

## INSPECTION

### LOCATING AND CLEARING AC UNBALANCES

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#### 1. GENERAL

**1.01** This section describes how to locate and clear unbalances in AC power and lighting systems.

**1.02** It is reissued to:

- Update the format to conform with Pacific Company (PAC) Standards.
- Include the appropriate legend on Page 1 in accordance with AT&T's "Guidelines and Procedures for Safeguarding Information" and PAC's System Instruction (SI) 178.

*Note:* Marginal arrows used to denote changes are omitted.

**1.03** Certain types of broadband carrier channel banks, as well as lower level sections of other telephone equipment, are susceptible to the influence of stray 60-cycle (and harmonics) noise fields. The principal causes of these fields are multi-grounded neutrals and improper pairing of the hot and neutral wires in the AC power and lighting systems.

**1.04** When a pair of wires is feeding a load, the current flowing from the power source to the load through the hot wire equals that flowing back to the power source through the neutral wire. Magnetic fields generated by the current in each wire are equal in magnitude but opposite in direction; therefore, they cancel each other. However, if the supply and return currents in the wires are of different magnitude, complete cancellation does not occur; and a magnetic field is set up around the pair. This field will induce noise currents into nearby telephone circuits.

**1.05** *Inspect AC power and lighting systems before acceptance or when they are suspected of being a source of noise.*

**1.06** The National Electrical Code and National Bureau of Standards Handbook specify that an AC system should be grounded *only at* the service entrance. The identified conductor, commonly known as *the white wire*, is the grounded conductor or neutral. Erroneous or careless installation or abrasion of the insulation on the neutral wires causes grounds at points other than the service entrance. This is referred to as a multi-grounded neutral.

**1.07** Improper pairing of the *hot* and neutral wires of a circuit pair occurs where an individual circuit load of a given circuit has the *hot* wire on the circuit and the neutral wire on a different circuit. Where this occurs, the supply and return currents differ; and a resultant field is set up around the pair (or conduit containing the pair). Improper pairing usually occurs because individual circuits are not kept separate in junction boxes along main aisles. These boxes are usually filled to capacity with wires, making it easy to interchange circuit pairs.

**1.08** The Building Maintenance force shall be informed when trouble is located in an AC lighting or power system. They will make arrangements with the Building Engineer, Western Electric

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Company (WE), or an outside contractor, as appropriate, to clear the trouble. Central office maintenance forces should make no attempt to clear trouble in AC lighting or power systems.

### 2. TOOLS AND TEST EQUIPMENT

**2.01** In addition to tools normally available, the following tools and test equipment are required:

- 572B Tool (Probe), 147B Amplifier and 723A Receiver.
- Nonconducting Extension Rod (5 to 10 feet long).

**2.02** The 572B Tool (Probe), 147B Amplifier, and 723A Receiver are part of the 1-A Cable Fault Locator J94730A. (See Section 100-150-101.)

(a) **The 572B Tool (Probe).** The 572B Tool is a magnetic type probe, 1/2-inch in diameter and 6-5/8 inches long. This tool is designed primarily for locating wires and detecting crosses and is also useful in detecting AC unbalances.

(b) **The 147B Amplifier.** The 147B Amplifier is mounted in an aluminum casing. The outside dimensions are 4-7/16 inches by 4-7/16 inches by 1-7/16 inches. It weighs approximately 1-1/2 pounds. Two controls and two jacks are provided on the front panel of the amplifier. The controls are a 2-position switch, designated PROBE and COIL, for selecting the input impedance and a potentiometer, designated Volume (VOL), for adjusting the gain of the amplifier. The two jacks are designated INPUT and Receive (REC). The INPUT jack is used to connect the 572B tool to the amplifier, and REC jack is used to connect the receiver and battery supply to the amplifier. When the 147B amplifier is used with the 572B tool, the PROBE-COIL switch must be left in COIL position.

(c) **The 723A Receiver.** The 723A Receiver is equipped with a single receiver, headband, cord and plug.

