Gourdie/Fraser & Associates, Inc.

Consulting Engineers Surveyors Planners

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May 30, 1985

Applicant June 10th
Check No. ......
13P
addl. info
Date ... Rec'd 6/19/85
Received By ...

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

ATTN: Dr. Burce S. Mallett
Materials Licensing Section

SUBJECT: NRC License No. 21-16540-01

Gentlemen:

The following is provided as a response to items addressed in your May 8, 1985 letter of transmittal of our renewal license.

1. Training of personnel will be unchanged from the program outlined in our August, 1984 training manual and addressed in our September 9, 1983 letter to you. Four hours of self study and approximately eight hours of operation practice will be employed. A written exam will be applied with a minimum score of 80% required.

2. Our training manual has been revised as of January, 1985 to reflect the acquisition of CPN gages and the removal of Soiltest gages. A copy is attached.

3. Transportation, storage and emergency procdures are presented in Sections IV, VII, IX of the aforementioned training manual.

4. Personnel qualified to use our gages were lised on our application for renewal. The following persons, referenced in earlier correspondence, are no longer with our firm:

   a) Donald Parker
   b) Gary Holcombe
   c) Michael Pond

5. The Soiltest gages were shipped to Campbell Pacific Nuclear Corp. on Sepbember 27, 1984 for disposal. Enclosed are NRC Form 314

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and a supplemental letter detailing the disposal. Please remove the Soiltest gages from our license; we have no intention of utilizing them in the future.

I trust the above adequately provides the information you require. If you have any questions, please contact me.

Sincerely yours,

GOURDIE/FRASER & ASSOCIATES, INC.

Michael F. Kelly, P.E.
Manager, Materials Engineering
and Geotechnical Section

MFK/djk
Enclosures

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GOURDIE/FRASER & ASSOCIATES
NUCLEAR DENSITY GAGE TRAINING MANUAL
TABLE OF CONTENTS

I. INTRODUCTION

The operation of the nuclear density device requires that the operator be familiar not only with the correct methods for calibrating, utilizing and maintaining the instrument, but with the safety requirements which are imposed as a result of the potential for excessive radiation exposure during normal operation, and particularly in the event of damage to the gage. The Nuclear Regulatory Commission (NRC) requires that organizations using the nuclear density device have a training program for operators encompassing the correct use of the gage and the proper safety measures to be followed. This manual has been prepared to satisfy, in part, those requirements.

Operation and maintenance of the gage are adequately covered by the instruction manual supplied by the manufacturer and the appropriate training will be conducted through a combination of study of the operator's manual and hands-on use in the field under the direction of qualified Gourdie/Fraser personnel.

The Troxler and Campbell Pacific Nuclear (CPN) gauges are the devices which Gourdie/Fraser considers the standard instrument, and this manual is prepared to reflect that position. However, much of the information presented herein can be applied to other nuclear density gauges, which Gourdie/Fraser may have opportunity to utilize.

II. RADIATION THEORY

The quantities of radioactive material contained in nuclear moisture and density gauges are quite small, and an operator may safely use a gauge daily without receiving any bodily damage due to radiation. In addition, each radioactive source is doubly encapsulated to afford even greater protection for the operator. However, all radioactive sources, no matter how small, should be handled with care.

The purpose of this section is to acquaint the operator with the types and characteristics of radiations with which he will be working.

A. RADIATION CHARACTERISTICS

1. TYPES OF RADIATION:

Various elements, both naturally occurring (Radium) and reactor produced (Cesium and Americium) are unstable and slowly decay to a more stable state. The act of decay produces emissions of energy. These emissions are either "rays" of electromagnetic radiation (Gamma Rays) or are actual particles of material (neutrons, for example). The radioactive materials in nuclear gauges emit four types of radiation which the operator should know about; alpha and beta particles, photons, and neutrons. Of these four, the alpha and beta particles are completely stopped by the walls of the source container; therefore, only the

characteristics of the photons and neutrons need to be discussed in detail.

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.

Photons (sometimes called gamma rays) are a form of electromagnetic radiation, somewhat similar to radio waves and rays of light, and are electrically neutral. However, unlike light rays, photons are extremely penetrating and may pass through several inches of lead or concrete without being deflected. The energy of a photon is usually expressed in units of millions of electron volts, or MeV. This need not be discussed any further except to state that, in general, the higher the energy, the more penetrating the photon will be.

