TELEDYNE OHIOCAST
1075 JAMES STREET - P.O. BOX 900
SPRINGFIELD, OHIO 45501
TELEPHONE (513) 325-7631
TELEX 20-5415

July 7, 1983

United States Nuclear Regulatory Commission
Radioisotopes Licensing Branch
Division of Fuel Cycle and Material Safety
Washington, D.C. 20555

Gentlemen:

This letter is in reference to our license 34-00412-03.

Please be advised that an organizational structure change has been made at Teledyne Ohiocast.

The following change is in effect:

Assistant Safety Officer - G. Epley

Mr. Epley has been appointed to the position of Assistant Safety Officer to replace J. Mahajan, who has been transferred to other duties at Teledyne Ohiocast.

The following is a brief description of the education and training experience of Mr. Epley.

1. Seven years experience as a radiographer Level I at Teledyne Ohiocast.

2. Attained certification as Level II Radiographic Testing per SNT-TC-1A on 6/24/83.

An announcement of this change was made to the employees of the Radiography Department of Teledyne Ohiocast effective 7/5/83.

Mr. S. Hart, who is the acting Safety Officer, attained his Level III Radiographic Testing per SNT-TC-1A on 3/27/81. Since that time he has been employed as the Supervisor of all testing and inspection.

Should there be any questions or comments, I ask that they be directed to this writer.

Sincerely,

John A Jordak

John A. Jordak
Technical Director

JAJ/pf

MEMORANDUM

TELEDYNE OHIOCAST

July 7, 1983

NOTICE NOTICE NOTICE

TO: All Employees - Radiographic Testing

FROM: John A. Jordak - Technical Director

SUBJECT: NRC License 34-00412-03

As of 7/5/83, G. Epley will act in the capacity of Assistant Safety Officer for this department. He will assist S. Hart, who is the Safety Officer.

John A Jordak

John A. Jordak

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TELEDYNE OHIOCAST
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July 27, 1983

OPERATING INSTRUCTIONS FOR GAMMA INDUSTRIES SOURCE CHANGER

For Removal of Decayed Source and Installation of Replacement Source.

1.0 All source exchanges to be conducted by Safety Officer and will be conducted as follows:

1. Be certain to have an operating survey meter on hand.
2. Locate the source changer within two feet of the shielded head.
3. Remove plug or source tube from the machine outlet.
4. Remove ROUND PLUG from source changer. Save (NEW) source number plate.
5. Connect the short source tube supplied to machine outlet and source changer outlet.
6. Connect source position indicator control to machine lock box and extend control so that operator is positioned full 25 feet from machine.
7. Run decayed source into source changer by turning control handle clockwise until source stops in the changer.
8. At this point, the survey meter should be employed to insure that source has been safely located in shielded position.
9. Disconnect short source tube at source changer and disengage disconnects, being careful not to pull out source.
10. Replace ROUND PLUG, securing decayed source in changer.
11. Remove HEX HEAD PLUG from source changer, being careful not to pull out source cable inside.
12. Carefully pull the source cable disconnect only enough to allow joining of disconnects.
13. Join disconnects on control cable and source cable.
14. Connect short source tube to source changer outlet.
15. Pull source into machine by turning control handle counter clockwise.
16. After a monitor check has been made with a survey meter, remove short source tube.
17. Replace HEX HEAD PLUG on empty source changer hole.

OPERATING INSTRUCTIONS FOR GAMMA INDUSTRIES SOURCE CHANGER

18. Remove decayed source number plate from plate holder on machine and replace with new source number plate attached to lead seal wire. Attach old source number plate to source changer cap plug by lacing seal wire provided through number plate when sealing returned source.

19. Two (2) Lead Seal wires have been furnished with your new source. One (1) is to be used for re-sealing source changer cap plugs and attaching old source number plate, and one (1) for sealing "U" Bolt Lock on changer box.

20. Two D.O.T. style shipping labels are included in the envelope. These are to be pasted over the similar labels on the shipping box. The blank spaces should be filled in as follows:

    Principal Radioactive Content - Spell out: Iridium 192 or Cobalt 60, not IR 192.

