Operation and Maintenance Manual

Model 106C

AEC #SGM49A

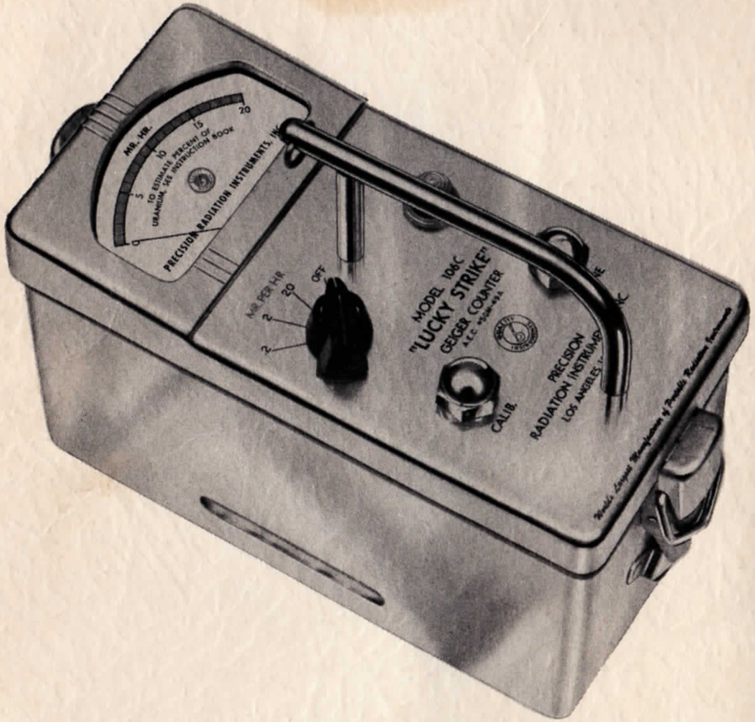
"Lucky Strike" Geiger Counter*

* Trademark

PRECISION RADIATION INSTRUMENTS, INC.

Los Angeles 16, California

World's Largest Manufacturer of Radiation Instruments



Model 106C "Lucky Strike" Geiger Counter

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Precision Radiation Instruments, Inc.

MODEL 106C INSTRUCTION MANUAL

I. GENERAL INFORMATION

The Model 106C is a battery operated Geiger Counter. The instrument has sensitivity ranges of 20, 2.0 and 0.2 milliroentgens per hour. It employs a Geiger tube as the detecting element, and detects both beta and gamma rays.

The presence of very small amounts of radiation can be detected by taking a measurement with a Geiger Counter. A count can be taken by counting the flashes of the neon bulb, the clicks in the earphone or by observing the meter reading.

The instrument will normally produce clicks in the earphones at the rate of about 30 to 50 per minute. This is the normal background count caused by cosmic rays and natural radioactivity and does not indicate the presence of ore bodies. When a higher level of radioactivity is encountered, the number of clicks per minute will increase. A fair amount of radioactivity will cause the clicks to be as rapid as the firing of a machine gun. This can be demonstrated by bringing the radioactive calibration disc supplied with the instrument up to the window in the case.

To permit accurate meter readings, the instrument is provided with three ranges of sensitivity. These ranges are selected by means of the range switch (marked MR PER HR) on the panel. The setting of the range switch does not affect the number of clicks heard in the phones or the number of flashes observed on the neon flasher. The individual clicks, however, are loudest on the .20 range. Since the intensity of radiation is greatly affected by the distance between the source and the detector, samples should be brought as close as possible to the window in the case of the instrument.

The Model 106C has a calibration adjustment and is weatherproof. The calibration adjustment is located on the top panel of the instrument. A calibrated radium disc is supplied with the instrument. It is mounted in a clip on the end of the case.

The 106C can be used in the laboratory as well as for Civil Defense and prospecting. In Civil Defense work, the instrument is classed as a low level beta-gamma survey meter.

Geiger Counters do not detect metals, minerals or any material that is not radioactive. Metal locators are required for such purposes.

II. DEFINITION OF TERMS

Certain terms are encountered in the use of radioactivity measurements which are peculiar to this use and which should be explained in order to make this text more understandable.

Radioactivity: The process whereby certain elements emit particles or rays due to the disintegration of the nuclei of their atoms. The main types of radioactivity are alpha particles, beta particles and gamma rays. Since gamma rays are the only type of radiation with appreciable penetrating power, they are of the most importance to the prospector.

Beta particles and gamma rays are emitted in essentially equal numbers by radioactive elements. However, beta particles are so readily absorbed by rock or soil that they are of interest to the prospector only under special circumstances. Beta particles are completely absorbed by about 1/8 of an inch of loose soil or by only 1/16 of an inch of rock, thus, only those beta particles emitted within 1/16″ of the surface of an ore specimen can possibly be detected by a Geiger Counter. This means that readings of beta activity are only "skin deep." Also, since beta radiation is not usually uniformly distributed through the sample, a reading of beta radiation can give a false impression of the value of the ore.

