Coratomic.

CORATOMIC, INC.
300 INDIAN SPRINGS ROAD
P.O. BOX 434
INDIANA, PENNSYLVANIA 15701
PHONE: (412) 349-1811 • TELEX 86-6658

August 19, 1985

MS 18
P5

Ms. Jenny M. Johansen, M.S.
Nuclear Materials Safety Section B
Division of Radiation Safety
and Safeguards
United States Nuclear Regulatory Commission
Region 1
631 Park Avenue
King of Prussia, Pennsylvania 19406

Dear Ms. Johansen:

RE: License No. SNM-1319
Docket No. 070-01342
Control No. 23545

We are enclosing two copies of our response to your request for additional information.

Sincerely,

John R. Klingensmith

John R. Klingensmith
Patient Records Specialist

enclosures (2)

23545

License No. SNM-1319
Docket No. 070-01342
Control No. 23545

1. Regarding your survey meters and counting equipment for alpha and neutrons, please submit the following information for each instrument.

   a. Manufacturers Name and Model No.
   b. Number available
   c. Sensitivity range
   d. Type of detector
   e. Type of radiation detected
   f. Method of calibration or determining counting efficiency

Answer:

We have two meters which we use. The first meter is a Scintillation Alpha Counter, Model SAC-4. It is manufactured by Eberline Instrument Corporation, P. O. Box 2108, Santa Fe, NM 87501. Please see Attachment 1 for answers to 1c to 1e, and Attachment 2 for answer to 1f.

The second meter is a Victoreen Model 488A Geiger Counter. It is manufactured by Victoreen Instrument Division of VLN, 10101 Woodland Avenue, Cleveland, OH 44104. Please see Attachment 3 for the answers to 1c to 1f.

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2. Please submit an outline of the subjects covered in your annual training lecture, the length of time involved for each subject, the name of the instructor, if other than your radiation safety officer (RSO), and the training and experience of the instructor if other than your RSO.

Answer:

I. All Radioactive Material Contained In Sealed Sources (30 minutes)

   A. Fuel Specifications

   B. Fuel Capsule Specifications

   C. Required Markings on Outer Surface of Pacemaker

II. Radiation Exposure From Pacemakers (30 minutes)

   A. Radiation Exposure to Families of Pacemaker Patients

   B. Radiation Exposure to Pacemaker Patients

   C. Radiation Exposure to Pacemaker Workers

   D. Radiation Exposure in Shipping of Pacemakers

III. Radiation Safety Procedures (1 hour)

   A. Radiation Detection Instruments

   B. Film Badges

   C. Leak-Test Procedures

   D. Posting and Securing Areas Where Radioactive Materials are Used or Stored

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3. Please clarify your recovery/return program. Are the nuclear batteries ever removed from the explanted pacemakers returned to you from the licensed medical institutions and placed in a new pacemaker?

Answer:

When batteries are returned to Coratomic, they may be re-furbished and the nuclear fuel re-used.

4. Please clarify if the inventory/leaktest information given to our inspector during the August 17, 1984, inspection of your facility is the total number of sources you have on hand or does it include the sources which are implanted in patients. We note that this list contained 570 sources.

Answer:

The list is not the total number of sealed sources which we have on hand. Some of the sealed sources are presently implanted in patients.

5. Exhibit X for your Model C-100 protocol (July 1, 1975), Exhibit X for your Model C-101 protocol (November 1, 1975), and Exhibit IX of your Model C-101-P protocol (March 2, 1983), indicate applications for pacemaker licenses should be sent to the USNRC, Washington, D. C. Please correct these exhibits to reflect submission of an application to the Regional Office of the NRC which has jurisdiction over the state in which the applicant resides. It is our understanding that you are only manufacturing and transferring the Model C-101-P pacemaker and protocol, if so, it is only necessary to correct the March 2, 1983, protocol for the C-101-P pacemaker.

Answer:

Coratomic no longer manufactures the Model C-100 pacemaker or the Model C-101 pacemaker. Explanted Model C-100 and Model C-101 pacemakers are transferred from licensed hospitals to Coratomic. There are a small number of Model C-101 pacemakers, approximately 10, which have never been implanted. They are occasionally transferred to and from licensed hospitals. We currently manufacture only the Model C-101-P pacemaker. Model C-101-P pacemakers are transferred to and from licensed hospitals.