    Activity of Contents. . . . . . . Number of curies.

    Transportation Index . . . . . . By radiation survey - MR/hr. at 3 ft.

21. Return the source changer containing short source tube to:

    GAMMA INDUSTRIES
    2255 Ted Dunham Avenue
    Baton Rouge, Louisiana 70821

KOWIPE LEAK TEST KIT PROCEDURE

1.0 PREPARING THE UNIT FOR LEAK TESTING

1.1 All leak testing will be performed by the Radiation Safety Officer.

1.2 A source is contained in the unit to be tested, be sure to use a survey meter to prevent exposure during all of the following procedures. The survey meter that will be used will be the CDV 700 Unit.

1.3 The source is contained in a remotely operated unit, disconnect the source tube from the shielded head after checking with the survey meter to make sure that the source is in a safe position within the head.

2.0 TAKING THE LEAK TEST SAMPLE

2.1 Open Kowipe Leak Test Kit

(a.) Disolve the contents of attached packet in a small volume of water.

(b.) Remove swab in packet on left. Dip cotton tip in solution and proceed with the wipe test by swabbing areas nearest and most accessible to the source.

(c.) Replace the swab in the same container from which it was removed.

(d.) Remove the second swab and perform the wipe test with the swab dry.

(e.) Return the swab to the proper container.

2.2 Measure the radiation level at the surface of the test tube.

NOTE: The instrument that you use for this measurement must be accurately calibrated, and it must have a scale that permits accurate reading of the radiation value given in these instructions.

2.3 If a reading of more than 0.5 mr/hr. is observed, follow the procedure given in Paragraph 3.0.

2.4 If a reading of less than 0.5 mr/hr. is observed, follow the procedure given in Paragraph 4.0.

3.0 HANDLING PROCEDURES FOR SAMPLES READING MORE THAN 0.5 MR/HR

3.1 If your test instrument shows a radiation level of more than 0.5 mr/hr. at the surface of the test tube, there may be gross contamination of the unit, and the following steps should be taken:

(1) Put the test swab back in its place in the shipping container. DO NOT SEND IT TO GAMMA INDUSTRIES.

(2) Immediately remove the radiography unit or source storage container from service. Keep the leak test sample and the contaminated unit together in a safe place until decontamination personnel can take care of them.

(3) As soon as possible, call the nearest N.R.C. Operations Office. Inform them of your findings and subsequent actions.

(4) Contact Gamma Industries and provide them with the same information. Use the following address or telephone number:

Gamma Industries
2255 Ted Dunham Avenue
Baton Rouge, La. 70821
Attention: Radiation Safety Officer
Telephone: (504) 383-7791

4.0 HANDLING PROCEDURES FOR SAMPLES READING LESS THAN 0.5 MR/HR

4.1 If your test instrument shows a radiation level of <u>less</u> than 0.5 mr/hr. at the surface of the Kowipe Leak Test Kit, you mail the sample to Gamma Industries for further testing and certification. You are not required to return the sample by Railway Express. No radiation warning label need be affixed to the outside of the shipping container.

4.2 Be sure the requested information is completed to properly identify the source.

4.3 Return the Kowipe Leak Test Kit to Gamma Industries for analysis (same address as 3.1 item 4)

PREPARED BY: Steve Hart

Steve Hart
Safety Officer

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To describe a gammaray, we must first look at the construction of an atom. Several fundamental parts (or particles) of the atom must first be described.

(A) Electron - a negative charged particle orbiting around a central mass.

(B) Proton - a positive charged particle in the central mass of an atom.

(C) Neutron - a neutral particle having no electrical charge in the central mass.

Therefore, an atom is a central mass of protons and neutrons with orbiting electrons. Since an atom has no electrical charge, the number of electrons equal the number of protons.

