BATTERY SUPPLY NOISE

PROCEDURES FOR MAKING AND EVALUATING NOISE MEASUREMENTS ON CENTRAL OFFICE BATTERY SUPPLIES

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1. GENERAL

1.01 Power plants are potential noise sources in working communications systems. This section provides specific procedures for measuring the various types of noise that appear on central office battery supplies.

1.02 ➧This section does not affect Equipment Test Lists.

1.03 This section contains the information previously contained in Section 331-200-502, Issue 1, dated October 1968. Arrows are used to indicate the changes that have been made. Additional information has been added to bring the section up to date.➧

1.04 All types of noise may be observed from time to time in battery supply cabling and wiring. Although the power plant may contribute noise, other central office sources tend to generate the predominating contribution. Also, noise completely external to the telephone plant may appear on battery wiring. The noise from each of these sources tends to be characteristic of the source. Therefore, listening tests should be conducted with the measurements to help identify the noise source. Circuit noise is usually characterized as hum, tone, beating tones, static, frying, microphonics, intermodulation, impulses, clatter, hissing, or crosstalk. Because these terms are ambiguous, a brief definition of their accepted meanings as related to noise is given as follows:

Hum—Normally the audible effect of 60-Hz harmonics. (Hum may also apply to dial tone crosstalk and similar sounds heard as noise.)

Tone—Single audible frequencies of relatively constant amplitude. Howling repeaters frequently generate unwanted tones that may couple into the transmission path. Several interfering tones may combine in a disturbed circuit to produce variations in amplitude or pitch, or both. This is frequently described as "singing".

Hissing—The effect of thermal noise. Thermal noise originates in all parts of the telephone system, but it is predominantly in components working at elevated temperatures, such as electron tubes.

Frying—Noise which frequently originates at base metal contacts carrying current.

Static—A crackling, popping sound. Sources of static include atmospheric noise, corona discharge on high-voltage transmission lines, high-voltage discharge or arcing in electrical equipment, and central office clatter. Static can occur as direct induction at voice frequencies or it can be demodulated from higher frequencies by radio or carrier channelizing equipment.

Crosstalk—Unwanted speech in message channels. Usually, it is intelligible words and phrases, but may also be present as garbled speech or babble. Garbled crosstalk

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may be entirely from demodulation products of carrier-frequency crosstalk or may include intermodulation products.

Microphonics—Usually low-pitched, bell-like sounds generated at contacts under light pressure or within electron tubes. In both cases, microphonics are most often caused by the part reproducing vibrations present in the supporting structure.

Intermodulation—A number of noise sounds, including babble, produced by the many complex frequencies present in carrier and radio systems. Intermodulation increases as the system load increases.

Impulses—Very sharp clicks and pops that rise substantially above other noise. Impulses of short duration may not be audible in a telephone receiver, but may adversely affect data.

Clatter—The general background noise from central office operation. Clatter is almost nonexistent under light calling conditions, but it increases with load through the busy period.

1.05 Battery supplies present very low impedances. Therefore, the 3-type and 7A noise measuring sets (NMS) and the 4A noise analyzer and readings are not true dBrn (power), but actually are noise voltage indications. However, differences between two readings may still be expressed in dB. Since the battery impedance is so much lower than 600 or 900 ohms, the measuring sets should indicate about the same voltage, regardless of whether set for 600 ohms, 900 ohms, or bridging. The bridging or other high-impedance setting is preferred, and must be used with the 3C NMS.

1.06 Listening tests are very helpful when noise measurements indicate that battery noise is a problem. The monitoring receivers, furnished with the two types of noise measuring sets (3-type and 7A) and the 4A noise analyzer, are convenient for this purpose. A small loudspeaker with an amplifier, such as the AT7888 List 1A (Section 106-020-112), may be used in place of the monitoring receiver. When the 3A or 3B NMS is used, a 10,000-ohm resistor must be placed in series with the amplifier input to avoid impairing the accuracy.

1.07 This practice assumes that battery supply noise will be measured only when other measurements on lines, trunks, or facilities indicate a battery supply might be introducing noise. Systematic routine measurement of battery noise should be undertaken only on the decision of area plant administration and then based on local conditions. Other routines called for in present practices, such as periodic inspections and tests of filter capacitors, must be completed at the recommended intervals to assure that critical power supply components are functioning correctly.

