ELECTRIC METERS

NOTE: Before starting meter testing, contact apartment or mobile home park manager, then individual tenants to inform them of your purpose and of the fact that their electric power may be off for a short period of time.

The resources referenced here are EPO, California Code of Regulations, and California Business and Professions Code.

SPECIAL SAFETY NOTE

There is an inherent danger and possibility of a damaging explosion and/or severe electrical shock when testing electrical meters. Before an official is assigned to this program, the official should receive formal classroom training. Inspectors must have "hands-on" training before testing meters of 240 volts and less.

DMS strongly recommends that officials **do not test** meters where the service voltage at the meter **exceeds 240 volts** between phases.

The utilities have recognized the danger in high voltage testing (voltages exceeding 240 volts). Their practice is to train meter-persons for lengthy periods under close supervision, a procedure which is not feasible in most weights and measures jurisdictions.

Pre-Test Inspection

Note: EPO Ref. T provides additional information on utility billing rules, meter complaints, and meter safety.

1. **Identification**. **G-S.1 [1.10]**

   1.1. Each meter shall have the following information legibly marked on the front of the nameplate or register: **4027.1, S.6**

   (a) Manufacturers' name or trademark, type designation, and serial number.
   (b) Voltage rating.
   (c) Test amperes (**TA**).
   (d) Maximum amperes (**CL**) {meter class}.
   (e) Watt-hour or disk constant ($\mathbf{K_h}$) {expressed as watt-hours per revolution}.
   (f) Register ratio ($\mathbf{R_r}$) and multiplier (if 10 or larger).
   (g) Frequency rating (**Hz**).
   (h) Number of meter stator(s) or elements (polyphase).
   (i) Ratio or rating of auxiliary devices.

2. **Type approval**.

   Place an unapproved device tag on the meter if the meter is not type approved. **B&P 12500.5** Note any information about the meter that will help in testing.

3. Overall condition of meter.

3.1. Terminals, seals, glass, and insulation. **G-UR.4.1 [1.10]; 4027.1, S.2, S.3, S.5.**

Note: Read and consider **EPO Ref. T** as a check before testing.

4. Installed Meters.

4.1. Can the meter be tested safely? (Wear appropriate personal protective equipment, glasses and gloves, etc.) **Safety First 4027.5, UR.2**

4.1.1. Exposed non-current carrying metal parts of fixed equipment, metal boxes, cabinets, and fittings which are not electrically connected to grounded equipment, shall be grounded as required by National Electrical Code, Article 250. **Equipment Grounding 4027.1, S.4**

4.1.2. The terminals of the meter shall be arranged so that the possibility of short circuits in removing or replacing the cover, making connections and adjusting the meter is minimized. **Terminals 4027.1, S.3**

4.1.3. The main circuit breaker or main switch and fuses and their auxiliary equipment shall be installed in the load service near its entrance as supplied to the tenant. It is intended to constitute the main control and means of cut-off for the supply to the tenant. **Thermal Overload Protectors 4027.5, UR.2.5**

4.1.4. Unobstructed entrance and standing space. **Location of Meter 4027.5, UR.3.1**

4.1.5. Meter shall be located not less than 30 inches nor more than 75 inches above standing surface. **Meter Heights 4027.5, UR.3.2**

4.1.6. Verify that socket voltages across A and B matches the designed meter form and voltage. Some locations may be served by several different distribution circuits and voltages. Remember the “A” position in the socket is always energized.

4.1.7. **Do not** test meters exceeding 240 volts between phases. **EPO REF-K**

4.2. Mechanical meters must be installed in a level and perpendicular manner in accordance with manufacturer’s specifications. **G-UR.2.1 [1.10]**

4.3. Remote meter installation. Check for ground faults; verify space being billed is only space served by each meter. Verify that common use areas such as street lights are not wired into the load side of the tenant’s circuit. **G-S.2 [1.10]; 4027.5, UR.3.3; B&P 12024; B&P 12024.1**

5. Suitability.

5.1. Meter class. Verify that CL equals or exceeds total amperage being sold (plus main disconnect rating). Remember, electric meters must have a minimum CL of 60. Older unmarked meters must use the following formula.
Also, see **EPO REF-K** for obsolete and unsafe meters

$$\text{Meter Class CL} = \text{Test Amperes TA}^{*} \text{ x } \frac{\%\ \text{Overload Rating (from table, page 39-15)}}{100}$$

***** This may be the Name Plate Amp Rating

Example: Duncan, Type MF, TA is15, Overload rating is 400% (from Table page 39-15

$$\text{CL} = 15 \text{ x } \frac{400}{100} = 60$$

5.2. Meter constant. Verify that the product of the meter register ratio (Rr_m) and disk constant (Kh_m) equals the meter constant. This will verify the correct register is being used with the meter. Use the tables on pages 15, 16, 17, 18 for the appropriate meter constant.

