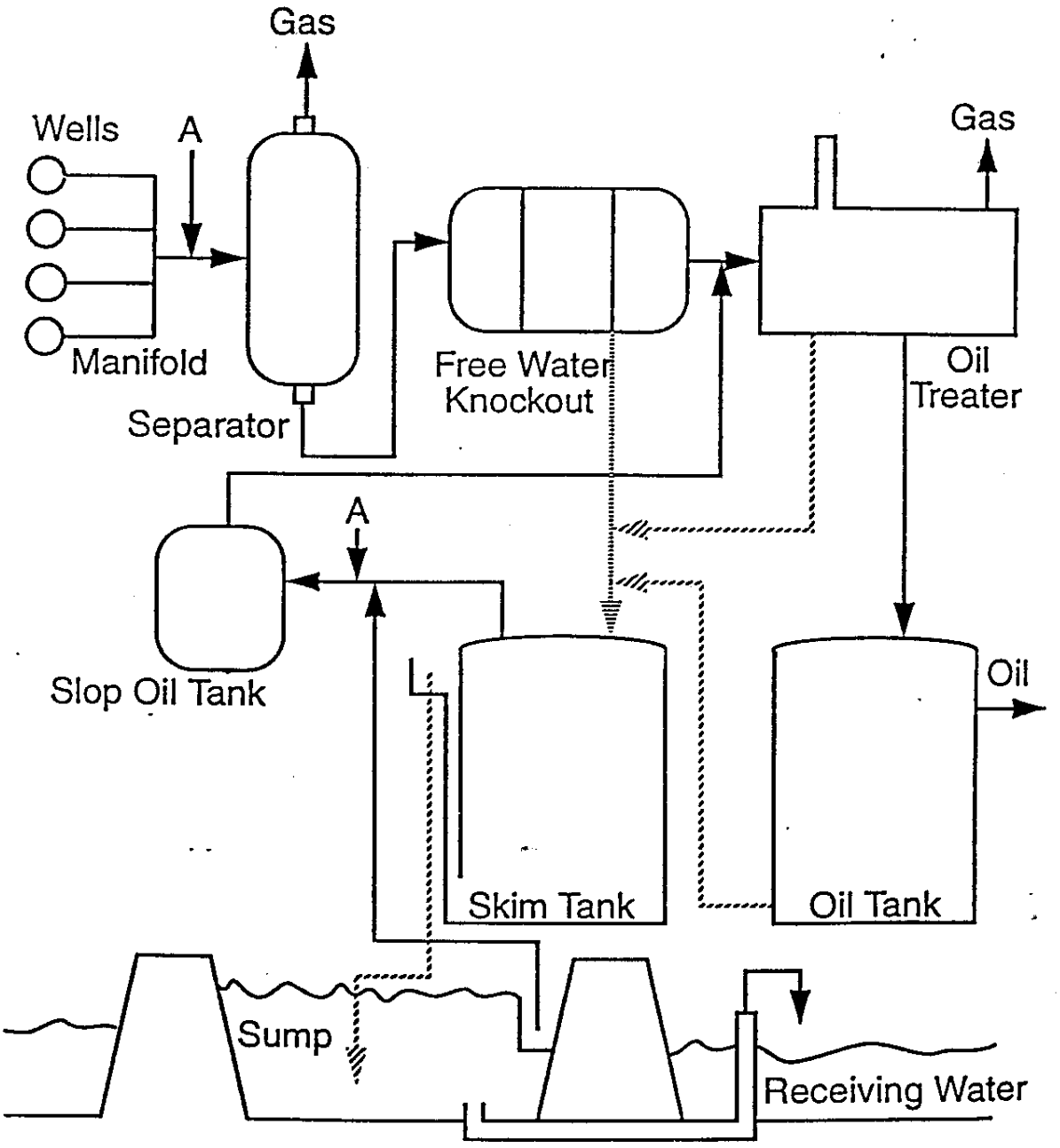
DEPARTMENT OF ENVIRONMENTAL QUALITY
RADIATION PROTECTION DIVISION
Implementation Manual for Management of NORM in Louisiana



DRAFT SEPTEMBER, 1995

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I. INTRODUCTION

On January 20, 1995, the revised NORM regulations (LAC 33:XV. Chapter 14) became effective. This revised Implementation Manual reflects the changes and revisions which were made. It also includes the Radiation Protection Division's position on certain NORM issues that are not specifically addressed in the NORM regulations.

II. EXEMPTION STANDARDS (§1404)

The revised NORM regulations categorize the NORM standards in three basic categories: A. Diffuse NORM waste B. Equipment C. Land. Each person or company/operator must determine that their material, equipment, facilities, and/or land is either exempt or regulated under the standards that are outlined below. If the exemption standards cannot be applied, the person or company/operator are regulated under the general license (§1408) and are subject to the requirements.

A. Diffuse NORM Waste (§1404.A)

- all material that has no beneficial use or value (e.g., tank sludges, production sands, pipe scale, etc.) not specifically addressed in §1404.C
- activity of the material measured to be 5 picocuries per gram of radium-226 or radium-228, above background; or
- 150 picocuries per gram of any other NORM radionuclide
- 100 square meter averaging not included in this category
- activity to be determined by a radiological laboratory or estimated using an approved field method; not determined by using a microR survey meter
- material(s), as stated in §1404.F - I. are exempt from this category

B. Equipment (§1404.B)

- all tanks, vessels, heater-treaters, pipe, tubular goods, filters, clean-out traps, etc.
- the maximum radiation exposure rate at any accessible point on the equipment does not exceeds 50 microroentgens per hour.

Note: A piece of equipment at a site may exhibit an exposure rate below 50 microroentgens per hour and, therefore, be exempt from notification requirements and site registration requirements; however, material removed out of the equipment from cleaning operations may become non-exempt and regulated under §1404.A. Consideration should be given to sampling any material removed from equipment which exibited readings greater than twice background levels.

C. Land (§1404.C)

- oilfield & gas properties, pipeyards, real estate, pits
- concentrations averaged over any 100 square meters; and

- no single non-composited sample to exceed 60 picocuries per gram of radium-226 or radium-228

The land exemption is categorized into two standards:

i. - 5 picocuries per gram or less of radium-226 or radium-228, above background, averaged over the first 15 centimeters depth; and

- 15 picocuries per gram above background, averaged over each subsequent 15 centimeter thick layer of soil

ii. - 30 picocuries per gram or less of radium-226 or radium-228, averaged over 15 cm depth increments; and

- no member of the public (continually present) could receive a total effective dose equivalent (TEDE) exceeding 100 millirem a year. A person or company/operator must supply dose calculations for §1404.C.2 to meet the exemption. The TEDE is the sum of the external dose (e.g., TLD badge) and the internal exposure - ingestion or inhalation.

III. INSTRUMENTATION (§1406)

Prior to performing gamma surveys, a person or company/operator should obtain a radiation instrument capable of measuring the energies of radiation that are characteristic of NORM. The Division uses one-by-one inch sodium iodide detectors in conjunction with an appropriate ratemeter or a microroentgen meter. However, the licensee may choose other instrumentation if appropriate. The instrument used should be properly calibrated at annual intervals, and a daily check of the battery and response to radiation should be performed to assure proper operation (*a Coleman lantern mantle can be a useful and inexpensive check source*). Personnel must be adequately trained in interpreting meter readings (LAC 33:XV.Chapter 14 Appendix A).

Note: These instruments are not intrinsically safe. There is some potential for sparking when detector cables are connected or disconnected, or when switches are turn on or off. Where explosives atmospheres may be encountered, explosive gas measurements should be made prior to the radiation survey.

IV. GAMMA SURVEYS (§1407)

The daughter products of natural uranium and thorium are the primary contributors of the radioactivity in NORM. These daughters products emit alpha, beta, and gamma radiations. The alpha and beta radiations do not normally penetrate through the vessel or pipe wall. However, the gamma radiation can be measured outside the vessel or pipe and can be used to determine the occurrence of NORM in the equipment. Consequently, this Section only addresses performing gamma surveys, and information is provided to assist a person or company/operator to perform surveys at potentially contaminated sites or existing contaminated sites for reasons of identification, notification, and release.

A. The Confirmatory Survey

Confirmatory Survey - a survey of potentially contaminated land, equipment, or sites in order to establish, with reasonable certainty, the absence or magnitude of NORM contamination.

A person or company/operator should, to a reasonable extent, survey **potentially** contaminated

sites or production fields within their control. A major objective of this survey is to identify contaminated equipment and therefore, prevent the inadvertent use of contaminated equipment in the general public (e.g., playground equipment, fences, ballpark bleachers, gates, etc.).

It is recommended that the confirmatory survey be conducted systematically. Individuals involved in the confirmatory survey must have training as outlined in Appendix A of the NORM regulations (Chapter 14) or previous radiological training and experience. The submittal of a confirmatory survey to the Division should be accompanied with documentation of the surveyors' training.

If the confirmatory survey reveals that a site or production field is required to be regulated under §1404, the person or company/operator responsible for the contamination will become subject to general license requirements (see **V. General License Requirements).**

If a person or company/operator declares a production field to be a NORM field and notifies the Division that the field is NORM contaminated using the Form RPD-36-2, the confirmatory survey is considered complete for that field.

If a person or company/operator has previously performed confirmatory surveys on all their sites or production fields, and has reported those that do not meet the exemption requirements, the person or company/operator is not required to re-survey those sites or production fields. However, because NORM contamination in equipment is the result of accumulation over time, sites previously surveyed as being less than 50 microroentgens per hour may exceed the screening level in the future.

Prior to beginning a survey, the surveyor should perform a battery check & field calibration check on his survey meter in order to establish the survey meter is functioning properly. The surveyor should began by making a brief sketch of the site and establishing background. Background should be established at the boundary of the site, or at an area far enough away from contaminated equipment, waste, and land so that there are no interfering non-background radiation levels. Background should be established by holding the survey probe at waste height.

1. Equipment

The surveyors should scan the equipment by moving the radiation instrument slowly over the equipment's external surface. A general rule in surveying equipment at a production facility is to follow the production train. The response of the instrument should be continuously monitored while surveying.

If notification will be made by the entire field, the survey may be stopped once a meter reading exceeds 50 microroentgens per hour. The equipment should be marked/tagged (e.g., spray painted, metal tag wired to equipment, etc.) the reading documented, and reported to the Division on the Form RPD-36-2 (see **Attachment #1**). Upon the Division's receipt of the Form RPD-36-2, the field will be registered as a NORM field.

If notification will be made by individual site, the surveyor should attempt to survey all the equipment located at the site. All measurements made on equipment should be recorded and documented. Equipment measured to read above 50 microroentgens per hour should be marked/tagged, a reading recorded on the site sketch, and reported to the Division on the Form RPD-36-1 (see **Attachment #2**). Upon the Division's receipt of the Form RPD-36, the site where the equipment is located will be registered as a NORM site and assigned a site

ID#.

Common areas where NORM accumulation has been found in equipment are:

- Oil Production Facilities

Heater treaters. water knockouts, liquid product tanks, separators, tubing and piping (particularly at points where flow direction or velocity changes), water transfer pumps, and produced water handling equipment.

- Gas Plants

Propane/ethane reflux pumps, liquid product pumps and storage tanks, and points of flow velocity or directional changes (particularly in piping in propane, ethane, and product service).

All surveys of equipment should be documented and maintained on file.

2. Land

The surveyor should survey the ground surface of sites potentially contaminated by existing or former oilfield & gas operations. The surveyor should systematically transverse the potentially contaminated areas with the survey meter approximately 1 centimeter from the ground surface. The surveyor's goal is to make a quick determination of where NORM contamination is present. A general rule in identifying NORM contamination is a survey meter reading that is greater than twice background. Areas identified with readings greater than twice background should be marked, recorded on a site sketch, and a 100 square meter delineation constructed (see **B. Delineation & Sampling/Analysis**).

Areas suspected to exceed 60 picocuries per gram, should be sampled individually, and not be considered for 100 square meter delineation. Samples taken from the suspected areas should be sent to a radiological lab for analyses or an estimated analyses performed utilizing a Division approved field method (see **B. Delineation & Sampling/Analysis**).

The surveyor is allowed to average sample data in accordance with §1404.C. If the land does not meet the exemption criteria of §1404.C, notification must be made to the Division and considered for future remediation (see **C. Decontamination /Remediation**). Surveys of areas with no readings equal to or greater than twice background should be recorded and maintained on file.

Upon completion of the land survey, all areas of identified contamination should be demarcated to prevent workers from walking through the contamination, thereby reducing the potential of contaminating themselves and spreading contamination. It recommended that the surveyor should perform a whole body frisk to verify the absence of contamination on his/her body.

B. Delineation & Sampling/Analysis

The delineation and sampling procedures as outlined below can be utilized in the different phases of assessment - the confirmatory survey, remediation activities, and the release survey.

Areas of land potentially contaminated should be delineated so that optimum grid spacing includes the size of the area to be surveyed. In no case should any grid spacing be greater than 10 meters. In areas of known contamination, the grid spacing should not exceed 3 meters. Each grid line should be surveyed from outside point to outside point. Readings should be recorded at no more than 10 meter or 3 meter intervals, as appropriate. The surveyor should document his delineation on a site sketch including survey readings, marked hot spots, and sample locations.

If the delineated areas warrant the need to take samples, the surveyor should take an appropriate amount of samples within the 100 square meter grid in the first 15 centimeters to characterize the contamination. No more than three samples can be composited together for one sample. A chain of custody should be completed and sent for radiological analyses.

Outlined below are general rules/examples of sampling and delineation:

When sampling an area, the samples collected should be representative of the entire area. If the contaminated area covers 50% of the 100 square-meter area, then 50% of the samples collected should be from the contaminated area.

When sampling a contaminated area which is less than a 100 square-meter area, the contaminated area must be sampled as part of a single 100 square-meter area (see **Figure 1**). The contaminated area may not be split into two sections which are located in two separate 100 square-meter areas (see **Figure 2**). Figure 1 depicts an acceptable method of sampling; and Figure 2 depicts an unacceptable method of sampling such an area.

If the contamination occurs in narrow strips, one meter wide or less, the licensee may divide the contaminated area into more than one sampling area (see **Figure 3**). The dimensions of the sampling area should not be narrower than five meters on any boundary.

If a small area of contamination is encountered (less than one meter in diameter), then the contaminated area should be placed in the center of the 100 square-meter sampling area. A minimum of one sample should be collected from the hot spot and a minimum of four additional samples collected by sampling one meter toward the center from each corner of the 100 square-meter area (see **Figure 4**).

If numerous small contaminated areas are present in close proximity to one another, they should be sampled as one 100 square-meter area, and a more widely distributed array of samples should be collected from such an area (see **Figure 5**)

Figure 5 indicates seven samples collected from the 100 square-meter area. The licensee may choose fewer or additional sampling locations within the 100 square-meter sampling area, as long as the sampling method is statistically valid.