1.08 Test leads that parallel either charge or discharge leads may pick up noise by induction. This induced noise may cause large errors in noise measurements. Thus, the shortest possible twisted pair of test leads that run at right angles or well separated from power conductors provide the most reliable measurements. Shielded leads may also help reduce coupling. However, the ground used for the shield must be carefully selected, as outlined in the following, to assure that it does not influence the measurements. It may be necessary to ground both ends of the shield to reduce inductive effects.

1.09 In most central offices, there are fuse panels, power panels, or power distribution panels equipped with spare fuse holders. These are reasonably safe and adequate for noise measurements. A small fuse, 1-1/3 amperes or less, placed in a vacant fuseholder which is then used as the ***battery*** terminal for connection to the NMS input, will protect test leads, measuring instruments, and power equipment against faults or equipment failures. In the few cases where no spare fuse is available, make up a well-insulated cord with a small fuse in the lead.

> ***Warning: Central office batteries will supply large amounts of current under short circuit conditions. This current will generate heat in any conductor that happens to form a short circuit. Small conductors will fuse quickly and splatter molten metal exposing anyone in the vicinity to burns and flash. Larger metal objects, such as tools, if allowed to short-circuit a battery, may seriously damage the conductors involved, the batteries themselves, or operate protective devices and cause a major service interruption.***

1.10 The sections describing the various noise measuring sets and analyzers suggest grounding the sets during calibration and measurement. In general, this is a good practice. However, the ground is not essential except for noise-to-ground measurements; and, if the available grounds carry noise voltages, the connection may affect the readings of the NMS. To be sure the ground does not affect the measurement, verify that the meter reading does not change with the ground connected and with it disconnected. Also, long test set ground leads that are run to distant frames, may create ground loops which pick up additional noise that might couple into the circuits being measured. Where a test set ground is used, make sure the test connection is secure, preferably to a ground bus, rather than to the framework. Finally, check for and tighten loose bolts and gutter taps in the ground bus itself.

2. APPARATUS

2.01 ♦The apparatus listed below are required for making the tests described in this section.

For Message Circuit Noise Measurements

1—3-type noise measuring set (3A or 3C) equipped with monitoring headphone (1 required) and 497A network.

1—W2FD patch cord (or equivalent), 9-1/2 feet long, equipped with KS-16336, L1 insulated clips on one end and No. 134 cord tips on the other end.

For Carrier Frequency Noise Measurements

1—J94007A (7A) carrier frequency noise measuring set (or equivalent) e/w 497A

1—Balanced shielded cord e/w No. 3458 double coaxial plug on one end and two KS-16336, L1 insulated line clips (or equivalent) and one type 59 ground clip (or equivalent) on the other end.

For Harmonics of 60 Hz

1—4A frequency analyzer (or equivalent)

1—2W21 cord with 364 tools (spade tips) at one end and insulated clips soldered to the other end.

Twisted pair conductors with insulated clip on one end and spade tips on the other end may be used.♦

3. PROCEDURE

3.01 These test procedures are divided into three parts (message noise measurements, carrier frequency noise, and 60-Hz harmonics) because of the different noise categories and the various test sets used to make the measurements. Each set of measurements is a separate test and can be performed independently.

A. Message Noise Measurements

STEP	PROCEDURE
1	Set up the 3-type noise measuring set at or near the point of measurement and calibrate in accordance with Section 103-611-100 (3A) or 103-611-101 (3C).
2	Set the DBRN switch to 85.
3	Set the FUNCTION switch to BRDG.
4	Set the DAMP switch to NORM.
5	Insert the 497A network in the WTG jack oriented for C MESSAGE.
6	Plug monitoring headphone into the AC MON jack.

STEP	PROCEDURE
7	➧Record the location of each measurement, such as main power panel, fuse bay number, relay rack number, switch frame number, etc. A sample form for recording these measurements is included as part of this section. The form is suitable for reproduction.➧
8	Connect the test clips of the 2W42A cord through a 1-1/3 amp fuse in a spare position on the battery fuse panel and to the associated ground bus. If there is no spare fuse and the connections must be made to a battery supply bus with a fuse test lead, use extreme care to avoid connections that might lead to a service interruption. ***Warning: Central office batteries will supply large amounts of current under short circuit conditions. This current will generate heat in any conductor that happens to form a short circuit. Small conductors will fuse quickly and splatter molten metal, exposing anyone in the vicinity to burns and flash. Larger metal objects, such as tools, if allowed to short-circuit a battery, may seriously damage the conductors involved, the batteries themselves, or operate protective devices and cause a major service interruption.***
9	Adjust the DBRN switch to obtain a reading between +2 and +9 on the meter scale. The actual noise level will be the sum of the meter reading pulse the DBRN switch setting. ***Requirement:***