4027.1, S.6; EPO No. 39-15, 39-16, 39-17, 39-18

$$Rr_m \text{ x } Kh_m = \text{Meter Constant}$$

Example: Duncan Type MS, R_r is 13 8/9, Kh_m is 7.2

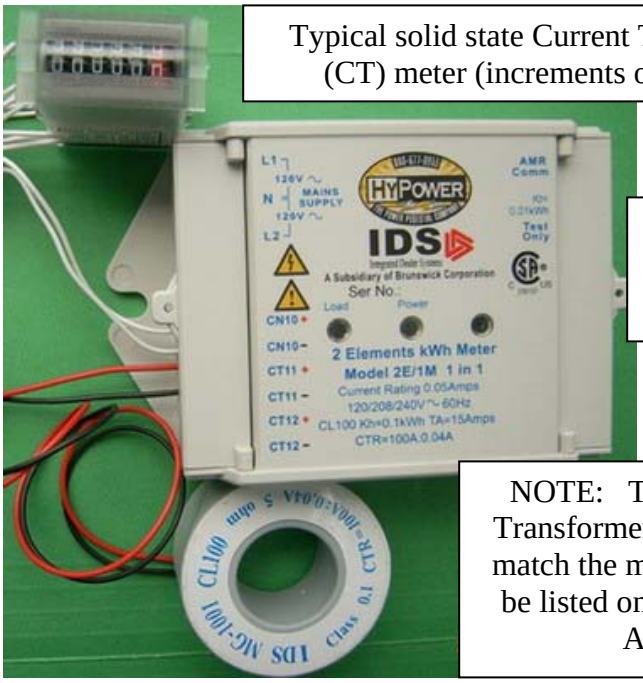
13 8/9 X 7.2 = 99.999 rounded to 100, (from table 39-15)

6. Pre-Test Determinations.

For solid state meters wherever the term revolution is used, it may be interpreted as increment or count.

Typical mechanical rotating disk socket meter (revolutions)

Typical solid state socket meter (increments or counts)



Typical solid state Current Transformer (CT) meter (increments or counts)

NOTE: A complete meter includes the Indicator, CT and meter itself.

NOTE: The CTR (Current Transformer Ratio) label must match the meter label and also be listed on the Certificate of Approval.

Determine value of meter revolution and minimum meter revolution for testing

Basic formula $Kh_s \times R_s = Kh_m \times R_m$

Where:

Kh_s Disk constant of the standard; this will change as different current loads are used.

R_s Number of revolutions of the standard or the value the standard should display. (minimum 8 revolutions on Knopp standards, minimum of 1 minute test for Probewell or other solid state standards)

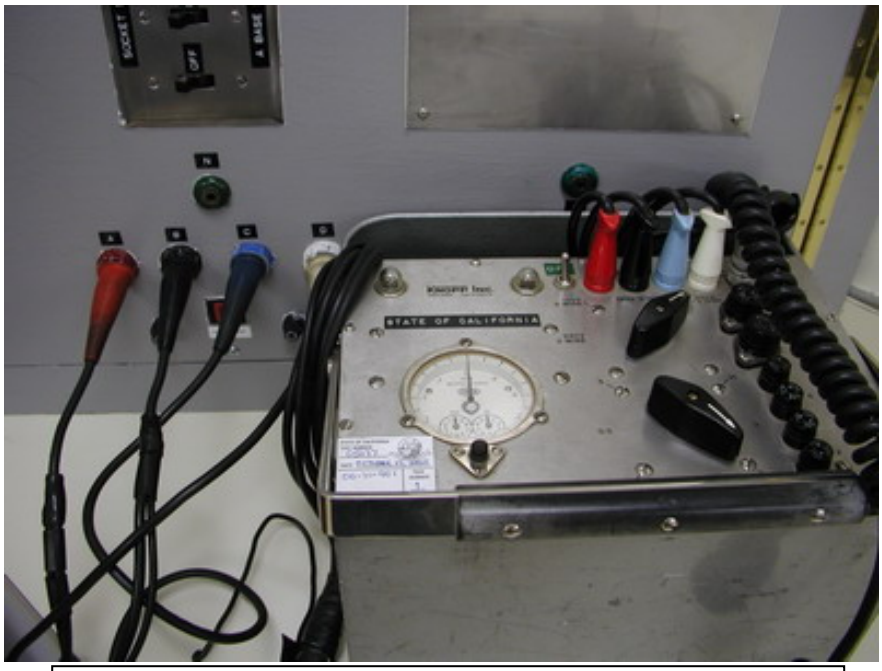
Kh_m Disk constant of the meter being tested (stated on the name plate of the meter).

R_m Disk revolutions of the meter being tested; minimum 1 revolution, no partial disk revolutions.

4027.2, N.3.

Test Revolutions: In all tests, to reduce error and uncertainty, the standard requires a minimum of 8 revolutions for Knopp standards or minimum of a 1 minute test for solid state standards like Probewell, and the meter under test, one revolution; **CCR 4027.2, N.3**

Probewell Standard with a mechanical rotation disk meter



Knopp FS-8 Standard connected to a laboratory test board

These tables give the Kh_s for Knopp Standards based on Amp load and Voltage:

Table A

Knopp FS-4,6,7,8&9 Kh Values Readout = Revolutions		
Test Amp	120V	240V
Load	Kh_s	Kh_s
0.5	0.06	0.12
1.5	0.18	0.36
3	0.36	0.72
5	0.6	1.2
15	1.8	3.6
30	3.6	7.2

Table B

Knopp FS-9 Kh Values Readout = Watthours		
Test Amp	120V	240V
Load	Kh_s	Kh_s
0.5	0.1	0.1
1.5	0.3	0.3
3	0.6	0.6
5	1	1
15	3	3
30	6	6

Example 1

Example 2

Note: The above information was used to create the tables located on pages 39-13 and 39-14.

Example 1: Light Load Test (3Amp)

Single stator, TA30, 120V, Kh_m 10 watt hours.

