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Report is required by: OAR 860-023-0015

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PGE Annual Meter Report and Certification

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Portland General Electric
121 SW Salmon Street • Portland, OR 97204
portlandgeneral.com

April 27, 2023

Public Utility Commission of Oregon
Attn: Filing Center
201 High Street SE
P.O. Box 1088
Salem, OR 97308-1088

RE: RE 93 PGE 2022 Annual Meter Report and Certification

Pursuant to OAR 860-023-0015, PGE hereby submits the Company's 2022 Annual Meter Report and Certification.

Should you have any questions regarding this filing, please contact Mary Widman at mary.widman@pgn.com Please direct all formal correspondence and requests to the following email address pge.opuc.filings@pgn.com

Sincerely,

\s\ Robert Macfarlane

Robert Macfarlane
Manager, Pricing & Tariffs

Enclosure



Portland General Electric
121 SW Salmon Street · Portland, Ore. 97204

Portland General Electric

2022 Annual Meter Report and Certification to Oregon Public Utility Commission

Bob Simpson, P.E.

Bob Simpson

Senior Manager – Substation & Meter Operations

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Manager – Operations & Planning Engineering

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1. Overview

Portland General Electric (PGE) follows the guidelines of ANSI C12.1-2014 Code for Electricity Metering to evaluate the performance and accuracy of new and installed metering systems. PGE standards, practices and procedures for maintaining the accuracy of electric meters are based on accepted industry metering and quality standards and are maintained in compliance with applicable regulatory requirements and rules. The intent of PGE's metering policies, procedures, and practices is to properly apply, install and maintain meters and metering devices to ensure the accuracy of customer metering.

In addition, PGE uses a meter inventory management database, PowerTrack, meter consumption and billing software, Oracle Meter Data Management (MDM) and Customer Care & Billing (CC&B), to monitor the accuracy of installed metering systems and to verify correct customer billing.

In-service random sample and periodic meter testing, based on industry sampling procedures, are used to evaluate the accuracy of installed metering systems and to detect inaccurate meter groups. Statistical information from this testing is used to determine future maintenance and testing.

PGE follows National Institute of Standards Technology (NIST) requirements to ensure watt-hour measurement equipment to test the accuracy of revenue meters is correctly calibrated. PGE maintains a Standards Laboratory that is responsible for the certification of all watt-hour standards used within PGE.

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2. Metering Management Review

The review of PGE metering policies, practices, and procedures shows that PGE complies with the following: ANSI C12.1-2014 Code for Electricity Metering, ANSI Z1.9-2003 (R2013) Sampling Procedures and Tables, Oregon Public Utility Commission (OPUC) Electric Utility Metering Policy, and applicable sections of the Oregon Revised Statutes (ORS) and Oregon Administrative Rules (OAR).

The PGE Electric Metering Test and Inspection Policy, provided in Appendix A, outlines the procedures used to direct the electric metering test and verification programs. The standards, practices, and procedures for maintaining the accuracy of electric metering systems are based on acceptable national metering and quality standards and are maintained in compliance with applicable regulatory requirements and rules.

PGE metering practices and programs direct the surveillance of metering systems and customer service facilities. The results of the surveillance efforts are used to determine potential trends in the installed metering systems. Statistical information is then used to determine future maintenance and testing.

All test equipment used to validate metering accuracy is traceable to NIST or other nationally recognized standards organizations or laboratories. Calibration standards are used to verify test equipment accuracy every six months.

PGE experienced major supply chain delays from its primary meter supplier in 2021 and 2022. Delays are decreasing but are anticipated to continue through 2023. No customer impacts are expected due to management of PGE meter inventory. PGE is pursuing alternate meter suppliers in 2023 to further reduce potential supply chain effects as part of its risk mitigation strategy.

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3. Summary of Significant Deficiencies

Two wiring errors on existing metering systems were identified in 2022, as shown in Table 1.

Table 1 – Summary of Significant Deficiencies

<u>PROBLEM</u>	<u>DATE FOUND</u>	<u>FOUND DURING</u>	<u>CITY</u>
CT wiring backward (All phases)	5/26/2022	Site verification performed within ninety (90) days of installation	Oregon City
CT wiring backward (All phases)	8/24/2022	Site verification performed within ninety (90) days of installation	Happy Valley

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4. Corrective Action Plans

No failed lots were found among the three (3) Periodic Meter Groups (PMG) conducted in 2022; therefore, no Correction Action Plans (CAP) were necessary.

In 2021, lot 535-545-IN-ISA2-2021 was classified as a defective meter group. The lot failure occurred due to one (1) meter of the tested fifty (50), with a weighted-average accuracy of 59.99 percent, which caused the percent non-conforming to exceed the acceptable percent limit defined in ANSI/ASQ Z1.9-2003 (R2013) Table B-3. An additional fifty (50) tests were added to 2022 testing for this meter type and added to lot 535-545-IN-ISA2-2022-CAP as part of the corrective action plan.

Lot 535-545-IN-ISA2-2022-CAP passed acceptable percent limit defined in ANSI/ASQ Z1.9-2003 (R2013) Table B-3. Results are shown in Table 2. No further corrective action is required.

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Table 2 – HMG Statistical Summary – Corrective Action Plan

1	2	3	4	5a	5b	6a	6b	7	8	9	10	11	12	13
Lot Name	Population	Sample Size	Number Tested	Average Sample Weighted Average	Standard Deviation	Maximum Sample Weighted Average	Minimum Sample Weighted Average	Number of Meters with Greater than 2%	Number of Uniquely Defective Meters Excluded	Number of Uniquely Defective Meters Excluded Due to Manufacturer Defects	Excluded Meters	ANSI Z1.9 Conclusion	Number of Meters Below 98%	Number of Meters Exceeding 102%
535-545-IN-ISA2-2022-CAP	2482	50	50	100.00	0.08	100.20	99.82	0	0	0	0	P	0	0

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5. Homogenous Meter Groups and Periodic Meter Groups

In-service periodic meter testing and random sample meter testing were performed on all installed meters under the post-AMI meter deployment program.

