
2	0.0278	17	0.0266	32	0.0237	47	0.0242
3	0.0191	18	0.0248	33	0.0472	48	0.0282
4	0.0267	19	0.0412	34	0.0275	49	0.0237
5	0.0511	20	0.0190	35	0.0320	50	0.0331
6	0.0227	21	0.0275	36	0.0244	51	0.0243
7	0.0391	22	0.0378	37	0.0387	52	0.0276
8	0.0303	23	0.0209	38	0.0366	53	0.0295
9	0.0239	24	0.0272	39	0.0249	54	0.0330
10	0.0223	25	0.0415	40	0.0227	55	0.0273
11	0.0241	26	0.0327	41	0.0323	56	0.0250
12	0.0314	27	0.0291	42	0.0277	57	0.0292
13	0.0283	28	0.0552	43	0.0340	58	0.0278
14	0.0304	29	0.0260	44	0.0257	59	0.0498
15	0.0334	30	0.0273	45	0.0320	60	0.0358
Sample Size (n)	60			Confidence Level (1-α)	0.95		
Average NW (X̄)	0.030541667 grams			Student-t (k)	2.000995378		
Std. Dev. (s)	0.007750326 grams			Extrapolated NW (W)	46.179 grams		
u_{x̄}	0.001000563 grams			u_c	0.003257983 grams		
Lowest NW (sample)	0.024022457 grams			U_T	9.85704501 grams		
RSD	25.4%			Lowest Extrapolated NW	36.32195499 grams		
Hypergeometric Sampling				Samples that must be (+)		625	
Minimum Statutory Wt.				15 grams		Samples to be analyzed	
						4	
Reported Weight Extrapolation				Reported NW	19.08854167 grams	0.673329042	ozs.
					19.089*		
Reported U_T	4.074506039 grams	Ranges	15.01403563	-	23.16304771	grams	
	4.075*						
	*(N = 625, n = 60)		0.529604953	-	0.81705313	ozs.	
			0.03310031	-	0.051065821	lbs.	

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Case #: Dataset 4 **Population Size (N):** 151
Unit #: 1-151
Analyst: TR **Balance ID:** 24AP8 **Total Gross Weight (g):** 479.81

Extrapolation of Net Weight (NW)

Balance Readability: 0.01 g **u_w (unexpanded):** 0.073617359

Unit:	Net Weight (g):	Unit:	Net Weight (g):	Unit:	Net Weight (g):	Unit:	Net Weight (g):
1	3.87	16	4.18	31	3.10		
2	2.78	17	2.66	32	2.37		
3	1.91	18	2.48	33	4.72		
4	2.67	19	4.12	34	2.75		
5	5.11	20	1.90	35	3.20		
6	2.27	21	2.75	36	2.44		
7	3.91	22	3.78	37	3.87		
8	3.03	23	2.09	38	3.66		
9	2.39	24	2.72	39	2.49		
10	2.23	25	4.15	40	2.27		
11	2.41	26	3.27				
12	3.14	27	2.91				
13	2.83	28	5.52				
14	3.04	29	2.60				
15	3.34	30	2.73				

Sample Size (n)	40	Confidence Level (1-α)	0.99
Average NW (\bar{X})	3.0915 grams	Student-t (k)	2.707913184
Std. Dev. (s)	0.856859352 grams	Lowest NW (sample)	2.673965477 grams
RSD	27.7%	Extrapolated NW (W)	466.8165 grams
u\bar{x}	0.135481359 grams	U_T	63.04771292 grams
u_c	0.154190513 grams	Lowest Extrapolated NW	403.7687871 grams

Hypergeometric Sampling

Confidence Level (1-α)	0.99	Units inferred to be (+)	6
Minimum Statutory Wt.	15 grams	Units to be analyzed	2

Reported Weight Extrapolation *Adjusted N = Units inferred to be (+) = 6 and n = Sample Size = 40

Case #: Dataset 4				Population Size (N):		151	
Unit #: 1-151							
Analyst: TR				Balance ID:		Total Gross Weight (g):	
						479.81	
Extrapolation of Net Weight (NW)				Balance Readability:		u_w (unexpanded):	
				0.01 g		0.073617359	
Unit:	Net Weight (g):	Unit:	Net Weight (g):	Unit:	Net Weight (g):	Unit:	Net Weight (g):
1	3.87	16	4.18	31	3.10	46	
2	2.78	17	2.66	32	2.37	47	
3	1.91	18	2.48	33	4.72	48	
4	2.67	19	4.12	34	2.75	49	
5	5.11	20	1.90	35	3.20	50	
6	2.27	21	2.75	36	2.44	51	
7	3.91	22	3.78	37	3.87	52	
8	3.03	23	2.09	38	3.66	53	
9	2.39	24	2.72	39	2.49	54	
10	2.23	25	4.15	40	2.27	55	
11	2.41	26	3.27	41		56	
12	3.14	27	2.91	42		57	
13	2.83	28	5.52	43		58	
14	3.04	29	2.60	44		59	
15	3.34	30	2.73	45		60	
Sample Size (n)	40			Confidence Level (1-α)	0.99		
Average NW (X̄)	3.0915 grams			Student-t (k)	2.707913184		
Std. Dev. (s)	0.856859352 grams			Extrapolated NW (W)	466.8165 grams		
					466.817		
u_{x̄}	0.135481359 grams			u_c	0.154190513 grams		
Lowest NW (sample)	2.673965477 grams			U_T	63.04771292 grams		
					54.056		
RSD	27.7%			Lowest Extrapolated NW	403.7687871 grams		
Hypergeometric Sampling				Samples that must be (+)		6	
Minimum Statutory Wt.				15 grams		Samples to be analyzed	
						2	
Reported Weight Extrapolation				Reported NW	18.549 grams	0.654297254	ozs.
					18.549*		
Reported U_T	2.505207136	grams	Ranges	16.04379286	-	21.05420714	grams
	n.a.*						
	*(N = 6, n = 40)			0.565928601	-	0.742665907	ozs.
				0.035370538	-	0.046416619	lbs.

