Commonwealth of Virginia
Radiation Protection Regulatory Guide

Guidance for Well Logging, Tracer, and Field Flood Study

ORH-720 J

Virginia Department of Health
Radioactive Materials Program
109 Governor Street, Room 730
Richmond, VA 23219
Phone: (804) 864-8150

Revision 1

EXECUTIVE SUMMARY

Virginia Regulatory Guides (**VAREGS**) are issued to describe and make available to the applicant or licensee, acceptable methods of implementing specific parts of **12VAC5- 481, 'Virginia Radiation Protection Regulations'**, to delineate techniques used by the staff in evaluating past specific problems or postulated accidents, and to provide guidance to applicants or licensees. VAREGS are not substitutes for **12VAC5-481, 'Virginia Radiation Protection Regulations'**, therefore, compliance with them is not required. Methods and solutions different from those set forth in this guide will be acceptable if they provide a basis for the Virginia Department of Health (VDH), Radioactive Materials Program, to determine if a radiation protection program meets the current rule and protects health and safety.

Comments and suggestions for improvements in this VAREG are encouraged and it will be revised, as appropriate, to accommodate comments and to reflect new information or experience. Comments should be sent to: **Virginia Department of Health, Radioactive Materials Program, 109 Governor Street, Room 730, Richmond, VA 23219.**

Requests for single copies of this guide (which may be reproduced) can be made in writing to: Virginia Department of Health, Radioactive Materials Program, 109 Governor Street, Room 730, Richmond, VA 23219.

This guide is also available on our website: http://www.vdh.virginia.gov/Epidemiology/RadiologicalHealth/.

This VAREG, 'Guidance for Well Logging, Tracer, and Field Flood Study', has been developed to streamline the application process for a Well Logging, Tracer, and Field Flood Study license. A copy of the VDH form, 'Application for a Radioactive Material License Authorizing the Use of Material in Well Logging, Tracer, and Field Flood Study', is located in **Appendix A** of this guide.

Appendix F through V provide examples, models, and additional information that can be used when completing the application.

It typically takes 60-90 days for a license to be processed and issued if the application is complete. When submitting the application be sure to include the appropriate application fee listed in **12VAC5-490**.

In summary, the applicant will need to do the following to submit an application for a well logging, tracer, or field flood study license:

- Use this regulatory guide to prepare the VDH form, 'Application for a Radioactive Material License Authorizing the Use of Material in Well Logging, Tracer, and Field Flood Study' (**Appendix A**).
- Complete the VDH form, 'Application for a Radioactive Material License Authorizing the Use of Material in Well Logging, Tracer, and Field Flood Study' (**Appendix A**). See 'Contents of Application' of the guide for additional information.
- Include any additional attachments:
    - All supplemental pages should be on 8 ½" x 11" paper.
    - Please identify all attachments with the applicant's name and license number (if a renewal).
- Avoid submitting proprietary information unless it is absolutely necessary. If submitted, proprietary information and other sensitive information should be clearly identified and a request made to withhold from public disclosure.
- Submit an original signed application along with attachments (if any). This submission can be made via scanned copies forwarded via facsimile or electronic mail or via postal mail of the documents.
- Submit the application fee (for new licenses only).
- Retain one copy of the licensee application and attachments (if any) for your future reference. You will need this information because the license will require that radioactive material be possessed and used in accordance with statements, representation, and procedures provided in the application and supporting documentation.

If you have any questions about the application process please contact this office at (804) 864-8150.

CONTENTS

Executive Summary 2
Contents 4
List of Appendices 5
List of Tables 6
List of Figures 6
Abbreviations 7
Purpose of Guide 9
Licenses 11
The 'As Low As Reasonably Achievable (ALARA)' Concept 12
Who Regulates Facilities in the Commonwealth of Virginia? 13
Management Responsibility 14
Safety Culture 15
Applicable Rule 16
How to File 17
Where to File 18
License Fees 19
Contents of Application
Item 1. Type of Application 20
Item 2 Name and Mailing Address of Applicant 20
Item 3. Person to Contact Regarding Application 21
Item 4. Location of Radioactive Material 21
Radiation Safety Officer, Logging Supervisors and Logging Assistants
Item 5. Radiation Safety Officer (RSO) 22
Item 6. Training for Logging Supervisors, Logging Assistants, and Tracer/Field Flood Study Users 23
Radioactive Material
Item 7. Radioactive Material 24
Item 7.1 Purpose(s) for Which Licensed Material Will Be Used 28
Item 8. Financial Assurance and Recordkeeping for Decommissioning 30
Facilities and Equipment
Item 9. Facilities and Equipment 31
Item 9.1 Minimization of Contamination 32
Radiation Safety Program
Item 10. Radiation Safety Program 33
Item 10.1. Well Owner/Operator Agreements 34
Item 10.2. Radiation Safety Program Audit 36
Item 10.3. Termination of Activities 37
Item 10.4. Radiation Monitoring Instruments 38
Item 10.5. Material Receipt and Accountability 39
Item 10.6. Leak Tests 40
Item 10.7. Occupational Dosimetry 40
Item 10.8. Public Dose 42
Item 10.9. Maintenance 43
Item 10.9.1. Daily Maintenance 43
Item 10.9.2. Semi-Annual Inspection and Routine Maintenance 44
Item 10.9.3. Maintenance Requiring Special Authorization 44
Item 10.10. Operating and Emergency Procedures 45
Item 10.11. Transportation 46
Well Logging, Tracer and Field Flood Study Operations

Item 11. Well Logging, Tracer, and Field Flood Study Operations 47
Item 11.1. Drill-To-Stop Large Sealed Sources 47
Item 11.2. Measurement While Drilling \ Logging While Drilling 47
Item 11.3. Energy Compensation Sources 48
Item 11.4. Use of Sealed Sources or Neutron Generators in Fresh Water Aquifers 48
Item 11.5. Tracer Studies in Single Well Applicators 49
Item 11.6. Field Flood and Secondary Recovery Applications (Tracer Studies in Multiple Wells) 49
Item 11.7. Tracer Studies in Fresh Water Aquifers 50
Item 11.8. Radioactive Collar and Subsidence or Depth Control Markers 51
Item 11.9. Neutron Accelerators Using Licensed Material 51
Item 11.10. Depleted Uranium Sinker Bars 52
Item 12. Waste Management 53
Fees and Certification
Item 13. License Fees 56
Item 14. Certification 57

LIST OF APPENDICES

Appendix A VDH form, 'Application for a Radioactive Material License Authorizing the Use of Material in Well Logging, Tracer, and Field Flood Study' 58
Appendix B VDH form, 'Certificate of Disposition of Material' 72
Appendix C Sample Correspondence Delegation Letter 75
Appendix D Reserved 77
Appendix E Reserved 78
Appendix F Field Flood Studies/Enhanced Recovery of Oil and Gas Wells 79
Appendix G Suggested Well Logging and Field Flood Audit Checklist 83
Appendix H Information Needed for Transfer of Control Application 95
Appendix I Guidance on Decommissioning Funding Plan and Financial Assurance 97
Appendix J NRC Letter Dated August 10, 1989: Transmitting Temporary Generic Exemptions to Well Logging Licensees 100
Appendix K Typical Duties and Responsibilities of Radiation Safety Officer 110
Appendix L Well Logging Supervisor and Logging Assistant Training Requirements 113
Appendix M Annual Internal Job Performance Inspection Checklist for Well Logging Supervisors and Well Logging Assistants 117
Appendix N Radiation Monitoring Instrument Specifications and Model Survey Instrument Calibration Program 119
Appendix O Guidance for Demonstrating that Unmonitored Individuals are Not Likely to Exceed 10 Percent of the Allowable Limits 124
Appendix P Guidance for Demonstrating that Individual Members of the Public will not Receive Doses Exceeding the Allowable Limits 126
Appendix Q Notification of Proper Persons in the Event of an Accident 132
Appendix R Model Leak Test Program 135
Appendix S Transportation 138
Appendix T Procedures for Waste Management 147
Appendix U Reserved 150
Appendix V Actions to be Taken if a Sealed Source is Ruptured 151

LIST OF TABLES

Table 1 Who Regulates the Activity? 13
Table 2 Traits of a Positive Nuclear Safety Culture 15
Table 3 Radiation Safety Officer Duties and Authorities 23
Table 4 Types of Radioactive Materials Used in Field Flood Studies and Single Well Tracer Operations 28
Table 5 Sample Format for Providing Information About Requested Radioisotopes 29
Table 6 Commonly Used Licensed Materials Requiring Financial Assurance/Decommissioning Funding Plan 30
Table 7 Acceptable License Termination Screening Values of Common Radionuclides for Building Surface Contamination....38
Table 8 Occupational Dose Limits for Adults 41
Table 9 Isotopes With Half-lives Greater Than or Equal to 120 Days 98
Table 10 Sample Worksheet for Determining Need for a Decommissioning Funding Plan or Financial Assurance 99
Table 11 **12VAC5-481, Part XIV** Training Requirements....114
Table 12 Typical Survey 120
Table 13 Calculation Method, Part 1: Hourly and Annual Doses Received from a Logging Source Stored in Above Ground Transportation Container....130
Table 14 Calculation Method, Part 2: Annual Dose Received from a Logging Source Stored in Above Ground Transportation Container 131
Table 15 VDH Notifications 134