The surveyor should use appropriate sampling tools (*e.g., shovel, auger, trowel, coring device, etc.*) to retrieve representative samples at the appropriate depths. Tools should be wiped and cleaned between samples to prevent possible cross contamination. The surveyor should retrieve

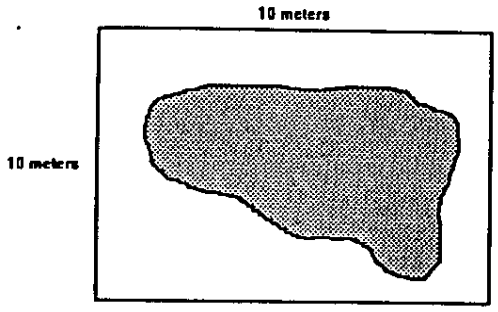

Figure 1

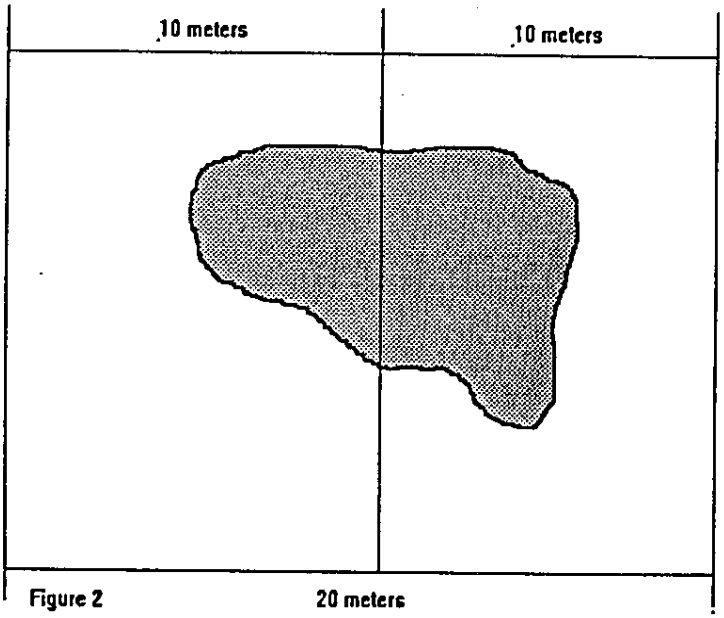

Figure 2

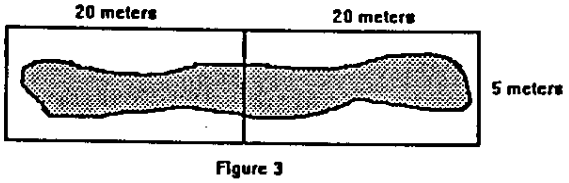

Figure 3

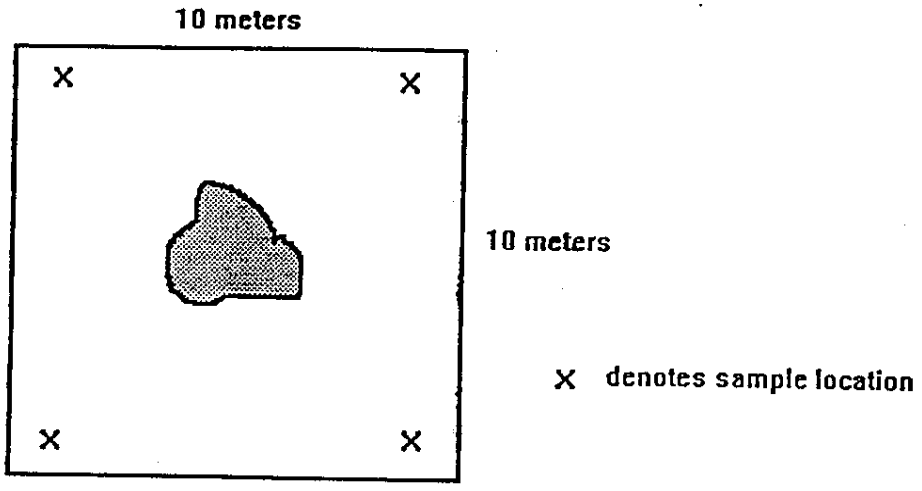

FIGURE 4

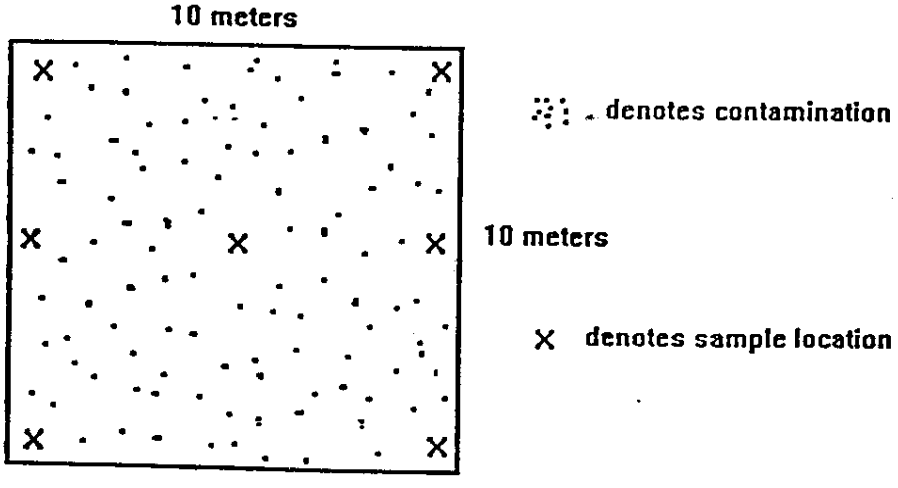

FIGURE 5

approximately a quart or one pound of soil to be analyzed *(e.g., a Ziploc® bag, a plastic wide mouth container, etc)* . Each sample should be labeled including date, sample location, sample #, etc. Samples to be sent to a laboratory should be accompanied with a chain of custody. If samples will be sent through the mail system refer to **Attachment #3.**

A screening method has been included in **Attachment #4** to assist the surveyor in determining what samples need to be sent to a laboratory for more precise radiological analyses. Other field methods maybe acceptable for screening Ra-226 in the field. Persons utilizing this present field screening method must have documentation of their training to perform this method.

V. GENERAL LICENSE REQUIREMENTS (§1408)

NORM General License Number - the number assigned by the Division to the person or company/operator that are regulated under §1408.A.

NORM Site or Field Specific Identification Number - the number assigned by the Division to each registered NORM site or NORM field.

A. Notification

Each licensee must notify using the Form RPD-36 of sites/production fields that are contaminated with NORM above the regulatory standards. The Form RPD-36-1 should be filed for individual contaminated sites (*e.g., wellsite, production facility, pipeyard, storage tank, transfer line, etc.*) whereas the Form RPD-36-2 should be filed for each production field that is designated as being NORM contaminated. Notification by production field assumes all components in the field are potentially contaminated.

Upon receipt of the Form RPD-36, the notifier will be recognized as a general licensee under §1408, assigned a NORM general license number, and the NORM site or NORM field will registered under a site or field specific number. Licensees can determine their general license number and NORM site numbers from the invoice that is sent out from the Division. For subsequent notification, the notifiers general license number will remain the same but the NORM site or NORM field will be given a specific identification number. The general license will remain in effect for a person or company/operator until all NORM sites or NORM fields have been either released for unrestricted use or transferred to another operator. The Division requests that licensees contact the Division, in writing, of any transfers of NORM sites or NORM fields to another licensee.

B. Worker Protection

The general licensees under §1408.A.3 are required to submit worker protection procedures to ensure the protection of workers during either onsite maintenance operations or excavation of land activities. The general licensees under §1410.A are required to submit worker protection procedures to ensure the protection of the workers during the cleaning of equipment that contains levels of NORM below the regulatory level. The worker protection plans should be in accordance with Appendix B of the NORM regulations. General licensees are required to trained all workers involved in onsite maintenance in accordance with the worker protection procedures submitted to the Division. Training records must be maintained by the general licensees and made available for inspection by the Division.

C. 90-DAY STORAGE

Storage of diffuse NORM waste in a container, without submittal of a NORM Waste Management Plan, will be limited to 90 days from the date of generation. Containers of diffuse NORM waste shall be managed in accordance with the requirements of §1414.

D. NORM WASTE MANAGEMENT PLAN

A person or company/operator subject to general licensure may store diffuse NORM waste up to 365 days from its initial generation if a NORM Waste Management Plan is submitted. The 365 day clock begins at such time diffuse NORM waste is generated and placed inside a waste container. Containers utilized in the storage of diffuse NORM waste for 365 days must be such as to prevent the leakage of diffuse NORM waste into the environment. Licensees may submit one plan for all their NORM storage sites provided the sites are referenced in the plan and a Form RPD-36-1 is submitted for each site. Each storage site would be subject to all requirements outlined in the plan.

Basic Requirements:

1. Containment within drum storage area;
2. Use of ground covers or some other means to prevent the contamination of the underlying ground;
3. Restrictive access to drum storage area;
4. Quarterly inspections - drum integrity, visible labeling, contamination surveys;
5. Inventory Program for incoming and outgoing diffuse NORM waste;
6. Contingency plan;
7. Notify, in writing, the parish governing officials of the storage facility;

These requirements apply only to container storage of NORM waste and do not cover activities involving decontamination, treatment, repackaging, and processing of diffuse NORM waste.

Financial Security for Storers

Financial assurance will be required for interim storers of NORM waste. The licensee should calculate financial assurance based on the transfer and disposal/treatment of the licensee's estimated yearly inventory of containerized NORM waste.

E. DECONTAMINATION/REMEDIATION (§1408.C & §1417)

Prior to the decontamination/remediation of equipment and land, the person or company/operator should have notified the Division as outlined in V. General License Requirements. The decontamination for release for unrestricted use of contaminated facilities, sites, or equipment shall only be performed by persons specifically licensed by the division, the U.S. Nuclear

Regulatory Commission, another agreement state, or another licensing state to conduct such work or as otherwise authorized by the division.

1. Equipment

All equipment exceeding 50 microroentgens per hour must be decontaminated before it will be considered for unrestricted use. All equipment exceeding 50 microroentgens per hour that has been out of service for one year must decontaminated or recycled/disposed. Decontamination must reduce the exposure rate to less 50 microroentgens per hour and the external surfaces must be free of loose contamination (*less than 2X background in counts per minute*).

Note: Many commercial scrap yards have established acceptability limits for equipment to be received into their facilities (*e.g., equal to or less than 10 microroentgens per hour*). Therefore, a piece of equipment that meets regulatory requirements for release for unrestricted use may be denied at a commercial scrap yard.

2. Land

The licensee should have determined from the confirmatory survey which areas of contamination exceeded the exemption standards of §1404.C and therefore require remediation. The remediation must be performed to reduce the concentration to below 5 picocuries per gram in the first 15 cm.

Should decontamination/remediation activities involve construction that may impact the ground to a depth greater than three feet, the licensee must obtain prior approval by the Department of Environmental Quality, Ground Water Protection Division, Certification Program.

VI. TREATMENT/DISPOSAL OPTIONS (§1412)

Treatment/disposal options stated in A thru D are limited to diffuse NORM waste that can be classified as nonhazardous oilfield waste (NOW). The Department of Natural Resources, Office of Conservation dictates the determination of a waste to be NOW.

A. Commercial Nonhazardous Oilfield Waste (NOW) Facilities (§1412.A.3)

NOW waste containing NORM concentrations not exceeding 30 picocuries per gram of radium-226 or radium-228, can be treated at a commercial nonhazardous oilfield waste facility. The current regulations make no distinction as to whether the diffuse NORM waste was generated from a registered NORM site, a non-registered NORM site, or a production facility in OCS waters, etc.

B. Commercial NORM/NOW Facilities (§1412.A.4)

Within the State, NOW waste containing NORM concentrations not exceeding 200 picocuries per gram of radium-226 or radium-228 can be treated at a specifically licensed commercial NORM/NOW facility.

C. Placement In a Well available for Plugging & Abandonment

The DNR/OC and the Division will consider proposals for downhole disposal of NORM solids and NORM contaminated tubular goods and equipment in wells which are to be plugged and abandoned, if such procedures are performed in accordance with approved practices (See **Attachment #5**).

The NORM P/A disposal permit Form UIC-30 (See **Attachment #5**) shall be completed by the applicant and forwarded to the DNR/OC. Applications to utilize a well for NORM disposal shall be submitted to the DNR/OC Injection and Mining Division. When the DNR/OC approves the UIC-30, a copy will be forwarded to the Division and the general licensee. Prior to the Division issuing authorization for P/A disposal, it must be in receipt of an approved UIC-30.

Concurrent with submission of the UIC-30 to the DNR/OC, the applicant must submit the Request for Disposal Form RPD-34 (See **Attachment #6**) to the Division. The Division will notify the parish government of the application and review the information supplied on the Form RPD-34. If the information satisfies the requirements, the Division will issue three letters of authorization: 1) Operator/applicant 2) Specific licensee performing work (as required) 3) Notification to the Parish Government. The permittee should notify by phone both the DNR/OC and the Division at least 24 hours before the first placement of NORM in the wellbore.

For instances where tubing or piping have been retrieved from a production well, the tubing or piping has been surveyed to be NORM contaminated, and the well will be plugged and abandoned, the operator may place the tubing or piping back into the well for P/A activities under DNR/OC approval. Authorization from the Division will not be required in this situation. Contaminated tubing or piping transferred from other well locations to be disposed into a well will require the complete permitting procedures as outlined above.

For utilization of orphan wells, licensees should contact the DNR/OC for more information.

D. Non-Retrieved Flowlines and Pipelines

General licensees will be authorized by the division to leave flowlines and pipelines already buried underground in place provided that the following criteria are met:

a. A survey of the soil surface above buried pipelines/flowlines or on contact with surface pipelines/flowlines is performed and no reading exceeding 25 microroentgens per hour above background is obtained. Special attention should be given to areas where changes in flow occur such as elbows or restrictions in tubulars. The survey should be documented showing the date of survey, surveyor's name, survey instrument description, and last calibration date, NORM general license number, NORM site specific identification number, pipeline/flowline origin and destination, facility contact, NORM contaminated facility address, and name of the administrative authority of the general licensee. These records should be maintained indefinitely;

b. The buried pipeline/flowline is flushed to remove hydrocarbons and produced salt water in accordance with general industry standards and regulations; and,

c. The lease agreement allows the pipelines/flowlines to remain unretrieved.

If any readings exceed 25 microroentgens per hour above background, the general licensee may

request an exemption from the Division. However, in addition to the survey documentation required above, an assessment of environmental damage due to pipeline/flowline retrieval or further isolation and an estimate of public exposure potential must be submitted in the exemption request. The Division will advise the general licensee of its decision in writing and provide a copy of that decision with pertinent documents to the DNR.

E. Commercial Smelting Operations (§1412.D)

At present, there are scrap metal brokers that are receiving shipments of NORM contaminated equipment for transfer to international metal smelters.

F. Land Burial - Commercial Low Level Radioactive Waste Facilities

Licensed facilities exist outside the State that can receive and dispose of diffuse NORM waste. It is important to contact the licensing State in which the disposal facility is located in order to verify the waste form acceptance criteria. Some states that have disposal sites require point-of-origin inspection prior to the waste being sent to their state.

VII. SITE RELEASE FOR UNRESTRICTED USE (§1417)

A. Land (§1417.A.1)

Registered sites where land contamination was previously reported must meet the following criteria prior to being considered for release for unrestricted use:

i. Records indicate areas of previous contamination were remediated to be below 5 picocuries per gram or less of radium-226 or radium-228, above background, in the first 15 centimeters, as determined by radiological laboratory analysis..

ii. The licensee has performed a post-survey of the land that documents the remediation of the contaminated areas.

iii. Records document the transfer of contaminated soil from the site to an authorized and/or licensed facility for treatment, storage, and/or disposal.

B. Equipment (§1417.A.2.)

Registered sites where equipment had been previously reported to be contaminated, will be considered for release if the licensee has resurveyed the entire site and the following criteria are met:

i. Records indicate no piece of equipment is found to exceed 50 microroentgens per hour at the site.

ii. Records indicate that equipment previously reported to be NORM contaminated has been decontaminated and free of loose contamination* (less than 2X background in counts per minute) or records indicate the equipment was transferred to another NORM registered site.

* A wipe should be smeared on the exterior surface of equipment and counted in a low background area (maximum bkg 50 cpm) with a survey meter or a scaler with an appropriate detector.

C. Filing for Release

The licensee should submit a written request to the Division in order to release a site under general licensure. The request must include information as outlined in **Attachment #7.**

Information submitted to the Division will be evaluated and the site considered for release. In some cases, the Division may send an inspector to perform a survey inspection before the release will be authorized. The Division may deny a release request in cases where insufficient information was submitted, survey data is suspect or questionable, and/or the Division inspector's field survey revealed incomplete remediation efforts. In such cases, the licensee will be contacted.

If the Division's evaluation determines the site can be released for unrestricted use, a letter releasing the site for unrestricted use will be issued by the Division and sent to the licensee.

VIII. MANIFEST & TRANSPORTATION REQUIREMENTS (§ 1418)

The transfer of diffuse NORM waste or NORM contaminated equipment must be documented and records maintained by the general licensee. The transfer to a <u>specific licensee</u> for treatment, decontamination, storage, or disposal shall be accompanied with a NORM waste manifest RPD-37 (See **Attachment #8**). Licensees that notify and register by production fields (RPD-36-2) should use the four digit field identification number (FXXXX) in lieu of the facility identification number. Shipments of NOW that is contaminated with NORM not exceeding 30 picocuries per gram of radium-226 or radium-228 and transferred to a NOW facility <u>shall not</u> require a NORM manifest (RPD-37) but shall require a NOW manifest UIC-28 (see **Attachment #9**).

Effort should be made in the shipment of NORM contaminated equipment to tape up all ends and openings of the equipment to prevent any loose contaminated material from being spilled or leaked into the environment.

In instances where NORM contaminated equipment or diffuse NORM waste has been determined to have total activities greater than 2000 picocuries per gram, licensees must consider transportation regulations from the State and Federal regulatory agencies (see **Attachment #10**).

IX. LABELING & POSTING

A. Oil & Gas Production Equipment

1. In Service (LAC 33:XV.454.6 *...installed manufacturing or process equipment, such as piping and tanks*)

Equipment in use at a production facility determined to exceed 50 microroentgens per hour, are exempt from labeling purposes. However, in the event equipment radiation levels are 2000 microroentgens per hour or greater, access to the area surrounding the equipment must be restricted (LAC 33:XV.421.A.2). At 5000 microroentgens per hour or greater it must be posted with a sign reading "Caution: Radiation Area". In consideration of the ALARA principle, it is recommended that the general licensee attempt to communicate the presence of NORM contamination to field workers by attaching a metal tag, or a plastic placard, or sprayed painted information on pieces of equipment that are NORM contaminated.

2. Out-of-Service

Contaminated equipment that is out-of-service should be labeled in accordance with LAC 33:XV.453. Equipment reading 2000 microroentgens per hour and above must be handled as referenced above.

B. Containerized NORM Waste

All containers containing NORM waste must be labeled in accordance with LAC 33:XV.453. In addition, each container should have the following information labeled on them - the name of the company, the general or specific license number, the date it was placed in the container, and the exposure rate measured at the surface. The area in which the containers are stored should be made restrictive and be posted with "Caution: Radioactive Material".

C. Tubular Goods and Pipe

(1403. Definitions - *"Container...This does not include tubular goods or drill pipe for labeling purposes under these regulations."*)

Tubular goods and pipe in storage are not required to be labeled in accordance with LAC 33:XV.453. However, the storage area may be required to be restricted or posted depending on the radiation level.