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Case #: Dataset 5 **Population Size (N):** 160
Unit #: 1.1-1.160
Analyst: MB **Balance ID:** E8002S **Total Gross Weight (g):** 82464

Extrapolation of Net Weight (NW)

Balance Readability: 1 g **u_w (unexpanded):** 0.839052045

Unit:	Net Weight (g):	Unit:	Net Weight (g):	Unit:	Net Weight (g):	Unit:	Net Weight (g):
1.1	498	1.16	497	1.31	493		
1.2	502	1.17	503	1.32	496		
1.3	505	1.18	504	1.33	505		
1.4	497	1.19	499	1.34	502		
1.5	508	1.20	509	1.35	498		
1.6	501	1.21	500	1.36	507		
1.7	500	1.22	499	1.37	510		
1.8	497	1.23	498	1.38	494		
1.9	496	1.24	495	1.39	503		
1.10	494	1.25	496	1.40	500		
1.11	502	1.26	503	1.41	499		
1.12	503	1.27	506	1.42	499		
1.13	500	1.28	500	1.43	502		
1.14	507	1.29	502	1.44	497		
1.15	505	1.30	598	1.45	498		

Sample Size (n)	45	Confidence Level (1-α)	0.99
Average NW (\bar{X})	502.8222222 grams	Student-t (k)	2.692278266
Std. Dev. (s)	15.09257627 grams	Lowest NW (sample)	496.3574368 grams
RSD	3.0%	Extrapolated NW (W)	80451.55556 grams
u_{x̄}	2.249868434 grams	U_T	1034.365662 grams
u_c	2.401232247 grams	Lowest Extrapolated NW	79417.18989 grams

Hypergeometric Sampling

Confidence Level (1-α)	0.99	Units inferred to be (+)	21
Minimum Statutory Wt.	10000 grams	Units to be analyzed	3

Reported Weight Extrapolation *Adjusted N = Units inferred to be (+) = 21 and n = Sample Size = 45

Reported NW	10559.26667 grams	372.4674744 ozs.	23.27921715 lbs.
	10559.267*		
Reported U_T	135.7604932 grams	4.788814376 ozs.	0.299300899 lbs.
	N/A*		
Lower Limit	10423.50617 grams	367.6786601 ozs.	22.97991625 lbs.
Upper Limit	10695.02716 grams	377.2562888 ozs.	23.57851805 lbs.

The overall level of confidence for weight and identity is at least 98.01%.

Case #: Dataset 5				Population Size (N):		160	
Unit #: 1-160							
Analyst: MB				Balance ID:		Total Gross Weight (g):	
						82464	
Extrapolation of Net Weight (NW)				Balance Readability:		u_w (unexpanded):	
				1 g		0.839052045	
Unit:	Net Weight (g):	Unit:	Net Weight (g):	Unit:	Net Weight (g):	Unit:	Net Weight (g):
1	498	16	497	31	493	46	
2	502	17	503	32	496	47	
3	505	18	504	33	505	48	
4	497	19	499	34	502	49	
5	508	20	509	35	498	50	
6	501	21	500	36	507	51	
7	500	22	499	37	510	52	
8	497	23	498	38	494	53	
9	496	24	495	39	503	54	
10	494	25	496	40	500	55	
11	502	26	503	41	499	56	
12	503	27	506	42	499	57	
13	500	28	500	43	502	58	
14	507	29	502	44	497	59	
15	505	30	598	45	498	60	
Sample Size (n)	45			Confidence Level (1-α)	0.99		
Average NW (X̄)	502.8222222 grams			Student-t (k)	2.692278266		
Std. Dev. (s)	15.09257627 grams			Extrapolated NW (W)	80451.55556 grams		
u_{x̄}	2.249868434 grams			u_c	2.401232247 grams		
Lowest NW (sample)	496.3574368 grams			U_T	1034.365662 grams		
RSD	3.0%			Lowest Extrapolated NW	79417.18989 grams		
Hypergeometric Sampling				Samples that must be (+)		21	
Minimum Statutory Wt.				10000 grams		Samples to be analyzed	
						3	
Reported Weight Extrapolation				Reported NW	10559.26667 grams	372.4674744	ozs.
					10559.267*		
Reported U_T	135.7604932	grams	Ranges	10423.50617	-	10695.02716	grams
	n.a.*			367.6786601	-	377.2562888	ozs.
	*(N = 21, n = 45)			22.97991625	-	23.57851805	lbs.