A total of thirty (30) Homogenous Meter Groups (HMG) and three (3) Periodic Meter Groups (PMG) were identified in the 2022 test year. Table 2 and Table 3 show HMG and PMG lot groups, respectively. Each lot group is identified by internal PGE stock codes.

Total number of HMG lots increased for 2022 test year. Two (2) meter groups were added for a new residential meter type, Sensus Stratus iQ.

Table 3 – HMG Lot Names

HMG Lot Names	
0503-0509-IN-IQ-2022	0508-IN-ICONA-2022
0503-0509-IN-SSA3-22	0523-AB-A3-2022
0503-IN-ISA2-1-2022	0524-AB-A3-2022
0503-IN-ISA2-2-2022	0525-AB-A3-2022
0503-LG-AXR-2022	0526-AB-A3-2022
0505-IN-ICONA-2022	0527-AB-A3-2022
0505-IN-IQ-2022	0528-0529-AB-A3-2022
0505-LG-AXR-2022	0530-AB-A3-2022
0506-IN-ISA2-2022	0531-AB-A3-2022
0507-0509-IN-ICONA-1	0622-AB-OPT-2022
0507-0509-IN-ICONA-2	0800-ION-2022
0507-0509-IN-ICONA-3	220-AB-OPT-2022
0507-0509-IN-ICONA-4	240-623-AB-OPT-2022
0507-0509-IN-ICONA-5	534-536-539-ICONA-22
0507-0509-IN-ICONA-6	535-545-IN-ISA2-2022

Table 4 – PMG Lot Names

PMG Lot Names
PERIODIC-AB-2022
PERIODIC-PM-2022
SUBSTATION-2022

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6. Summary of PMG Metering Audits

- a) Annual Test and Inspection: Large Commercial and Industrial customers served by substation metering.
- b) Biennial Test and Inspection: Commercial and Industrial customers with an average load greater than 1.0 MW.
- c) 5-Year Test and Inspection: Customers with an average load between 500 kW and 1.0 MW were transitioned with commission approval to HMG in 2014.
- d) 12-Year Test and Inspection: Customers with an average load less than 500 kW were transitioned with commission approval to HMG in 2014.

PMG testing summaries and associated defects, if applicable, are provided in Table 5 and Table 6, respectively.

Table 5 – PMG Audit Summary

PMG Description	PMG Population	PMG Sample Size	PMG Number Tested	Average Sample Weighted Average	Defects by Causes	Revenue Implications Due to Defects
PERIODIC-AB-2022	151	82	82	99.99	N/A	N/A
PERIODIC-PM-2022	67	15	15	100.00	N/A	N/A
SUBSTATION-2022	231	76	76	100.00	N/A	N/A

Table 6 – PMG Metering Defect Summary

PMG Description	Meter ID	Test Date	Failure Code	Pass/Fail	Full Load	Light Load	Weighted Average	Corrective Action
N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

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7. Statistical Summaries of Inspections/Tests and CAP Retirements for HMG

In-service random sample meter testing was performed in thirty (30) HMG on all installed meters under PGE's post-AMI meter deployment program. Statistical summary of inspections performed on HMG are shown in Table 7.

There were no additional deficiencies found; therefore, no CAP retirements were necessary in 2022.

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Table 7 – HMG Statistical Summary

1	2	3	4	5a	5b	6a	6b	7	8	9	10	11	12	13
Lot Name	Population	Sample Size	Number Tested	Average Sample Weighted Average	Standard Deviation	Maximum Sample Weighted Average	Minimum Sample Weighted Average	Number of Meters with Greater than 2%	Number of Uniquely Defective Meters Excluded	Number of Uniquely Defective Meters Excluded Due to Manufacturer Defects	Excluded Meters	ANSI Z1.9 Conclusion	Number of Meters Below 98%	Number of Meters Exceeding 102%
0503-0509-IN-IQ-2022	22027	100	103	100.01	0.04	100.19	99.92	0	0	0	11	P	0	0
0503-0509-IN-SSA3-22	50194	150	150	100.01	0.07	100.26	99.78	0	0	0	22	P	0	0
0503-IN-ISA2-1-2022	68364	150	153	99.95	0.08	100.15	99.71	0	0	0	4	P	0	0
0503-IN-ISA2-2-2022	69139	150	156	99.92	0.14	100.16	98.71	0	0	0	15	P	0	0
0503-LG-AXR-2022	36204	150	150	100.03	0.05	100.17	99.91	0	0	0	29	P	0	0
0505-IN-ICONA-2022	28822	100	105	100.04	0.07	100.2	99.91	0	0	0	22	P	0	0
0505-IN-IQ-2022	950	35	35	100.03	0.03	100.12	99.98	0	0	0	4	P	0	0
0505-LG-AXR-2022	8345	75	79	100.06	0.03	100.12	99.98	0	0	0	5	P	0	0
0506-IN-ISA2-2022	2649	50	50	100.19	0.12	100.60	99.89	0	0	0	6	P	0	0
0507-0509-IN-ICONA-1	99678	150	150	99.96	0.10	100.19	99.45	0	1	0	14	P	0	0
0507-0509-IN-ICONA-2	99832	150	151	99.97	0.07	100.21	99.74	0	0	0	7	P	0	0
0507-0509-IN-ICONA-3	99999	150	155	100.01	0.13	101.36	99.75	0	0	0	22	P	0	0
0507-0509-IN-ICONA-4	99904	150	152	99.98	0.13	100.21	98.73	0	0	0	29	P	0	0
0507-0509-IN-ICONA-5	99735	150	153	100.00	0.08	100.29	99.63	0	1	0	48	P	0	0
0507-0509-IN-ICONA-6	33681	100	100	99.98	0.14	100.68	99.19	0	1	0	7	P	0	0
0508-IN-ICONA-2022	17083	100	103	100.12	0.08	100.29	99.71	0	1	0	14	P	0	0
0523-AB-A3-2022	4239	75	76	99.97	0.08	100.10	99.68	0	0	0	8	P	0	0
0524-AB-A3-2022	811	35	35	99.95	0.08	100.06	99.73	0	0	0	7	P	0	0
0525-AB-A3-2022	2048	50	51	99.98	0.07	100.11	99.68	0	0	0	4	P	0	0
0526-AB-A3-2022	316	20	20	99.98	0.05	100.05	99.86	0	0	0	4	P	0	0
0527-AB-A3-2022	334	20	20	99.98	0.07	100.08	99.75	0	0	0	4	P	0	0
0528-0529-AB-A3-2022	18398	100	105	99.98	0.05	100.07	99.71	0	0	0	12	P	0	0
0530-AB-A3-2022	3164	50	50	99.96	0.07	100.07	99.74	0	0	0	9	P	0	0
0531-AB-A3-2022	26396	100	101	100.06	0.99	109.83	99.69	1	0	0	14	P	0	1
0622-AB-OPT-2022	9	3	5	99.95	0.05	100.04	99.90	0	0	0	1	P	0	0
0800-ION-2022	158	15	16	99.98	0.07	100.05	99.82	0	0	0	17	P	0	0
220-AB-OPT-2022	5	3	3	99.94	0.02	99.95	99.92	0	0	0	1	P	0	0
240-623-AB-OPT-2022	147	10	10	99.95	0.08	100.02	99.74	0	0	0	4	P	0	0
534-536-539-ICONA-22	26850	100	101	100.04	0.11	100.18	99.18	0	0	0	8	P	0	0
535-545-IN-ISA2-2022	2482	50	56	100.04	0.12	100.69	99.79	0	0	0	3	P	0	0