X. FEES (LAC 33:XV.Chapter 25)

Upon the Division receipt of a FORM RPD-36, the licensee will be sent an invoice. Subsequent invoices will be sent annually for each NORM site or NORM field. For fee categories, the licensee should obtained a copy LAC 33:XV.Chapter 25. An identification number will be assigned to each NORM site or NORM field. Each identification number will have a suffix code that will indicate the type of site (see **Attachment #11**).

XI. ATTACHMENTS

For additional information or clarification, contact the Department of Environmental Quality, Radiation Protection Division at (504) 765-0160.

All correspondence should be sent to:

Department of Environmental Quality
Radiation Protection Division
Licensing Section
P.O. Box 82135
Baton Rouge, LA 70884-2135

Some of the Attachments are provided to be copied for use.

ATTACHMENT #1

NOTIFICATION OF A NORM SITE
SUBJECT TO GENERAL LICENSURE
DEPARTMENT OF ENVIRONMENTAL QUALITY
PERMITS DIVISION
REGISTRATIONS & CERTIFICATIONS SECTION
POST OFFICE BOX 82135
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FOR OFFICE USE ONLY
ISSUE NEW GENERAL LICENSE #
ISSUE NEW NORM FACILITY ID#
AI#
APPLICATION

Form RPD-36 (Rev 5/01)

This application is for
• Site Registration • Site Transfer • Site Release • Record Update

NORM NOTIFIER INFORMATION

NORM General License Number:			
Notifier Name:			
Physical Address: No. & Street	City & State	Zip Code	Parish
Mailing Address: No. & Street	City & State	Zip Code	
Billing Address: No. & Street	City & State	Zip Code	
Federal ID#:			
Primary Contact:	Job Title:		
Telephone #:	Fax#:		

NORM SITE INFORMATION

Type of Site (i.e. well site, production facility, pipe yard, drum storage, refinery, etc.):	
Site Name or Well Name:	Well Serial # (if applicable):
Field Lease Name (if applicable):	Field ID#:
Physical Location/Address:	
Parish:	Location Phone #:
Directions to Site (origin point from nearest city limits):	
Briefly Describe Site (size, terrain, structures):	
Describe How This Site Became Subject to Norm Regulations/Type of Contamination:	

SURVEY INFORMATION

Survey Date:			
Surveyor's Name & Company Affiliation:			
Radiation Instrument Used:		Calibration Date:	
Highest Exposure Reading Measured on a Piece of Equipment (microroentgens/hr):		Highest Exposure Reading Measured on the Ground/or Solids (microroentgens/hr):	
Concentration:	Isotope	Activity (picocuries per gram)	**TOTAL ACTIVITY** (picocuries per gram)
	! Radium 226		
	! Radium 228		
	! Other NORM radionuclide_____		
Approved/Accredited Laboratory		Agency Interest Number of Laboratory	

SITE TRANSFER INFORMATION

Transferee NORM General License Number:		Date of Transfer:	
Transferee Name:			
Physical Address: No. & Street	City & State	Zip Code	Parish
Mailing Address: No. & Street	City & State	Zip Code	
Primary Contact:		Job Title:	
Telephone #:		Fax#:	

SITE RELEASE INFORMATION

The following information must be included with this form in accordance with LAC 33:XV.1417:

1. Copy of the Form RPD-35 Temporary Jobsite Notification indicating the specific licensee that performed the work
2. Manifest records indicating transfer and any other records indicating the whereabouts and status of NORM waste and/or contaminated equipment transferred from this site
3. The results of tests, experiments, or any other analyses relating to backfill of excavated areas, closure and sealing
4. Any proposed revision of plans for:
    a. Decontamination and/or dismantlement of surface facilities
    b. Backfilling of excavated areas, and/or
    c. Stabilization of the NORM site for post-closure care
5. Any new information regarding the environmental impact of closure activities and long-term performance of the NORM site
6. Copy of closeout survey, sample results performed after cleanup, and qualifications of person who performed survey
7. Duplicate survey plot without radiation readings

CERTIFICATION

Signature (Responsible Party/Company Representative)	Application Date
Name (Print)	Job Title

ATTACHMENT #2

ATTACHMENT #3

MAILING RADIOACTIVE MATERIALS (NORM)
General Requirements

It is against the law to mail radioactive materials using the U.S. Postal system. However, radioactive materials can be shipped as Limited Quantity using a private carrier such as UPS or Federal Express.

The following general requirements apply to Limited Quantity shipments:

The maximum radiation level allowed on the external surface of the package is 500μR/hr. [49CFR173.421.b]

The total amount of radium-226 or radium-228 shipped in a single package shall not exceed 50,000,000 picocuries per package. [49CFR173.423, Table 7, Material package limit column]

The materials need to be packaged in a strong, tight, container which will be able to maintain its integrity under the conditions of normal transport. [49CFR173.421.a]

The outside of the inner packaging, or if there is no inner packaging, the outside of the packaging itself, must bear the word "Radioactive" [49CFR173.421.d].

The following statement must be contained in or on the package, with the packing list, or otherwise forwarded with the package: "This package conforms to the conditions and limitations specified in 49CFR173.421 for radioactive material, excepted package - limited quantity of material, UN2910". [49CFR173.421-1.a].

If Type A packaging is used, the outside of the packaging must incorporate a feature, such as a seal, that is not readily breakable, and that, while intact, is evidence that the package has not been opened. In the case of packages shipped in exclusive use closed transport vehicles, the cargo compartment may be sealed instead of the individual packages [49CFR173.412.b].

ATTACHMENT #4

DETECTION OF RA-226/RA-228 CONTAMINATION IN SOIL AND OTHER SOLIDS AT LEVELS OF REGULATORY CONCERN USING FIELD-DEPLOYABLE INSTRUMENTS

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H. Miller, Martin-Marietta Energy Systems
D. Van Gent, Louisiana State University and A&M College
M. Hebert, NORMCO, Inc.
S. Fauver, U.S. Department of Energy
J. Courtney, Louisiana State University and A&M College

ABSTRACT

Techniques are presented for rapid analysis of soil and other solids for ^{226}Ra and ^{228}Ra. These techniques provide a useful method for rapid field analysis from which most decontamination disposal decisions can be developed. In most cases, the minimum detectable activity is less than regulatory limits; however, due to variability, the techniques presented may not be precise for uncontrolled release of soil or other solids.

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INTRODUCTION

The detection of $^{226}Ra/^{228}Ra$ contamination at oilfield production and support facilities in Louisiana has led state radiation protection authorities to amend existing regulations governing the release of contaminated sites for unrestricted use. Ra-226, a member of the ^{238}U decay series, and ^{228}Ra, a member of the ^{232}Th decay series, originate in petroleum-bearing formations and, under specific conditions of temperature and pressure encountered during production, accumulate in production equipment in the form of mineral scales and sludges. During routine maintenance and equipment cleaning operations, scales and sludges are dislodged from equipment, and, if handled and/or disposed of without special precautions, will present potential soil contamination problems. Levels of ^{226}Ra

in scale, sludge and soil in excess of 1000 pCi/g have been observed.

Louisiana, Texas, Mississippi, Arkansas, and Georgia have promulgated regulations covering NORM. In each of these states, limits have been established for uncontrolled release of land. These range from 5 to 30 pCi/g for ^{226}Ra or ^{228}Ra. In addition, it is highly desirable to know the ^{226}Ra concentration of NORM waste stored in barrels.

Laboratory analysis for ^{226}Ra in soil samples can be time-consuming and costly. Use of a reliable soil screening technique that could be performed in the field could significantly reduce total labor and costs. This paper documents the feasibility of using field-deployable instruments to screen samples for ^{226}Ra contamination at levels of current regulatory concern.

METHODS

To test the reliability of using a screening technique for the detection of ^{226}Ra in soil, an evaluation of instrument response to a series of ^{226}Ra spiked soil standards was performed using the following field-deployable instruments:

- hand-held survey meter equipped with a 1 x 1 in. sodium iodide detector
- portable scaler/single channel analyzer (SCA) connected to a 2 x 2 in. sodium iodide detector

The soil standards were prepared with a uniform geometry and specific activities ranging from 5 to 250 pCi/g of ^{226}Ra. Four replicate contact measurements were taken of each standard. Instrument response, based on either total gamma exposure rates or the detection of gamma emission from ^{226}Ra daughters was plotted versus ^{226}Ra concentration.

Radium-226 soil standard preparation. The ^{226}Ra soil standards were prepared from standard reference material (No. 4959) obtained from the National Institute of Standards and Technology (NIST). Dried, finely-milled estuarine sediments were spiked with a stock solution containing a known concentration of ^{226}Ra. After drying, the spiked sediments were rolled and shaken for two hours to assure uniform mixing. The spiked sediments were mixed with appropriate quantities of clean sediment to yield the following specific activities: 5, 10, 15, 20, 25, 50, 100, 200,

and 250 pCi/g. Enough sediment (approximately 1400 gm) was placed in one-liter, wide-mouth Nalgene bottles to fill the bottles to capacity. The bottles were sealed to allow for the ingrowth of ^{226}Ra daughters (approximately 28 days).

Radium-228 soil standard preparation. The ^{228}Ra standards were prepared from reagent grade thorium nitrate ($Th[NO_3]_4 \cdot 4\ H_2O$) which had grown into radioactive equilibrium with its daughters for over 30 years. A stock solution was prepared by dissolving the reagent into deionized-distilled water. A small aliquot of the stock solution was measured out into a stainless-steel planchet, dried at 60 degrees centigrade, and prepared for alpha spectrometry.

The planchet was analyzed by alpha spectrometry using a surface barrier solid-state detector and multichannel analyzer (MCA). It was determined that all daughters were at greater than 95% in equilibrium with ^{232}Th using the area under each alpha peak obtained during a 60,000-sec count.

A second aliquot of the stock solution was mixed with 80 gm of finely-milled estuarine sediment and dried overnight at 60 degrees centigrade. The sediment was subsequently placed in a standard gamma counting container (petri dish) and counted by gamma spectroscopy. The sediment was assayed for ^{228}Ac by means of an efficiency curve generated by a NIST traceable mixed gamma standard (Calibration No. 0146) in the same geometry and sample matrix (estuarine sediment). All gamma-emitting daughters were found to be in secular equilibrium with the ^{228}Ac.

The concentration of ^{232}Th and ^{228}Ra contained in the stock solution was inferred from the assay results of the ^{228}Ac by gamma spectroscopy. Subsequently, a 1400-g, 100 pCi/g ^{228}Ra-supported standard consisting of estuarine sediment in a one-liter Nalgene bottle was prepared using the assayed stock solution. A portion of the stock solution prepared above was placed in a 1000-ml beaker, heated to boiling, and an excess amount of ammonium hydroxide was added in order to remove essentially all thorium present as the insoluble hydroxide (solubility product $< 10^{-34}$). The precipitate was removed by filtration and discarded. The resulting filtrate was brought down to a pH of four by addition of sufficient glacial acetic acid.

Barium nitrate and lead nitrate were added to the acidified filtrate which was then brought to boiling. Reagent grade sulfuric acid was then added, in excess, in order to precipitate the barium and lead as the insoluble sulfate. During this process, any radium present is co-precipitated with the sulfates.

The resulting precipitate was allowed to crystallize overnight and then filtered the following morning. The precipitate was dissolved in hot EDTA mixed with ammonium hydroxide. After cooling, droplets of glacial acetic acid were added until the pH was brought down to four. At this point, the barium-EDTA complex is destroyed, and re-precipitates as the insoluble sulfate along with the radium. The resulting precipitate was filtered and redissolved in hot EDTA mixed with ammonium hydroxide. The resulting solution was used to prepare an unsupported stock solution of ^{228}Ra. An aliquot of the stock solution was analyzed by alpha spectroscopy in order to ensure complete removal of ^{232}Th.

After sufficient time for ^{228}Ac ingrowth, the unsupported stock solution was assayed for ^{228}Ac by gamma spectroscopy as outlined above and the concentration of ^{228}Ra inferred. Subsequently, a 1400-g, 100 pCi/g ^{228}Ra-unsupported standard consisting of estuarine sediment in a one-liter Nalgene bottle was prepared using the assayed stock solution.

Survey meter measurements. Gamma exposure rates (in μR/hr) at contact with the surfaces of the soil standards were measured with a Ludlum Model No. 19 micro-R meter, and two Ludlum Model No. 3-97 survey meters; all three instruments were equipped with a 1 x 1 in. sodium iodide detector and calibrated on all scales by direct comparison to readings on a factory-calibrated pressurized ion chamber exposed to a radium source. The instruments were operated in a slow-response mode, and replicate measurements were taken at one-minute intervals.

SCA measurements. Peak counts were collected over a five-minute sampling period using a Ludlum Model No. 2200 scaler ratemeter connected to a Ludlum Model No. 44-2 high energy gamma detector. The scaler ratemeter is equipped with an SCA that can be switched on for pulse height discrimination.

The Model No. 44-2 detector has a 2 x 2 in. NaI(Tl) crystal rated for the detection of gamma energy in the 60 keV to 2 MeV range.

Peak counts were collected with a threshold setting of 598 keV and a window setting adjusted to 30 keV, yielding an effective energy range of 598 to 628 keV. This region of interest was selected to assure the detection of the 609 keV gamma for ^{214}Bi, a daughter of ^{226}Ra.

The detector was clamped to a ringstand. A grooved ring was set directly above the exposed surface of the detector to allow the standards to rest horizontally in contact with the detector.

Four replicate measurements were taken of each soil standard with the instrument operating first in the gross count mode, followed by the SCA mode. Background counts were subtracted from gross counts to yield net counts. Net counts were averaged.

MEASUREMENT RESULTS

Survey meters. Figures 1 and 2 include the results of replicate measurements on standards ranging from 0 to 50 pCi/g 50 and from 50 to 250 pCi/g ^{226}Ra taken with three different sodium iodide detectors (micro-R meters). The limit of detection for this technique is approximately 30 to 35 pCi/g for a 1400-g sample. Since most NORM samples contain some ^{228}Ra (rule-of-thumb: ^{228}Ra concentration is approximately 33% of the ^{226}Ra concentration), this technique can be biased high. If one assumes that the ^{228}Ra concentration is 33% of the ^{226}Ra concentration then the bias is small considering the other unknown errors. The curves in Figs. 1 and 2 are expressed mathematically as follows.

For Fig. 1., 0 to 50 pCi/g:

$$\text{pCi/g } ^{226}\text{Ra} = -0.244 + (5.969 * \mu\text{R/hr}) \quad (1)$$

For Fig. 2, 50 to 250 pCi/g:

$$\text{pCi/g } ^{226}\text{Ra} = -30.925 + (8.406 * \mu\text{R/hr}) \quad (2)$$

SCA. Figures 3 and 4 include the results from 0 to 50 pCi/g and from 50 to 250 pCi/g. The region from 0 to 50 pCi/g is the most important concentration range. If the concentration exceeds 50 pCi/g, then one has to remediate or dispose of the NORM waste, so there is really no need to have a very precise estimate at levels above 50 pCi/g. As stated above, any ^{228}Ra will bias the results high. The curves in Figs. 3 and 4 are expressed mathematically as follows:

For Fig. 3 (0 to 50 pCi/g):

pCi/g ^{226}Ra = −1.650 + (0.076 * ct/5 min.) . . . (3)

For Fig. 4 (50 to 250 pCi/g):

pCi/g ^{226}Ra = 1.409 + (0.080 * ct/5 min.) . . . . (4)

By setting a 30 keV window from 898 to 928 keV (911 keV photopeak ^{228}Ac), a direct estimate of ^{228}Ra can be accomplished using Figs. 5 and 6 for 0 to 50 pCi/g ^{228}Ra and for 50 to 250 pCi/g ^{228}Ra, respectively. These curves were derived by rationing the concentrations; thus, the curves are identical and are split for ease of use. Figure 7 depicts the count rate per pCi/g of ^{228}Ra in the 598 to 628 keV region (609 keV photopeak ^{214}Bi). The curves in Figs. 5, 6, and 7 are expressed mathematically as follows.

For Fig. 5 (0 to 50 pCi/g):

pCi/g ^{228}Ra = ... (5)

For Fig. 6 (50 to 250 pCi/g):

pCi/g ^{228}Ra = 9.040 + (0.114 * ct/5 min) . . . . . (6)

For Fig. 7:

ct/5 min = 0.152 + 5.512 pCi/g est. ^{228}Ra . . . . . (7)

COMPUTER DERIVED ESTIMATES OF AVERAGE NORM CONCENTRATION OF BARRELED NORM

It is desirable to be able tc estimate the average ^{226}Ra concentration of NORM waste contained in barrels. It is both expensive and difficult to collect representative samples and have laboratory analyses accomplished. Figures 8, 9, 10, 11, and 12 are curves to convert survey meter readings to concentrations depending on the assumed ^{226}Ra/^{228}Ra ratio. To use these curves, one must assume some ratio of ^{226}Ra to ^{228}Ra and take readings on the bottom fourth and middle of barrel, and the top fourth and top of barrel. then average the four readings and apply the average to the appropriate curve.