Kh_S = 0.36 from Table A above
Kh_m = 10
R_m = assume a meter revolution of 1

Solve for **R_S** using $R_s = \frac{Kh_m (R_m)}{Kh_s}$ substituting $R_s = \frac{10(1)}{0.36} = 27.778$

In the above example the value of one revolution of the meter is 27.778 revolutions of the standard.

In this example, **$R_S \geq 8$** so only one revolution is needed for this test. If **R_S** had been < 8, **R_m** would need to be increased in whole revolutions until **$R_S \geq 8$** (see Example 2 below). If a Probewell standard or other solid state standard is used, a minimum of 1 minute is required.

Thus, for a meter with no error, one revolution = 27.778 revolutions of the standard

To calculate percent error:

$$\frac{\text{Meter Indication} - \text{Standard Indication}}{\text{Standard Indication}} x 100 = \%\, error \text{ of meter}$$

Where value of meter indication for one revolution is 27.778 and the standard indicates 27.930 revolutions

Step 1: $\frac{27.778 - 27.930}{27.930} \text{x}\, 100 = \%\, \text{error}$

Step 2: $\frac{-0.152}{27.930} \text{ x } 100 = \%\, \text{error}$

Step 3: $-0.00547 \text{ x } 100 = -0.54\,\%$

Example 1 result: Meter is under-registering by 0.152 revolutions or 0.54%

Example 2: Full Load Test (30Amp)

Single stator, TA30, 120V, Kh_m 6 watt hours.

Kh_S = 3.6 from Table A, **EPO 39.5**
Kh_m = 6
R_m = assume a meter revolution of 1

Solve for **R_S** using $R_s = \frac{Kh_m (R_m)}{Kh_s}$ substituting $R_s = \frac{6(1)}{3.6} = 1.667$

In the above example the value of one revolution of the meter is 1.667 revolutions of the standard; less than the required minimum of 8 revolutions.

In this example, $\mathbf{R_s}$ < 8. Increase $\mathbf{R_m}$ in whole revolutions until $\mathbf{R_s}$ ≥ 8

Using $R_m = \frac{Kh_s(R_s)}{Kh_m}$ $R_m = \frac{3.6(8)}{6}$ = 4.8 (R_m must be in whole revolutions)

Increase R_m to 5 and substitutes in $R_s = \frac{Kh_m(R_m)}{Kh_s}$ $= \frac{6(5)}{3.6}$ = 8.333

Thus, for a meter with no error, five revolutions = 8.333 revolutions of the standard

Note: Solid state standards (Probewell) require a minimum of a 1 minute test.

To calculate percent error:

$$\frac{\text{Meter Indication} - \text{Standard Indication}}{\text{Standard Indication}} x100 = \%\ error\ \text{of meter}$$

Where value of meter indication for five revolutions is 8.333 and the standard indicates 8.125 revolutions

Step 1 $\frac{8.333 - 8.125}{8.125} \text{ x } 100 = \%\text{ error}$

Step 2: $\frac{0.208}{8.125} \text{ x } 100 = \%\text{ error}$

Step 3: $0.0256 \text{ x } 100 = 2.56\ \%$

Example 2 result: Meter is over-registering by 0.208 revolutions or 2.56%.

7. Tolerances. (Full and light loads.) **4027.4, T.2**

7.1. Maintenance = +/- 2%.

7.2. Acceptance = +/- 1%.

Note: Acceptance tolerance shall not exceed 1 percent for full and light loads. Acceptance tolerances shall be applied to new and rebuilt meters before they have been placed in service. **Tolerance Values, 4027.4 T.2.(b)**

In example 1, the meter under registered by 0.54%. It is in tolerance for both Maintenance and Acceptance for the light load 3 amp test.

In example 2, the meter over registered by 2.56%. It is out of tolerance for both Maintenance and Acceptance for the full load 30 amp test. If this test was conducted first there is no need to do the light load test. Mark the meter “Out of Order”. It should be removed from service or not installed.

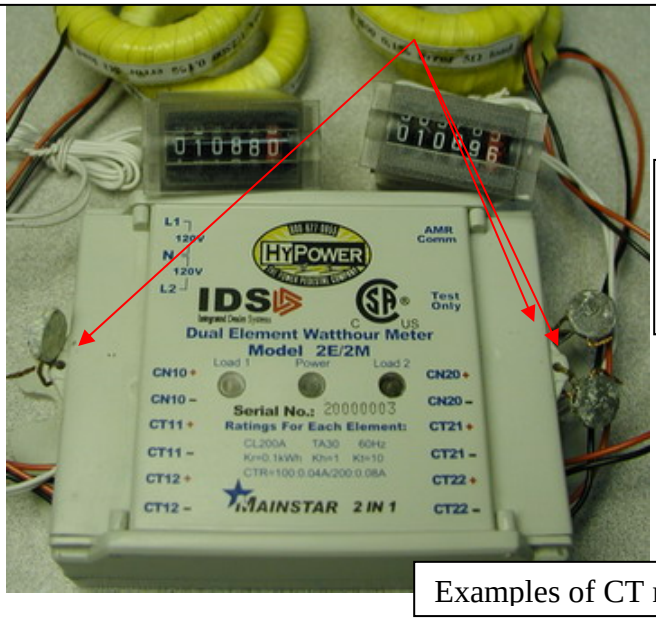
8. Provision for sealing.