Milliroentgen: The unit of measurement of radiation. This term is usually used with a unit of time; i.e., milliroentgens per hour (abbreviated MR/HR). The term MR/HR denotes the rate at which radiation is arriving at a given point. MR/HR, in measuring the amount of radiation being received is comparable to measuring speed of travel in terms of miles per hour. MR/HR is the most reliable measure of radiation intensity because the MR/HR in a given field of radiation will always be the same, no matter what type of instrument is used in making the measurement. The instrument is actually measuring the average of the counts per minute being received and then translates it into milliroentgens per hour. However, measurements of counts per minute vary greatly with the type and efficiency of the particular instrument used and other factors. For example, one instrument may be one hundred times as sensitive as another. In this case, the more sensitive instrument would indicate one hundred times as many counts per minute in the same field of radiation as the less sensitive instrument. Therefore the instrument is calibrated in MR/HR instead of counts per minute.

If a man stays twelve hours in a field of radiation which has an intensity of five MR/HR, he will have been exposed to 60 milliroentgens. This is the maximum amount which health physicists generally believe to be harmless, even when repeated day after day.

Background: A certain portion of any radioactivity measurement is not attributable to the radioactive sample being measured, but comes from other sources. This portion of the measurement is called "background." It is caused by cosmic radiation, natural radioactivity of the earth, and other sources, and is present everywhere to some extent.

Geiger tube: The Geiger tube is a gas-filled tube used as the detecting element in a Geiger Counter. The Geiger tube employed in the 106C is 3/4″ in diameter and about 4″ long. The beta particles and gamma rays which strike it produce electrical pulses which, in turn, actuate the electric circuits and the meter of the instrument.

Overburden: This is the term applied to the rock or soil lying between an ore deposit and the surface of the earth.

III. MEANING OF METER READINGS

Measurements of radiation intensity are made by reading the values indicated on the meter in milliroentgens per hour (MR/HR). The instrument continuously counts the average of the number of rays being detected, and translates this into readings in MR/HR. MR/HR readings can be translated into percentage of uranium oxide content. Instruction for this translation are included in Section VII, Assaying with a Geiger Counter.

The needle of the meter will never be perfectly still, because of the random nature of the occurrence of the radiation being measured. Radiations arrive at spasmodically spaced intervals; therefore, the needle of the meter constantly changes position. The correct reading of the meter is the average of the lowest and highest positions occupied by the meter needle. For example, with the range switch set to 20, if the meter needle fluctuates about the center of the scale, but half the time is to the right of the 10 mark and half the time is to the left of the 10 mark, the correct reading is 10 MR/HR.

In fields of high radioactivity, the meter needle will be steadier, and more accurate readings can be made because more radioactive rays are detected per time interval. Therefore, readings taken on the 20 range will be steadier and more accurate than readings of very low intensity taken on the .20 range.

On the .20 range, the numbers at the major divisions of the meter scale should be read as .05, .1, .15, and .2 MR/HR. On the 2.0 range, the major scale divisions should be read as .5, 1.0, 1.5 and 2.0 MR/HR. On the 20 range, the numbers are read directly, 5, 10, 15, and 20 MR/HR.

The following chart gives examples of correct readings of various indications on each range switch setting.

Meter Reading Chart

WHEN MR PER HR SWITCH IS TURNED TO	.20	2.0	20
And meter needle points to 5 — Correct reading is	.05 MR/HR	.5 MR/HR	5 MR/HR
And meter needle points to 10 — Correct reading is	.10 MR/HR	1.0 MR/HR	10 MR/HR
And meter needle points to 15 — Correct reading is	.15 MR/HR	1.5 MR/HR	15 MR/HR
And meter needle points to 20 — Correct reading is	.20 MR/HR	2.0 MR/HR	20 MR/HR
And meter needle points half way between 10 and 15 — Correct reading is	.125 MR/HR	1.25 MR/HR	12.5 MR/HR

IV. DETECTION RANGE

It is not possible to specify the distance at which a Geiger Counter will detect a deposit. This depends on many factors such as the size and quality of the deposit, the thickness and type of overburden covering the deposit, whether the overburden itself is radioactive, etc. It appears that important, though very small, traces of radioactivity are often located in the soil over the actual ore body even though the ore is some distance below the surface. Such traces of radioactivity produce a weak response in the counter as though the rays from the actual ore body were penetrating the intervening amount of soil or overburden. In one case, by careful measurements and the use of contour maps, a large body of uranium ore was discovered 200 feet below the surface. The radioactivity at the surface was only twice that of the surrounding area and upon drilling a test hole, it was found that the radiation level decreased as depth increased. At intermediate depths, there was actually less radioactivity than occurred at the surface. Drilling was continued and the radiation level began to rise again until, at a depth of 200 feet, the commercial ore body was discovered.

Experiences of this kind are common enough to say that there is no simple answer to the question, "How deep may buried ore be detected?" It can be shown that a very few feet of barren quartz or limestone can almost completely absorb the rays from a large body of uranium beneath it. But it is also true that telltale traces of uranium are usually found in the overburden above the ore body even though the ore is deeply buried and these traces often enable the prospector to locate the real vein.

