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TELEPHONE (203) 467-4426

MS 18
K7

January 3, 1986

United States Nuclear Regulatory Commission
Region 1
631 Park Avenue
King of Prussia, Pennsylvania 19406

ATT: Marlene Taylor

Dear Ms. Taylor:

RE: LICENSE NO. 06-19319-01
DOCKET NO. 030-17428
CONTROL NO. 103728

Per your letter dated October 4, 1985 and our subsequent telephone conversation regarding the above, the following should satisfy your requirements regarding the individual items.

1. The instructor is myself, Patrick J. Morrissey. As the instructor, I have received what is equivalent to an 80-hour course requirement in radiation safety directly from Campbell Pacific Nuclear Corporation. During our involvement with CPN Corporation since 1977, we have completed at least the following:

   a. One week (40 hours) at the Campbell facility in Pacheco, California. The purpose of this was familiarization with all components of the nuclear gages including planning, preparation, and giving the radiation safety course recommended by the factory. (a copy of the standard training manual is enclosed for your review.)

   b. During our first years with CPN Corp., to more completely familiarize myself with the CPN gages, Mr. Patrick J. Campbell, then president of Campbell Pacific Nuclear Corp., made numerous trips to my territory during which I assisted in at least six

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one-day (8 hour) courses, using the manual referred to above. Since then, we have given in excess of 20 training courses, thereby reinforcing our familiarity and expertise with the safety procedures.

c. From 1977 to 1985, the CPN Corporation has evolved through a series of technical advances. Primary changes were computer oriented; however, in our effort to market this continually changing product, we have had to either show, demonstrate, and/or use this equipment on a very regular basis.

d. We are also the authorized factory repair station for all repairs. While this is not on a regular basis, we do provide this service as required.

2. Records documenting the training done by Patrick J. Morrissey of our employees and/or others are and will continue to be maintained for a minimum of two years from the date training is completed.

3. ConSpec Associates Inc. will only provide such service (where the removal of the source rod is necessary) that requires the routine maintenance and/or repair of the guide tube or its assembly. This includes roller, bearings, seals, and/or other parts. In no way will the CPN 131 capsule ever be removed from the source rod. Our procedures would require that if the source rod is to be removed, that an area of 10 foot radius be available from where the source rod would be placed during the repair. The source rod itself will be placed in a prepared pig and/or earthen environment (sand or soil) to its full depth. This procedure requires that the handle assembly be removed so as to allow the top of the source rod to extend over the guide tube. The handle is then repositioned in the source rod, removed from the gage assembly, and placed in the prepared area immediately, at all times holding the source rod at arm's length.

The Cesium source in an EXPOSED condition yields only 3.3 Mrem/hour at one meter. Most repairs of this type require less than two hours, and the source rod is placed in a safe condition during this time.

At no time is the CPN 131 encapsulated source ever disturbed and/or removed from the source rod itself.

This procedure is reversed upon completion of the repair.

In the years that we have repaired CPN gages, we have only once found it necessary to remove the source rod for any repair. Furthermore, to have a radiation survey meter in-house, which we feel would be used at most once every two to three years, and which require calibration on an annual basis should not be required.

Our standard procedure also requires that film badges be worn at all times while using the equipment.

We therefore, would request that the above procedure would be acceptable without the use of the survey meter.

Hoping the above meets your requirements, we look forward to hearing from you.

Very truly yours,

ConSpec Associates, Inc.

Patrick J. Morrissey

PJM:js
Enc.

Patrick J. Morrissey
President

CPN CORP
130 SO. BUCHANAN CIRCLE
PACHECO, CA 94553
415-687-6472

TECH MANUAL TM-1

Radiation Safety, Operating Procedures
and Technician Maintenance

Applicable to
All forms of Geophysical Testing
Equipment utilizing Radioactive Sources

CAMPBELL PACIFIC NUCLEAR CORPORATION

NUCLEAR OPERATOR TRAINING COURSE

CAMPBELL PACIFIC NUCLEAR CORPORATION.

This course is a simple one day course designed to permit a soil gauge operator to use his gauge safely, in accordance with applicable legal restrictions, and accurately to obtain the desired field results. Completion of the course qualifies the operator to meet NRC or Agreement State licensing requirements. Operators are encouraged to attend other available radiation courses at local universities, highway departments or other agencies.

AGENDA

MORNING:
* Principles of Nuclear Physics for Soil Measurement
* Health Safety Regulations and Emergency Measures
* Application of Radioisotopes to Soil Gauge Design

AFTERNOON:
* Field Use of Nuclear Gauges
* Calibration and Statistical Evaluation of Results
* Quiz
* Demonstration and Work Sheet Preparation

PRINCIPLES OF NUCLEAR PHYSICS RELATIVE TO SOIL MEASUREMENT

1.00 General: Various elements, both naturally occuring (Radium) and reactor produced (Cesium and Americium) are unstable and are slowly decaying to a more stable state. The act of decay produces emissions of energy upon disintegration of the atoms. These emissions are either "rays" of electromagnetic radiation (Gamma Rays) or are actual particles of material (neutrons, for example). Other emissions are produced from various radioactive materials, however, we are concerned with only the gamma and neutron radiation for purposes of nuclear soil gauging.

Gamma radiation occurs spontaneously from the Cesium or Radium source material.

Neutron emission occurs when an alpha particle emitter (Americium, Plutonium, or Radium) is mixed with Beryllium powder in a tightly compressed pellet. The alpha particles strike the Beryllium atoms to produce fast neutrons of an average energy of 5 million electron volts (MEV). The suffix "Be" is attached to the alpha source name to denote its use as a neutron source when it is mixed with Beryllium (RaBe, AmBe, PuBe).

These emissions are detected by appropriate detectors (Geiger Mueller tubes) for gamma and (Boron Tri-fluoride-BF3 or Helium-3 H3 tubes) neutron measurements. The resultant signals are displayed electronically as an index of soil density and moisture.

Radioactivity, both gamma and neutron, may be thought of as being similar to light from an incandescent bulb. The light rays diminish rapidly as we move away from the bulb (by the inverse square of the distance from the lamp), and they have the ability to penetrate various materials to some degree, ranging from nearly complete penetration (glass) to nearly complete blockage (metal shield).

Radiation obeys the same rules, although its penetration capabilities are generally much greater than light. The farther we are from the source, the safer we are, and the more absorbing material (shielding) we place between ourselves and the source, the safer we are. It is theoretically impossible to shield any radioactive source completely, however, careful gauge design and appropriate choice of shielding materials can reduce the radiation to an acceptable level with negligible absorption by the user under proper operating procedures.

1.01 Gamma Radiation: Gamma radiation is electromagnetic "photon" energy capable of penetration of several inches of most materials. It is essentially high energy "light ray" energy. It is useful for the total mass measurement of heavy materials and is used to determine total density of soil.

Gamma radiation is emitted in several energy levels by a sealed Radium source and in a single energy level by a Cesium source. The Cesium level is 0.66 MEV and requires less shielding than the multi-level output of the Radium source. The fixed spectrum emission is also superior for soil density determination purposes. Cesium, a reactor produced isotope requires a license for use anywhere in the U.S. and in foreign countries.

1.02 Neutron Radiation: Neutron radiation consists of small, non-charged particles emitted from the source at an average energy level of approximately 5.0 MEV. This is known as "fast" neutron emission. Neutron detectors "see" only slow, or "thermal" neutrons, therefore, the fast neutrons must slow down or they will be ignored by the detectors. Neutrons slow down by colliding with other objects much like a rifle bullet richocheting from rock to rock.

Collision of the fast neutrons with the nuclei of large atoms results in rebounding of the neutrons with little loss of energy. Collision with the orbiting electrons (approximately 1/1840th the weight of a neutron produces little loss of energy. However, collision with an object of the same mass will produce a major loss of energy or slowing down.

The only atom which can markedly slow down a fast neutron, and which we would likely see in soil, is hydrogen. The hydrogen nucleous is the same mass as the neutron and slows down the neutron immensely compared to collisions with other nuclei. The greatest loss of energy in any collision is when two similar mass objects collide.

A simple analogy is that of a golf ball colliding with a bowling ball. The golf ball would rebound with little loss of energy. The golf ball colliding with BB's (electrons floating around a nucleous) would push them aside. However, two golf balls colliding would produce a strong loss of energy in each of them, or a transfer of energy from one to the other.

This is what happens when a fast neutron hits a hydrogen atom. The neutron is markedly slowed down. A few collisions with hydrogen atoms reduces a fast neutron to the slow or "thermal" energy at which the moisture detectors in the soil gauge can "see" the slow neutron.

Thus, the moisture channel is in reality a "Hydrogen Analyser" and is responsive to any form of hydrogen present whether it be in the form of water, or of some organic matter. It is possible to measure water on a construction site because the only form of hydrogen we normally see on a soil site is free water, the very feature we are trying to measure. However, bound water within the mineral matrix, organic matter, roots, or

asphalt in an asphalt pavement would also provide hydrogen moderation and the neutron gauge would "read" it accordingly. If we know the quantity of extraneous hydrogen, we can account for it in calibration and the gauge can still be used for moisture determination.

Neutron radiation is emitted by any alpha producing source when mixed with Beryllium. CPN uses Americium/Beryllium (AmBe) source in its soil gauges.

2.00 Source Nomenclature: Certain terms are used to describe radiation factors important to us as users and we will explain them herein.

CURIE is a term used to describe the size of a radioactive source. It tells us that we have a quantity of material disintegrating at the rate of 3.7×10^{10} disintegrations per second, or the same rate as one gram of Radium. This is not an index of how dangerous the source might be, only an index of quantity of the material in question.

We deal in small quantities of material and use only millicuries of radioactive material.

The potential danger of a source is not only a factor of the Curie size, but also of the type of material and the type of emissions it is producing.

ROENTGEN is a term describing the amount of radiation accumulated, or dose, or exposure. A roentgen of radiation could be accumulated by standing near a large radioactive, unshielded source for a short time or near a small, unshielded source for a long time.

REM is a superior term for human exposure accumulation than Roentgen because it has been corrected to provide a common base for effects on mankind. Some radiation is highly penetrating and would be more potentially dangerous than other forms. The description becomes equal when we correct them all to the common REM base.

We deal in small amounts of radiation and shall work with millirems.

MILLIREM/HOUR (MREM/HR) is a term used to describe the "brightness" of a radioactive gamma source. It is the strength of the radiation field at the point of measurement. This term is similar to foot candles of light when discussing light.

The brightness of a radiation field will be dictated by the type of radioactive material involved, the size of the source, the amount of shielding present, and the distance we are from the source. The total amount of radiation we would accumulate would then become a factor also of how long we remained in that field.

Because we deal with small sources, and because CPN PORTAPROBES and HYDROPROBES use small, well shielded sources, we will be involved with only Millirems of radiation and with levels which are only in the Millirem/Hour range.

FLUX is a term properly describing the strength of a neutron field. It properly describes the number of neutrons per square centimeter per second falling on a surface. CPN survey forms include the neutron readings in the form of MREM readings for ease of comparison and for determination of potential radiation levels or accumulation.

A conventional survey meter will read only the gamma or beta output of a device. Only special neutron meters will read neutron output. The CPN profiles in the manuals include the neutron levels converted to MREM readings.

3.00 Dose Calculations: Radiation dose calculations are easily done if the operator knows the radiation level in which he is working and the time or duration of exposure. Merely multiply the MREM/HR value times the duration of exposure. The result is MREM dose accumulated.

An accepted level for maximum occupational accumulation, by edict of the Nuclear Regulatory Commission, is 5.0 REM/Year. This is approximately 100 MREM/Week allowing for vacations.

We are always interested in minimizing radiation of any sort, however, the above level is a level established by statute as a legal limit.

3.01 PORTAPROBE Calculations: The average radiation level at 2' from the PORTAPROBE is less than 0.5 MREM/HR.

The average level on the surfaces is 5 MREM/HR.

We are primarily interested in whole body dose not just the fingers and feet. (Extremities can absorb 15 times the whole body allowances.) Accordingly, the 2' distance represents the probable position of the body from the gauge when we are using the device.

Normal operating procedures require the user to handle the gauge for approximately 10 seconds per test and a busy day would normally result in approximately 30 tests per day being taken. Some days will be heavier in work load and others will be lighter. An operator can probably average the 30 test figure. If he works at the testing for five days a week, then how much radiation would he absorb?

10 seconds x 30 tests = 300 seconds/day = 5 Min.

5 Minutes/day of close gauge contact x 5 days = 25 minutes/week.....round it off to ½ hour.

¼ hour x 0.5 MREM/HR = 0.25 MREM accumulation.

This is only $\frac{1}{400}$ the allowed dose!

It is apparent that the operator, following the prescribed operating procedures, would not accumulate any excessive exposure. The gauge is safe for the intended purpose.

The operator must not sit the gauge in his lap, nor attempt to repair the radioactive source in any fashion.

NEVER EXPOSE THE SOURCE UNNECESSARILY!

DO NOT TOUCH THE EXPOSED SOURCE!

4.00 Soil Gauge Sources: The most common soil gauge sources are:

Cesium 137 for gamma emission

Americium 241/Be for neutron emmision

Radium 226/BE for combined gamma and neutron emission.

All sources are supplied in a sealed stainless steel capsule, doubly encapsulated and further welded into a stainless steel source rod or located permanently in the gauge housing.

Sources are manufactured for CPN by a number of manufacturers to CPN specifications. They are all identical. They have been approved for manufacture by CPN's licensing jurisdiction, the State of California Public Health Department, as well as for specific use in CPN products.

Source should never be removed from their mountings and no attempt should ever be made to repair them. Advise the factory immediately in the event of damage to a source. See the section regarding Emergency Procedures in the Radiation Precaution Section (Red Section) of your gauge manual.

5.00 Licensing: The primary licensing agency in the U.S. is the Nuclear Regulatory Commission which has jurisdiction over reactor produced isotopes, but not Radium.

As of this writing, 25 states have undertaken their own licensing and are known as Agreement States. They have "agreed" to license in accordance with the NRC, can be somewhat more restrictive, but not less restrictive. In all cases they license Radium as well as other materials. They also include X-Ray machines as well as any other ionizing device or material.

Therefore, it is possible to use Radium sources in some states where only the Federal Law prevails, but this is only due to a quirk of law and does not connote that Radium is safer than other materials.

The Federal License applies for the reactor produced materials (Cesium and Americium) in all states not doing their own licensing and on all Federal property regardless of location.

Accordingly, a Radium Source gauge could be used on Federal property in an Agreement State, although it could not be taken off the Federal Property and used and, in this instance, no license would be required in that state.

The license spells out the conditions under which the material can be used and strictly limits the user.

IT IS ESSENTIAL THAT THE OPERATOR READ AND UNDERSTAND THE LICENSE UNDER WHICH HE PROPOSES TO USE RADIOACTIVE MATERIALS.

The license dictates the use of the materials and this must not vary. Your license will stipulate that the material is to be used for the "measurement of moisture and density of construction materials". It cannot be used for other purposes. An attempt to X-Ray an object with the with the gauge might be moderately successful, but it is also patently illegal unless your license specifically allows such actions.

The license will require that one person be designated as Radiation Safety Officer (RSO). He is responsible for the general adherence to the license, the maintenance of the required record files, and is the person who should be contacted immediately in the event of an emergency.