For Fig. 8 (Assume 0% ^{228}Ra):

pCi/g ^{226}Ra = 0.0 + (1.300 * avg. μR/hr) . . . . . (8)

For Fig. 9 (Assume 10% ^{228}Ra):

pCi/g ^{226}Ra = 0.0 + (1.138 * avg. μR/hr) . . . . . (9)

For Fig. 10 (Assume 25% ^{228}Ra):

pCi/g ^{226}Ra = 0.0 + (0.962 * avg. μR/hr) . . . . . (10)

For Fig. 11 (Assume 33% ^{228}Ra):

$$pCi/g\ ^{226}Ra = 0.0 + (0.888 * \text{avg. } \mu R/hr) \quad (11)$$

For Fig. 12 (Assume 50% ^{228}Ra):

$$pCi/g\ ^{226}Ra = 0.0 + (0.765 * \text{avg. } \mu R/hr) \quad (12)$$

APPLICATION OF THE TECHNIQUE

Estimation of soil or other solids concentration with micro-R meter. Collect a sample by filling a one-liter Nalgene bottle. For soil samples, collect a sample of soil known to be free of NORM contamination. Note that all soil contains some radioactivity. One must subtract this background from the sample of interest. If other solids are being analyzed, a Nalgene bottle filled with something of similar density to that of the samples of interest should be used to obtain background. Sugar is a commonly used material.

Determine the microroentgen/hr reading on the background sample by placing the Nalgene bottle on its side and in contact with the micro-R meter. Position the meter so that the center of the detector is at the approximate middle of the horizontal bottle.

In a similar manner, determine the microroentgen/hr reading on the bottle containing the sample of interest.

Subtract the background reading from the reading on the sample of interest.

From Figs. 1 or 2 (or Eqs. 1 or 2), determine the ^{226}Ra concentration of the sample of interest.

Should one wish to correct for the weight of the sample in grams, adjust the result by dividing 1400 by the weight of the sample of interest.

Example:

- Background sample reads 9 μR/hr
- Sample of interest reads 21 μR/hr
- Sample of interest weighs 1570 grams
- Net reading: 21 μR/hr - 9 μR/hr = 12 μR/hr

From Fig. 2, 12 μR/hr predicts a ^{226}Ra concentration of $\approx$ 70 pCi/g .

Adjusting for weight,

$$70\ pCi/g * 1400 \div 1570 \approx 62\ pCi/g\ .$$

Using Eq. 2 yields an estimate of,

$$-30.925 + (8.06 * 12\ \mu R/hr) = 70\ pCi/g\ ^{226}Ra\ .$$

(Adjust for difference in weight as above.)

Estimation of soil or other solids for ^{226}Ra concentration with the SCA. Collect a sample by filling a one-liter Nalgene bottle. For soil samples, collect a sample of soil known to be free of NORM

contamination. Note that all soil contains some radioactivity. One must subtract this background from the sample of interest. If other solids are being analyzed, a Nalgene bottle filled with something of similar density to that of the sample of interest should be used to obtain background. Sugar is a commonly used material.

Determine the counts per five minutes on the background sample by placing the Nalgene bottle on its side in contact with the detector. Mounting the detector vertically on a laboratory ring stand with a surface to hold the Nalgene bottle in contact with the detector is a convenient method for maintaining a uniform geometry. Position the detector so that the center of the detector is at the approximate middle of the horizontal bottle.

In a similar manner determine the counts per five minutes on the bottle containing the sample of interest.

Subtract the background reading from the reading on the sample of interest.

From Figs. 3 or 4 (Eqs. 3 or 4), determine the ^{226}Ra concentration of the sample of interest.

Should one wish to correct for the weight of the sample in grams, adjust the result by dividing 1400 by the weight of the sample of interest.

Should one wish to correct for ^{228}Ra, follow the technique below for determining ^{228}Ra concentration.

After determining the ^{228}Ra concentration, refer to Fig. 7 (or Eq. 7) to obtain the count rate in the 598 to 628 keV region due to the ^{228}Ra.

Subtract the estimated count rate from the observed count rate.

From Figures 3 or 4 (Eqs. 3 or 4) determine the ^{226}Ra concentration. Adjust for weight as described above.

Example:

- Assume a ^{228}Ra concentration of 20 pCi/g
- Background ct/5 min: 129
- Sample of interest ct/5 min: 1347
- Weight of sample of interest: 1256 grams
- Net ct/5 min: 1347 − 129 = 1218

From Figure 4, 1218 counts per five minutes; determine the ^{226}Ra concentration ≈ 100 pCi/g.

Adjusting for weight,

100 pCi/g * 1400 ÷ 1256 ≈ 111 pCi/g .

If one wants to correct for ^{228}Ra content, proceed as follows.

From Figure 7 (or Eq. 7), determine the counts per five minutes in the 598 to 628 keV region due to ^{228}Ra: 20 pCi/g ≈ 110 ct/5 min.

Mathematically (Eq. 7),

0.152 + (5.512 * 20 pCi/g est. ^{228}Ra) = 110 ct/5 min .

Adjust 598 to 628 keV region,

1218 − 110 ≈ 1108 .

From Figure 4, 1118 counts per five minutes, determine the ^{226}Ra concentration ≈ 90 pCi/g.

Correct for weight as above,

90 pCi/g * 1400 ÷ 1256 ≈ 100 pCi/g .

Estimation of soil or other solids for ^{228}Ra concentration with SCA. Set SCA for the 898 to 928 keV energy region. Collect a sample by filling a one-liter Nalgene bottle.

For soil samples, collect a sample of soil known to be free of NORM contamination. Note that all soil contains some radioactivity. One must subtract this background from the sample of interest. If other solids are being analyzed, a Nalgene bottle filled with something of similar density to that of the samples of interest should be used to obtain background. Sugar is a commonly used material.

Determine the counts per five minutes on the background sample by placing the Nalgene bottle on its side in contact with the detector. Mounting the detector vertically on a laboratory ring stand with a surface to hold the Nalgene bottle in contact with the detector is a convenient method for maintaining a uniform geometry. Position the detector so that the center of the detector is at the approximate middle of the horizontal bottle.

In a similar manner determine the counts per five minutes on the bottle containing the sample of interest.

Subtract the background reading from the reading on the sample of interest.

From Figs. 5 or 6 (or Eqs. 5 or 6) determine the ^{228}Ra concentration of the sample of interest.

Should one wish to correct for the weight of the sample in grams, adjust the result by multiplying the weight of the sample of interest divided by 1400.

Example:

- Background ct/5 min: 89
- Sample of interest ct/5 min: 976
- Weight of sample of interest: 1528 grams
- Net ct/5 min: 976 − 89 = 887

From Figures 5 or 6 (or Eqs. 5 or 6), 887 counts per five minutes, determine the ^{228}Ra concentration ≈ 110 pCi/g.

Mathematically,

$$9.04 + (0.114 * \text{ct/5 min}) = 110 \text{ pCi/g } ^{228}\text{Ra} .$$

Adjusting for weight,

$$110 \text{ pCi/g} * 1400 \div 1528 \approx 101 \text{ pCi/g} .$$

Estimation of ^{226}Ra concentration in barreled waste using a micro-R meter. Take the following readings at the barrel's surface: top of barrel, one-fourth up side of barrel, one-half up side of barrel, and three-fourths up side of barrel.

Average the four readings.

Choose a ^{228}Ra percent. Note: there is no way to know what percentage to use. Choice may be based on past experience or 33% may be used.

From Figs. 8, 9, 10, 11, and 12, depending on the assumed ^{228}Ra percent, the curves are mathematically expressed as follows:

for Fig. 8 (assume 0% ^{228}Ra):

$$\text{pCi/g } ^{226}\text{Ra} = 0.0 + (1.300 * \text{avg. } \mu\text{R/hr}) ;$$

for Fig. 9 (assume 10% ^{228}Ra):

$$\text{pCi/g } ^{226}\text{Ra} = 0.0 + (1.138 * \text{avg. } \mu\text{R/hr}) ;$$

for Fig. 10 (assume 25% ^{228}Ra):

$$\text{pCi/g } ^{226}\text{Ra} = 0.0 + (0.962 * \text{avg. } \mu\text{R/hr}) ;$$

for Fig. 11 (assume 33% ^{228}Ra):

$$\text{pCi/g } ^{226}\text{Ra} = 0.0 + (0.888 * \text{avg. } \mu\text{R/hr}) ;$$

and

for Fig. 12 (assume 50% ^{228}Ra):

$$\text{pCi/g } ^{226}\text{Ra} = 0.0 + (0.765 * \text{avg. } \mu\text{R/hr}) .$$

Determine the ^{226}Ra concentration.

Example:

- Reading on top of barrel: 125 μR/hr
- Reading one-fourth up side of barrel: 110 μR/hr
- Reading one-half up side of barrel: 100 μR/hr
- Reading three-fourths up side of barrel: 135μR/hr

Average reading:

$$(125 + 110 + 100 + 135) \mu\text{R/hr} \div 4 = 118 \mu\text{R/hr} .$$

From Figs. 8, 9, 10, 11, and 12 (or Eqs. 8, 9, 10, 11,

and 12), the estimated ^{226}Ra concentrations — depending on the assumed ^{228}Ra percent — are 150, 130, 115, 105, and 90 pCi/g for ^{228}Ra percents of 0%, 10%, 25%, 33%, and 50%, respectively. Similar values mathematically derived are 153, 134, 114, 105 and 90 pCi/g ^{226}Ra.

Note of Caution

During the course of developing the above curves and equations, it was determined that there was significant variation from instrument to instrument. Hand-held micro-R meters varied by up to 25%, and SCAs varied by up to 20%. Because of this, analyst should calibrate the instruments in the manner described above rather than use the figures and curves presented. The techniques for estimation of ^{226}Ra assume that ^{222}Rn is in equilibrium with its parent (^{226}Ra) and its daughters through ^{214}Po. Any disequilibrium will result in an underestimate of ^{226}Ra. Laboratory estimates of ^{222}Rn lost from NORM samples are usually 5% or less.[1,2] Thus the possible underestimate should be small.

CONCLUSIONS:

It is possible to develop field techniques with an adequate degree of accuracy for most applications. However, no field technique has the degree of accuracy necessary to ensure meeting the regulatory levels for the release of land for uncontrolled use. Nevertheless, one could use the field technique by applying a safety factor. For example, the release criterion is at 30 pCi/g ^{226}Ra; only release land for uncontrolled use if the SCA technique yielded a ^{226}Ra estimate of less than 25 pCi/g.

ACKNOWLEDGMENTS

The authors wish to express their appreciation to Ludlum Measurements, Inc. for the loan of instrumentation used in this study.

REFERENCES

1. Hebert, M.B. and Scott, L.M.: "A Radiological Characterization of Remediated Tank Battery Sites," *Health Physics* (1994), in press.
2. Scott, L.M., Van Gent, D.L., and Hebert, M.B.: "Measurement of Radon Flux and Radon Emanation Fraction from Petroelum Production Operations," *Health Physics* (1995), under review.

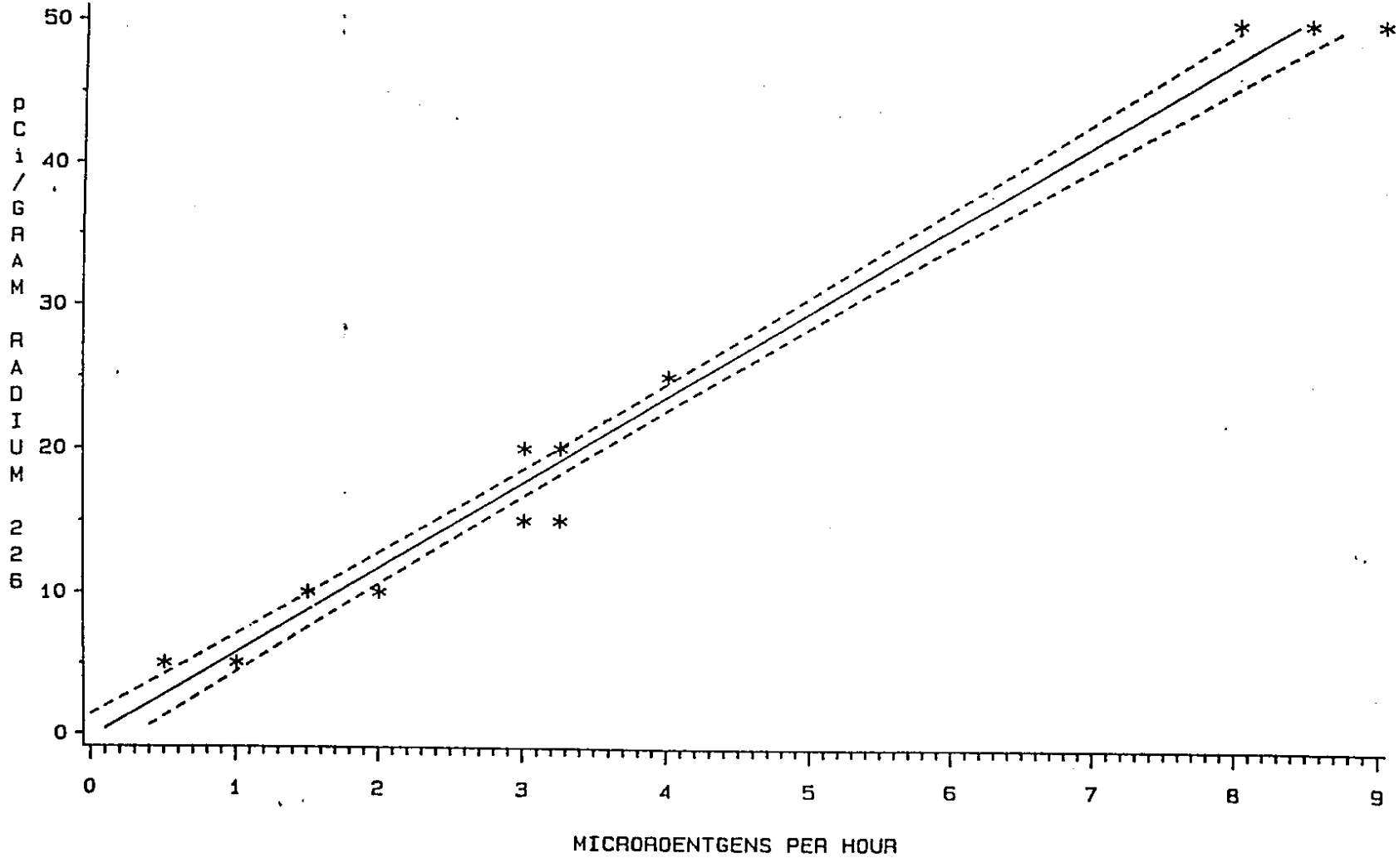


Figure 1. Ra-226 Concentration Based on Micro-R Meter Readings — Standard 1400-g Sample — 0 to 50 pCi/g

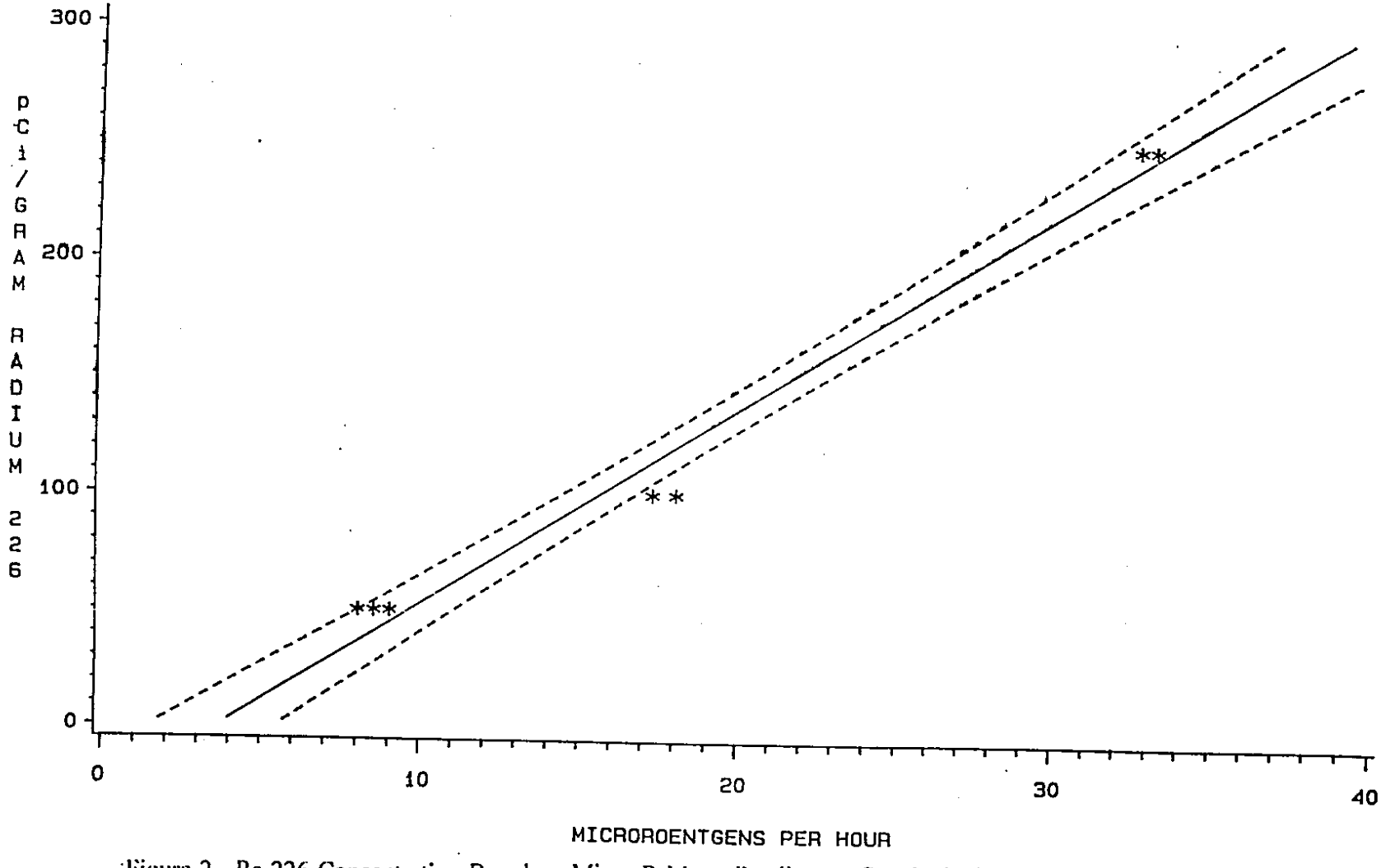


Figure 2. Ra-226 Concentration Based on Micro-R Meter Readings — Standard 1400-g Sample — 50 to 250 pCi/g