V. SPECIAL FACTORS AFFECTING RESULTS

A. General Considerations:

The air and all rocks and soil are radioactive to some extent. The radioactivity of soil and rocks arises from the presence of

minute traces of relatively small quantities of radioactive elements, including uranium and thorium. The radioactivity in the air is due to two gases, radon and thoron, and traces of radioactive elements in dust which is carried in the air, and also to cosmic radiation from outer space. Because the radioactivity in rocks and soil is generally due to traces or "impurities," only general statements can be made concerning the amount of radioactivity associated with particular types of rocks. Furthermore, since the chemical behavior of the radioactive elements is frequently different from that of the other elements in which they occur, the distribution of radioactivity in the surface layers of rock and soil may be influenced by the presence of ground waters which "percolate" up to the surface of the earth. The radioactivity reading from all these sources together is referred to as the "background reading."

B. Mass Effect:

Mass effect is the effect caused by a large volume (mass) of radioactive rock or soil. A geiger counter normally responds to the *total* amount of radioactivity around it. Therefore a large amount of low percentage ore all around the instrument can cause the same meter reading as a small sample of rock with a high radioactivity content. Prospectors are sometimes misled by this "mass effect" and believe they have found a valuable uranium deposit, when actually, they are near a large body of very low grade ore which is valueless. In general, background readings even several times normal are not significant unless small samples which give high readings can be found in the area. If high readings can be obtained in an area, but not from individual ore samples, this indicates that the ore body is deeply buried or that the reading is due to the "mass effect." Another situation in which "mass effect" is important occurs when the instrument is placed in a hole in the ground. If the area is even slightly radioactive, readings taken in the hole show the *total* of the radiation coming from the soil *all around* the instrument and will, therefore, be higher than readings made when the instrument is on top of the ground. The same effect can be seen when readings are taken in a small crevice or a narrow cut, or when entering a mine which has a low percentage of uranium ore.

The easiest way to test for mass effect is to take small ore samples *out of the area* of high readings and take a reading on the samples.

C. Thorium:

In searching for uranium, it should be remembered that thorium is also radioactive. There is no convenient way to distinguish between the readings obtained from uranium and thorium bearing ores (other than chemical analysis). Since thorium itself is valuable, and is often associated with the rare earth minerals which are also valuable, any thorium bearing deposits should be carefully investigated.

D. Terrain and Types of Rock:

Because of the effect of local terrain (drainage ditches, rock outcrops, bogs, road cuts, etc.) on radioactivity distribution, care must be used in interpreting radioactivity readings. Lakes, swamps, and rivers usually produce low values of radioactivity. The radioactivity over a fresh road cut will frequently be abnormal (either high or low). Radioactivity readings frequently show a characteristic change over faults, being higher on one side than on the other.

In general, it may be said that granite, pegmatite, and shale are likely to be more radioactive than limestone, quartzite, or sandstone. But there will be many exceptions to this rule; for example, the highly radioactive carnotite is often found in sandstone. It should be remembered, too, that granite may sometimes contain very low grade uranium; therefore, the mass effect should be considered when prospecting around large granite formations.

E. Weather and Atmospheric Conditions:

The amount of radioactivity in the air at any location may vary from day to day and with speed and direction of prevailing winds. It is also generally believed that radioactivity in the air is lower during periods of high barometric pressure because radon gas then escapes from the earth more slowly. The best measurements therefore, will be made on days of high barometric pressure and little or no wind. The effect of atmosphere can be determined by repeating readings on successive days when the direction of prevailing winds has changed.

The Model 106C is not affected by heat, or electrical or magnetic storms. Remember, however, that battery life is greatly reduced when the batteries are used at low temperatures. For example, at 32 degrees Fahrenheit, their life will be about ten percent of normal. However, if the batteries are not in use while exposed to low temperatures, these temperatures will not affect their life.

F. Ice and Snow:

The instrument readings will be affected by the presence of ice and snow on the ground. Ice is a particularly efficient absorber of gamma radiation. Most of the gamma rays will be absorbed by the ice if it is three or four feet thick. The extent to which snow will absorb the gamma radiation depends upon the thickness of the layer of snow and how closely it is packed.

VI. HOW TO PROSPECT FOR URANIUM

The first step in prospecting is to check the calibration of the instrument. To calibrate the Model 106C turn the MR PER HR switch to the position marked 2.0. Remove the plastic calibration disc from the clip at the end of the instrument case, and place it with the radium spot flat against the window in the side of the case. Move the disc along the window to the point where it gives the highest meter reading.

Observe the meter for about twenty seconds and decide what its average reading is. If the average reading is not equal to the number stamped on the calibration disc, remove the cap nut from the CALIB. control on the panel of the instrument. Adjust this control with a screwdriver until the average meter reading is about equal to the number stamped on the disc. The instrument is now calibrated and ready for measuring radiation. This procedure should be followed each time the instrument is turned on for use, about one-half hour after that, and every two hours or so thereafter while the instrument is in continuous use. The purpose of the calibration procedure is to compensate for changes in battery voltages which take place with age and use. A little experience will show that when the batteries are fresh, their voltages will not change very rapidly, but after many hours of use the battery voltages will begin to change more rapidly, and more frequent calibration adjustments may be necessary. The calibration procedure constitutes a complete check of the condition of the batteries. Inability to calibrate the instrument generally indicates that some or all of the batteries have reached the end of their useful life and should be replaced.