**2.03 Nonconducting Extension Rod.** When using the 572B Tool, it is desirable to attach it to an extension rod so that it can reach points near the ceiling and at the base of the bay frames. A fiber, light-weight wooden or fiberglass rod 5 to 10 feet long may be used for this purpose.

### 3. DRAWINGS

**3.01** When necessary, refer to the drawings showing floor plans, power conduit, cable running lists, frame and aisle lighting series, and the wiring list and block schematic for power equipment and AC service.

### 4. PRECAUTIONS

**4.01** General safety precautions against personal injuries, equipment damage, and service interference shall be observed at all times.

### 5. COMMON TROUBLES

**5.01** Some common AC troubles are:

(a) Neutral wires pinched to ground potential by clamps, box covers, screws or washers in receptacles and fluorescent lighting fixtures.

(b) Neutral wires bonded to ground for power and lighting panels, and in panels of equipment.

(c) Improper pairing of black and white wires in conduit or metallic sheaths due to improper connections in junction boxes.

(d) Incorrect wiring of receptacles and receptacle connection plugs.

### 6. TESTING PROCEDURES

**6.01** At each lighting panel, make sure all circuit breakers are closed (turned on) and that all lights served by the panel are turned on. Also make sure that each receptacle circuit is loaded with a load of at least 100 watts.

**6.02** When testing for AC unbalances at a power panel, be sure all circuits of the panel are energized. If some of the circuits supply trolley ducts, load these by plugging a soldering iron or mobile test set into each duct. This is necessary to check for improper pairing.

**6.03** Use the 572B Tool, 149B Amplifier, and 723A Receiver to investigate the areas around conduit and light fixtures. If a loud hum is heard, it may indicate AC unbalances.

**6.04** Different types of AC-powered mobile testing equipment will normally cause a slight AC hum on their AC supply circuits as detected with the 572B Tool, 147B Amplifier, and 723A Receiver. Therefore, the probe amplifier cannot be used satisfactorily to detect a grounded neutral in such testing equipment. To check test equipment for grounded neutral, disconnect it and check the neutral to ground with an ohmmeter. A possible trouble could be a shorted or leaky capacitor in the power supply of the mobile testing equipment.

**6.05** Current supply sets, which are used in some offices, supply 60-volt, 60-cycle current to K2 carrier equipment. These sets have been found to be a source of serious AC noise on the conduit, BX cabling, and superstructure near the sets. The main cause of this AC noise appears to be a fairly common installation error, which is made by interchanging two black wires on B4 and B6 of a K2 amplifier panel (SD-59113-02). One of these black wires connects to the grounded side of the 60-volt AC transformer; the other connects to the 24-volt battery ground. Erroneously interchanging the two, effectively creates a multi-grounded AC neutral which causes the AC noise. Other causes of AC noise from current supply sets may be multi-grounded neutrals, either in the 110- to 220-volt input supply to the sets, or on the 60-volt output circuit.

**6.06** Use the 572B Tool, 147B Amplifier, and 723A Receiver to investigate the area around the current supply sets. Probe the BX cables which supply power to the sets, the overhead conduit, and the superstructure in the vicinity of the sets. A loud AC hum in the receiver may indicate AC unbalances. If possible, disconnect the current supply sets to see if the hum disappears. If two BX cables carry the 110- to 220-volt supply, they should be in the same cable run. If an unbalanced current is found flowing in the BX, a trouble condition exists somewhere on the current supply set circuits. In this event, it will be necessary to examine the entire circuit. The most probable cause of trouble is turn-over of the two black ground wires (6.05). Check these grounds to see that they are connected according to SD-59113-02. If these two ground wires are correctly connected, use the probe-amplifier to find and correct other multi-grounded neutrals on the circuits.