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Answer to Question 5 (continued):

We propose the addition of the following cover letter to the protocols for the Model C-101 pacemaker, and the Model C-101-P pacemaker:

"All government hospital license applications should be sent to:

U. S. Nuclear Regulatory Commission
Division of Fuel Cycle and Material Safety, NMSS
Washington, DC 20555

"Hospitals located in Agreement States should mail their license applications to the appropriate office in that state, instead of to the N. R. C. for approval. The Agreement States are as follows:

1. Alabama
2. Arkansas
3. Arizona
4. California
5. Colorado
6. Florida
7. Georgia
8. Kansas
9. Kentucky
10. Louisiana
11. Maryland
12. Mississippi
13. Nebraska
14. Nevada
15. New Hampshire
16. New York
17. North Carolina
18. North Dakota
19. Oregon
20. South Carolina
21. Tennessee
22. Texas
23. Washington

"Hospitals located in Connecticut, Delaware, District of Columbia, Maine, Massachusetts, New Jersey, Pennsylvania, Rhode Island, or Vermont, send applications to:

U. S. Nuclear Regulatory Commission, Region I
Nuclear Material Section B
631 Park Avenue
King of Prussia, PA 19406

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Answer to Question 5 (continued):

" Hospitals located in Puerto Rico, Virginia, Virgin Islands, or West Virginia, send applications to:

U. S. Nuclear Regulatory Commission, Region II
Material Radiation Protection Section
101 Marietta Street, Suite 2900
Atlanta, GA 30323

"Hospitals located in Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, Ohio, or Wisconsin, send applications to:

U. S. Nuclear Regulatory Commission, Region III
Materials Licensing Section
799 Roosevelt Road
Glen Ellyn, IL 60137

"Hospitals located in Idaho, Montana, New Mexico, Oklahoma, South Dakota, Utah, or Wyoming, send applications to:

U. S. Nuclear Regulatory Commission, Region IV
Material Radiation Protection Section
611 Ryan Plaza Drive, Suite 1000
Arlington, TX 76011

"Hospitals located in Alaska, Hawaii, and U. S. Territories and Possessions in the Pacific, send applications to:

U. S. Nuclear Regulatory Commission, Region V
Material Radiation Protection Section
1450 Maria Lane, Suite 210
Walnut Creek, CA 94596"

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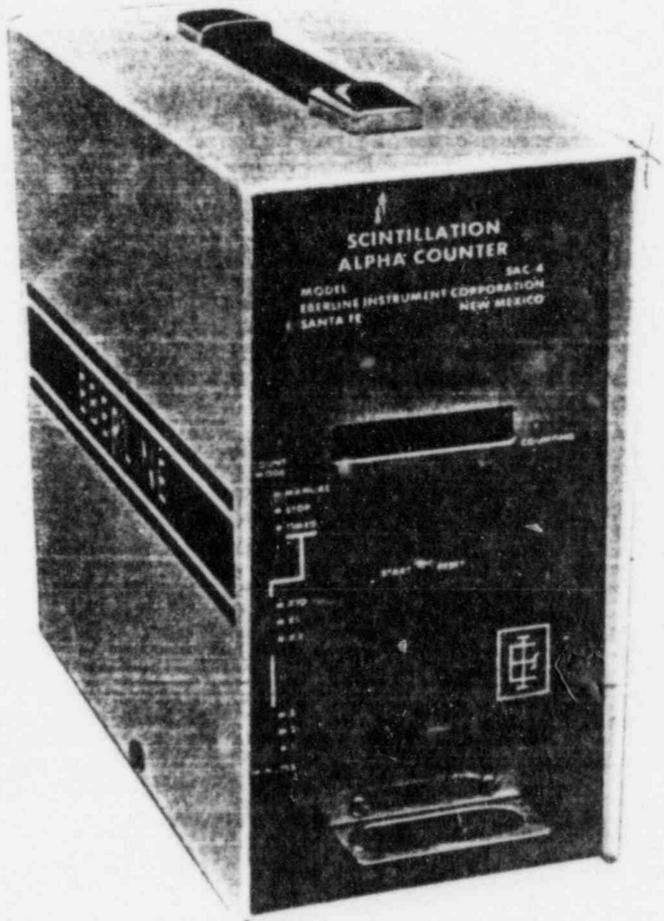
6. It appears from Attachment 1, "Fuel Capsule Assembly Procedure", that you are manufacturing the sealed source that is contained in your pacemakers, please clarify.

Answer:

This is a material specification used by our suppliers. We do not manufacture sealed sources, but receive them from licensed suppliers.