When a photon (gamma ray) enters a slab of material, any of three things may happen. First, the photon may be absorbed (stopped) by the material. Second, the photon may be

deflected or "scattered" in the material, and come out of the material with a different direction and lower energy than when it entered (of course, sometimes the photon is scattered several times before being absorbed or coming out of the material). Third, the photon may pass through the material without being scattered or absorbed.

It is impossible to accurately predict what will happen to a single photon entering a certain material. However, if a beam of photons is directed at the material, it is possible to calculate the percentages of the beam that will be absorbed, scattered, or transmitted. The percentage of photons that will pass through a material depends mostly on the energy of the photons and the density of the material. For example, if a beam of 1.25 MeV photons was directed at a concrete block 285 mm (11.2 inches) thick, 10% of the beam would be transmitted. However, only 44 mm (1.73 inches) of lead would be required to cut this same beam down to 10% because lead is much denser than concrete. Gamma radiation 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 137 is the isotope used in the nuclear density gages. Cesium, a reactor produced isotope requires a license for use anywhere in the U.S. and in foreign countries.

Neutrons are extremely small, very dense particles. They are electrically neutral, and are emitted from the source at an average energy level of approximately 5 MeV and quite penetrating. Unlike gamma rays, the penetrating power of neutrons through a material does not depend on the density of the material, but on the material composition.

Emission at the 5 MeV energy level 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. Neutrons are slowed down most effectively by a material containing a high percentage of hydrogen atoms (such as water or polyethylene). For this reason, neutrons are used to measure the moisture content of soils or other materials.

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 the 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 nucleus 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 nucleus) 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 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 produce 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. Troxler and CPN use Americium/Beryllium (AmBe) sources in their soil gauges.

Some radioactive elements emit only gamma rays, some emit others, singularly or in combinations of all types. An element which is radioactive is a "radionuclide". During the process of emission of radiation, a radionuclide undergoes at least one change in its structure and ultimately becomes a stable element, such as lead. This process of change is called "decay".

The half-life of a radioactive material is the time required for the activity of a sample of material to decrease to one-half of its initial value, or what amounts to the same thing, the time for half the atoms of the sample to decay. The following example shows the decay of a 2 mCi sample of cesium 137, showing its half-life:

Time	Amount of Radioactive Material
0 years	2 mCi
30 years	1 mCi
60 years	0.5 mCi
90 years	0.25 mCi

Half-life = 30 years

2. 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 the 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 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 (Roentgen Equivalent Man) is a superior term for human exposure accumulation to 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 Troxler and CPN gages 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 describes the number of neutrons per square centimeter per second falling on a surface.

A conventional survey meter will read only the gamma or beta output of a device. Only special neutron meters will read neutron output.

3. TYPES OF SOURCES IN TROXLER & CPN GAGES

Nuclear density instruments are available with cesium 137 gamma sources for measuring density and americium 241:beryllium neutron sources for measuring moisture.

Both sources meet or exceed NRC, DOT, and IATA regulations for "SPECIAL FORM" or sealed source materials. Except for the direct radiation hazards, the sources are extremely safe.

The first encapsulation in the Troxler gauge of the cesium 137 material is a glass bead approximately 1.5 millimeters in diameter which is wipe free even if broken up into pieces. This bead, if ingested, would pass through the digestive system without leaving any traces of absorbed material. The glass bead contains nominally 8 mCi of cesium 137. The second encapsulation is vacuum melted stainless steel in which the closure is fusion welded. This source capsule is fusion welded into the source rod to provide a third encapsulation. The encapsulation in the CPN gauge is essentially identical, except that the capsule is entirely stainless steel. The source is 10 mCi of cesium 137.

The americium 241 material in each gage is a compacted mixture of americium oxide and the beryllium metal target. The pressed pellet nominally contains 40 - 50 mCi of

americium 241. This pellet is fusion welded in two separate stainless steel capsules and is contained within the instrument in another stainless steel housing embedded in lead.

The cesium 137 material decays with the emission of a beta particle with a maximum energy of 1.167 MeV and an average energy of .195 MeV. The half-life of this decay is 30 years. With this emission the cesium 137 material is transformed into barium 137m, which is still unstable and decays with the emission of a .662 MeV gamma photon with a half-life of 2.5 minutes. The beta emission is absorbed by the stainless steel capsule, and the result is effectively a .662 MeV gamma source with a yield of 2.5×10^8 photons per second.