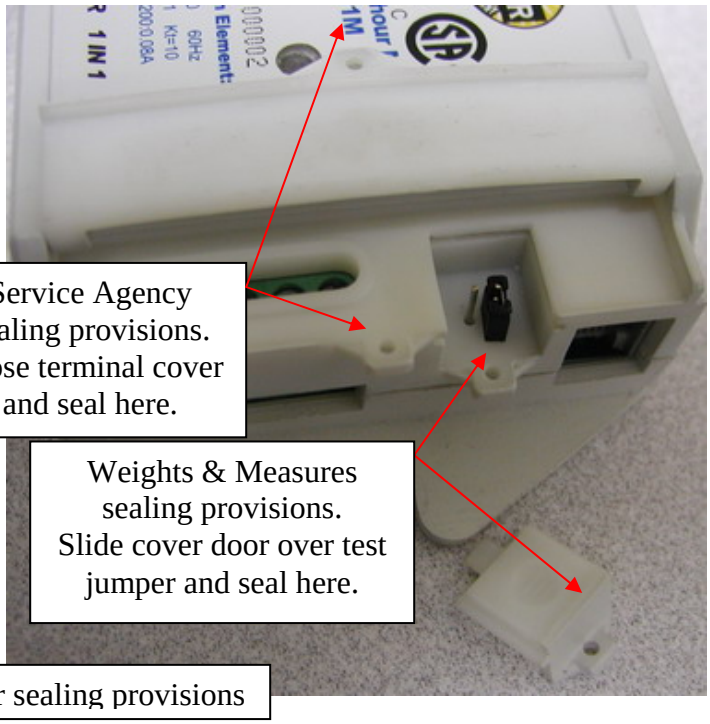
8.1. Provisions shall be made for applying a security seal to the meter cover, meter sealing ring, and terminal block cover. **4027.1, S.5.1**

Note: Do not remove the manufacturer's glass cover seal. This may void the meter warranty. However, a lead and wire seal may be used in addition to the manufacturer's seal.

8.2. Meter enclosures shall be so designed that the cover may be sealed. Provision shall be made for reading the meter without destroying the seal. **4027.1, S.5.2**

CT meters may have Weights & Measures sealing provisions for test jumpers. CT meters may also have Service Agent provisions for wiring terminals after installation.

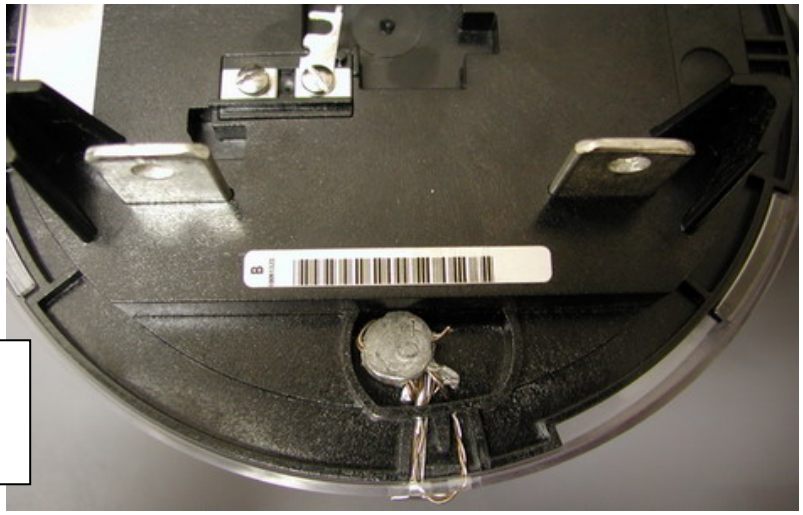




Service Agency sealing provisions. Close terminal cover and seal here.

Weights & Measures sealing provisions. Slide cover door over test jumper and seal here.

Examples of CT meter sealing provisions



Example of Socket meter sealing provisions (seals the cover to the meter body)

8.3. Thermal overload protector enclosures shall be designed to facilitate sealing. A provision shall be made for resetting circuit breakers or replacing fuses without destroying the seal.
4027.1, S.5.3

Test Procedure

Note: Review safety notes and inspect each installation to be tested. If unsafe, do not test. Notify property owner and local building officials.

1. Ensure field standard voltage switch **matches** line service voltage of system being tested.

2. Connecting field standard to meter.

   2.1. "A" base meters – See Special Hazard Note (EPO No. 39-20) prior to connecting test standard to meter.

      2.1.1. Ensure field standard current switch is in **off** position before connecting the standard to meter (if standard has an on/off switch).

      2.1.2. Turn off or disconnect electrical service to tenant while performing the meter test.

      2.1.3. Connect field standard to meter and observe warning lamps (Knopp standard). If glowing, **DO NOT** turn current switch "on". A correct hook-up is indicated by the warning lamps **not** glowing.

      Knopp exception: If lead C (blue lead) is not used, warning lamp will have dull glow, and this is ok.

   2.2. Socket base meters.

      2.2.1. Turn off or disconnect electrical service to tenant while performing meter test.
      Note: Service (line) terminals will still be powered and exposed.

      2.2.2. Remove meter from socket, top to bottom (pull A/B then C/D).
      Note: When removing socket meters, use the lower jaws as a fulcrum and pull the blades from the line-side jaws with a downward force on the meter before withdrawing the lower blades.

      2.2.3. Carefully install meter test jack into meter socket.

      2.2.4. Install meter into test jack.

      2.2.5. Connect field standard to test jack and observe warning lamps.

3. **Starting watts**. The rotor or indicator for a meter shall rotate or increment continuously when a load is applied equal to 0.5 ampere. **4027.2, N.1**
   Note: On Probewell standards, use 1 ampere load with 0.5 PF (power factor) setting.

