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BASIC TRAINING

IN

RADIATION SAFETY

HOW TO USE THE MORE FAMILIAR MONITORING INSTRUMENTS.

by

K.F. Bishop

Health Physics and Medical Division,
U.K.A.E.A. Research Group,
Atomic Energy Research Establishment,
HARWELL.

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INTRODUCTION

Page

The following pages describe the use of the:-

and the

These notes are prepared for use during the practical work associated with the Basic Radiation Safety training courses, but it is hoped that they will find more widespread application, and in particular that they will encourage those working in controlled areas to use the instruments described without hesitation. The emphasis throughout is on the use of the instruments as such, rather than on the details of monitoring techniques.

Type 1349A Beta-Gamma Survey Meter

N.B. Instrument should be switched-on and checked before taking it to where it is to be used, keeping it switched-on as approaching job.

Switching-On and Checking

1. Advance switch from "OFF" to "A1". Meter pointer should pass red line at mid-scale.

(a) If it does not*, switch-off without advancing switch further, as further switching may damage instrument.

(b) If pointer does pass red line,

2. Advance switch to "A2". Again, meter pointer should pass red line.

(a) If it does not*, switch-off immediately as before.

(b) If pointer passes red line,

3. Advance switch to "ZERO". The pointer must now be adjusted to "O" on the scale, using the "ZERO" knob. If the "ZERO" knob cannot be turned far enough, or if the pointer flicks backwards and forwards across the scale, the instrument is faulty*. If this is the case, switch-off. Note that when zeroing, the position of the pointer depends a little on whether the instrument is standing on its back, or up on its end. Zeroing should ideally be conducted with the instrument in the attitude in which it is to be used. When zeroing has been completed, do not move the "ZERO" knob at all in subsequent operations, but,

4. Advance switch smoothly through "1500", "150" and "15" to "CAL". The pointer should now rise fairly slowly and settle down to a steady reading (dithering slightly) near or between the two red lines marked "CAL". Reject as faulty* an instrument which does not behave in this manner. If the instrument behaves correctly,

5. Switch back one position to "15" (the full-scale reading then being 15 mr/hr.), unscrew knurled knobs on back of case, fold back rear panel to expose aluminium 'window' and secure rear panel by means of press-stud on side of case. Note: The aluminium window is thin and delicate. Do not damage it. The instrument is now ready for use.

In Use

The instrument is used principally for the measurement of Gamma- and X-radiation (and may also be used for the measurement of Beta Radiation), in the immediate vicinity of where the user is working. By means of the switch, full-scale readings of 15, 150, 1500 mr/hr. may be set. Local H.P. advice should be sought when choosing which range to use, if in doubt. The instrument reads directly in mr/hr., but the following points need to be remembered:-

1. If beta radiation is being measured, position the instrument such that the aluminium window at the back faces the source of radiation.

2. The instrument under-estimates the intensity of beta-radiation and soft X- and gamma rays. Seek local H.P. advice if you do not know the correction factor to apply.

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*Report faulty instruments to H.P. & M. as soon as possible.

3. The instrument will under-estimate the intensity of radiation coming from an active specimen, close to the specimen, even if the aluminium window is in contact with it.

4. The instrument will under-estimate the intensity of a beam of radiation if the beam is narrower than the instrument. The narrower the beam, the more seriously will the instrument under-estimate.

Switching-Off

Switch-off after leaving job by:-

1. Returning switch to "OFF" position and,

2. Closing back panel over aluminium window and securing by means of knurled knobs.

Note: If the instrument 'lives' in a pre-arranged position when not in use, replace it there after switching-off.

Type BN 110 General Purpose Monitor, with Type BN 111 alpha-contamination probe

N.B. A disc of uranium metal about 0.9" dia. by 1/32" thick is needed for setting-up the instrument according to the following instructions. This may consist of a "Source Type 1623A, A.E.R.E. Cat. No. 3-7/15269", kept with the instrument, or a suitable piece of uranium may sometimes be found glued to the case of the instrument.

Before Switching-On

Check that:-

1. At least two minutes have elapsed since the instrument was last "on". Rapid switching-off and then on again may damage it.