LIST OF FIGURES

Figure 1 Examples of Sealed Sources Used In Well Logging Operations....26
Figure 2 Features of a Typical Source Abandonment....35
Figure 3 Permanent Identification Plaque 36
Figure 4 Bird's Eye View of Office 127
Figure 5 Downhole Storage Array 129

ABBREVIATIONS

ALARA	As Low As is Reasonably Achievable
ALI	Annual Limit on Intakes
ANSI	American National Standards Institute
bkg	Background
BPR	Business Process Redesign
Bq	Becquerel
cc	centimeter cubed
CDE	Committed Dose Equivalent
CEDE	Committed Effective Dose Equivalent
Ci	Curie
CFR	Code of Federal Regulations
cm^2	centimeter squared
cpm	counts per minute
C/kg	Coulombs/Kilogram
cpm	Counts Per Minute
DFP	Decommissioning Funding Plan
DIS	Decay-In-Storage
DOE	United States Department of Energy
DOT	United States Department of Transportation
dpm	Disintegrations Per Minute
DTS	Drill-To-Stop
EA	Environmental Assessment
ECS	Energy Compensation Source
EDE	Effective Dose Equivalent
EPA	United States Environmental Protection Agency
F/A	Financial Assurance
FDA	United States Food and Drug Administration
FR	Federal Register
GM	Geiger-Mueller
GBq	Gigabecquerel
IN	Information Notice
LLW	Low Level Waste
LSA	Low Specific Activity
LWD	Logging While Drilling
MBq	Megabecquerel
MC	Manual Chapter
MCi	millicurie
mGy	Milligray
mR	Milliroentgen
mrem	Millirem
mSv	Millisievert
MWD	Measurement While Drilling
NCRP	National Council on Radiation Protection and Measurements
NIST	National Institute of Standards and Technology
NMSS	Office of Nuclear Material Safety and Safeguards
NORM	Naturally-Occurring Radioactive Material
NRC	United States Nuclear Regulatory Commission
NVLAP	National Voluntary Laboratory Accreditation Program
OSL	Optically Stimulated Luminescence

QA	Quality Assurance
R	Roentgen
RG	Regulatory Guide
RQ	Reportable Quantities
RSO	Radiation Safety Officer
SDE	Shallow Dose Equivalent
SI	International System of Units (abbreviated SI from the French Le Systeme Internationale d'Unites)
SSD	Sealed Source and Device
SSDR	Sealed Source and Device Registration
std	Standard
Sv	Sievert
T1/2	Half-life
TAR	Technical Assistance Request
TEDE	Total Effective Dose Equivalent
TI	Transportation Index
TLD	Thermoluminescent Dosimeters
USASI	United States of America Standards Institute
USC	United States Code
USDA	United States Department of Agriculture
VDH	Virginia Department of Health
μCi	microcurie
%	percent

PURPOSE OF GUIDE

This document provides guidance to an applicant in preparing a license application for well logging, tracer, and field flood study. It also provides guidance on VDH's criteria for evaluating a well logging, tracer and field flood study license application. It is not intended to address the commercial aspects of manufacturing, distribution, and service of sources in devices. Byproduct material, depleted uranium, and special nuclear material, as defined in **12VAC5-481-10**, are used for a variety of purposes to include well logging and tracer applications involving both single or multiple well bores; conventional well logging and tracer operations; and, in some cases, research and development. Examples include the following applications:

- Sealed sources are used in cased and uncased boreholes
- Tracer materials are used in single well applications
- Tracer materials are used in multiple well applications (field flood study) for enhanced recovery of oil and gas wells
- Sealed sources are used for calibration of applicant's survey instruments and well logging tools
- Sealed sources and tracer materials are used in the research and development of new techniques and equipment.

This guide identifies the information needed to complete VDH form 'Application for a Radioactive Material License Authorizing the Use of Material in Well Logging, Tracer, and Field Flood Study' (**Appendix A**).

The format for each item number in this guide is as follows:

- **Rule** - references the requirements from **12VAC5-481 'Virginia Radiation Protection Regulations'** applicable to the item;
- **Criteria** - outlines the criteria used to judge the adequacy of the applicant's response;
- **Discussion** - provides additional information on the topic sufficient to meet the needs of most readers.

The information submitted in the application must be sufficient to demonstrate that proposed equipment, facilities, personnel, and procedures are adequate to protect the health and safety of the citizens of the Commonwealth of Virginia in accordance with the agency's guidelines. Submission of incomplete or inadequate information will result in delays in the approval process for the license. Additional information will be requested when necessary to ensure that an adequate radiation safety program has been established. Such requests for additional information will delay completion of the application's review and may be avoided by a thorough study of the rule and these instructions prior to submitting the application.

12VAC5-481 'Virginia Radiation Protection Regulations' requires the applicant and/or licensee to develop, document, and implement procedures that will ensure compliance with the rule. The appendices describe radiation protection procedures. Each applicant should read the rule and procedures carefully and then decide if the procedure addresses specific radiation protection program needs at the applicant's facility. Applicants may adopt a procedure included in this VAREG or they may develop their own procedures to comply with the applicable rule.

In this guide, "dose" or "radiation dose" means absorbed dose, dose equivalent, effective dose equivalent, committed dose equivalent, committed effective dose equivalent, or total effective dose equivalent (TEDE). These terms are defined in the **12VAC5-481-10.** Rem and Sievert (Sv), its SI equivalent (1 rem = 0.01 Sv), are used to describe units of radiation exposure or dose. These units are used because **12VAC5-481 'Virginia Radiation Protection Regulations', Part IV 'Standards for Protection Against Radiation',** sets dose limits in terms of rem, not rad or roentgen. A useful rule of thumb is an exposure of 1 roentgen is equivalent to an absorbed dose of 1 rad and dose equivalent of 1 rem.

This VAREG provides the latest guidance, shows the requirements in terms of the **12VAC5-481, 'Virginia Radiation Protection Regulations',** and provides a user-friendly format to assist with the preparation of a license application.

LICENSES

Applicants should study this document, related guidance, and all applicable regulations carefully before completing the VDH form, ‘Application for a Radioactive Material License Authorizing the Use of Material in Well Logging, Tracer, and Field Flood Study**’**. VDH expects licensees to provide requested information on specific aspects of their proposed radiation protection program in attachments to the application. When necessary, VDH may ask the applicant for additional information to gain reasonable assurance that an adequate radiation protection program has been established.

After a license is issued, the licensee must conduct its program in accordance with the following:

- Statements, representations, and procedures contained in the application and in correspondence with VDH;
- Terms and conditions of the license; and
- **12VAC5-481 ‘Virginia Radiation Protection Regulations’**.

THE 'AS LOW AS IS REASONABLY ACHIEVABLE (ALARA)' CONCEPT

12VAC5-481-630, Radiation protection programs, states that *"each licensee shall develop, document, and implement a radiation protection program commensurate with the scope and extent of licensed activities"* and *"the licensee shall use, to the extent practical, procedures and engineering controls based upon sound radiation protection principles to achieve occupational doses and doses to members of the public that are...ALARA."* This section also requires that licensees review the content of the radiation protection program and its implementation annually.

Information directly related to radiation protection standards in **12VAC5-481 'Virginia Radiation Protection Regulations', Part IV 'Standards for Protection Against Radiation'**, is contained in:

- NRC's NUREG-1736, 'Consolidated Guidance: 10 CFR Part 20 - Standards for Protection Against Radiation'.

Applicants should consider the ALARA philosophy detailed in these reports when developing plans to work with licensed radioactive materials.

WHO REGULATES FACTILITIES IN THE COMMONWEALTH OF VIRGINIA?

In the special situation of work at federally controlled sites in the Commonwealth of Virginia, it is necessary to know the jurisdictional status of the land in order to determine whether the Nuclear Regulatory Commission (NRC) or VDH has regulatory authority. The NRC has regulatory authority only over land determined to be "exclusive federal jurisdiction," while VDH has jurisdiction over non-exclusive federal jurisdiction land (see **Table 1**). Applicants and licensees are responsible for finding out, in advance, the jurisdictional status of the specific areas where they plan to conduct licensed operations. VDH recommends that applicants and licensees ask their local contact for the federal agency controlling the site (e.g., contract officer, base environmental health officer, district office staff) to help determine the jurisdictional status of the land and to provide the information in writing, so that licensees can comply with NRC or VDH regulatory requirements, as appropriate. The following table lists examples of regulatory authority.