4. **Creep test.** A meter disk that creeps more than one revolution or the digital register increments, the meter shall be removed from service. **4027.2, N.4**

5. **Meter tests.** Meters shall be tested at full load and light load. **4027.2, N.2**

   5.1. Full load test shall not be less than the test amperes (TA) of the meter.

   5.2. Light load test amperes shall be 5% to 10% of the meter TA. However, it may be 20 percent or 5 amps, whichever is less, of the TA when testing a 240-volt, 3-wire, single phase meter with an unbalanced load (energizing a single current coil).

   5.3 Full and light load tests shall require 8 or more revolutions of the test standard. Light and full load tests require at least 1 revolution of the meter under test. **4027.2, N.3**

6. Disconnect field standard from meter or test jack.

7. Remove meter from test jack, top to bottom (A/B then C/D).

8. Remove test jack from meter socket.

9. Apply appropriate seals if meter is correct. Tag meter “out of order” if it does not meet code requirements.
   B&P 12505 and 12506

10. Install meter into socket (C/D then A/B).
    Note: When installing a socket meter, line up the load jaws and meter blades, press these home; then using the bottom jaws as a fulcrum, rock the meter into place. Do not twist the meter in a manner to spring the jaws.

11. Important. Turn on electrical service to tenant.

ELECTRIC METER COMPLAINTS

1. Record meter reading. Compare present reading with the most current billing, invoice. This reading should be reasonably proportionate with the amount of energy consumed since the last meter reading on the invoice. Energy consumption may be influenced by tenant practices and the weather. Past billings from similar weather patterns may be helpful in determining usual consumption for the period in question. If meter readings are deemed incorrect, talk to the park owner/manager regarding proper methods of meter reading. Refer to EPO References O and T for jurisdiction and enforcement guidelines.

   > **Note:** Each customer invoice shall clearly and separately show the opening and closing meter readings and the dates of those readings. All rates and quantities shall be clearly identified and shall include the applicable rate structure and the total charge for the billing period. The operator of a utility service system shall maintain all records of pertinent rate schedules, and individual customer billing for a period of at least 12 months. These records shall be made available at reasonable times to the customer and weights and measures officials. **CCR, Chapter 5, 4090**

2. Check the meter. **EPO 39-2**

   2.1. Is it installed in a level and perpendicular manner in accordance with manufacturer's specifications? **G-UR.2.1 [1.10]**

   2.2. Voltage. Using a voltmeter, make sure the correct meter has been installed for a given service entrance voltage, do not assume it is okay (i.e., 120, 240, or 208 volts). There is one exception; "A" position must always be hot. **EPO NO. 39-2, 4.1.7**

   2.3. Meter class. Verify that CL equals or exceeds total amperage being sold (main breaker plus any breakers wired in parallel to main). Also, a minimum CL of 60. For older unmarked meters, use the following formula. **EPO REF-K; EPO Nos. 39-15, 39-16, 39-17, 39-18**

$$\text{Meter Class} = \frac{\text{Name Plate Amp Rating x \% Overload Rating}}{100}$$

   2.4. Determine that the meter constant is correct for the meter. **EPO Nos. 39-15, 39-16, 39-17, 39-18.**

$$Rr_m \times Kh_m = \text{Meter Constant}$$

   2.5. Test the meter for accuracy. **EPO 39-9 Test Procedure**

3. Potential causes for increased electric usage: New major appliances, entertainment, occupants (guests, a new baby), space heaters, hot water heater, air conditioner (clogged filters), leaky faucets (hot water), using the cooking range for space heating, and extreme weather conditions. Incorrect wiring of common areas to the load side of the meter and mislabeling of meter circuit. Verify that the meter disconnect shuts off power to the correct tenant.

4. Ensure that the property is on the proper mastermeter/submeter rate schedule and that the billing is properly computed at the serving utility domestic tariff. Tenants should have received applications to enroll in rate reduction programs offered by the serving utility and, where qualified, should receive the rate discounts. Any interest and late charges must also follow the utility tariff rules. See EPO Reference T for more detailed information on investigating submeter complaints.

5. Miscellaneous. High bill complaints can originate when neighboring tenants compare electric meter disc speeds. A meter disc having a Kh = 2 will turn 6 times faster than one with a Kh = 12 for the same load. Both meters, of course, will indicate the same number of KWh consumed.

   Periodic rate increases also account for some customer high bill complaints.

6. On high usage complaints, try to determine if common area loads such as lighting, laundry, etc. are inoperable when the tenants main disconnect is off-line. If common area lighting or laundry is also off-line, the common area wiring must be removed from the tenants' service or load.

KNOPP FS-4, 6, 7, 8, 9 ELECTRIC METER STANDARDS

READOUT FOR STANDARD = ***REVOLUTIONS***

SINGLE STATOR METERS: Std. vs. Meter Test Ratios for ***Balanced*** Meter Tests Only