5.01 Application for License:

Forms are available from CPN for NRC or Agreement States with the required nomenclature preprinted.

Additional information is filled in for the specific applicant and this is submitted to the appropriate agency for the geographic location.

Upon return, the license must be followed to the letter.

Contact CPN for assistance in obtaining an application or a license.

5.02 Transfer of Radioactive Material to Others

Radioactive material can only be transferred to others if the other party is appropriately licensed to receive and possess or use the material. The only sure proof is a copy of the other party's license. That is why CPN requests a copy of our customer's licenses before we ship out a product to them.

5.03 Reciprocity: Licensees can generally use their device in another license jurisdiction for a period not to exceed 180 days provided the other jurisdiction is notified of the intrusion and is notified of the nature of material, the device in which it is to

be used, the duration of the use, and the location. Notify the other jurisdiction at least 5 days prior to your intended use. CPN Technical Data Sheet # 5 lists the agreement states.

Use for a period of longer than 180 days will require the obtaining of a license in the other jurisdiction.

The new jurisdiction may require submission of a local reciprocity form with proof of your present license. It is wise to contact the other jurisdictional office well in advance of your planned use.

6.00 Transportation: U.S. Government D.O.T. Regulations control the transportation of radioactive materials on public accessways. All CPN products are furnished in D.O.T. Yellow Label II, Type 7A shipping and storage containers. Yellow II labeling means that the outside of the container has less than 10 MREM/HR on any surface and less than 0.5 MREM/HR at 3' from any surface. Under these conditions, no placarding of the vehicle is required. The devices themselves will generally not meet the Yellow II requirements when not in the shipping cases and, if transported on public roadways, would require a placard stating, "RADIOACTIVE", in 4" high letters, front, back, and sides of the vehicle.

The case should be locked during transportation to prevent unauthorized entry to the device.

Anyone can transport the gauge, however, only properly trained and licensed operators can use the gauge.

When transported on commercial carriers, a "SHIPPER'S CERTIFICATION FOR RADIOACTIVE MATERIALS" form should be affixed to the outside of the case. A copy of a suitable certification is included in the Radiation Precautions Section of this manual and in all gauge manuals.

Many airlines will not carry radioactive materials on passenger aircraft. Check before you ship or attempt to take a unit with you.

Contact the factory for assistance.

The reference for DOT Regulations is Title 49, Parts 17 through 173.350.

Your vehicle should always be locked when the gauge is stored therein, and the gauge should be securely fastened down to the bed in an open pickup truck.

The CPN gauges are designed for easy field service and do not require shipment of the radioactive portions to the factory. All CPN electronics may be removed for service without interfering with the radioactive sources.

7.00 Storage: The CPN Gauges should be stored in their shipping cases in a locked area with key access only by the licensed operators. CPN recommends that permanent storage be 10 feet from the nearest point of full time work requirements.

Post a permanent CAUTION-RADIOACTIVE MATERIAL sign on the storage area door. These are available from CPN.

CPN recommends that a sketch of the proposed storage area be furnished the licensing agency upon submission of the initial application. The agency may be able to comment on the proposal to insure compliance with local requirements. An appropriate sketch form is included with all CPN license applications.

CPN recommends that the local fire department be called in for a review of the storage location and of the nature of the device stored therein. This may preclude frantic phone calls should a fire occur and the fire department not know the nature of the radioactive material.

8.00 Health Safety Considerations:

Two major considerations are:

1. Protection of the operator
2. Protection of the General Public

Protection of the operator is achieved through adherence to the manufacturer's instructions, successful completion of the Operator's Training Course, and good gauge design by the CPN factory.

Protection of the General Public is achieved through the factors in item 1. combined with restriction of access to the device by untrained and uninformed individuals. The responsibility for this lies primarily with the licensed operators who keep the gauge safely away from unauthorized people.

8.01 Film Badges: Most licenses will require the operators to wear film badges. These are similar to dental badges, carried in a small plastic holder, and processed monthly. They record the gamma absorption of the user with excellent accuracy. The neutron record is not so accurate and fades with time. The record is a lifetime accumulation record and a copy of the accumulation to date should be obtained by each operator upon leaving his employment. He should present this record to the next employer, if nuclear devices are to be used, and the record can be continued in unbroken form.

A typical film badge service is:

R. S. Landauer Jr., & Co.
999 N. Sepulveda Blvd.
El Segundo, CA 90245
213-640-1015

8.02 Field Safety Procedures:

The gauge is to be under control of a licensed operator at all times. Although interested parties may wish to view the gauge in operation, they may not use it themselves unless properly trained to do so.

A licensed operator may not train another person in the use of the device unless his license specifically permits this training.

There are no general regulations regarding erection of barriers or signs while the gauge is in use. Local requirements of the employer may differ. The gauge has a secure radiation label and the presence of the licensed operator would normally be deemed adequate protection of the device from outsiders. CPN does not recommend the adoption of extraordinary precautions. It is the intention of the safety regulations to protect all parties, not frighten them with unnecessary restrictions or rituals.

See Section 11.00 on Emergencies.

9.00 Leak Testing: License regulations require that all sealed sources be "leak tested" occasionally to insure that the radioactive material is all secure in the source and none has leaked out. This is accomplished by a swab test for CPN products and is generally performed annually by the RSO or any other authorized individual. Your license may require a six months interval. READ YOUR LICENSE.

Leak test kits are available from the CPN factory at a nominal cost.

Your gauge instruction manual will contain detailed instructions regarding leak testing of your device. Follow them closely. It is NOT necessary to remove the source or open the shutter on CPN gauges to effect leak testing.

Up to date leak test certificates must be maintained in the Radiation License File for inspection at all times. This must certify that less than 0.005 microcuries of removable contamination was removed from the gauge at its last test.

10.00 Records: The Radiation Safety Officer is responsible for maintenance of all records pertaining to the radioactive materials. CPN would recommend that a three ring notebook be maintained with tabbed sections for:

a) License and supporting documentation.
b) Personnel records, training, etc.
c) Film Badge Records.
d) Leak Test Records.

This is to be available to license inspection personnel at all times.

11.00 EMERGENCIES:

The operator should attempt to prevent exposure to himself and to others and must insure that the radioactive materials do not escape the capsule and contaminate the area.

Due to the methods of encapsulation, it would require a very severe accident to damage the capsule and result in loss of materials.

In the event of gauge damage:

1. Protect people....keep them away, keep them out of the immediate area until you are certain everything is alright.

2. Protect the gauge from further damage. Get it back to its storage area when you are certain that it is moveable. Do not be unduly bold or brave.

3. Protect the surrounding area from contamination. Freeze the site in the event of a severe accident involving major gauge destruction.

4. Call for help from your RSO who should have an immediately available list of local emergency service offices, the nearest Public Health Office, the nearest hospital or university where radiation specialists may be located, and the CPN factory phone.

A DECISION POINT may be exercised:

A. The gauge is damaged, but is intact, and the source is obviously in place and not damaged. (Dropped, minor runover, flood.)

B. The gauge is damaged, is torn open or is not in a condition to determine source integrity. (Fire, major runover, buried.)

In the event of A: The operator should close the shutter if possible, place the gauge in its shipping case, place the case in the storage location and call the factory for assistance.

In the event of B: The operator should freeze the site, stop the vehicle if involved, get the driver off the vehicle, rope off the area around the site, keep people from walking through the site, and should call for help from a trained nuclear investigator who KNOWS HOW TO USE A SURVEY METER. Contrary to local requirements, CPN does not recommend that operators have their own survey meters for accident precautions. It is better to get an expert on the site rather than an amateur if the source should really be damaged.

Just keep people out of the damage area until it is cleared by the nuclear expert.

Play it safe if there is any doubt!

11.01 Theft: Call the police and the factory. Somebody usually calls the factory sooner or later trying to establish a price for this sort of commodity.

11.02 Fire: Call the fire department and advise them of the nature of the radioactive materials involved. Inform them that it is a sealed source. Your problems will be much simpler if you have already had them in to view the device BEFORE you had a fire. Call the public health department for assistance in preparing the recovered source for shipment to the factory or to another authorized disposal service. DO NOT BURY IT OR OTHERWISE ATTEMPT TO DISPOSE OF THE SOURCE.

12.00 Service and Maintenance:

Detailed service sections are in the individual gauge manuals. For purposes of this course:

1. The CPN products are all field serviceable without removing the source.

2. The entire electronics and battery assemblies can be removed with simple screwdrivers. These can be returned to the factory for service without shipping the source.

3. CPN does not recommend performing mechanical service other than the authorized cleaning of the shutter.

   In the event of a severely damaged or jammed shutter, contact the factory.

13.00 Additional Training Materials:

Radiation Dosimetry, (Hine and Brownell) Academic Press, Inc., 125 E. 23rd St., NY NY

National Bureau of Standards Handbooks available from the Supt of Documents, Washington, 25, DC:

92 SAFE HANDLING OF RADIOACTIVE ISOTOPES

54 PROTECTION AGAINST RADIATION FROM RADIUM, COBALT 60, AND CESIUM 137.

59 PERMISSIBLE DOSE FROM EXTERNAL SOURCE OF IONIZING RADIATION.

Many other excellent references will be found in your public library or technical bookstores. Most public health departments have pamphlets available on the subject of radiation. An excellent reprint of such a handbook is in the back of all CPN Instruction Manuals and this training manual.

Many colleges have short courses on nuclear matters, safety, etc.

CPN recommends an occasional refresher Operator Training Course for all operators.

14.00 APPLICATION OF RADIOISOTOPES TO SOIL GAUGES.

14.01 General: If a gamma source is placed next to a geiger tube, the tube will produce a series of pulses which may be counted electronically and displayed numerically.

If an absorbing material is placed between the source and the detector, the count rate will be reduced. If the absorber is thick and very heavy, the count rate will be reduced to near zero.

If the source, intervening shield (lead) and the detector are placed on a surface, then some radiation will be reflected or "scattered back" to the detector from the source and the system will again produce counts. These counts will be proportional to the density of the reflecting material and we would have a "Backscatter Gauge".

If the source were dropped into a hole in the soil and the detectors left on top slightly away from the hole, then we would have a transmission gauge with the radiation being "transmitted" through the soil. The signal is again proportional to density.

If a neutron source and a slow neutron detector are placed on a soil surface, then the count rate will be proportional to the amount of hydrogen present which should normally be proportional to moisture.

It makes little difference if the surface for either form of measurement is flat or is round as a result of being a larger hole drilled into the ground as in the case of "Depthprobes".

14.02 Surface Gauges: Model A, Model BR, Model MC, etc.

Backscatter is the technique of placing source and detector on the surface of a flat material. This technique measures only the top 2" of soil and is very sensitive to surface roughness or quality of site preparation.

Transmission is the technique of pre-drilling a a small hole in the ground and then inserting the radioactive source in the ground via the moveable source rod. This technique permits measurement to specific depths to 12" and is insensitive to surface roughness. It is very accurate and is the preferred method of measurement for soils.

DENSITY is measured by either of the two above techniques.

MOISTURE is measured by backscatter only. It is not a transmission phenomenon. The Model MC Series gauges use a separate source in the bottom casting to insure constant backscatter operation and permit simultaneous counting of both density and moisture.

Moisture obtains approximately 90% of its returned thermal neutrons from the closest 6" of soil.

14.03 Depth Gauges — Model 500 Series, HYDROPROBE, etc.

The information under surface gauges has general application to depth gauges as well. Depth gauges require a predrilled hole approximately 2" in diameter, cased with thin wall aluminum or steel, into which the probes are lowered.

All depth gauge measurements are backscatter of nature and are subject to the surface roughness effect of the walls of the access tube. This will have little effect on moisture, but is influential in the density mode. Degradation of the hole wall during drilling and casing will influence the accuracy of the density channel.

14.04 Chemical Composition Response

All density gauges are influenced to some extent by the varying outer electron orbit arrangement of the different soil elements. The major elements in soil are aluminum, silicon, calcium, oxygen, and some hydrogen where moisture is present. Agricultural soils will also have carbon and trace elements of other materials in excess of those found in constr-ction soils.

Gamma absorption is primarily effected by the mass of the atoms, thus the density channel is a mass channel. However, low energy gamma rays below 200 KEV are also influenced strongly by the atomic number of the atom as opposed to its weight. Thus, the different atoms moderate the high energy gammas approximately in proportion to the weight of the atoms (something we are trying to measure). However, the low energy, gammas are influenced by the orbiting electron arrangements proportional to atomic number. This is also a factor to the 5th power of the atomic number, something we could well do without!

To avoid this, CPN uses special platinum cathode geiger tubes, internal filtering, and special geometrical design of the shutter arrangement to cancel this potential error. It is no longer a serious factor in density gauges manufactured by CPN, at least where the soils are the usual mix of silicon and calcium.

14.05 Density effect on Moisture:

Thermal neutrons are eventually captured by one atom or another and they disappear. This is accompanied, usually, by emission of a strong gamma ray which can then be detected by the density channel. This error is very small, if noticeable at all, and is not a soil measurement problem.

It has no bearing on Depth Probes due to the geometry of these devices as compared to the surface devices.

14.06 Chemical Effect on Moisture:

This is not common, but may be experienced in soils having a high capture cross section for thermal neutrons. Such soils would have a lot of Boron in them or Cadmium. These soils would absorb the thermal neutrons before they can get to the detectors and a low reading moisture error would result. These are uncommon and are found in salt flats or specific areas.

They are not a problem in agricultural soils.

14.07 Bound Water Effect on Moisture:

This is very common.....it creates a major error in all moisture gauges, whether surface or depth.

Various mineral combinations, largely silicates, have a water of hydration characteristic wherein they combine with water molecules in other than free water form. The hydrogen analyser neutron gauge correctly measures this bound water although this may not have any value whatsoever for either construction compaction or agriculture growth.

Correction for this error is made by measuring the desired water fraction by conventional means and then correcting the factory curve accordingly.

In agricultural measurements, additional sources of hydrogen from hydrocarbon compounds in the humus and root structures may also incorporate errors. These are also easily corrected by drawing a correction to the factory curve based on soil measurements, or tensiometer readings.

Moisture gauges all tend to read higher than they should due to this moisture error.

15.00 Calibration Variations:

The user should view his nuclear gauge as a tool and should not be reluctant to change its calibration to suit his needs if required in the field.

CPN feels that its calibration standards are accurately prepared and calibrated, however, we recognize that our standards to not exactly agree with those of other manufacturers or of major users. We also recognize that other manufacturers do not agree with major users either. In short, there is no universal standard at this time and any calibration is subject to change by the ultimate gauge buyer.

Our MC-2 series gauge even has a Bias provision to permit adjustment of the curve where this is felt necessary.

CPN would counsel the user, however, to be very sure in changing a calibration. The gauge is usually right.

15.01 Calibration Field Check using Compaction Box :

Sometimes a surface unit will provide results in disagreement with conventional methods of testing (sandcones or baloon tests) and a dispute arises regarding accuracy of the nuclear test.

While complicated calibration programs have been developed for nuclear gauges, the only final answer must be based on actual field testing on real soil materials.

CPN products are chemically corrected for the usual soil elements of silicon, calcium, aluminum, and oxygen. However, the presence of a new element of substantial quantity could introduce an error of significant (measureable) amount.