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8. Listing of Uniquely Defective Meters Found in Sample Meter Tests by HMG

Within in-service random sample meter testing performed in thirty (30) HMG, there were four (4) uniquely defective meters found in Sample Meter Tests for 2022. The following table lists the uniquely defective meters.

Table 8 – HMG Uniquely Defective Meter Summary

HMG Description	Meter ID	Test Date	Failure Code	Pass/Fail	Full Load	Light Load	Weighted Average	Corrective Action
0507-0509-IN-ICONA-1	24299348IN	N/A	UNKNOWN	Fail	0%	0%	0%	WOULD NOT TEST
0507-0509-IN-ICONA-5	27298002IN	N/A	DAMAGED; HOUSE FIRE	Fail	0%	0%	0%	WOULD NOT TEST
0507-0509-IN-ICONA-6	33891189IN	N/A	DAMAGED	Fail	0%	0%	0%	BROKEN DURING REMOVAL
0508-IN-ICONA-2022	25322666IN	N/A	DAMAGED	Fail	0%	0%	0%	BROKEN DURING REMOVAL

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9. Listing of Metering Hazards, Failures, and Major Defects Found in Periodic Test Program

No instances of metering hazards, failures, or major defects were found in the Periodic Meter Test Program in 2022.

Portland General Electric 2022 Annual Report and Certification

10. Inspections/Tests and Targeted CAP Retirements

Of the three (3) PMG lots tested in 2022, no deficiencies were detected. All lots passed ANSI testing with no meter groups requiring a CAP.

Of the thirty (30) HMG lots tested in 2022, no deficiencies were detected. All lots passed ANSI testing with no meter groups requiring a CAP.

No targeted retirements are currently planned for 2023.

Portland General Electric 2022 Annual Report and Certification

11. Changes to PGE Metering Practices

PGE metering practices and procedures for maintaining the accuracy of electric meters and metering systems remain the same in accordance to accepted national metering and quality standards and are maintained in compliance with applicable regulatory requirements and rules.

PGE began exchanging non-remote disconnect residential meters with remote disconnect meters in 2020 at non-owner occupied locations, sites identified with a lack of contract, and any site visited for credit purposes. The initial phase of the project consisted of 25,000 meters exchanged in 2020. Targeted exchanges decreased through 2022 due to supply chain delays experienced in 2021 and 2022.

PGE commenced evaluation of sample selection inspection levels used to generate sample sizes as described in ANSI/ASQ Z1.9-2003 (R2013) Section A7. PGE is concurrently initiating an assessment intended to formulate a defined analytics plan, outlined in ANSI C12.1-2022, to monitor and identify meter performance aberrations to ensure in-service meters are performing properly.

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12. Multi State Utilities Report

Not Applicable.

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13. Number of Qualified Meter Technicians by Classification

The following table represents PGE technical staff in 2022:

Table 9 – PGE Meter Services Qualified Technicians in 2022

Technical Staff in PGE Meter Services	
Meter Foremen	3
Meter Technicians	2
Journeyman Metermen	15
Apprentice Metermen	2

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14. Utility Policy Changes Requiring Commission Approval

Changes to Portland General Electric Metering Test and Inspection Policy were submitted to Staff in 2019. Policy revision aligns with current industry testing methods and practices while ensuring system validation through statistical analysis.

Policy was adopted by Commission on April 21, 2020, under Docket No. UM 1384 with an effective date of April 22, 2020. Policy is provided in Appendix A.

There are no additional anticipated policy changes requiring approval by Commission at this time.

**Portland General Electric
2022 Annual Report and Certification**

Appendix A

Portland General Electric Meter Test and Inspection Policy

PORTLAND GENERAL ELECTRIC METER TEST AND INSPECTION POLICY

PROCEDURES FOR MAINTAINING THE ACCURACY OF PORTLAND GENERAL ELECTRIC STANDARDS, METERS, AND METERING SYSTEMS

**Previous Revision – February 5, 2014
Revision – April 22, 2020**

1. Scope

This document outlines the procedural requirements of Portland General Electric's (PGE or Company) scheduled electric metering test and verification programs. This policy is submitted to satisfy OAR 860-023-0015 as required by the Oregon Public Utility Commission (OPUC or Commission).

PGE deployment of solid-state Advanced Metering Infrastructure (AMI) meters occurred between 2008 and 2010 to replace in-service electromechanical meters. AMI meters allow for automated collection of meter data through a fixed two-way communication network. Adjustments to policy were made post-deployment for increased monitoring and verification purposes to ensure meter accuracies remained within acceptable tolerances.