$$\frac{R_s}{R_m} = \frac{Kh_m}{Kh_s}$$

Meter Kh	Volt Range	30 AMP		3 AMP		15 AMP		1.5 AMP		5 AMP		0.5 AMP	
		Std.	Meter	Std.	Meter	Std.	Meter	Std.	Meter	Std.	Meter	Std.	Meter
2/3	120	8.33	45	11.11	6	11.11	30	11.11	3	10.00	9	11.11	1
	240	8.33	90	8.33	9	8.33	45	11.11	6	8.33	15	11.11	2
1	120	8.33	30	8.33	3	8.33	15	11.11	2	8.33	5	16.67	1
	240	8.33	60	8.33	6	8.33	30	8.33	3	8.33	10	8.33	1
1.2	120	8.33	25	10.00	3	10.00	15	20.00	3	10.00	5	20.00	1
	240	8.33	50	8.33	5	8.33	25	10.00	3	10.00	10	10.00	1
1-1/3	120	10.00	27	11.11	3	11.11	15	14.81	2	11.11	5	22.22	1
	240	8.33	45	11.11	6	10.00	27	11.11	3	10.00	9	11.11	1
1.5	120	8.33	20	8.33	2	8.33	10	8.33	1	10.00	4	25.00	1
	240	8.33	40	8.33	4	8.33	20	8.33	2	10.00	8	12.50	1
1-2/3	120	8.33	18	9.26	2	8.33	9	9.26	1	8.33	3	27.78	1
	240	8.33	36	9.26	4	11.11	24	9.26	2	8.33	6	13.89	1
1.8	120	10.00	20	10.00	2	10.00	10	10.00	1	9.00	3	30.00	1
	240	10.00	40	10.00	4	10.00	20	10.00	2	9.00	6	15.00	1
2	120	8.33	15	11.11	2	10.00	9	11.11	1	10.00	3	33.33	1
	240	8.33	30	8.33	3	8.33	15	11.11	2	8.33	5	16.67	1
2.4	120	10.00	15	13.33	2	8.00	6	13.33	1	8.00	2	40.00	1
	240	8.33	25	10.00	3	10.00	5	13.33	2	10.00	5	20.00	1
3	120	8.33	10	8.33	1	8.33	5	16.67	1	10.00	2	50.00	1
	240	8.33	20	8.33	2	8.33	10	8.33	1	10.00	4	25.00	1
3-1/3	120	8.33	9	9.26	1	11.11	6	18.52	1	11.11	2	55.56	1
	240	8.33	18	9.26	2	8.33	9	9.26	1	8.33	3	27.78	1
3.6	120	10.00	10	10.00	1	10.00	5	20.00	1	12.00	2	60.00	1
	240	10.00	20	10.00	2	10.00	10	10.00	1	9.00	3	30.00	1
6	120	8.33	5	16.67	1	10.00	3	33.33	1	10.00	1	100.00	1
	240	8.33	10	8.33	1	8.33	5	16.67	1	10.00	2	50.00	1
6-2/3	120	11.11	6	18.52	1	11.11	3	37.04	1	11.11	1	111.11	1
	240	8.33	9	9.26	1	11.11	6	18.52	1	11.11	2	55.56	1
7.2	120	10.00	5	20.00	1	8.00	2	40.00	1	2.00	1	120.00	1
	240	10.00	10	10.00	1	10.00	5	20.00	1	12.00	2	60.00	1
12	120	10.00	3	33.33	1	33.33	5	66.67	1	20.00	1	200.00	1
	240	8.33	5	16.67	1	10.00	3	33.33	1	10.00	1	100.00	1

TWO STATOR METERS: Std. vs. Meter Test Ratios for ***Balanced*** Meter Tests Only

$$\frac{R_s}{R_m} = \frac{Kh_m}{Kh_s \times 2}$$

Meter Kh	Std. Setting	30 AMP		3 AMP		15 AMP		1.5 AMP		5 AMP		0.5 AMP	
		Std.	Meter	Std.	Meter	Std.	Meter	Std.	Meter	Std.	Meter	Std.	Meter
3.6	120 2 Wire	8.00	16	10.00	2	8.00	8	10.00	1	9.00	3	30.00	1
7.2	120 2 Wire	8.00	8	10.00	1	8.00	4	20.00	1	12.00	2	60.00	1
14.4	120 2 Wire	8.00	4	20.00	1	8.00	2	40.00	1	12.00	1	120.00	1

NOTE: Kh_s = 0.6 @ 120V and 5 Amps

KNOPP FS-9 ELECTRIC METER STANDARD

READOUT FOR STANDARD = ***WATT-HOURS***

SINGLE STATOR METERS: Std. vs. Meter Test Ratios for ***Balanced*** Meter Tests Only

$$\frac{R_s}{R_m} = \frac{Kh_m}{Kh_s}$$

Voltage 120 or 240 Meter K_h	30 AMP		3 AMP		15 AMP		1.5 AMP		5 AMP		0.5 AMP	
	Std.	Meter	Std.	Meter	Std.	Meter	Std.	Meter	Std.	Meter	Std.	Meter
2/3	8.00	72	10.00	9	8.00	36	11.11	5	10.00	15	13.33	2
1	8.00	48	8.33	5	8.33	25	10.00	3	8.00	8	10.00	1
1.2	8.00	40	10.00	5	8.00	20	8.00	2	12.00	10	12.00	1
1-1/3	8.00	36	11.11	5	8.00	18	13.33	3	12.00	9	13.33	1
1.5	8.00	32	10.00	4	8.00	16	10.00	2	12.00	8	15.00	1
1-2/3	8.33	30	8.33	3	8.33	15	11.11	2	8.33	5	16.67	1
1.8	11.11	37	9.00	3	9.00	15	12.00	2	9.00	5	18.00	1
2	8.00	24	10.00	3	8.00	12	13.33	2	8.00	4	20.00	1
2.4	8.00	20	8.00	2	8.00	10	8.00	1	12.00	5	24.00	1
3	8.00	16	10.00	2	8.00	8	10.00	1	9.00	3	30.00	1
3-1/3	8.33	15	11.11	2	10.00	9	11.11	1	10.00	3	33.33	1
3.6	12.00	20	12.00	2	12.00	10	12.00	1	10.80	3	36.00	1
6	8.00	8	10.00	1	8.00	4	20.00	1	12.00	2	60.00	1
6-2/3	10.00	9	11.11	1	11.11	5	22.22	1	13.33	2	66.67	1
7.2	12.00	10	12.00	1	12.00	5	24.00	1	14.40	2	72.00	1
12	8.00	4	20.00	1	8.00	2	40.00	1	12.00	1	120.00	1