(Fortunately, this new element, if in sufficient quantity to produce an error, would then increase the value of the soil to the point where we would be mining the material for its intrinsic value and would not be building a freeway or a housing development on it.)

Where a dispute arises, however, there is a method of proofing of the calibration of the nuclear gauge, or of the conventional device, to produce an accurate sample of the soil suitable for testing.

This technique revolves around the use of a compaction box.

The user should build a sturdy, wooden or metal box measuring 18.6 x 18.6 x 11" inside dimension. Allowing the last inch as "freeboard" to retain loose material during preparation, the finished box will be 10" deep and the volume is 2.00 Cubic Feet.

1) When a dispute arises, we will compact a boxful of material at a very specific density.....a density appropriate for the material maximum weight. Choose a density of approximately 95% of Proctor for the typical sample. Any density can be compacted in the box, however, from pour point to 100% compaction.

2) Presume we select a density of 130 PCF for the sample. The box holds two cubic feet, therefore, the final box weight will be 2 x 130 PCF or 260 pounds total weight.

   We will compact this into a ten inch thickness, therefore, each inch will contain 26 pounds of soil.

3. Weigh out exactly 26 pounds of the material, spread it around uniformly, and compact it with a flat rammer having a square bottom of approximately 4 x 4 or 5 x 5'.

   Measure down from the top at all points to insure even compaction to a depth of 10" from the top of the box.

4) Repeat this layer compaction until 10" of compacted soil is obtained.

Note:

Each layer MUST be exactly 1" thick. If you over compact by 1/16", this represents a 6% error in THAT lift, or an error of 8 PCF out of 130 PCF! That is unacceptable and the box should be dumped out and started over.

5) Take nuclear gauge readings on the box.

   The gauge should read the box weight correctly and will do so 95% of the time!

   The other 5% of disagreement will generally be due to miscalibration of the device and not due to some peculiarity of the soil.

6) Take conventional tests on the box, including taking of sandcones in the box.

   The usual result will be a disagreement between the sandcone and the box weight.

7) Since the box is a simple device from an engineering standpoint, there can be little doubt as to its correctness if the operator used care in preparation of the sample. Any disagreement must be in the devices.

For further information, write or call for CPN Technical Data Sheet # 4, ACCURACY VERIFICATION USING COMPACTION BOX AND HAMMER.

15.02 Depthprobe Calibration:

Density depthprobes tend to read low in the field due to abrasion of the access tube wall during drilling and casing. Unfortunately, the depthprobe measurement is a backscatter measurement with the same errors as a surface unit.

Relative readings from one level to another, however, will tend to be accurate.

Moisture depthprobes are more accurate than the density depthprobes due to the deeper reading of moisture as opposed to density. Adjustments of the moisture calibration to accomodate bound water conditions, roots, or other organic hydrogen inclusions may be necessary.

For irrigation management, a tensiometer reading is generally used for this starting point determination.

RADIATION PRECAUTIONS

1.00 General: When used in accordance with instructions, the CPN nuclear products represent no danger to the user or to the general public.

The general public is specifically restricted from access to the device by virtue of the operating procedures, locked storage and transportation limitations, and legal restrictions imposed by licensing.

Operator protection is obtained through adequate training plus good gauge design for maximum bioshield useage.

Gamma sources are relatively easy to shield, requiring only careful design of heavy metal shielding (lead, spent uranium, tungsten, etc).

Neutron sources are very difficult to shield. Use of high hydrogen moderators may provide shielding but this is accompanied by defeat of the measurement capacity of the gauge. It is impossible to moderate the neutrons with heavy plastic shielding and still expect the ground moisture to then moderate more neutrons for measurement. Neutron shielding is further complicated in that the thermal neutrons are captured by the moderating material with a resultant emission of gamma radiation of fairly high energy.

An ideal neutron shield would be several inches of plastic for fast neutron moderation, covered over with 1/16" of cadmium sheet for thermal neutron capture, which in turn would be covered with an inch of lead to stop the resultant gammas.

Unfortunately, this combination would be impossible to lift and would no longer measure moisture.

The best radiation protection program of all is a concentrated effort at maintaining the maximum distance from the source at all times combined with expeditious use of the device. Operators should not stand unnecessarily close to the units during operation and should not carry them except by the appropriate carrying handles.

CPN constantly reviews available detectors and source materials to permit reduction in source size and reduction in external radiation levels.

1.01 Surface Gauges: Normal operation of the PORTAPROBE requires the operator to be within 2' of the gauge for a period of approximately 10 seconds per test. There is little reason to be closer than that distance nor to work longer than this period to obtain a test. It may take longer than 10 seconds to prepare the site, however, the nuclear gauge should be remote from the site at this time.

A busy day can result in 30 tests being taken.

A busy work week would include five days of this extensive testing.

If we multiply this all together:

30 tests/day x 10 seconds/test = 300 seconds or 5 minutes/day of exposure within 2'

5 days x 5 minutes = 25 minutes. This can be rounded off to ½ hour.

The average exposure level at 2' from the gauge is 0.5 MREM/HR.

½ hour x ½ MREM/HR = ¼ MREM accumulation in a busy work week with the PORTAPROBE.

Operators are allowed a weekly average accumulation of 100 MREM.

The dose to be expected from the PORTAPROBE using proper procedures is only 1/400th of the allowed dose. This is a large safety factor in the PORTAPROBE design limitations and operating instructions.

1.02 Depth Probes: The radiation from depth probes can be higher because of the work requirement of the depthprobe. Unlike the surface gauges, the depthprobes are carried around by the operator to a greater extent. The sources are the same size, and the shielding is equal, or even better, but the immediate vicinity work requirement is higher.

CPN 500 Series depthprobes are designed to be carried with a strap or handle. The source area is carried near the lower extremities or ankles.

Density depthprobes are used primarily for research and the duty cycle is not high. The use of such a gauge would be infrequent during a total year's time, and radiation accumulation will be low compared to other gauge uses.

The major depthprobe consideration will be the Model 503 HYDROPROBE for irrigation management. This unit will be used routinely, almost daily, throughout the growing season which may be all year long in some areas.

Gamma output from the HYDROPROBE is almost negligible. The Americium 241/Be source has a low energy gamma output which is not used for moisture measurement and which is shielded out internally with a small lead sheath. Gamma radiation on the surface of the HYDROPROBE is approximately 1 MREM/HR which reduces to less than 0.05 MREM/HR at 2' from the gauge.

Thermal neutron output is approximately 0.2 MREM/HR on the surface.

Fast neutron output is approximately 4 MREM/HR on the surface of the gauge as measured with an Eberline PNR-4 neutron counter.

Total gamma and neutron radiation at mid-trunk

of the human body, with the HYDROPROBE carried at the side by its handle, is approximately 0.3 MREM/HR.

The anticipated duty cycle in close proximity to the gauge is approximately 2 hours/day during a full work day. The operator will be driving part of the time, performing some paperwork functions part of the time, and trudging through the fields part of the time. We believe that the work cycle trudging through the field carrying the HYDRO-PROBE will be approximately 2 hours out of an 8 hour day.

Multiplying out:

2 hours/day x 5 days x 0.3 MREM/HR = 3.0 MREM accumulation in a week.

This is 1/30th of the allowed weekly dose.

It is important that the gauge be carried in its appropriate carrying location in the back of the vehicle at maximum practical distance from the operator, and that all use of the gauge be performed with speed.

The gauge is at its safest when the probe is in the ground in the process of taking reading. No measureable radiation is present at the gauge electronics in this operation.

GOOD RADIATION PRACTICE

Keep the curious away, but do not make such a big thing of it that people are frightened.

Replace the lock then the device is not in use and store under secure lock and key. Only licensed operators should have the key to the gauge.

Place the handle of the surface gauge in SAFE position when not in actual use.

Retract the depthprobe into its shield when not in actual use.

Do not intentionally expose any source in air.

Wear film badges routinely. Do not store them in heated environments, glove compartments, etc.

Work fast and keep distance between gauge and operator. Distance and brevity are the two best operator protective programs.

2.00 EFFECTS OF RADIATION EXPOSURE:

Radiation is not detectible by the body during exposure. It cannot be seen, heard, smelled, or felt.

Prolonged exposure will upset cell structure, however, and the body will eventually react to the insult as it would with the attack of germ cells or virus. The body defense mechanism will correct the insult or injury and will destroy any damaged cells whether from sickness or from radiation exposure.

Concentrated radiation in a short period of time is more difficult for the body to handle than is radiation spread over a longer period of time.

The Nuclear Regulatory Commission regulations allow a maximum accumulation of radiation by workers in an occupational use of radioactive materials to be 5.0 REM per year.

This reduces down to 1.25 REM/Qtr, which is a reporting level. The Radiation Safety Officer is required to report an exposure of this level to his license jurisdiction with a report on the manner in which it was received and regarding protective procedures to be taken to prevent it from happening again.

This also reduces down to 100 MREM/WK, allowing for two weeks vacation for the worker.

This is to be considered a maximum recommended tolerance level. We shall always strive to maintain accumulation as low as possible. The less radiation received, the better. We receive radiation constantly from outer space, from the buildings in which we live, from medical X-Rays, and from high energy radar and microwave emissions. Soil gauges are just one more source of energy added to the rest. We shall always strive to keep the total radiation at a minimum, however.

Exposure to radiation is relatively immeasureable in small amounts accumulated from exposure to a soil gauge under normal operating procedures.

Detection of radiation exposure is largely by observation of reported sickness symptoms, combined with observed cell count changes in a blood sample, and also combined with definite knowledge of the probability of exposure.

A change in cell count alone could occur from a cut finger as much as from exposure.

SOME TYPICAL ROUTINE EXPOSURES

Chest X-Ray	100 MREM	Live in Denver as opposed to San Francisco, about 3 times more background radiation due to higher altitude.
Tooth X-Ray	10 - 30 MREM	
Commercial jet flight San Francisco to New York	3 MREM	
		GI Series for ulcer couple REM !

SYMPTOMS OF RADIATION DOSES - WHOLE BODY

(Presume the following radiation exposures were obtained in a period of approximately 24 hours or less.)

(Note that the dose rates are in whole REMS. The exposure from a soil gauge under the most arduous labor conditions is only measured in MilliREMS.)

ACUTE DOSE - REMS	PROBABLE EFFECT
9 - 50	No obvious effect, except some possible blood count changes.
80 - 120	Vomiting and nausea for about 1 day in 5 to 10% of exposed personnel. Fatigue but no serious disability.
130 - 170	Vomiting and nausea for about 1 day, followed by other symptoms of radiation sickness in about 25% of personnel. No deaths anticipated.
270 - 330	Vomiting and nausea in nearly all personnel on first day, followed by other symptoms of radiation sickness. About 20% deaths within 2 - 6 weeks.
400 - 500	Vomiting and nausea in all personnel on first day, followed by other symptoms of radiation sickness. About 50% deaths within 1 month, survivors convalescent for about 6 months
Note:	Deaths would most likely be from some sickness that the body would normally have thrown off. A cut finger turns into blood poisoning, a cold turns into pneumonia. The body defense mechanism is so busy taking care of damaged cells from radiation that it is unprepared to fight off the other normal insults that occur to the body from day to day. Intensive care in a hospital in a germ-free atmosphere would reduce fatalities greatly.
550 - 750	Vomiting and nausea in all personnel within 4 hours after exposure, followed by other symptoms of exposure. Up to 100% deaths, any survivors convalescent for about 6 months.
1000	Vomiting and nausea in all personnel within 1 hour after exposure. Probably no survivors from radiation sickness.
5000	Incapacitation almost immediately. All personnel would be fatalities within 1 week.
Note:	Radiation at these levels would result from direct involvement in a spill in a radioisotopes processing plant, a massive failure of protective systems in a nuclear reactor plant, or from nuclear warfare. The radiation exposure at these levels would do more than merely damage a few cells here and there. Enough cells would be damaged in major body control networks so that the basic body functions would be decommissioned. The brain would not function, breathing control would be lost, etc..... in effect, the power plugs would have been pulled on the body's computor.

EMERGENCY PROCEDURES

3.00 General: The operator must protect human life first, then property from damage due to a radiation incident.

We must prevent the raw radioactive material from escaping to the atmosphere or environment.

The source material is encapsulated in two stainless, welded containers, which is further securely mounted into the gauge enclosure. It is highly unlikely that the material could escape in the event of a severe accident or fire, however, our protective program must insure that we plan for this eventuality.

The first action to be taken in the event of an accident with the CPN PORTAPROBE or the HYDROPROBE is to keep other people away from the site.

Then exercise the following decison point;

* The Gauge is superficially damaged, dented, flooded, or otherwise injured from a drop, minor runover, etc.

  The enclosure is in one piece with a minor break or two in the sheet metal or casting and the source is obviously in place, at least the source location is not torn apart.

  1) Turn the gauge over to view the source area, if necessary. Do not walk through the site material where the gauge was pushed or pulled.

     Inspect the source area visually to insure no damage to shutter or source mounting.

  2) If source area is intact, pick up gauge, place in storage container and return to permanent storage area.

  3) Call the RSO, and CPN factory for assistance in shipping the gauge back to the factory for repair or disposal.

  DO NOT SHIP THE GAUGE WITHOUT FACTORY APPROVAL OR KNOWLEDGE.

* The gauge is broken apart, severely burned, severely crushed with parts strewn around, or the source area is visually damaged.

  1) Freeze the site. Rope off the damage site for 10' around, Stop the vehicle and have the driver walk away. Do not walk through the damage site. If radioactive material is loose it can be picked up and tracked elsewhere.

  2) Call the RSO, and/or the nearest public health department office for help. Call us. The objective is to get an expert radiation technician to the site with an operating survey meter who can determine if the radioactive material is lost or is intact.

     CPN does not recommend that customers purchase their own survey meter for this purpose. There is little likelihood of an accident to begin with and the survey meter can prove to be an item of false security in the event of a serious accident. The operator will not know how to use it properly and may only confound an already bad circumstance by releasing a potentially contaminated site.

  3) The radiation expert will determine whether the site is safe, will remove the contamination if there is any, and will prepare the gauge for shipment to the factory for repair, or disposal.

  4) In the event of severe damage, it may be necessary to dispose of the source through a local disposal agency licensed for this operation.

     The radiation technician or local public health department will assist in this action.

  5) Call the CPN factory and advise of the problem. We will want to know the circumstances to assist in possible advice to others in future training programs.

To ease the minds of operators in this regard, CPN has never had a damaged gauge requiring extreme security precautions, although we have had a number of gauges thoroughly run over in the years that we have manufactured many units.

We know of no other manufacturer, either, who has experienced this degree of damage.

3.01 Important Phone Numbers:

RSO _____

Public Health _____

CPN Factory 415-687-6472

Fire _____

Police _____

Notify the public health office, police and our offices immediately in the case of a stolen gauge.

4.00 Leak Testing: All radioactive sources must be tested for contamination periodically. CPN sources are doubly encapsulated in stainless steel and the likelihood of a leaking source is very remote, however they still must be leak tested in accordance with regulations, basically every six months.

CPN sources are approved for a one year waiver under our CPN license,however, local jurisdictions may still require the six month period. It is important that your license be followed.

The user may test his own gauge following CPN instructions. Leak test kits are available from the factory and an initial kit was supplied with the gauge.