SCINTILLATION ALPHA COUNTER
MODEL SAC-4



Features:

COMPLETE ALPHA COUNTER

TWO-INCH DIAMETER SAMPLE SIZE

PRESET TIME: .1 to 50 MINUTES

ELECTRONIC TIMER

SOLID STATE ELECTRONICS

DETECTOR AND DRAWER ASSEMBLY EASILY DECONTAMINATED

COUNTERS MAY BE GANGED FOR MULTICHANNELS (SPECIAL COVER)

SCINTILLATION ALPHA COUNTER MODEL SAC-4

GENERAL DESCRIPTION

The Scintillation Alpha Counter, Model SAC-4, is a complete system consisting of a two-inch detector, high voltage power supply, charge sensitive input amplifier, timer and six decade readout. All circuits are solid state, except the detector, with extensive use of integrated circuits to enhance reliability.

SPECIFICATIONS

1. DETECTOR

a. Sample Size: 2-1/32" diameter x 3/8" thickness, maximum. The sample thickness can be corrected by an adjustable sample holder in the slide.

b. Scintillation Phosphor: ZnS(Ag) powder on a plastic light pipe.

c. Photomultiplier Tube: 2" diameter, 10 stage, S11 response, end window.

d. Efficiency: 80% of 2π minimum from a 1" diameter ^{239}Pu source.

e. Background: Less than 0.3 counts per minute.

f. Plateau: At least 200 volts long with a slope of less than 1% per 100 volts.

2. HIGH VOLTAGE: Regulated, variable by a rear panel control to approximately 1500 volts. The supply (EIC Model P-201A) is a plug-in module for ease of maintenance.

3. AMPLIFIER: Charge sensitive input allowing very high input sensitivity with excellent noise rejection, followed by a dc coupled amplifier fed back for stability and control. Overall sensitivity adjustable by an internal control from 1.0 to 10.0 volts per picocoulomb (approximately 0.1 to 1.0 volt per millivolt equivalent on voltage sensitive input).

4. DISCRIMINATOR: Internally biased at 1.25 volts which gives an overall sensitivity from .125 to 1.25 picocoulombs (approximately 1.25 to 12.5 millivolts), depending on amplifier gain.

5. TIMER: Preset times from 0.1 minute to 50 minutes in a 1, 2, 5 sequence referenced to line frequency yielding an accuracy typically better than 0.05%. Long term accuracy is even better. All integrated circuits are plugged in for ease of maintenance.

6. SCALER: Six decade light emitting diode readout. Counting light stays lit when in counting mode. Decade counters and count gate are plugged in for ease of maintenance.

7. INSTRUMENT RESOLUTION: Approximately seven microseconds.

8. RESET-START: Resets scaler and timer to zero and starts a timed count.

9. COUNT MODE

a. TIMED position automatically stops count after preset time selected on timer.

b. MANUAL position counts continuously.

c. STOP position does not count.

10. POWER: 105-125 VAC, 60 Hz, 1/4 amp, 3-wire.

11. TEMPERATURE: 32°F to 140°F with less than ±50 volts plateau shift.

12. MECHANICAL

a. Size: 11-1/2" H x 6" W x 14" D, including controls.

b. Weight: 16-3/4 lbs.

EBERLINE INSTRUMENT CORPORATION
P. O. BOX 2108 SANTA FE, NEW MEXICO 87501
PHONE 505 982 1881 TWX: 910 985 0678
TELEX 660445 EBERLINE ABQ

December 6, 1971

SECTION I
GENERAL

A. DESCRIPTION

The Scintillation Alpha Counter, Model SAC-4, is a complete system consisting of a two-inch detector, high voltage power supply, charge sensitive input amplifier, timer, and six decade readout. All circuits are solid state, except the detector, with extensive use of integrated circuits to enhance reliability.

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Charge sensitive input allowing very high input sensitivity with excellent noise rejection, followed by a dc coupled amplifier fed back for stability and control. Overall sensitivity adjustable by an internal control from 1.0 to 10.0 volts per picocoulomb (approximately 0.1 to 1.0 volt per millivolt equivalent on voltage sensitive input).

4. DISCRIMINATOR

Internally biased at 1.25 volts, which gives an overall sensitivity from .125 to 1.25 picocoulombs (approximately 1.25 to 12.5 millivolts) depending on amplifier gain.

5. TIMER

Preset times from 0.1 minute to 50 minutes in a 1, 2, 5 sequence referenced to 60 Hz line frequency yielding an accuracy typically better than 0.05%. All integrated circuits are plugged in for ease of maintenance. The timer has an oscillator for use with battery or 50 Hz line. The capability of syncing with a 50 Hz line is incorporated in the timer circuitry. For this procedure, refer to Section IV, D, 3.