TWO STATOR METERS: Std. vs. Meter Test Ratios for ***Balanced*** Meter Tests Only

$$\frac{R_s}{R_m} = \frac{Kh_m}{Kh_s \times 2}$$

Meter K_h	Std. Setting	30 AMP		3 AMP		15 AMP		1.5 AMP		5 AMP		0.5 AMP	
		Std.	Meter	Std.	Meter	Std.	Meter	Std.	Meter	Std.	Meter	Std.	Meter
3.6	120 2 wire	9.00	30	9.00	3	9.00	15	12.00	2	9.00	5	18.00	1
7.2	120 2 wire	9.00	15	12.00	2	12.00	10	12.00	1	10.80	3	36.00	1
14.4	120 2 wire	12.00	10	12.00	1	12.00	5	24.00	1	14.40	2	72.00	1

NOTE: Kh_s = 1.0 @ 120 or 240 V and 5 AMPS

DUNCAN ELECTRIC METERS
(LANDIS & GYR)

Meter Basic Kh (Based on 120 Volts 5 Amps)	Meter Type	Year Manufactured	Name Plate Amp Rating	% Overload of Name Plate Amp Rating	Meter Constant (Rr x Kh)
1/4	M	1912	All Ratings	110%	100
	M1	1913			
1/3	MD	1926	22 Amp	300%	133
			5 Amp		
			10 Amp		
			15 Amp		
			25 Amp		
			50 Amp	250%	
	MF	1934	All Ratings	400%	
	MFFE	1949			
6/10	MK	1954		666%	100
	MQ	1960			
	MS	1969			
	MSII	1977 to Present			
	MX	1997 to Present			200

NOTES:

1. Shaded Area on Table: Obsolete and Unsafe Electric Watt-Hour Meters (Refer to EPO-REF-K).

2. Meter Class (CL): (Name Plate Amp Rating) x (% Overload of Name Plate Amp Rating) ÷ 100

3. Minimum Meter Rating: Class 60

GENERAL ELECTRIC METERS

<table>
<tr><th>Meter Basic Kh (Based on 120 Volts 5 Amps)</th><th>Meter Type</th><th>Year Manufactured</th><th>Name Plate Amp Rating</th><th colspan="2">% Overload of Name Plate Amp Rating</th><th>Meter Constant (Rr x Kh)</th></tr>
<tr><td rowspan="5">3/10</td><td>(i)</td><td rowspan="2">1903</td><td rowspan="5">All Ratings</td><td colspan="2"></td><td rowspan="15">100</td></tr>
<tr><td>(i)-8</td><td colspan="2"></td></tr>
<tr><td>(i)-10</td><td rowspan="2">1910</td><td colspan="2">110%</td></tr>
<tr><td>(i)-14</td><td colspan="2" rowspan="2">200%</td></tr>
<tr><td>(i)-15</td><td>1915</td></tr>
<tr><td rowspan="10">6/10</td><td>(i)-16</td><td>1927</td><td>5 Amp</td><td colspan="2" rowspan="3">400%</td></tr>
<tr><td rowspan="3">(i)-18</td><td rowspan="3"></td><td>15 Amp</td></tr>
<tr><td>25 Amp</td></tr>
<tr><td>50 Amp</td><td colspan="2">250%</td></tr>
<tr><td>(i)-20 A</td><td rowspan="4">1934</td><td>5 Amp</td><td colspan="2" rowspan="3">400%</td></tr>
<tr><td>(i)-20 B</td><td>15 Amp</td></tr>
<tr><td>(i)-20 C</td><td>25 Amp</td></tr>
<tr><td>(i)-20 S</td><td>50 Amp</td><td colspan="2">300%</td></tr>
<tr><td rowspan="3">(i)-30</td><td rowspan="3">1937</td><td>5 Amp</td><td colspan="2" rowspan="2">400%</td></tr>
<tr><td>15 (12 2) Amp</td></tr>
<tr><td>50 Amp</td><td>A Base 300%</td><td>Socket 250%</td></tr>
<tr><td>(i)-50</td><td>1948</td><td>All Ratings</td><td colspan="2">400%</td></tr>
<tr><td>(i)-55, (i)-60, (i)-70</td><td>1955 to Present</td><td>All Ratings</td><td colspan="2">666%</td></tr>
</table>

NOTES:

1. Shaded Area on Table: Obsolete and Unsafe Electric Watt-Hour Meters. (Refer to EPO-REF-K)

2. Meter Class (CL): (Name Plate Amp Rating) x (% Overload of Name Plate Amp Rating) ÷ 100

3. Minimum Meter Rating: Class 60

SANGAMO ELECTRIC METERS
(SCHLUMBERGER)