The americium 241 material decays with the emission of an alpha particle having an average energy of 5.45 MeV and a gamma photon of 0.06 MeV. The half-life of this decay is 458 years. Other minor emissions of daughter products are present but are not significant. The gamma yield of 5.6×10^8 photons per second is mainly absorbed by the capsule along with all of the 1.5×10^9 alphas per second. Some of the alphas are absorbed by the beryllium target material, producing a $Be^9 (,n)C^{12}$ reaction. Other alpha particles are self-absorbed by the americium 241. The carbon 12 has excess energy and produces a small quantity of 1-9 MeV photons. The final result is effectively a neutron source of 7.0×10^4 neutrons per second with an average energy of 4.5 MeV and less than 5.6×10^8 gammas per second at an energy of 0.06 MeV.

B. OPERATOR EXPOSURE

1. EXPOSURE LIMITATIONS

In order to protect personnel from overexposure to radiation, the Nuclear Regulatory Commission and the Federal Radiation Council have established exposure limits for radiation workers. These limits, expressed in mrems, are reproduced in the following table.

EXPOSURE LIMITS FOR RADIATION WORKERS

Type of Exposure	Millirem Limits for 13 weeks	1-week rate	1 year
Whole body; head and trunk; active blood-forming organs; lens of eyes, gonads	1,250	96	5,000
Skin of whole body	7,500	577	30,000
Hands and forearms; feet and ankles	18,750	1,442	75,000

A licensee may permit an individual to receive a dose to the whole body greater than that above, provided: (1) the dose during the 13 week quarter does not exceed 3 rems and (2) the accumulated occupational dose to the whole body does not exceed [5 x (N-18)]rems; where N equals the individual's age.

These limits are intended to be highly conservative, and do not represent the absolute maximum exposure a person could receive without becoming ill or suffering radiation damage. This can be done quite easily by following established handling precautions.

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.

The gamma dose rate (mrem/hour) at any point from the unshielded cesium-137 source in the Troxler gauge can be calculated for any distance (D) in millimeters and is equal to $2{,}500{,}000/D^2$. For several values of "D", the dose rate in mrem/hour is given in the table below. The neutron dose rate (mrem/hour) at any point from the unshielded americium-241:beryllium source can be calculated for any distance (D) in millimeters and is equal to $62{,}500/D^2$. This dose rate is also given in the table below.

Distance (mm)	Gamma Dose Rate (mrem/hr)	Neutron Dose Rate (mrem/hr)
10	25,000.0	625.0
50	1,000.0	25.0
100	250.0	6.3
500	10.0	0.25
1000	2.5	0.06

Table I - Dose Rates For Unshielded Gauge Sources - Troxler Gages

These rates are probably similar to the CPN gage rates.

Dose rates for the Troxler gauges with the source rod in the SAFE or BACKSCATTER positions are shown below. The measurements given are for the right or left side of the instrument and are the highest levels around or over the instrument.

Distance (meters)	Gamma Dose (mrem/hr)	Neutron Dose (mrem/hr)	Total (mrem/hr)
Surface	14.0	1.0	15.0
0.1	2.5	0.5	3.0
0.2	0.7	0.2	0.9
0.4	0.2	0.1	0.3
1.0	0.1	0.05	0.15

Table II -3400-B Series Dose Rates

The average radiation level at 2' from the CPN gage is less than 0.5 mrem/hr. The average level on the surface of the gage is 5 mrem/hr.

Note that the figures in Table 1 are for unshielded sources, a condition not likely to be experienced with proper safety precautions and normal usage. The table does demonstrate the significant decrease in dose rate with increasing distance from the source.

A sample exposure calculation would be as follows: Suppose the user stands in a 0.2 mrem-per-hr. field for 2 minutes each test for 50 tests a day, 5 days a week. The total daily dose would then be: 0.2 mrem/hr x 2/60 hr/test x 50 tests/day = 0.333 mrem/day or 1.67 mrem/wk. This is much less than the 96 mrem allowed for 1 week, and represents a level of testing (and consequently, exposure) much greater than normal.

Using the dose rate data for the Troxler gauges and exposure limits as prescribed by the NRC, it can be easily

shown that no hazardous dose can be received by the operator if reasonable procedures are used. As an example, the operator could place his hands on the surface of the instrument for 90 hours each week before reaching the maximum recommended level for the hands. Assuming the distance of 0.4 meters (16 inches) from the instrument during operation, he could use the instrument for 300 hours each week without exceeding the maximum recommended levels for these parts of his body. Obviously, these conditions would never normally exist.

