Introduction to Metering

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From the Guidebook for Linemen and Cablemen, Second Edition

Pages 771 to 803

Introduction

- Accurate metering is required for effective billing, accounting, and ratemaking for electric, gas, and water utilities. (PSC)
- Metering necessary for retail customers, wholesale customers, generation, transmission, substations
- Main purpose as the “cash register”, but Advanced Metering Infrastructure (AMI) also provides system parameters – voltage, current, outages, etc. Also enables Distribution Automation (DA) – direct load control, reactive control (capacitators),conservation voltage reduction, distributed generation control, etc.

Determining Cost to Customer

- Energy charge – kilowatt-hour (kWh)
- Demand (capacity) Charge – kilowatt (kW)
  - Or kilovolt-ampere (kVA) demand
- Customer Charge – fixed charge (billing, metering)

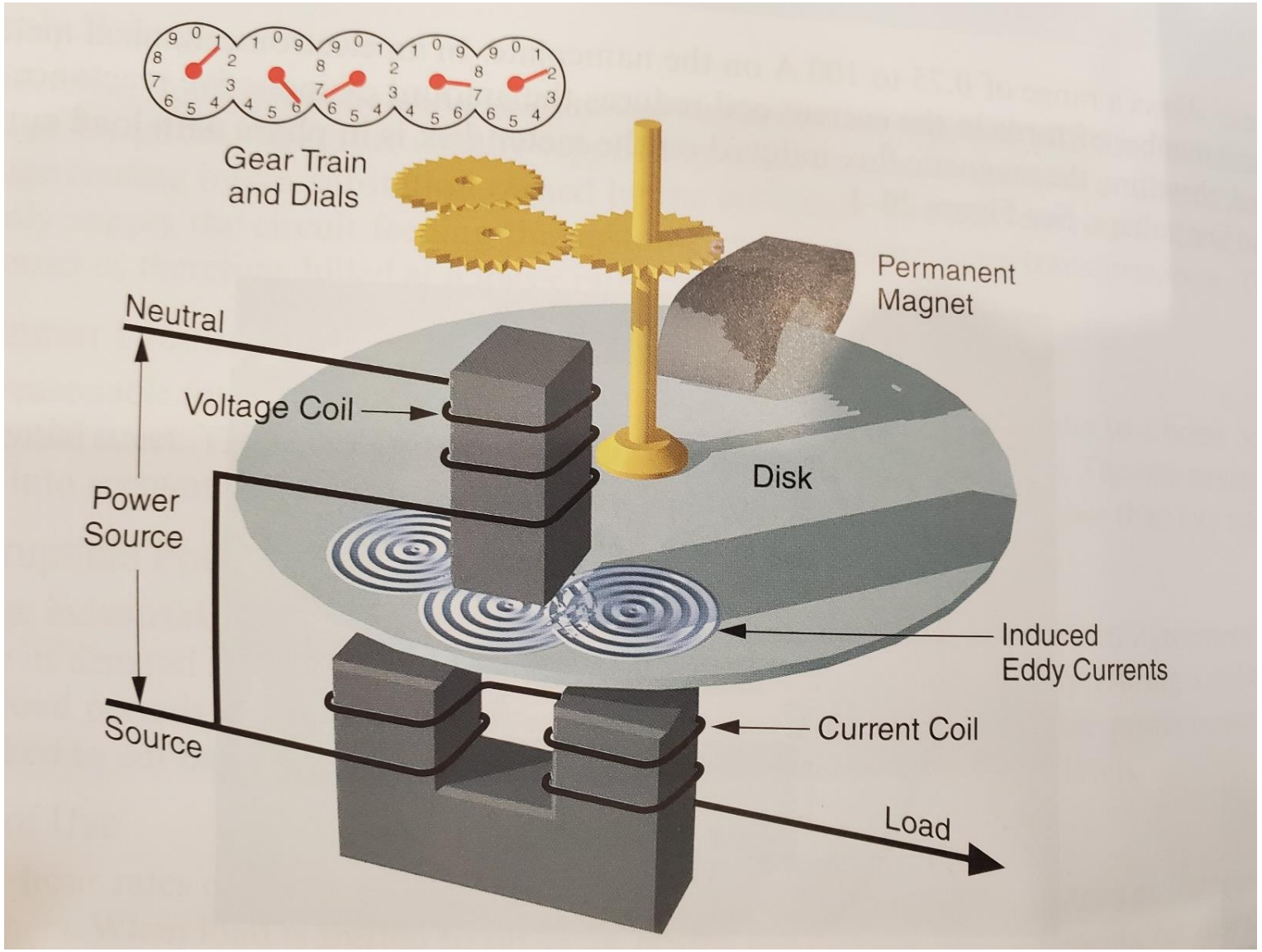
Variables that Affect Cost

- Fixed Charges
  - Minimum Bill
  - Supply Voltage
  - Location
  - Interruptible Power
- Metered Charges
  - Energy Consumption
  - Peak Demand
  - Power Factor
  - Load Factor
  - Metering and Ownership Discounts

Other Charges/Optional Rates

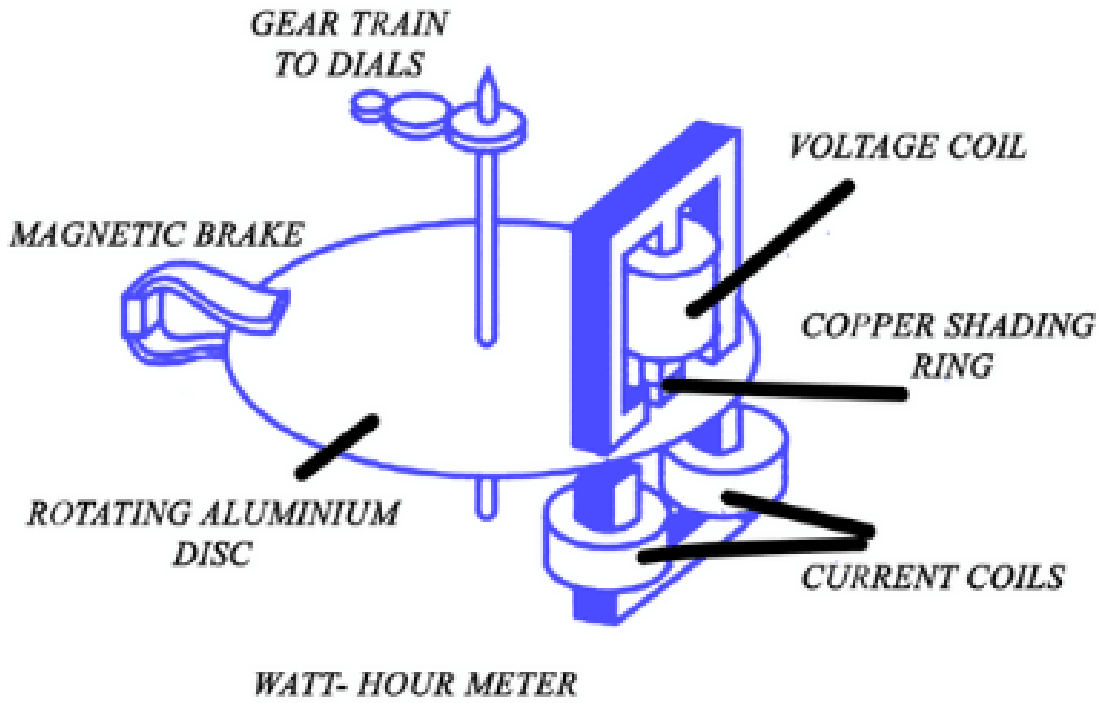
- Net Energy Billing (photovoltaic systems)
- Market-based rates
- Time of Use
- Demand Curtailment
- Electric Vehicle Charging (and discharging)