The number of protons or electrons define the atomic number, and the atomic weight is the sum of the neutrons and protons. All the known elements such as carbon, iodine, lead, gold, etc. are composed of electrons, protons and neutrons, these and many more elements may exist in one or more forms having the same atomic number, but having a different atomic weight. When the atomic weight of an element is different from its stable or standard known form or determined weight, it is called an isotope. Many isotopes are "stable", that is, they remain as is without change, other isotopes are "unstable" in that they may change spontaneously. The unstable isotope may release energy in this change, this energy may be in the form of alpha, beta and/or gamma radiation, such isotopes are termed radioactive.

The use of a magnetic field gives us an idea of what the parts of the energy of the radioactive isotope is made of, the alpha particle goes to the negative pole; therefore, the alpha particle is positive in charge, the beta particle is drawn to the positive pole. Therefore it is negative, and the gamma radiation does not go to either pole; therefore, it must be neutral and we may assume it to be an energy wave such as sound or light or X-ray.

What are alpha and beta rays? Alpha and beta rays are not rays at all, but particles. Alpha rays (particles) are helium atoms that are positively charged because of the loss of two electrons. Beta rays (particles) are very high speed electrons.

Some facts about alpha and beta particles -

(1) Alpha "rays" are entirely absorbed in an inch or two of air, or even a sheet of paper.

(2) Beta "rays" can be detected after traveling several yards or in about 1/4" of plastic.

(3) While both alpha and beta "rays" ionize (charge the air negative or positive) gases through which they pass, the alpha particle ionizes more than the beta particle.

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What are gamma rays? Gamma rays are waves of energy. Some facts about gamma rays -

(1) Gamma rays are similar to X-rays except gamma rays are of much shorter wave length.

(2) Gamma rays are not detected by electric or magnetic fields.

(3) Gamma rays ionize gases through which they pass.

(4) Gamma rays are detectable after passing through steel, concrete, lead, etc.

(5) The attentuation of gamma rays passing through a material is a function of the density of the material.

Gamma rays are electromagnetic photons, identical in nature with X-rays and for this reason it is possible to use radioactive isotopes as a substitute for X-rays.

UNITS OF RADIATION DOSE

Curie: The original usage was the quantity of radon in equilibrium with one gram of radium. Later the definition was "that quantity of material which undergoes the same number of disintegrations per second as one gram of radium".

A curie is now defined as that quantity of radioactive material which undergoes 37 billion disintegrations per second. (Symbol C)

Roentgen: Unit of radiation intensity only, is now defined as that quantity of radiation, that ionizes 1cc of air to produce one electrostatic unit of electricity of either sign, or; that quantity of radiation such that the associated corpuscular emmssion per 0.001293 group of air produces in air ions carrying one electrostatic unit of quantity of electricity of either sign. (Symbol R)

Rad: The unit of absorbed dose which is 100 ergs per gram of material and is the measure of the energy imparted to matter by ionizing particles per unit mass of irradiated material at the phase of interest.

Rem: The roentgen-equivilant-man. That quantity of any type of ionizing radiation which, when absorbed by man, produces an effect equivalent to the absorption by man of one roentgen of X or gamma radiation.

The following are considered equivalent to a dose of one rem -

1 Roentgen of X or gamma radiation.
1 Rad of X, gamma, or beta radiation.
0.1 Rad of neutrons or high energy protons.
0.05 Rad of particles heavier than protons with sufficient energy to reach the lens of the eye (alpha and accelerated deuterons).

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Millicurie: 1/1000 of a curie, 1000 millicuries are required to make one curie. (Symbol mc)

Millirem: 1/1000 of a rem. 1000 millirems are required to make one rem. (Symbol mr)

Microcurie: 1/1,000,000 of a curie, one million microcuries required to make one curie. (Symbol μc)

HAZARDS OF EXCESSIVE RADIATION

Exposure by radiation occurs to all humans, animals and matter. This exposure is natural and is in the form of cosmic rays. These cosmic rays average about 0.1 R/year at sea level; in higher altitudes such as Denver it may be as high as 0.5 R/year. An x-ray examination may be as high as 0.5 R to 5 R per exposure, while a fluoroscopic examination may produce 10 to 20 R per minute of exposure.