**6.07** Multi-grounded neutrals have also been found on other equipment. One such case is the dehydrator which supplies dry air to the TD2

waveguide and antenna system. In some installations the neutral wire on terminal 20 (SD-59698-01) has been bonded to the dehydrator panel by a copper strap. A No. 6 wire to the office grounding system has also been bonded to the panel. Thus the AC neutral is effectively connected to the office grounding system, causing unbalance on the AC power BX cable. Whenever a copper strap is found on terminal 20, it should be removed.

**Caution:** *Before removing the copper strap, make sure the dehydrator is grounded to the office grounding system.*

**6.08** Multi-grounded neutrals occur on Teletypewriter (TTY) equipment in many TTY locations. These occur when the neutrals are erroneously connected to ground potential (conduit or conduit boxes) by bare wires run in the conduit. These multi-grounded neutrals should be removed by qualified personnel.

**6.09** Some types of loads, such as rectifiers, develop a considerable field in their general vicinity. Unless there is an indication of unbalanced currents in the power leads feeding the rectifiers, there probably is nothing which can be done about removing the field. If rectifiers are installed too close to sensitive equipment, it may be necessary to relocate equipment or to shield the sensitive equipment.

## **7. CORRECTIVE PROCEDURES**

**7.01** The corrective procedures covered in this part *should be performed by qualified personnel.*

**7.02** The Building Maintenance forces shall be notified when an unbalance is detected by the testing procedures (see Part 6). They will make arrangements with the Building Engineer, WE, or an outside contractor, as appropriate, to clear the trouble.

**7.03** These procedures are described to allow maintenance forces to locate the trouble, understand the trouble clearing procedures, and make acceptance tests when the troubles are corrected.

**7.04** *Correction of Multi-grounded Neutrals in Lighting Circuits.* If an unbalance in the lighting circuit is detected by the testing procedures of 6.01, the circuit should be first checked for multi-grounded neutrals.

- (a) At the panel, open the breakers of the troubled circuit(s) and disconnect the neutral wire from the neutral bus.



**Caution:** *Since there is a possibility that the circuit can be crossed with a circuit from another power feed, the neutral wire can become energized through the load when it is disconnected from the neutral bus. Therefore, all wires should (at all times) be considered "hot" and tested for foreign voltage before proceeding further.*

- (b) Use an ohmmeter to measure the neutral circuit wire to frame ground. A zero or very low reading indicates one or more multi-grounded neutrals somewhere on the circuit. These grounds can be isolated by disconnecting the individual loads (fluorescent lighting fixtures) and observing the ohmmeter as each load is disconnected (Fig. 1). Leave each load disconnected until the ground is found and removed. If the ground is in the conduit between junction boxes, the wire is probably chaffed or the insulation broken. The wire will have to be replaced. After all grounds have been removed, reconnect the neutral wire to the neutral bus at the panel and energize the circuit(s) [breakers on]. If the unbalance still exists, improper pairing is indicated. In this event proceed with 7.05.

**7.05 Correction of Improper Pairing in Lighting Circuits.** The following procedures should be used after the procedures of 7.02 have determined that the circuit is free of multi-grounded neutrals (Fig. 2).



**Caution:** *In performing the procedures below, it will be necessary to work on energized circuits. When performing these procedures, two men should always be present; and rubber gloves should be worn for protection against electrical shock.*

- (a) Improper pairing consists of two types:
  - (1) The neutral of a given circuit supplies neutral return for a load whose *hot* wire is on a different circuit, or,

- (2) The *hot* wire of a given circuit supplies voltage to a load, whose neutral is on a different circuit. At the panel, open the breakers on the troubled circuit(s) and note if the unbalance disappears. If not, improper pairing of type (1) is indicated. This trouble can usually be located in one of the junction boxes on the circuit. Trace the circuit to the junction boxes and disconnect neutrals until the unbalance disappears. (This is a trial and error procedure, but it is not too difficult to find the trouble.)