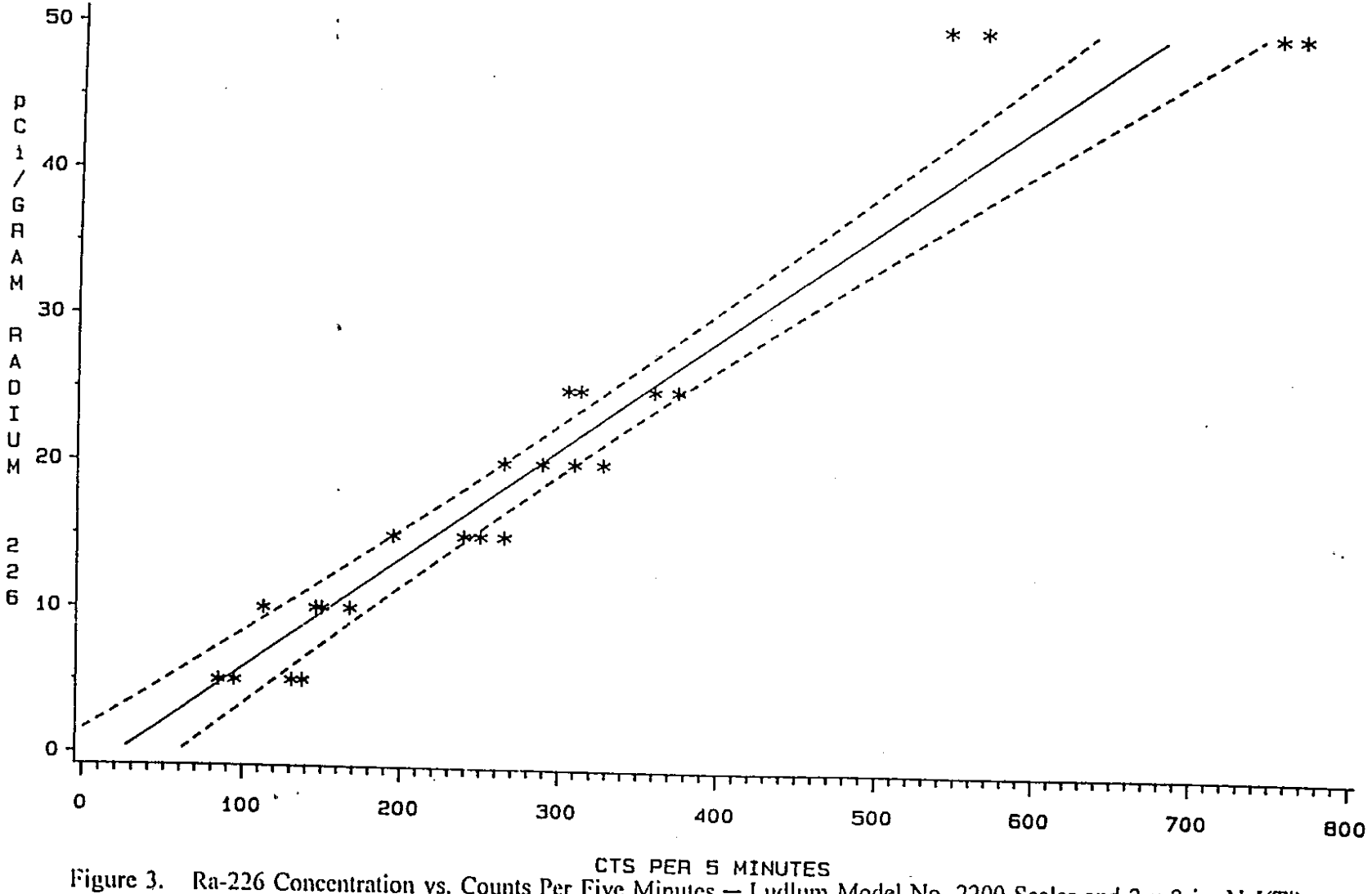


Figure 3. Ra-226 Concentration vs. Counts Per Five Minutes — Ludlum Model No. 2200 Scaler and 2 x 2 in. NaI(Tl) Detector — 0 to 50 pCi/g

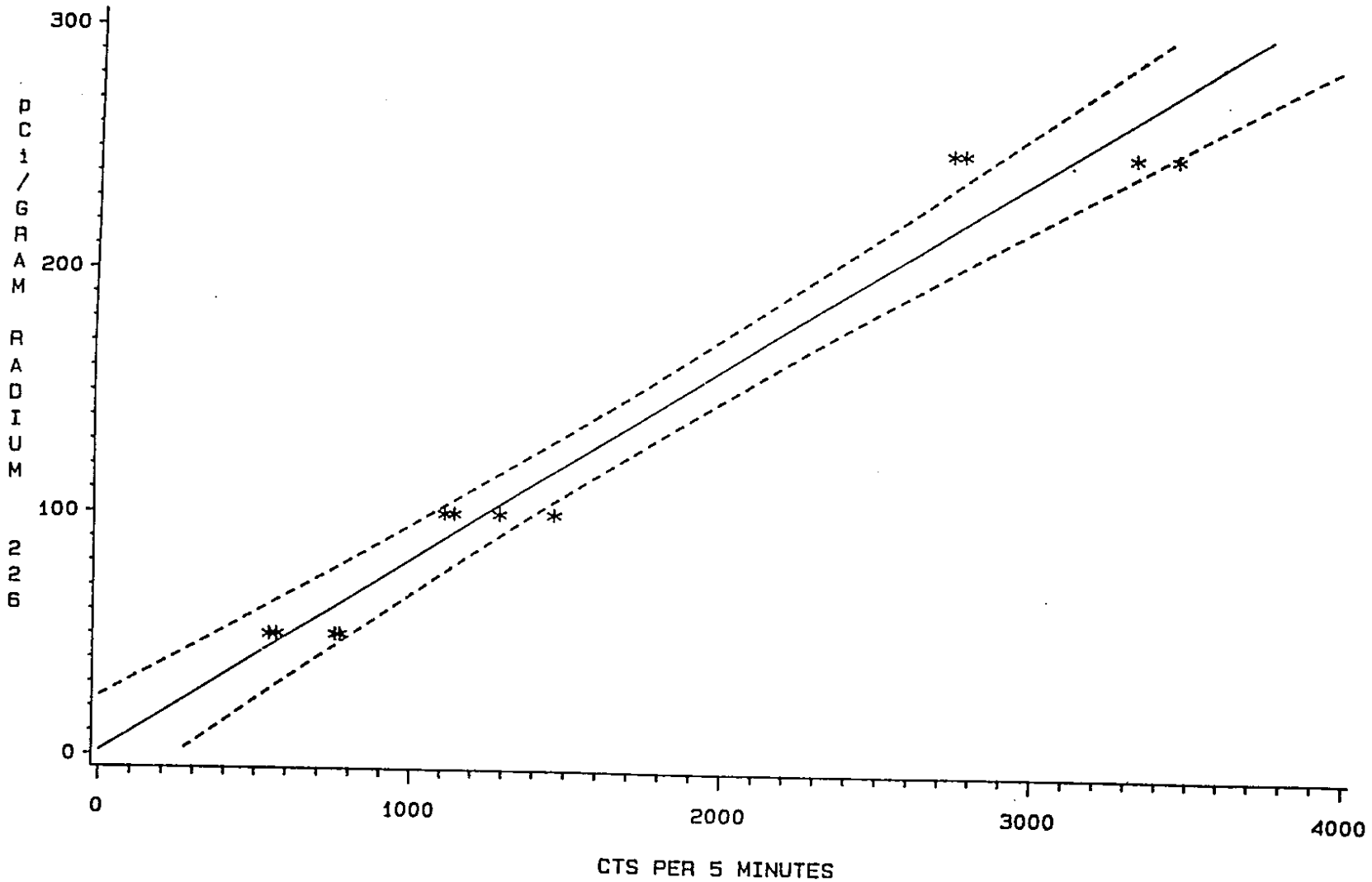


Figure 4. Ra-226 Concentration vs. Counts Per Five Minutes — Ludlum Model No. 2200 Scaler and 2 x 2 in. NaI(Tl) Detector — 50 to 250 pCi/g

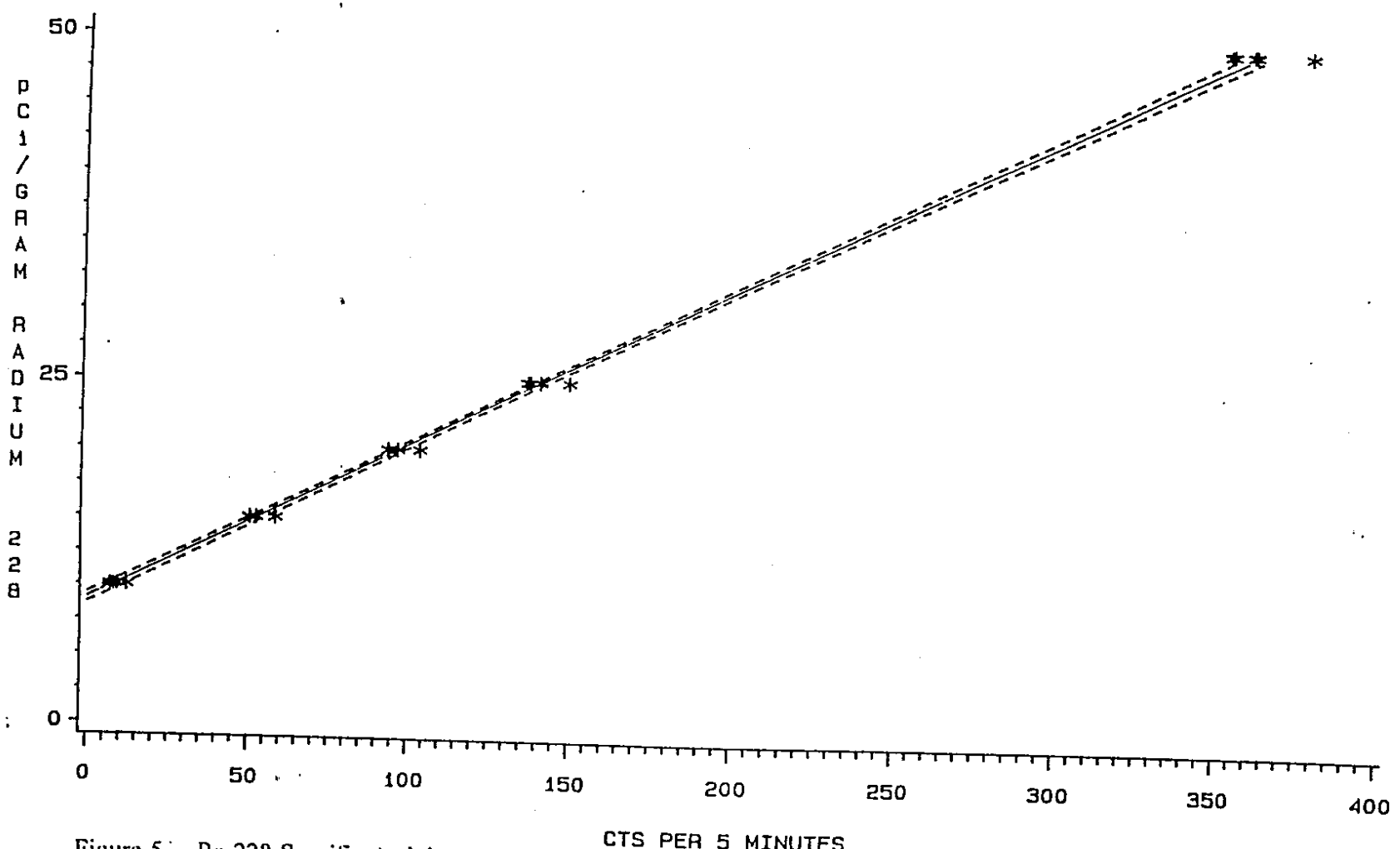


Figure 5. Ra-228 Specific Activity vs. Counts Per Five Minutes — Ludlum Model No. 2200 Scaler and 2 x 2 in. NaI(Tl) Detector — Unsupported ^{228}Ra, Standard 1400-g Sample — 0 to 50 pCi/g

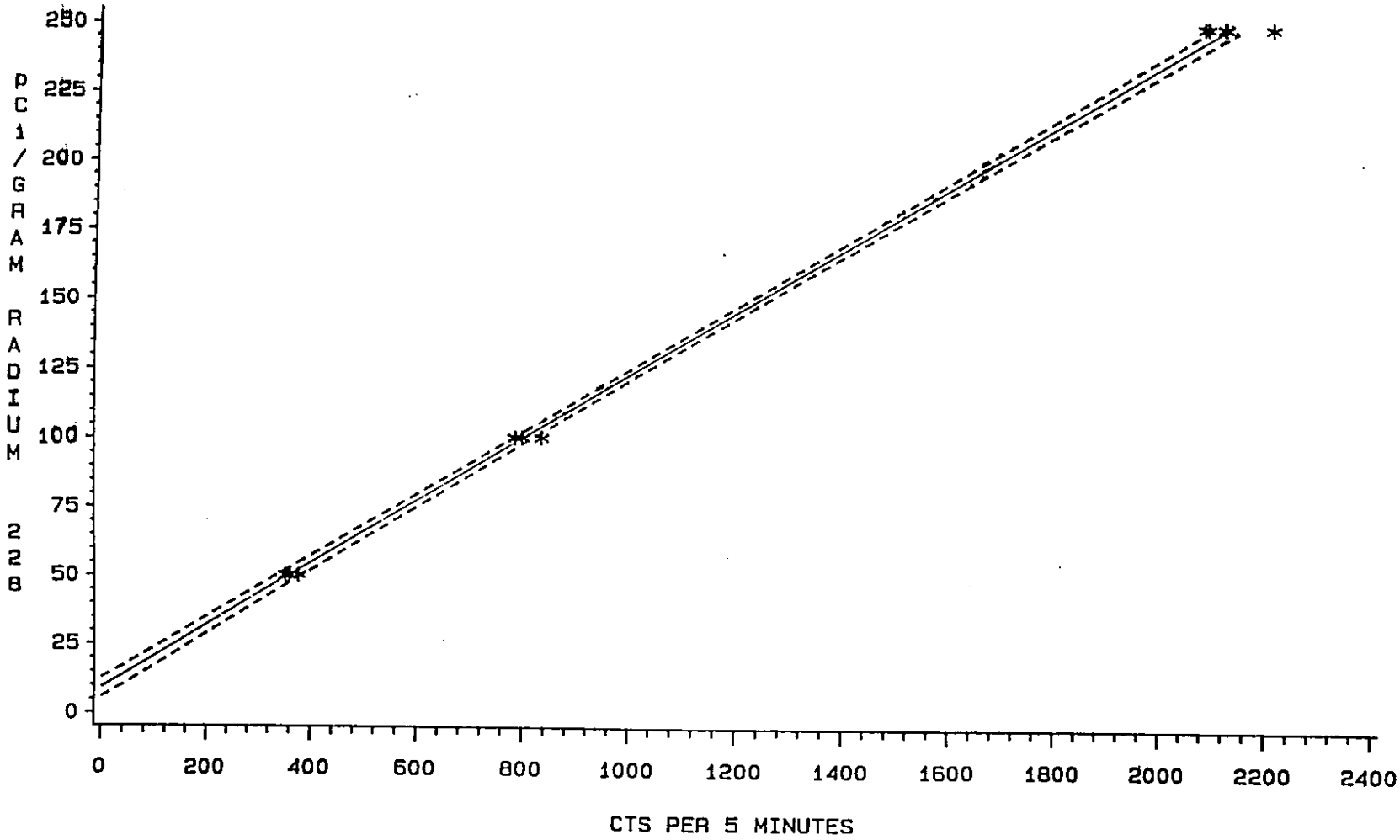


Figure 6. Ra-228 Specific Activity vs. Counts per Five Minutes — Ludlum Model No. 2200 Scaler and 2 x 2 in. NaI(Tl) Detector — Unsupported ^{228}Ra, Standard 1400-g Sample — 50 to 250 pCi/g