6. SCALER

Six decade light emitting diode readout. Counting light stays lit when in counting mode. Decade counters and count gate are plugged in for ease of maintenance.

7. INSTRUMENT RESOLUTION: Approximately seven microseconds.

8. RESET-START: Resets scaler and timer to zero and starts a timed count.

9. COUNT MODE

a. TIMED position automatically stops count after preset time selected on timer.

b. MANUAL position counts continuously.

c. STOP position does not count.

10. POWER: Line -115 or 230 ±10% VAC switch selectable, 50/60 Hz, 1/4 amp, 3-wire. Battery - Any battery 7.5 volts minimum, 14 volts maximum at 1.0 amp load.

11. TEMPERATURE: 32°F to 140°F with less than 50V plateau shift.

12. MECHANICAL

a. Size: 11-1/2" H x 6" W x 14" D, including controls.

b. Weight: 16-3/4 lbs.

SECTION II
OPERATION

A. DESCRIPTION OF CONTROLS

1. EXTERNAL (See Figures 1-1 and 2-1)

a. COUNT MODE: Switch to select timed count (TIMED), no count (STOP), or continuous count (MANUAL).

b. RESET-START: Switch to reset all appropriate circuitry to zero and start a timed counting sequence.

c. COUNT TIME IN MINUTES: Switches to select desired counting time.

d. POWER (Rear Panel): Switch to supply power to the instrument.

e. H. V. ADJUST (Rear Panel): Control for adjusting to proper high voltage.

f. 115-230 VAC Switch: Selects either 115V or 230V 50/60 Hz.

2. INTERNAL (See Figure 2-2)

a. GAIN (Amplifier Board): Control for adjusting gain of amplifier.

b. TIME BASE (Timer Board): Control for adjusting time base of timer when instrument is used with a battery. (This is not a normal mode of operation for a SAC-4, so no adjustment of this control is necessary when operating from an AC line.)

B. PREPARATION FOR USE

1. The instrument should be checked for physical damage.

2. Plug cord into 115 VAC, 60 Hz power source.

3. Turn POWER switch ON and push RESET-START.

C. OPERATION CHECK

1. Place an alpha source in the instrument.

2. Set MODE switch to MANUAL. Instrument should begin counting. Count lamp should light.

3. Set MODE switch to TIMED.

4. Set COUNT TIME IN MINUTES switches to 1 and X.1.

5. Push RESET-START switch. Instrument should stop counting after 6 seconds.

6. Check efficiency and background. Refer to Section IV, D, 2,e and f.

D. OPERATING THE INSTRUMENT

1. Set MODE switch to TIMED.

2. Determine a count time and set COUNT TIME IN MINUTES accordingly.

3. Pull the sample drawer until it is fully extended and place the sample to be counted on the adjustable sample holder.

The sample holder snap ring may be used to hold a flexible 2-inch diameter sample flat.

For maximum efficiency, rotate the sample holder until the surface of the sample is as high as possible, but make sure that no part of the sample extends beyond the surface of the slide.

4. Push sample drawer fully closed.

5. Push RESET-START switch.

6. Instrument will stop counting after the preset time and the scaler will display the total counts for that time.

E. PRACTICAL CONSIDERATIONS OF COUNTING RANDOM EVENTS (RADIOACTIVITY)

1. STATISTICAL DEVIATION

When the total number of counts recorded from a radioactive source is small, the number can be considerably different from the average source value due to statistical deviation.

The radiations from a source are random in nature and the laws of probability apply. From a determined number of co[illegible]s, the following equations can be used to calculate the d[illegible]ion to be expected from the average source value.

[illegible]ard deviation (S.D.) is defined as the square root of [illegible]ge total number of counts (N_A). The symbol

for this is σ. Thus,

$$S.D. = \sigma = \sqrt{N_A} \qquad \text{Eq. I}$$

Any determination (N) on a sample will be within a certain deviation of the average a fixed percent of the time, as listed below.

$N = N_A \pm .674\,\sigma$	50% of the time	Eq. II
$N = N_A \pm \sigma$	68% of the time	Eq. III
$N = N_A \pm 2\sigma$	95% of the time	Eq. IV
$N = N_A \pm 3\sigma$	99.7% of the time	Eq. V

Example A: A 2500 CPM source is counted 100 times for 1 minute each.