- (b) If the unbalance disappears when the circuit breakers of the troubled circuit are opened, an improper pairing of type (2) is indicated. Close the breakers and use the individual bay lighting switches to turn off all lights on the circuit. If so, an improper pairing of type (2) is confirmed; and an interconnection with a different circuit can usually be found in one of the junction boxes on the circuit. This trouble can sometimes be isolated by leaving the individual bay lighting switches of the troubled circuit off and observing the fluorescent lights while opening and closing the circuit breakers of other circuits at the panel. A fluorescent light inadvertently connected to this circuit will be observed going off and on. Reconnect the neutral of this fixture to the correct circuit. Lighting circuits controlled by more than one switch should be tested for all possible combinations of switch positions.

**7.06 Correction of Receptacle Circuits.** Most testing equipment (6.04) will cause AC hum on a receptacle circuit. Therefore, all testing equipment should be disconnected before proceeding with (a) through (c) as follows:

- (a) If a circuit supplies power to base receptacles and the procedures in 7.04 and 7.05 isolate troubles to the receptacle circuit, the trouble is probably a multi-grounded neutral on one or more receptacles or incorrect wiring in one or more of the interconnecting cables which connect the base receptacles together. The receptacles of the troubled circuit can be located by opening the circuit breaker and plugging a lamp into receptacles along each bay until the de-energized receptacles are located. Verify the circuit by closing the breaker and noting that the lamp plugged into the receptacle lights. When the receptacles of the troubled circuit have been located, use the 572B Tool, 147B Amplifier, and 723A Receiver as specified in 7.06 (b) and (c), to locate the trouble.