BATTERY SUPPLY	MEASURING SET	FURTHER ANALYSIS NOT NECESSARY	FURTHER INVESTIGATION	IMMEDIATE ACTION
Talk				
24V or 48V	3A	30 dBrnc or less ➧(See Note)➧	31-40 dBrnc	Over 40 dBrnc
Signal				
24V, 48V	3A	55 dBrnc or less	Over 55 dBrnc	—
130V	3A	70 dBrn 3 kHz Flat	Over 70 dBrn	—

➧ ***Note:*** **When testing on the load side of decentralized discharge filters, typical values should be 20 dBrnc or less. Where noise on the load side does exceed 20 dBrnc, careful listening checks should be made to determine if the noise on the load side is, or is not, identical with that on the battery supply side.**➧

STEP	PROCEDURE
10	During the measurements, listen to noise on the battery supply with the monitoring headphone and note the character of the noise i.e., crosstalk, tone, impulse, hum (60-Hz harmonics), static, frying, hissing, etc.
11	Using the work sheet, record the noise measurement and the description of the noise.
12	Carefully remove test connections.

B. Carrier Frequency Noise Measurements

STEP	PROCEDURE
1	Set up the 7A carrier frequency noise measuring set at or near the point of measurement and calibrate in accordance with the procedure on the front panel of the test set and Section 103-500-100.
2	Set the DBRN switch to 80.
3	Set the FUNCTION switch to BRDG ADD 10.
4	Set the DAMP switch to NORM.
5	Set the MODE switch to SUPP CARRIER—USB or SUPP CARRIER—LSB.
6	Insert the 497A weighting network in the WTG jack oriented for 3 KC FLAT.
7	Plug the 1022A headset into the PHONE jack.
8	Record the location of the measurement.
9	Connect the test clips of the balanced shielded cord through a 1-1/3 amp fuse in a spare position on the fuse panel of interest and to the associated ground bus. ***Warning: Central office batteries will supply large amounts of current under short circuit conditions. This current will generate heat in any conductor that happens to form a short circuit. Small conductors will fuse quickly and splatter molten metal, exposing anyone in the vicinity to burns and flash. Larger metal objects, such as tools, if allowed to short-circuit a battery, may seriously damage the conductors involved, the batteries themselves, or operate protective devices and cause a major service interruption.***
10	Set the CARRIER FREQ dial to 10 KC.
11	Slowly sweep the dial from 10 kHz to 552 kHz and observe the meter readings while adjusting the DBRN switch to maintain a reading between +2 and +9 dBrn on the meter scale. At the point of maximum reading, record the noise level, the frequency, and the description of the noise. ***Note:*** The noise level will be the meter reading, plus the DBRN switch setting, plus 10 dBrn. ***Requirement:***

BATTERY SUPPLY	MEASURING SET	FURTHER ANALYSIS NOT NECESSARY	FURTHER INVESTIGATION	IMMEDIATE ACTION
130V	7A	50 dBrn 3 kHz Flat	Over 50 dBrn	—
24V, 48V		No requirement		

STEP	PROCEDURE
12	Carefully remove test connections.

C. 60-Hz Harmonics Measurements

STEP	PROCEDURE
1	Set up the 4A frequency analyzer at or near the point of measurement and calibrate in accordance with the procedure on the front panel of the set and Section 103-635-100.
2	Set the DECIBELS switch to 90.
3	Set the INPUT SELECTOR to POWER VOLTS.
4	Record the location of the measurement on a form as in Fig. 3.
5	Connect a twisted pair to the binding posts POWER VOLTS and multiple with another twisted pair to the POWER MILLIVOLTS binding posts.
6	Connect the EXT GRD binding post to a ground and check its suitability as described in 1.07.
7	Connect the other end of the twisted pair between a 1-1/3 amp spare fuse on the panel of interest and the associated ground.
	Warning: Central office batteries will supply large amounts of current under short circuit conditions. This current will generate heat in any conductor that happens to form a short circuit. Small conductors will fuse quickly and splatter molten metal, exposing anyone in the vicinity to burns and flash. Larger metal objects, such as tools, if allowed to short-circuit a battery, may seriously damage the conductors involved, the batteries themselves, or operate protective devices and cause a major service interruption.
8	Set the BATTERY switch to ON.
9	Starting at the low-frequency end of the FREQ KC scale gradually rotate the thumb wheel while watching the meter. The presence of a frequency component in the range covered by the set will be indicated by a deflection of the meter pointer. The specific frequency component can be read directly on the FREQ KC scale. Many signals are complex and there may be several indications from a single circuit in the range of 15 Hz to 5 kHz. Particular attention should be given to 60 Hz and its multiples or harmonics.
10	Continue to slowly sweep the dial from 15 Hz to 5 kHz, observe the meter reading while adjusting the DECIBELS switch to maintain a reading between −10 and +4 on the meter scale.