The second step is to turn the MR PER HR switch to the .20 position. This is the most sensitive range on the instrument and should be used in prospecting and also for low level Civil Defense area surveys. When a sample being tested causes the meter to go off scale, the switch should be changed to the next higher range. If the meter still goes off scale, switch to the next higher range, and so on.

The third step is to determine the background count. An instrument always produces a small reading which is not caused

by the presence of ore. This reading is called background count. This background count will vary from place to place and day to day. The place to place change is caused by the difference in the percentage of radioactive materials common to each place. The day to day change is usually due to cosmic radiation and atmospheric conditions. In order to determine the meaning of a reading it is necessary to know what part of the reading comes from the ore being measured and what part comes from background count. To do this you simply determine what the background count is and deduct it from the total reading. Background count can be determined by observing the meter reading when entering an area of interest for prospecting. For greatest accuracy several readings of one, two or three minutes duration should be taken in this area. These readings should then be averaged to establish the "normal" background of that area. (A slightly different reading may be obtained at a different time of day.)

When prospecting with the Model 106C, the normal background reading will usually fall between .01 and .03 MR/HR, depending on location and other factors. Many prospectors believe that any reading over normal background is good reason for further investigation of the location, such as surveying the surrounding area or taking samples from below the surface. This is good practice since a deposit may be buried under rock or soil overburden which would reduce the intensity reading at the surface or in the air above it.

Background can vary greatly and it must be measured separately and be subtracted from any measurement upon which it will have an effect.

EXAMPLE:

Sample reading	.03 MR/HR
Background reading	.02 MR/HR
Correct reading	.01 MR/HR

After establishing normal background, you simply walk over any area of interest while watching the meter of the instrument or the neon flasher or while listening to the clicks in the earphone. It is not necessary to keep the instrument right at the surface of the ground because gamma rays have more than sufficient range to reach the instrument if carried at hip level.

When the meter reading increases by even as much as 50% or if the clicks or flashes increase by that amount, you have encountered an area worthy of further investigation.

A detailed search for the source of the high radioactivity should then be made by holding the instrument close to all exposed rocks or outcroppings in the area of highest readings or by collecting samples from the area of high radioactivity and checking them by holding them against the window of the 106C and observing the meter reading. If nothing further is encountered, this may indicate that the material is in a pocket, or that the deposit is covered by a large quantity of earth or rock. It is also possible that the prospector is merely observing a mass effect. At this point, he should dig below the surface until small samples can be found which give a significant reading or he should look further for another location of greater interest.

One of the best methods for defining the extent of radioactive deposits is to construct radioactivity contour maps or grids. To do this, it is necessary to systematically take readings over a large area and to record them on a map. The area to be explored should be ruled off like a checkerboard, or grid, and readings should be made at the corners of every square. In preliminary work, when it is desirable to cover the most ground in the shortest time, the squares may be made quite large, say 300 feet on a side. If, after all the readings have been mapped, there appear to be significant variations in some part of the area covered, then, in the region of interest, additional readings should be made at

the center of each of the squares. This will generally produce a total set of readings from which reliable radioactivity contours (called isorads) may be drawn. The purpose in making the additional set of readings at the center of the squares formed by the first set is to obtain the most uniform coverage, i.e., each new point is located at the maximum possible distance from all other points.

When taking readings in this manner, it is desirable to hold the instrument as high above ground as convenient so that the radioactivity from a fairly large area of ground is averaged in the measurement at each point. The choice of distance to be used between points in such a survey depends very much upon the local topography. For example, if the region is very flat with few or no outcroppings, then fairly large distances between points may be used. If, however, the terrain is very irregular, the readings should be taken near each topographic feature. For purposes of finally determining the extent of a newly discovered radioactive ore body, readings are often taken every 10 to 20 feet.

The most accurate results in making a grid survey can be obtained by taking the actual count of the number of pulses detected at each point by using the earphones or neon flasher. A minimum of three minutes should be taken for each measurement. The longer the period of time used, the more precise will be the measurement. However, the counting time must always be exactly the same for every reading taken during the survey.

After a satisfactory number of readings have been taken in the area and recorded in their respective locations on a map, it will generally be found that the easiest way to develop contours is to divide all the readings into three ranges, high, intermediate, and low; then, with a red pencil, circle each high value and, with a blue or green pencil, circle each low value. By holding the map at some distance from the eyes, it usually will be possible to distinguish any significant pattern that may be present.

When you locate a well-defined area in which the readings are uniformly high, or in which only one figure is outstandingly high, then this area should be investigated further by digging for small samples (as described above) or by putting down a test drill hole to whatever depth is practical for the area. To check the radioactivity in drill holes, a Drill Hole Geiger Counter is required. For information on Drill Hole Geiger Counters, write to Precision Radiation Instruments, Inc., 4223 West Jefferson Boulevard, Los Angeles 16, California.

