METERS FOR POWER PLANTS

CONTENTS

1. GENERAL

1.1 Scope

1.11 This section covers meters for power plants. These may be furnished loose or panel-mounted and are to be distinguished from portable meters covered in Handbook 34.

1.12 No attempt should be made to correct meter defects or damage on the job. Return new meters to the supplier for repair or exchange in accordance with authorized practices. Reused meters on telephone company owned equipment should be repaired, recalibrated or exchanged as directed by the telephone company.

1.2 Associated Information

1.21 Certain meters are checked for accuracy and adjusted to agree with a portable standard meter during power plant tests in accordance with Handbook 21.

1.22 Refer to Section 130 in this handbook for information on meters furnished on engine-alternator control panels when the engine-alternator is to operate in parallel with other engine-alternators.

1.3 Precautions

1.31 Do not touch ammeter shunts that are in service. In ordinary operation they may reach temperatures as high as 190°F (88°C) which is one manufacturer's maximum rating for shunts.

1.32 Before disconnecting a dc ammeter from a circuit determine whether it has an external shunt. An external shunt must be left in the circuit and the instrument disconnected by removing the small meter leads at the shunt. If there is no external shunt the circuit will be opened as soon as the meter is disconnected, causing a hazardous condition as well as a possible service interruption, and it will be necessary to bridge around the meter before disconnecting it.

1.33 Current transformers are used with many ac ammeters and wattmeters. The secondary winding of each current transformer must be shorted before disconnecting the associated meter. If the winding is left open (not shorted) and the primary carries current, high voltages and high temperatures will occur in the winding. This can cause severe shock to personnel, and possible damage to equipment.

1.4 Inspection

1.41 Inspect meters after unpacking or after unpacking the equipment on which they are mounted. Examine for damage, missing parts, defects of finish, etc. Where replacements are required originate a J.I.M. in accordance with established routines. In all cases it will be necessary to return the damaged or defective meter for credit.

1.5 Return of Instruments to Supplier

1.51 Hold the meter until the replacement is received, then pack in the box used to ship the replacement, unless the box was damaged, using the same method of packing. This should prevent further damage to the meter and enable the supplier to extend maximum credit. When returning wattmeters be sure to return the potential box, resistor box, or transducer with the instrument.

1.6 Descriptions of Meters and Accessories

1.61 Meter Types

1.611 General: Meters for use on dc circuits and on ac circuits at power line frequencies are of three general types: D'Arsonval, electrodynamometer and electromagnetic. Sometimes a rectifier is used in series with the D'Arsonval movement. Principles are described below.

1.612 D'Arsonval: For use on dc only. A coil arranged to turn on jewel bearings is mounted in the field of a permanent magnet. Coil motion is restrained by two flat coiled springs which also serve to conduct current to the coil. Current through the coil produces a magnetic field causing the coil to turn in the permanent magnet field. This movement may be used to measure either dc current or dc voltage.

1.613 Electrodynamometer: For use on ac and dc. The meter has a fixed coil and a pivoted coil. When con-

nected to a circuit both coils carry current. The magnetic fields cause the movable coil to turn. Use is limited to dc and ac circuits below 200 hertz. When both coils are connected in series, as in a voltmeter or ammeter, needle deflection is proportional to the square of the current. Consequently, the scale is not linear and is quite compressed at the lower end. A wattmeter is a meter of this type with fixed coils energized by circuit current and movable coils energized by circuit voltage.

1.614 Electromagnetic: For use on ac and dc. This is sometimes known as the moving-vane type. A fixed coil energized by circuit current or voltage sets up a magnetic field which moves a pivoted iron vane or tube to which the pointed is attached. These meters are rugged, inexpensive, and available in various ranges up to about 750 volts and 100 amperes. This type of meter may be used on either dc or ac circuits below 200 cycles per second.

1.615 D'Arsonval with Rectifier: Sometimes the meter described in Paragraph 1.612 has a rectifier added in series with the coil so that it may be used on ac circuits. This is the usual thing in a volt-ohmmeter, for example, where ac and dc scales are provided. Accuracy on ac with the rectifier is quite a bit less than the accuracy of the movement alone on dc.

1.62 Multipliers

1.621 Meter coils have very low resistance and would burn out if connected to voltages higher than about 0.1 volt. A resistance, known as a "multiplier", can be added in series with the coil to allow higher voltages to be measured. The multiplier in many instances is inside the case. Multipliers or potential boxes for wattmeter coils are external and carry the same serial number as the meter. These resistance boxes are included in the instrument calibration and have to be sent along with the instrument when it is returned to the supplier or sent out for calibration.