Under average conditions, a full time operator working a 40 hour week can expect to receive about 4 mrem per week or 50 mrem per 13 weeks for his whole body and approximately 50% higher for his hands and feet. This dose is only 4% of the maximum recommended level for radiation workers.

2. EFFECTS OF RADIATION EXPOSURE:

Radiation is not detectable 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 Radiation Protection Officer is required to report an exposure above NRC limits 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.

The NRC limits are 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 immeasurable 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.

TABLE III - 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	GI (x-ray) Series for ulcer..... a couple of REM!
Commercial jet flight San Francisco to New York.......... 3 MREM	

TABLE IV - 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% 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 computer.

III. PROTECTION AGAINST RADIATION

There are three ways a person can protect himself from a radioactive source: 1) time, 2) distance, and 3) interposition of shielding material.

As expected, the amount of radiation a person receives is directly proportional to the time duration of the exposure. If radiation levels are known; it is easy to calculate the total dose received for various times (for a given distance from the source).

As a person moves away from a source, the amount of radiation he receives falls off sharply. By moving away, the person represents a smaller "target area" to the source. In fact the radiation obeys the "inverse square" law. This law states that the radiation intensity decreases as the inverse square of the distance from the center of source to the "target". The equation is shown below:

$I_B = I_A(D_A/D_B)^2$ where: I_A and I_B are the intensity at distances D_A and D_B, respectively.

Example: If a person standing one foot from a source receives 40 mrem/hr, moving to two feet away would reduce the intensity to 10 mrem/hr; moving to four feet away would reduce the intensity to 2.5 mrem/hr. (Also, refer to Table I and use the above relationship to check the values of intensity.)

The other method of protection is to place material between the source and the target. To a reasonable approximation, it makes no difference where the shielding material is placed between the source and the target, as long as the material thickness remains constant. Dense materials (lead, concrete, etc.) provide the best shielding against gamma radiation; while hydrogenous (hydrogen containing) material affords good protection against neutrons.

The Troxler gauges Gourdie/Fraser uses use tungsten as the biological shield for gamma radiation. Tungsten offers many advantages over lead, such as: higher melting point, greater density, higher scattering and absorption coefficients, and much greater dimensional stability. Since the shield is also a part of the gauge geometry for backscatter measurements, tungsten prevents a calibration shift caused by cold-flowing of lead.

The tungsten shield produces a reduction of gamma dose rate on the surface of approximately 50 to 1.

Since any shielding of neutrons also produces thermal neutrons which affect the measurement of moisture, no provision is made to reduce the neutron dose rate except distance. Small amounts of thermal neutron absorbers are included to eliminate neutrons thermalized by components of the instrument. The neutron dose rate is kept within reasonable levels by simply limiting the neutron yield of the source.

IV. HANDLING PROCEDURES

The nuclear gauges were designed with operator safety as a prime consideration. However, as with any piece of potentially hazardous equipment, some general precautions should be observed.

1. Do not operate or attempt to operate the instrument unless you have been authorized to do so.
2. Keep the source position in the "SAFE" or stored position when not in use.
3. Wear a Film Badge or other dose measurement device when using or transporting the instrument.
4. While exposure dose levels are well within limits for radiation workers, never expose yourself to the bare source without sufficient reason for justification of the additional dose.
5. Keep all unauthorized persons out of the operating area. A suggested distance is 5 meters (15 feet). The general public must not be unnecessarily exposed to radiation.
6. Maintain security of the instrument at all times. The source lock should be in place when not in use and the instrument should be kept on a locked vehicle when transported. When stored, the area should be locked. Not only is it an expensive

piece of equipment but, if stolen, could be abandoned under conditions which could be a hazard to the general public.

7. Every user organization has standard operating procedures; the operator should follow those procedures and report any that he feels unsafe.
8. Insure that the gauge has had leak test measurements at the proper intervals as required by our Radioactive Materials License.
9. If you have any doubts about use of the instrument, ASK. The Radiation Protection Officer either has the answer or can obtain one.

Regulations require that locks be maintained on radiographic equipment to prevent accidental exposure of a sealed source when not under the direct supervision of approved personnel. In addition, storage containers shall be physically secured to prevent tampering or removal by unauthorized personnel. In other words, the trigger padlock (on the Troxler gage) or the integral handle lock (on the CPN gage) shall be engaged any time the gage is not under the direct supervision of approved GFA personnel (e.g. while at lunch, overnight, if the gage must be left in a vehicle while the operator is temporarily elsewhere, etc.). Additionally, the gage, in its case, will be secured in a locked room at the end of each day. This responsibility will rest with the last operator of the day to use the gage.

