Various Applications of Electric Metering & How They Relate to Revenue Protection

> Presented by: Guy Cattaruzza United Illuminating

NURPA – September 19, 2007

 1872: Samuel Gardiner takes out the first known patent on an electric meter.

1880's: The Edison Electric Light Company, The Thomson-Houston Electric Co., the Union Switch & Signal Co. all form independently.

The Union Switch & Signal Co. reorganizes into the Westinghouse Electric & Manufacturing Co.

The Edison Electric Light Company becomes Edison General Electric Co. and then merges with Thomson-Houston to become the General Electric Co.

September 19, 2007

- 1898: The Stanley Instrument Co. introduces a radically different meter which attempted to eliminate the sapphire or diamond bearings in use at the time (which required regular maintenance). It worked at first but soon failed and the idea was abandoned.
- 1902: Westinghouse introduces the first ball bearing on their Type A meter instead of the pivot bearing in general use at that time (the ball bearing would eventually be adopted by all the manufacturers by the 1930s).
- 1903: GE introduced the Type I meter which was the first AC watthour meter to be mass-produced. This model was also considered the first "modern" meter as it has all the major features found in today's meters. As late as 1960, many of these were still in use.

 1928: Westinghouse introduces the first socket-type meter, the OB "detachable".
 September 19, 2007
 NURPA
 3

- 1931: The NEC was revised to allow the meter to be connected ahead of switches and fuses, which made it harder for dishonest customers to tap into the unmetered part of the electrical service on their property. This change along with the introduction of sockettype meters made it possible to move the meters outside where they could be read without entering the customer's premises.
- **1940:** GE begins development on a new type of bearing using the magnetic suspension principle but work on this was put on hold when the US entered WWII.
- 1948: The magnetic bearing GE had been working on was finally introduced on the I-50 single phase meter (which was billed "The first all-new meter in 50 years").
- 1960:Duncan, Sangamo, and Westinghouse all introduce meters using magnetic bearings.

September 19, 2007

Electro-Mechanical Metering

Thompson-Houston Recording Wattmeter 1892-1910



September 19, 2007

GE Type I (1903-1913)



September 19, 2007



GE Type I4 (1913-1927)

September 19, 2007

NURPA

8

GE Type I30 (1937-1954)



September 19, 2007

GE Type 50 (1948-1990)



September 19, 2007

GE Type I70S (1968-Present)



September 19, 2007

Fundamentals of a Single Phase Induction Watthour Meter



September 19, 2007

Revenue Protection on Electro-Mechanical Meters

Hole Drilled in Bottom of Lexon Cover (Copper Wire Inserted)



Small Magnets on Provision Cover & Heavy Duty Ring (No Effect)



September 19, 2007

Magnet with 115 lb Pull. Disc Stopped Turning Completely



September 19, 2007

Open Potential Clip (Single Phase Meter)



September 19, 2007

Wiring From Open Potential Screws to Light Switch



Telephone Wire Attached to Open Potential Clip



On Meters With a Potential Clip a Resister Can Reduce Registration by Up to 98% Depending on Resistor Size



September 19, 2007

Wire From Open Potential Screw Would be Grounded When Ring is Installed. 120 Volts to Ground on a 240 Volt Potential Coil Causes the Meter to Run at 50%



One Potential Wire Cut and Soldered to the Inside of the Lightning Arrestor. When the meter is Installed the Arrestor Grounds to the Provision Resulting in 50% Registration





SLB Type J5S With ERT



L&G Type MSII With Cellnet



AMR Module Flags

Reverse Rotation Tilt Switches Magnetic Flags Power Outage

Need systems, reports, analysts/investigators to interpret flags and take corrective action

L&G Meter With Module Detached

Rr 13 8/9

KILOWATTHOURS

UICO 031621862 MSI

Screws Removed and module misaligned so no disk rotation is detected but no power outage or tilt switch.

Electronic Metering

- 1970's: With the advances in electronics, the manufacturers (as well as a few third-party companies) started introducing electronic registers and automatic meter reading devices.
- **1980's:** Many manufacturers were offering hybrid meters with electronic registers mounted on induction-type meters.
- **1990's:** Further advances in electronics allowed the manufacturers to start introducing meters that were fully electronic and used no moving parts.
- 2000's: Some manufactures discontinue production of mechanical meters and solid state or fully electronic meters become standard and only meter available.

Itron Centron and Elster Alpha Electronic Meters



Electronic Measurement

Two sections: Multiplier and Register No moving parts Convert analog current and voltage to digital Hall effect, time division multiplication, Transconductance amps, and digital sampling Electromechanical tampering methods don't apply to solid state meters

The Hall Effect





September 19, 2007

Transconductance Amp



Three Phase Electronic Meter



September 19, 2007

Revenue Protection on Electronic Meters

Internal Circuitry Showing Jumpers Line to Load on 2 Phases of 3 Phase Meter



Close up Showing Jumpers Line to Load on 2 Phases of 3 Phase Meter





Electronic Circuitry of 3 Phase Meter Showing Bent Pins on 1 Phase (Disconnected)



Close up of Three phase meter Showing bent Pins on 1 Phase (Disconnected)



September 19, 2007

Internal Circuitry Showing Where Currents Enter Meter From Current Transformers



Close-up Showing Micro Filaments Used as Shunts Across Each Phase



AMR / AMI Metering and it's affects on Revenue Protection

AMI and the Future of Revenue Protection

- New mesh networks with full two-way communications
- Advanced meter capabilities with extensive diagnostics
- **Exponential increase in meter reads and meter data**
- Ex.: 500,000 meter company
 - 1 monthly read 500,000 reads/mo
 - 1 daily read
 1 hourly read

500,000 reads/hio 500,000 reads/day, 15M reads/mo 12M reads/day, 360M reads/mo

AMI and the Future of Revenue Protection

 Will require Meter Data Management Systems
 Will require systems, reports, analysts/investigators to research, investigate and take corrective action

Energy Diversion will become more innovative and with the rich data available, we will need to become smarter than the thief's

AMI and the Future of Revenue Protection



September 19, 2007

Pro's & Con's

- Better knowledge of unbilled revenues
- > Notification of Illegal Reconnects
- Ability to examine consumption patterns from daily read information
 - > Pinned disc's
 - > Open Potentials
- Ability to examine 15 minute interval data
 - Pinned Disc's & Open Potentials occurring on an overnight basis

- Loss of regular field visits to examine our metering equipment
- Inability to determine connections ahead of the metering scheme (Gas & Electric)
 - > The meter will tell you only what it sees not what it doesn't see
- Unless additional services are known unmetered (unbilled revenue can occur for years
- <u>The combination of these factors</u> <u>along with the rising cost of energy</u> <u>increases the potential for revenue</u> <u>loss significantly</u>