1.63 Shunts

1.631 A dc meter will usually provide full-scale deflection with about 0.035 ampere (35 milliamperes). To measure larger currents it is necessary to divert or bypass most of the current around the meter allowing only the current necessary for operation to reach it. This is done by a piece of equipment known as a "shunt". For meters having scales up to about 75 amperes the shunt may be in the meter case; above this the shunt is usually external. The meter connects to the shunt by a pair of small leads. Any given meter movement may be used on different ranges by properly calibrating the scale and furnishing the proper shunt. The ampere rating of the shunt should match the meter scale, if it is an ammeter, or the coil current rating on other dc meters.

1.632 Meter leads to the shunt are included in the meter calibration and shall not be cut, spliced or used with other meters. A lead length of five feet is standard with some manufacturers. Excess lead may be coiled and tied as indicated in Handbook 18.

1.64 Current Transformers

1.641 Current transformers are used with ac ammeters and wattmeters when current exceeds five amperes. They are designed for various current ratios and have a five ampere secondary winding which connects to the meter. There are two common types, the "doughnut" type and the "self-contained" type. The doughnut type fits over a line lead which becomes the primary winding; the self-contained type has a piece of bus-bar as the primary winding, which is rigidly connected into the circuit. A bar to short the secondary winding is usually furnished on the self-contained type and this bar must be operated to short the winding before disconnecting a meter. The doughnut type does not have a shorting bar and transformer leads must be securely connected together with no current thru the primary before disconnecting a meter. The transformer leads usually run to a terminal strip where the shorting operation can be accomplished. The circuit may then be loaded with no damage to the transformer. Different current transformer ratios allow a standard five ampere meter movement to be used on wide ranges of current. The current transformer also provides a means of insulating the meter from the line.

1.642 Wiring diagrams indicate dots or small crosses on leads from one end of a current transformer. These are polarity marks and they are indicated on the actual transformer by a white dot near a terminal or a white dot on a lead. Polarity must be observed in connecting these transformers or the meter connected to them may read incorrectly.

1.65 Potential Transformers

1.651 Potential transformers are often used to step down line voltage, as many meter potential windings are rated at 110 volts. The potential transformer also provides a means of insulating a meter from the line.

1.66 Transducers

1.661 The wattmeter transducer is a static device to produce DC output directly proportional to the AC power input.

1.662 The frequency transducer converts frequency span into a linear DC output current which can then be used to actuate the frequency meter mounted on an instrument panel.

1.663 These transducers are included in the instrument calibration and have to be sent along with the instrument when it is returned to the supplier or sent out for calibration.

2. INSTALLING EQUIPMENT

2.1 Tools and test equipment

Quantity	Code	Description
1	R-1005	Screwdriver, 7/8", Jeweler
1	ITE-1000	Voltmeter, AC
1	ITE-4737	Voltmeter, True RMS
1	ITE-4040	Adjusting Set, DC
1	ITE-4474	Voltmeter, Power, DC
2	ITE-9501	Cords, Test

NOTE: Should other test equipment be required it may be borrowed from the telephone company.

3. GENERAL REQUIREMENTS

3.1 Meters shall be checked mounted in place on their panels. Those meters mounted on steel panels are specially calibrated and removing them from the panel will affect their indications.

3.2 Meter connections shall be tight. Tighten as necessary taking care not to strain terminals by exerting too much pressure.

3.21 Poor connections at meter current terminals and at shunts will result in high temperatures at the terminals as well as incorrect readings.

4. ZERO INDICATION

4.1 With no current flowing in the meter, the pointer shall indicate zero, except on suppressed-zero meters (having no zero mark) and those meters which have been adjusted to agree with a portable meter at some point on the scale.

4.11 If the meter is equipped with an external zero-adjuster, turn the adjuster screw as required with a suitable screwdriver. There is some slack motion between the adjuster and the pointer. When pointer has been moved to the desired position back the adjuster off slightly. Tap gently on the panel with a pencil eraser. If the needle shifts off zero, readjust.

5. SUPPRESSED-ZERO METERS

NOTE: Suppressed zero voltmeters manufactured by Western Electric and some Weston models are not equipped with zero adjusters. Other such meters are equipped with dummy zero adjusters. In these cases, it will be necessary to remove the cover and adjust the torsion spring. For Western Electric meters, shift the adjusting arms, as required, to adjust the pointer indication. The arm is held by friction and not clamped. For Weston meters, it is necessary to loosen the adjusting arm clamping screws before moving the arm. After making an adjustment tighten clamping screws. While the cover is removed make sure there is no lint or other foreign matter inside the case or in the airgap.