This policy revision aligns with current industry testing methods and practices while ensuring system validation through statistical analysis.

2. General

The intent of PGE's metering policies, procedures, and practices is to properly apply, install and maintain meters and metering devices to ensure the accuracy of customer metering. No meter or metering device shall be placed in service, or allowed to remain in service, that has an incorrect watt-hour constant, that is mechanically or electrically defective, incorrectly connected, installed, or applied, or that is outside acceptable accuracy tolerances. No device shall be placed on or in a meter or metering system that could adversely affect the accuracy or performance of the meter or metering system.

PGE standards, practices and procedures for maintaining the accuracy of electric meters and metering systems are based on accepted national metering and quality standards and are maintained in compliance with applicable regulatory requirements and rules.

PGE has established practices and programs for continuing surveillance of its metering systems and customer service facilities to determine and take appropriate action

concerning hazards, failures and defects associated with metering systems and customer service facilities.

All PGE employees and contractors who perform work associated with customer metering systems shall be trained and be alert in the normal course of their daily work to identify and report safety, security, revenue and other metering defect issues.

3. References

This document references the following industry and PGE standards:

- PGE Meter Services shall communicate and implement metering policies, standards and procedures internal to the company and to applicable contractors.
- ORS 757.250 and OAR 860-023-0015 shall be used as minimum legal standards for metering system compliance.
- ANSI C12.1-2014 Code for Electricity Metering shall be used as a minimum maintenance standard for accuracy performance for standardizing equipment and in-service tests and metering devices.
- ANSI/ASQ Z1.4-2003 (R2013) Sampling Procedures and Tables for Inspection by Attributes shall be used as a minimum for meter acceptance testing.
- ANSI/ASQ Z1.9-2003 (R2013) Sampling Procedures and Tables for Inspection by Variables for Percent Nonconforming shall be used as a minimum standard for in-service meter sample testing.
- PGE Electric Service Requirements is used as standard for new metering and service installations.
- Public Utility Commission of Oregon Order No. 08-245 in UE 189.

4. Definitions

- (a) AMI Meter – a solid-state electronic meter which provides for two-way communications to allow the automated collection of metering data and for sending signals to the meter.
- (b) Company – Portland General Electric
- (c) Defective Meter Group – An identified homogeneous group of meters, or distinct subdivision thereof, that exceeds acceptable percent nonconforming, as defined in ANSI/ASQ Z1.9-2003 (R2013).
- (d) Homogeneous Meter Group (HMG) – A group of meters produced by the same manufacturer, having related type designation, of the same design and the same relationship of parts.
- (e) Metering System – The entire metering circuit and installation including all sensing, measuring, totalizing, registering and communication devices as well as enclosures, instrument transformers, wiring and communication links.
- (f) NIST – National Institute of Standards and Technology, under US Dept. of Commerce.
- (g) Periodic Meter Group (PMG) – A group of metering systems tested, inspected, and verified in a specific year that are on the same test frequency in a Periodic Meter Test Program.

- (h) Periodic Meter Test Program – An established scheduled pattern of meter testing and site verification where each site will be selected according to a designated regular time-interval.
- (i) Sample Meter Test Program – An established random pattern of testing meters belonging to a HMG whereby each meter has an equal opportunity to be selected for testing each year.
- (j) Uniquely Defective Meter – A meter selected for random sampling with unusable test results, including meters with broken covers, missing test data, accuracy performance characteristics greater than + 5% resulting from unique physical experience or unique electrical experience, and is not representative of other in-service meters in its HMG.

5. Watt-hour Standards and Standardizing Equipment

(a) PURPOSE:

To ensure watt-hour measurement equipment used to test accuracy of billing meters is calibrated and traceable to National Institute of Standards Technology (NIST).

(b) RESPONSIBILITY:

The Company maintains a Standards Laboratory that is responsible for certification of all portable watt-hour standards used within PGE. The Standard Laboratory is available at all times, by appointment, during business hours for inspection or use by Commission's representatives.

(c) SUMMARY OF METHOD:

The Company uses a reference watt-hour standard to compare all other watt-hour standards to ensure revenue meter accuracy. The calibration accuracy of the reference standard is verified at six-month intervals to Standard Instruments and are traceable to NIST. If the accuracy of the reference standard is outside acceptable tolerances as defined by ANSI C12.1-2014 Section 3, the Company shall calibrate the standard to acceptable limits, if possible. The reference watt-hour standard is stored and used in a temperature and humidity-controlled environment.

The reference watt-hour standard is used to certify portable watt-hour standards at intervals not to exceed six-months. Certifications are performed by PGE's Instrument Laboratory using a comparison method with a secondary watt-hour standard.

Documentation for all calibrations and for calibration procedures and results for each reference standard, portable watt-hour standard, and portable secondary watt-hour standard is maintained in a database system and should be kept for at least five years. A calibrated certification tag is affixed to each watt-hour standard. Each certification tag contains the calibration date, calibration result, next calibration due date, and the calibrating technician initials. Calibrations are performed following the guidance of ANSI C12.1-2014, ANSI code for Electric Metering.

6. Meter Quality Assurance

(a) PURPOSE:

To assure meters meet Company accuracy requirements before acceptance or installation in accordance to ANSI C12.1-2014.

(b) RESPONSIBILITY:

The meter manufacturer shall test all new single-phase and three-phase meters before being shipped to the company. The manufacturer shall provide certified test data for all new meters to the company. The Company is responsible for analysis of meter manufacturers test data to ensure accuracy specifications are met. The Company shall provide copies of its analysis of the manufacturers test data to the Commission its next Annual Certification Report. If the Company purchased used solid-state meters, the Company is responsible for testing all the purchased meters. The Company is responsible for keeping meter test records in accordance with Section 13 of this policy.