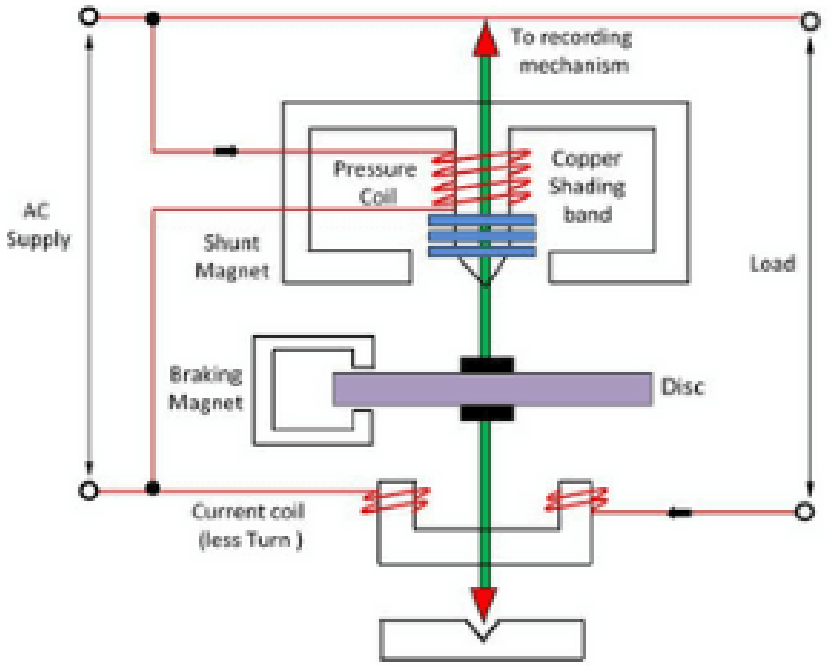
Workings of an Electric Meter



Workings of an Electric Meter

What is the Construction of AC Energy Meter?





Electrical 4 U

Workings of an Electric Meter

- Potential Coil
  - Some rated specifically for 120, 240, or 480 volts
  - Some “multi-ranging”
- Current Coil
  - 100 amp (Class 100)
  - 200 amp (Class 200)
  - 320 amp (Class 320)
  - 20 amp (Class 20, instrument rated)
- Elements
  - Combination of current and voltage coils in the meter (1, 2, 2-1/2, and 3)

Constants

- Kh Constant
  - Watt-hours per disk revolution or electronic meter pulse
  - Kh = 7.2 means 1 disc revolution consumes 7.2 watt-hours
    - 1000 revolutions = 7.2 kWh
- Kr Constant
  - Register ratio
    - Ratio between the register gear train and the value registered on the meter dial
    - Less common on electronic meters
- Meter Multiplier
  - Function of instrument transformer ratios used in Class 20 metering
  - 400/5 current transformer will have x80 multiplier
- Pulse Multiplier
  - Used with third-party metering software (MV-90_
  - Pulse outputs to customer-owned energy management software/control

Meter Forms

- Meter forms, or the form number on an electric meter are the numbers that help us as meter techs determine what type of meter should go in a particular service.

