INSTRUCTIONS

INSTRUMENT TRANSFORMERS

DRY TYPE

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INSTRUMENT TRANSFORMERS

DRY TYPE

The several types of transformers covered by these instructions include indoor and outdoor instrument transformers, metering outfits, portable instrument transformers, split-core current-measuring sets, and auxiliary transformers. These instructions apply also to Type Y transformers, which are not strictly standard but which utilize the mechanical construction of standard transformers. For information on the installation and care of dry-type transformers with unusual ratings of frequency, secondary voltage, current, etc., consult the nearest Sales Office of the General Electric Company. When any special information is requested, give the complete nameplate data in order to identify the transformer.

HANDLING

When unpacking and handling the transformer, exercise care not to damage the insulation. Make an inspection to see whether any damage has occurred during shipment. Transformers that are reshipped to the point of installation, even though this be done by truck, should be supported only by the core or mounting supports. Do not use the bushings or leads for handles.

DRYING OUT

Transformers that have been subjected to submersion or have been stored for some time in a damp place should be dried out previous to installation. When drying out is necessary the following method should be used:

Allow the transformer to stand not less than 12 hours in a room of approximately even temperature.

Measure the resistance of the windings and record the room temperature.

Short-circuit the primary winding and apply voltage to the secondary winding through such controls that sufficient current will flow in the windings to raise the temperature to approximately 80 C. This temperature should be maintained until the transformer is dry.

To determine the temperature of the winding (approximately) assume that for each per cent increase in resistance the temperature rise of the winding is 2½ C. Find the temperature rise and add this to the starting (room) temperature: the result will be the final temperature.

The amount of current necessary to obtain this temperature varies because of the variations in losses and copper densities in the different types of transformers. It is advisable to start with a current not greater than 2 amperes in the secondary of a potential transformer and not greater than 5 amperes in the secondary of a current transformer, and gradually raise this current until the proper heating is obtained. Increases of current should be made cautiously with regular observation of the rise of temperature of the winding. The rise of temperature should not exceed 6 C per half hour.

When facilities for measuring the resistances are not available the temperature may be taken by placing the bulb of a spirit thermometer on each coil as close to the winding as the insulation will permit. The bulb of the thermometer should be covered with clean dry cotton waste so that the bulb will have as nearly as possible the actual temperature of the coil. In the case of current transformers of high current capacity the actual temperature of the primary winding can be quite closely obtained by placing the bulb of the thermometer directly on the primary terminal.

Do not use mercury thermometers.

TESTING

Dielectric Tests

If it is desired to make insulation tests after the drying out period, or at any other time, these tests should be made in accordance with the ASA standards for transformers, regulators, and reactors (superseding A.I.E.E. standards No. 4 and No. 14). These rules should be strictly followed, both as to the value of test voltage and in the method of application.

Polarity Tests

Convenient methods for testing polarity are given in A.S.A. Transformer Standards, and also in the N.E.L.A. Metermen's Handbook.

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Ratio and Phase Angle Tests

Refer to N.E.L.A. Metermen's Handbook and General Electric Company's publication, GEA-601, Instrument Transformers.

MOUNTING

When connecting instrument transformers into power or distribution lines, it is important to make the connection in a manner to avoid placing line strains upon the terminals of the transformers.

Where the primary leads consist of cables, as in the case of certain outdoor transformers, the connection should be made in such a manner so as not to bend the leads sharply where they enter the bushing. The connection should also be so made as to prevent swaying of the cables.

Where the primary leads are brought out through stud-type bushings or so-called fixed terminals, care should be exercised to prevent either longitudinal or transverse strains upon the bushings.

Instrument transformers of "transformer less primary" (window) type should be installed in such a manner that the weight of the transformer is not carried by the bus. Holes are provided in the angle core clamps which may be used for fastening the transformer either to a flat surface or to mounting brackets. No brackets are furnished with the transformer because of the wide variety of mounting conditions.