(c) SAMPLING METHOD:

Sample testing of new meters is accomplished by selecting samples based on shipment size as defined in ANSI/ASQ Z1.4-2003 (R2013) with a General Inspection Level II, Acceptance Quality Limit (AQL) of 2.5, and Double Sampling Plan. Accuracy testing is performed based on ANSI C12.20-2015, Company accuracy tolerance specifications, and includes functionality testing of AMI communication modules. If number of failed accuracy tests is less than limit defined in ANSI/ASQ Z1.4-2003 (R2013), shipment is accepted. See Appendices for detailed acceptance testing policy.

The Company requires accuracy for new meters at light and full loads to be within + 0.3% for solid-state electronic meters. Any sample test lot found to be outside acceptable accuracy limits would be held from service until repaired or replaced. . Weighted percent registration is defined by ANSI C12.1-2014, Section 5.1.4.1, Method 1.

(d) METER MANUFACTURER ASSESSMENT

The Company will perform a quality assessment on each watt-hour meter supplier at intervals not to exceed five years.

7. In-Service Random Sample Meter Testing

(a) PURPOSE:

The purpose of this test program is to detect inaccurate meter groups and yield statistical information on which to base future maintenance and testing.

The in-service testing program includes watt-hour meters of the following types:

- Self-contained single phase and three phase revenue meters.
- Instrument transformer rated revenue meters.

(b) **RESPONSIBILITY:**

The Company shall report on the results of its in-service random sample meter testing in its Annual Certification Report. The Company is responsible for keeping these results for at least ten years.

(c) **METHOD:**

Random sample of meters are selected annually from each applicable Homogeneous Meter Group (HMG) using the company meter asset database and placed into sample lots. Sample lots are created and tested in the following manner:

Meters are grouped by equipment type, manufacturer, and model having the same design and relationship of parts. For large HMGs over 150,000 meters, subgroups no larger than 100,000 meters are created.

Group sample sizes are based on ANSI/ASQ Z1.9-2003 (R2013) with a General Inspection Level II, Acceptance Quality Limit (AQL) of 2.5, and Double Specification Limit. Maximum Allowable Percent Defective for each meter sample lot is determined from ANSI/ASQ Z1.9, Table B-3.

The test results of uniquely defective meters are excluded from statistical analysis only if the cause of the error can be attributed to external causes or outside forces (e.g., vandalism, tampering, lightning, corrosive environment, etc.).

(d) **TEST RESULTS ANALYSIS:**

Sample plan test results are analyzed based on ANSI/ASQ Z1.9-2003 (R2013). If Estimated Lot Percent Defective exceeds Maximum Allowable Percent Defective for two consecutive years the lot is considered to be a “failed” lot. Meters within a failed lot will be retired within four years.

The company shall evaluate uniquely defective meters identified within each HMG. Condition codes are assigned to uniquely defective meters based on initial condition of meter installation.

8. In-Service Periodic Meter Testing

(a) **PURPOSE:**

The purpose of this testing and verification program is to identify and correct inaccurate and defective metering systems. Additionally, this program is to detect inaccurate meter groups and yield statistical information on which to base future maintenance and testing.

This in-service program includes revenue meters that are for services with an average load 1MW and greater.

(b) **RESPONSIBILITY:**

The Company shall provide the results of its in-service periodic meter testing in its Annual Certification Report. The Company is responsible for keeping these results for at least ten years.

(c) **METHOD:**

Large Commercial/Industrial customers served by substation metering will receive biennial meter testing and inspection. Commercial/Industrial customers that have an average load greater than 1MW will receive biennial meter testing and inspection. Meter lots will be divided into groups based on company equipment type and manufacturer.

A meter is defined as acceptable if as-found average accuracy is within $100 + 0.3$ percent registration. Weighted percent registration is defined by ANSI C12.1-2014, Method 1.

All meters with an error greater than $+ 0.3 \%$ in as-found testing are removed from service. All meters with an error greater than $+ 5 \%$ in as-found testing are declared uniquely defective and removed from service. The test results of uniquely defective meters are excluded from statistical analysis only if the cause of error is attributed to external causes or outside forces (e.g., vandalism, tampering, lightning, corrosive environment, etc.).

9. Instrument Transformers

(a) **PURPOSE:**

To ensure that metering transformers are accurate in accordance to ANSI C12.1-2014 and IEEE C57.13-2016.

(b) **RESPONSIBILITY:**

The Company is responsible for ensuring current and voltage transformers used for revenue metering are accurate and within acceptable accuracy tolerance limits. The Company is responsible to validate manufacturer test results.

(c) **SUMMARY OF METHOD:**

The Company requires all metering current and voltage transformers be tested by the manufacturer. The manufacturer will provide the company with certified test results that verify voltage withstand, ratio correction factor, and phase angle tests were performed. All current and voltage transformers utilized for revenue metering will have an in-service test and validation performed within 90 days of installation.

(d) **TESTING:**

Pre-installation tests are performed by the manufacturer in accordance with ANSI C12.1-2014 section 5.2.1. Metering current and voltage transformers are rated at 0.3% accuracy or better.

Field Testing/Verification complies with ANSI C12.1-2014 section 5.2.3 and section 5.2.4. All instrument transformers, both new and returned from service, will have a field test/verification performed within 90 days of installation. The following tests/verifications are performed after meter installation is in-service:

- ANSI C12.1-2014: 5.2.3.1---Burden Test
- ANSI C12.1-2014: 5.2.3.2---Secondary Voltage Test
- ANSI C12.1-2014: 5.2.4-----Inspection

(e) INSTRUMENT TRANSFORMER MANUFACTURER ASSESSMENT

The Company will perform a quality assessment on each instrument transformer supplier at intervals not to exceed five years.

10. Testing and Verification Methods

(a) RESPONSIBILITY:

The Company is responsible for operating, maintaining, and revising metering test and verification program. Tests and verifications are performed by the company or approved contractor for the Company.

(b) TESTING:

Watt-hour tests are performed at 100 percent of nameplate test current (FL) and 10 percent of nameplate test current (LL) in accordance with ANSI C12.1-2014.

A meter is defined as acceptable if as-found average accuracy is within $100 + 0.3$ percent registration. Weighted percent registration is defined by ANSI C12.1-2014, Method 1.