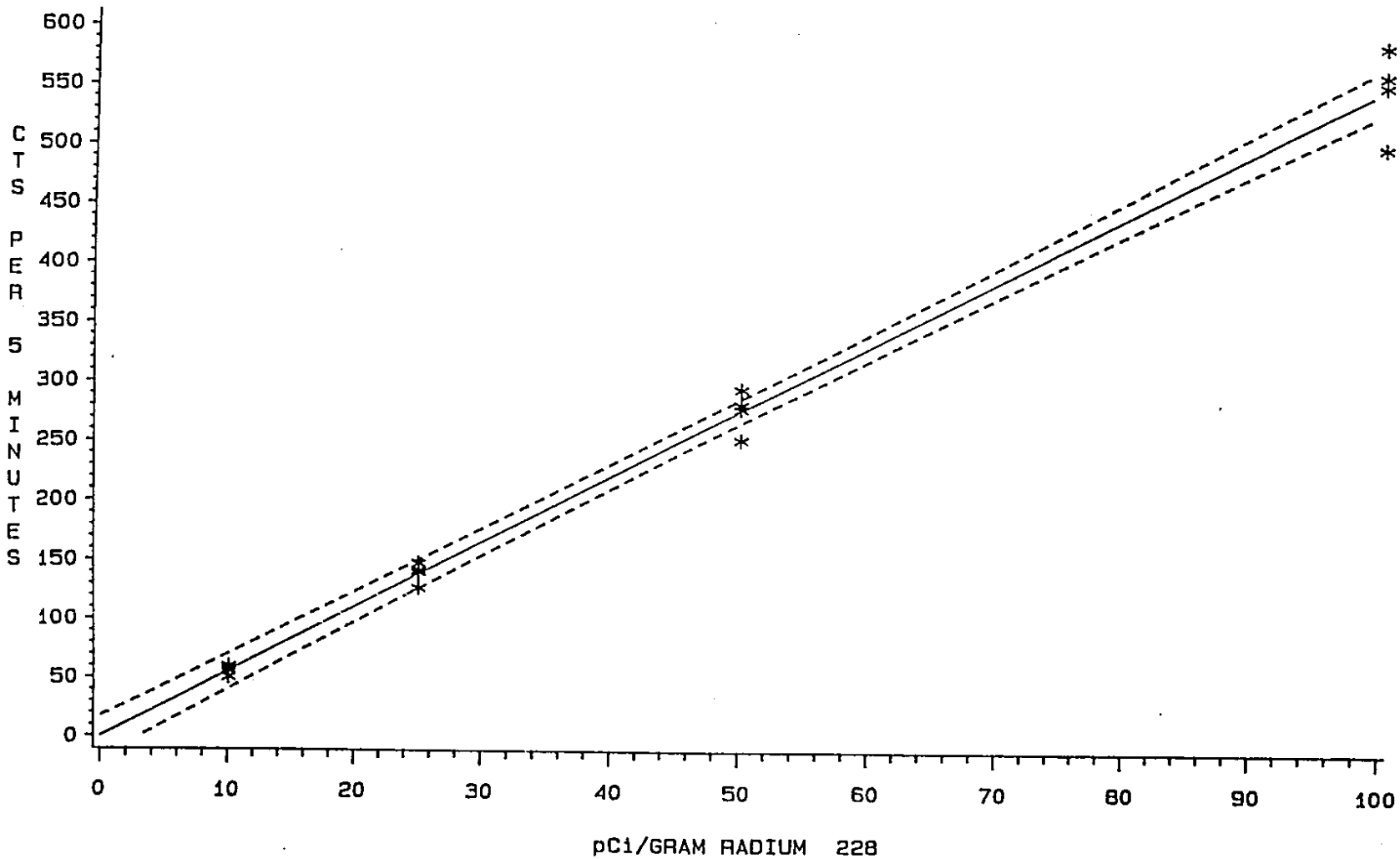


Figure 7. Counts Per Five Minutes in the 609 keV Region Attributed to ^{228}Ra — Ludlum Model No. 2200 Scaler and 2 x 2 in. NaI(Tl) Detector — Unsupported ^{228}Ra, Standard 1400-g Sample

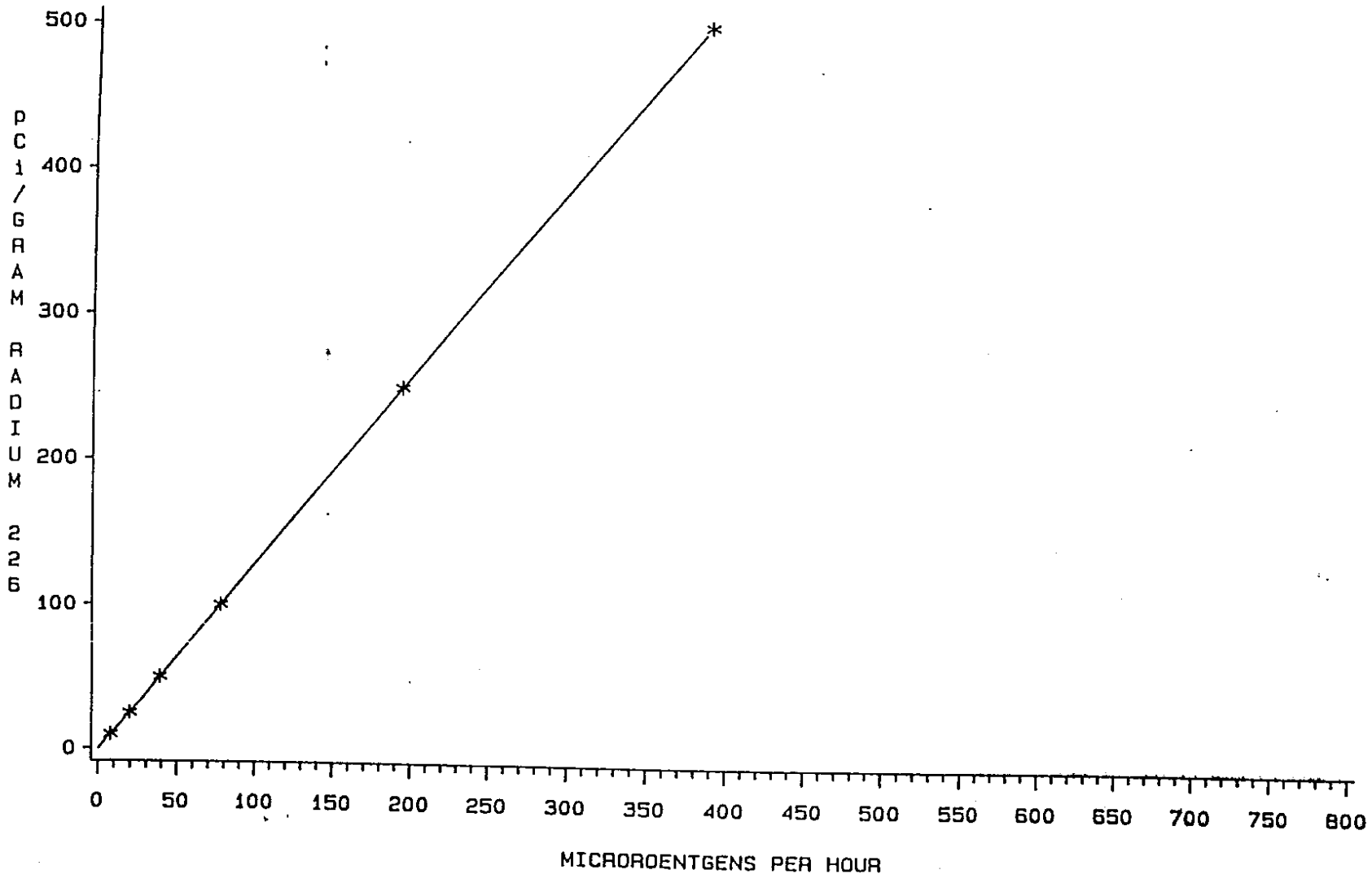


Figure 8. Ra-226 Concentration Based on Average Micro-R Meter Readings on Barrel — ^{228}Ra Concentration: 0% of ^{226}Ra Concentration

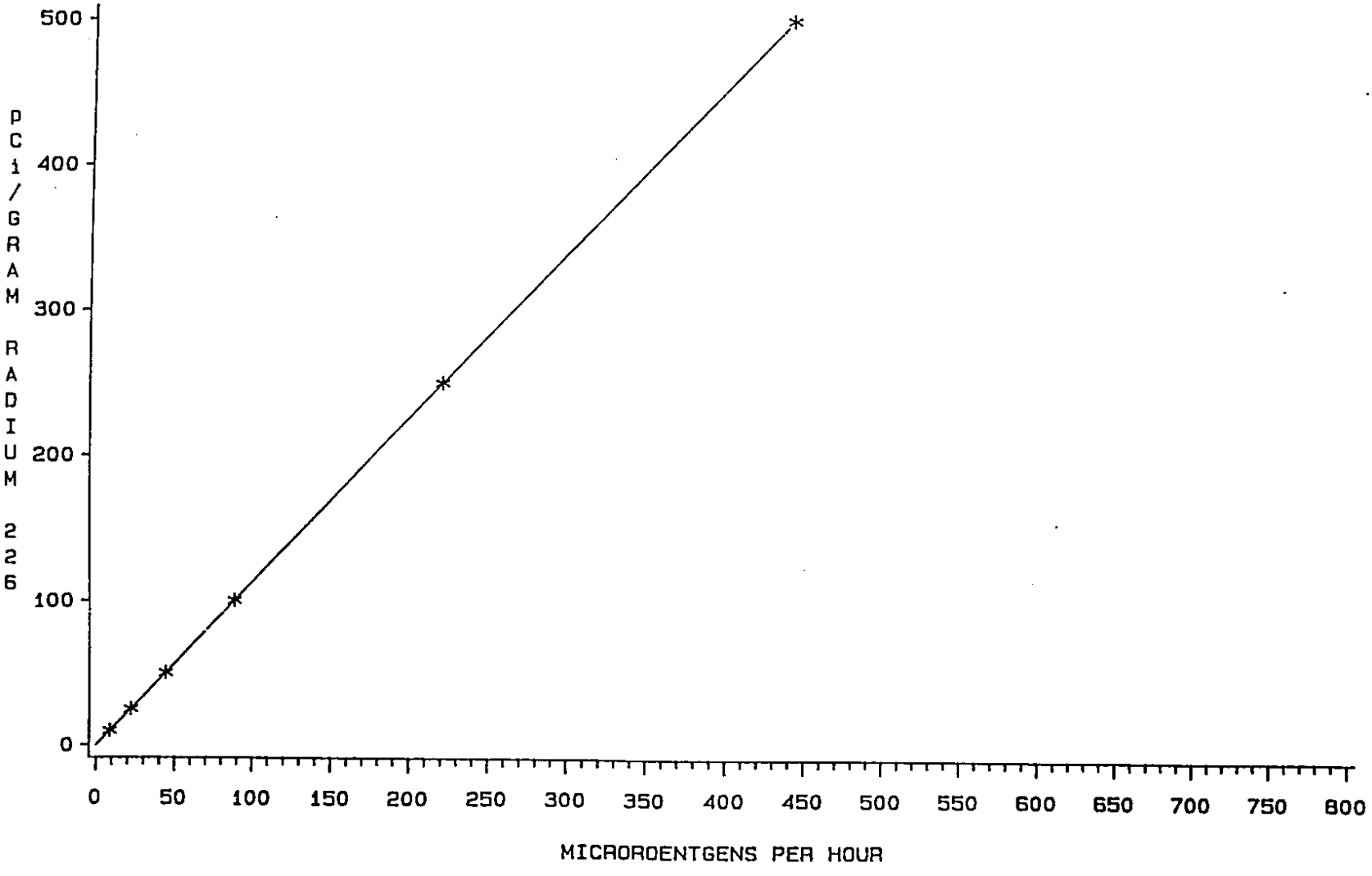


Figure 9. Ra-226 Concentration Based on Average Micro-R Meter Readings on Barrel — ^{228}Ra Concentration: 10% of ^{226}Ra Concentration

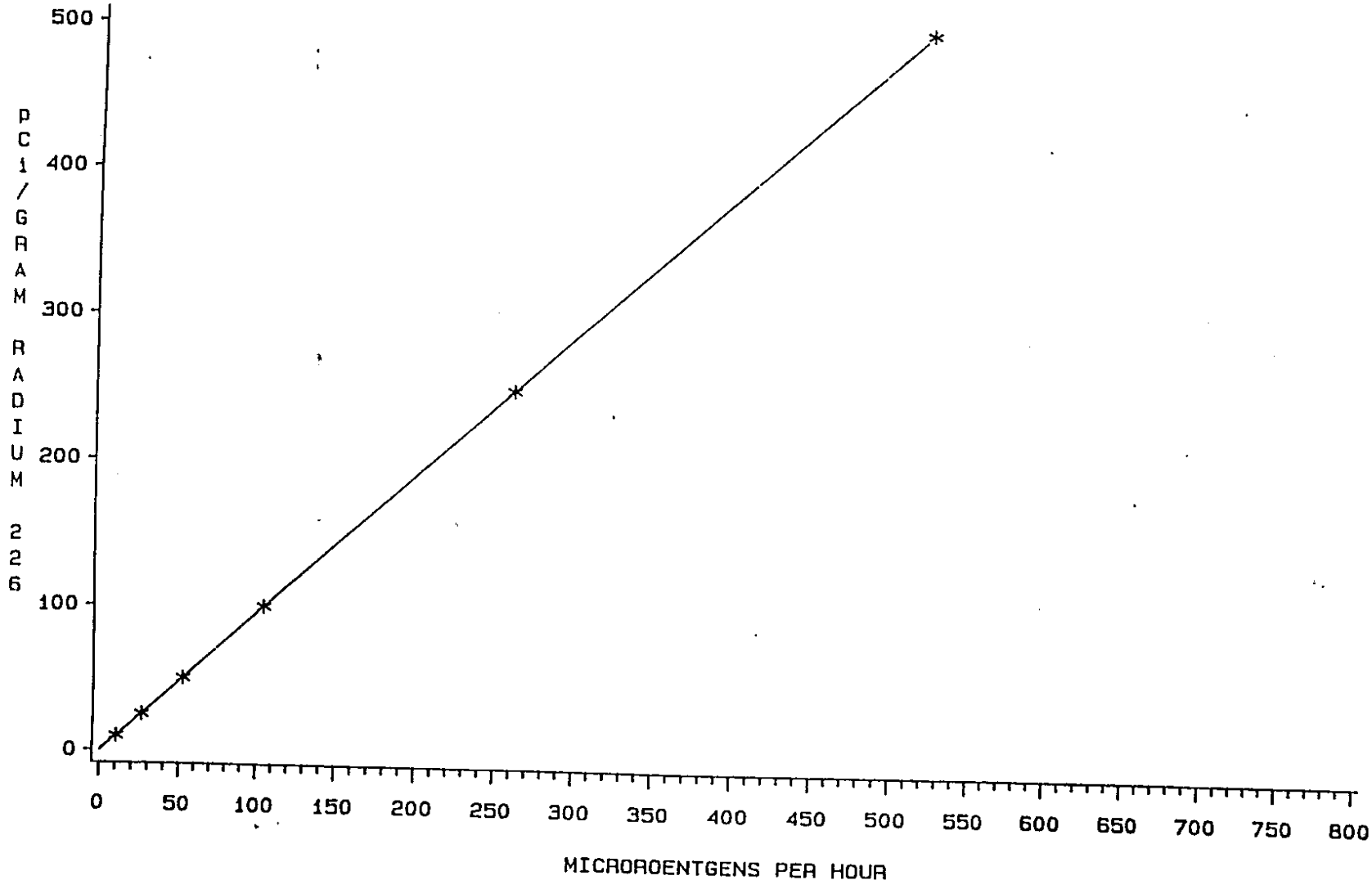


Figure 10. Ra-226 Concentration Based on Average Micro-R Meter Readings on Barrel — ^{228}Ra Concentration: 25% of ^{226}Ra Concentration