For high-current transformer ratings, 2000 amperes and above, there may be some interference from the field of the return bus unless the bus centers are kept at a minimum distance of 15 in. apart; for ratings above 5000 amperes this distance should not be less than 24 in. In case this type transformer is used with more than one primary turn, the loop should be at least 24 in. in diameter. Care should be taken to see that the secondary leads are twisted closely together and carried out without passing through the field of the primary conductors. It is not necessary that the bus exactly fill the window, but the bus or buses should be centralized.

CONNECTIONS

The resistance of all primary and secondary joints should be kept as low as possible to prevent overheating at the contacts, and particularly in the case of current transformer secondary circuits, to prevent an increase in the secondary burden.

Secondary Leads

When planning installations of current transformers, the resistance voltage drop of the secondary leads should be included in calculating the secondary volt-ampere burden carried by the transformer. This total burden should be kept within limits suited to the transformers used. For ordinary conditions, secondary leads whose resistance does not exceed that of 100 feet of leads of No. 10 B.&S. copper wire (200 feet of wire) are satisfactory. This resistance is 0.2 ohm, requiring 5 volt-amperes at 5 amperes.

In the case of potential transformers the voltage drop in the secondary leads may affect the indications of the connected instrument and meters. For the usual conditions 50 feet of leads of No. 10 B.&S. copper wire (100 feet of wire) are satisfactory.

The above instructions regarding the length and size of the leads to be used should be considered as general. In cases where instruments and instrument transformers have been furnished as a unit by the factory, no change should be made in the length or size of leads which might change the volt-ampere burden in them. If any change is needed consult the nearest Sales Office of the Company.

Secondary Burdens

When calibrations are furnished with transformers, it is important that the connected burden to be in agreement with the burden used in calibration. If it becomes necessary or desirable to change the connected burden, and if there is any question regarding the effect of the change in the accuracy of the transformer, the nearest Sales Office of the Company should be consulted. Questions regarding the maximum allowable burdens should also be referred to the Company's nearest Sales Office.

If transformer calibrations are required, it is important that complete information be furnished the Company, including the number of devices to be connected in the secondary of each transformer, the rating of the device and type if the device has more than one current

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or voltage, capacity, size, and length of leads to be used, the frequency of the circuit, and the method of connection.

Secondary Terminals

Most indoor current transformers are supplied with an enclosed secondary terminal block which can be sealed. When shipped, the cover of the terminal block is in the reversed position because the short-circuiting device between the secondary terminals is closed.

The procedure for making secondary connections is as follows:

Remove the cover, attach the service leads, open the short-circuiting device by loosening the screw or nut and turning the bridge 90 degrees counterclockwise, and then retighten the screw or nut. Turn the cover 180 degrees from the shipping position, and reinstall it on terminal block. The cover cannot be replaced after the service leads are in place until the short-circuiting device is opened.

Some transformers have their secondary terminals arranged for conduit connection. This conduit connection can be made from the bottom, top, or either side, by removing the terminal cover and changing the cover support to the desired position. The position of the secondary terminals should not be changed.

Grounding

The casings and frames of instrument transformers should always be grounded. The secondaries should also be grounded close to the transformers. If, because of special connections, grounding the secondary appears impracticable, the matter should be referred to the General Electric Company. No. 2 B.&S. copper wire is recommended to ground casings and frames, particularly of outdoor transformers where arcovers are more likely to occur. Not smaller than No. 12 B.&S. copper wire should be used to ground the secondaries. Grounding the feet of instrument transformers also grounds the cores, casings and frames.

If it is necessary to change the secondary connections, be careful not to disturb ground connections.

Polarity

In wiring instrument-transformer circuits, it is necessary to maintain the correct polarity relation between the line and the devices connected to the secondaries. For this reason, the relative polarity of the windings of each transformer is indicated by a marker H_1 on or near one primary terminal, and a marker X_1 near one secondary terminal; and in most cases by white bushings or markings of white paint. Where taps are present, all terminals will be marked. The primary leads will be H_1, H_2, H_3, etc., in order, and the secondary terminals X_1, X_2, X_3, in order, and the tertiary, if present, Y_1, Y_2, Y_3, in order, H_1 indicating the same instantaneous polarity as X_1 or Y_1.