In order to find the approximate percentage of uranium in the ore, all you need do is to follow the instructions under Chapter VII, Assaying with a Geiger Counter. If the ore which is found appears to have promise, send at least a one pound sample to U.S. Geological Survey, Geochemistry and Petrology Branch, Building 213, Naval Gun Factory, Washington, D. C. They will assay the sample without charge and give their report only to the individual submitting the sample. If their report indicates the ore has commercial value, it should be offered for sale to the U.S. Atomic Energy Commission, 1901 Constitution Avenue, Northwest, Washington 25, D.C., Attention: Raw Materials Operation.

For additional information on prospecting, the book "Prospecting for Uranium" can be obtained from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C., price 55 cents.

VII. ASSAYING WITH A GEIGER COUNTER

There are, in general, two ways in which to determine the amount of uranium in ore. The most fundamental way is to directly measure the uranium in a sample by chemical means. Chemical assays are essentially infallible, but they require the use of a chemical laboratory and are relatively time consuming.

The other method of assaying uranium ore is the so-called radiometric method. This method is based on the fact that nearly always, the amount of radioactivity of a sample of ore (which can be measured with a Geiger Counter) is proportional to the amount of uranium in it. There are some important exceptions to this, however. Uranium is not the only radioactive element which occurs in nature. Thorium is also radioactive. It is somewhat similar to uranium and in given regions the two elements occur in the same ores. For example, in Southern California, several deposits are known to contain both thorium and uranium. The radioactivity of such ores cannot be used as an accurate measure of the uranium content since the radioactivity of thorium cannot be easily distinguished from that of uranium.

The accuracy of a radiometric assay is also sometimes influenced by the fact that the radioactivity of uranium itself— alpha particle emission — is not the kind which can be detected by field Geiger Counters. However, the products of the radioactive decay of uranium are themselves radioactive and two of these, radium and radon, are actually responsible for most of the radioactivity observed in uranium ores. Because radium is chemically much different than uranium, when uranium ore is exposed to the weathering action of air and water at the surface of the earth, the radium may be dissolved away and redeposited nearby in other rocks. Thus, samples of weathered uranium ore may exhibit higher or lower amounts of radioactivity than would be expected on the basis of their actual uranium content. To indicate that a given figure is the result of a radiometric assay and that it is therefore subject to the above sources of error, a radiometric assay is generally labeled as percent uranium oxide (equivalent).

In spite of these potential hazards, the method of radiometric assaying is so convenient that it is very frequently used, and in most cases it is possible to predict quite accurately the amount of radioactivity associated with uranium by radiometric assaying.

NOTE: While making an assay, caution should be taken to make sure that the distance from the instrument to the sample being measured is carefully controlled. The "INVERSE SQUARE" law applies here. That is, the radiation intensity decreases in proportion to the square of the increase in distance from the sample.

EXAMPLE:

Reading from sample at 3 inch distance = 2 MR/HR

Reading from sample at 6 inch distance = .5 MR/HR

By taking a reading from this sample at 6 inches, the distance from which the first reading was taken has been doubled (multiplied by 2). Since the radiation intensity decreases in proportion to the square of the increase in the distance, the reading at 6 inches must be ¼ of the reading at 3 inches. The factor of increase in distance is 2; 2 squared is 4; therefore, the first reading (2 MR/HR) is divided by 4 when the distance from the sample is doubled, 2 MR/HR divided by 4 equals .5 MR/HR.

From this example, it is apparent that if readings are taken from two samples to determine the relationship between the amount of radioactivity in each, any difference in the distance at which these readings are taken can cause a large error, if the inverse square law is not taken into consideration.

The Model 106C may be used in the following manner for making estimates of uranium content of ore samples:

A—Comparing Samples: The Model 106C can be used to make a rough estimate of the uranium content of a piece of ore in percent of uranium oxide (equivalent) by comparative methods. To do this it is necessary to obtain a sample of ore that has been assayed and has a known uranium content. Place this

sample at a particular distance from the instrument and observe the meter reading. Then take a sample of the ore of unknown value and place it at the same spot. If the ore is roughly of the same physical size and shape as the assayed sample and has the same uranium content, it will give about the same reading on the meter. If it has twice the uranium content, it will give twice the reading, and so forth. Background readings must always be deducted from the readings of the sample being measured.

The percentage of uranium oxide (equivalent) can be calculated as follows:

1. Deduct the background to get the "corrected" readings of both samples.
2. Divide the "corrected" reading taken from the unknown sample by the "corrected" reading from the assayed sample.
3. Multiply the result of step 2 by the percentage of uranium oxide in the assayed sample. The answer will be the percentage of uranium oxide (equivalent) in your ore sample.

EXAMPLE: (assume that the chemically assayed ore sample contains .6 percent uranium oxide, and the background reading is .02 MR/HR)

1. Reading from *assayed* sample...........	.14 MR/HR
Deduct background reading	.02 MR/HR
"Corrected" reading	.12 MR/HR
Reading from *unknown* sample......	.17 MR/HR
Deduct background reading	.02 MR/HR
"Corrected" reading	.15 MR/HR

2. .15 divided by .12 equals 1.25.
3. 1.25 multiplied by .6 equals .75, indicating that your ore sample contains .75 percent of uranium oxide (equivalent).