The leak test must be returned to our analysis lab for processing. A certificate will be returned for the licensee's file for inspection by licensing authorities at any time.

4.01 Surface Gauges:

One test is required for the BRC MK II Series, two tests for the BRC MC Series.

BPC Mark II Series:

1) Stand gauge on end, leave shutter closed.

2) Wet swab in detergent, swab the cleanout ring. Do not swab the source rod.

3) Return the swab to our analysis lab in the envelope provided.

4) A certificate will be returned for your records.

BRC MC Series:

The MC Series uses two separate sources to permit the simultaneous counting at all times. Two sources must be leak tested therefore. However, only one swab need be used.

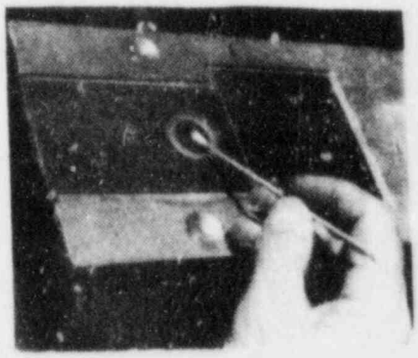
1) Stand gauge on end, leave shutter closed.

2) Wet swab in detergent, swab the cleanout ring. Do not swab the source rod.

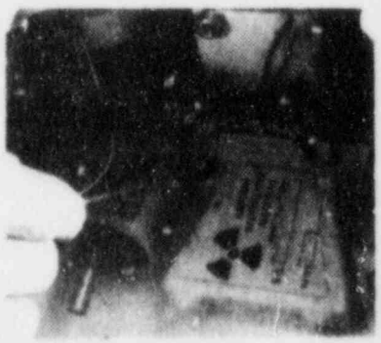
3) Set gauge upright, remove screws and raise electronics to service position. Swab red spot at lower left of guidetube casting adjacent to the moisture detector and adjacent to the internal radiation label.

4) Return the swab to the analysis lab in the envelope provided.

5) A certificate will be returned for file.



LEAK TESTING MODEL BRC MK II GAUGE AND CESIUM SOURCE OF A ANY MC SERIES GAUGE



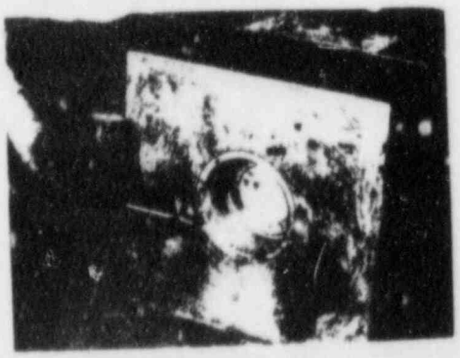
LEAK TESTING MOISTURE SOURCE ON MC GAUGE

4.02 Depthprobes:

1) Lay probe on its side. If source is leaking, contamination will be inside the shield tube.

2) Wet swab and swab inside of shield tube.

3) Return swab to lab. A certificate will be returned for your records.



LEAK TESTING DEPTH PROBE IN SHIELD TUBE

5.00 TRANSPORTATION OF YOUR GAUGE

Transportation via common carrier or in private vehicles on public roads of items containing goods deemed dangerous, such as the radioactive materials in your gauge, is regulated by Title 49 Code of Federal Regulations Parts 170-190.

To transport dangerous goods you must meet specific requirements as to: selecting the proper shipping name, packaging, labeling, marking and filling out of the waybill including certifying the shipment.

5.01 PROPER SHIPPING NAME

The gauge contains 10 mCi of Cesium-137 doubly encapsulated in welded stainless steel enclosures. 50 mCi of Americium-241/Beryllium is enclosed in a second enclosure. Radioactive material encapsulated in this manner would if released from the shipping package as a result of a shipping accident have little possibility of releasing any removable contamination and is classified as **SPECIAL FORM**. This type of encapsulation has been evaluated to meet the free drop, percussion, heating and immersion requirements. The proper shipping name selected from 172.101 is:

RADIOACTIVE MATERIAL, SPECIAL FORM, N.O.S., UN2974

N.O.S. stands for not otherwise specified.

5.02 PACKAGING

The package (plastic or aluminum shipping case) has been evaluated to meet the water spray, free drop, corner drop, penetration and compression requirements and is classified as a **TYPE A** package. Additionally the package meets the requirements for and is classified as a **TYPE 7A** package. It is also a TYPE A quantity since 10 plus 50 mCi is less than the allowable 20 Curies for special form.

The shipper is to maintain on file for one year a complete certification and supporting safety analysis covering the packaging and special form requirements. CPN as the original shipper supplied such a certification with the gauge in a packet addressed to the Radiation Safety Officer.

5.03 LABELING

The gauge in its plastic or aluminum shipping case has a maximum dose rate of 9 mrem/hr of combined gamma and neutron radiation on the surface nearest the source and a dose rate of .025 mrem/hr at 3 feet. It therefor ships under a **YELLOW II** label which covers packages with a dose rate of more than 0.5 and less than 50 mrem/hr on the surface of the package and less than 1.0 mrem/hr at 3 feet.

The transport index is a number placed on the package to indicate to the carrier the degree of control to be exercised during transportation. It indicates the maximum radiation dose rate at 3 feet from the package surface. For simplicity it is rounded up to the nearest tenth. The dose rate at 3 feet for the CPN gauge is .025 mrem/hr. When rounded up it must be marked on the YELLOW-II label as a **TRANSPORT INDEX** of 0.1.

Radioactive YELLOW-II labels should be affixed to at least TWO opposite sides of the package. Entered on the labels should be Cs-137 10mCi, Am-241/Be 50 mCi and a 0.1 Transport Index. As shipped from the factory, CPN's gauges have Yellow-II labels on three visible surfaces.

5.04 MARKING

The package must be marked with:

The country of origin for international shipments
The shipping package type in 1/2" letters
The proper shipping name
The name and address of the shipper or the consignee

CPN's gauges have the following marking:

USA DOT 7A
TYPE A
RADIOACTIVE MATERIAL,
SPECIAL FORM, N.O.S., UN2974

The shipping label provides both the shipper's name and address and the consignee's name and address.

5.05 WAYBILL

The description on the waybill should be as follows:

> **One case, RADIOACTIVE MATERIAL,**
> **SPECIAL FORM, N.O.S., UN2974**
> **Americium 241/Be, 50 mCi**
> **Cesium 137, 10 mCi**
> **Transport Index 0.1**
> **RADIOACTIVE YELLOW II Label**
> **USA DOT 7A, TYPE A Package**

The dangerous goods should be the first item on the waybill if some non-dangerous goods are part of the shipment and an X should be placed in the DG (old HM) column.

The waybill should contain a **CERTIFICATE** as follows:

> **This is to certify that the above-named materials are properly classified, described, packaged, marked and labeled and are in proper condition for transportation according to the applicable regulations of the Department of Transportation.**

This certificate will normally be pre-printed on the waybill.

5.06 MISC

The outside of the package must incorporate a **SEAL** which will be evidence that the package has not been illicitly opened during shipment.

The vehicle does **NOT** require placarding. Radioactive Yellow-III shipments require placarding while Yellow-II shipments are exempt.

The shipping papers must be readily accessible for inspection or in the event of an accident. They must be within the reach of the driver and visible to a person entering the driver's compartment. When the driver is not at the vehicle's controls the shipping papers must be on the drivers seat or in a holder on the drivers door.

When transporting the gauge by private vehicle on public roads all of the above is applicable except; a shipping label with the shipper's or consignee's name is not required, and certification on the shipping paper is not required.

To meet the requirement for accessible shipping papers, the driver should have on the seat or on the drivers door a document which lists the words "SHIPPING PAPER", the name and address of the company or organization he represents, and the description listed above for truck shipments.

The number of packages of radioactive material in any vehicle should be limited to a total transport index of 50. A package with a transport index of 0.1 should be at least one foot from the nearest person. Also it should be at least 3 feet from any undeveloped film for a transit time up to 8 hours. The gauge case should be locked. If the driver leaves the vehicle then the keys should be removed from the ignition and the vehicle locked. If the the gauge is stored in an open area such as the back of a pickup then the case should be chain locked or otherwise secured to the vehicle.

If the gauge is outside its shipping case then the gauge itself is considered the shipping package. Its dose rates are higher but still meets the Yellow-II requirements. It would NOT however meet the requirements for labeling and marking.

5.07 AIR SHIPMENTS

Air shipments must comply with Title 49 and the International Air Transport Association's Dangerous Goods Regulations.

For a Yellow-II label, an air shipment must have a transport index of 1.0 or less.

Radioactive material may not be transported aboard passenger carrying aircraft unless that material is intended for use in, or incident to, research, or medical diagnosis or treatment.

Under most circumstances your gauge will be limited to shipment on cargo-only aircraft. In addition to the above requirements for transportation by truck the following requirements must be met to ship by cargo-only aircraft.

CARGO-AIRCRAFT-ONLY labels must be attached next to the Yellow-II labels.

The air waybill must include the following information:

DANGEROUS GOODS AS PER
ATTACHED SHIPPER'S DECLARATION.
CARGO AIRCRAFT ONLY

Two copies of a shippers declaration must be supplied to the carrier (actually it is best to supply an additional copy for each carrier which will be involved). Amendments or alterations are not allowed unless they are signed by the the same signature as used to sign the document. The declaration should be per the attached example.

For international shipments a copy of the **CERTIFICATE OF COMPETENT AUTHORITY** must be attached. CPN's special form sources have been issued certificate number USA/0115/S, a copy of which is printed on the back of the shippers declaration.

Moisture only gauges contain only Americium. For the shipment of these gauges the information is the same except delete all references to Cs-137, 10 mCi. The moisture gauge still meets and requires a Yellow-II label and has a T.I. of 0.1.

5.09 TRANSFER

Before transfering your gauge to a second party within the USA you must verify that the transferee's license authorizes the receipt of the type, form, and quantity of radioactive material contained in your gauge. Per Title 10, Chapter 1, CFR Part 30.41, there are two acceptable methods for verification.

(1) You may have in your possession, and have read, a current copy of the transferee's license.

(2) You may have in your possession a written certification by the transferee that he is authorized by license to receive the type, form, and quantity of radioactive material to be transferred, specifying the license number, issuing agency and expiration date.

The RSO package originally supplied with your gauge includes a copy of CPN's license to allow you to return your gauge to CPN for repair or other reasons. Additional copies are available upon request.

SHIPPER'S DECLARATION FOR DANGEROUS GOODS

Shipper
CPN CORP
130 S BUCHANAN CIR
PACHECO, CAL 94553

Air Waybill No. 123 12345 6678
Page 1 of 1 Pages
Shipper's Reference Number (optional) JO 12345

Consignee
HAPPY CONSTRUCTION CO
1234 MAIN ST
BOSTON, MASS 01118

Two completed and signed copies of this Declaration must be handed to the operator

IATA

TRANSPORT DETAILS

This shipment is within the limitations prescribed for (delete non-applicable)
PASSENGER AND CARGO AIRCRAFT
CARGO AIRCRAFT ONLY

Airport of Departure: SAN FRANCISCO

Airport of Destination: BOSTON

WARNING

Failure to comply in all respects with the applicable Dangerous Goods Regulations may be in breach of the applicable law, subject to legal penalties. This Declaration must not, in any circumstances, be completed and/or signed by a consolidator, a forwarder or an IATA cargo agent.

Shipment type (delete non-applicable)
NON-RADIOACTIVE / RADIOACTIVE

NATURE AND QUANTITY OF DANGEROUS GOODS (See sub-Section 81 of IATA Dangerous Goods Regulations)

Dangerous Goods Identification: Proper Shipping Name	Class or Div. (Sub-risk)	UN or ID No.	Subsidiary risk	Quantity and type of packing	Packing Inst.	Authorization
RADIOACTIVE MATERIAL, SPECIAL FORM, N.O.S.	7	UN2974		CESIUM 137 AND AMERICIUM 241/BE, ONE TYPE A PACKAGE X 10 mCi Cs-137 AND 50 mCi Am-241/Be EACH	I 0.1 YELLOW II	SP FOR CERTIFICATE SEE REVERSE SIDE

Additional Handling Information

NONE

I hereby declare that the contents of this consignment are fully and accurately described above by proper shipping name and are classified, packed, marked and labelled, and are in all respects in the proper condition for transport by air according to the applicable International and National Governmental Regulations.

Name/Title of Signatory
E. MANCUSO / EXPERT MSC

Place and Date
PACHECO, CAL JUL 21, 1983

Signature

STRAIGHT BILL OF LADING
ORIGINAL - NOT NEGOTIABLE

CONSOLIDATED FREIGHTWAYS
CFWY

JO 12345

SINGLE SHIPMENT PICKUP

6/1/83

HAPPY CONSTRUCTION COMPANY
123 MAIN STREET
CONCORD, CA 94523

CPN CORPORATION
130 SOUTH BUCHANAN CIRCLE
PACHECO, CA 94553

No. Units	Item	Kind of Packaging, Description of Articles, Special Marks and Exceptions	Weight	Rate	CHARGES
1	X	Case, RADIOACTIVE MATERIAL, SPECIAL FORM, N.O.S., UN 2974 Cs-137, 10 mCi Am-241/Be, 50 mCi RADIOACTIVE YELLOW-II Label Transport Index 0.1 URA DOT 7A Type A Package	78 lbs		

1

.40 lb

FREIGHT CHARGES

CPN CORPORATION
130 S. BUCHANAN CIR.
PACHECO, CA 94553
415-687-6473

CONSOLIDATED FREIGHTWAYS

SHIPPER'S DECLARATION FOR DANGEROUS GOODS

Shipper

Air Waybill No.

Page of Pages

Shipper's Reference Number *(optional)*

Consignee

Two completed and signed copies of this Declaration must be handed to the operator.

WARNING

Failure to comply in all respects with the applicable Dangerous Goods Regulations may be in breach of the applicable law, subject to legal penalties. This Declaration must not, in any circumstances, be completed and/or signed by a consolidator, a forwarder or an IATA cargo agent.

TRANSPORT DETAILS

This shipment is within the limitations prescribed for: *(delete non-applicable)*

PASSENGER AND CARGO AIRCRAFT | CARGO AIRCRAFT ONLY

Airport of Departure

Airport of Destination:

Shipment type: *(delete non-applicable)*

NON-RADIOACTIVE | RADIOACTIVE

NATURE AND QUANTITY OF DANGEROUS GOODS *(see sub-Section 8.1 of IATA Dangerous Goods Regulations)*

Dangerous Goods Identification				Quantity and type of packing	Packing Inst	Authorization
Proper Shipping Name	Class or Division	UN or ID No	Subsidiary Risk			

Additional Handling Information

I hereby declare that the contents of this consignment are fully and accurately described above by proper shipping name and are classified, packed, marked and labelled, and are in all respects in the proper condition for transport by air according to the applicable International and National Government Regulations.

Name/Title of Signatory

Place and Date

Signature *(see warning above)*

ML18

"OFFICIAL RECORDS COPY"

US Department
of Transportation

**Research and
Special Programs
Administration**

400 Seventh Street, S.W.
Washington, D.C. 20590

IAEA CERTIFICATE OF COMPETENT AUTHORITY

Special Form Radioactive Material Encapsulation

Certificate Number USA/0115/S

(Revision 3)

This certifies that the encapsulated source, as described, when loaded with the authorized radioactive contents, has been demonstrated to meet the regulatory requirements for special form radioactive material as prescribed in IAEA 1/ and USA 2/ regulations for the transport of radioactive materials.

