

ATTACHMENT A

PUBLIC SERVICE COMPANY OF NEW HAMPSHIRE D/B/A EVERSOURCE ENERGY

Meter Sample Testing Program Summary – 2018

Submitted: October 17, 2018

A waiver granted by the Commission in late 2017 allowed Eversource to implement a unique sample testing plan for the calendar year 2018 testing period. Following is a summary of the testing program and results.

Eversource requested a waiver of the sample testing approach described in Puc 305.03 to improve the efficiency of the testing program and bring it up to date with current industry standards related to sample testing. Specifically, Eversource requested adoption of the sample testing approach outlined in ANSI/ASQ Z1.3-2003, American National Standard, Sampling Procedures and Tables for Inspection by Variables for Percent Nonconforming.

To validate the new testing program, Eversource agreed with the Commission Staff and the Office of Consumer Advocate (“OCA”) to test double the number of meters recommended in ANSI/ASQ Z1.3-2003 during 2018. In addition, a prorated amount was included within this year’s results to accommodate a requested shift in the testing period to align with the calendar year. Under the agreement, the Commission allowed Eversource to select up to half of the number of meters within each lot to be tested from qualified meters that had been recently removed from service as part of the course of normal business and were now in stock. The remaining quantity of meters were selected from the traditional method of targeting specific in-service meters. To comply with the agreement, Eversource would separately identify and report the test results for each meter grouping to determine any impact to the overall test results. Eversource assigned a test code of 91 to meters tested from those recently removed/stock meters, and a test code of 11 to meters selected for testing from the targeted in-service group of meters. The test codes are used to differentiate the statistical analysis reports shown on the following pages.

After reviewing the results of the 2018 testing program, should the results fall within specified limits, under the agreement Eversource was permitted to renew its original request for a permanent waiver that would allow Eversource to test per the sample lot sizes indicated in ANSI/ASQ Z1.3-2003.

The following pages show the results of Eversource’s statistical analysis following ANSI/ASQ Z1.3-2003, separated by their in-service (code 11) vs. in stock (code 91) selection types, and a combined analysis for the total quantity of sample meters tested for each of the six sample lots applicable for the 2018 sample testing program. Eversource selected and tested slightly more meters than were required for each sample lot to ensure the minimum test quantities were met.

As indicated by the ANSI analysis reports, all sample lots were found to be within acceptable tolerance limits. Only one sample lot (Lot # 6) showed a standard deviation value greater than 0.1 (0.32 for the 42 meters tested). These results are still well within established tolerances, but

they do highlight the accuracy performance differences between the older electromechanical meters included within Lot #6 and the solid-state meters within the other lot groupings.

The test results confirm Eversource's expectation that the general population of in-service meters, most of which are relatively new solid-state meters, have a weighted accuracy performance that is well within the tolerances defined in Rule 305.03 (d)(1). In addition, the results also show no deviation between those meters that were removed as the course of normal business (i.e. the "stocked meters") vs those that were specifically targeted for testing.

In that the test results are within the limits specified in the agreement, in submitting this report Eversource renews its waiver request as follows:

- The Commission should waive the existing sample testing selection criteria within Rule 305.03 and permit Eversource to use the quantities per ANSI/ASQ Z1.3-2003 guidelines.
- That the waiver be in effect for the sample testing period starting on January 1, 2019.
- That all future testing periods be on an annual basis from Jan–Dec of each year.
- That the sample testing program would include all self-contained single and poly phase meters.
- That meters eligible for inclusion within each sample testing lot be any combination of in-service meters and those recently removed from service, excluding damaged or tampered meters.