B—Direct Estimate It is possible to make a reasonable estimate of uranium content of an ore sample by a direct measurement of the sample with the Model 106C as follows:

1. Place the 106C on a table where the assay is to be made. This should be several feet away from the ore which is to be assayed. Carefully note the average reading on the instrument. This is the background reading.

2. Take a sample of the ore that is representative of all the ore in the ore body, pulverize it to a fine powder, and make sure it is well mixed.

3. On a sheet of clean paper beside the instrument where the background reading was taken, mark off a rectangle measuring 4 inches by 7 inches. A convenient way to do this is to place the 106C on the paper and trace the outline of the bottom of the case with a pencil.

4. Measure out 5 ounces of the pulverized ore. Place it on the rectangle which was drawn on the paper, and, with a straightedge or knife, spread the ore to an even thickness over the entire area of the rectangle. This will provide a layer of about three eighths of an inch thick.

5. Place another sheet of paper over the ore, to prevent the ore from adhering to the instrument, then place the 106C *crosswise* (not diagonally) over the layer of ore, so that the window in the bottom of the 106C case is centered across the middle of the rectangle. Carefully note the average reading on the instrument.

6. Subtract the background reading taken in step 1, from the reading produced by the ore sample, as taken in step 5. The result, in MR/HR, is approximately equal to the percentage of uranium oxide (equivalent) in the ore. For example, .15 MR/HR represents .15% uranium oxide (equivalent).

C—Standard Samples: A very accurate means of performing radiometric assays depends upon the use of samples of pulverized ores of accurately known assay value which are compared with pulverized samples of the unknown ore of identical size. Several different sets of such standard ore samples with instructions for their use are now commercially available. The A.E.C. supplies one called a "Set of Counter Calibration Samples" which may be purchased for $10.00 from the Director of Laboratory, U.S. Atomic Energy Commission, P.O. Box 150, New Brunswick, New Jersey.

VIII. PREVENTIVE MAINTENANCE AND BATTERY REPLACEMENT

If the instrument is stored for long periods such as one year, the batteries should be removed. The instrument should be given the same care as would be given a portable radio and should be protected as much as possible from rough handling. No servicing should be attempted by unqualified persons except for battery replacement and setting of the calibration control. Sensitivity falls off as the batteries wear out and may be reset by adjusting the CALIB. control. "A" batteries should be replaced when they fall below 1.10 volts; the 45 and 67½ volt "B" batteries should be replaced when they fall below 35 and 53 volts, respectively.

Batteries should always be tested under load. It is therefore desirable to have the instrument turned on when battery voltages are measured. The instrument should be turned off at all times when not in use to conserve the batteries. Geiger tubes are extremely fragile and can be easily broken if improperly handled, although they will stand considerable jarring when mounted in the instrument. Geiger tubes should not be replaced or handled by other than experienced personnel.

The Model 106C uses one 67½ volt "B" battery (R.C.A. type VSO16 or Eveready type 467); one 45 volt "B" battery (R.C.A.

type VSO55 or Eveready type 455); and two flashlight batteries. The flashlight batteries should be replaced only with R.C.A. type VSO36, Eveready type D99, or equivalent leakproof cells.

The batteries can be replaced by unhooking the latch fasteners at each end of the case and lifting the instrument out of the case. The "A" batteries (which should require changing about three times as often as the "B" batteries) can be replaced simply by pulling them out of their holders. To replace the "B" batteries, slide them out of their compartment and then unsnap the terminal strips. Batteries can be purchased from most radio and hardware stores, etc., and no experience is required for their replacement.

When replacing batteries, make certain that new batteries are of the types recommended in this section. The batteries typically can be expected to give many hours of service, as shown in the table below:

Battery Life

BATTERY TYPE	67½V.	45V.	1½V.
Continuous Use	280 Hrs.	280 Hrs.	40 Hrs.
4 Hour Daily Use	330 Hrs.	330 Hrs.	100 Hrs.

Battery life is greatly reduced when the batteries are used at low temperatures. For example, at 32 degrees Fahrenheit, their life will be about ten percent of normal. However, if the batteries are not in use while exposed to the low temperatures, these temperatures will not affect their life.

IX. THEORY OF OPERATION

The 106C contains three miniature vacuum tubes; one type 1U5 and two type 1AF4. The 1U5 is used in a circuit which produces the 900 volts necessary to operate the Geiger tube. An

NE-2 neon bulb operates as a relaxation oscillator to provide a basic frequency of about 150 cycles per second. The oscillator output is used to "key" the pentode section of the 1U5. Each time the current is cut off in the 1U5, a pulse of high voltage is developed across the choke coil in its plate circuit. By means of the diode section of the 1U5, these pulses are rectified to produce the steady high voltage. A second NE-2 neon bulb is used in conjunction with a bleeder consisting of a string of high value resistors in an automatic voltage regulating circuit designed to conserve "B" battery current.