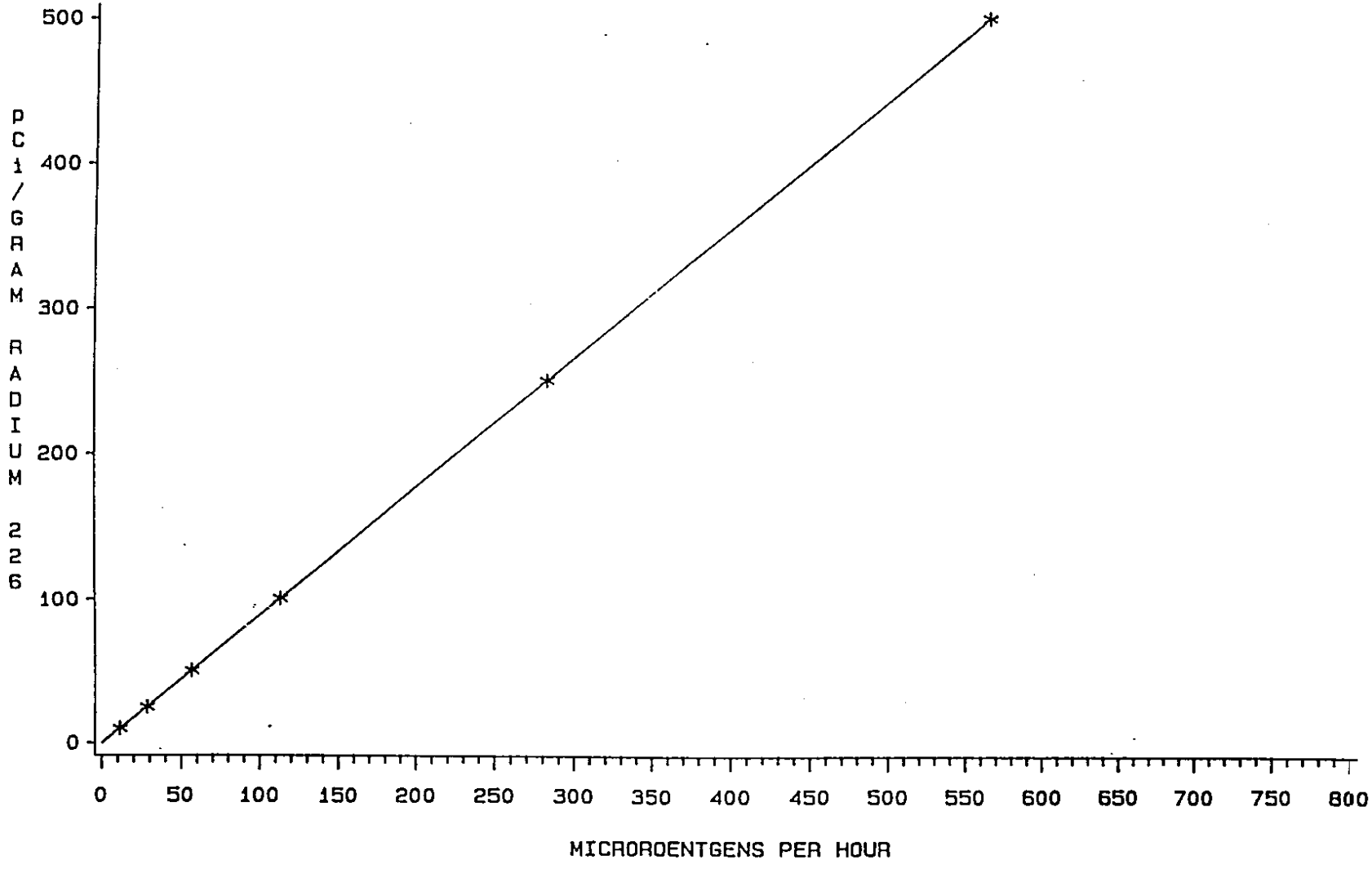


Figure 11. Ra-226 Concentration Based on Average Micro-R Meter Readings on Barrel — ^{228}Ra Concentration: 33% of ^{226}Ra Concentration

ATTACHMENT #5

UIC-30

WORK PERMIT to Plug and Abandon a Well Utilized for NORM Disposal

Office of Conservation
Injection and Mining Division

Work Permit No._____

Well Serial No._____ Well Name & No._____

Approximate Date Work To Begin (MM-DD-YY)_____ Parish_____

Field _____ Sec._____ Twn._____ Rge._____

Operator_____ Code _____ Phone ( )_____

Address_____

Condition of Well _____

Perforated Interval(s) _____ Total Depth_____

EXISTING CASING PROGRAM				PROPOSED CEMENT PLUGS *			
CASING SIZE	HOLE SIZE	DEPTH SET	SACKS OF CEMENT	DEPTH OF PLUGS FROM	DEPTH OF PLUGS TO	#SACKS CEMENT	HOW PLACED?

* Provide schematic diagram of well on back of this form.

Depth to Base of Lowermost USDW: _____ (10,000 ppm TDS) Source _____

Proposed Cast Iron Bridge Plug Setting Depth:_____

Proposed Mud-Laden Fluid: _____ ppg Viscosity _____ cp

POINT OF ORIGIN OF NORM (solids/tubing/casing/equipment): _____

(please mark applicable boxes below)

☐ NORM SOLIDS: Total Volume: _____ BBLS Total Radium Activity: _____ picocuries (pCi)

NORM SOLIDS PLACEMENT METHOD: ☐ SLURRY ☐ ENCAPSULATION IN: ☐ TUBING ☐ CASING ☐ OTHER

☐ NORM CONTAMINATED: ☐ TUBING ☐ CASING ☐ EQUIPMENT

Total Footage of Tubing/Casing: _____ feet Maximum Level _____ microR/hr Average Level _____ microR/hr

Depth(s) of NORM Solids/Tubing/Casing/Equipment Placement: From _____' To _____' / From _____' To _____'

From _____' To _____' / From _____' To _____'

Remarks:_____

Permit Requested By_____ / _____ Date _____

Typed Signature

FOR CONSERVATION USE ONLY!

Permit Approved By _____ Date _____

Permit Denied By _____ Date _____

Reason Denied:_____

Well SN: _____

NORM CHECK LIST
Form UIC-30

____1. Is well information correct, & is the signature original?

____2. Is there a before & after well sketch?

____3. If casing is to be removed, will it expose any open hole?

____4. Is the shoe of the surface casing at least 100 feet below the USDW?

____5. Will each set of production perforations be plugged with a 100 foot cement plug (minimum)?
____ If a Cast Iron Bull Plug (CIBP) is to be used, will there be 10 feet of cement on top of the CIBP?

____6. Will the bottom plug be tagged and the casing and botoom plug be tested to 1000 psig for 30 minutes with less than 100 psi loss?

____7. Will the top of the NORM plug and/or NORM tubing be deeper than 100 feet below the shoe of the surface casing?

____8. Will the CIBP above the NORM plug be placed at least 50 feet below the shoe of the surface casing?

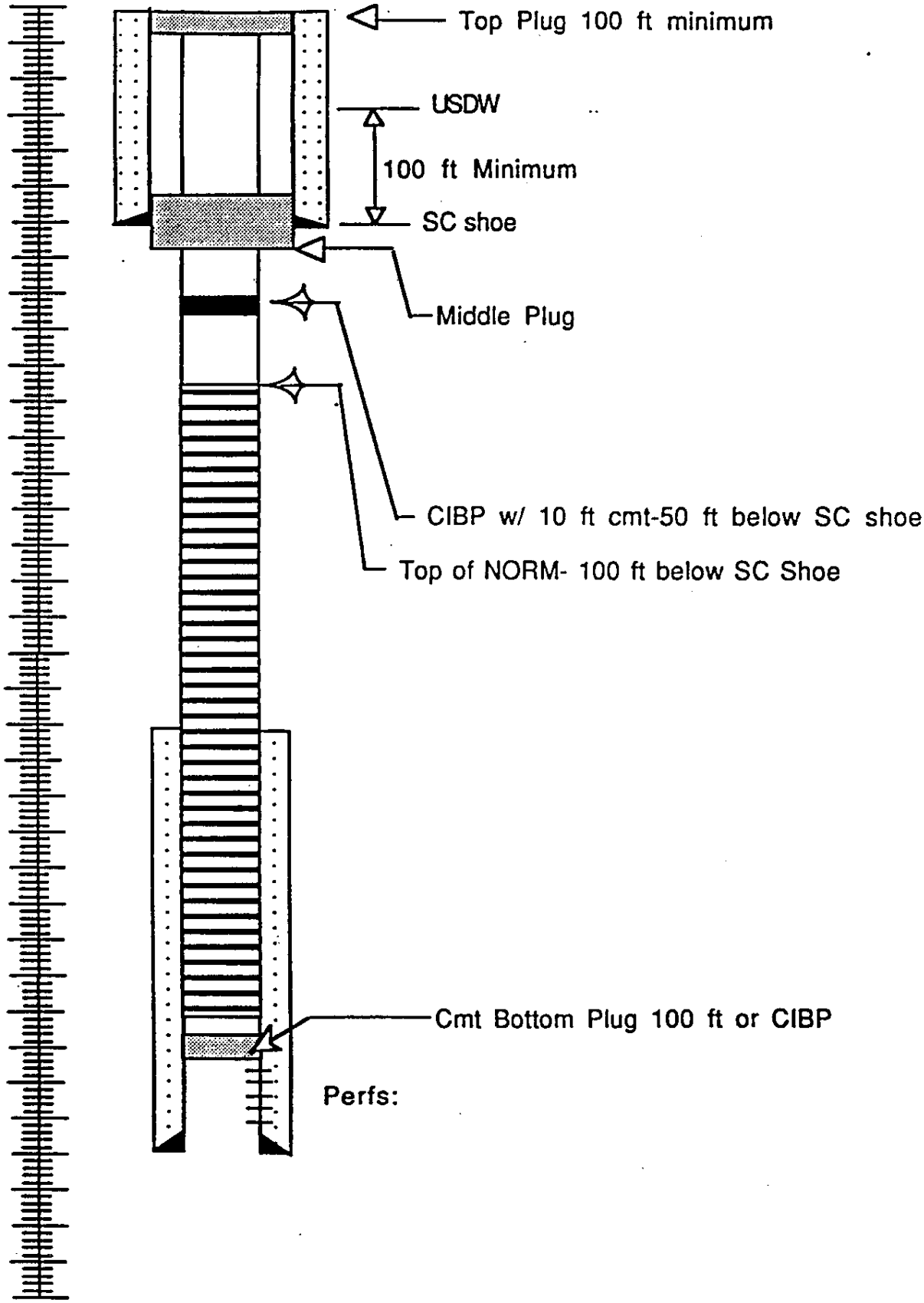
____9. Will the middle cement plug in the production/surface casing annulus and inside the production casing be 100 feet or greater and be 50/50 with the surface casing shoe?
____ If cement can not be circulated, will the production casing/surface casing annulus be squeezed and a 100 foot cement plug be placed on top of the CIBP?
____ If the annulus can not be squeezed, will a 200 feet of cement be placed on top of the CIBP?

____10. Will the middle plug be tested to 1000 psig for 30 minutes with less than 100 psi loss?

____11. Will the fluid between the cement plugs be 9 ppg+?

____12. Will the top plug be 100 feet or greater?

____13. Will the casing be cut 2 feet below ground level or 10 feet below the mud line?



NORM P&A Example

Department of Natural Resources
Office of Conservation
Injection and Mining Division

NORM Disposal Guidelines
Plugging and Abandonment Procedures

Application to plug and abandon any well under the jurisdiction of the Office of Conservation which is to be utilized for downhole disposal of NORM solids and/or NORM contaminated tubing, shall be made on Form UIC-30, **Work Permit to Plug and Abandon a Well Utilized for NORM Disposal**. Form UIC-30 is to be submitted to the Injection and Mining Division, P. O. Box 94275, Baton Rouge, Louisiana 70804-9275 for review.

The Department of Environmental Quality (DEQ), Office of Air Quality and Radiation Protection (OAQRP), will be sent a copy of Form UIC-30 upon approval of the application. If approved, a copy of Form UIC-30 must be attached to the application to DEQ to perform jobsite (NORM disposal) activities.

The following procedures shall be utilized by oil and gas operators for the disposal of NORM contaminated tubing and/or NORM solids into a well that is to be plugged and abandoned:

a. Cement plugs, in addition to those specified in the following procedure, shall be placed in the well to contain high pressure sands, freshwater sands, and as may be required by the Office of Conservation.

b. A bottom cement plug of at least one hundred (100) feet in length shall be placed immediately above the uppermost perforated interval in the well. In multiple completed wellbores, sufficient cement shall be used to adequately isolate each perforated pool, one from the other. A cast iron bridge plug with a minimum of ten (10) feet of cement on top is acceptable in lieu of the one hundred (100) foot cement plug.

c. The bottom cement plug shall be tagged and both the cement plug and production casing pressure tested to one thousand (1000) psig for thirty (30) minutes for integrity. More than 100 psi pressure loss in thirty (30) minutes constitutes loss of integrity. If loss of integrity cannot be corrected, the well is not a candidate for disposal of NORM contaminated tubing and/or NORM solids.

d. Once mechanical integrity of the bottom cement plug and production casing is established, NORM contaminated tubing and/or NORM solids may be placed in the well. NORM solids shall be placed by the circulation method and spotted beginning at the top of the bottom casing plug. NORM solids may be placed as per above with NORM contaminated tubing, which may then be left in the well. NORM contaminated tubing shall be placed in the well so as not to disturb the integrity of the cement plug.

e. NORM contaminated tubing and/or NORM solids shall be placed inside the production casing at a depth deeper than one hundred (100) feet below the

surface casing shoe. A cast iron bridge plug shall then be placed at least fifty (50) feet below the base of the surface casing shoe.

f. A cement plug of at least one hundred (100) feet in length shall be placed in the production/surface casing annulus and inside the production casing so that cement shall extend at least fifty (50) feet below the surface casing shoe. This cement shall be placed by pumping down the annulus using a calculated displacement. In the event that cement cannot be pumped down the annulus, the cement shall be placed by perforating the production casing at least fifty (50) feet below the surface casing shoe and circulating, if possible or if not, by squeezing the outer cement plug into the annulus. A cement plug of at least one hundred (100) feet in length shall then be placed in the production casing above the bridge plug. The production casing cement plug shall be tagged and pressure tested to one thousand (1000) psig for thirty (30) minutes. In the event that cement cannot be circulated or squeezed into the annulus, a cement plug of at least two hundred (200) feet in length shall be placed immediately above the cast iron bridge plug in the production casing. The production casing cement plug shall be tagged and pressure tested to one thousand (1000) psig for thirty (30) minutes for integrity (more than 100 psi pressure loss in thirty (30) minutes constitutes loss of integrity).

g. A top cement plug of at least one hundred (100) feet in length shall be placed at the top of the well in the production/surface casing annulus and inside the production casing.

h. General Requirements:

i. Mud-laden fluid between cement plugs shall be of a density of at least nine (9.0) pounds per gallon.

ii. NORM contaminated tubing and/or NORM solids shall not be placed in any well where production casing has been retrieved or in any open hole. NORM contaminated tubing and/or NORM solids shall not be disposed of in any wells where the bottom cement plug or casing fails the pressure integrity test. NORM contaminated tubing and/or solids shall not be placed in any well in which the surface casing is not set at least one hundred (100) feet below the base of the lowermost USDW.

iii. Well casing(s) shall be cut a minimum of two (2) feet below plow depth on all land locations and a minimum of ten (10) feet below the mud line on all water locations. Explosives shall not be used to remove the casing(s)/wellhead.

iv. NORM contaminated solids shall not be mixed with any cement slurry that is to be used as a plug.

v. Except where otherwise provided in this procedure all cement plugs shall be placed by the circulation method and hydrostatically balanced. The well must be in a static condition at the time cement plugs are placed in the well.

ATTACHMENT #6

STATE OF LOUISIANA
DEPARTMENT OF ENVIRONMENTAL QUALITY
RADIATION PROTECTION DIVISION
P.O. BOX 82135
BATON ROUGE, LOUISIANA 70884–2135

REQUEST FOR DISPOSAL IN A P/A WELL

OPERATOR OF RECORD

NAME:_____ GENERAL LICENSE #:_____

ADDRESS:_____ CITY:_____

STATE:_____ ZIP CODE:_____ PHONE ( ):_____

CONTACT PERSON (include title):_____

SIGNATURE OF REQUESTER:_____ DATE REQUESTED:_____

DISPOSAL MATERIAL/WASTE INFORMATION

CONTAMINATED TUBING:_____ft. _____ diameter AVERAGE EXPOSURE RATE:_____microR/hr

NORM SOLIDS (including encapsulated solids):_____total grams TOTAL RADIUM ACTIVITY OF SOLIDS:_____ picocuries (pCi)
(volume (grams) x average activity (pCi/grams) = pCi)

GENERATING FIELD(S) AND/OR LOCATION(S):_____

P/A WELL INFORMATION

WELL NAME & NO.:_____ SERIAL NUMBER:_____

FIELD NAME:_____ PARISH:_____

DESCRIBE SITE SPECIFIC ACTIVITIES:_____

_____

_____

DIRECTIONS TO JOB–SITE:_____

_____

LOCAL ORDINANCES OR PERMITS REQUIRED?:_____ IF SO, HAVE THEY BEEN OBTAINED?:_____

LIST:_____

LANDOWNER NOTIFIED?:_____ YES _____ NO PROJECTED DATE WORK BEGINS:_____

NORM SPECIFIC LICENSED CONTRACTOR:_____ LICENSE #_____
(as required by the Division)

CONTRACTOR &/OR OPERATOR NORM SITE SUPERVISOR:_____

OFFICE USE ONLY!