Meter Forms

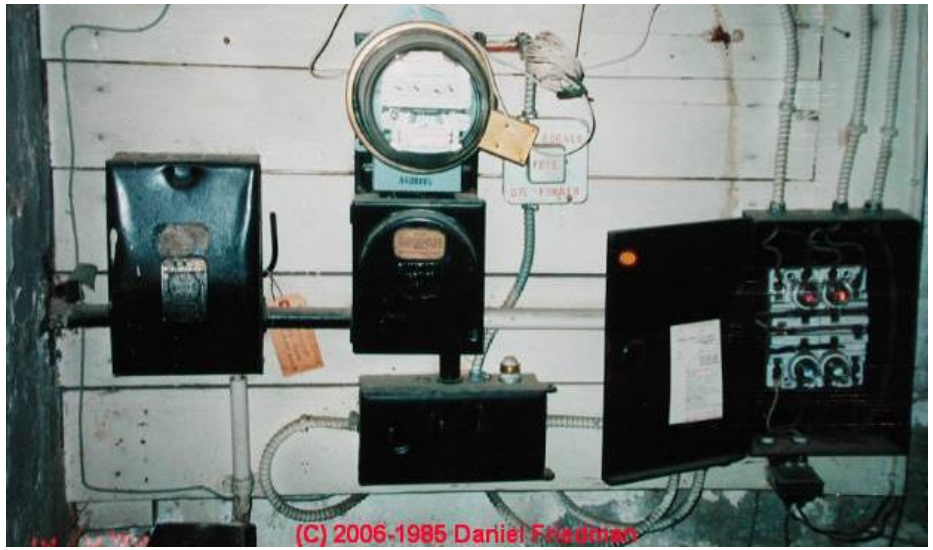
Form	Wires	Circuit	Elements	SC/TR	Class
1S	2	1Ø	1	SC	200, or 320
2S	3	1Ø	1	SC	200, or 320
3S	2	1Ø	1	TR	20
4S	3	1Ø	1	TR	20
9S, 10A, 48A	4	3Ø Y or Δ	3	TR	20
12S	3	Network or 3ØΔ	2	SC	200, or 320
13A	3	Network or 3ØΔ	2	SC	150
16S	4	3Ø Y or Δ	3	SC	200, or 320
16A	4	3Ø Y or Δ	3	SC	150
36S[1,3] 36A[1,3,4]	4	3Ø Y	2½	TR	20
45S[2,3] 56S[5] 45A[2, 3]	3,4,5	1Ø, 2Ø, Network, 3Ø Y or Δ	2	TR	20
9S	4	3Ø			200, or 320

Meter Forms

Form	Wires	Circuit	Elements	SC/TR	Class
10A (No KYZ)	4	3Ø		TR	20
45A (No KYZ)	3	3Ø		TR	20
2S		1Ø		SC	200
16S		3Ø		SC	200
16SB	4	3Ø		SC	20
12SB	3	3Ø			20
3CS	2	1Ø	1	TR	20

Notes:

[3]. These forms are the traditional 2 ½-and 2-element solution for metering 4-wire circuits in the United States. However, 2 ½- and 2-element meters in 4-wire circuits do not produce a Blondel solution. Without a Blondel solution, systematic errors may occur when a voltage imbalance exists.