Table 1: Who Regulates Activity?

Applicant and Proposed Location of Work	Regulatory Agency
Federal agency regardless of location (except that Department of Energy [DOE] and, under most circumstances, its prime contractors are exempt from licensing [**10 CFR 30.12**])	NRC
Non-federal entity in non-Agreement State, U.S. territory, or possession	NRC
Non-federal entity in Virginia at non-federally controlled site	VDH
Non-federal entity in Virginia at federally-controlled site **not** subject to exclusive Federal jurisdiction	VDH
Non-federal entity in Virginia at federally-controlled site subject to exclusive federal jurisdiction	NRC

A current list of Agreement States (states that have entered into agreements with the NRC that give them the authority to license and inspect radioactive material used or possessed within their borders), including names, addresses, and telephone numbers of responsible officials are maintained by the NRC Office of Federal and State Materials and Environmental Management Programs and is available on their website: http://nrc-stp.ornl.gov/.

MANAGEMENT RESPONSIBILITY

VDH endorses the philosophy that effective radiation protection program management is vital to safe operations that comply with VDH regulatory requirements.

"Management" refers to the chief executive officer or other individual having the authority to manage, direct, or administer the licensee's activities or that person's delegate or delegates.

To ensure adequate management involvement, a management representative (i.e., chief executive officer or delegate) must sign the submitted application acknowledging management's commitments to and responsibility for the following:

- Radiation protection, security and control of radioactive materials, and compliance with rule;
- Knowledge about the contents of the license application;
- Compliance with current VDH and United States Department of Transportation (DOT) regulations and the licensee's operating and emergency procedures;
- Provision of adequate resources (including space, equipment, personnel, time, and, if needed, contractors) to the radiation protection program to ensure that the public, and workers are protected from radiation hazards;
- Appointment of a qualified individual who has agreed in writing to work as RSO;

Management may delegate individuals (i.e., an RSO or other designated individual) to submit amendment requests to VDH. A correspondence delegation letter must be completed, signed by management and submitted to VDH. A sample letter has been included in **Appendix C**.

SAFETY CULTURE

Nuclear safety culture is defined as the core values and behaviors resulting from a collective commitment by leaders and individuals to emphasize safety over competing goals to ensure protection of people and the environment. Individuals and organizations performing regulated activities bear the primary responsibility for safely handling and securing these materials. Experience has shown that certain personal and organizational traits are present in a positive safety culture. A trait, in this case, is a pattern of thinking, feeling, and behaving that emphasizes safety, particularly in goal conflict situations (e.g., production versus safety, schedule versus safety, and cost of the effort versus safety). **Table 2** show traits of a positive nuclear safety culture.

Table 2: Traits of a Positive Nuclear Safety Culture

Trait	Result
Leadership: Safety Values and Actions	Leaders demonstrate a commitment to safety in their decisions and behaviors
Problem Identification and Resolution	Issues potentially impacting safety are promptly identified, fully evaluated, and promptly addressed and corrected commensurate with their significance
Personal Accountability	All individuals take personal responsibility for safety
Evaluating Work Processes	The process of planning and controlling work activities is implemented so that safety is maintained
Continuous Learning	Opportunities to learn about ways to ensure safety are sought out and implemented
Environment for Raising Concerns	A safety conscious work environment is maintained where personnel feel free to raise safety concerns without fear of retaliation, intimidation, harassment, or discrimination
Effective Safety Communications	Communications maintain a focus on safety
Respectful Work Environment	Trust and respect permeate the organization
Questioning Attitude	Individuals avoid complacency and continually challenge existing conditions and activities in order to identify discrepancies that might result in error or inappropriate action

Individuals and organizations performing regulated activities are expected to establish and maintain a positive safety culture commensurate with the safety and security significance of their activities and the nature and complexity of their organizations and functions. This applies to all licensees, holders of quality assurance programs approvals, vendors, and suppliers of safety-related components, and applicants for a license or quality assurance program approval, subject to VDH authority. More information relating to safety culture can be found at: http://www.nrc./about-nrc/regulatory/enforcement/safety-culture.html

APPLICABLE RULE

It is the applicant's or licensee's responsibility to obtain, read, and follow **12VAC5-481, 'Virginia Radiation Protection Regulations'**.

The following parts of **12VAC5-481**, **'Virginia Radiation Protection Regulations'** contain regulations applicable to well logging, tracer, and field flood study licensees:

- Part I 'General Provisions'
- Part III 'Licensing of Radioactive Material'
- Part IV 'Standards for Protection Against Radiation'
- Part X 'Notices, Instructions, and Reports to Workers; Inspections'
- Part XIII 'Transportation of Radioactive Material'
- Part XIV 'Radiation Safety Requirements for Wireline Service Operations and Subsurface Tracer Studies'

Requests for single copies of the above documents (which may be reproduced) can be made in writing to: Virginia Department of Health, Radioactive Materials Program, 109 Governor Street, Room 730, Richmond, VA 23219 or for an electronic copy go to our web site at: http://www.vdh.virginia.gov/Epidemiology/RadiologicalHealth/.

HOW TO FILE

Applicants for a materials license should do the following:

- Be sure to use the most recent guidance from VDH in preparing an application.
- Complete VDH form, 'Application for a Radioactive Material License Authorizing the Use of Material in Well Logging, Tracer, and Field Flood Study' (**Appendix A**).
- For each separate sheet that is submitted with the application, identify and key it to the item number on the application or the topic to which it refers.
- Submit all documents on 8-1/2 x 11 inch paper.
- Avoid submitting proprietary information unless it is necessary. If submitted, proprietary information and other sensitive information should be clearly identified and a request made to withhold from public disclosure.
- Submit an original, signed application. This submission can be made via scanned copies forwarded via facsimile, electronic mail or postal mail of the documents.
- Retain one copy of the license application for future reference.

Deviations from the suggested wording of responses as shown in this VAREG or submission of alternative procedures will require a more detailed review.

Note: Personal employee information (i.e.; home address, home telephone number, Social Security Number, date of birth and radiation dose information) should not be submitted unless specifically requested by VDH.

WHERE TO FILE

Applicants wishing to possess or use radioactive material in the Commonwealth of Virginia are subject to the requirements of **12VAC5-481 'Virginia Radiation Protection Regulations'** and must file a license application with:

Virginia Department of Health
Radioactive Materials Program
109 Governor Street, Room 730
Richmond, VA 23219

LICENSE FEES

The appropriate fee must accompany each application. Refer to **12VAC5-490** to determine the amount of the fee. VDH will not issue the new license prior to fee receipt. An application for a new license or an amendment to an existing license requesting authorization to conduct field flood studies requires that an environmental assessment be performed. Full cost of this fee is assessed by the professional staff. Once technical review begins, no fees will be refunded. Application fees will be charged regardless of VDH's disposition of an application or the withdrawal of an application.

Licensees are also subject to annual fees; refer to **12VAC5-490**.

Direct all questions about VDH's fees or completion of **Item 13** of VDH form, 'Application for a Radioactive Material License Authorizing the Use of Material in Well Logging, Tracer, and Field Flood Study' (**Appendix A**) to: Virginia Department of Health, Radioactive Materials Program, 109 Governor Street, Room 730, Richmond, VA 23219 or call (804) 864-8150.

CONTENTS OF AN APPLICATION

Item 1: Type of Application

Obtain the correct application form for either a new license or a renewal, check the appropriate box and, if appropriate, list the license number for a renewal.

This guide is written to instruct a new licensee in the process of applying for a radioactive material license. Not all discussions will be appropriate to a licensee renewing an existing license.

Item 2: Name and Mailing Address of Applicant

List the legal name of the applicant's corporation or other legal entity with direct control over use of the radioactive material. A division or department within a legal entity may not be a licensee. An individual may be designated as the applicant only if the individual is acting in a private capacity and the use of the radioactive material is not connected with employment in a corporation or other legal entity. Provide the mailing address where correspondence should be sent. A Post Office box number is an acceptable mailing address.

Notify the agency of changes in mailing address.

The licensee must also provide sufficient information for the agency to ensure the proposed corporation or controlling legal entity is a valid entity. Verification of this identity can be accomplished by submitting a copy of the company's license from the NRC or another Agreement State or a government contract or certification, etc.

Note: The agency must be notified immediately in the event of change of ownership or control and bankruptcy proceedings, see below for more details.

Timely Notification of Transfer of Control

Rule: 12VAC5-481-330, 12VAC5-481-450, 12VAC5-481-500

Criteria: Licensees must provide full information and obtain the agency's **written consent prior** to transferring ownership or control of the license, or, as some licensees call it, 'transferring the license'.