2. The BN 111 probe is connected.

3. The "PROBE" switch is set to "ALPHA".

4. The "E.H.T. COARSE" switch is set to position "1".

5. The "E.H.T. FINE" knob is turned fully anti-clockwise.

6. The "SPEAKER" switch is set to "ON".

7. The "MONITOR" switch is set to "E.H.T.".

8. The "RANGE" switch is set to "X 10".

Switch-On by depressing "MAINS ON" switch. The red lamp on the front panel should light.* The meter pointer should move to the left of the lower end of the scale and remain there. (Sometimes the pointer kicks up the scale before settling down to the left. This does not matter). There is a delay of a minute or so before the instrument is sensitive.

To Check when the instrument is sensitive, advance the "E.H.T. COARSE" switch to position "2" and return it to position "1". If the instrument is sensitive, this operation will cause the meter pointer to rise up the scale and then fall back.

Setting-Up**

1. Turn the "MONITOR" switch to "COUNT".

2. Place the uranium disc centrally in contact with the face of the probe.

3. Advance the "E.H.T. COARSE" switch slowly, a step at a time. The alpha counts will be made audible by the loudspeaker and the alpha counting rate will be indicated by the meter. Note: A steady deflection of the pointer is not obtained. It swings erratically about an average position. If the average position of the pointer exceeds 35 to 40 c.p.s. (counts per second), (i.e. 3.5 to 4.0 on the black scale, multiplied by the "X 10" of the "RANGE" switch position), decrease the "E.H.T. COARSE" switch by one position and advance the "E.H.T. FINE" knob by turning clockwise until the average count rate is 35 to 40 c.p.s. Note that this operation has to be performed slowly in order to give the pointer time to 'catch-up'.

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* See footnote, p.2.

**Sometimes instruments will be found with control settings marked on a label on the probe by the local H.P. office. In this case, follow the alternative setting-up procedure described below.

Setting-Up Instrument carrying Instructions from Local H.P. Office

1. Leave the "MONITOR" switch set to "E.H.T.".

2. Advance "E.H.T. COARSE" switch until meter pointer passes E.H.T. setting on red scale laid down by H.P. office. Return switch one position.

3. Increase E.H.T. slowly by advancing "E.H.T. FINE" knob until pointer indicates on the red scale the E.H.T. laid down by the H.P. office.

4. Set "MONITOR" switch to "COUNT".

5. Place the uranium disc centrally in contact with the face of the probe. The alpha counts will be made audible by the loudspeaker and the alpha counting rate will be indicated by the meter. Note that a steady deflection is not obtained but that the pointer swings erratically about an average position. The average deflection as indicated on the black scale, multiplied by the "X 10" of the "RANGE" switch should agree with the counting rate specified by the local H.P. office. If it does not appear to do so, consult the local H.P. staff.

Checking

1. Remove the probe from the uranium disc. The count rate should fall to a 'background' of not more than a few per minute*.

2. Point the face of the probe towards the light. This should not cause the instrument to count*.

3. If the probe is very light-sensitive, pointing the face of the probe towards the light may stop the instrument counting completely. Check this in the following manner. Point the face of the probe towards the light and scan the face of the probe by moving the uranium disc slowly backwards and forwards across its surface, keeping the disc close to the face. If light is 'flooding' the instrument, preventing it from counting, no alpha counts will be registered until, for example, the shadow of the disc falls on a pinhole in the face. This cuts the light out and permits the alpha particle to be counted*. Note that this check requires a uranium disc which is not glued to the case of the instrument.

When you are satisfied that the background is not excessive and that the probe is not light-sensitive, the instrument is ready for use.

In Use

Alpha contamination on a surface is detected by holding the probe such that its face is parallel to the surface and as close to the surface as possible, without actually touching it. Avoid contaminating the face of the probe and remember that the aluminium 'window' is thin and easily damaged.

A surface larger than the probe face is scanned by moving the probe slowly across the surface in a systematic fashion such that none of the surface is missed. The presence of alpha contamination is indicated by the loudspeaker and the meter. With practice, spots of contamination can often be detected by ear. The meter will show how badly the surface is contaminated and the "RANGE" switch may be set at will such that:-

At "X 1", the full-scale meter deflection corresponds to 5 c.p.s.

At "X 10", the full-scale meter deflection corresponds to 50 c.p.s.

At "X 100", the full-scale meter deflection corresponds to 500 c.p.s.

At "X 1000", the full-scale meter deflection corresponds to 5,000 c.p.s.

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*See footnote, p.2.

These figures may be compared with the derived working limits of surface contamination, namely:-

5 c.p.s.* usually, in 'White' or 'Blue' contamination areas,

50 c.p.s.** usually in a 'Red' contamination area.