REVIEWER:_____ UIC–30 PERMIT #:_____/DATE ISSUED:_____

NOTE: This form is to completed by general licensees to obtain authorization to have NORM waste or contaminated equipment placed into a P/A well. Authorization is granted by a prepared letter signed by the assistant secretary of the Office of Air Quality and Radiation Protection. RPD–34 (R ; 4/95)

ATTACHMENT #7

INFORMATION TO BE INCLUDED WITH REQUEST FOR RELEASE

1. Letter from company specifically requesting release from general license for location

2. General License Information
   a. address
   b. contact person
   c. phone number
   d. general license number, (i.e., LA-1234-N01)

3. Type of contamination, (i.e., soil, piping, heater treater, etc.)

4. Location of remediation or decontamination activities
   a. on site – include copy(ies) of Form RPD-35 Temporary Jobsite Notification indicating the specific licensee(s) that performed the work
   b. off site – indicate the specific licensee/facility and include manifest records indicating transfer

5. Facility ID Number

6. Facility Name

7. Facility Location
   a. address
   b. phone number
   c. directions to location (indicate GPS coordinates for well site or most prominent accessible landmark within area requested for release)
   d. parish
   e. description of site: size, structures, terrain (wooded, water, residential, etc.)

8. Contact person (with phone number) for facility to be released

9. Copy of closeout survey, sample results performed after cleanup, and qualifications of person who performed survey

10. Records indicating the whereabouts and status of NORM waste and/or contaminated equipment transferred from the site including manifest records to specifically licensed treatment, decontamination, storage, or disposal facilities

11. Duplicate of survey plot without radiation readings

12. Mail requests & information to: Louisiana Department of Environmental Quality
    Permits Division-Registrations and Certifications Section
    P. O. Box 82135
    Baton Rouge, LA 70884-2135

** NOTE** The Department does not consider a Plugged and Abandoned report as confirmation or verification that the previously reported NORM contamination has been removed.

ATTACHMENT #8

Department of Environmental Quality
Permits Division
Registrations & Certifications Section
P.O. Box 82135
Baton Rouge, LA 70884-2135
Phone: (225) 765-0143 Fax: (225) 765-0220

(For Office Use Only)
FORM
Date Received: _____
Date Scanned: _____
User Group: _Radiation_____
AI#: _____

PLEASE PRINT OR TYPE

This form usually consists of 6 carbon copy pages. Make copies as needed.

NORM WASTE MANIFEST	1. Page 1 of ____	2. Generator's/Shipper's **NORM** Facility ID#	3. Generator's Lic.# or Shipper's Lic.#

4. Generator's or Shipper's* name and Mailing Address (Check as apply) { Generator { Shipper

5. Phone ( )

6. Transporter #1 Company Name 7. Phone ( )	8. Transporter #1's ICC #
9. Transporter #2 Company Name 10. Phone ( )	11. Transporter #2's ICC #
12. Designated Commercial Facility Name (Check as apply) { Disposal { Storage { Decontamination 13. Phone ( )	14. Facility's Specific License # or LDEQ Agency Interest #

If the designated facility is not a commercial facility, complete items 15 & 16 (Check as apply) { Disposal { Storage { Decontamination

15. Facility name (if applicable) and location:

16. Phone ( )

17. Description of NORM waste (e.g., scale, soil, sludge) or contaminated equipment (e.g., heater treater, tubulars) NORM>2000 picoCuries per gram must have US DOT description	18. MicroR/ hr Reading	19. Activity concentration pCi/gm	20. Container No.	21. Type	22. Total Quantity	23. Unit Wt/Vol
a.						
b.						
c.						

24. Special Handling Instructions and Additional Information

25. Generator's certifications: I herby declare that the contents of this consignment are fully and accurately described above by proper shipping name and are classified, packed, marked, and labeled, and are in all respects in proper condition for transport by highway according to applicable international and national government regulations.

Generator's Printed Name	Signature	Date
Shipper's Printed Name	Signature	Date

26. Transporter 1 Acknowledgement of Receipt of NORM

Printed Name	Signature	Date

27. Transporter 2 Acknowledgement of Receipt of NORM

Printed Name	Signature	Date

28. Designated Facility Owner or Operator: Certification of Receipt of NORM

Printed Name	Signature	Date

IF SPILLED IN LOUISIANA CALL THE REGISTRATIONS & CERTIFICATIONS SECTION AT (225) 765-0143
{AFTER HOURS EMERGENCY # (225) 765-0160}

*NOTE: Shipper denotes a decontamination or treatment facility.

ATTACHMENT #9

NONHAZARDOUS OILFIELD WASTE SHIPPING CONTROL TICKET

UIC - 28

STATE OF LOUISIANA
OFFICE OF CONSERVATION
P.O. BOX 94275
BATON ROUGE, LA 70804-9275

Manifest No. 1126952

CONSERVATION COPY
ORIGINAL

PART I TO BE COMPLETED BY GENERATOR

CODES

Generator

Address

Telephone No.

City/State/Zip

ORIGINATION OF WASTE (see instructions on back)

Well Name & No. / Description

LUW Type Field

WASTE IDENTIFICATION AND AMOUNT (IN 42 GALLON BARRELS)

01 Salt Water	07 Prod. Sands/Solids	13 BS & W Waste
02 Oil Base Mud	08 Fresh Water	14 Pipeline Test Water
03 Water Base Mud	09 Rainwater	15 Com. Facility Waste
04 Completion Fluids	10 Washout Water	16 Oil Spill Waste
05 Prod. Pit Sludges	11 Washout Pit Water	50 Salvage Crude Oil
06 Prod. Tank Sludges	12 Gas Plant Waste	99 Other

DESTINATION OF WASTE

SITE CODE

Commercial Facility (Company) Name

Site Name

CERTIFICATION: The waste described above was consigned to the carrier named below. I certify that the foregoing is true and correct to the best of my knowledge.

Signature of Generator's Authorized Agent

☐ am ☐ pm

Date and Time of Shipment

PART II: TO BE COMPLETED BY TRANSPORTER IN PRESENCE OF GENERATOR

PSC PERMIT

Transporter

Telephone No.

Address

Truck License No.

City/State/Zip

Trailer License No.

If transported by barge, barge and tug identification

Barge and Tug Id.

CERTIFICATION: I certify that the waste in quantity above was received by me for shipment to the above destination.

Signature of Transporter's Agent

☐ am ☐ pm

Date and Time Received

PART III: TO BE COMPLETED BY COMMERCIAL FACILITY

SITE CODE

Facility (Company) Name

Site Name

CHEMICAL ANALYSES

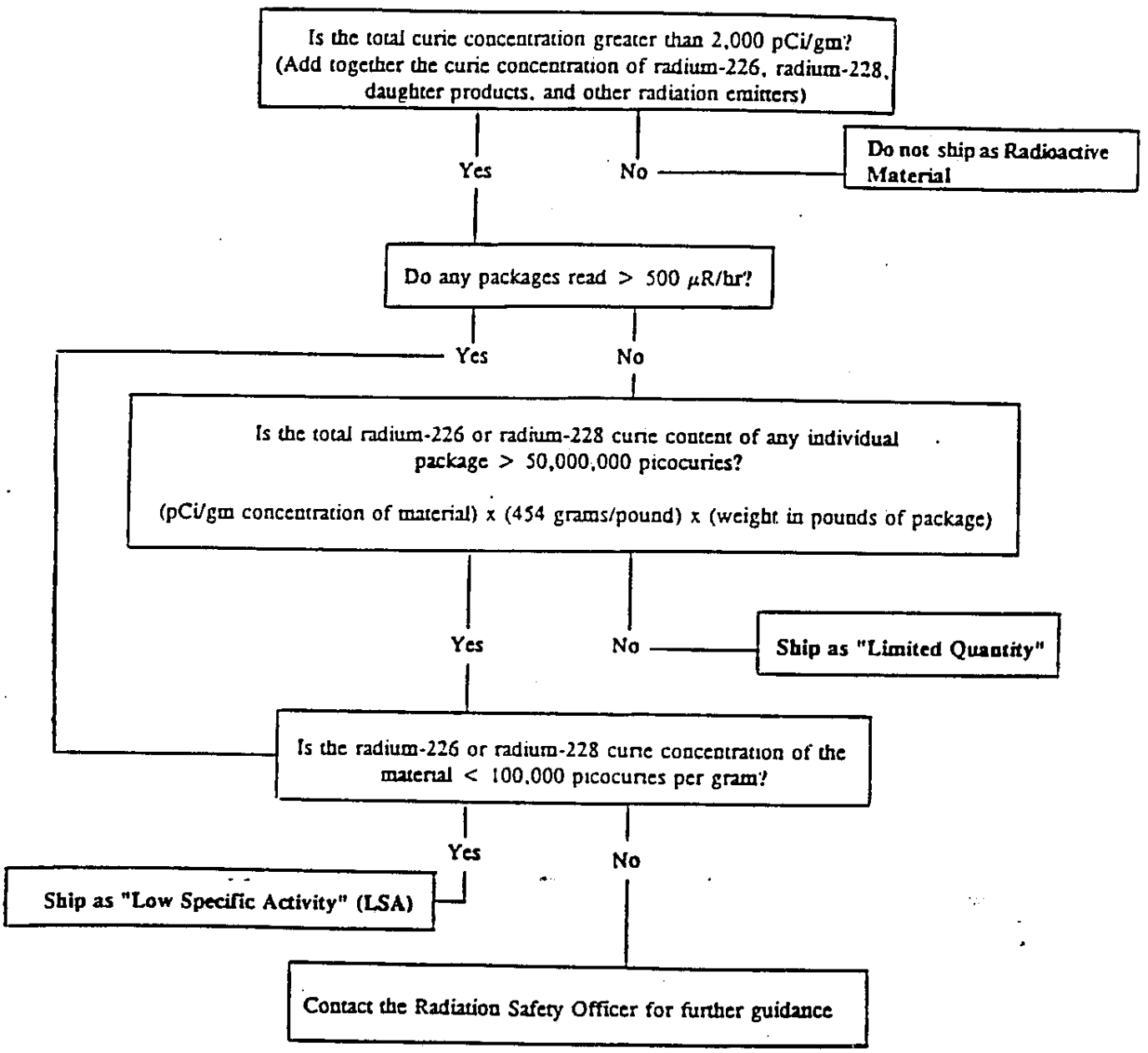
Chloride (Mg/l)	Conductivity (mmhos/cm)	pH

CERTIFICATION: I certify that the waste described in Part I was received by me via the transporter described in Part II.

☐ am ☐ pm

ATTACHMENT #10

NORM SHIPPING CATEGORY DECISION FLOW CHART



LIMITED QUANTITY SHIPMENTS
GENERAL REQUIREMENTS
49CFR173.421

Basic Description:
Radioactive Material, excepted package - limited quantity; UN2910.

1. Maximum Allowed Activity Level:
The total activity of radium-226 or radium-228 shipped shall not exceed 50,000,000 picocuries per individual package contained in the shipment. [49CFR173.423, Table 7, Material package limit column]. The following equation may be used to calculated the total radium-226 or radium-228 activity:

(pCi/gm radium-226 or 228 concentration) x (454 grams/pound) x (weight in pounds of package being shipped)

> **Note:** 50,000,000 picocuries radium-226 or radium-228 activity can be exceeded by shipping a package weighing 3,671 pounds, contaminated at 30 pCi/gm radium-226 or radium-228, or by shipping a package weighing 22,026 pounds, contaminated at 5 pCi/gm radium-226 or radium-228.

2. Maximum Allowed Radiation Levels:
Radiation levels on the external surfaces packages shall not exceed 500 µR/hr [49CFR173.421.b].

3. Package Requirements:
A strong tight container must be used [49CFR173.421.a].

4. Shipping Label Requirements
Packages shipped as Limited Quantity are exempt from D.O.T. shipping label requirements [49CFR173.421]. **Note:** Containers of NORM still need to be labeled in accordance with the Louisiana Administrative Code, Title 33, Part XV, Chapter 4, Article 453.

5. Package Marking Requirements:
The outside of the inner packaging, or if there is no inner packaging, the outside of the packaging itself, must bear the word "Radioactive" [49CFR173.421.d].

6. Special Restrictions of the Package:
The package can not contain more than 15 grams of uranium-235.

7. Vehicle Placard Requirements
Vehicle placards are not required for Limited Quantity shipments [49CFR172.500.3].

8. Special Communication Requirements:

The following statement must be contained in or on the package, with the packing list, or otherwise forwarded with the package: "This package conforms to the conditions and limitations specified in 49CFR173.421 for radioactive material, excepted package - limited quantity of material, UN2910". [49CFR173.421-1.a].

9. Maximum Allowed Contamination Levels:
The maximum contamination levels on the external surfaces of the packages shall not exceed:
[49CFR173.433.a, Table 11].

Alpha	220 dpm/100cm^2
Beta/Gamma	2,200 dpm/100cm^2

LSA SHIPMENTS, EXCLUSIVE USE VEHICLES GENERAL REQUIREMENTS

49CFR173.425

Basic Description:
Radioactive material, LSA, n.o.s.; UN2912.

1. Maximum Allowed Activity Concentration Level
The maximum radium-226 or radium-228 concentration of the material being shipped shall not exceed 100,000 picocuries per gram [49CFR173.403.n and 49CFR173.425].

2. Maximum Allowed Radiation Levels
The maximum radiation levels for LSA shipments made in exclusive use vehicles shall not exceed the following:
[49CFR173.441]

Non-Exclusive Use or an Exclusive Use Open Transport Vehicle	Exclusive Use - Closed Transport Vehicle
200 mrem/hr on the package	1,000 mrem/hr on the package 200 mrem/hr on the vehicle 10 mrem/hr at any point 2 meters from the vehicle 2 mrem/hr in the cab of the vehicle

3. Package Requirements
A strong tight container must be used [49CFR173.425.1].

4. Shipping Label Requirements
White I, Yellow II, or Yellow III shipping labels shall be affixed to packages in accordance with 49CFR172.400. **Note 1:** D.O.T. shipping labels are not required to be affixed to packages of low specific activity radioactive material when transported under the below requirements: [49CFR173.425.b, 49CFR172.400.a.7] **Note 2:** Containers of NORM still need to be labeled in accordance with the Louisiana Administrative Code, Title 33, Part XV, Chapter 4, Article 453.

1. Materials must be packaged in strong, tight packages so that there will be no leakage of radioactive material under conditions normally incident to transportation.

2. Packages must not have any significant removable surface contamination (see 49CFR173.443 for contamination limits, or paragraph 7 below, titled "Maximum Contamination Levels").

3. External radiation levels must comply with 49CFR173.441. (see paragraph 2 above, titled "Maximum Radiation Levels" for radiation level limits).

4. Shipments must be loaded by the consignor and unloaded by the consignee from the conveyance or freight contained in which originally loaded.

5. There must be no loose radioactive material in the conveyance.

6. The shipment must be braced so as to prevent shifting of lading under conditions normally incident to transportation.

7. Except for shipments of unconcentrated uranium or thorium ores, the transport vehicle must be placarded with the placards prescribed in accordance with 49CFR172, subchapter F, as appropriate.

8. The exterior of each package must be stenciled or otherwise marked "Radioactive - LSA". Packages, with a capacity of 110 gallons or less, that contain a hazardous substance, must be stenciled or otherwise marked with the letters "RQ" in association with the above description. For vessel transportation, packages that contain a marine pollutant must be marked in accordance with 49CFR172.322.

9. Specific instructions for maintenance of exclusive use shipment controls must be provided by the shipper to the carrier. Such instructions must be included with the shipping paper information.

10. Transportation by aircraft is prohibited.

When affixing shipping labels, the following requirements must be met:

1. Two labels must be affixed to each package [49CFR173.403.f].
2. Labels shall not be affixed to the bottom of a package [49CFR173.406.a.i].

5. Package marking Requirements:
The exterior of each package must be stenciled or otherwise marked "Radioactive - LSA". Packages with a capacity of 110 gallons or less, that contain a hazardous substance, must be stenciled or otherwise marked with the letters "RQ". [49CFR173.425.b.8].

6. Vehicle Placard Requirements
"Radioactive" placards must be affixed to all four sides of vehicles transporting LSA materials. [49CFR173.425.b.7].

7. Maximum Allowed Contamination Levels:
The maximum contamination levels associated with a LSA shipment are as follows

[49CFR173.443]:

Non-Exclusive Use Vehicle	Exclusive Use Vehicle	
	Beginning	During, and End
Alpha:	Alpha:	
220 dpm/100cm^2	220 dpm/100cm^2	2,200 dpm/100cm^2
Beta/gamma:	Beta/gamma:	
2,200 dpm/100cm^2	2,200 dpm/100cm^2	22,200 dpm/100cm^2

8. Other Special Requirements

Shipments of LSA materials must be loaded by the consignor and unloaded by the consignee from the conveyance or freight container in which they were originally loaded [49CFR173.425.b.4].

Shipments of LSA materials must be braced so as to prevent shifting of lading under conditions normally incident to transportation [49CFR173.425.b.6].

ATTACHMENT #11

IDENTIFICATION CODES

CODE	DESCRIPTION
BG	BARGE
CI	CONTAMINATED
CL	CONTAMINATED LAND
CP	CHEMICAL PLANT
DS	DRUM STORAGE
EQ	EQUIPMENT
FD	OIL & GAS FIELD
FI	FIELD IDENTIFICATION
FS	FIELD STORAGE
GA	GAS STATION
GP	GAS PLANT
MP	MANUFACTURING PLANT
MS	MISCELLANEOUS
PF	PRODUCTION FACILITY
PL	PIPELINE
PT	PIT
PY	PIPE YARD
R	REFINERY
TB	TANK BATTERY
TK	TANK
WH	WAREHOUSE