Significance of Polarity Markings

When connection is made to a secondary terminal having a polarity marking similar to a given primary terminal, the polarity will be the same as if the primary service conductor itself were detached from the transformer and connected directly to the secondary conductor. In other words, at the instant when current is flowing toward the transformer in a primary lead of a certain polarity, current will tend to flow away from the transformer in the secondary lead of similar polarity.

When connecting instrument transformers with meters or instruments, refer to the Instructions furnished with the meters or instruments involved.

MAINTENANCE

After instrument transformers for indoor installation have been installed, they should need no care other than seeing that they are kept clean and dry. Transformers for outdoor installation should receive the same care in operation as power transformers of similar design and of similar voltage rating.

Considerable care should be exercised to make and keep the resistance of all contacts in the secondary circuit as low as possible.

Note:—Always consider current transformers as a part of the circuit to which they are connected, and touch only the secondary leads, and such portions of the transformer as are properly grounded.

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Do not open the secondary circuit of current transformers while the transformer is connected in a line circuit, since by so doing the core may be permanently magnetized, and voltages dangerous to human life are likely to be induced across the secondary terminals. To remove any device from the secondary circuit of a current transformer when current is flowing through the primary, the secondary of the transformer should first be short-circuited, and care should be taken not to disturb the ground connection of the secondary of the transformers.

FUSES

Potential transformer fuses are intended primarily to protect the line rather than the transformer, although the modern fuse will afford protection to the transformer in a large number of cases. With the exception of the current-limiting fuse, Type EJ-1, potential transformer fuses are not designed to open the maximum short-circuit currents which may flow when a short circuit occurs in the transformer. For this reason, current-limiting resistors should be used in series with the fuse when necessary to limit the current to a value which the fuse can interrupt satisfactorily.

Replacing Fuses

Since many potential transformers are furnished with two fuses, the fuse in the grounded side should be replaced by a brass tube of the same size as the fuse or by some solid connection.

The fuses of Type E-32 and JE-2 potential transformers, 3000 volts and below, are supported by a hinged cover. If it is necessary to replace a fuse while the transformer is connected to an operating circuit, the cover should be opened by an insulated hook. After the new fuse is inserted, the cover should be closed also by means of the insulated hook, which should be of sufficient length to prevent the operator from being burned in case a short circuit exists in the transformer. The cartridge fuse may be replaced by the EJ-1, Size A.

In testing fuses for continuity of circuit, not more than 0.25 ampere should be used.

In replacing the EJ-1 fuses or in substituting the EJ-1 for the ES-1 or the cartridge fuse, care should be taken to select a fuse unit with the nearest voltage rating above line-to-line voltage of the circuit regardless of the rated voltage of the transformer. Do not attempt to overinsulate with fuse units of higher voltage ratings, as undesirable overvoltages may result. One permissible exception to this general rule is the use of the Size A, Type EJ-1 fuse in Type JE-32 or JE-2 transformers. In this case the Size A fuse can be used on either 2300-volt delta circuits or 2300/4150-volt grounded "Y" circuits.

Fuses can be refilled at the factory, provided they show no serious external defects.

DEMAGNETIZING

If by accident a current transformer becomes magnetized, it should be demagnetized in the following manner before being used for precision work: Connect at least 50-ohms resistance in series with the meters or instruments in the secondary circuit. Bring the primary current up to as near full load as possible and gradually reduce the secondary resistance by one-ohm steps until it reaches zero, being careful not to open the secondary circuit in the process.

DIFFERENTIAL PROTECTION

Standard General Electric current transformers may be used for differential protection through a considerable range of burden and overcurrent. This range is limited by the difference in burden, the maximum overcurrent, the mechanical and thermal short-time rating. Information regarding these points may be obtained from the nearest Sales Office of the Company.

INDIVIDUAL TYPES OF TRANSFORMERS

Outdoor Instrument Transformers

Bushings of outdoor instrument transformers sometimes become broken. Where the transformer is of the compound-filled construction such as Types K-78, K-81, JK-2, JK-6, JK-8, JK-10, JK-12, E-26, etc., the bushings can best be replaced by returning the transformer to the factory. When the casing is not filled with compound, such as Types WF-6 and E-36 (3000 volts and below), the bushing can be easily replaced by removing the bottom of the transformer casing.