Meter Basic Kh (Based on 120 Volts 5 Amps)	Meter Type	Year Manufactured	Name Plate Amp Rating	% Overload of Name Plate Amp Rating	Meter Constant (Rr x Kh)
5/24	B	1901	All Ratings	110%	200
	H 1	1911	All Ratings	200%	
	H 2	1914			
1/3	H c	1928	5 Amp	400%	
			10 Amp		
			15 Amp		
			25 Amp		
			50 Amp	250%	
	HF	1934	5 Amp	400%	100
			10 Amp		
			15 Amp		
			25 Amp		
			50 Amp	250%	
6/10	J	1940	All Ratings	400%	
	J2	1954	All Rating	666%	
			50 Amp	400%	
	J3	1960	All Ratings	666%	
	J4, J5	1970 to Present	All Ratings	666%	200

NOTES:

1. Shaded Area on Table: Obsolete and Unsafe Electric Watt-Hour Meters. (Refer to EPO-REF-K)

2. Meter Class (CL): (Name Plate Amp Rating) x (% Overload of Name Plate Amp Rating) ÷ 100

3. Minimum Meter Rating: Class 60

WESTINGHOUSE ELECTRIC METERS
(ABB)

Meter Basic Kh (Based on 120 Volts 5 Amps)	Meter Type	Year Manufactured	Name Plate Amp Rating	% Overload of Name Plate Amp Rating	Meter Constant (Rr x Kh)
1/3	Metal Cover	1898 - 1902	All Ratings	110%	1600
	Metal Cover "A"	1903			
	Metal Cover "B"	1905			
	Metal Cover "C"	1907			
	Metal Cover "CA"	1911			
	OA Sub A	1912	All Ratings	200%	
	OA Sub B	1914			
	OA Sub C	1915			
	OA Sub D	1916			
	OA Sub E	1917			
	OA Sub F	1926			
	OB	1924 - 1934	All Ratings	200%	1200
	OC	1932 - 1941	5 Amp	200%	
			10 Amp		
			15 Amp		
			25 Amp		
			50 Amp	400%	
	C	1937 - 1958	All Ratings	400%	
6/10	D	1955 - 1963	All Ratings	666%	100
	D2, D3, D4, D5	1963 to Present	All Ratings		

NOTES:

1. Westinghouse single-phase and polyphase meter types D, D2, D7 and D3 with serial numbers 30,000,000 to 39,999,999 are **not approved** and shall be taken out of service. If these types of meters do not have **original** manufacturer's serial number on the name plate, they are to be considered as part of the 30,000,000 to 39,999,999 series. (Refer to EPO-REF-K)

2. Shaded Area on Table: Obsolete and Unsafe Electric Watt-Hour Meters. (Refer to EPO-REF-K)

3. Meter Class (CL): (Name Plate Amp Rating) x (% Overload of Name Plate Amp Rating) ÷ 100

4. Minimum Meter Rating: Class 60

TESTING PROCEDURES FOR *2-STATOR* ELECTRIC METERS

This is the State of California testing policy for 2-stator **self-contained** and 2-stator Class 10 **transformer rated** (200:5A), rotating disk watt-hour meters using Knopp FS-4, -6, -7, -8, and -9 test standards or other compatible standards. The policy has been developed to promote uniform testing procedures for 2-stator type watt-hour submeters.

- A **self-contained** 2-stator meter shall be balance load tested and may be single stator tested if time permits.

- The *full load* test for a **self-contained** 2-stator meter shall be at its nameplate TA rating. The *light load* test current shall be at 10% of the meter TA. The *light load* current value shall be doubled if the meter is single stator tested.

- A **transformer rated** 2-stator meter shall be single stator tested and may be balance load tested. Each current transformer (C.T.) of a meter shall be energized by the standard's phantom load test current. The meter C.T.(s) shall drive the meter disk. Meter only testing, without the C.T. (s) in the metering circuit, is an unreliable test of the system.

- The *full load* test for a **transformer rated** 2-stator meter shall be at 60 amperes. This is accomplished by putting two loops of the test conductor through the C.T. core, for the stator being tested, and then selecting the 30 ampere range on the standard. The *light load* test shall be at 6 amperes. This is accomplished by selecting the 3 ampere range on the standard after the *full load* test is completed. The wiring hook-up is the same for *full load* and *light load* tests.

Conventional wiring diagrams have been developed by the Division of Measurement Standards to assist county personnel in the test procedures described above. They may be obtained from your State Area Device Specialist. There may be legitimate test procedures using other than the State developed wiring diagrams. Any alternate test procedure must be evaluated and determined to be correct by your State Area Device Specialist. For example, an alternate test procedure could be used where a county has specifically wired their laboratory test board for testing certain type electric meters.

SPECIAL HAZARD

When testing a 240 volt 3-wire ("A" Base) Meter

NOTE:

1. When testing a 240 volt 3-wire meter ("A" Base only) there is a serious short circuit hazard when connecting the STANDARD "D" alligator clip to the METER "D" screw position, <u>if not done correctly</u>.

2. To reduce this hazard to a minimum, *do not* squeeze open the Standard "D" alligator clip *before* touching it to the METER "D" screw position.

3. After touching the METER "D" screw with the STANDARD "D" alligator clip (closed) then open it in a horizontal plane (sideways) to make the connection.

4. If by error, the STANDARD "D" alligator clip is opened in a vertical plane (up and down) there is a good possibility of a 240 volt short circuit, through the STANDARD alligator clip, between the METER "D" screw and the meter potential link which is just above "D" screw (see the above picture).

5. This 240 volt short circuit has been made many times in the past and the results are violent. The meter is ruined and at times even the glass cover of the meter is shattered. Be very careful.

(Rev. 3/10/08)

PO NO. 39-21

ectric Meters

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