Chart 1

ANSI Sample Testing Analysis for all meters tested - 2018

This analysis follows the example shown in ANSI Z1.9-2003, Example B-3, page 40, for determining pass/fail status of a lot using a double specification limit, variability unknown, standard deviation method, using one AQL value for both upper and lower specification limits

Updated 9/27/18

Parameter	Eversource NH 2018 Sample Testing Plan						Comments
	Total Sample Tested Meters						
AQL (%)	1	1	1	1	1	1	Assumed, based on prior PUC ruling
Upper Spec. Limit	101	101	101	101	101	102	Based on existing PUC limits
Lower Spec. Limit	98	98	98	98	98	98	Based on existing PUC limits
Lot Number	1	2	3	4	5	6	Lot identifier
Lot Size	482709	36864	14832	26542	362	160	Number of installed meters in the lot
Sample Size Code	P	N	M	M	H	G	From Z1.9 table A-2
Sample Size (n)	200	150	100	100	20	15	From Z1.9 table B-3.
Sample Size NHPUC required	500	375	250	250	50	38	Total of test code 11 & 91 meters to be tested.
Actual qty. tested (total)	509	395	253	270	57	42	This value used in calculations below as "n".
Sum of Measurements	50895.62	39522.10	25310.77	26989.73	5700.21	4200.70	ΣX = Sum of measured WA % Registrations
Sum of Measurements ^2	5089127.74	3954424.04	2532155.08	2697947.39	570042.18	420144.21	ΣX^2
Correction Factor (CF)	5089124.04	3954421.24	2532154.46	2697946.39	570042.00	420140.01	$CF = (\Sigma X)^2/n$
Corrected Sum of Squares (SS)	3.7031	2.8063	0.6242	1.0041	0.1839	4.2017	$SS = \Sigma X^2 - CF$
Variance (V)	0.0073	0.0071	0.0025	0.0037	0.0033	0.1025	$V = SS/(n-1)$
Estimate of Lot Std. Dev. (s)	0.0854	0.0844	0.0498	0.0611	0.0573	0.3201	$s = \text{sqrt}(V)$
Sample Mean (Xbar)	99.991	100.056	100.043	99.962	100.004	100.017	$Xbar = \Sigma X/n$
Upper Spec. Limit (U)	101	101	101	101	101	102	U = row 5 values shown above
Lower Spec. Limit (L)	98	98	98	98	98	98	L = row 6 values shown above
Quality Index (Q _u)	11.81	11.19	19.24	16.99	17.38	6.20	$Q_u = (U - Xbar)/s$
Quality Index (Q _l)	23.32	24.36	41.04	32.11	34.96	6.30	$Q_l = (Xbar - L)/s$
Est. of Lot Percent Ncf. above U (P _u)	0	0	0	0	0	0	From Z1.9 table B-5
Est. of Lot Percent Ncf. above U (P _l)	0	0	0	0	0	0	From Z1.9 table B-5
Total Est. Percent Ncf. In Lot (P)	0	0	0	0	0	0	$P = P_u + P_l$
Max. Allowable Percent Ncf. (M)	2.04	2.05	2.18	2.18	2.93	3.06	From Z1.9 table B-3
Acceptability Criterion (Pass or Fail)	Pass	Pass	Pass	Pass	Pass	Pass	If P < M, Pass, else Fail

The Lot sizes are based on the installed meter count for each Lot as of 1/26/2018, when the samples lots were selected.

Lot #	Summary Statistics for Weighted Average Accuracy					
	1	2	3	4	5	6
Lot Description	Centron	Centron Bridge (1P)	Centron Bridge (3P)	GE I-210(+C)	Other Solid State	Electro-Mechanical
Minimum	99.74	99.79	99.91	99.76	99.88	99.3
Maximum	100.46	100.37	100.22	100.32	100.14	100.59
Average	99.99	100.06	100.04	99.96	100.00	100.02
Standard Deviation	0.0854	0.0844	0.0498	0.0611	0.0573	0.3201
3 Sigma	0.26	0.25	0.15	0.18	0.17	0.96

Chart 2

ANSI Sample Testing Analysis for the targeted in-service meters

This analysis follows the example shown in ANSI Z1.9-2003, Example B-3, page 40, for determining pass/fail status of a lot using a double specification limit, variability unknown, standard deviation method, using one AQL value for both upper and lower specification limits