5.1 Suppressed-zero meters of present manufacture have the zero-adjuster screw connected to the pointer mechanism. Check volt-meters for accuracy as in Paragraph 5.2. If this accuracy requirement is not met, adjust as in Paragraph 5.3 and recheck accuracy as in Paragraph 5.2

5.2 Check a suppressed-zero voltmeter for accuracy using an ITE-4474 in parallel. Adjust the voltage source to any desired point on the scale of the voltmeter under test and compare the reading with that of the ITE-4474. The voltmeter being tested should agree with the ITE-4474 reading within ± 1%. For example, a voltmeter with scale of 30-60 and rated ± 1% accurate should agree anywhere on its scale with the ITE-4474 indication within .01 x 60, or .6 volt.

NOTE: The variable voltage source mentioned above can be the power plant or an ITE-4040 DC Adjusting Set connected for BGV condition. If the ITE-4040 is used, it will be necessary to disconnect the meter being tested from the power plant circuit.

5.3 If accuracy check in Paragraph 5.2 is out of limits make one adjustment as follows with the zero-adjuster screw.

5.31 Determine the lowest main division on the low end of the suppressed-zero meter scale and adjust the variable voltage source or the ITE-4040 resistance until the ITE-4474 Voltmeter indicates this value. Set the pointer of the meter under test to this value (first main division on low end) using the zero-adjuster screw on the front of the meter or in accordance with the Note, above.

5.32 Repeat accuracy check in Paragraph 5.2. If the meter does not now meet its accuracy requirement, it should be replaced.

6. FREEDOM OF MOVEMENT

6.1 The pointer shall follow any change in circuit conditions without sticking.

6.2 In case internal damage is suspected which might cause the pointer to stick at some point, arrange to run the pointer slowly across the scale. This may be done by varying the voltage on a voltmeter or the load current on an ammeter.

7. ACCURACY

7.1 Accuracy of an instrument is usually given in per cent (%). This is per cent of full-scale and this accuracy should hold anywhere on the scale. Test methods sometimes require adjusting the meter pointer, by means of the zero-adjuster, to read exactly the same as a portable meter at a certain point. This, of course, changes the accuracy at any other point on the scale and a rated overall accuracy no longer holds.

7.2 The indication of a voltmeter used for floating a battery when compared with an ITE-4474 DC Power Voltmeter connected in parallel with it, shall agree with the ITE-4474 within ±0.2 volt on 24 and

48 volt systems and within ±0.5 volt on 130 volt or higher systems. These limits apply anywhere in the float range.

7.3 Whenever a meter has been adjusted to indicate the same as a standard meter at some point, it is desirable to seal the adjustment by placing a piece of tape of some kind over the zero-adjuster.

7.4 Except as directed in test sections, meters will generally not need to be checked for accuracy. If there is no external evidence of damage, such as cracked or broken glass or a damaged or dented case, and freedom of movement (Paragraph 5) is satisfactory, the meter should not require an accuracy check.

8. STATIC CHARGES ON METERS

8.1 During cleaning operations, static surface charges may build up on meters with lucite cases which affect the meter. The static charge problem may generally be overcome by wiping meter face with a clean KS-2423 cloth moistened with Anstac 2-M cleaner. Allow surface to dry and wipe with a dry cloth. In case this does not correct the problem it will be necessary to apply Anstac 2-M cleaner to both inside and outside of the meter case in the manner indicated above.

9. POWER FACTOR METERS

9.1 The allowable error of Weston Model 356 Power Factor Meter is ±0.01.

NOTE: The pointer of a power factor meter does not return to zero when current is removed from the meter.

Arrows not shown due to extensive changes.

Vertical lines at side of paragraphs indicates requirements.

9.2 If the meter is thought to be in error it is recommended that arrangements be made, in accordance with authorized local practice, to send the meter and associated accessories to a local power company, or meter repair company equipped to make the check.

10. FREQUENCY METERS

10.1 The allowable error of Weston Model 214 Frequency Meter is ±0.3 cycles.

NOTE: The pointer of this meter does not return to zero when current is removed from the instrument.

10.2 If accuracy of the meter is in doubt it may be checked by connecting to a source of known frequency. This may be the output of an engine-alternator using the reed-type frequency meter on the control (which can be read to 0.25 cycle).

11. AC WATTHOUR METERS

11.1 The allowable error of General Electric Co. AC Watthour Meter is ±2%.

11.2 If a check of one of these meters is required, it is recommended that arrangements be made, in accordance with authorized local practice, to have the local power company or some other well-equipped organization make the check.

Manager, Product Engineering

Reason for Reissue:
(1) To add information on suppressed-zero instruments, Par. 5.
(2) To add information on transducers.
(3) To add additional test equipment.
(4) To remove Table 1 on instrument accuracies

Replaces Section 20 dated 10-20-60 and T.I. dated 6-18-65.