Note that d.w.l.'s given in counts per second depend on the type of probe used. The figures quoted apply to the BN 111 alpha probe.

When monitoring is finished, the probe should be replaced in the clips on the left-hand side of the top of the instrument. The loudspeaker may be switched-off, but remember that it needs to be switched-on again before more monitoring is undertaken.

Switching-Off

If the instrument is not likely to be needed for some time, it may be switched-off. To do this,

1. Return "E.H.T. FINE" knob to the fully anti-clockwise position.

2. Return "E.H.T. COARSE" switch to position "1".

3. Raise "MAINS ON" switch.

Do not now switch-on again until at least two minutes have elapsed.

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*I.e., 10^{-5} μc/sq.cm.

**I.e., 10^{-4} μc/sq.cm.

Type BN 110 General Purpose Monitor, with Type AP 2 alpha-contamination probe

N.B. A disc of uranium metal about 0.9" dia. by 1/32" thick is needed for setting up the instrument according to the following instructions. This may consist of a "Source Type 1623A, A.E.R.E. Cat. No. 3-7/15269", kept with the instrument.

Before Switching-On,

Check that:-

1. At least two minutes have elapsed since the instrument was last "on". Rapid switching-off and then on again may damage it.

2. The AP 2 probe is connected.

3. The "PROBE" switch is set to "BETA-GAMMA". (The "ALPHA" position is more sensitive than the "BETA-GAMMA" position; too much so when using an AP 2 probe).

4. The "E.H.T. COARSE" switch is set to position "1".

5. The "E.H.T. FINE" knob is turned fully anti-clockwise.

6. The "SPEAKER" switch is set to "ON".

7. The "MONITOR" switch is set to "E.H.T.".

8. The "RANGE" switch is set to "X 10".

Switch-On by depressing "MAINS ON" switch. The red lamp on the front panel should light*. The meter pointer should move to the left of the lower end of the scale and remain there. (Sometimes the pointer kicks up the scale before settling down to the left. This does not matter). There is a delay of a minute or so before the instrument is sensitive.

To Check when the instrument is sensitive, advance the "E.H.T. COARSE" switch to position "2" and return it to position "1". If the instrument is sensitive, this operation will cause the meter pointer to rise up the scale and then fall back.

Setting-Up**

1. Turn the "MONITOR" switch to "COUNT".

2. Place the uranium disc centrally in contact with the face of the probe.

3. Advance the "E.H.T. COARSE" switch slowly, a step at a time. The alpha counts will be made audible by the loudspeaker and the alpha counting rate will be indicated by the meter. Note. A steady deflection of the pointer is not obtained. It swings erratically about an average position. If the average position of the pointer exceeds 25 to 30 c.p.s. (counts per second), (i.e. 2.5 to 3.0 on the black scale, multiplied by the "X 10" of the "RANGE" switch position), decrease the "E.H.T. COARSE" switch by one position and advance the "E.H.T. FINE" knob by turning clockwise until the average count rate is 25 to 30 c.p.s. Note that this operation has to be performed slowly in order to give the pointer time to 'catch-up'.

Setting-Up Instrument carrying Instructions from Local H.P. Office

1. Leave the "MONITOR" switch set to "E.H.T."

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*See footnote, p.2.

**Sometimes instruments will be found with control settings marked on a label on the probe by the local H.P. office. In this case, follow the alternative setting-up procedure described below.

2. Advance "E.H.T. COARSE" switch until meter pointer passes E.H.T. setting on red scale laid down by H.P. office. Return switch one position.

3. Increase E.H.T. slowly by advancing "E.H.T. FINE" knob until pointer indicates on the red scale the E.H.T. laid down by the H.P. office.

4. Set "MONITOR" switch to "COUNT".

5. Place the uranium disc centrally in contact with the face of the probe. The alpha counts will be made audible by the loudspeaker and the alpha counting rate will be indicated by the meter. Note that a steady deflection is not obtained but that the pointer swings erratically about an average position. The average deflection as indicated by the black scale, multiplied by the "X 10" of the "RANGE" switch should agree with the counting rate specified by the local H.P. office. If it does not appear to do so, consult the local H.P. staff.