From Eq. I, $S.D. = \sigma = \sqrt{2500} = 50$ CPM

The distribution of the individual counts will be as follows:

From Eq. II, 50 counts will be within 2500 ±34, or 2466 to 2534 CPM.

From Eq. III, 68 counts will be within 2500 ±50, or 2450 to 2550 CPM.

From Eq. IV, 95 counts will be within 2500 ±100, or 2400 to 2600 CPM.

From Eq. V, nearly all counts will be within 2500 ±150, or 2350 to 2650 CPM.

There is always the possibility that a count will be far away from the average, but this will happen only a small percentage of the time.

2. CONFIDENCE LEVEL

When the average count from a sample is not known and the accuracy of one determination must be specified, a confidence level must be used. Confidence level corresponds to the percentages in Equations II through V. At 50% confidence level, any one determination will be within $\pm.674\sigma$ of the average count. At the 95% confidence level, any one determination will be within $\pm 2\sigma$ of the average count.

Example B: A one minute determination on a sample reads 1747 counts. The standard deviation (σ) is 42. The accuracy of the determination can be specified as follows:

1747 ±28 CPM 50% confidence level or 1747 ±84 CPM 95% confidence level.

The 95% confidence level is in fairly common usage, however any level can be used as long as it is specified.

3. ERROR IN COMBINING TWO DETERMINATIONS

If the background count is comparable to the sample count, considerable error can be had in the solution when the background is subtracted out. The following formula applies:

$$R = R_S - R_B \pm 2\sqrt{\frac{R_S}{T_S} + \frac{R_B}{T_B}} \qquad \text{95\% confidence level}$$

R = Net count rate of sample in counts per minute,

R_S = Count rate of sample and background in counts per minute.

R_B = Count rate of background in counts per minute,

T_S = Time that sample and background were counted in minutes,

T_B = Time that background was counted in minutes.

Example C: Background count is 20 counts in 10 minutes, and sample plus background count is 100 counts in 10 minutes. So,

$R_S = 100/10 = 10$ CPM
$R_B = 20/10 = 2$ CPM
$T_S = 10$ minutes
$T_B = 10$ minutes

$$R = 10 - 2 \pm 2\sqrt{\frac{10}{10} + \frac{2}{10}} = 8 \pm 2\sqrt{1.2} = 8 \pm 2.2 \text{ CPM } (8 \pm 27\tfrac{1}{2}\%)$$

at 95% confidence level.

To get the highest accuracy in the minimum amount of time, the sample counting time (T_S) and background counting time (T_B) should be distributed according to the following formula:

$$\frac{T_S}{T_B} = \sqrt{\frac{R_S}{R_B}}$$

4. RESOLVING TIME ERROR

When counting samples with a high count rate, the determination can be in error because of the finite resolving time of the counting system. The resolving time of a counter can be determined by counting two sources of approximately the same value individually and then together and applying the following formula:

$$\tau = \frac{R_1 + R_2 - R_{12}}{2(R_1 R_2)}$$

where:
τ = Resolving time (seconds)

R_1 = Counting rate, source 1 (counts per second)
R_2 = Counting rate, source 2 (counts per second)
R_{12} = Counting rate, source 1 + 2 (counts per second)

When the resolving time is known, an observed count can be corrected by applying the following formula:

$$R = \frac{R_o}{1 - R_o \tau}$$

where:
R = True counting rate (counts per second)
R_o = Observed counting rate (counts per second)
τ = Resolving time (second)

Due to simplification of the above equations, the accuracy of the correction is limited if the correction exceeds about 20%.

Calibration of Alpha Counter

Eberline Scintillation Alpha Counter Model SAC-4

1. Assure that the sample table is positioned tightly against the snap ring and the copper retaining ring.

2. Place the Pu^{239} standard source in the center of the sample table. Push the sample drawer fully closed.

3. Set COUNT MODE to TIMED, and the COUNT TIME in MINUTES switches to 1 and X10 to obtain a ten minute timed count.

4. Push the START-RESET button; the counter will begin counting.

5. When the count lamp goes out, divide the final count by 10 to get the average counts per minute (cpm). If this value lies in the Average cpm Range on the calibration sticker, record the efficiency of the counter as that which is listed on the calibration sticker. Set the counter's COUNT TIME in MINUTES switches to 1 and X1 before doing the wipe tests in order to obtain one minute timed counts.

6. If the average counts per minute is outside the Average cpm Range on the calibration sticker, repeat steps 1 thru 5 above. If the second ten minute timed count does not yield an average cpm in the calibration range, a new determination of the counter's efficiency must be made.