Updated 9/26/18

Parameter	Eversource NH 2018 Sample Testing Plan						Comments
	Sample Test Code 11 Meters						
AQL (%)	1	1	1	1	1	1	Assumed, based on prior PUC ruling
Upper Spec. Limit	101	101	101	101	101	102	Based on existing PUC limits
Lower Spec. Limit	98	98	98	98	98	98	Based on existing PUC limits
Lot Number	1	2	3	4	5	6	Lot Identifier
Lot Size	482709	36864	14832	26542	362	160	Number of installed meters in the lot
Sample Size Code	P	N	M	M	H	G	From Z1.9 table A-2
Sample Size (n)	200	150	100	100	20	15	From Z1.9 table B-3.
Sample Size NHPUC required	500	375	250	250	50	38	Total of test code 11 & 91 meters to be tested.
Actual qty. tested (test code 11)	259	291	128	180	48	36	This value used in calculations below as "n".
Sum of Measurements	25900.37	29121.51	12808.98	17994.10	4799.99	3601.41	$\Sigma X =$ Sum of measured WA % Registrations
Sum of Measurements $\wedge 2$	2590076.34	2914305.68	1281796.92	1798821.06	479998.15	360285.50	ΣX^2
Correction Factor (CF)	2590074.00	2914303.59	1281796.63	1798820.19	479998.00	360282.06	$CF = (\Sigma X)^2/n$
Corrected Sum of Squares (SS)	2.3370	2.0861	0.2898	0.8628	0.1535	3.4415	$SS = \Sigma X^2 - CF$
Variance (V)	0.0091	0.0072	0.0023	0.0048	0.0033	0.0983	$V = SS/(n-1)$
Estimate of Lot Std. Dev. (s)	0.0952	0.0848	0.0478	0.0694	0.0571	0.3136	$s = \text{sqrt}(V)$
Sample Mean (Xbar)	100.001	100.074	100.070	99.967	100.000	100.039	$\text{Xbar} = \Sigma X/n$
Upper Spec. Limit (U)	101	101	101	101	101	102	U = row 5 values shown above
Lower Spec. Limit (L)	98	98	98	98	98	98	L = row 6 values shown above
Quality Index (Q _u)	10.49	10.92	19.47	14.88	17.50	6.25	$Q_u = (U - \text{Xbar})/s$
Quality Index (Q _l)	21.03	24.45	43.34	28.33	34.99	6.50	$Q_l = (\text{Xbar} - L)/s$
Est. of Lot Percent Ncf. above U (P _u)	0	0	0	0	0	0	From Z1.9 table B-5
Est. of Lot Percent Ncf. above U (P _l)	0	0	0	0	0	0	From Z1.9 table B-5
Total Est. Percent Ncf. In Lot (P)	0	0	0	0	0	0	$P = P_u + P_l$
Max. Allowable Percent Ncf. (M)	2.04	2.05	2.18	2.18	2.93	3.06	From Z1.9 table B-3
Acceptability Criterion (Pass or Fail)	Pass	Pass	Pass	Pass	Pass	Pass	If $P < M$, Pass, else Fail

The Lot sizes are based on the installed meter count for each Lot as of 1/26/2018, when the samples lots were selected.

Lot #	Summary Statistics for Weighted Average Accuracy					
	1	2	3	4	5	6
Lot Description	Centron	Centron Bridge (1P)	Centron Bridge (3P)	GE I-210(+C)	Other Solid State	Electro-Mechanical
Minimum	99.74	99.79	99.95	99.76	99.88	99.3
Maximum	100.46	100.37	100.22	100.32	100.14	100.59
Average	100.00	100.07	100.07	99.97	100.00	100.04
Standard Deviation	0.0952	0.0848	0.0478	0.0694	0.0571	0.3136
3 Sigma	0.29	0.25	0.14	0.21	0.17	0.94

Chart 3

ANSI Sample Testing Analysis for the "stocked" meters recently removed from service