Discussion: Transfer of control may be the result of mergers, buyouts, or majority stock transfers. Although it is not VDH's intent to interfere with the business decisions of licensees, it is necessary for licensees to obtain prior VDH written consent before the transaction is finalized. This is to ensure the following:

- Radioactive materials are possessed, used, or controlled only by persons who have valid licenses issued by VDH, NRC, or another Agreement State;
- Materials are properly handled and secured;
- Persons using these materials are competent and committed to implementing appropriate radiological controls;
- A clear chain of custody is established to identify who is responsible for the disposition of records and licensed materials;
- Public health and safety are not compromised by the use of such materials.

Appendix H identifies the information to be provided about changes of ownership or control.

Notification of Bankruptcy Proceedings

Rule: 12VAC5-481-500

Criteria: 12VAC5-481-500 states: "*Each licensee shall notify the agency in writing immediately following the filing of a voluntary or involuntary petition for bankruptcy under any Chapter of Title 11 (Bankruptcy) of the United States Code by or against: 1. The licensee 2. An entity (as that term is defined in 11 USC §101 (15)) controlling the licensee or listing the license or licensee as property of the estate; or 3. An affiliate (as that term is defined in 11 USC §101 (2)) of the licensee*" and "*...shall indicate the bankruptcy court in which the petition for bankruptcy was filed and the date of filing of the petition*".

Discussion: Even though a licensee may have filed for bankruptcy, the licensee remains responsible for all regulatory requirements. VDH needs to know when licensees are in bankruptcy proceedings in order to determine whether all licensed material is accounted for and adequately controlled and whether there are any public health and safety concerns (e.g., contaminated facility). VDH shares its determinations with other entities (i.e., trustees, etc) so that health and safety issues can be resolved prior to completion of bankruptcy proceedings.

Licensee must notify VDH immediately of the filing of a bankruptcy petition.

Item 3: Person to Contact Regarding Application

Criteria: Identify the name and title of the individual who can answer questions about the application and include his or her telephone number.

Discussion: This is typically the proposed Radiation Safety Officer or a knowledgeable management official, unless the applicant has named a different person as the contact. The agency will contact this individual if there are questions about the application.

Notify the agency if the contact person or the contact person's telephone number changes so that the agency can contact the applicant or licensee in the future with questions, concerns, or information. This notice is 'for information only' and does not require a license amendment.

Item 4: Location of Radioactive Material

Rule: 12VAC5-481-450, 12VAC5-481-500, 12VAC5-481-3151, 12VAC5-481-3180, 12VAC5-481-3350, 12VAC5-481-3360

Criteria: Applicants must provide a specific address for each location where radioactive material will be used, stored, or dispatched.

Discussion: Specify the street address, city, and state or other descriptive address (e.g., on Highway 17, 5 miles east of the intersection of Highway 10 and State Route 234, Anytown, VA) for each facility at which licensed material will be used, stored, or dispatched, and any field stations. Field stations are locations where licensed materials are stored or used and equipment is dispatched to temporary job sites. If devices will not be stored at a dispatch or field station, indicate this. The applicant should indicate whether or not these facilities will be used for use and/or storage of devices. The descriptive address should be sufficient to allow a VDH inspector to find the storage location. **A Post Office Box is not acceptable.**

Being granted a VDH license does not relieve a licensee from complying with other applicable federal, state, or local regulations (e.g., local zoning requirements for storage locations).

Note: As discussed later under "Financial Assurance and Record Keeping for Decommissioning," licensees do need to maintain permanent records on where licensed material was used or stored while the license was in force. This is important for making future determinations about the release of these locations for unrestricted use (e.g., before the license is terminated).

Item 5: Radiation Safety Officer (RSO)

Rule: 12VAC5-481-450, 12VAC5-481-500, 12VAC5-481-3151

Criteria: RSOs and potential designees are responsible for ensuring that the licensee's radiation safety program is implemented in accordance with approved procedures, and must have adequate training and experience.

Discussion: The person responsible for the radiation protection program is called the RSO. The agency believes the RSO is the key to overseeing and ensuring safe operation of the licensee's well logging, tracer, or field flood study program. The RSO needs independent authority to stop operations that he or she considers unsafe and have sufficient time and commitment from management to fulfill certain duties and responsibilities that ensure that radioactive materials are used in a safe manner.

The RSO may delegate certain day-to-day tasks of the radiation protection program to other responsible individuals (potential designees). For example, a large well logging firm with multiple field stations and/or temporary job sites may appoint individuals designated as 'site RSOs' who assist the RSO and are responsible for the day-to-day activities at the field stations and/or temporary job sites. Licensees may also appoint other individuals who may 'step-in' as an emergency contact when the RSO is unavailable. The potential designees do not need to meet the required RSO qualifications; however, these individuals should be qualified and experienced with adequate knowledge of the activities to which they are assigned. Applicants do not have to identify other responsible individuals if day-to-day tasks, etc. will not be delegated.

Table 3. Radiation Safety Officer Duties and Authorities

Radiation Safety Officer
Duties and Authorities
1. Establish and oversee all operating, emergency, and ALARA procedures and review them regularly.
2. Oversee proper disposal of all material including transportation of the material according to VDH and DOT requirements.
3. Ensure required inventories, leak tests, etc. are conducted and the records are recorded and maintained.
4. Ensure personnel are trained as required.
5. Operations are conducted safely and corrective actions are implemented, when necessary, including terminating operations.
6. Make certain all use and maintenance is performed and operations and equipment are used properly.
7. Perform annual audit and notify appropriate parties if any item is found to be not in compliance with VDH rule.
8. Maintain records and calibration of all survey instruments and determine each for proper operation.
9. Preserve accountability of all sources and devices while in field and in the office.
10. Be prepared to monitor any emergency event including loss of a source downhole or possible rupture.
Above all, the RSO is the key to maintaining the radiation safety of the operations to the workers, the public, and the environment.

Typical RSO duties are listed in **Table 3** and **Appendix K**. The agency requires the name of the RSO on the license to ensure that licensee management has always identified a responsible, qualified person and that the named individual knows of his or her designation as RSO. Provide the agency with a copy of an organizational chart showing the RSO and other designated responsible individuals, to demonstrate that he or she has sufficient independence and direct communication with responsible management officials. Also, show in the organizational chart the position of the individual who signs the application in **Item 14** of the VDH form, 'Application for a Radioactive Material License Authorizing the Use of Material in Well Logging, Tracer, and Field Flood Study' (**Appendix A**).

To be considered eligible for the RSO position, the applicant must submit for review the specific training and experience of the proposed RSO and detail his or her duties and responsibilities. The proposed RSO should have had a minimum of 1 year of actual experience as a logging supervisor. The RSO is expected to coordinate the safe use of licensed materials and to ensure compliance with the applicable requirements of **12VAC5-481, 'Virginia Radiation Protection Regulations'**. The RSO should possess a thorough knowledge of management policies, company administrative and operating procedures, and safety procedures related to protection against radiation exposures.

Note: It is important to notify the agency and obtain a license amendment prior to making changes in the designation of the RSO responsible for the radiation safety program.

Item 6: Training for Logging Supervisors and Logging Assistants, and Tracer/Field Flood Study Users

Rule: 12VAC5-481-30, 12VAC5-481-450, 12VAC5-481-500, 12VAC5-481-2260, 12VAC5-481-2270, 12VAC5-481-2280, 12VAC5-481-3151, 12 VAC, 5-481-3270

Criteria: Well logging supervisors and well logging assistants must have adequate training and experience as outlined in **12VAC5-481-450, 12VAC5-481-2270,** and **12VAC5-481-3270**. Although persons engaged in field flood studies operations are not specifically addressed in **12VAC5-481 'Virginia Radiation Protection Regulations', Part XIV, 'Radiation Safety Requirements for Wireline Service Operations and Subsurface Tracer Studies'**, the agency will accept classroom training for tracer studies to be an appropriate guide for individuals engaged in field flood studies.

Discussion: A logging supervisor is a person who performs or personally supervises well logging operations, tracer/field flood study applications and is responsible for ensuring compliance with VDH regulations and the safe use of radioactive materials. A logging assistant is an individual, who under the direct supervision and in the physical presence of the logging supervisor, uses well logging equipment (sealed sources containing byproduct material, related handling tools, unsealed sources of byproduct material, well logging devices, and radiation survey instruments) in performing well logging operations.

Didactic training and testing requirements, performance requirements, annual refresher training, and annual audit requirements for logging supervisors and logging assistants are outlined in **12VAC5-481-3270**. Refer to **Appendix L** as an aid in determining the specific training requirements for logging supervisors, logging assistants, and individuals authorized to conduct field flood study/tracer applications. The applicant must submit a description of its training program for logging supervisors, logging assistants, and/or individuals authorized to conduct field flood study applications. Because **12VAC5-481-3270** contains different requirements for logging supervisors and logging assistants, applicants must include training programs for each category. When describing the training programs for these positions, include the sequence of events from the time of hiring through the designation of individuals as logging supervisors or logging assistants. Experienced logging supervisors who have worked for another well logging, tracer, or field flood study licensee should receive formal instruction similar to that given to prospective logging assistants.