The present A.E.C. regulations limit exposure dosages to 1.25 R per calendar quarter to the whole body, gonads, eyes and blood forming parts except where specific requirements are met. This amounts to less than 100 mr/week. The total accumulative dosage should not exceed 5 times your age at the last birthday less 5 minus 18 (5 (age-18)). This is no more than an average of 5 R for each year after your 18th birthday. The maximum dose in one week should not exceed 300 mr (when permission is granted). Emergency exposures to 25 Rems once in a lifetime is assumed to have no affect on radiation tolerance.

The estimated dose for varying degree of injury might be put into table form as follows:

Dose Rate	Period of time	Effect
500 R/day	2 days	Death nearly 100%
100 R/day	Until death	Average survival time 15 days, 100% death 30 days.
60 R/day	10 days.	Death or high rate of crippling injuries
30 R/day	10 days	Moderate disabilities
10 R/day	365 days	Some deaths
3 R/day	Few months	No drop in efficiency
0.5 R/day	Many months	No large scale drop in life span

The effect of acute radiation dosage to the whole body is:

0-25 R	No obvious injury
25-50 R	Blood change - no injury
50-100 R	Blood change, some injury
100-200 R	Injury, possible disability
200-400 R	Injury and disability, death possible
400 R	Death to 50%
600 R or more	100% Death

METHODS OF CONTROLLING RADIATION DOSE

The three methods of controlling radiation dose are (1) shielding (2) distance and (3) time.

A short description is included along with an example or two for each method of control. In actual practice all three methods are used at the same time, only under very rare circumstances would one or two methods be ignored. Therefore, for field use or calculations for safe operations each part must be applied when calculations for radiation protection are made to determine what the radiation will be.

Shielding

One of the means of protection against exposure to radiation is the placement of some material between the source of radiation and the individual. This process is called shielding.

Shielding, or to be more correct, the absorption of radiation, reduces the intensity of radiation from isotopes according to the shielding thickness and density.

The effectiveness of the shielding material varies according to its density and also varies according to the radiation emitted from the various isotopes.

The thickness of a material required to reduce radiation intensity to one half or one tenth of its previous value is called its half value layer (HVL) or its tenth value layer (TVL). The following tables are the values for common materials with Colbalt and Iridium:

Material	$C_o{}^{60}$	$I_R{}^{192}$
Lead 1/10	1.62"	0.64"
1/2	0.49"	0.19"
Concrete 1/10	8.6"	6.2"
or		
Aluminum 1/2	2.6"	1.9"
Iron 1/10	2.90"	2.0"
1/2	0.87"	0.61"

The following are examples for shielding problems:

Example (1) How much lead is required to reduce 15000 mr/hr $C_o{}^{60}$ Radiation intensity to 15 mr/hr?

	Radiation	Pb (TVL)	Inches
Solution	15000 mr/hr	0	0
	1500 mr/hr	1	1.62
	150 mr/hr	2	3.24
	15 mr/hr	3	4.86

Example (1) continued -

Answer - <u>4.86 inches lead required.</u>

Example (2) How much concrete is required to reduce Iridium radiation intensity from 25000 mr/hr to 2.5 mr/hr?

	Radiation	Concrete (TVL)	Inches
Solution	25000 mr/hr	0	0
	2500 mr/hr	1	6.2
	250 mr/hr	2	12.4
	25 mr/hr	3	18.6
	2.5 mr/hr	4	24.8

Answer - <u>24.8 inches of concrete required.</u>

The attached chart may be used to calculate the amount of lead or concrete required by use of a reduction factor. An example of this would be 50,000 mr/hr of Cobalt down to 5 mr/hr. This is a reduction of $\frac{50,000 \text{ mr/hr}}{5}$ 10,000 per the chart 35 inches of concrete are required.