1. Source Description — The source described by this certificate is identified as Gulf Nuclear, Inc., Model VL-1 which is a double encapsulation constructed of stainless steel and measures from 1/8 to 1 inch in diameter and from 1/4 to 3 inches long.

2. Radioactive Contents — The authorized radioactive contents of this source consist of not more than 1 curie of americium-241, cobalt-60, cesium-137, barium-133, mercury-197 or - 203, chromium-51 or iridium-192.

3. This certificate, unless renewed, expires March 1, 1988.

This certifiate is issued in accordance with paragraph 803 of the IAEA Regulations 1/and in response to the February 9, 1983 petition by Campbell Pacific Nuclear and in consideration of the associated information therein.

Certified by:

R R Rawl

March 7, 1983
(DATE)

Richard R. Rawl
Chief, Radioactive Materials Branch
Office of Hazardous Materials Regulation
Materials Transportation Bureau

1/ "Safety Series No. 6, Regulations for the Safe Transport of Radioactive Materials, 1973 Revised Edition" published by the Interantional Atomic Energy Agency (IAEA), Vienna, Austria.

2/ Title 49, Code of Federal Regulations, Parts 100-199, USA.

Revision 1-extended expiration date.

Revision 2-reflected conformance to the 1973 IAEA Regulations.

Revision 3-extended expiration date.

STATE OF CALIFORNIA
DEPARTMENT OF HEALTH

RADIOACTIVE MATERIAL LICENSE

Pursuant to the California Administrative Code, Title 17, Chapter 5, Subchapter 4, Group 2, Licensing of Radioactive Material, and in reliance on statements and representations heretofore made by the licensee, a license is hereby issued authorizing the licensee to receive, use, possess, transfer or dispose of radioactive material listed below; and to use such radioactive material for the purpose(s) and at the place(s) designated below. This license is subject to all applicable rules, regulations and orders of the Department of Health now or hereafter in effect and to any conditions specified in this license.

1. Licensee: ACME SOILS ENGINEERING CO.	3. License no.: 1000-10 Amendment no.: ORIGINAL
2. Address: 1000 Main Street, Milpitas, CA 94555	4. Expiration date: 2/15/80
	5. Inspection agency: DIS-SF (Division of Industrial Safety)

6. Nuclide	7. Form	8. Possession limit
A. Cesium-137, Americium-241/Be	A. Sealed source (Campbell Pacific Nuclear Corp. Model CPN-131)	A. 5 source pairs not to exceed 10 millicuries of Cesium-137 and 50 millicuries of Americium-241/Be each.
B. Americium-241/Be	B. Sealed source (Campbell Pacific Nuclear Corp. Model CPN-131)	B. 1 source not to exceed 50 millicuries of Americium-241/Be.

9. Authorized use

A. To be used as a component of a Campbell Pacific Nuclear Corp. gauge Model A, B(R) C, M(C), or 500 series for determination of moisture/density in engineering materials.

B. To be used in CPN Model 503 for determination of moisture measurement.

10. Radioactive material may be used at temporary job sites of the licensee in areas not under exclusive federal jurisdiction throughout the State of California. Radioactive material may be permanently stored only at 1000 Main Street, Milpitas,(A, B, & C.)
500 Suburban Avenue, Placerville, Calif.(D.)

11. Radioactive material may be used only by, or under the supervision and in the physical presence of, individuals who: (1) have satisfactorily completed a course, accepted by the Department as adequate, in safe use of soil gages containing radioactive material; and also (2) have been designated by the radiation safety officer as qualified to use radioactive material under this license. The licensee shall: (1) maintain available for inspection a current list of individuals so designated; and (2) provide each such individual with a statement, authorizing use of radioactive material under this license, signed by the radiation safety officer. (Information on which courses have been accepted by the Department as adequate for the purpose of this condition may be obtained from the Department.)

12. The radiation safety officer in this program shall be Alexander Benowitz

For the State Department of Health

Date _____ by _____

Simon Kinsman, Ph.D., Chief
Radiologic Health Section
744 P Street, Sacramento, Calif. 95814

RH 2880-66 (12/73)

RAD PREC 6/83

State of California—Health and Welfare Agency

Department of Health

Page 2 of 2 pages

RADIOACTIVE MATERIAL LICENSE

License Number 1000-10

Amendment Number Orig.

Continued

Supplementary Sheet

This license is subject to all numbered conditions below.
Conditions to which this license is not subject are marked N/A.

__X__ This license is subject to an annual fee of THREE HUNDRED dollars due and payable on the anniversary of the date of issue of this license. _____.

_____ In accordance with Section 6103 of the California Government Code, this license is not subject to payment of an annual license fee.

__X__ Sealed sources contained in soil gauges shall be tested for leakage and/or contamination at intervals not to exceed one year.

__X__ Records of leak test results shall be kept in units of microcuries and maintained for inspection. Any leak test revealing the presence of 0.005 microcuries or more of removable radioactive material shall be reported to the State Department of Health, Radiologic Health Section, 744 P Street, Sacramento, California 95814, within 5 days of the test. This report should include a description of the defective source or device, the results of the test, and the corrective action taken.

_____ Tests for leakage and/or contamination of sealed sources shall be performed only by persons specifically authorized to perform those services.

__X__ The following individuals are authorized to collect wipe test samples of sealed sources possessed under this license, using leak test kits acceptable to the State Department of Health:

Alexander Benowitz

__X__ Maintenance and repair of soil gauges shall be performed only by persons specifically authorized to perform those services.

__X__ At any time the licensee is engaged in making measurements by authority of this license, at either a permanent or a temporary job site, he shall have a current copy of each of the following documents available for inspection at the job site:

(a) statement authorizing individual to use radioactive material. (See Condition 11)
(b) this license
(c) Manufacturer's instruction manual with appropriate emergency procedures

__X__ Except as specifically provided otherwise by this license, the licensee shall possess and use radioactive material described in Items 6, 7 and 8 of this license in accordance with statements, representations and procedures contained in the following documents:

Application and letter dated 1/13/77 and signed by Alexander Benowitz.

For the State Department of Health

Date _____

by I. M. Smart for

Radiologic Health Section
744 P Street, Sacramento, Calif. 95814

RH 2851-SG (6/75)

CPN CORP
130 SO. BUCHANAN CIRCLE
PACHECO, CA 94553
415-687-6472

MAGIC NUMBERS AND TERMS

Radiation is similiar to light.

It **INCREASES** in strength by a factor of **FOUR** each time the distance from the source is cut in **HALF**.

It **DECREASES** in strength by a factor of **ONE/FOURTH** each time the distance from the source **DOUBLES**.

* * *

Millicurie: Small **QUANTITY** of radioactive material.

Milliroentgen: Small **EXPOSURE** of gamma radiation.

Millirad: Small **DOSE** of **ABSORBED** radiation.

Millirem: Small **DOSE** of **ABSORBED** radiation **CORRECTED** for its **EFFECT** on **MAN**.

Millirem/hour: The **DOSE RATE** of a radiation field.

* * *

100 mrem: Weekly allowed dose for an industrial worker. (5 rem per year is maximum work dose).

1/2 mrem: Average heavy work week dose for a **PORTAPROBE** user. (0.5% of allowed weekly dose).

3 mrem: Average heavy work week dose for a **HYDROPROBE** user. (3% of allowed weekly dose). This is more than for a **PORTAPROBE** due to longer close contact during field carrying of the **HYDROPROBE**.

1/4 mrem: Average heavy work week dose for a **HYDROTECTOR** user. (0.25% of allowed weekly dose).

* * *

5 mrem/hr: Average dose rate at surface where hands must touch.

1/2 mrem/hr: Average **GAMMA** dose rate at 2 feet from **PORTAPROBE**.

1/3 mrem/hr: Average **NEUTRON** dose rate at 3 feet from **PORTAPROBE** or **HYDROPROBE**. (source to midtrunk distance when carrying gauge).

* * *

EMERGENCY: Minor (Source intact)

1) Return the gauge to the storage container.
2) Call the RSO and CPN factory.

Major (Source damaged or lost)

1) Stop the vehicle, if involved, get the driver out of the way.
2) Rope off area.
3) Call RSO and CPN factory.
4) Call Public Health. They have the training and equipment required.
5) Do not be unduly bold and brave. Save that for later.

RESPONSIBILITY: You are responsible for the safe and legal use, transportation and storage of the gauge.

You are responsible for the protection of the unwary general public from unnecessary exposure.

CPN CORP
130 SO. BUCHANAN CIRCLE
PACHECO, CA 94553
415-687-6472

Technical Data Sheet #5

STATE OF ALABAMA
Div of Rad Hlth
Rm 510, St Off Bldg
Montgomery, AL 36130
Aubrey Godwin, Dir
(205)261-5313
(205)832-5069*

STATE OF ALASKA
USNRC Region V

STATE OF ARIZONA
Arizona Rad Reg Agency
925 South 52nd St, Ste 2
Tempe, AZ 95281
Charles F. Tedford, Ex Dir
(602)255-4845

STATE OF ARKANSAS
Div of Rad Cntl
Arkansas Dept of Hlth
& Emer. Mgt. Programs
4815 West Markham
Little Rock, AR 72201
Frank Wilson, Dir
(501)661-2301
(501)753-2256*

STATE OF CALIFORNIA
Rad Hlth Branch
Dept of Service
714 P St, Rm 498
Sacramento, CA 95814
Steve Eckberg, Chf
(916)322-2073
(916)391-7716*

STATE OF COLORADO
Rad & Haz Waste CNTL Div
4210 E 11th Ave
Denver, CO 80220
Albert J. Hazle, Dir
(303)320-8333, Ext 6246
(303)320-1465*

STATE OF CONNECTICUT
USNRC Region I

STATE OF DELAWARE
USNRC Region I

STATE OF FLORIDA
Office of Rad. Control
Dept of Hlth & Rehab Ser
Rad. Materials Section
1317 Winewood Blvd
Tallahassee, FL 32301
Lyle E. Jerrett, Ph.D., Dir
(904)487-1004
(904)487-7437*

STATE OF GEORGIA
Rad Hlth Section
Dept of Hum Res
1256 Briarcliff Rd. N.E.
Carol Connell, Chf
Atlanta, GA 30306
(404)894-5795
(404)656-4300*

STATE OF HAWAII
USNRC Region V

STATE OF IDAHO
Rad Contr Sect, Env Div
Dept of Hlth & Welf
Statehouse Mail
Boise, ID 83720
Robert D. Funderburg, Supvr
(208)334-4107

STATE OF ILLINOIS
USNRC Region III

STATE OF INDIANA
USNRC Region III

STATE OF IOWA
USNRC Region III

STATE OF KANSAS
Dept of Hlth & Env
Div of Env
Bur of Air Quality & Rad
Forbes Field, Bldg #321
Topeka, KS 66620
Gerald W. Allen, Dir
(913)862-9360
(913)296-3102*

STATE OF KENTUCKY
Rad Control Branch
Cabinet for Human Res
275 East Main St
Frankfort, KY 40621
Donald R. Hughes, Mgr
(502)564-3700
(502)564-7815*

STATE OF LOUISIANA
Nuc Energy Div
P. O. Box 14690
Baton Rouge, LA 70898
William H. Spell, Admin
(504)925-4518* (also)

STATE OF MAINE
USNRC Region I

STATE OF MARYLAND
Div of Rad Control
Env Hlth Adm, Dept Hlth &
Ment Hyg, 201 W Preston St
Baltimore, MD 21201
Robert E. Corcoran, Chf
(301)383-2744/2735
(301)243-8700*

STATE OF MASSACHUSETTS
USNRC Region I

STATE OF MICHIGAN
USNRC Region III

STATE OF MINNESOTA
USNRC Region III

STATE OF MISSISSIPPI
Div of Rad Hlth
State Dept of Hlth
P. O. Box 1700
Jackson, MS 39215-1700
Eddie S. Fuente, Dir
(601)354-6657/6670

STATE OF MISSOURI
USNRC Region III

STATE OF MONTANA
USNRC Region IV

STATE OF NEBRASKA
Dept of Hlth
Div of Rad Hlth
301 Centennial Mall South
P. O. Box 95007
Lincoln, NE 68509
Ellis Simmons, Dir
(402)471-2168

STATE OF NEVADA
Regulatory Hlth Svcs
Rad Hlth Sec
505 East King St
Carson City, NV 89710
John Vaden, Sup
(702)885-4750

STATE OF NEW HAMPSHIRE
Rad Hlth Prgm
Bur of Env Hlth
St Dept of Hlth & Welf
Hazen Dr
Concord, NH 03301
Diane S. Tefft, Mgr
(603)271-4588

STATE OF NEW JERSEY
USNRC Region I

STATE OF NEW MEXICO
Rad Prot Bureau
Env Improv Div, POB 968
Santa Fe, NM 87503
Tom Buhl, Chf
(505)984-0020 Ext 272

STATE OF NEW YORK
Div of Sfty & Hlth
NYS Dept of Labor
Two World Trade Center
New York, NY 10047
Dr. Francis J. Bradley, Prin Rad
(212)488-7790
(518)457-2200*

STATE OF NORTH CAROLINA
Rad Prot Section
Div of Facility Ser
NC Dept of Hum Res
P. O Box 12200
Raleigh, NC 27605
Dayne H. Brown, Chf
(919)733-4283
1-800-662-7956*

STATE OF NORTH DAKOTA
ND St Dept of Hlth
Div of Env Engr
Rad Cntr Prgm
1200 Missouri Ave
Bismarck, ND 58505
Dana K. Mount, Dir
(701)224-2348
1-800-472-2121*

STATE OF OHIO
USNRC Region III

STATE OF OKLAHOMA
USNRC Region IV

STATE OF OREGON
OR St Hlth Div
Rad Cont Section
1400 SW 5th Ave, POB 231
Portland, OR 97207
Ray D. Parin, Mgr.
(503)229-5797

STATE OF PENNSYLVANIA
USNRC Region I

STATE OF RHODE ISLAND
RI Rad Con Agency
206 Cannon Bldg
75 Davis St
Providence, RI 02908
James E. Hickey, Admin
(401)277-2438
(401)647-3311* (State Police

STATE OF SOUTH CAROLINA
Bur of Rad Hlth
St Dept of Hlth & Env Cntr
J. Marion Sims Bldg
2600 Bull Street
Columbia, SC 29201
Heyward Shealy, Chf
(803)753-5548
(803)758-5531*

STATE OF SOUTH DAKOTA
USNRC Region IV

STATE OF TENNESSEE
Div Rad Hlth
Dept of Health and Env
150 9th Ave., North
Nashville, TN 37203
Michael H. Mobley, Dir
(615)741-5181

STATE OF TEXAS
Div of Occup Hlth & Rad
Texas Dept of Hlth
1100 West 49th St
Austin, TX 78756
David K. Lacker, Dir
(512)835-7000
(512)458-7460*

STATE OF UTAH
Bur of Rad Cntr
St Dept of Hlth
150 W. North Temple
Box 2500
Salt Lake City, Utah 84110
Larry Anderson, Dir
(801)533-6734
(801)533-6145*

STATE OF VERMONT
USNRC Region I

STATE OF VIRGINIA
USNRC Region II

STATE OF WASHINGTON
Rad Control Program
DSHD MS LD-11
Dept of Soc & Hlth Serv
Olympia, WA 98504
Nancy P. Kirner, Supv
(206)753-3459
(206)682-5327*

STATE OF WEST VIRGINIA
USNRC Region II

STATE OF WISCONSIN
USNRC Region III

STATE OF WYOMING
USNRC Region IV

U.S. NUCLEAR REGULATORY COMM

USNRC, Region I
631 Park Avenue
King of Prussia, PA 19406
John Glenn
(215)337-5000

USNRC, Region II
101 Marietta St, NW, Swt 3100
Atlanta, GA 30303
Earl Wright
(404)221-4503

USNRC, Region III
799 Roosevelt Road
Glen Ellyn, IL 60137
Bruce Mallett
(312)932-2500

USNRC, Region IV
611 Ryan Plaza Dr, Swt 1000
Arlington, TX 76012
Jack Whitten
(817)860-8100

USNRC, Region V
1450 Maria Lane, Swt 210
Walnut Creek, CA 94596
Beth Riedlinger
(415)943-3700

* 24 HR Emergency Phone Number

FOR ASSISTANCE:

CPN CORPORATION
130 S. Buchanan Circle
Pacheco, CA 94553
(415)687-6472

SECTION III

OPERATOR MAINTENANCE PROCEDURES

THIS SECTION APPLIES TO BASIC MAINTENANCE TO BE PERFORMED BY THE FIELD OPERATOR WITH A MINIMUM OF TOOLS AND EQUIPMENT AND WITH A MINIMUM ELECTRONICS KNOWLEDGE.