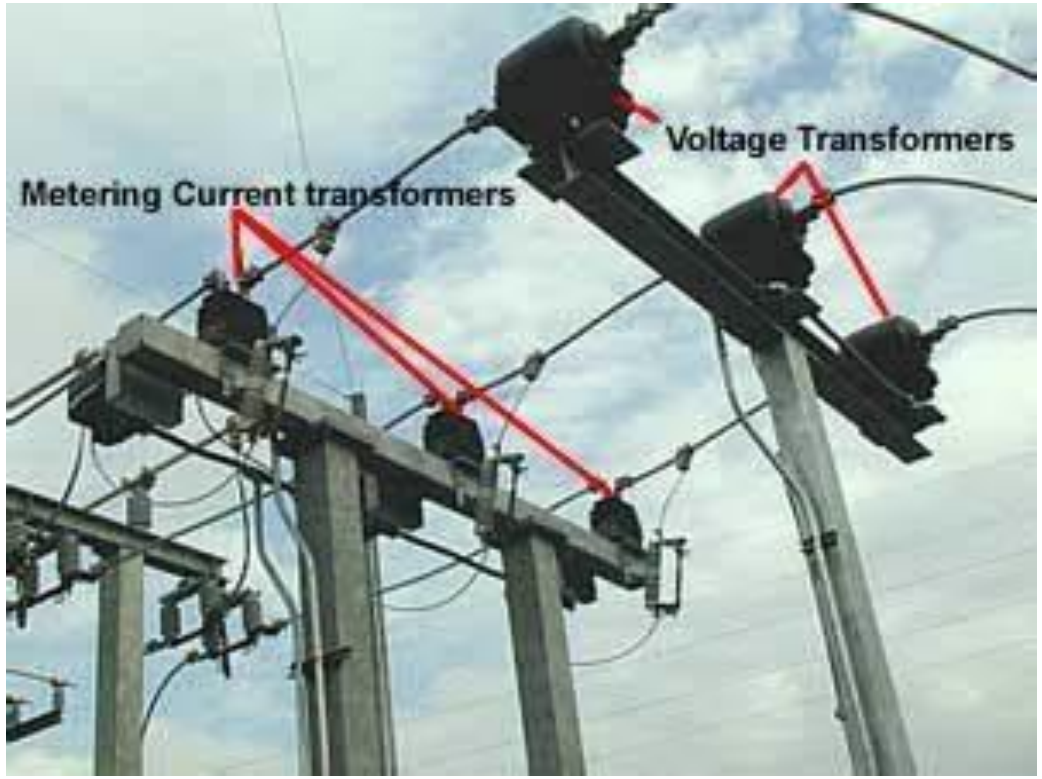
Type of Meters

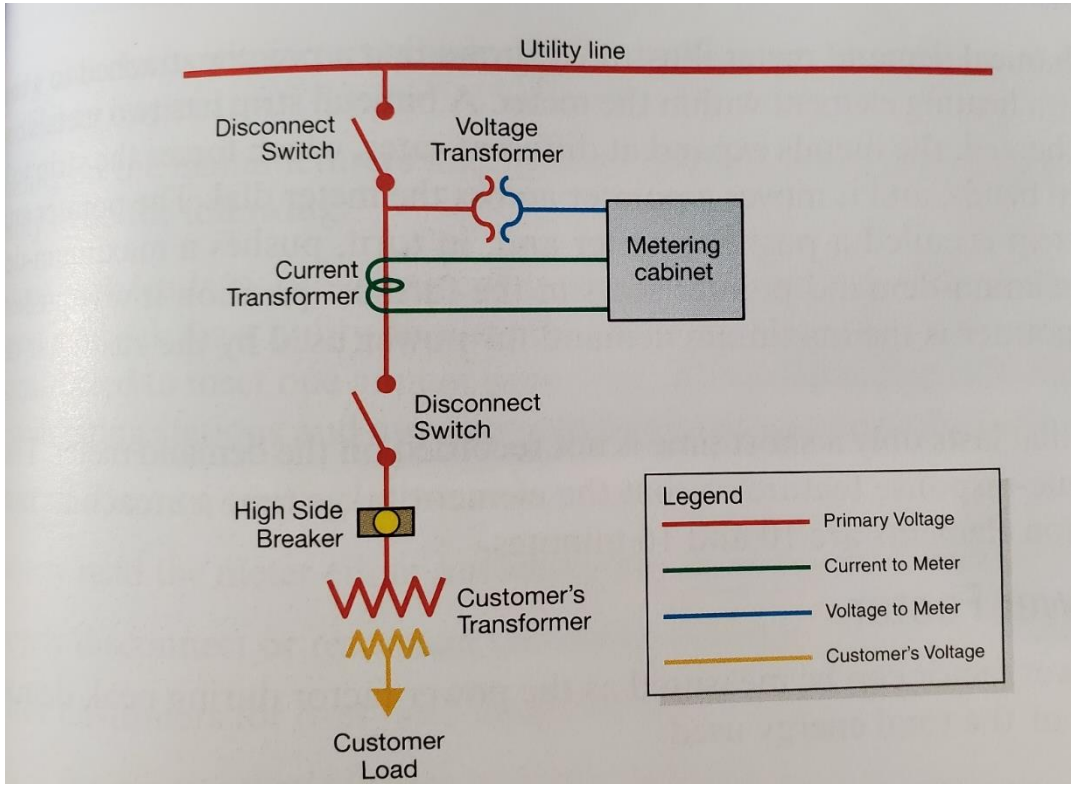
- A-Base Meters
- S-Base Meters
- K-Base (bolt-in) Meters

Types of Meters

- Self Contained Metering
  - Direct measurement, typically up to 200 amps, but also 320 amps
  - Class 200, Class 320 meters
- Instrument-Rated Metering
  - Using voltage or current instrument transformer
  - Class 20 meters
- Primary Metering
  - Using high voltage rated instrument transformers
  - Class 20 meters
  - On pole or in metering switchgear

