

Accuracy Limits for Substation and Generation Watthour Meters



1. Scope

This work practice covers the acceptable shop and field test accuracy limits for substation, generation, and interchange electromechanical and solid state watthour meters.

This work practice applies throughout the Seattle City Light (SCL) substations and generation facilities.

Test procedures are outside the scope of this work practice. See SCL 2505.15.

2. Application

This work practice is for use by SCL station meter electricians. It documents the acceptable percentage error limits for all new equipment and maintenance testing.

3. Introduction

All applicable SCL watthour meters shall be tested within the accuracy limits stated in the tables presented in Section 5. The required limit is dependent upon the meter construction type, accuracy class rating and its failure limit. The acceptable accuracy limits will be calculated in percent registration and any meter found or calibrated outside its failure limit will be recommended for removal from service.

Electromechanical meters will be accurate within the values presented tables 5a and 5b. These values, which have been established by SCL, exceed those defined in ANSI C12.1 and C12.20 as well as WAC 480-100-338.

Solid-state meters will be accurate within the ANSI accuracy class rating over all test conditions. See Table 5c.

4. Testing Load Parameters

The current class and associated test amperes listed in Table 4 shall be used.

Full load testing shall be 100% of rated test amperes at unity power factor.

Light load testing shall be 10% of rated test amperes at unity power factor.

Power factor testing shall be 100% of rated test amperes at 50% power factor.

All tests shall be run at 100% of meter's rated test voltage, as defined by the meter nameplate. Typical test voltages are 69 V, 120 V, and 277 V.

Table 4. Test Amperes Defined by ANSI C12.20

Current Class	Full Load (A)	Light Load (A)	50% Power Factor (A)
2 A	0.25	0.025	0.25
10 A	2.5	0.25	2.5
20 A	2.5	0.25	2.5
100 A	15	1.5	15
200 A	30	3	30
320 A	50	5	50

Note: Other values may be used as recommended by the manufacturer.

5. Accuracy Requirements

Meters shall meet the applicable accuracy requirements listed in this section to achieve a "pass" rating.

"As found" tests will be completed to determine meter accuracy before recalibration.

"As left" tests will be completed after all adjustments are completed.

For meters that cannot be adjusted to meet the accuracy limits listed in this section, a failure limit calculation will be used to determine whether a "pass" rating can be achieved. See Section. 6.

Table 5a. Accuracy Limits for Polyphase Electromechanical Meters

As Found Limits	% Error	% Accuracy
Series Full Load	0.2	99.8-100.2
Series Light Load	0.3	99.7-100.3
Series Power Factor	0.3	99.7-100.3
Element Full Load	0.4	99.6-100.4
Element Power Factor	0.5	99.5-100.5
Balance Full Load	0.4	99.6-100.4
Balance Power Factor	0.5	99.5-100.5
Light Load Repeatability	0.2	99.8-100.2
As Left Limits	% Error	% Accuracy
Series Full Load	0.1	99.9-100.1
Series Light Load	0.2	99.8-100.2
Series Power Factor	0.2	99.8-100.2
Element Full Load	0.3	99.7-100.3
Element Power Factor	0.4	99.6-100.4
Balance Full Load	0.3	99.7-100.3
Balance Power Factor	0.4	99.6-100.4
Light Load Repeatability	0.2	99.8-100.2

Table 5b Accuracy Limits for Single-Phase Electromechanical Meters

As Found Limits	% Error	% Accuracy
Series Full Load	0.2	99.8-100.2
Series Light Load	0.3	99.7-100.3
Series Power Factor	1.0	99.0-101.0
Light Load Repeatability	0.2	99.8-100.2
As Left Limits	% Error	% Accuracy
Series Full Load	0.1	99.9-100.1
Series Light Load	0.2	99.8-100.2
Series Power Factor	1.0	99.0-101.0
Light Load Repeatability	0.2	99.8-100.2

Table 5c. Accuracy Limits for Solid-State Meters

Accuracy Class-Ca0.1	% Error	% Accuracy
Series Full Load	0.1	99.9-100.1
Series Light Load	0.1	99.9-100.1
Series Power Factor	0.1	99.9-100.1
Element Full Load	0.1	99.9-100.1
Element Power Factor	0.1	99.9-100.1
Balance Full Load	0.1	99.9-100.1
Balance Power Factor	0.1	99.9-100.1
Accuracy Class-Ca0.2	% Error	% Accuracy
Series Full Load	0.2	99.8-100.2
Series Light Load	0.2	99.8-100.2
Series Power Factor	0.2	99.8-100.2
Element Full Load	0.2	99.8-100.2
Element Power Factor	0.2	99.8-100.2
Balance Full Load	0.2	99.8-100.2
Balance Power Factor	0.2	99.8-100.2
Accuracy Class-Ca0.5	% Error	% Accuracy
Series Full Load	0.5	99.5-100.5
Series Light Load	0.5	99.5-100.5
Series Power Factor	0.5	99.5-100.5
Element Full Load	0.5	99.5-100.5
Element Power Factor	0.5	99.5-100.5
Balance Full Load	0.5	99.5-100.5
Balance Power Factor	0.5	99.5-100.5

6. Failure Limits

In general, a watthour meter's percent registration varies depending on load. To determine the failure limit, an average percentage registration method will be used. This is commonly called the average accuracy or final accuracy. For meters that achieve any test results outside the applicable accuracy limits, a failure limit value shall be calculated.

Method 4 described in ANSI C12.1 shall be used to determine the failure limit:

Method 4: The average percent registration for poly-phase meters shall be calculated using the percent registration at Full Load (FL), Light Load (LL), and Power factor (PF). Giving the FL percent registration a weight of four, the LL percent registration a weight of 2. The standard correction factor (CF), shall be included when calculating these limits.

$$\text{Average Percent Registration} = \frac{4FL(CF) + 2LL(CF) + PF(CF)}{7}$$

Meters that achieve a failure limit outside the values described in Table 6 shall be recommended for removal and replacement.

Table 6. Failure Limits

Failure Limits	% Error	% Accuracy
Generator	0.2	99.8-100.2
Station Service	1.0	99.0-101.0
SCL Line	1.0	99.0-101.0
Primary Source Intertie	0.2	99.8-100.2
Secondary Source Intertie	0.3	99-7-100.3
Transformer Bank	1.0	99.0-101.0

7. References

ANSI C12.1, American National Standard for Electric Meters Code for Electricity Metering; National Electrical Manufacturers Association (NEMA) Standards Publication, 2008

ANSI C12.20, American National Standard for Electricity Meters - 0.2 and 0.5 Accuracy Classes; National Electrical Manufacturers Association (NEMA) Standards Publication, 2010

SCL Work Practice 2505.15; "Accuracy Tests for Substation and Generation Watthour Metering"

WAC 480-100-338; Accuracy Requirements for Electric Meters

8. Sources

Eltrich, Patrick; Station Meter Electrician, subject matter expert, and originator of 2505.14 (patrick.eltrich@seattle.gov)

Everist, Arlen; Station Meter Electrician and subject matter expert for 2505.14 (arlen.everist@seattle.gov)

IEC 62053-22/23; Electricity Metering Equipment (AC) – Particular Requirements, Part 22: Static meters for active energy (classes 0,2 S and 0,5 S) and Part 23: Static Meters for Reactive Energy (classes 2 and 3), International Electrotechnical Commission (IEC), 2003

WAC 480-100-333; Initial Accuracy of Electric Meters