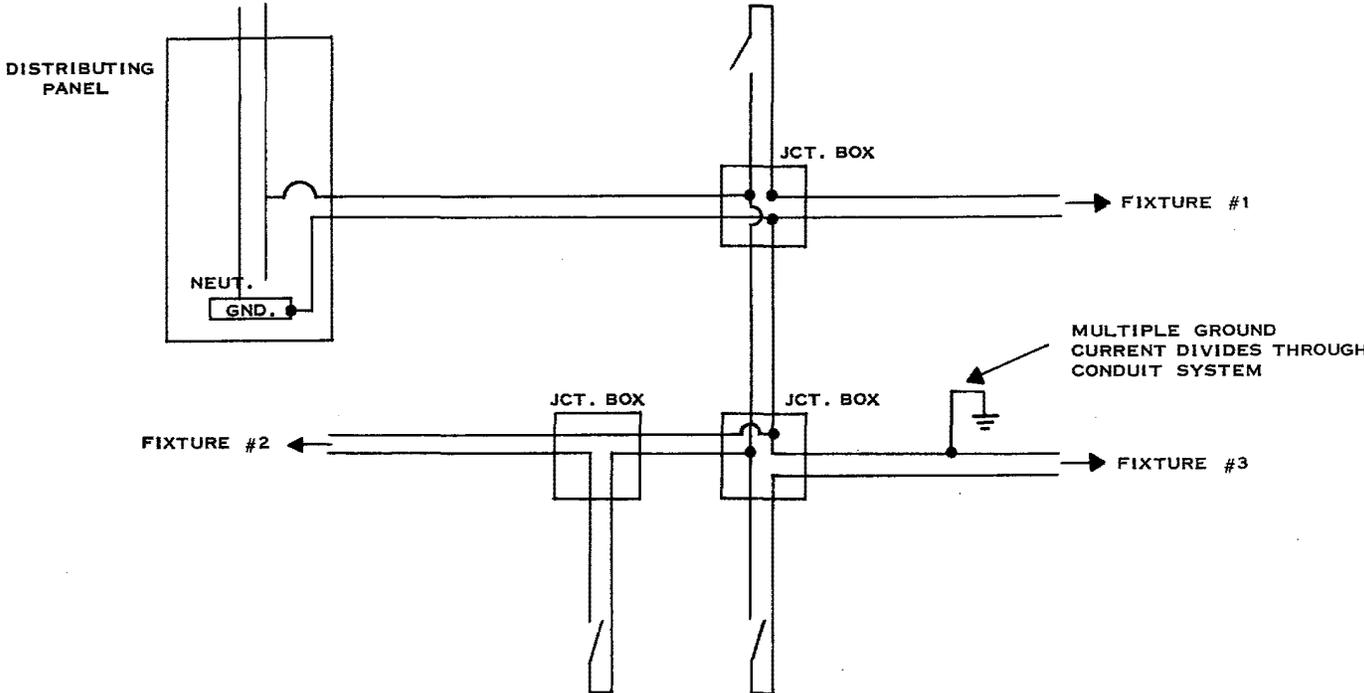


Fig. 1

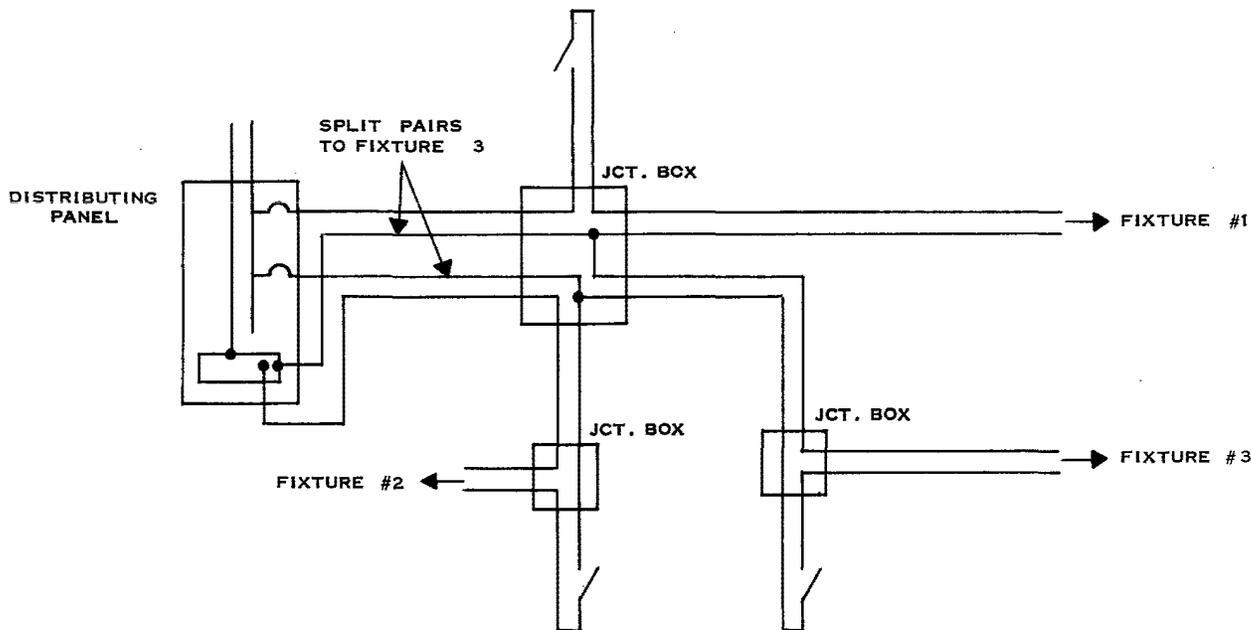


Fig. 2

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(b) To facilitate operations, fasten the 572B Tool securely to the nonconducting fiberglass or wooden extension rod. Place the plug of the 572B Tool in the INPUT jack and the plug of the 723A Receiver in the REC jack of the 147B Amplifier. Set the PROBE-COIL switch to COIL and VOL control to maximum clockwise position.

(c) Place the 572B Tool against each base receptacle of the troubled circuit and listen to the receiver for AC hum. If AC hum is heard, proceed to the next outlet until outlets are located between which the AC hum changes abruptly.

The trouble should be located in one of the receptacles or in the wires that interconnect the receptacles. (It is possible that no AC hum will be heard on the defective receptacle but on adjacent receptacles.)

**Power Panel Circuits**

**7.07** Corrective procedures for power panel circuits are essentially the same as those of lighting panel circuits except that they should be more simplified.