This analysis follows the example shown in ANSI Z1.9-2003, Example B-3, page 40, for determining pass/fail status of a lot using a double specification limit, variability unknown, standard deviation method, using one AQL value for both upper and lower specification limits

Updated 9/26/18							
Parameter	Eversource NH 2018 Sample Testing Plan						Comments
	Sample Test Code 91 Meters						
AQL (%)	1	1	1	1	1	1	Assumed, based on prior PUC ruling
Upper Spec. Limit	101	101	101	101	101	102	Based on existing PUC limits
Lower Spec. Limit	98	98	98	98	98	98	Based on existing PUC limits
Lot Number	1	2	3	4	5	6	Lot identifier
Lot Size	482709	36864	14832	26542	362	160	Number of installed meters in the lot
Sample Size Code	P	N	M	M	H	G	From Z1.9 table A-2
Sample Size (n)	200	150	100	100	20	15	From Z1.9 table B-3.
Sample Size NHPUC required	500	375	250	250	50	38	Total of test code 11 & 91 meters to be tested.
Actual qty. tested (test code 91)	250	104	125	90	9	6	This value used in calculations below as "n".
Sum of Measurements	24995.25	10400.59	12501.79	8995.63	900.22	599.29	ΣX = Sum of measured WA % Registrations
Sum of Measurements ^2	2499051.40	1040118.37	1250358.16	899126.34	90044.03	59858.72	ΣX^2
Correction Factor (CF)	2499050.09	1040118.00	1250358.03	899126.21	90044.01	59858.08	$CF = (\Sigma X)^2/n$
Corrected Sum of Squares (SS)	1.3131	0.3634	0.1373	0.1263	0.0258	0.6327	$SS = \Sigma X^2 - CF$
Variance (V)	0.0053	0.0035	0.0011	0.0014	0.0032	0.1265	$V = SS/(n-1)$
Estimate of Lot Std. Dev. (s)	0.0726	0.0594	0.0333	0.0377	0.0568	0.3557	$s = \sqrt{V}$
Sample Mean (Xbar)	99.981	100.006	100.014	99.951	100.024	99.882	$Xbar = \Sigma X/n$
Upper Spec. Limit (U)	101	101	101	101	101	102	U = row 5 values shown above
Lower Spec. Limit (L)	98	98	98	98	98	98	L = row 6 values shown above
Quality Index (Q _u)	14.03	16.74	29.63	27.83	17.17	5.96	$Q_u = (U - Xbar)/s$
Quality Index (Q _l)	27.28	33.77	60.54	51.80	35.63	5.29	$Q_l = (Xbar - L)/s$
Est. of Lot Percent Ncf. above U (P _u)	0	0	0	0	0	0	From Z1.9 table B-5
Est. of Lot Percent Ncf. above U (P _l)	0	0	0	0	0	0	From Z1.9 table B-5
Total Est. Percent Ncf. In Lot (P)	0	0	0	0	0	0	$P = P_u + P_l$
Max. Allowable Percent Ncf. (M)	2.04	2.05	2.18	2.18	2.93	3.06	From Z1.9 table B-3
Acceptability Criterion (Pass or Fail)	Pass	Pass	Pass	Pass	Pass	Pass	If P < M, Pass, else Fail

The Lot sizes are based on the installed meter count for each Lot as of 1/26/2018, when the samples lots were selected.

Lot #	Summary Statistics for Weighted Average Accuracy					
	1	2	3	4	5	6
Lot Description	Centron	Centron Bridge (1P)	Centron Bridge (3P)	GE I-210(+C)	Other Solid State	Electro-Mechanical
Minimum	99.74	99.89	99.91	99.84	99.9	99.39
Maximum	100.17	100.21	100.09	100.03	100.1	100.38
Average	99.98	100.01	100.01	99.95	100.02	99.88
Standard Deviation	0.0726	0.0594	0.0333	0.0377	0.0568	0.3557
3 Sigma	0.22	0.18	0.10	0.11	0.17	1.07