Primary Metering One-Line

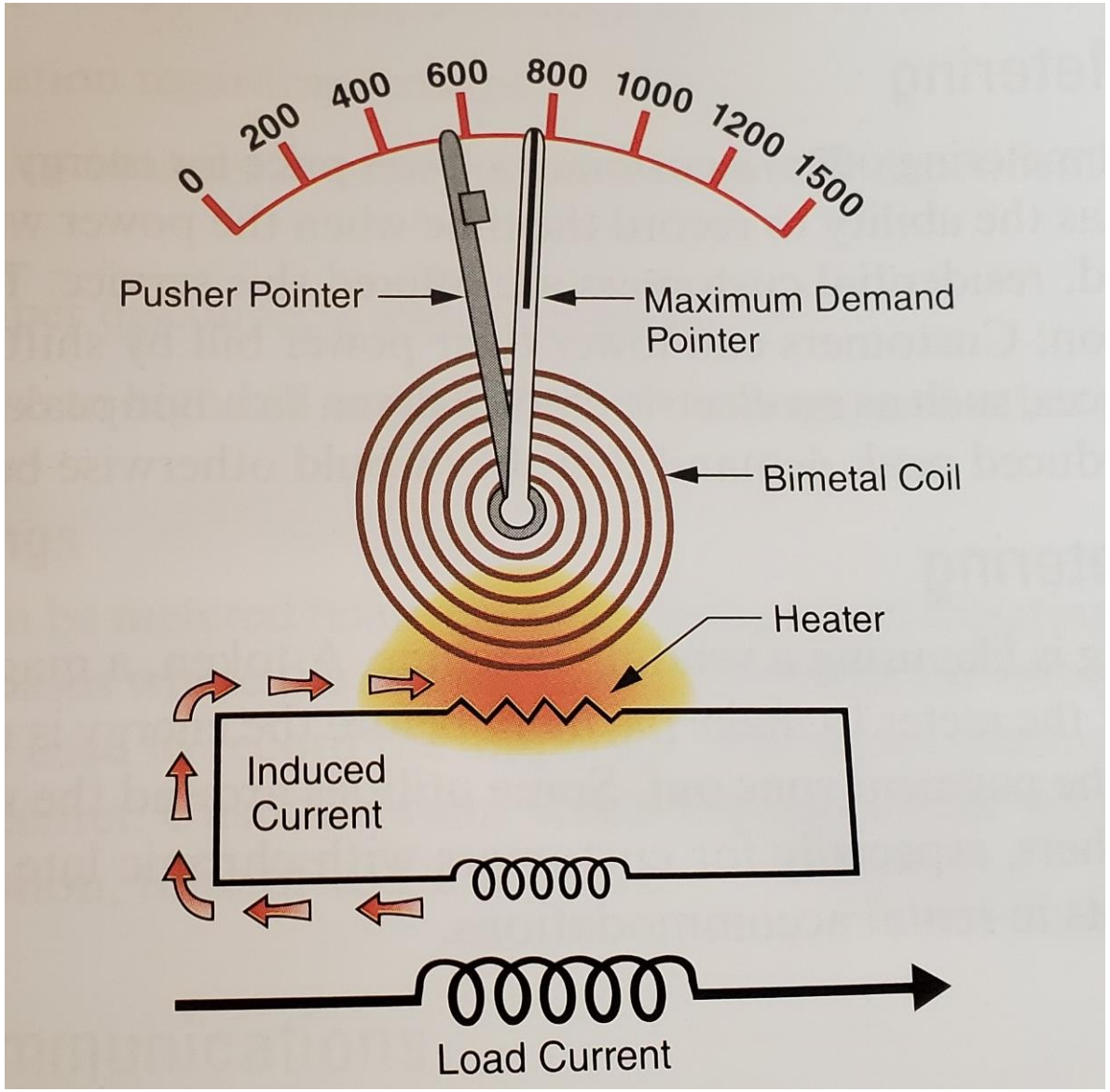




Metering Demand

Determination of Maximum Measured Demand and On-peak Maximum Demand: The Maximum Measured Demand in any month shall be that demand in kilowatts necessary to supply the average kilowatt-hours in 15 consecutive minutes of greatest consumption of electricity during each month. Such Maximum Measured Demand shall be determined from readings of permanently installed meters or, at the option of the utility, by any standard methods or meters. Said demand meter shall be reset to zero when the meter is read each month. The Maximum Measured Demand that occurs during the On-peak period shall be the On-peak Maximum Demand.