DETAILED MAINTENANCE PRCEDURES USING OSCILLOSCOPES, WAVE FORMS, VOLTAGE READINGS, AND EXTENSIVE SCHEMATIC REFERRAL ARE AVAILABLE IN SECTION IV.

SECTION IV IS PROVIDED FROM THE FACTORY UPON REQUEST.

MAINTENANCE COVERED BY SECTION III INVOLVES ONLY THE USE OF A SIMOLE VOLTMETER, COMMON HAND TOOLS, AND REPLACEMENT OF COMPLETE CIRCUIT ASSEMBLIES.

1.00 GENERAL

PORTAPROBE Nuclear Gauges require little maintenance other than an occasional cleaning of the shutter and replacement of batteries.

Should a problem occur, the operator can repair his own gauge by replacement of batteries, printed circuit boards, or other major sub-assemblies on a low cost exchange basis.

It is CPN policy that the user buys "tests" not a pretty gauge, and our goal is to keep the unit in the field doing its job, not back in the factory being fixed.

Service problems will occur in three areas:

1. Batteries
2. Mechanical jamming of shutter....needs cleaning.
3. Electronic parts failure.

PORTAPROBE gauges minimize service problems in these three areas by careful design:

1. Batteries are replaceable with ordinary flashlight batteries available from local suppliers or from the supermarket.
2. The shutter mechanism uses a quick-release cleanout plate for ease of cleaning.
3. Electronics use CMOS circuits for long life and low current drain. All boards are removable by the operator with a screwdriver and can be replaced by exchange units without adjustments.

The CPN warranty is not void by operator replacement of any parts unless he attempts to repair a circuit board itself.

2.00 BATTERIES

The MC Series PORTAPROBES use NICAD rechargeable 4 Ampere Hour D Size cells as standard batteries. CPN uses Gould 4.0 SC 160°F special cells for superb high temperature performance. Other industrial NICAD cells may also be used.

Please note that D-Size NICAD cells purchased in a supermarket or camera store may actually be C-Size cells in a D-Size overpack. This can be observed by reading the recommended maximum charge rate on the cell. NICADS are usually charged at a maximum of 1/10th rated capacity. Thus, a 4 AH D Size NICAD will warn the user not to charge at more than 400 milliamps rate.

If the cell advises a maximum of 120 ma rate, then the cell is a C-Size 1.2 AH cell regardless of the package size.

The PORTAPROBE gauges will operate on the lower capacity cells, however, the time of operation per charge will be reduced.

MC Series gauges will also operate on alkaline D-Size cells. They can be used in the absence of available NICAD batteries, HOWEVER, DO NOT ATTEMPT TO CHARGE ALKALINE CELLS. DAMAGE MAY RESULT TO THE GAUGE IF THE ALKALINE CELL BURSTS FROM THE CHARGING.

Ordinary zinc-carbon cells may be used to operate the gauges, however, the operating time will be quite short.

2.10 CHARGING (Figure #1)

CHARGE NICAD BATTERIES ONLY. DO NOT CHARGE ALKALINE OR ZINC-CARBON CELLS! WARRANTY IS VOID IF DAMAGE IS OBSERVED FROM IMPROPER CHARGING.

Plug the wall charger into 110/60HZ supply and plug the charger plug into the charger terminal on the MC casting. The gauge will automatically charge with no danger of overcharging.

CPN recommends charging over a weekend or over

night whenever the "L" low battery indicator (MC-1) or "RECHARGE" annunciator (MC-2) is on.

NICADS lose approximately 1% of their charge per day through self-discharge. The gauge will require charging if it has been in storage for a period of months.

It is recommended that the battery pack be disconnected (pulled forward) if the gauge is to be stored for a long period.

2.20 ANTICIPATED TESTS PER CHARGE

Current consumption is low due to use of CMOS circuitry. The total time between charges will be a function of the number of test taken and the total time passage between charges.

An MC burns approximately 80 milliamperes during count periods. It burns approximately 2 ma during quiescent periods (no counting).

The NICADS have a 4,000 milliampere charge life when new and fully charged. (4.0 Ampere hours).

Thus, if the gauge was not used during a charge period, the gauge should operate approximately 2,000 hours per charge or approximately 83 days.

If the gauge is used continuously with no rest, it would last approximately 50 hours and would provide 3000 one minute tests (50 x 60).

How long it will last for a given user and how many tests will be available, is thus a combination of passage of time and tests performed.

The charge should last for many weeks for a typical user.

Alkaline cells offer a 10 ampere hour life per cell, but are not rechargeable. Thus, a set of alkaline cells should easily last a summer of use for a typical user. They should be discarded after the use period.

Zinc-Carbon cells offer a much shorter ampere hour capacity varying by type of cell and manufacturer. They will work in a pinch, but will not prove satisfactory for long term operation.

DO NOT CHARGE ZINC-CARBON CELLS!

2.30 TESTING BATTERIES (Figure #2)

Provision is made in the MC gauges for testing of cells under operating load. Test points are provided at the front lip of the battery pack holder for individual testing of cells in the gauge while under operating load.

Remove the front battery plate.

Using a DC voltmeter on a low range, test each individual cell while the gauge has been counting for a lengthy period. Place the gauge on standard count to obtain a lengthy load cycle. Keep repeating the count cycle command while testing the cells, that is, keep the gauge running.

TYPE OF CELL	DC VOLTAGE MEASUREMENT FULL CHARGE	5 % CHARGE	DISCHARGE
NICAD	1.30	1.1	1.0
ALKALINE	1.50	1.1	1.0

2.4 BATTERY REPLACEMENT (Figure 3.)

Remove the front battery plate.

Remove the knurled nut retaining the battery pack in the gauge.

Slide the battery pack out of the gauge.

Remove the appropriate hold down plate atop the cell that is to be replaced.

Replace the cell, button end UP (positive end UP).

Replace the hold down plate, replace the pack, and replace the front battery plate.

3.0 SHUTTER MAINTENANCE (Figure 4.)

The shutter is a carbide-tungsten-lead combination for maximum shielding and maximum longevity.

It will require occasional cleaning due to dirt buildup within the shutter chamber.

Set the gauge on its side or tail with the source in SAFE position.

Remove the 1/4 turn fasteners holding the cleanout plate in position.

Remove the plate and the captive shutter.

Clean the shutter and the plate thoroughly, and clean out the shutter chamber with a brush. It is not necessary to extend the source to clean the end of the rod! Leave it alone!

Spray the shutter, cleanout plate, and the interior of the chamber with molybdenum-disulphide lubricant. This lubricant should then be allowed to dry for a period of four hours or more to cure to the metal. This will provide a long life lubrication of the shutter for maximum utility between cleanings.

DO NOT FORCE THE SOURCE ROD HANDLE WHEN THE SHUTTER IS DIRTY.

CPN does not recommend the use of oil or grease for lubrication, however, several customers have reported good performance by spraying WD-40 into the shutter chamber without disassembling it. The use of WD-40 will not injure the gauge or effect test results. If it works for you, use it.

4.0 SHIPPING CASE MAINTENANCE

The shipping case is a fiberglass case built to MILSpec standards. It is very strong and will produce excellent service.

Clean it periodically with soap and water, both inside and out.

Repairs can be effected by use of any fiberglass repair kits from an auto parts store or plastics hobby store. Paint the repair orange.

5.0 GAUGE EXTERIOR MAINTENANCE

Wash the gauge with soap and water if it becomes unusually dirty. Remove asphalt with a mineral solvent.

Do not scratch the display window with abrasive cleaners.

If a major accident damages the case by puncturing, we recommend that the case be returned to CPN for repair or replacement.

If the bottom casting is damaged, this must be returned to CPN for repair. The moisture source is permanently mounted in the bottom casting and this must not be field repaired!

6.0 ELECTRONIC PARTS FAILURE

Failure of the electronics will require replacement of one or more of the circuit boards. This can be done by the user. The PORTAPROBES are designed to facilitate complete removal of all electronic circuit boards, detector, and batteries by the user without effect on the PORTAPROBE warranty.

Some circuits are interactive between boards. That is, a failure may require replacement of more than one board. This will be rare.

To diagnose which board may have failed, it is necessary that the exact nature of the failure be determined. Please do not call the factory and merely state, "something is wrong." We know that or you would not have called.

The user must determine which functions in the gauge do not work. Test all functions and have this information available, with the gauge at your side, when you call the factory for assistance.

The factory service department will ask various questions concerning one or more operations to determine the full nature of the problem and will then recommend a course of repair action.

The factory will forward a set of replacement boards or other parts for the diagnosed problem. The user will replace the defective parts and will return the defective parts to the factory for credit against the exchange replacement program. It is necessary that the factory receive the parts back or full charge will be levied for the parts sent out.

6.10 DIAGNOSTIC QUESTIONS

1. Does the display work?

   On all channels?

2. Does the gauge beep during counting?

3. Does the gauge count in TEST MODE?

   What does it indicate upon completion?

4. Does it count in STANDARD MODE?

   Is this a normal standard count?

   What is the spread of the standard count? Refer to Paragraph 2.01 of OPERATING SECTION.

5. Does it count in the field count conditions?

   In all time sequences?

6. If possible, have a sequence of ten or twenty 1/4 minute counts available for reading over the phone to our serviceman.

7. How long has the problem existed? If intermittant, describe when it occurs as opposed to when it does not occur.

NOTE:

The screw in the upper right corner of the electronics subassembly actuates a power interlock. When it is turned counter-clockwise a couple of turns it disconnects the electronic subassembly from the batteries.

This prevents damage to the electronics during removal or hazard to the operator because of an inadvertant short of the electronics boards to the gauge chassis frame.

This screw can also be used as a "Dead Storage Switch" for long term storage of more than a month or two. Simply back off the screw until the gauge does not work.

The screw must be full clockwise for the gauge to operate.

CPN recommends that batteries be removed from the gauge if storage is intended for more than six months to prevent possible corrosion from a defective, dead cell.

To remove the electronics subassembly, remove the four mounting screws and lift the assembly out of the case carefully. Disconnect the detector, battery, and speaker leads. Note that these leads are polarized by size and/or color to prevent accidental error in reassembly.

Replace the entire assembly or replace boards as appropriate for the service required.

Replace the assembly into the case.

The gauge will not operate until the safety screw in the upper right corner is tightened and the associated small microswitch is operated.

6.30 REMOVAL OF DETECTORS

1. The GM tube is removed from under the electronics by removing the two screws on the lead GM housing and lifting out the housing. Do not damage the lead foil chemical compensation sheet.

2. To remove the BF3 tube, remove the battery pack and electronics. Separate the casting assembly and slide the upper orange casting away from the bottom pan assembly.

   Remove the tube from the red mounting plate.

NOTE: Use care in handling detector tubes and in working around the connector ends of the tubes. These are high voltage areas and finger prints or careless work can result in noisy performance due to high voltage leaks or loss of signal.

Use clean hands and carefully clean the connectors of any oils or solder flux. Keep leads well separated from nearby metal around the end of the GM tube.

6.40 REPLACEMENT OF FUSE

The fuse is on the battery pack assembly.

A spare is also supplied on the assembly.

Replace fuses with the same size as removed, 1.5 Amp Slo-blo.

Repeated fuse blowing indicates internal electronic trouble.

6.50 REMOVAL OF HANDLE ASSEMBLY

The handle may be removed by lowering it to the backscatter position. A 5/32" Allen Screw will be observed through the small hole in the guidetube.

Loosen this screw approximately 1/2 turn and the handle will slide out.

It is important that the handle be reinstalled accurately and vertically to insure that the latch pin properly engages the ramp stops inside the guidetube.

6.60 BEARING MAINTENANCE

The bearings are doubly sealed to prevent intrusion of foreign materials and to retain the lubricant. Eventually they have to be cleaned or replaced, however.

Removal or maintenance of the bearings is not a recommended customer maintenance item unless the customer is qualified for instrument service.

IF THE BEARINGS ARE A PROBLEM, WE WOULD RECOMMEND THAT THE GAUGE BE RETURNED TO CPN FOR REPLACEMENT AND RECALIBRATION OF THE GAUGE ON A COMPLETE OVERHAUL BASIS.

To remove the bearings, remove the handle, then pop the cap off the top of the guidetube and remove the source rod from the gauge, placing it in a remote storage area at least 20' from the nearest work area, preferably in a lead pig or in a concrete room.

Remove the lock nut at the rear of the bioshield casting. Drive the tapered guidetube lockpin out towards the front of the gauge. The guidetube can now be removed from the gauge.

Replace the bearings using CPN A401203 Bearing Assembly including seals. Pack the bearings with molybdenum disulphide grease liberally.

6.70 DAMAGE TO THE CASTINGS

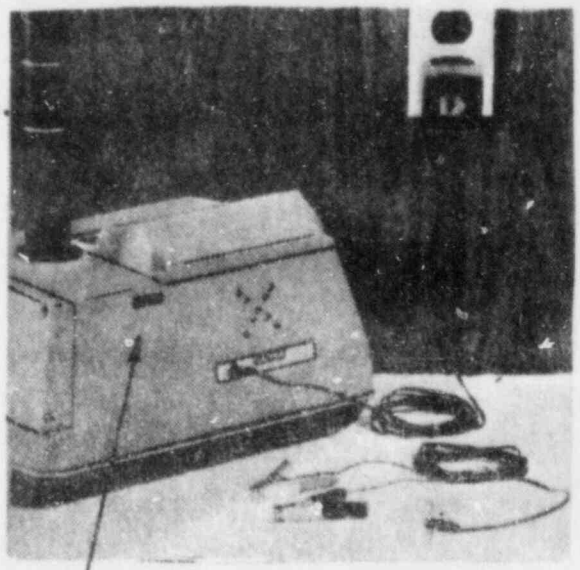
It is essential that should damage be incurred on the castings that the gauge be returned to the factory for repair or disposal.