V. PERSONNEL MONITORING

GFA shall not permit any person to use this equipment unless at all times the user is in the possession of a film badge dosimeter or pocket chamber. Chambers shall be read daily and records maintained. Film badge reports shall be maintained for inspection. GFA uses film badges, and reports are available for inspection at the Traverse City office, maintained by the RPO (Radiation Protection Officer).

Film badges will not record localized overdosage. Overexposure of the hands and fingers will not be recorded by a badge worn on the shirt pocket. If a badge is overexposed, however, overexposure to the body is almost a certainty.

VI. RECORDS AND REPORTS

1. Each office shall conduct a quarterly physical inventory to account for all sealed sources received and in its possession. The record will be maintained by the RPO for inspection at the Traverse City office. Each operator will verify that the gage assigned to him has been leak tested and inventoried before using the gage.

2. Each licensee shall have all sealed sources leak tested at intervals not to exceed six months. In the absence of a certificate, the source shall not be put into use until tested.

3. Reports from film badge service will be maintained for inspection by the RPO at the Traverse City office.

4. When an individual terminates employment with a GFA, a record of his total received dose will be made available to the employee.

5. The NRC license, license application, the above referenced records, NRC bulletins, and all correspondence and other documentation are maintained by the RPO at the Traverse City office. This is available to all employees for their review and use upon request.

VII. INCIDENTS/ACCIDENTS

1. The RPO must report any theft or loss of licensed material by telephone or telegram to the appropriate agency. A listing of the NRC regional office for Michigan is noted below.

   Within 30 days after the loss, a written report must be filed giving detailed description of the source, circumstances of the loss, statement of disposition, possible radiation exposures or hazard, actions taken to recover the source and procedures which will be implemented to prevent a recurrence of the loss or theft.

2. The RPO must report any overexposure of operators which exceeds the limits given in section II-B-1, detailing circumstances of the exposure and possible injury.

3. In the event of an accident which causes potential harm to the source, such as a vehicle driving over the gauge or an automobile accident while in transit, the operator must first ensure that no personnel are allowed within 30 feet of the source and then contact the Radiation Protection Officer. The Radiation Protection Officer will contact the Regional Office of the NRC for further instructions.

   The Radiation Protection Officer is:

   Mike Kelly (616) 946-5874 (T.C. office)
   (616) 941-0958 (home)

   The NRC regional office for Michigan is:

   Region III, USNRC
   Office of Inspection and Enforcement
   799 Roosevelt Road
   Glen Ellyn, IL 60137
   (312) 932-2625

Other important organizations are:

Michigan Department of Public Health
Radiological Health Division
Division Chief (517) 373-1578
Engineering Planning & Response Unit (517) 373-1578

Troxler Electronic Laboratories, Inc.
(919) 549-8661

Campbell Pacific Nuclear Corp.
(415) 687-6472

A. ACCIDENTS:

Depending on the severity of the accident and the condition of the gage, a decision on action to be taken will have to be made, as follows:

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

2. The gauge is damaged, is torn open or is not in a condition to determine source integrity, i.e., the gauge is broken apart, severely burned, severely crushed with parts strewn around, or the source area is visually damaged.

IN THE EVENT OF 1:

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 RPO, who will call the 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.

IN THE EVENT OF 2:

1. Freeze the site. Rope off the damage site for 30' around, Stop the vehicle and have the driver walk away. Do not

walk through the damaged site. If radioactive material is loose it can be picked up and tracked elsewhere.

2. Call the RPO, who will contact the nearest public health department office for help. 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.

   Gage manufacturers do 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. The RPO will call the factory and advise of the problem, who will want to know the circumstances to assist in possible advice to others in future training programs.

B. <u>THEFT</u>:

Call the RPO who will call the police and the factory.

C. <u>FIRE</u>:

Call the RPO who will call the fire department and advise them of the nature of the radioactive materials involved. The fire department should be informed that it is a <u>sealed source</u>. The RPO will call the public health department for assistance in preparing the recovered source for shipment to the factory or to another authorized disposal service. GFA personnel must NOT BURY IT OR OTHERWISE ATTEMPT TO DISPOSE OF THE SOURCE.