Distance

The best protection from radiation is some shielding material, the heavier (or denser) the material the better, but shielding materials are not always available in a useable shape or quantity. Therefore, another protection for radiation safety must be used. This is distance between the source of radiation and the individual.

The method for calculation of distance and radiation intensity is the inverse square law. Since X-rays and gamma-rays travel in straight lines in all directions, it can be said that if an operator is two feet away from a source he will receive 1/4 the radiation he would receive if he were one foot away. $I = \frac{1}{D^2}$.

More often the operator is concerned with determing what an intensity will be at a new or unknown distance. These then are unknowns to him and can be calculated from the known distance and known intensity, hence the following formula.

$$\frac{I_U}{I_K} = \frac{D_K^2}{D_U^2}$$

I_U - Intensity Unknown
I_K - Intensity Known
D_K^2 - Distance X Distance of Known
D_U^2 - Distance X Distance of Unknown

From this one formula all distances or intensity factors can be calculated.

The following is the radiation emitted from one curie of Cobalt or Iridium in mr/hr.

Isotope	1 Meter *	1 Foot
Co^{60}	1350	14500
Ir^{192}	550	5900

(* 1 Meter equals 39.37 inches)

Example (1) 1 Curie of Cobalt. What is its intensity at 5 feet?

Solution

$$\frac{I_U}{I_K} = \frac{D_K^2}{D_U^2}$$

$$\frac{I_U}{14{,}500 \text{ mr/hr}} = \frac{1 \times 1 \text{ foot}^2}{5 \times 5 \text{ foot}^2}$$

$$I_U = \frac{14{,}500 \text{ mr/hr}}{25}$$

Answer $\underline{I_U = 580 \text{ mr/hr}}$

Examplo (2) 0.5 curie of Iridium. What intensity at 3 feet?

Solution 0.5 curie = 0.5 x 5900 mr/hr at 1 foot
0.5 curie = 2950 mr/hr

$$\frac{I_U}{I_K} = \frac{D_K^2}{D_U^2}$$

$$\frac{I_U}{2950\ \text{mr/hr}} = \frac{1 \times 1\ \text{foot}^2}{3 \times 3\ \text{foot}^2}$$

$$I_U = \frac{2950\ \text{mr/hr}}{9}$$

Answer $I_U = 339$ mr/hr

EXAMPLES USING TIME

1 hour = 60 minutes
1 minute = 60 seconds

Example (1) If the radiation at a given point was 20000 mr/hr, what would be the maximum time you could remain there to get a dose of less than 11 mr?

Solution: (a) $\frac{20000\ \text{mr/hr}}{60\ \text{min/hr}}$

(b) 333.3 mr/min
(b) $\frac{333.3\ \text{mr/min}}{60\ \text{sec/min}}$

5.55 mr/sec
(c) 5.55 mr/sec x 2 sec

Answer 11.10 mr for 2 seconds

Example (2) How many mr would you receive in 10 seconds from radiation of 15000 mr/hr?

Solution: (a) $\frac{15000\ \text{mr/hr}}{60\ \text{min/hr}}$

250 mr/min
(b) $\frac{250\ \text{mr/min}}{60\ \text{sec/min}}$

(c) 4.16 mr/sec

(d) 4.16 mr/sec x 10 sec.

Answer: 41.6 mr

WORKING TIME

When shielding is not available for protection against radiation and the area in which you must work is restricted, one other means of safety from radiation remains and that is the amount of time of exposure you can tolerate. The determination is straight forward.

1 hour equals 60 minutes
1 minute equals 60 seconds
1 hour equals 3600 seconds

(Example 1) How many seconds could you remain in a radiation area where the intensity is 6000 mr/hr if you do not want to receive over 10 mr.

$$6000 \text{ mr/hr} \div 3600 \text{ sec/hr}$$

$$\frac{6000}{3000} \text{ mr/sec} = \frac{5}{3} \text{ mr/sec}$$

$$10 \text{ mr} \div \frac{5}{3} \text{ mr/sec}$$

$$\frac{10 \text{ mr}}{\frac{5}{3} \text{ mr/sec}} = \frac{10 \times 3 \text{ sec}}{5} = \underline{\underline{6 \text{ seconds}}}$$

(Example 2) If you remained in a radiation of 10000 mr/hr for 30 seconds how much radiation would you receive?