The AMERICIUM 241/BE source is permanently located in the bottom casting pan and this must be maintained in undisturbed condition.

Removal or repair is a factory item ONLY.

FIG. 1 CHARGING

Optional 12 VDC Cord illustrated.



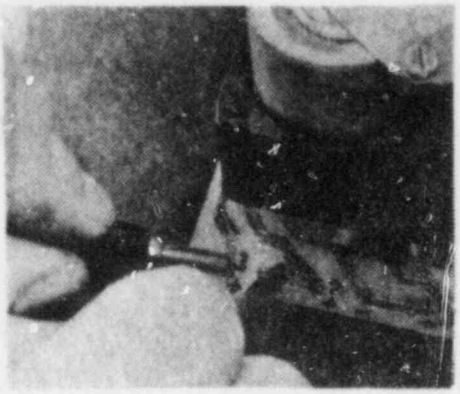


FIG. 2 TESTING BATTERIES UNDER LOAD

Observe polarity of individual cell test points on front of battery pack.

Safety Switch located under Upper Right Cnr electronics mounting screw. Shuts off power when gauge is disassembled. Use as STORAGE SWITCH for long term storage. Back out until gauge turns off.

FIG. 3 BATTERY REPLACEMENT

Positive terminal upright.

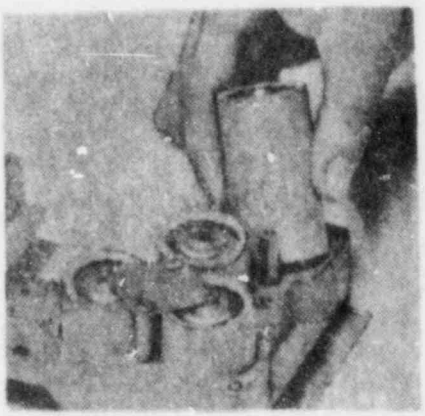


FIG. 4 SHUTTER MAINTENANCE

6-32 fasteners simplify plate removal

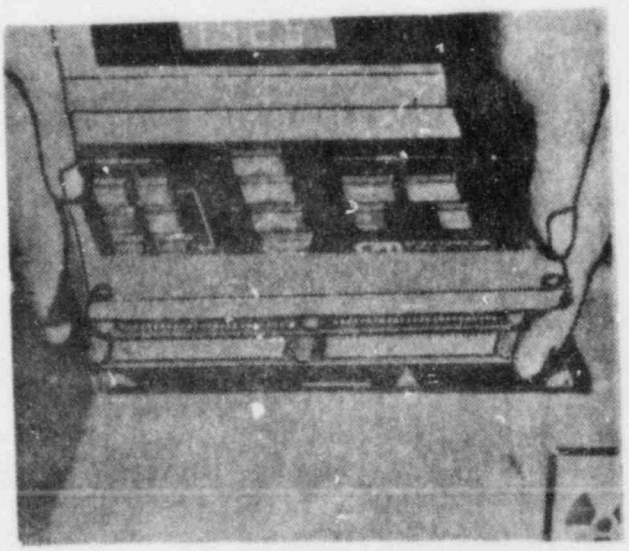
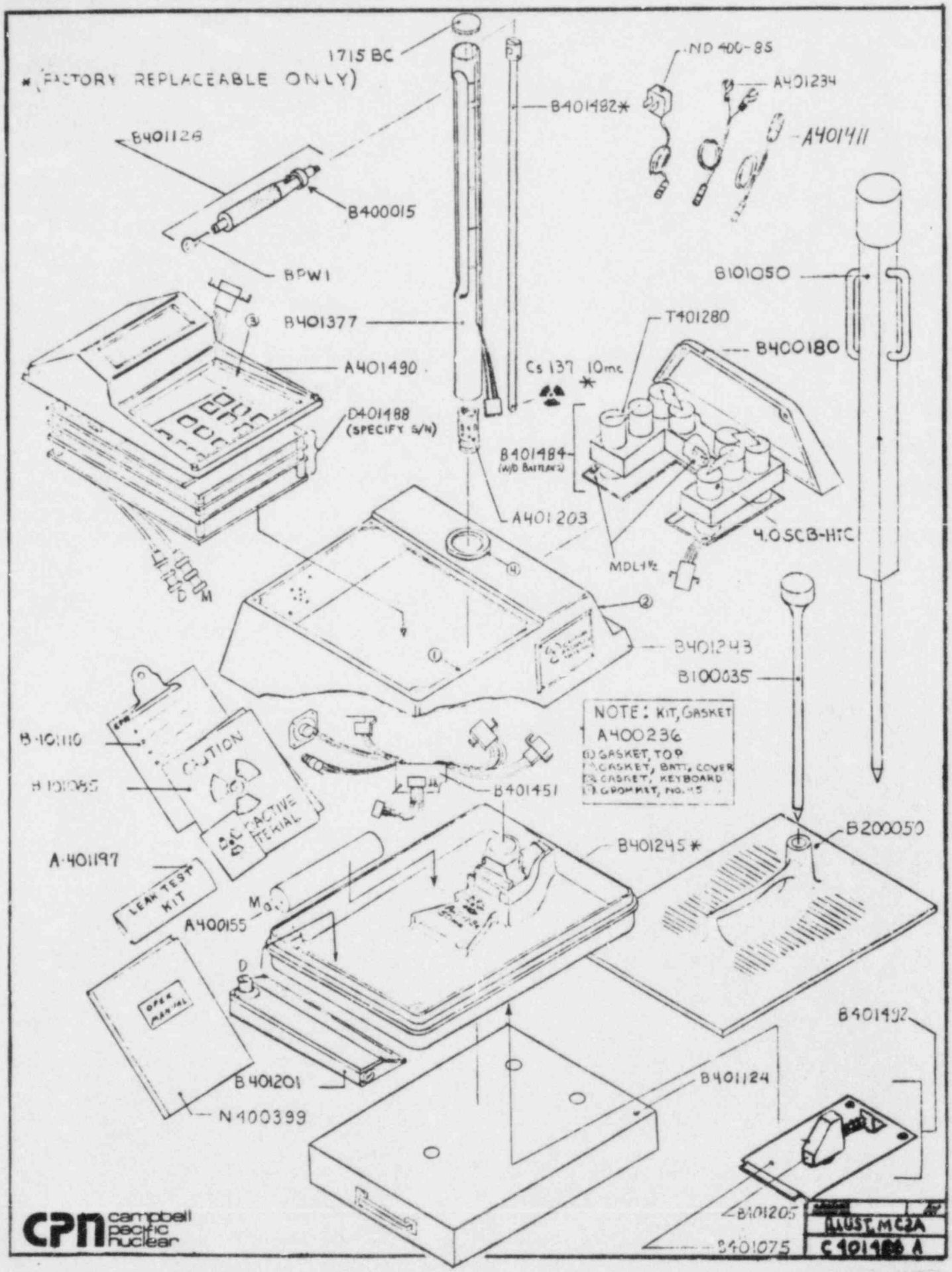


FIG. 5 REMOVAL OF ELECTRONICS

Remove slowly, disconnect cables. Keep fingerprints off circuit bds.


1715 BC
* (FACTORY REPLACEABLE ONLY)
ND 400-85
A401234
A401411
B401482*
B401128
B400015
BPW1
B101050
B401377
T401280
B400180
A401490
Cs 137 10mc *
D401488 (SPECIFY S/N)
B401484 (W/O BATTERY)
A401203
4.0 SCB-HIC
MDL 1½
B401243
B100035
NOTE: KIT, GASKET A400236
1) GASKET, TOP
2) GASKET, BATT. COVER
3) GASKET, KEYBOARD
4) GROMMET, NO. 15
B401110
CAUTION
RADIOACTIVE MATERIAL
B401085
B401451
A401197
LEAK TEST KIT
A400155
B401245*
B200050
OPER. MANUAL
B401201
N100399
B401492
B401124
B401205
B401075
CPN campbell pacific nuclear
ILLUST. M-82A
C401900 A

CPN CORP
130 SO. BUCHANAN CIRCLE
PACHECO, CA 94553
415-687-6472

PARTS LIST

MC-2 Major Sub-Assemblies Parts List

MODEL MC-2 MAJOR SUB-ASSEMBLIES PARTS LIST

PART NO	DESCRIPTION	WEIGHT(lb)
B100035	Drill Pin, Forged	4.0
B101050	Hammer, Campbell, Impact Type	23.0
B101085	Sign-Kit, Caution	.4
B101110	Clipboard-Asy, MC-2	1.0
B200050	Guideplate, Cast Aluminum	6.5
B400015	Wear Ring	0.5
B401075	Cleanout-Plate-Asy	2.0
B401124	Standard-Block-Asy, MC	9.0
B401128	Handle-Asy w/keys	1.0
A400134	Display, LCD, Annunicator	.05
A400155	Detector, BF3	2.0
B400180	Cover Battery access, MC	1.5
A401197	Leak Test Kit	.02
B401201	Detector-Asy, GM	2.5
A401203	Bearing-Asy	1.0
B401205	Shutter Block	5.0
A401228	Case-Asy, MC	25.0
A401234	Cable, DC Chg, Batt Clips	2.0
A400236	Gasket-Set, MC	.3
B401243	Shell-Asy	5.0
B401245	*Pan-Asy	
T401280	PC-Asy, Batt Clip	.2
B401377	Guidetube-Asy, 8", MC-2	2.0
N400399	Manual, Operator, MC-2	.4
N400401	Manual, Maintenance, MC-2	.6
A401411	Cable, DC Chg, MC, Cig-Ltr	2.0
C401451	Harness-Asy, MC-2	0.5
B401482	*Source Rod-Asy, 8", MC-2	
N401484	Battery Holder-Asy (less batt-cells)	1.0
A401488	Stack-Asy, MC-2	4.0
A401490	Housing-Asy, Elect, MC-2	2.0
B401492	Clean-Out-Shutter-Asy	7.0
AC-20KA254	Padlock w/2 keys	2.0
BPW-1	Key, for A401128 Handle-Asy	.2
H-1064	Wrench, Allen Hex 5/32	.2
MDL-1-1/2	Fuse, 1-1/2 SB	.02
	Charger, 8 D NICAD'S (400 mA)	.5
PH2-4	Screwdriver, Phillips #4	.5
	Batt-Cell, NICAD, D, 4Ah	.5
17158C	Plug, 1-1/3D for top of guidetube	.2
7560	Display, LCD, Digital	.05

* These parts contain a radioactive source. They are replaceable at the factory only.

***** EXCHANGE PROGRAM *****

PART NO	EXCHANGE ITEM
A401188	Stack-Asy, MC-2
A401494	PC-Asy, Keybd-Disp, MC-2
B401145	PC-Asy, Display, MC-2
B401362	PC-Asy, Keyboard, MC-2
B401353	PC-Asy, I/O, MC-2
B401368	PC-Asy, Computer(serial no__)
B401390	PC-Asy, Analog & Power Supply
	Guidetube-Asy, 82, 81, 122, or 121

If the returned item is not in good condition or is not returned to the factory within 30 days, the customer will be billed the item full price.

01-15-35

RADIATION SIMPLIFIED

by

SIMON KINSMAN

California State Department of Public Health

Campbell Pacific Nuclear Corporation would like to express our thanks to

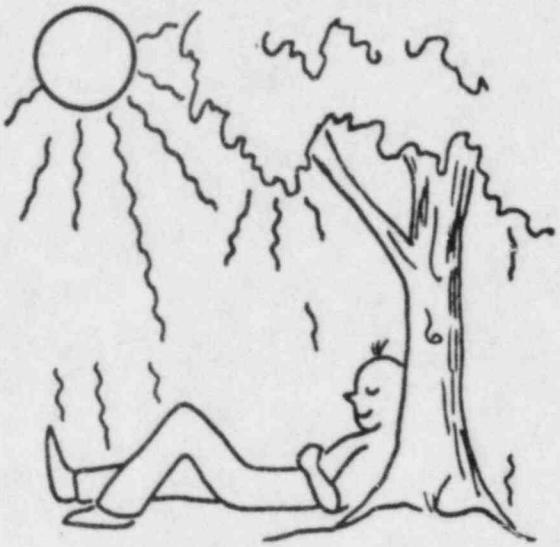
Dr. Simon Kinsman, Ph.D.
Chief, Bureau of Radiological Health, California State Department of Public Health, Berkeley, California for permission to reprint.

WHAT IS RADIATION?

Radiation in a variety of forms is familiar to all of us. Light is radiation we can see. Heat is radiation we can feel. Ultraviolet and X-Ray we neither see nor feel. None of the four can be heard or smelled. All are like light because they do not continue after the source (bulb) is turned off or removed.

Radiation is as old as the universe. Stars are intensely radioactive; our earth now only slightly so. Ever since his first appearance, man has been exposed to both visible and invisible radiation from the sun. Like sunshine and rain, thunder and lightning, radioactive substances until very recently occurred only in nature.

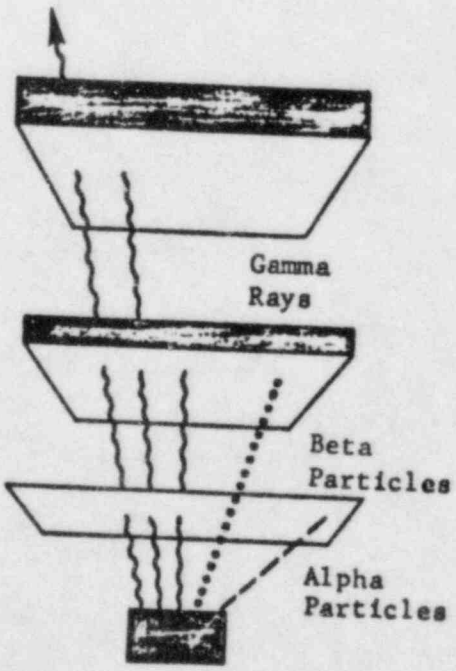
Radiation from radioactive material is a stream of fast flying particles or waves which come from tiny units of matter called atoms. Atoms of a single element often consist of different kinds which behave alike chemically, yet have slightly different weights. These varieties are called "isotopes". The atoms of stable isotopes are not radioactive, but those of unstable or radioactive substances give off portions of themselves, and change into other isotopes in the process.



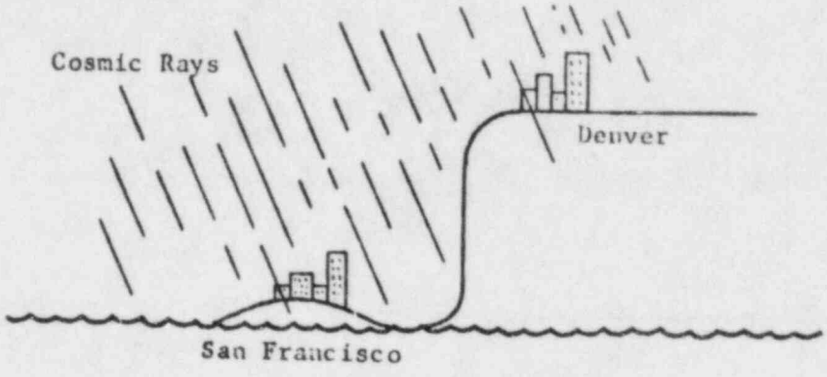
SUNLIGHT IS A FORM OF RADIATION

UNSTABLE STABLE

Within the past sixty-five years we have learned much about radiation. Man-made radiation in the form of X-rays was discovered in Germany in 1895. In France, a year later, natural radioactivity was first identified with uranium. Within two years, one of its main sources was isolated--the naturally radioactive element, radium. Invisible rays from this element were soon found to be of three kinds: (1) heavy particles which travel but an inch or so in air, (2) lighter particles which travel a few feet, and, (3) waves similar to those of light, but too short to be seen by the human eye, which penetrate to considerable distances, even through several inches of lead. These three forms of invisible radiation are called Alpha, Beta, and Gamma Rays.