Measuring Demand



Advanced Metering Infrastructure (AMI) aka – Smart Meters

- Reduce peak loads by providing customers Time of Use Rates
- Collect and store metering data on an hourly (or 15 minute) basis
- Remote Reading
- Remote disconnect and reconnect
- Monitor over/under voltage
- Monitor outages and meter tampering
- Measure peak demand and aggregate by transformer setting
- Outage management, GIS interface
- Data for engineering planning

Other AMI Benefits

- Rate options for customers – Time of Use, Real time pricing
- Energy Use options for customer – using dynamic price signals
- Present outage information to customers
- Quicker response to outages – react before the customer calls
- Quicker, cheaper, and safer disconnects and reconnects
- More effective response to high bill complaints, low voltage, other problems that might otherwise require a truck roll

Meter Safety – Specific Hazards

Specific Hazards – Meter installation and Removal

Specific Hazard – Striking or pounding on the glass cover can break the glass or polycarbonate cover, or cause other internal damage.

Barriers – Use a meter installer and removal tool on S-base meter to reduce the risk of injury from breaking glass.





Specific Hazards – Arc Flash

Specific Hazard – A high explosive fault current can be available at a meter installation, especially at and installation fed from a large transformer and a short run of large service conductor, Any accidental arc can be explosive.

Barrier – Using and installation tester or the voltmeter method, conduct tests to ensure there is no fault in the service. Use a meter installer and removal tool on S-base meters to reduce the risk of injury from explosive faults. Wear appropriate personal protective equipment including eye protection, FR clothing, rubber gloves, face and shield. For instrument-rated meter settings, use test switches and potential transformers. Avoid working on self-contained 480 volt setting live.