(c) CALIBRATION:

Electronic meters are not calibrated.

(d) VERIFICATION OF METERING SYSTEMS:

Meter system verifications are performed on all metering installations when tested; this includes periodic and sample tests along with new, transformer service installations 90 days after the service was energized. The purpose of the verification is to assure the correctness of the meter installation and associated records, it will include the following when applicable:

- A. Meter accuracy testing
- B. Demand register testing
- C. Correctness of meter application
- D. Meter loading
- E. Correctness of billing multiplier
- F. Correctness of wiring
- G. Condition of wiring
- H. Current transformer sizing
- I. Quality and ratio of instrument transformers (verify nameplate data)
- J. Current transformer burden tests
- K. Voltage measurements
- L. Current measurements
- M. Phase angle test
- N. Instantaneous power factor measurements
- O. Security of the metering system and components
- P. Accessibility of the meter and other metering devices
- Q. Safety of the metering system and site
- R. Safety and condition of the electric distribution system
- S. Current diversion
- T. Revenue implications (i.e., customer under-billing or over-billing)

11. Security and Revenue Protection

PGE will maintain documented procedures to ensure and verify the physical security and safety of metering installations through training of personnel, control of sealing and locking devices, and installation of seals and locking devices for meter system security and integrity. Additional controls will be used for meter information technology security. Password protections will be maintained for programmable meters to prevent unauthorized adjustment, programming or data acquisition.

Revenue validation and protection programs will include training of field and billing personnel and high/low energy usage audits designed to trigger consumption investigations. Qualified personnel are assigned the responsibility to investigate field conditions that may have loss of revenue implications.

12. Electric Service Requirements

Specific applications of the Electric Utility Service Equipment Requirements Committee (EUSERC) manual are described in the company Electric Service Requirements, available at: PortlandGeneral.com/ESR.

13. Record Keeping

Records are maintained for all laboratory and field test standards by serial number. Records for standards are maintained for the life of the equipment plus five years. Test records are maintained for all meters and auxiliary transformers for the life of the

equipment plus one year. All energy diversion investigations are recorded and records are maintained for five years.

The record of the most recent accuracy test of each instrument transformer is maintained for at least as long as the instrument transformer is in service plus three years. The record of each instrument transformers includes the manufacturer's name or trademark, type, and serial number. Each instrument transformer placed in service will be marked with the same information.

The record of the most recent accuracy test of each watt-hour meter is maintained for at least as long as the instrument transformer is in service plus three years. Accuracy record of each watt-hour meter includes the following:

- A. Date of test;
- B. Reason for test;
- C. Reading and accuracy of meter as found and as left;
- D. Identification of person who performed the test; and
- E. Identification of equipment used to test meter.

The record of each watt-hour meter includes the following:

- F. Manufacturer and date of purchase, along with any testing data provided by the manufacturer that is used by the entity for acceptance testing of the meter;
- G. Manufacturer or Company's identification number;
- H. Date and place of present or most recent installation
- I. Date and type of last major repair, or of final disposition;
- J. Nameplate data, which includes:
 - i. Form designation or circuit description;
 - ii. "Watt-hour meter" or other description;
 - iii. Manufacturer's name or trademark;
 - iv. Manufacturer's type;
 - v. Electrical current class;
 - vi. Rated voltage;
 - vii. Number of wires;
 - viii. Frequency;
 - ix. Test amperes;
 - x. Watt-hour meter constant; and
 - xi. Watt-hour meter test constant (if applicable).

14. Meter Tests Requested by Customers

If a customer requested that a meter that serves their account be tested for accuracy, the Company shall test the customer's meter, in accordance with OAR 860-021-0130.

15. Treatment of Inaccurate Metering Data

Upon discovery that a meter serving a customer is outside acceptable OPUC limits as defined in OAR 860-021-0130, the Company shall correct the metering error. The Company shall direct its billing department to adjust customer bills according to the corrected metering data and reimburse customer for all overcharges as defined in OAR 860-021-0135.

16. Annual Metering Management Review

PGE will annually evaluate the currency of its metering policies, practices and procedures with updated national and state regulations, standards and guidelines. PGE will maintain a documented management review program to ensure compliance with OPUC regulations and established company policies and directives.

17. Annual Report and Certification to OPUC

Meter Services will submit an annual certification report to the Commission as set out in Section S of the OPUC's Electric utility Metering Policy. Included in the report are:

- A. Company's analysis of newly purchased watt-hour meter accuracy tests provided by the manufacturers
- B. Meter group descriptions
- C. Number of meters in the group
- D. Number of meters tested per group
- E. Mean of the as-found Average Accuracy for each group
- F. Standard deviation of the as-found Average Accuracy for each group
- G. High/low range of the as-found Average Accuracy for each group
- H. Percentage above/below 100 + 2 % Average Accuracy for each group
- I. Number of meters uniquely defective per HMG group listed by cause and analysis of defects
- J. Company's analysis of in-service periodic meter testing
- K. Proposed action for future testing and maintenance based on test results
- L. Meter Audit failures listed by cause and analysis of defects for PMG's
- M. Nonconformance Revenue Implications
- N. The number of qualified personnel employed by PGE
- O. Executive Summary of Annual Metering Management Review

**Portland General Electric
2022 Annual Report and Certification**

Appendix B

OPUC Electric Utility Metering Policy

Oregon Public Utility Commission

Electric Utility Metering Policy

The Oregon Public Utility Commission has adopted this policy as a reasonable and prudent utility practice to ensure the accuracy and correctness of customer metering and billing.

A Scope - This document outlines the requirements for Oregon regulated electric utilities to satisfy Oregon Public Utility Commission (OPUC) regulations related to electric meter testing and verification programs, maintenance of watt-hour standards and standardizing equipment, and the annual reporting to the OPUC. (See OAR 860-023-0015 and other related metering regulations in Section D.)