The two 1AF4 tubes are connected in a biased multivibrator circuit which greatly amplifies the signals from the Geiger tube and which drives the indicating devices.

X. CORRECTIVE MAINTENANCE

Failures can result from the common faults of electronic circuits such as burned out resistors, shorted capacitors, etc. Standard servicing techniques may be used with one major exception. The 900 volts across the Geiger tube can be measured accurately only with an electrostatic voltmeter. Any ordinary meter, even of the vacuum tube voltmeter type, will load the circuit sufficiently to cause a drop in voltage of 100 volts or more. When replacing the power supply tubes, it may be necessary to reset the high voltage. The high voltage can be decreased by reducing the number or value of resistors in the string of high value resistors. The high voltage can be increased by adding resistance to this string. In production, one or more of these resistors may have been short-circuited to initially adjust high voltage. No controls located inside the instrument should be adjusted by anyone but an experienced electronics technician who has a laboratory standardized gamma ray source. All Authorized Service Stations of Precision Radiation Instruments, Inc. are so equipped.

XI. LABORATORY CALIBRATION PROCEDURE

(For Authorized Service Shops Only)

Before calibrating, make sure that 900 to 940 volts are being obtained at the Geiger tube. Arrange the instrument so that the side of the case which has the window for the Geiger tube is toward the standard radium source. The Geiger tube should be at right angles to the line of the source, and its axis centered over the reference line for the field strength required.

Set the MR PER HR switch to the .20 position. Place the instrument in a .1 MR/HR field and adjust the CALIBRATION control on the panel to obtain a meter reading of .1 MR/HR over background. Then remove the instrument from its case and place it in a field of 1.0 MR/HR Turn the MR PER HR switch to 2.0. Adjust the 2.0 trimmer to obtain a 1.0 MR/HR reading. Finally, place the instrument in a 10 MR/HR field. Turn the MR PER HR switch to 20 and adjust the 20 trimmer to obtain a 10 MR/HR reading.

XII. GUARANTEE AND AUTHORIZED SERVICE

All parts except the batteries are guaranteed for a period of ninety days from date of purchase against defects in workmanship and material. The batteries cannot be guaranteed as they can be easily damaged by misuse. Always check the batteries before returning the instrument for service. The instrument should be returned in the original packing material or be covered on all sides with a thick layer of soft packing material. Enclose a note stating exactly in what way the instrument has not been performing properly, from whom it was purchased, and the date of purchase. To obtain service, pack the instrument carefully as described above, and return it insured and prepaid to your nearest Authorized Service Station.

The technicians at all Precision Authorized Service Stations are completely competent to handle any service problem which may arise. They are trained at the Precision Radiation Instruments Factory Service School and have met the requirements established by the school. Prompt service can be obtained because every Authorized Service Station normally carries a complete stock of genuine Precision repair parts.

NOTE: Because it is possible for untrained persons to damage the instrument by attempting repairs, the factory guarantee is voided if an instrument has been worked on by anyone other than our Authorized Service Stations.

P. R. I. Authorized Service Stations

ALASKA

ANCHORAGE RADIO & TELEVISION, INC.
443 Fourth Avenue
Anchorage, Alaska

ARIZONA

COMMERCIAL RADIO CORP.
747 North Stone
Tucson, Arizona

VINSON-CARTER ELECTRIC CO.
325 North Fourth Street
Phoenix, Arizona

CALIFORNIA

ALAMEDA RADIO & TV CO.
612 South Victory Boulevard
Burbank, California

BLACKSTONE ELECTRO-SPECIALTIES CO.
6129 N. Blackstone
Fresno 3, Calfornia

ENGINEERS SYNDICATE, Ltd.
5011 Hollywood Boulevard
Los Angeles, California

INDUSTRIAL INSTRUMENT SERVICE CO.
606 North Ventura Avenue
Ventura, California

[redacted]

LANGSON'S TELEVISION CO., INC.
614 No. Los Angeles Street
Anaheim, California

LEONARD'S
381 South First Street
San Jose, California

CALIFORNIA (cont.)

MICROMATIC, ASSOCIATES
2322 West Whittier Boulevard
Montebello, California

ROBERTS ELECTRIC
821 Palm Avenue
Imperial Beach, California

SHELBY INSTRUMENT CO.
1701 Magnolia Avenue
Long Beach 13, California

TELEVISION SERVICE CO.
900 Colton
Colton, California

THE ROBERT DOLLAR CO.
Marine Division
50 Drumm Street
San Francisco, California

CANADA

SEISMIC SERVICE
SUPPLY, LTD.
1318 9th Avenue East
Calgary, Alberta, Canada

COLORADO

G & H URANIUM
Post Office Box 1467
Durango, Colorado

GEIGER CENTER
1201 Broadway
Denver, Colorado

MINERALS ENGINEERING CO.
801 Fourth Avenue
Grand Junction, Colorado

ILLINOIS

ELECTRONIC AIDES
23 West Hubbard Street
Chicago 10, Illinois

MICHIGAN

[redacted]