STEP	PROCEDURE
11	Record the measurements. The frequency and level of all peaks in the 15-Hz to 5-kHz ranges should be recorded on the form.
12	Carefully remove all test connections. ***No Requirement:*** 4A noise analyzer best suited to troubleshooting procedures.

4. EVALUATION OF MEASUREMENTS

4.01 In general, voice frequency noise measured at a talk battery fuse panel should not exceed 30 dBrnc. In no case should the noise exceed 40 dBrnc. These noise values include a reasonable allowance for the noise attenuation of the typical talking battery supply arrangements for subscriber loops from central offices. There are only two general types of talking battery feed circuits, repeating coil and bridged impedance, but there is considerable variation in the apparatus used in different types of central office equipment. These differences, together with variations in loop current, make the noise attenuation vary over a fairly wide range. Thus, measured noise in the range between 31 and 40 dBrnc may, or may not, be satisfactory. Whether further investigation is required will depend on the noise levels in the transmission circuits served by the battery supply in question. Similar considerations apply to signal and plate battery supplies. If the noise in the affected circuits, cable or carrier, meets objectives as stated in the relevant practices, no further investigation is required. Conversely, where noise on trunks or subscriber lines is also excessive and correlates in harmonic content, or other characteristics, with the noise observed on the battery supply circuit, further investigation of the battery supply will be necessary.

4.02 Noise in excess of 40 dBrnc on a talk battery supply requires immediate investigation and corrective action. The following paragraphs describe a number of likely trouble situations and what might be done to reduce the noise in each case.

4.03 Seasonal effects and sometimes daily power load may increase noise considerably. An example is the effect of commercial ac power system load variation. At certain times, these systems contain more harmonics which can enter communications circuits as inductive interference. Also, the effect of high calling rates during busy periods on overall telephone system noise may obscure any noise effects contributed by battery supplies.

4.04 C-message weighted noise measurements should usually be considerably less on the load side of a filter than on the source side. Three-kHz flat-weighted noise, however, may sometimes be about the same on both sides of a filter because the filter attenuates low frequencies much less than higher ones. It may, in some cases, be higher on the load side, which might indicate either low frequencies coming in from the outside plant, or possibly resonance effects in the filter.

4.05 Excessive C-message weighted noise on the talk battery side (load side) of a filter may indicate an open capacitor fuse or defective filter capacitor (see Fig. 1). However, such a measurement is not conclusive. A supplemental measurement of noise ahead of the filter (on the battery or source side) will help clarify the first measurement. The supplemental measurement should be at the signal battery fuse panel supplying the filter. Considerably higher noise readings at the signal battery bus suggest that the filter is working. Noise about the same on both sides of a filter or only moderately higher on the battery side tends to confirm the original inference that the filter capacitor is defective. In such a case, check that the capacitor fuse is not missing or blown. This condition may also indicate trouble with the inductor or that the filter is reversed with the capacitor on the source sides of the inductor. An inductor on the load side of the capacitor will increase the apparent battery supply impedance and further increase the noise.

4.06 Any inadvertent path connecting the talk battery side of a filter to signal battery will short the series inductor and essentially destroy the effect of the filter. Such paths will not be apparent because usually no fuses will blow. The only indication will be that noise on the talk battery will be about equal and similar in character to noise on the signal battery. As an example, ringing machines must be connected through a fuse to signal battery. An alarm fuse parallels the main fuse, although it does not need to be on the same fuse panel. This fuse could be inadvertently located on a talk battery fuse panel and thus provide a connection for noise between signal battery and the load side of the filter.

4.07 Common impedance crosstalk in the battery circuit is usually low except under trouble conditions. The crosstalk coupling loss from one subscriber line circuit to another via the common impedance of the battery supply path lies in the range of 120 to 150 dB without the discharge filter. Thus, crosstalk via the common impedance of the battery circuit is insignificant and the presence or absence of discharge filters is inconsequential from a crosstalk standpoint. Defective discharge filters, where the series inductor is in the circuit but the shunt capacitor is out of the circuit, as could happen with a blown capacitor fuse, would be an exception. In this case, the increased source impedance would adversely affect the noise on the load side of the filter.