Solution: $10000 \text{ mr/hr} \div 3600 \text{ sec/hr}$

$$\frac{10000 \text{ mr/hr}}{3600 \text{ sec/hr}} =$$

$$\frac{20}{9} \text{ mr/sec}$$

$$2.22 \text{ mr/sec} \times 30 \text{ sec}$$

Answer $\underline{\underline{66.6 \text{ mr}}}$

RADIATION DETECTION

Use of Radiation Survey Instruments

Survey meters used for detection of radiation are of the ionization type. In an ionization chamber when ionization occurs in a gas in the presence of an electric field, the ions will move in opposite directions, each going to the electrode having the charge opposite that of the ion. If the electrodes are connected to a battery, the ions reaching the electrodes will give up their charge and become neutral again, but at the expense of removing charge from the battery. This results in a current flow through the battery and the external circuit. This current, though extremely small, can be measured in terms of radiation intensity required to produce ionization. Instruments of this type are used for health monitoring and survey work.

The actual manual operation is as follows: the instrument is turned to the battery check or filament position which is useful as a quick check to see if the instrument is operable and allowed to warm up. Some instruments have a zero point on the control knob, others are adjusted for zero when on a given scale. The instruments have three ranges, 100X, 10X and 1X in this order, the reason for the descending order is to protect the instrument from going off scale, and possibly bending the indicator order. The scales will measure in the case of the Nuclear Chicago 2586, 2500 mr/hr, 250 mr/hr and 25 mr/hr. The ranges of the Tracerlab SU-1-E are 1500 mr/hr, 150 mr/hr and 15 mr/hr. The instruments are to be used in any case of emergency or where control and survey are to be made as required by AEC regulations Part 20, 30 and 34.

Another type of radiation instrument is the Geiger Counter. This type of instrument is used in areas where radiation intensity is low, where ionization type instruments are not accurate (in our case it is impractical although it might be accurate enough). The Geiger Counter can be used for measurement of low intensity because of the amplification within its ionization chamber as well as the amplification circuits. Each bit of radiation entering the Geiger tube produces an avalanche of ions; each avalanche can deflect a needle or can produce a click or can light a lamp because of the amplification circuit. The Nucleonic Uranium Finder and the Tracerlab Laboratory monitors are this type of instrument. These instruments can be used for monitoring or for room surveys, but should not be used for any of the surveys required by the N.R.C. unless permission has been given for specific applications.

Calibration Performed by Gamma Industries, every three months on each instrument.

The ionization instruments are calibrated in the following manner. Using a known source (type, curage and radiation intensity at one foot), rings are drawn or distances measured for different levels of radiation for each range, two levels for each scale range are required The intensity is calculated for the distances and the ranges to be calibrated. The source location and the center of the ionization tube are lined up. The source is exposed and a reading made, care should be used to protect the person doing the calibration and all who may be around him. Each of the three ranges, the 100X, 10X and 1X, are checked in this manner. Each scale must read + or - 20% to be acceptable for use.

Limitations

The ionization type instruments should not be used where low intensity radiation is present because of its inaccuracies at low intensity ranges.

Geiger Counters should not be used where high radiation intensity is used because of its tendency to "slug" or to become "inoperable" due to an excess amount of ionization. Each avalanche of ions causes some audible or visible reaction. If these avalanches are so rapid that the Geiger tube cannot recover from the previous avalanche, which may have occured only a fraction of a second earlier, the audible or visible signal will not register until the avalanches are again reduced. This tendency to "slug" makes this instrument unsatisfactory for emergency or survey work, but does not limit its usefulness as a monitoring tool.

Survey Techniques

With the knowledge of the source, strength and type of source, it is an easy matter to determine what are safe limits as required by the N.R.C. regulations in Part 20, 30 and 34. Once the required shielding and distances are laid out, a survey should be made with a calibrated survey (ionization) meter to check the calculated requirements for restricted and radiation areas.