Determination of Alpha Counter Efficiency

1. Do steps 1 and 2 above.

2. Set COUNT MODE to TIMED, and the COUNT TIME in MINUTES switches to 1 and X1.

3. Push the START-RESET button; the counter will begin counting.

4. When the count lamp goes out, record the displayed count.

5. Repeat steps 3 and 4 to obtain 50 one minute counts.

6. Divide the sum of all 50 counts by 50 to obtain the average total counts(NA). Take the square root of this value (NA) to obtain the standard deviation (σ).

Thus: $$\frac{\Sigma\ 50\ \text{counts}}{50} = NA \quad ; \quad (NA)^{\frac{1}{2}} = \sigma$$

7. The laws of probability state that any random determination (N) of the sample will be within the range, $NA \pm 2\sigma$, 95% of the time.

Thus: $N = NA \pm 2\sigma$ 95% of the time

where $NA \pm 2\sigma$ is a range of values from $(NA - 2\sigma)$ to $(NA + 2\sigma)$.

Example:

Fifty one minute counts of a Pu^{239} source were taken. The average total counts per minute was 937.

$$\frac{\Sigma 50 \text{ counts}}{50} = NA = 937 \quad ; \quad (NA)^{1/2} = (937)^{1/2} = \sigma = 31$$

For an average value of counts per minute of 937, there is a standard deviation of 31.

Therefore: Any count will be in the range 937 ± 2(31) 95% of the time.

ie., N = 875 to 999 95% of the time

Thus the 95% confidence range in this case is 875 to 999. We can be 95% certain that any random determination of the sample will fall in this range.

8. Take the minimum value in the 95% confidence range and divide it by twice the certified cpm of the Pu^{239} source to obtain the minimum efficiency of the counter.
9. Take the maximum value in the 95% confidence range and divide it by twice the certified cpm of the Pu^{239} source to obtain the maximum efficiency of the counter.
10. Therefore, the EFFICIENCY RANGE of the alpha counter has been determined with 95% confidence.

Example:

Continuing with the same example, the minimum value in the 95% confidence range is 875, and the maximum value is 999.

The Pu^{239} standard source in this case has a certified 1380 cpm.

Thus the minimum efficiency is: $\frac{875}{2(1380)} = .32 = 32\%$

The maximum efficiency is: $\frac{999}{2(1380)} = .36 = 36\%$

The efficiency range in this case is 32% to 36%, or 34% ± 2%, with 95% confidence. This efficiency has been determined in terms of disintegrations per minute (dpm). The actual count divided by the counter's efficiency yields actual dpm values. One microcurie is equal to 2.2×10^6 dpm. Thus, the actual dpm divided by 2.2×10^6 yields microcuries.

Example: The alpha counter's efficiency = 34% ± 2%
The final count of a determination = 5cpm

$$\frac{5 \text{ cpm}}{.34} = 14.71 \text{ dpm} \quad ; \quad \frac{14.71 \text{ dpm}}{2.2 \times 10^6} = 6.7 \times 10^{-6} \text{ microcuries}$$

INSTRUCTION MANUAL

for

NEUTRON SURVEY METER
MODEL 488A

Form: 1168C-10-70 Part No. 488-59 Litho U.S.A.

3-6. DETECTOR PROBE.

1. Model 488-22.

A. Construction.

This neutron sensitive probe consists of:

1. A boron-lined proportional counting gas-filled tube. Type RSN 127A, which when operated at 900 volts puts out a pulse from the B^{10} (n, alpha) reaction which is large enough to permit locating the preamp in the survey meter case rather than in the probe. The preamp and counting circuit sensitivity is such that gamma pulses are effectively discriminated against. The boron lining gives a 1/v sensitivity to thermal and slow neutrons.

2. A high-density polyethylene moderator which extends the detectable neutron energy range into the fast neutron region.

3. A 1/32" thick cadmium shield which permits discrimination against thermal neutrons.

B. Operation.

The detector tube, moderator, and cadmium shield may be fastened to each other and to the instrument case in any combination with the push-button fasteners on the detector tube flange and the cadmium shield flange.