4.08 Investigation of high noise measured on signal battery will usually depend on the kind of noise involved. Listening tests often give the clue to the specific source of the interference. Repeated measurements on several or all of the fuse panels in a central office may, by comparative magnitudes, help establish the direction of flow of the noise and point to a general area where the source might be located.

4.09 Harmonic analysis, using the 4A frequency analyzer, or an equivalent instrument, will identify and give the magnitude of 60-Hz harmonics, if any are present. The same procedure will help to identify tones of unrelated frequencies.

4.10 In cases where C-message weighted noise is excessive and listening tests with the monitoring receiver do not clearly identify the trouble, additional listening tests with 3-kHz flat weighting may help. Such measurements, in general, will be higher than C-message weighted measurements because of the effect of 60 Hz and any of its harmonics below about 900 Hz. Discharge filters have very little insertion loss at the lower frequencies and especially below 120 Hz.

4.11 Occasionally, direct measurements such as those described above will not identify a particular piece of power apparatus that is in trouble. A technique of ***on-off*** testing is sometimes effective where load conditions permit. In this procedure one or more pieces of apparatus are shut down. A significant change in the noise should identify the source. The batteries will carry the full office load for a reasonable period while the charging apparatus is shut down. However, it is not possible to shut down both ringing machines at the same time. One must continue to run or the whole office will fail.

4.12 Where battery noise measurements indicate that all filters are working properly but excessive noise persists in the talk battery leads, then either inductive interference in the outside plant, or noise from within the office is likely. The presence of 60-Hz harmonics should identify inductive interference. These enter the battery circuit via both common impedance in the ground path and inductive couplings. The neutral of the 120/240-ac building supply, if grounded at any point in the building beyond the service entrance, may introduce noise into the central office grounding system that can appear in the talk battery and elsewhere. Excessive coupling often occurs as the result of running high noise influence leads (power supply, telegraph, ringing, tone circuits, control circuits, etc) in the same cables, cable runs or bay wiring containing low level transmission circuits, or talk battery supply leads. The presence or absence of such a condition can often be ascertained by physical inspection of the cabling where the disturbed and disturbing pairs or wires are closely parallel and/or by temporarily rerouting either the disturbed or the suspected disturbing circuits. Occasionally noise can be traced to its source by using a 147B amplifier and pickup probe to follow power or other leads carrying high level noise. In checking talk battery leads, be sure they are paired throughout their length.

4.13 Where measurements do suggest that battery noise may be a contributor to the overall noise originating in a central office, it may be helpful to check the physical condition of batteries, rectifiers, commutators, filter capacitors, etc. To be effective, the filter capacitors must be connected on the talk battery or load side of the filter inductor and polarized properly with the correct size capacitor fuse in place. Occasionally, a capacitor fuse may open or be removed without blowing the alarm fuse. The unblown alarm fuse adds resistance in series with the capacitor, reducing its filtering action. Also, filter capacitors change their characteristics noticeably over longer periods of time because of aging effects. These, as they age, allow more noise to flow in the associated battery supply circuits. Division 032-1 contains a section describing tests on electrolytic capacitors.

4.14 Talk battery and ground supply conductors are paired only from the local fuse panel to the equipment. Signal battery conductors are seldom paired. Between the power plant and the various battery distribution panels, the battery and ground leads are not twisted because of their heavy gauge. As a result, their balance tends to be poor. Noise voltages and currents on battery and ground conductors may therefore induce disturbing voltages or currents on paralleling conductors if they are close together.

4.15 Small dial central offices are designed with no discharge filtering. In these situations if battery supply noise becomes a problem, decentralized filters and, in some cases, centralized filters should reduce the noise to acceptable levels.

4.16 Where noise is excessive at talk battery fuse panels fed from existing centralized discharge filters, replacing by or supplementing with decentralized filters is indicated.

4.17 Because of various built-in noise control features, built into voice-frequency repeater or carrier-frequency equipment, noise measured at a battery distributing fuse panel may be at quite high levels and still be well within acceptable limits when measured on the voice-frequency transmission path at the proper test jacks shown on the CLR card. Most of the noise signal on battery supply wiring is generated by the loads, ie, switches, amplifiers, relays, etc, and is fed back to the battery if not blocked by filters. Noise on talk battery is more likely to be induced by noise currents and voltages flowing on nearby wiring. The charge filters built into the various rectifiers substantially reduce carrier-frequency interference coming through or generated within the rectifier. In general, external decentralized filters are not required for voice-frequency repeaters or carrier systems. Where the battery supply and associated wiring is clearly the source of noise, defective filtering apparatus furnished with the equipment may be a likely cause. To verify the operation of plate battery filter components, considerations similar to those described for talk battery filters apply.