Testing Meter Socket before installation for Back feed and Faults

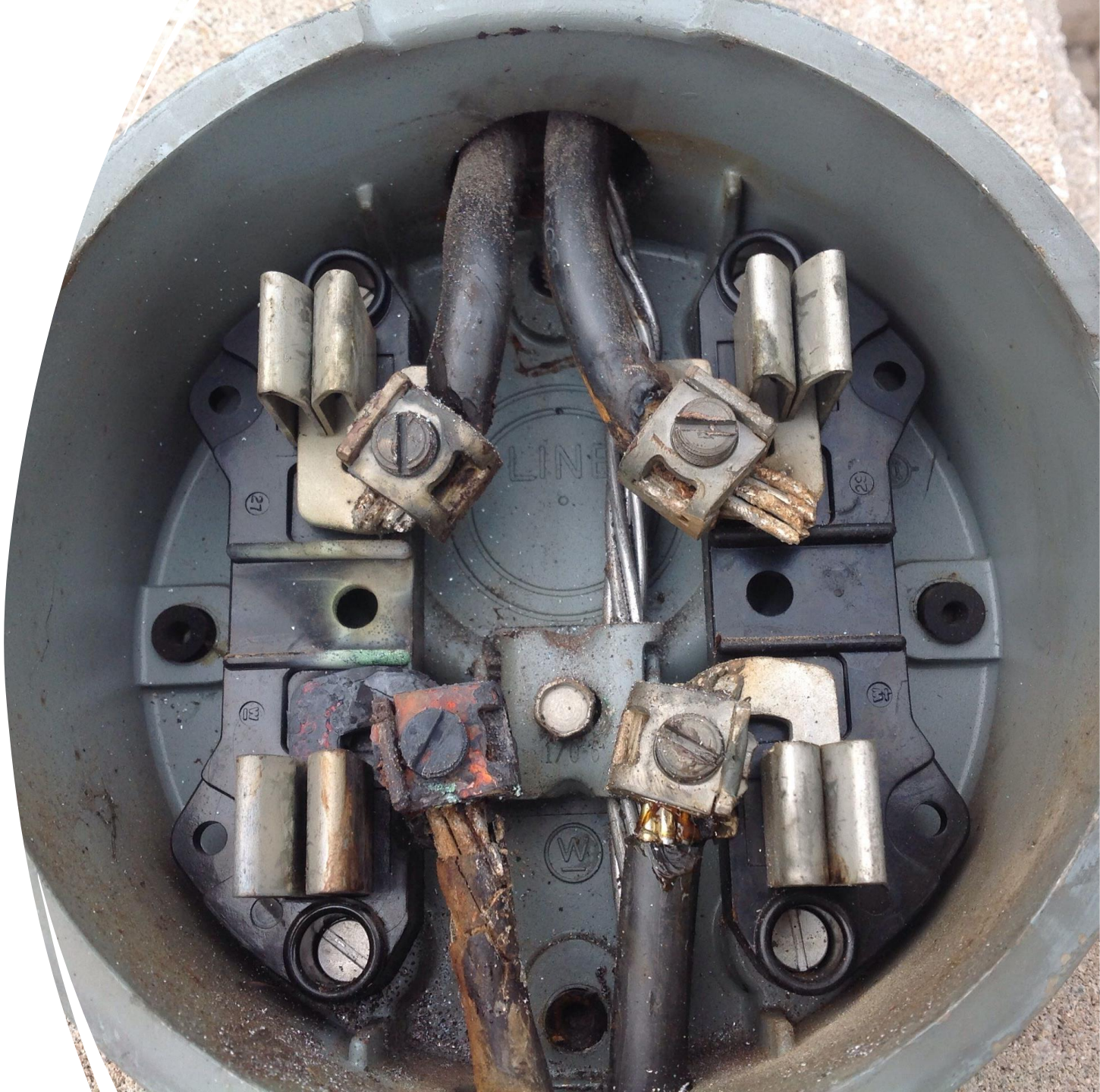




Specific Hazards – Deteriorated Meter Socket

Specific Hazard - Unknown potential shorting hazards, such as a broke meter lug or dropping an excessive load, can cause and excessive fault while removing a socket-type meter.

Barrier – Check the load on the meter. If facilities are available, open a source switch, bypass the load, or have the load reduced. Use a meter installer and removal tool on S-base meters to reduce the risk of injury from explosive faults. Wear PPE.





Specific Hazards – 480 volt Self-Contained Socket

Specific Hazard – Picking up or dropping a load with a 480-volt self-contained meter can cause an explosive arc because of the proximity of live parts and available fault current.

Barrier – Avoid live work on self-contained 480-volt meters. Label all 480-volt setting.

Specific Hazards – Open Circuit CT

Specific Hazard – There is a high voltage in the meter socket when a transformer-rated meter is removed without shunting the current transformers.

Barrier – Always shunt current transformers using a test switch before removing a transformer-rated meter. If no test switch available, install shunts at the terminals of the current transformer. Be wary of push-button self-shunting meter sockets.



Self-shunting pushbutton meter socket



Specific Hazards – Damaged Meter

Specific Hazard – Third party or natural hazard damages a meter.

Barrier – If the service is to remain energized, install a socket cover and seal meter socket to protect the public. Never leave an instrument-rated meter socket empty without shunting the current transformers. Consider using a meter socket jumper cover.



Other Hazards?

- What PPE or work practices do you use?
- Share any “near misses” related to meter settings
  - 2S and 12S settings
  - 480 volt metering
  - Tampering
  - Picking up, breaking load with self-contained metering

Spin Test to Determine Instantaneous Load

$$kW = \frac{3.6 \times Kh \times Rev.}{Sec.}$$

Where:

3.6 = the number of seconds per hour ÷ 1,000

Kh = the meter constant found on the meter nameplate

Rev. = the number of disk revolutions (choose 10 for easier calculations)

Sec. = time in seconds for the total number of revolutions counted