Checking

1. Remove the probe from the uranium disc. The count rate should fall to a 'background' of not more than a few per minute.*

2. Point the face of the probe towards the light. This should not cause the instrument to count.*

3. If the probe is very light-sensitive, pointing the face of the probe towards the light may stop the instrument counting completely. Check this in the following manner. Point the face of the probe towards the light and scan the face of the probe by moving the uranium disc slowly backwards and forwards across its surface, keeping the disc close to the face. If light is 'flooding' the instrument, preventing it from counting, no alpha counts will be registered until, for example, the shadow of the disc falls on a pinhole in the face. This cuts the light out and permits the alpha particles to be counted.*

When you are satisfied that the background is not excessive and that the probe is not light-sensitive, the instrument is ready for use.

In Use

Alpha contamination on a surface is detected by holding the probe such that its face is parallel to the surface and as close to the surface as possible, without actually touching it. Avoid contaminating the face of the probe and remember that the aluminium 'window' is thin and easily damaged.

A surface larger than the probe face is scanned by moving the probe slowly across the surface in a systematic fashion such that none of the surface is missed. The presence of alpha contamination is indicated by the loudspeaker and the meter. With practice, spots of contamination can often be detected by ear. The meter will show how badly the surface is contaminated and the "RANGE" switch may be set at will such that:-

At "X 1", the full-scale meter deflection corresponds to 5 c.p.s.

At "X 10", the full-scale meter deflection corresponds to 50 c.p.s.

At "X 100", the full-scale meter deflection corresponds to 500 c.p.s.

At "X 1000", the full-scale meter deflection corresponds to 5,000 c.p.s.

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*See footnote, p.2.

These figures may be compared with the derived working limits of surface contamination, namely:-

3 c.p.s.* usually, in 'White' or 'Blue' contamination areas,

30 c.p.s.** usually in a 'Red' contamination area.

Note that d.w.l.'s given in counts per second depend on the type of probe used. The figures quoted apply to the AP 2 alpha probe.

When monitoring is finished, the loudspeaker may be switched-off, but remember that it needs to be switched-on again before more monitoring is undertaken.

Switching-Off

If the instrument is not likely to be needed for some time, it may be switched-off. To do this,

1. Return "E.H.T. FINE" knob to the fully anti-clockwise position.
2. Return "E.H.T. COARSE" switch to position "1".
3. Raise "MAINS ON" switch.

Do not now switch-on again until at least two minutes have elapsed.

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*I.e., 10^{-5} μc/sq.cm.

**I.e., 10^{-4} μc/sq.cm.

Type BN 110 General Purpose Monitor, with Type 1021 C beta/gamma-contamination probe

N.B. A disc of uranium metal about 0.9" dia. by 1/32" thick is needed for setting up the instrument according to the following instructions. This may consist of a "Source Type 1623A, A.E.R.E. Cat. No. 3-6/15269", kept with the instrument, or a suitable piece of uranium may sometimes be found glued to the case of the instrument.

Before Switching-On

Check that:-

1. At least two minutes have elapsed since the instrument was last "on". Rapid switching-off and then on again may damage it.

2. The 1021 C probe is connected.

3. The sliding shutter on the probe is open.

4. The "PROBE" switch is set to "BETA-GAMMA".

5. The "E.H.T. COARSE" switch is set to position "1".

6. The "E.H.T. FINE" knob is turned fully anti-clockwise.

7. The "SPEAKER" switch is set to "ON".

8. The "MONITOR" switch is set to "E.H.T."

9. The "RANGE" switch is set to "X 1".

Switch-On by depressing "MAINS ON" switch. The red lamp on the front panel should light*. The meter pointer should move to the left of the lower end of the scale and remain there. (Sometimes the pointer kicks up the scale before settling down to the left. This does not matter.) There is a delay of a minute or so before the instrument is sensitive.

To Check when the instrument is sensitive, advance the "E.H.T. COARSE" switch to position "2" and return it to position "1". If the instrument is sensitive, this operation will cause the meter pointer to rise up the scale and then fall back.

Setting-Up**

1. Increase the E.H.T. applied to the counter in the probe by advancing the "E.H.T. COARSE" switch slowly a step at a time. At some setting, the back-ground counting rate of the probe will be made audible by the loudspeaker. When this occurs, decrease the setting of the "E.H.T. COARSE" switch by one position such that the loudspeaker becomes silent once again. Now increase the E.H.T. slowly by advancing the "E.H.T. FINE" knob in a clockwise direction until counting becomes just audible once more. Note the value of the E.H.T. at which this occurs on the red scale of the meter.