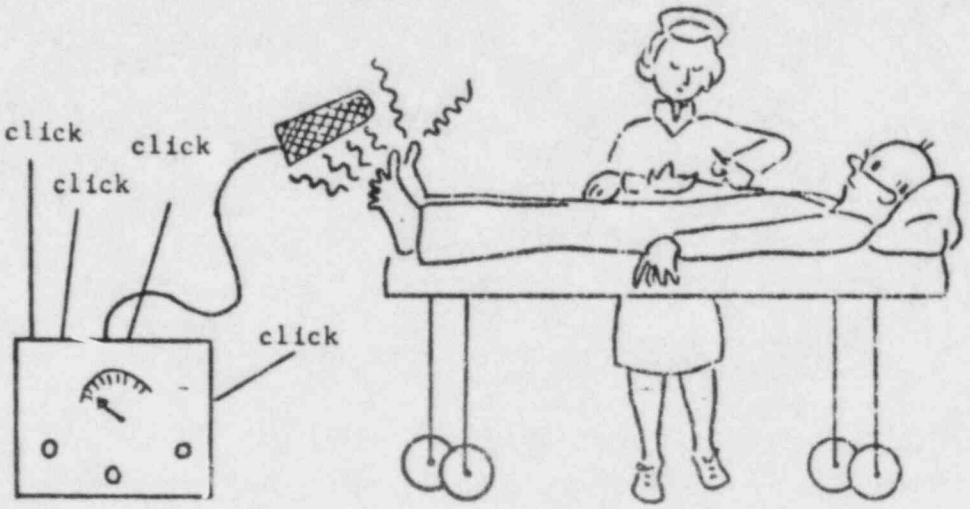
Shortly after the discovery of radium, man learned that for millions of years another form of invisible radiation had been coming at him from outside the earth's atmosphere. The source of these particles, called "cosmic ray", is still unknown. We do know, however, that they are stopped to some extent by the earth's atmosphere, and that if we were to live in Denver, Colorado, or elsewhere at high elevation, cosmic radiation would be two to four times as intense as it is at sea level. This is why scientists investigating cosmic rays employ balloons and aircraft to collect information at high altitudes.



Natural radioactive substances are widely distributed. They exist in minute quantities in our bodies, in the water we drink, the air we breathe, the soil we cultivate, even in the materials we use for building. Along with the cosmic radiation from outer space, these tiny sources have been sending out invisible radioactive signals for millions of years. It is against this backround of natural radiation that man has lived in the past and lives today. This so-called "backround radiation" varies slightly from one locality to another, and also with rain or snowfalls.

Within ten years of their discovery, practical uses were found for both X-rays and radium. X-rays proved valuable in locating bone fractures, in identifying diseases, and as a supplement to radium in the treatment of cancer. You probably had a chest X=ray recently or a picture of your teeth. If so, you have been exposed to a relatively harmless amount of X-radiation administered by your own doctor or dentist.

Within the past fifteen years, man has learned to take naturally stable atoms and make them artificially radioactive. It is these radioactive varieties, or "radioisotopes", which are proving to be among the most useful tools in the entire history of science. Because they are radioactive, their radiation tells where they are, even if the amount is extremely small. Their location or movement within the plant or animal tissues, and in indutrial and chemical processes, can, therefore, be traced by sensitive recording instruments. Used in this manner, radioisotopes are spoken of as "tracers".



IS RADIATION DANGEROUS TO YOU?

It can be: it may be; but it need not be.

Danger from radiation depends upon the degree of exposure. How dangerous is fire, or exposure to the sun? How dangerous is electricity? It depends upon your exposure.

We all use electricity, but we do not take chances. We have learned to live with these agents, and we can learn to live with radiation, too.

The chances of receiving an overexposure are slight. This depends upon how much you know about

radiation and the common methods for protecting yourself against it , and upon whether you are a reasonable person. You can get quite a burn from a match, but you must be close to it. So with radiation. There is little danger if you know what you are doing, and if you follow the safety rules.

Radiation effects on people were noticed shortly after the discovery of X-rays. These effects resulted from extreme exposures due to ignorance. We now have special instruments to detect and measure all types of radiation. The "Roentgen" has been adopted as the basic unit for radiation measurement. It is simply a label for a certain amount of radiation, just as the word, "inch", is the label or word used to describe a certain distance. Roentgens are commonly referred to as "r's", milliroentgens, or thousandths of a roentgen, as "mr's".

With this unit of measurement, we are able to compare radiation exposure with its effects on living tissue. Years of experiments with X-rays and radium and thousands of experiments with animals have made it possible to judge how much radiation we can stand or tolerate without harm. This tolerance level is considerably higher than the amount of exposure which the Atomic Energy Commission Employees are permitted to receive. (Now the Nuclear Regulatory Commission, Ed.) The standard operating limit is a continuing exposure of no more than 100 mr per week, not to be received in amounts greater than 1/20 r (50 mr) per day, except for unusual cases. Extensive experience indicates that an exposure of this amount can be given every week of your life without producing any detectable change whatsoever. This daily average is 1/30 the wartime operating limit established for the atomic bomb project.

How much radiation can you stand? The important thing is that you do not take too much at one time. Small exposures with intervals in between can add up to a fairly high amount without harmful effects because cells either recover by themselves or can be replaced by other cells. Furthermore, you may safely expose a portion of your body to a much higher amount than is permissible for the entire body.

Rapidly growing cells are somewhat more sensitive to radiation than normal cells. Upon this principle is based the treatment by radiation of certain types of cancer.

Radioactive materials can be harmful if within or on the body. You should, therefore, avoid inhaling radioactive substances or getting them into your food or drink, just as you avoid taking in arsenic, lead, or other poisonous substances.

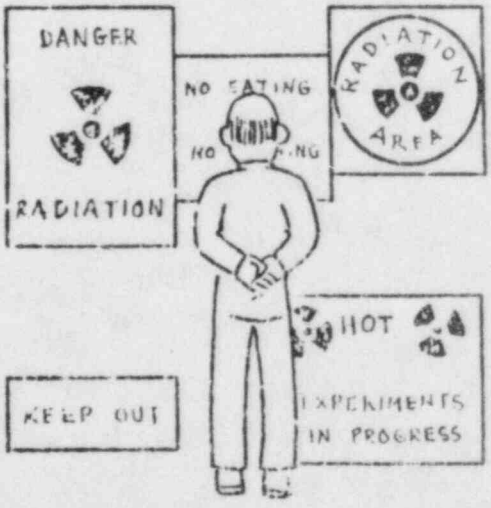
The amount might be harmless, but there is no need to take chances.

Radioactive materials differ widely in the rate at which they lose their radioactivity. The length of time they are kept in the body also varies. Radium and plutonium remain active for thousands of years and may be retained for long periods in the body, which such elements as radiosodium will be quickly eliminated and decay in a few days. Naturally, you must be careful to avoid taking even small amounts of the more poisonous materials into your mouth or lungs. This is why eating or smoking is forbidden in some radiation areas.

When you have a chest X-ray taken with the common tupe of automatic equipment, you receive approximately 0.3 r. As far as the medical profession knows, this is harmless. During an examination of the stomach or intestines, patients frequently receive a series of exposures over a period of a few hours which may total 15 or 20 r. To render a person sterile, the sex organs alone would have to receive a single dose of 400 - 800 r, and even more if the total amount were not given at one time.

Between 300 and 500 r of X or gamma radiation given to the whole body at once would probably prove fatal. This, however, is a terrific amount, a few thousand times the maximum permissible daily occupational exposure or tolerance.

As one radiation expert put it, "Tolerance is a poor word. Operating limit is better. We can tolerate a lot more radiation that the amount which we have set as our operating limit".

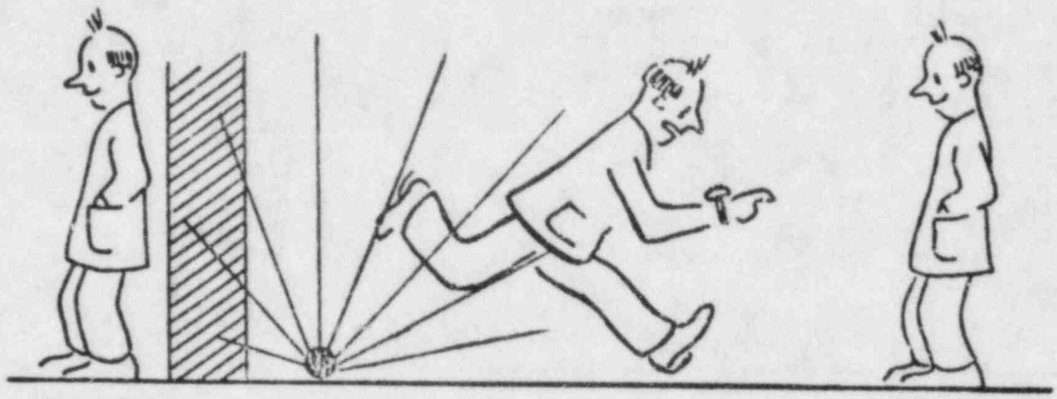


As a general precaution, sources of radiation are confined to special "radiation areas" in which they are either roped off or are clearly indicated. All radiation areas are marked with signs bearing the purple radiation symbol on a white backround. Near the source itself will be a warning sign with the purple symbol on a yellow backround and a card stating the tupe of radiation, its strength, and the precautions to be taken.

HOW TO LIMIT EXPOSURE TO RADIATION

Exposure to radiation can be limited in three ways:

(1) in time, (2) by distance, and (3) by shielding.



Shielding Time Distance

If you must work near radiation, the simplest way to limit your exposure is to stay in the vicinity as short a time as possible. If there is a time limit on your job, observe it.

A second method is to maintain a safe distance between you and the source of radiation. If in doubt as to what distance is safe, consult your supervisor or the Radiological Health unit. In general, the effect of radiation falls of sharply as you increase your distance from its source. Double the distance and your exposure is cut to one-quarter.

Shielding varies in nature and thickness, depending upon the energy and type of particles or waves. Alpha particles are stopped by a sheet of paper or the surface layer of skin on our bodies; beta particles by a quarter of an inch of wood or an eighth of an inch of metal; gamma rays and neutrons by substantial amounts of lead or concrete.

Special shielding materials such as paraffin and cadmium can also be used effectively to slow down and stop neutron radiation.

You can take it with you

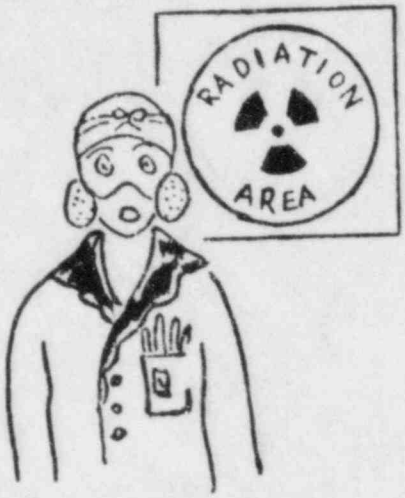
CONTAMINATION

Contamination is a more serious problem than exposure because it involves actual contact between you and a radioactive substance. An external source of radiation can be removed or shielded, but you cannot run away from something inside of you or on you. If by accident you get a small amount of radioactive material on your hands, feet, or street clothes, it might possibly be deposited in your body from the end of a cigarette, through a cut, or in your food.

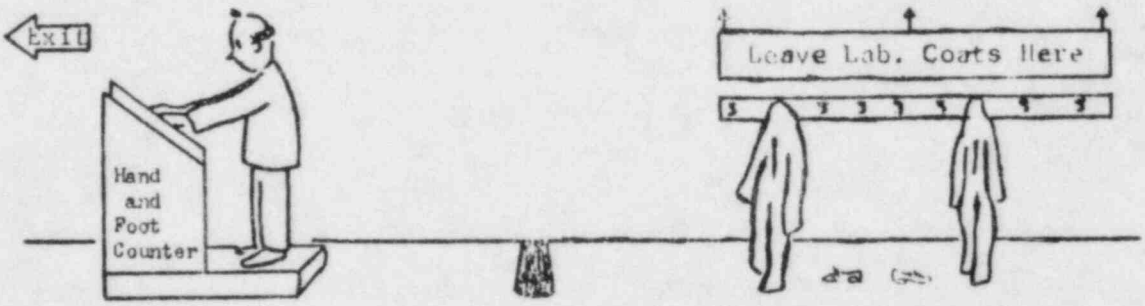
The longer lived materials, if not easily eliminated, might then cause trouble.

Fortunately, however, some isotopes with short half-lives, or ones which are easily eliminated, are valuable in the treatment of disease. Radioiodine, for example, is taken by mouth for treatment of certain thyroid conditions; radiosodium is used in measuring the circulation of the blood; and radiophosphorous in treating some types of leukemia.

To guard against contamination, special protective clothing is available in radiation areas. It use protects the wearer and helps to confine radioactive contamination within these areas. Laboratory coats or coveralls are widely used; in some locations caps, shoe covers, canvas or rubber gloves, masks, or respirators are also used. Protective clothing worn where radioactive materials are present is specially marked and washed.



Alpha, beta, and gamma radiation is not "catching" like a cold. Unless your hands, feet, or clothing are actually contaminated with materials which give off radiation, you



are quite safe. However, in working with radioactive materials wear protective clothing and upon removal of this clothing, wash with soap, check your hands, feet, etc., with instruments.

NRC FORM 218 (4-76) NRCM 0240

U.S. NUCLEAR REGULATORY COMMISSION

TELEPHONE OR VERBAL CONVERSATION RECORD

DATE: 12-18-85

TIME: 2:00 ☐ A.M. ☒ P.M.

☒ INCOMING CALL ☐ OUTGOING CALL ☐ VISIT

PERSON CALLING	OFFICE/ADDRESS	PHONE NUMBER / EXTENSION
Patrick Morrissey	CONSPEC.	
PERSON CALLED	**OFFICE/ADDRESS**	**PHONE NUMBER / EXTENSION**
M. Taylor		

CONVERSATION

SUBJECT: Abandonment Notice

SUMMARY

Mr. Morrissey asked for an extension on his response time, till ~~the~~ at least the beginning of the new year.

1/3/86

Has sent response in. WE should be receiving it SOON

NOT

REFERRED TO: L. Costello. for JK.

ACTION REQUESTED

Mr. Costello said that the extension will be granted.

☐ ADVISE ME OF ACTION TAKEN.

INITIALS

DATE

ACTION TAKEN

INITIALS

DATE