B General

1. Each customer meter and metering system shall be installed and maintained to accurately measure, register and record the energy used by the customer.
2. Each utility must install and maintain accurate and reliable customer metering systems in compliance with OPUC regulations and prudent utility practice in a manner that is traceable and in conformance with national NIST standards of measurement.
3. Each utility shall have written policies, practices, and programs to ensure the accuracy, proper installation, safety, maintenance, and security of its customer metering devices and systems.
4. Each utility shall report changes in metering policies and practices annually to the OPUC.
5. Each utility's metering policy and revisions shall be approved by the Commission prior to implementation. (See ORS 757.250 and OAR 860-023-0015).

C Definition of Terms

1. Defective Meter Group – An identified homogeneous group of meters, or distinct subdivision thereof, that has an unacceptable level of performance.
2. Homogeneous Meter Group (HMG) – A group of meters produced by the same manufacturer, having a related type designation, of the same design and the same relationship of parts.
3. Metering System – The entire metering circuit and installation including all sensing, measuring, conversion, totalizing, registering and communication devices as well as enclosures, wiring, and communication links.
4. NIST – National Institute of Standards and Technology, under US Dept. of Commerce
5. Periodic Meter Group (PMG) – A group of metering systems tested, inspected, and verified in a specific year that are on the same test frequency in a Periodic Meter Test Program. *(For example, all metering systems that are tested and verified on 5-year repeat interval and that are evaluated in a specific year shall be included in the same PMG group irrespective of meter manufacturer type or model number.)*
6. Should – Means “shall” (i.e., mandatory) unless a utility has prudent justification for using a higher or equivalent standard practice.
7. Uniquely Defective Meter - A meter selected for random sampling with accuracy performance characteristics greater than + 5% resulting from unique physical experience or unique electrical experience and is not representative of other in-service meters in its HMG.
8. Sample Meter Test Program - an established random pattern of testing meters belonging to a HMG whereby each meter has an equal opportunity to be selected for testing each year.
9. Periodic Meter Test Program - an established scheduled pattern of meter site verifications where each site will be selected according to the utility's designated regular time-interval.

OPUC Electric Utility Metering Policy, continued

D Applicable Oregon Laws and Administrative Rules (partial list)

1. ORS 757.250 and 757.255 – Directives for reasonable OPUC rules, standards and policies that address “examination and testing” of utility service installations and measurements.
2. OAR 860-023-0005, 860-023-0010, 860-023-0015, 860-021-0120, 860-021-0130, & 860-024-0010 – OPUC rules that address minimum standards associated with customer metering and facilities maintenance.
3. OAR 860-021-0135 – An OPUC rule that covers customer billing adjustments.

E References - In addition to the Oregon regulations in Section D, each utility should comply with national, state, and industry standards in developing and carrying out its examination and testing programs for customer metering systems. These standards include, but are not limited to, the following:

1. NIST Handbook 44, Section 1.1 (General Code) and Appendix A (Fundamental Considerations) as adopted into State Law by OAR 603-27-635 – Minimum standards for the specification, application, inspection and testing, operation, and maintenance of customer metering systems.
2. ANSI Standard C12.1-2008, Code of Electricity Metering – The minimum standard to be followed by electrical utilities for the examination and testing of customer metering systems and metering devices to ensure traceability to NIST standards.
3. ANSI/ASQC Standards Z1.4 (for attributes) and Z1.9 (for variables).2008 – Random sampling and non-conformance identification methods. Each utility shall use the appropriate sampling method based on the number of variables and attributes evaluated for each HMG.
4. Electric Utility Service Equipment Requirements Committee (EUSERC) Standards - This is the established guideline for each utility related to service entrance requirements for customer owned equipment. Specific applications of EUSERC Standards for each utility shall be described in each utility’s publication on electric service requirements.

F Reference Standards and Standardizing Equipment

1. Utility reference standards equipment (e.g., basic reference, transport, and working apparatus) shall comply with Subsection E.2.
2. Standards equipment and verification schedules shall be addressed in each utility’s metering policy and shall be approved by the OPUC. (See OAR 860-023-0015(5).)

G New Metering Device Acceptance

1. New meters and metering devices shall meet the minimum standards established in Subsection E.2.
2. All new meters, instrument transformers and other metering devices that can affect customer metering or billing accuracy shall be tested by the manufacturer or the utility before being placed into service.
3. If a utility relies on a manufacturer to perform the testing, the utility must have an effective quality assurance program to ensure the accuracy and quality of the new meters.
4. The testing and quality assurance programs covered in subsections 2 and 3 above shall be addressed in each utility’s metering policy that is approved by the OPUC.

H Acceptable Performance for Meters and Metering Devices

1. In-service meters and metering devices shall be maintained with an accuracy performance as specified in OAR 860-23-0015 and Subsection E.2.
2. Meters and metering devices shall be properly applied, installed and maintained to ensure accuracy of customer billings.

OPUC Electric Utility Metering Policy, continued

I In-Service Metering System Inspection, Testing, Maintenance, and Verification

1. The frequency of metering system audits, including tests, inspections, maintenance and verification of customer metering systems will be determined by each utility in conformance with OPUC regulations, national standards, manufacturer recommendations, and prudent utility practice giving due consideration to the type of metering systems involved and the consequences for failure.
2. Each utility shall have written practices that address meter system audits with checklists detailing the procedures. Each utility's audit practices shall specifically address meter system safety, accuracy, proper installation and application, security, current diversion prevention, wiring verification, and billing validation issues. Meter system audits should cover the elements addressed in Appendix A.
3. At minimum, the audit schedules of in-service metering systems shall comply with the annual program plans covered in Subsection E.2. and as approved by the OPUC.
4. All transformer-rated metering systems shall be tested, inspected, and verified after installation.

J Security

1. Metering seals and locking devices shall be conspicuous and reasonably permanent.
2. Each utility shall have established sealing and password protections within its metering systems to prevent unauthorized entry, adjustment, programming, or data acquisition.

K Revenue Validation Programs - Each utility shall have established procedures/programs for identifying and detecting:

- Incorrect billing;
- Evidence of tampering; and,
- Evidence of current diversion.

L Meter Groups

1. Each utility shall stratify its meters into appropriate HMGs for the Sample Meter Test Program and PMGs for the Periodic Meter Test Program.