The detector tube flange may be removed to permit insertion of the whole detector tube into a one inch cavity, if necessary. After turning the instrument off, the procedure for removing the flange is as follows:

1. Grasp the probe collar with a wrench.

2. Unscrew the handle by turning counterclockwise. Slide the handle down the cord.

3. Unscrew the cable connector at the probe.

4. Remove the collar and flange from the tube and the handle from the cord.

5. Screw the cable connector back on to the tube.

C. Sensitivity.

The sensitivity of the detector tube alone, to thermal neutrons when read on the 488A survey meter, is 12, 120, 1200 or 120,000 thermal neutrons per cm^2 per second (nv thermal) which corresponds to approximately .045, .45, 4.5 or 45 mrem per hour.

D. Area Surveys.

The thermal neutron detector is of prime interest to the health physicist because thermal and slow neutrons have a much higher interaction cross-section to human tissue than do intermediate and fast neutrons. Further, it is much more probable that an intermediate or fast neutron will be thermalized by human tissues before it is captured. Therefore, the ideal survey instrument would be a thermal neutron detector surrounded by a moderator which will thermalize the neutrons present in the same manner as the human body does. Since the dose rate is non-uniform throughout the body volume, and since the ideal moderator may be quite large, the moderator supplied with the 488A Survey Meter necessarily represents a compromise between the ultimate in accuracy, size, portability and convenience. The possibility of using the cadmium shield, moderator, and probe in different combinations also affords a convenient opportunity for determining the approximate neutron spectrum present. The 488A Survey Meter and 488-22 Neutron Probe will completely discriminate against gamma fields.

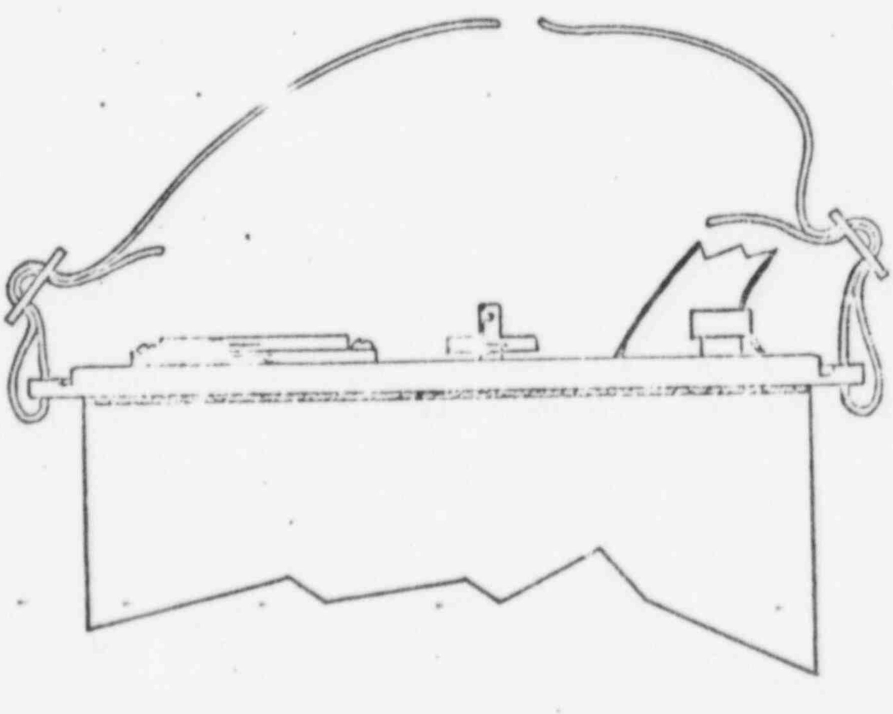

Figure 3-1. Attachment of the Carrying Strap.