4.18 Battery supply ground leads are frequently very noisy. These leads are often inadequate or indirectly routed. Noise results from current transients, generated by switching functions and other relay operations, flowing through these leads. Even though these leads are usually very large, they begin to have appreciable impedance at midaudio and higher frequencies. For this reason, one should not rely on the battery supply ground leads for shielding or for other critical grounds. Grounds for these purposes should preferably be the largest capacity bus of nearby availability. Carefully check to ensure that all associated bus bar bolts, splice plates, and gutter tops are tight. Long test equipment or other ground leads must be avoided. Such leads might form ground loops that will pick up noise and carry it to test gear, shielding, or both.

4.19 ♦It has been found that decentralized filters can experience a great variety of troubles. The following is a list of the more common troubles that have been found.

(1) Filter capacitors not connected because of failure to install fuses.

(2) Blown fuse undetected. Caused by alarm not being connected.

(3) Ground side of filter capacitor connected to rack instead of TALK ground.

(4) Load connected to input side of filter.

(5) Loose connections on current buses supplying fuse panels.

(6) Ground side of filter capacitor connected to signal battery.

(7) Ground side of filter capacitor connected to signal ground instead of TALK ground.

(8) Filter wired backwards.

(9) Filter output strapped to signal battery at fuse panel.

(10) Signaling equipment wired to filtered battery instead of signaling battery thus making the load noisy.

(11) Filter installed but not connected.

(12) Loose connections between filter and load at load point.

(13) Improper wiring options in–48 volt power plant.

(14) Aged filter capacitor. Dried out.

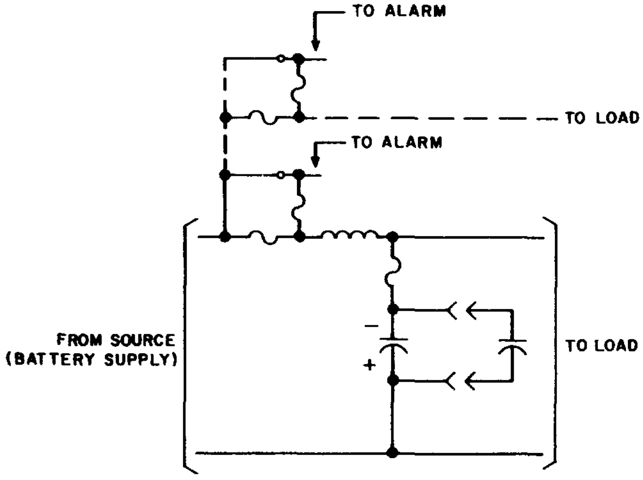

Fig. 1—Typical Filter

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BATTERY NOISE MEASUREMENTS
TROUBLE REPORT

OFFICE ______________________

DATE ______________________

TO:

The following battery noise measurement exceeds BSP limits. Please verify and institute corrective action as required.

Trouble Detail

1. Voltage ______________________ 2. Filtered or unfiltered ______________________
3. DBRN measurements __________ "C" MSG. ______ 3 KHz Flat ______________________
   (a) Load side of Filter ________ ________
   (b) Battery side of Filter ________ ________
   (c) Unfiltered ________ ________
4. Connected Equipment ______________________
5. Floor and/or Bay Number ______________________
6. Applicable Station Drawing No. ______________________
7. Power Plant Maintenance By ______________________

Note: "C" MSG. and 3 KHz FLAT wtg readings required for each applicable condition.

Originator ______________________

Title ______________________

DETAILS OF ACTION TAKEN:

Signed ______________________

A. T. & T. CO.

BATTERY NOISE MEASUREMENTS
WORK SHEET

WEIGHTING		DBRN MEASUREMENTS				
N.M.S. OR FREQUENCY	POINT OF MEASUREMENT AND VOLTAGE (1) (2)	AT FUSE PANEL	BATTERY SIDE OF FILTER	LOAD SIDE OF FILTER	DESCRIPTION OF NOISE	(3) CONNECTED EQUIPMENT

(1) Indicate filtered or unfiltered (F or U)
(2) Identify as load A, Bay No. or other
(3) Complete only when DBRN readings exceed limits

OFFICE ____________________

DATE ____________________