M Random Sampling Techniques for In-service Metering Systems

1. ANSI/ASQC Standards listed in Subsection E.3. shall, at minimum, be used as the basis for random statistical quality control and random sample selection of meters. Inspection level "General II - Normal" shall be used. A uniquely defective meter may be removed from the sample testing analysis.
2. Acceptable Quality Level (AQL) of 2.5% shall be used annually for determining the acceptability criteria for each HMG.
3. If a randomly sampled HMG is determined to not to meet the acceptability criteria of Subsections M.1. and M.2., it shall be classified as a defective meter group.

N Corrective Action Plans and Rejections of Metering Devices

1. Each utility shall have effective and expeditious procedures for handling defective meters and metering devices, defective metering systems, and defective meter groups.
2. For each defective meter group a Corrective Action Plan (CAP) shall be submitted to the OPUC in the utility's annual metering report. The plan shall address the following: corrective action schedules and costs; annual testing and verification actions; customer impact; and utility revenue impact.
3. When a HMG fails the acceptability criteria for a second time, the HMG shall be promptly and completely removed from service, within four (4) years unless otherwise approved by OPUC.

OPUC Electric Utility Metering Policy, continued

O Continuing Surveillance

Each utility shall have procedures/programs for continuing surveillance of its metering systems and customer service facilities to determine and take appropriate action concerning hazards, failures and defects associated with metering systems and customer service facilities. All utility employees and utility contractors (including, but not limited to, meter readers, meter & service personnel, and other operating employees) who perform work associated with customer metering systems shall be trained and be alert in the normal course of their daily work to identify and report safety, security, revenue, and other metering defect issues.

P Record keeping

The records of metering inspections and tests shall be retained in accordance with OPUC regulations and prudent utility practice. The retention of records shall be sufficient to identify long-term trends.

Q Qualified Metering Personnel

Each utility shall only employ or contract with qualified metering personnel who have received sufficient training and have demonstrated competency in the type of metering system to be worked.

R Annual Metering Management Review

1. Each utility shall annually evaluate the currency of its metering policies, practices and procedures with updated national and state regulations, standards and guidelines.
2. Each utility shall have a documented management review program to ensure compliance with OPUC regulations and established company policies and directives.

S Annual Report and Certification to OPUC

The annual report and certification to the OPUC shall contain the following information:

1. Overview statement describing the utility's metering programs and practices to ensure metering accuracy and correct customer billing;
2. Narrative of the utility's annual metering management review (see Section R);
3. Summary of any significant deficiencies found related to the utility's metering systems;
4. Submittal and update on metering CAPs, if any;
5. Meter group listings for HMGs and PMGs including significant group modifications;
6. Summaries of metering audits completed in previous year for each PMG in compliance with Appendix B, Section B.;
7. Statistical summaries of inspections/tests and CAP retirements completed in previous year for each HMG shall comply with Appendix B, Section A.;
8. A listing of uniquely defective meters found in the Sample Meter Test Program by HMG that summarize findings, failure cause and company corrective action;
9. A listing of metering hazards, failures, and major defects found in the Periodic Meter Test Program by PMG that summarize findings, failure cause and company corrective action;
10. Summary of inspections/tests and targeted CAP retirements planned for the current year for each HMG and each PMG;
11. Summary of changes to the utility's metering standard practices, if any;
12. For utilities that have multi-state metering programs, provide an Oregon-only breakout report for items 1 through 11 above;
13. Number of qualified meter technicians working in Oregon by job classification; and,
14. Anticipated utility policy changes requiring approval by the Commission.

Adopted by the Oregon Public Utility Commission on July 20, 2000, to become effective on January 1, 2001.

Appendix A

Meter System Audit

The metering system audit assures the correctness of the meter, the installation and associated records. An audit covers the following items as applicable to the meter system and to the tariff rate application involved:

1. Meter testing
2. Demand register testing
3. Correctness of meter application
4. Meter loading
5. Correctness of billing constant (i.e., multiplier)
6. Correctness of wiring
7. Condition of wiring
8. Current transformer sizing
9. Quality and ratio of instrument transformers
10. Current transformer burden tests
11. Voltage measurements
12. Current measurements
13. Phase angle test
14. Instantaneous power factor measurements
15. Security of the metering system and components
16. Accessibility of the meter and other metering devices
17. Safety of the metering system and site
18. Safety and condition of the electric distribution system
19. Current diversion
20. Revenue implications (i.e., customer underbilling or overbilling)

Appendix B – Summaries

- A. HMG Statistical Summaries** to be included in the annual report to the OPUC shall include the following minimum information for each HMG:
1. Meter group description and identification code (For each HMG also include manufacturer, model and subdivision if applicable)
 2. Numbers of meters or metering systems included in the group
 3. Numbers of metering systems planned to be tested and inspected during the report period
 4. Number of meter systems actually tested and inspected during the report period
 5. The average metering accuracy and standard deviation found
 6. The highest and lowest meter test accuracy found
 7. Number of meters that tested more than +/- 2 percent
 8. Number of uniquely defective meters excluded from above analysis, items 5 through 7.
 9. Number of uniquely defective meters in item 8 above with manufacturer major defects
 10. Number of other meters, not including uniquely defective meters, excluded from above analysis, items 5 through 7
 11. ANSI/ASQC Z1.4 or Z1.9 analysis conclusions
 12. Number of metering systems found including uniquely defective meters with revenue underbilling implications (more than 2 percent slow)
 13. Number of metering systems found including uniquely defective meters with revenue overbilling implications (more than 2 percent fast)
- B. PMG Summaries** to be included in the annual report to the OPUC shall include the following minimum information, except each PMG with single-phase, self-contained meters only shall have summaries the same as Section A above.
1. Meter group description and identification code
 2. Numbers of metering systems included in the group
 3. Numbers of metering systems planned to be audited
 4. Number of meter systems actually audited
 5. Summary data of meter systems found with major or critical defects by cause.
 6. Summary of revenue implications related to item 5 above.