Instructors who provide classroom training to individuals in the principles of radiation and radiation safety should have knowledge and understanding of these principles beyond those obtainable in a course similar to the one given to prospective logging supervisors. Individuals who provide instruction in the hands-on use of well logging and handling equipment should be qualified logging supervisors with at least 1 year of experience in performing well logging operations, or should possess a thorough understanding of the operation of well logging and handling equipment (e.g., a manufacturer's service representative).

An internal inspection program (audit) of the job performance of each logging supervisor and logging assistant ensures that the VDH regulations, license requirements, and the licensee's operating and emergency procedures are followed. The audit must include observation of the performance of each logging supervisor and logging assistant during an actual well logging operation at intervals not to exceed 12 months. If a logging supervisor or logging assistant has not participated in a well logging operation for more than 12 months since the last inspection, the individual must be inspected the first time he or she engages in well logging operations.

Item 7: Radioactive Material

Rule: 12VAC5-481-10, 12VAC5-481-400, 12VAC5-481-440, 12VAC5-481-450, 12VAC5-481-1151, 12VAC5-481-3151, 12VAC5-481-3180, 12VAC5-481-3190, 12VAC5-481-3240, 12VAC5-481-3241, 12VAC5-481-3250, 12VAC5-481-3300, 12VAC5-481-3310, 12VAC5-481-3320, 12VAC5-481-3430, 12VAC5-481-3740

Criteria: An application for a license will be approved if the requirements of **12VAC5-481-440, 12VAC5-481-450,** and **12VAC5-481-3151** are met. In addition, licensees will be authorized to possess and use only those

sealed sources and devices that are specifically approved or registered by the NRC or another Agreement State.

Any sealed source used for well logging that contains more than 3.7 MBq (100 microcuries) of byproduct or special nuclear material and is used downhole in well bores of gas wells, oil wells, or in mineral deposits, must satisfy one of the following criteria:

- Sealed sources that were manufactured before July 14, 1989, may use either the design and performance criteria from the United States of America Standards Institute (USASI) N5 10-1968 or the criteria specified in **12VAC5-481-3240**. The use of the USASI N5 10-1968 standard is based on an NRC Notice of Generic Exemption, a copy of the referenced generic exemption letter is included in **Appendix J**.
- Sealed sources are required to satisfy the requirements of **12VAC5-481-3240**.

The primary difference between the two standards is that the vibration requirement in **12VAC5-481-3240** is not included in the USASI standard. This vibration test was included to ensure consistency between the United States standard and international standards.

Discussion: Applicants should list each requested radioisotope by its element name and mass number (e.g., cesium-137), specify whether the material will be acquired and used in unsealed or sealed form, and list the maximum amount requested at any one time at all locations requested to be listed.

Note: Additional safety equipment and precautions are required when handling and using unsealed free-form volatile radioactive materials. (Volatile means that a liquid becomes a gas at a relatively low temperature when the sealed container within which the liquid is stored is left open to the environment.) Applicants requesting an authorization to use volatile radioactive material must provide appropriate facilities, handling equipment, and radiation safety procedures for using such material.

Possession limits should be specified in millicuries (mCi) [megabecquerels (MBq)] or curies (Ci) [gigabecquerels (GBq)] for each radioisotope. Applicants should include in the possession limits requested the total estimated inventory for all requested locations, including licensed material in storage and maintained as radioactive waste. The requested possession limits for any radioisotope should be commensurate with the applicant's needs and facilities for safe handling. Applicants, when establishing their possession limits for radioactive materials with half lives greater than 120 days, should review the requirements for submitting a certification for financial assurance for decommissioning, see **Appendix I**.

If a dose evaluation indicates, due to a release of radioactive materials, that the potential dose to a person off-site would exceed 0.01 sieverts (Sv) (1 rem) effective dose equivalent or 0.05 Sv (5 rems) to the thyroid, an emergency plan for responding to a release shall be included with the application. For Iodine-131, the quantity requiring an emergency plan is 370 GBq (10 curies).

Consult with the proposed supplier, manufacturer, or distributor to ensure that requested sources and devices, where applicable, are compatible with and conform to the sealed source and device designations as registered. Licensees may not make any changes to the sealed source, device, or source/device combination that would alter the description or specifications from those indicated in the respective registration certificates, without obtaining VDH's prior permission in a license amendment. To ensure that applicants use sources and devices according to the registration certificates, they may want to get a copy of the certificate and review it or discuss it with the manufacturer.

Sealed Sources

NRC or another Agreement State performs a safety evaluation of sealed sources before authorizing a manufacturer or distributor to distribute sources to specific licensees. The safety evaluation is documented in a

Sealed Source and Device (SSD) Registration Certificate. Some examples of sealed sources used in well logging applications are shown in **Figure 1**.

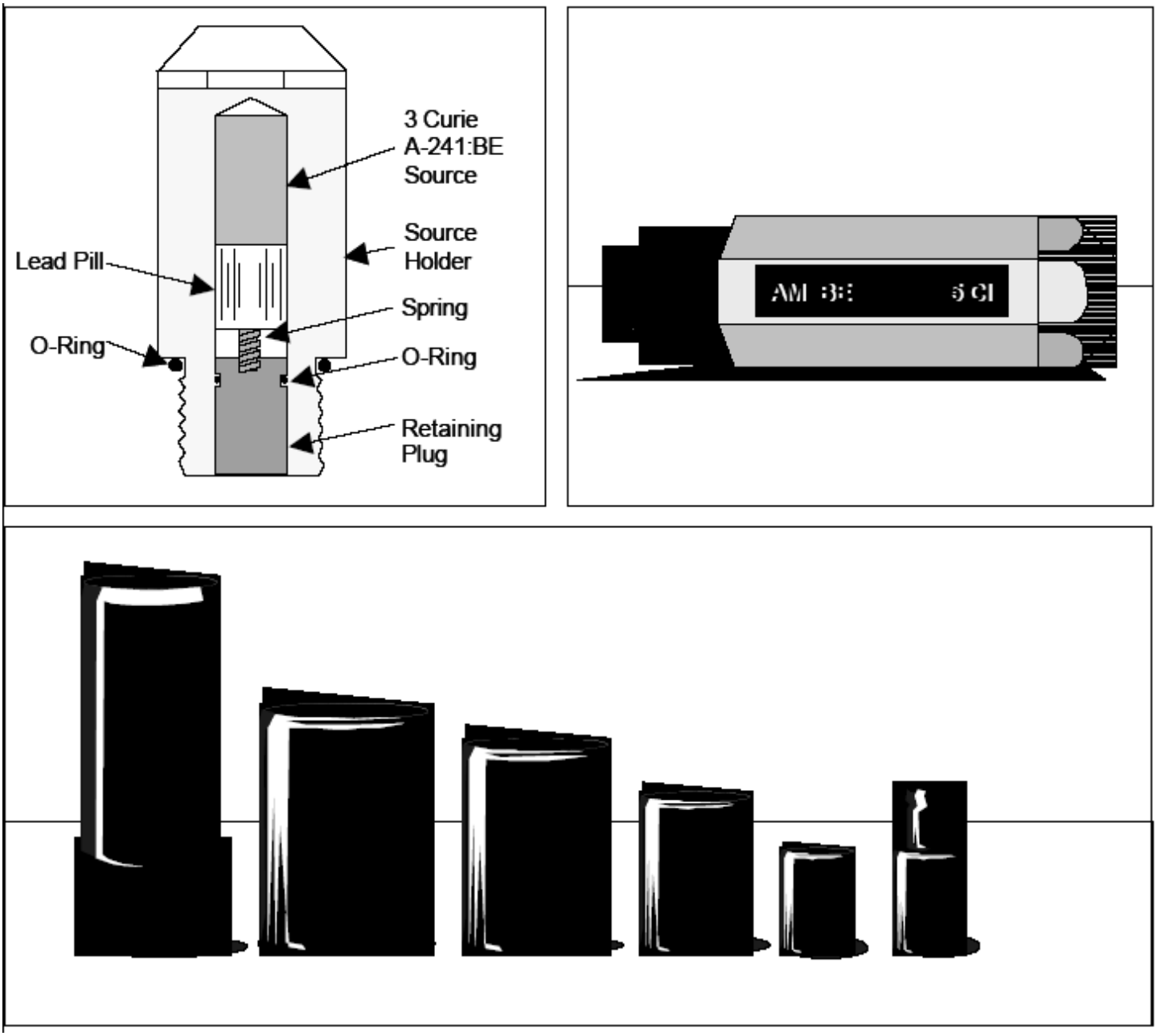


Figure 1. Examples of Sealed Sources Used in Well Logging Operations.