MISSOURI

WILSON-WILEY CO.
328 Richards Road
Kansas City, Missouri

NEVADA

LASSEN HOME SUPPLY
734 South Virginia Street
Reno, Nevada

NEW MEXICO

SAM'S RADIO SERVICE
218 Vassar, S. E.
Albuquerque, New Mexico

NEW YORK

AUTHORIZED MFR.
SERVICE CO.
919 Wycoff Avenue
Brooklyn 27, New York

NORTH DAKOTA

PAT'S RADIO &
ELECTRONIC SERVICE
Bowman
North Dakota

OREGON

HAWTHORNE ELECTRONICS
200 S. E. Hawthorne
Portland, Oregon

V. E. WILLEY
c/o Zimmerman Hardware
425 South Main
Pendleton, Oregon

P. R. I. Authorized Service Stations (cont.)

SOUTH DAKOTA

RADIO CENTER
723 Main Street
Rapid City, South Dakota

TENNESSEE

ELECTRA
DISTRIBUTING CO.
1914 West End Avenue
Nashville, Tennessee

TEXAS

FONVILLE ELECTRONIC
SERVICE
120 South Oak
Pecos, Texas

MUNDINE RADIO &
TELEVISION
217 East White Avenue
San Antonio, Texas

SWIECO, INC.
1512 E. Lancaster
Forth Worth 3, Texas

UTAH

ENGINEERS SYNDICATE, Ltd.
337 North Main
Moab, Utah

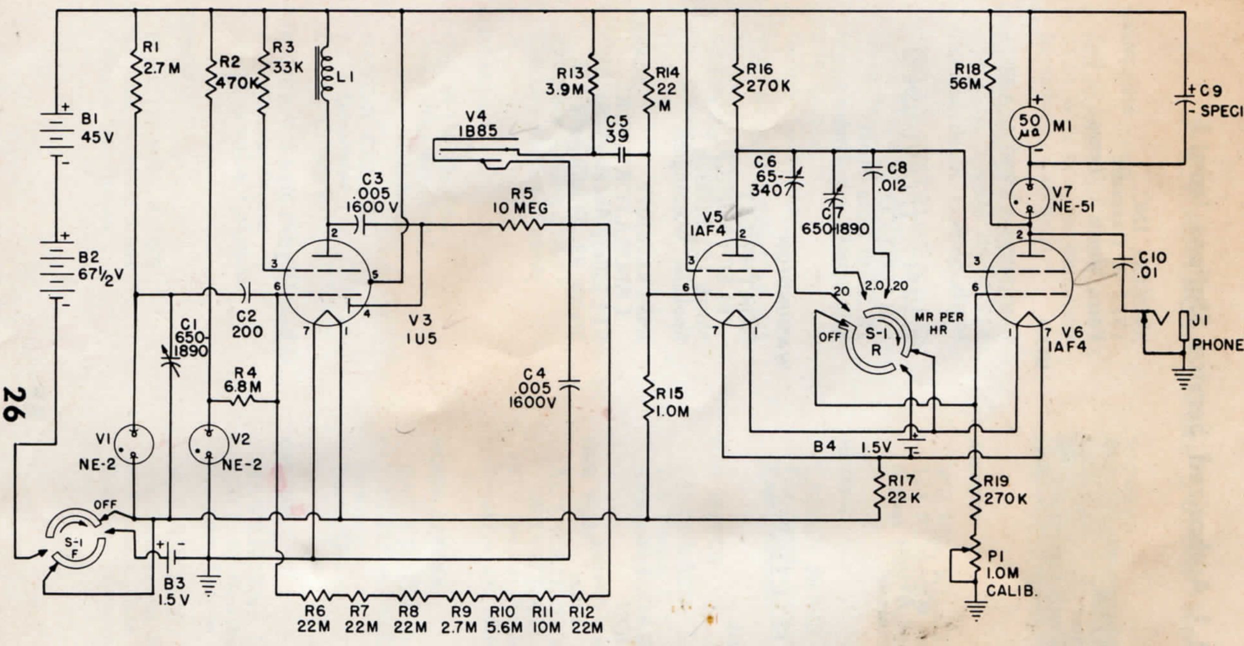
WARREN TELEVISION &
RADIO CO.
28 South Main Street
Salt Lake City 1, Utah

WASHINGTON

NORTHWEST
ELECTRONICS, INC.
North 102 Monroe
Spokane, Washington

INSTRUMENT
LABORATORY, INC.
934 Elliott Avenue West
Seattle 99, Washington

1B85 GM. -2- 1AF4. 1U5



NOTES:~

1. ~ SWITCH SEEN FROM KNOB END. "F" AND "R" ARE FRONT AND REAR SECTIONS OF S1.
2. ~ ALL CAPACITORS GREATER THAN 1 IN μμF; ALL LESS THAN 1 IN MFD.
3. ~ ONE OR MORE RESISTORS (R9, R10, R11, OR R12) MAY BE SHORTED OUT TO ADJUST HIGH VOLTAGE.

PRECISION RADIATION INSTRUMENTS, INC.
~GEIGER COUNTER~
MODEL 106C
DRAWN BY HRD
CHECKED BY SH
MAY 1955
D-20

DRI

"The Standard of the Industry"