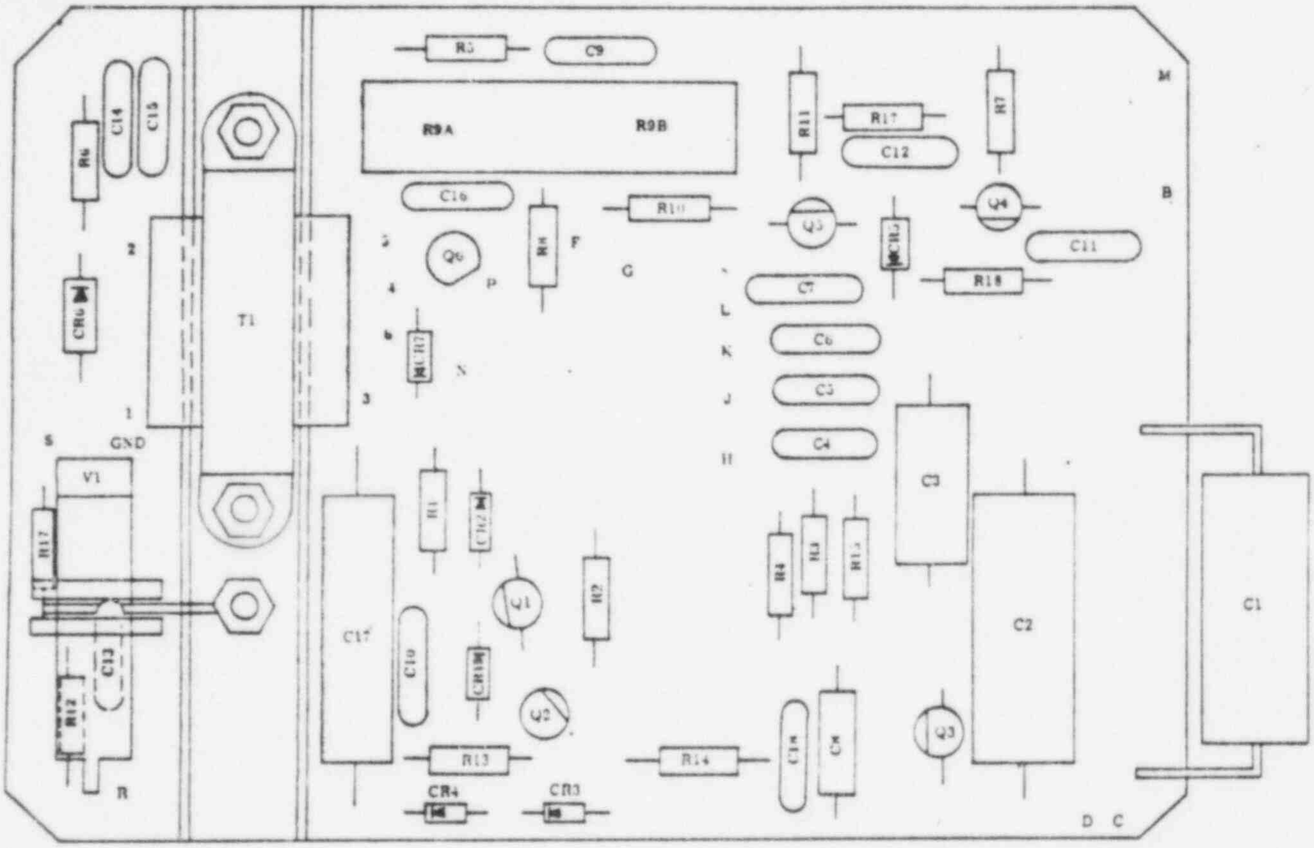

Figure 3-5. Circuit Board Assembly.

SECTION IV

MAINTENANCE

4-1. REPLACING THE BATTERIES.

Battery replacement is accomplished as outlined in the Section 3-1. The end point of the cells is 1 (one) volt per cell. By far the best preventive maintenance procedure that can be recommended is to make certain that the instrument is turned off at all times when not in use. Life of the batteries is about 100 hours under continuous operation, and 175 hours when operated four hours a day.

4-2. CALIBRATION.

The Model 488A Survey Meter can be calibrated in counts per minute by applying the output of a pulse generator to the input and adjusting the "CAL" adjusting potentiometer. A pulse generator producing negative pulses at least .05 volts in amplitude, approximately 5 microseconds in duration and approximately 6000 pulses per minute in repetition rate. Calibration is accomplished in the following manner:

a. Remove the case from the Model 488A.

b. Connect the output pulse generator, in series with a 500 $\mu\mu$fd, capacitor to the input connector on the Mo case top.

c. Turn the Model 488A to the X10 range and adjust the "CAL" potentiometer on the 488A circuit board until the meter scale reading is identical with the pulse repetition rate of the pulse generator.

4-3. CHECKING THE HIGH VOLTAGE POWER SUPPLY.

When the power supply is operating, a buzz of about 100 cps in frequency can be heard due to the oscillations of the power transformer laminations. If this buzz is not audible, the oscillator section is probably not operating and the setting of R9A should be checked. This screwdriver adjustment is set properly by the following procedure.

1. Insert a 0-100 ma meter in series with the power supply batteries, BT1 and BT2.
2. Turn the "HV" adjustment fully counter-clockwise.
3. Turn the instrument "ON".
4. Advance the screwdriver adjustment clockwise until the meter reads 33 ma with the new batteries.

The high voltage output of the power supply should be tested with an electrostatic voltmeter. The voltage