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Conduit connections can be made to the secondary of the Type WF-6 and Type E-36 by loosening the screws which hold the bushing in place, removing the bushing, and inserting conduit fitting in place of the porcelain bushing.

Metering Outfits

Metering outfits are an adaptation of standard current and potential transformers mounted in housings, suitable for indoor and outdoor service. This arrangement combines the transformer units, necessary wiring and, in some cases, the meters under one casing.

The standard primary test voltage for outdoor metering outfits (as specified for combined units by the American Institute of Electrical Engineers) is 15 per cent lower than the lowest required of any individual transformer.

Portable Transformers

When used under ordinary conditions portable transformers both potential and current except split-core current transformers, will not vary more than 1 per cent from their marked ratio. When better accuracy is required, the ratio and phase angle certificate should be used. By means of this certificate corrections can be made to within 0.1 per cent on ratio and to within 3 minutes on phase angle.

Portable potential transformers, Types E-6 and E-9 have terminals arranged with thumb nuts. Double-rated transformers have four primary terminals. Connecting links are used to make connections for the different ratios. Care should be exercised to clamp the links firmly in place in order to obtain good contacts.

The Types R-2 and R-3 current transformers have no primary windings. The cable carrying the current to be measured is threaded through the opening in the transformer core. One or more turns of the primary cable may be used to give different ratios. The ratio of the transformer with different numbers of primary turns is given on the connection nameplate attached to the transformer. If several primary turns are used, they should be distributed around the core. The voltage rating (2500 volts) of the Types R-2 and R-3 transformers is based on a single conductor passing straight through the transformer. If several primary turns are used, the primary cable should be insulated for the full voltage of the circuit.

The Type P-3 current transformer has a self-contained primary. Changes in ratio are made by metal links located on the top of the transformer. Connections for various ratios are indicated by the diagram shown on the nameplate. Care should be exercised in changing connections to clamp the links firmly in place in order to obtain good contacts.

The Types PR-1 and JP-1 current transformers are a combination of the Types P-3 and R-2 construction. For the lower ratios, the transformers have a self-contained primary. For the higher ratios the self-contained primary should be disregarded, and the primary should consist of a cable insulated for the full voltage of the circuit, passed through the opening in the core, as many turns being made as are necessary to obtain the desired ratio as shown on the connection nameplate. The same general instructions as are given above for the Types P-3, R-2, and R-3 apply also to the Types PR-1 and JP-1.

All portable current transformers, except the split-core type, are provided with a short-circuiting switch on the secondary. This switch should always be closed whenever it is necessary to open the secondary circuit with the transformer connected in the line. **This short-circuiting switch should always be opened after making connections.**

Split-core Current Measuring Sets

Split-core current transformers, Types G-4 and G-5, are intended to be used only with the instrument and leads with which the transformer is calibrated. The scales on the ammeters are marked to read primary amperes direct, and the ammeters should not be used to measure current unless used with the transformer with which they are calibrated. Changes in ratio are made by turning the rotating switch on the ammeter.

Split-core current transformers have no voltage rating, and must not be used around any conductor which is not insulated for the full voltage of the circuit.

The ground core surfaces must be kept clean and free from any dirt. A very slight opening

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between the two halves of the core will affect the calibration of the set. Current-measuring sets consisting of a split-core current transformer calibrated with an indicating ammeter and leads will have an accuracy of plus or minus 2 to 3 per cent, and with a recording ammeter and leads an accuracy of plus or minus 3 to 5 per cent.

A current adapter is used with the split-core transformer for measuring small currents. With the correct size of terminals attached to the adapter, insert it in place of the fuse in the cutout. Clamp the split-core transformer into the round loop of the adapter and read the ammeter. Compute the line current from the formula on the nameplate of the adapter. The use of the current adapter does not affect the accuracy of the current measuring set, and it may be used with sets having either the indicating ammeter or the recording ammeter.

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