2. Watching the meter, increase the E.H.T. by a further 100 volts (five small divisions on the meter scale). If this cannot be done by advancing the "E.H.T. FINE" control alone, turn this fully anticlockwise, advance the "E.H.T. COARSE" switch by one position, and then slowly advance the "E.H.T. FINE" knob once again until the desired value of E.H.T. is obtained.

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*See footnote, p.2.

**Sometimes instruments will be found with control settings marked on a label on the probe by the local H.P. office. In this case, follow the alternative setting-up procedure described below.

Setting-Up Instrument carrying Instructions from Local H.P. Office

Advance the "E.H.T. COARSE" switch until meter pointer passes E.H.T. setting on red scale laid down by H.P. office. Return switch one position. Now increase E.H.T. slowly by advancing "E.H.T. FINE" knob until pointer indicates on the red scale the E.H.T. laid down by the H.P. office.

Checking*

1. The instrument should be counting the background radiation in the working area, and this should be audible in the loudspeaker. Turn the "MONITOR" switch to "COUNT". This counting rate should now be indicated on the meter. Note that a steady deflection of the pointer is not obtained, but that the pointer swings erratically about an average position. One expects this counting rate to be about 3 to 5 c.p.s. (counts per second) under normal conditions, although it may be somewhat higher in some areas. The counting rate is obtained by multiplying the meter reading on the black scale by the setting of the "RANGE" switch.

2. Increase the "RANGE" switch setting to "X 1000" and hold the probe such that the uranium disc is centrally in the aperture, a little outside the probe case. The meter should indicate a counting rate of about 1,000 c.p.s. (that is about 1.0 on the black scale, multiplied by the "X 1000" position of the "RANGE" switch). Remove the probe from the uranium disc.

3. Return the "RANGE" switch to "X 1" and point the aperture in the probe towards the light. The background counting rate should neither increase, nor should it disappear. Closing and opening the shutter again should not alter the counting rate.

If the background counting rate exists but is not excessive, if the counting rate with the uranium disc is about right, and if the probe is not light-sensitive, the instrument is ready for use.

In-Use

Beta-Gamma contamination on a surface is detected by holding the probe such that the aperture is parallel to the surface and as close to the surface as possible, without actually touching it.+ Avoid contaminating the probe and remember that the glass counter it contains is thin and easily broken.

A surface larger than the aperture is scanned by moving the probe slowly across the surface in a systematic fashion such that none of the surface is missed. The presence of contamination is indicated by an increase in the 'clicking' rate of the loudspeaker and an increase in the deflection of the meter. This monitoring should normally take place with the shutter open. With practice, spots of contamination can often be detected by ear. The meter will show how badly the surface is contaminated and the "RANGE" switch may be set at will such that:-

At "X 1", the full-scale meter deflection corresponds to 5 c.p.s.

At "X 10", the full-scale meter deflection corresponds to 50 c.p.s.

At "X 100", the full-scale meter deflection corresponds to 500 c.p.s.

At "X 1000", the full-scale meter deflection corresponds to 5,000 c.p.s.

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*See footnote, p.2.

+Some persons may find spots of contamination easier to detect if the probe is held about 3" from the surface. Ref. Cook, J.E., "Some observations relating to the Efficiency of Personal Monitoring for Beta Contamination on Clothing". A.E.R.E.-R 4264 (1964).

These figures may be compared with the derived working limits of surface contamination, namely:-

5 c.p.s.* usually, in 'White' or 'Blue' contamination areas,

50 c.p.s.** usually, in 'Red' contamination areas.

Note that d.w.l.'s given in counts per second depend on the type of probe used. The figures quoted apply to the 1021 C beta-gamma probe. Note too that it is the increase above the background counting rate that matters. Monitoring using the technique described is difficult in areas where the background is high. Remember too, that if the contamination is very bad, the intensity of radiation coming from it might be sufficiently high to 'flood' the counter in the probe. Causing the instrument to indicate incorrectly, even to the extent of indicating nothing at all.

When monitoring is finished, the loudspeaker may be switched-off, but remember that it needs to be switched-on again before more monitoring is undertaken.

Switching-Off

If the instrument is not likely to be needed for some time, it may be switched-off. To do this,

1. Return "E.H.T. FINE" knob to the fully anti-clockwise position.

2. Return "E.H.T. COARSE" switch to position "1".

3. Raise "MAINS ON" switch.

Do not now switch-on again until at least two minutes have elapsed.

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*I.e., 10^{-4} μc/sq.cm.

**I.e., 10^{-3} μc/sq.cm.