Applicants must provide the manufacturer's name and model number for each requested sealed source. This information is necessary to ensure that each sealed source requested in the application is included in an SSD Registration Certificate, approved under the provisions granted by **12VAC5-481-3240**, or is identified on an VDH license and authorized for well logging. Applicants should consult with the proposed suppliers or vendors to ensure that the sealed sources and their uses for them, and if applicable, devices and other associated equipment, are in accordance with Registration Certificates. Applicants are encouraged to obtain copies of applicable SSD Registration Certificates for future reference.

For sealed sources used for well logging applications, only authorized possession of individual sealed sources are approved for well logging. It is necessary to get authorization for specific sealed source/well logging tool combinations. Consult with the manufacturer of the sealed sources before using associated equipment (e.g., well

logging tools, transport containers, handling tools, etc) to ensure that the associated equipment selected is compatible with sealed sources requested in the application.

A safety evaluation of sealed sources and devices is performed by NRC or another Agreement State before authorizing a manufacturer (or distributor) to distribute them to specific licensees. The safety evaluation is documented in a SSD Registration Certificate. SSD Registration Certificates contain sections on "*Conditions of Normal Use*" and "*Limitation and Other Considerations of Use*". These sections may include limitations derived from conditions imposed by the manufacturer or distributor, by particular conditions of use that would reduce radiation safety of the device, or by circumstances unique to the sealed source or device. Except as specifically approved by VDH, licensees are required to use the sealed source and devices according to their respective SSD Registration Certificates. Information on SSD Registration Certificates may be obtained through the agency, if necessary. Applicants must provide the manufacturer's name and model number for each requested sealed source and device (e.g., instrument calibrator) so that the agency can verify that each, when applicable, has been evaluated in an SSD Registration Certificate.

Tracer Materials

Each authorized radioisotope tracer will be listed on the license by its element name, chemical and/or physical form, and total possession limit. **Table 4** identifies the types of byproduct material used in tracer and field flood study applications covered by this report.

The following definitions are provided to clarify single and multiple well tracer operations addressed in this report:

- **Tracer Materials:** Radioactive isotopes in liquid, solid, or gas form that are injected into single well bores or underground reservoirs to monitor the movement of fluids or gases. Tracer studies involve a single well and require the use of an electronic well logging tool to detect the radioactive isotopes injected into the well.
- **Field Flood Studies or Enhanced Oil and Gas Recovery Studies:** Tracer studies involving multiple wells where one or more radioactive isotopes are injected and multiple oil or gas samples containing radioactive material are collected from each of the wells to determine the direction and rate of flow through the formation. Field flood tracer operations would not normally involve the use of an electronic well logging tool to detect the radioactive isotopes in the well.
- **Labeled Frac Sands:** Radioactive isotope(s) in liquid or solid forms that is (are) chemically bonded to glass and/or resin beads and injected into a single well in a density-controlled solution. Frac sand operations require the use of an electronic well logging tool to assess the amount of radioactive isotope(s) remaining in the underground reservoir formation.

Table 4. Types of Radioactive Materials Used in Field Flood Studies and Single Well Tracer Operations

Field Flood or Enhanced Oil and Gas Recovery Study Applications Tracers Used in Multiple Wells	
Gas	H-3, Kr-85, C-14, Br-82
Liquid	H-3, Na-22, S-35, Ca-45, Co-60, Ni-63, Zn-65, Sr-85, Sc-46, Sr-90, Ag-110m, I-125, I-131, La-140, Ir-192
Well Logging Tracer Applications Tracers Used in a Single Well	
Gas	Br-82, I-131, I-125
Liquid	Fe-59, I-125, I-131, Sb-124, Au-198, Ag-110m
Labeled Frac Sand	Sc-46, Br-82, Ag-110m, Sb-124, Ir-192

Applicant must provide an emergency plan, if required. Emergency plans are not routinely required for tracer materials with half-lives of less than 120 days and for quantities authorized in well logging and tracer licenses. Applicants should refer to **12VAC5-481-3740** to determine the quantities of radioactive material requiring an emergency plan for responding to a release.

Item 7.1: Purpose(s) for Which Licensed Material will be Used

Rule: **12VAC5-481-450, 12VAC5-481-480, 12VAC5-481-3151, 12VAC5-481-3240, 12VAC5-481-3250, 12VAC5-481-3261, 12VAC5-481-3280, 12VAC5-481-3320**

Criteria: Radioisotopes and sealed sources requested in the application must be used for purposes authorized by **12VAC5-481, 'Virginia Radiation Protection Regulations'**. The licensee must specify the purpose for which each radioisotope or sealed source listed in **Item 7** is to be used, as well as specifying the type of wells in which each type of material will be used (e.g., oil, gas, mineral, geophysical, etc.). In addition, the licensee should describe the type of mineral or geophysical logging to be conducted (e.g., coal, salt domes, etc). Sealed sources used in well logging devices should be used only for the purposes for which they were designed, in accordance with the manufacturer's written recommendations and instructions, as specified in an approved SSD Registration Certificate, and as authorized on an VDH license. The licensee shall specify the manufacturer and model number of each device.

Discussion: The applicant's request to use sealed sources and radioisotopes in well logging, tracer, and field flood studies should clearly specify the purpose for which each type of material will be used. Applicants should include a description that is sufficiently detailed to allow a determination for the potential for exposure to occupationally exposed individuals and/or members of the public.

Note: Traditionally, only federal or state authorities have been authorized to conduct logging in potable water wells in fresh water aquifers. Approval to conduct these operations requires that applicants justify the need and to provide assurance that sealed sources, in case of accidental loss in a potable water zone, could be recovered.

Applicants requesting authorization to perform any of the hazardous operations listed below should clearly indicate their intent and provide specific instructions for conducting such activities in their operating and emergency procedures:

- Removing a sealed source from a source holder of a logging tool and maintenance on sealed sources or holders

- Using destructive techniques to remove a stuck sealed source from a source holder
- Opening, repairing, or modifying any sealed source
- Knowingly injecting licensed radioactive tracer material into a fresh water aquifer
- Using a sealed source in a well without a surface casing to protect fresh water aquifers.

Applicants may use the format given in **Table 5** to provide the requested information.

Table 5. Sample Format for Providing Information About Requested Radioisotopes

Radioisotope	Chemical/Physical Form	Maximum Possession Limit	Proposed Use
Americium-241	Sealed neutron source (XYZ Inc., Model 10)	Not to exceed 5 curies per source	Oil, gas, and/or mineral logging.
Cesium-137	Sealed source (Okko Inc., Model 36)	Not to exceed 3 curies per source	Oil, gas, and/or mineral logging.
Hydrogen-3	Gas, titanium tritide neutron generator tube (Cols Inc., Model 3)	Not to exceed 3 curies per tube	Neutron activation logging in oil and gas wells in downhole accelerator
Iodine-131	Gas	100 millicuries total, not to exceed 20 millicuries per injection	Subsurface Tracer Operations
Iodine-131	Liquid	50 millicuries total, not to exceed 10 millicuries per injection	Subsurface Tracer Operations
Iridium-192	'Labeled' frac sand	200 millicuries total, not to exceed 15 millicuries per injection	Subsurface Tracer Operations
Cobalt-60	Metal wire	3 millicuries total, not to exceed 1 microcurie per individual unit	Pipe Joint Collar Markers, Subsidence Markers, Depth Determination
Silver-110m	Liquid	200 millicuries total, not to exceed 20 millicuries per injection	Field Flood Tracer Studies
Depleted Uranium	Sinker Bars	225 kilograms	Sinker Weights (Concentrated Mass)

If the material will be used in field flood studies where licensed material is intentionally released into the environment, an environmental assessment (EA) is required in accordance with appropriate Commonwealth of Virginia, Department of Environmental Quality (9VAC15-20) and United States Code regulations (**10 CFR 51.21**). NRC Supplement to Policy and Guidance Directive FC 84-20, *"Impact of Revision of 10 CFR Part 51 on Materials License Actions"*, Revision 1, provides criteria for determining when an EA is not needed. Applicants should note that authorization granted by VDH to use licensed material in tracer or field flood studies does not relieve them of their responsibilities to comply with any other applicable federal, state or local regulatory requirements.

Item 8: Financial Assurance and Recordkeeping for Decommissioning

Rule: 12VAC5-481-450, 12VAC5-481-500, 12VAC5-481-510, 12VAC5-481-571, 12VAC5-481-1161, 12VAC5-481-3350, 12VAC5-481-3360

Criteria: A licensee authorized to possess licensed material in excess of the limits specified in **12VAC5-481-450 C** must meet the requirements for decommissioning financial assurance.