VIII. <u>SERVICE AND MAINTENANCE</u>

Detailed service sections are in the individual gauge manuals. If there are any questions on required service or details of a particular maintenance task, contact the RPO who will advise or refer the operator to the factory. Leak test procedures are also covered in the operator manuals.

IX. TRANSPORT AND SHIPPING

A. GENERAL

The transportation of devices containing radioactive material requires conformance to regulations which are very restrictive in order to prevent possible damage to either the population or the environment. Within the United States, the controlling regulations for packaging, transport and shipping are contained in various sections of the Code of Federal Regulations as follows:

Title 14 CFR, Part 103 (air transport)

Title 39 CFR, Parts 124.2 (d), 125.2 (d) (parcel post)

Title 46 CFR, Parts 146, 149 (water transportation)

Title 49 CFR, Parts 170-190 (packaging, rail, water, highways)

In addition, some states have regulations which may be more restrictive than the above and the Air Transport Restricted Articles Tariff imposes some additional requirements. In general, these regulations are in agreement with and are, in fact, controlled by the Code of Federal Regulations.

International transportation of radioactive materials come under the regulations issued by the International Atomic Energy Agency (Regulations for the Safe Transport of Radioactive Materials, 1973 edition, Safety Series No. 6) and the International Air Transport Association (Restricted Articles Regulations).

Within the borders of other countries, their own statutory regulations apply but are, in general, similar to the international regulations.

Devices approved for transportation within a country may meet the requirements for international shipment but Competent Authority Certification of the encapsulation design must be obtained and copies supplied to the carrier.

B. 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.

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.

C. TRANSPORT

1. TRANSPORT BY PRIVATE MOTOR VEHICLE

Either instrument, in its container, may be transported by motor vehicle under the "YELLOW II" label without placarding the vehicle as required by 49 CFR 177.823 per Table I 49 CFR 172.504. 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. Therefore, the gage will always be in its case when transported on public roadways.

The source rod lock should be in place and the container placed in a portion of the vehicle which can be locked. When not in transit the instrument should be stored in a secured area.

Since the container has a Transport Index of 0.1, it may not be stored less than 0.3 meters (1 foot) from passengers per 49 CFR 177.842. It should also not be stored for more than 8 hours at less than 1 meter (3 feet) from undeveloped film.

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

2. TRANSPORT BY COMMON CARRIER

Either instrument, with the source rod lock in place and with either a wire seal through two or more latches or strapping around the outer container, meets all of the requirements of the Official Air Transport Restricted Articles Tariff No. 6-D, 14 CFR 103, 49 CFR 170-190, and the IATA Regulations relating to carriage of Restricted Articles by Air. Air transport is limited at the present time to "CARGO-ONLY" aircraft.

The shipping documents must include the Shipper's Certifications for radioactive materials as shown on the following page. The shipper retains one copy, the originating

carrier retains one copy and one copy accompanies the shipment.

The Airbill (or waybill if other than air shipment) must include the following description:

> RADIOACTIVE MATERIAL
> SPECIAL FORM, (N.O.S.)
>
> Cesium-137, 8 mCi, Group III
> Americium-241, 40 mCi, Group I
> Type A Packaging, Transport Index 0.1
> Radioactive "Yellow II" Label Required

The information above is for a Troxler gage. CPN gages must be described as above, except that the Cesium-137 level is 10 mCI and the Americium-241 level is 50 mCi. All other bill of lading information is identical.

Gourdie/Fraser
& Associates, Inc.

Consulting
Engineers
Surveyors
Planners

124 West State Street
P.O. Box 927
Traverse City, Michigan
49685-0927
(616) 946-5874

September 28, 1984

CPN Corporation
130 South Buchanan Circle
Pacheco, California 94553

RE: NIC-5 Trade-in

On September 27, 1984, we shipped two NIC-5 Densometers for trade-in. They were shipped by Parker Motor Freight.

One NIC-5 is to be credited ($ 500.00) towards the purchase price of a new Campbell Pacific MC-1 Densometer. The other NIC-5 is to be put on your books as a $ 500.00 credit towards the possible purchase of another CPN Densometer in the future (as per telephone conversation with Michael Kelly of our office).

Also, please send the two canisters that the NIC-5's were encased in back to us.

If you have any questions, please do not hesitate to call either myself or Michael Kelly.

Sincerely,

GOURDIE/FRASER & ASSOCIATES, INC.

Brett W. Gourdie

Brett W. Gourdie
Materials Testing Department

BWG/djk