Where a room is built for the specific purpose of containing a radiation source, signs should be affixed warning of the presence of radioactive material and also within the room areas of high radiation should be posted, and entries locked or kept under constant surveilance.

Where an outside area is to be used the area must be completely ringed off with rope, wire, fencing, etc. and the radiation areas must be posted and the restricted areas kept under constant surveillance. Signs must notify the passerby of the presence of radioactive materials to reduce the chance of exposure. The area laid out must be surveyed to be sure that the calculated limits of radiation are correct.

The survey technique is very simple thereafter - use the survey meter to check calculations of radiation, use the survey meter to be sure of the presence of radiation, use the survey meter to be sure of the return of the isotope to its storage or shielded position, use the survey meter as the best protection against accidental exposure. The knowledge of where radiation exists, how much, and from what direction are the first requirements to setting up protection, and a survey is the only sure method for the radiographer to determine its presence.

PERSONNEL MONITORING EQUIPMENT

Film Badge -
A film badge is a piece of photographic film in a waterproof case. An outer case holds the film and metallic filters which discriminate between different energy ranges, (beta, gamma and x-rays). The film badge has two parts - a cummulative (13 week) part and a weekly part. These films are developed and the blackening effect on the film is indicative of the radiation received by the badge and the wearer. An advantage of the film badge is that a record is made which cannot be altered or lost through improper reading and recording. A disadvantage is the dosage received cannot be determined until after development of the film.

Pocket Dosimeter -
This instrument is a quartz fiber electrometer with a microscope to allow it to be read. During the morning the dosimeter is charged so the scale reads zero. During the day the wearer may read it at any time and determine the amount of radiation received. The advantage of this instrument is that an operator finding he is receiving too much radiation can adjust his technique to reduce his exposure.

Pocket Chambers -
The pocket chamber is an ionization chamber which is not read directly. The pocket chamber is charged and read on a separate piece of apparatus. The principle of operation is simply this: the pocket chamber is a special form of condenser which discharges during exposure to radiation. The charger is the reading portion of this instrument which also contains the quartz fiber which indicates the amount of radiation received by the pocket chamber and the wearer.

Radiographic Equipment

The radioactive isotopes will be used in Budd Co. (Gamma Corp., Nuclear Systems and presently called Tatnal Measuring Systems) machines. These machines are for remote handling of the isotopes. The Cobalt-60 is contained in the Model 52 Multitron machine which can hold two sources of Cobalt up to 30 curies.
will hold up to 60 curies of Iridium 192.
Model 100 will hold up to 100 curies of Iridium 192
The construction of these machines is as follows - the "head" is made of lead and is covered with Aluminum. Within the head is an "S" tube which stores the isotope, the front of the "S" tube is a colimation cone; the back is connected to a lock box.

At the front of the "S" tube a projection tube of woven copper is connected. This guides or locates the source for exposure. At the back is a lock box which is connected to the control cable. This consists of a 46 foot cable and two 23 foot guide tubes. The guide tubes and cable are connected to a crank. The crank moves the "source projection cable" in and out when exposures are to be made.

One end of the cable is silver soldered to prevent it from unraveling; the other end is swagged to a coupling or "disconnect".

The source itself is in a stainless steel capsule which is welded together and swagged to a woven wire on one end; on the other end of this wire is swagged a coupling or "disconnect".

The source coupling is connected to the source projection cable and the guide tube screwed into the lock box and the projection tube is screwed into the "S" tube in the head, and the set-up is complete except for unlocking the head to start the process of radiographic exposures.

When not in use the radioactive isotopes are stored in the head and are locked by the use of a special type lock which fits over the woven wire that is connected to the sealed source. This makes removal of the isotope from the head impossible except in cases of emergency or vandalism.

The N.R.C. regulations set the limits for radiation from the surface of storage containers. These must be adhered to in order to produce a safe operation.