All licensees are required to maintain, in an identified location, records of information important to decommissioning of the facility until the site, or any area, is released for unrestricted use. Licensees must transfer records important to decommissioning either to the new licensee before licensed activities are transferred or assigned in accordance with **12VAC5-481-500** or to VDH before the license is terminated.

Discussion: VDH wants to ensure that decommissioning will be carried out with minimum impact on public and occupational health and safety and the environment. There are two parts to the rule: financial assurance that applies to SOME licensees, and recordkeeping that applies to ALL licensees.

12VAC5-481-450 C, when applicable, require the applicant to provide financial assurance or a decommissioning funding plan. This is to provide reasonable assurance that, after the technical and environmental components of decommissioning are carried out, unrestricted use of the facilities is possible at the termination of licensed activities. The agency's primary objective is to ensure that decommissioning will be carried out with minimum impact on the health and safety of the public, occupationally exposed individuals, and the environment. These requirements specify that a licensee either set aside funds for decommissioning activities or provide a guarantee through a third party that funds will be available. Before a license is issued, applicants are required to submit financial assurance or decommissioning funding plan when requesting authorization to possess any sealed or unsealed radioactive material with half life greater than 120 days exceeding certain the limits. Criteria for this determination is described in **12VAC5-481-450 C**.

Most well logging, tracer, and field flood study licensees use only a few of radioisotopes with a half life greater than 120 days. The most frequently used radioisotopes requiring financial assurance in unsealed form are Hydrogen-3, Carbon-14, and Silver-110 metastable, and, for sealed sources, Americium-241. **Table 5** provides a partial list of sealed and unsealed radioisotopes with a half life greater then 120 days with the corresponding limits. Radioisotopes with half lives greater then 120 days are listed in Column 1. Column 2 lists the corresponding possession limits of radioisotopes requiring financial assurance. Column 3 lists the corresponding possession limits of unsealed radioisotopes requiring the submittal of a decommissioning funding plan (DFP). These limits apply when only one of these radioisotopes is possessed. Applicants can use the data from **Table 6** or the method given in **Appendix I** to determine if financial assurance is required and the amount that is required when more than one of these radioisotopes is requested.

Table 6. Commonly Used Licensed Materials Requiring Financial Assurance/Decommissioning Funding Plan

Column 1: Radioisotope	**Column 2: Limit for F/A (millicuries*)**	**Column 3: Limit for DFP (millicuries*)**
Unsealed Materials		
H-3	1,000	> 100,000
C-14	100	> 10,000
Ag-110m	1	> 100
Sealed Materials		
Am-241	100,000	N/A

*1 millicurie = 37 MBq

NRC Regulatory Guide (RG) 3.66, *"Standard Format and Content of Financial Assurance Mechanisms Required for Decommissioning Under 10 CFR Parts 30, 40, 70, and 72"*, contains approved wording for each mechanism authorized to guarantee or secure funds.

Record Keeping

The requirements for maintaining records important to decommissioning, including the type of information required, are stated in **12VAC5-481-450 C**. All licensees are required to maintain these records in an identified location until the site is released for unrestricted use. In the event that the licensed activities are transferred to another person or entity, these records shall be transferred to the new licensee before transferring the licensed activities. The new licensee is responsible for maintaining these records until the license is terminated. When the license is terminated, these records shall be transferred to the agency.

12VAC5-481-450 C states the all of the records important to decommissioning must be maintained by a licensee and that they must be transferred or assigned according to **12VAC5-481-450 C**, if a license is transferred or to the agency, before the license is terminated. Licensees must maintain permanent records on locations where licensed materials are used or stored while the license is in force. These permanent records are important for making future determinations about the release of these locations for unrestricted use (e.g., before the license is terminated). Acceptable permanent records include sketches, written descriptions of specific locations where radioactive material is used or stored, and records of any leaking sealed sources, tracer material spills, contaminated waste storage areas, or other unusual occurrences involving the spread of contamination in or around the licensee's facilities or field stations. Permanent decommissioning records described above are not required for temporary job site locations.

References: NRC RG 3.66 and Policy and Guidance Directive FC 90-2 (Rev. 1), "*Standard Review Plan for Evaluating Compliance with Decommissioning Requirements*".

Item 9: Facilities and Equipment

Rule: 12VAC5-481-450, 12VAC5-481-630, 12VAC5-481-720, 12VAC5-481-840, 12VAC5-481-850, 12VAC5-481-860, 12VAC5-481-880, 12VAC5-481-930, 12VAC5-481-3170, 12VAC5-481-3180, 12VAC5-481-3200, 12VAC5-481-3250, 12VAC5-481-3260, 12VAC5-481-3300, 12VAC5-481-3310, 12VAC5-481-3330, 12VAC5-481-3350, 12VAC5-481-3360

Criteria: Facilities and equipment must be adequate to protect health, minimize danger to life or property and the possibility of contamination, and keep exposure to occupationally exposed workers and the public ALARA.

Discussion: Applicants must demonstrate that proposed facilities and equipment provide adequate storage capabilities, ensure that appropriate shielding is available to protect the health and safety of the public and employees, keep exposures to radiation and radioactive materials ALARA, and minimize the possibility of contamination from the uses, types, and quantities of radioactive materials requested.

Licensed materials located in an unrestricted area and not in storage must be under the constant surveillance and immediate control of the licensee. Areas where material is used or stored, including below ground bunker storage areas, should (1) be accessible only by authorized persons; and (2) secured or locked when an authorized person is not physically present. Use or storage areas cannot be considered restricted areas for purposes of radiation safety if accessible by unauthorized persons.

Applicants may delay completing facilities and acquiring equipment until after the application review is completed. Delaying the acquisition will allow for changes, if any, needed as a result of the application review. This delay will also ensure the adequacy of proposed facilities and equipment before the applicant makes a significant financial commitment. In all cases, the applicant cannot possess or use licensed material until after the facilities are approved, equipment is procured, and the license is issued.

Provide the following, as applicable:

- A drawing or sketch to an indicated scale or including dimensions of each proposed facility identifying areas where radioactive materials, including radioactive wastes, will be used or stored as well as adjacent buildings, boundary lines, security fences, and lockable storage areas. Illustrate area(s) where explosive, flammable, or other hazardous materials will be stored and the relationship and distance between restricted areas and unrestricted areas. Specify shielding materials (concrete, lead, etc) and means for securing radioactive materials from unauthorized removal.
- A drawing or sketch of proposed tracer material storage facilities including rooms, buildings, below ground bunker storage areas, or containers used for storage of both tracer and tracer waste materials; specifying the types and amount of shielding materials (concrete, lead, etc.) and means for securing tracer materials from unauthorized removal.
- Describe protective clothing (such as rubber gloves, coveralls, respirators, and face shields), auxiliary shielding, absorbent materials, injection equipment, secondary containers for waste water storage for decontamination purposes, plastic bags for storing contaminated items, etc., that will be available at well sites when using tracer materials.
- Describe proposed laundry facilities used for contaminated protective clothing, and specify how the contaminated waste water from the laundry machines or sinks is disposed. Operating and emergency procedures should address decontamination of the laundry area and equipment.
- Describe proposed decontamination facilities for trucks, tracer injection tools, or other equipment contaminated by tracer materials and specify how the contaminated waster water will be disposed. Operating and emergency procedures should address decontamination of these types of equipment and facilities.
- Describe equipment for 'repackaging' gaseous, volatile, or finely divided tracer material. Most tracer users do not repackage materials and acquire their injections in pre-calibrated amounts or 'ready to use' forms. However, when requesting the ability to repackage tracer, volatile, or finely divided materials, specify the following equipment for repackaging tracer materials: sinks, trays with absorbent material, glove boxes, fume hoods with charcoal filtration, filtered exhaust, special handling equipment including special tools, rubber gloves, etc.

12VAC5-481-930 authorizes the disposal of readily soluble radioactive materials via the sanitary sewage. Sanitary sewage does not include sewage treatment facilities, septic tanks, and leach fields owned or operated by a licensee.

Item 9.1 Minimization of Contamination

Rule: 12VAC5-481-450, 12VAC5-481-500, 12VAC5-481-630, 12VAC5-481-730, 12VAC5-481-740, 12VAC5-481-750, 12VAC5-481-1150, 12VAC5-481-1161, 12VAC5-481-3200 A, 12VAC5-481-3210, 12VAC5-481-3280, 12VAC5-481-3340, 12VAC5-481-3370

Criteria: Applicants for new licenses must describe how facility design and procedures for operation will minimize, to the extent practicable, contamination of the facility and the environment, facilitate eventual decommissioning, and minimize, to the extent practicable, the generation of radioactive waste.

Discussion: When designing facilities and developing procedures for their safe use, plan ahead and consider how to minimize radioactive contamination during operation, decontamination and decommissioning efforts, and radioactive waste generation. When submitting new applications, consider the following:

- Implementation of and adherence to good health physics practices while performing operations
- Minimization of distance to areas, to the extent practicable, where licensed materials are used and stored
- Maximization of survey frequency, within reason, to enhance detection of contamination
- Segregation of radioactive material in waste storage areas
- Segregation of sealed sources and tracer materials to prevent cross-contamination

- Separation of radioactive material from explosives
- Separation of potentially contaminated areas from clean areas by barriers or other controls.

Sealed sources found to be leaking in excess of 185 bequerels (0.005 microcuries) of removal contamination must be immediately withdrawn from use and placed in a safe storage location until disposed of according to VDH requirements. Special authorization must be granted by VDH to applicants to decontaminate a facility contaminated by a leaking sealed source. Approval granted in a license by VDH, NRC, or another Agreement State to provide these specialized services minimizes the spread of contamination and reduces radioactive waste associated with decontamination efforts.

Item 10: Radiation Safety Program

Rule: **12VAC5-481-450, 12VAC5-481-630, 12VAC5-481-990, 12VAC5-481-3151, 12VAC5-481-3260, 12VAC5-481-3280**

Criteria: A radiation safety program must be established and submitted to the agency as part of the application. The program must be commensurate with the scope and extent of activities for the use of licensed materials in well logging, tracer, and field flood study operations. Each applicant must develop, document, and implement a radiation protection program containing the following elements:

- Development and implementation of an ALARA program
- Description of equipment and facilities adequate to protect personnel, public, and the environment
- Confirmation that licensed activities are conducted only by individuals qualified by training and experience
- Development and maintenance of written operating and emergency procedures
- Implementation of an audit program to inspect the job performance of well logging supervisors and assistants
- Description of organization structure and individuals responsible for ensuring day-to-day oversight of the radiation safety program
- Establishment and management of a radiation safety and decommissioning records system.

Discussion: Individual components of a radiation safety program are addressed in the topics found in this VAREG. Some topics will not require the applicant to submit information as part of an application, but simply provide guidance to comply with a specific VDH requirement. VDH requires submission of operating and emergency procedures or, optionally, an outline or summary of each procedures that includes the important radiation safety aspects of each individual procedure.

Radiation safety programs including tracer materials must assure that they address these additional concerns methods or procedures for preventing the release of contaminated material, equipment or vehicles to unrestricted use from tracer or field flood study operations, radiation safety procedures and the well logging supervisors' responsibilities unique to tracer and field flood study operations, and tracer and field flood study equipment, techniques, and corresponding radiation safety procedures associated with use of tracer materials.

Appendix F includes a description of procedures for using tracer materials in field flood study operations.

Item 10.1 Well Owner/Operator Agreement

Rule: 12VAC5-481-480, 12VAC5-481-3160, 12VAC5-481-3340, 12VAC5-481-3370

Criteria: Well logging conducted with a sealed source shall only be performed if a written agreement with the employing well owner or operator is executed prior to commencement of the operation.

Discussion: Well logging operations conducted using a sealed source are performed only after a written agreement is executed with the employing well owner or operator. Written agreements must identify a responsible party for ensuring that the following steps will be taken if a source becomes lodged in a hole:

- A reasonable effort will be made to recover the source
- A person will not attempt to recover a lodged sealed source in a manner that, in the licensee's opinion, could result in its rupture
- During efforts to recover a sealed source, a licensee must continuously monitor the circulating fluids in the well bore, as required in **12VAC5-481-3340 G.**
- Contaminated equipment, personnel, or environment must be decontaminated prior to release
- If a sealed source is classified by the licensee as irretrievable after reasonable efforts at recovery have been expended, the following must be implemented within 30 days, as shown in **Figure 2**:
  - Source must be immobilized and sealed in place with a cement plug and there must be a means to prevent inadvertent intrusion, unless the source is not accessible to any subsequent drilling operations
  - Install a permanent identification plaque at the surface of the well, unless mounting of a plaque is not practical. **Figure 3** provides a diagram of a permanent identification plaque, describing the information that should be included on the plaque.
  - Notify the agency by telephone of the circumstances that resulted in the inability to retrieve the source and obtain approval to implement abandonment procedures.
- Send a copy of the abandonment report, within 30 days of the abandonment of the sealed source, to the agency and Virginia Department of Mines, Minerals, and Energy; Division of Gas and Oil. The abandonment report must contain all the information outlined in **12VAC5-481-3370 C 3**. Refer to **Appendices Q** and **V** for additional guidance.

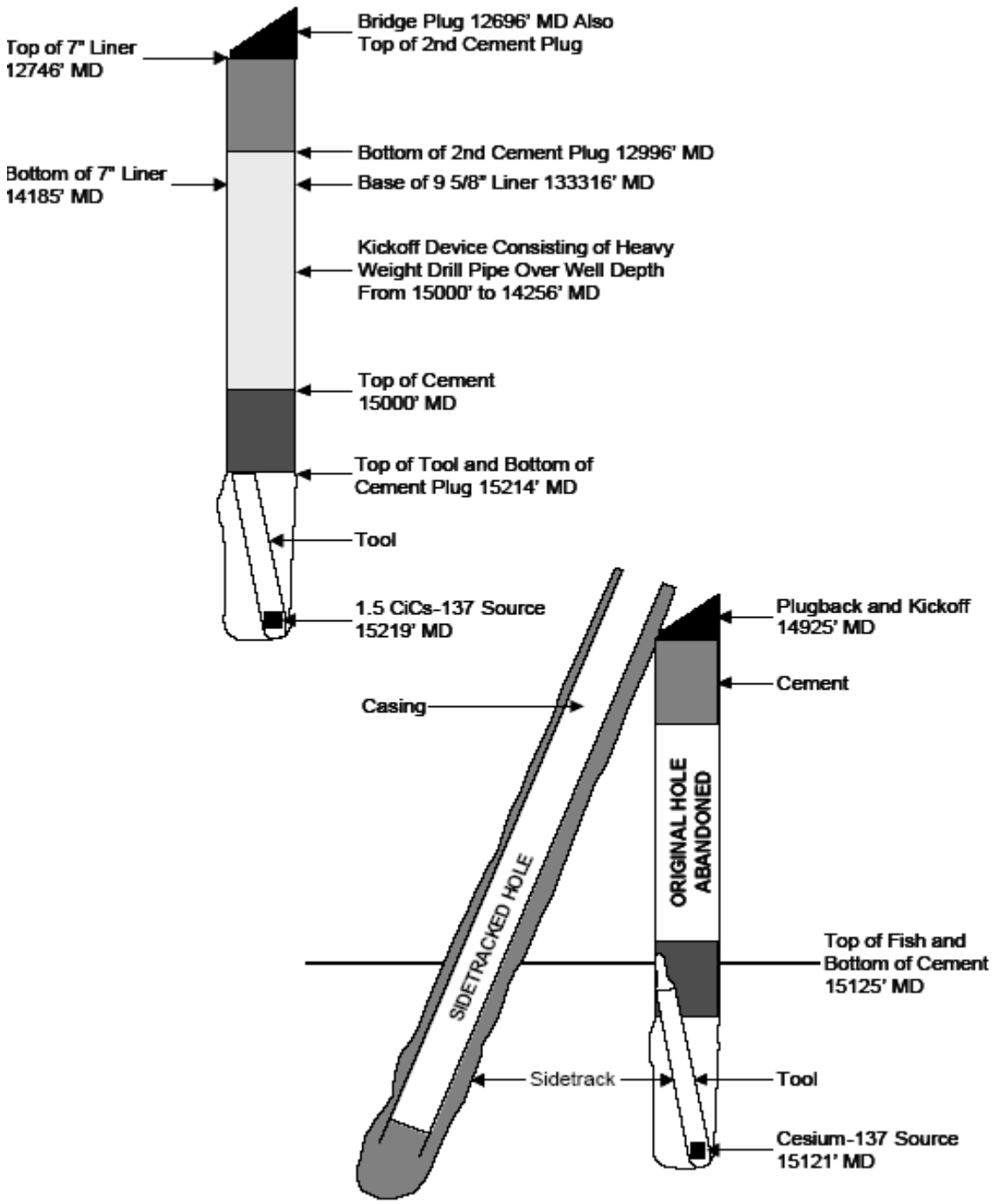


Figure 2. Features of a Typical Source Abandonment.

The agency is aware that in some circumstances, such as high well pressures that could lead to fires or explosions, the delay required to obtain approval to abandon the well may introduce an immediate threat. **Under such exigent circumstances, immediate abandonment, without prior approval, is authorized if a delay could cause an immediate threat to public health and safety.** Notification would be made as soon as possible after the abandonment. See **12VAC5-481-3370 C**.

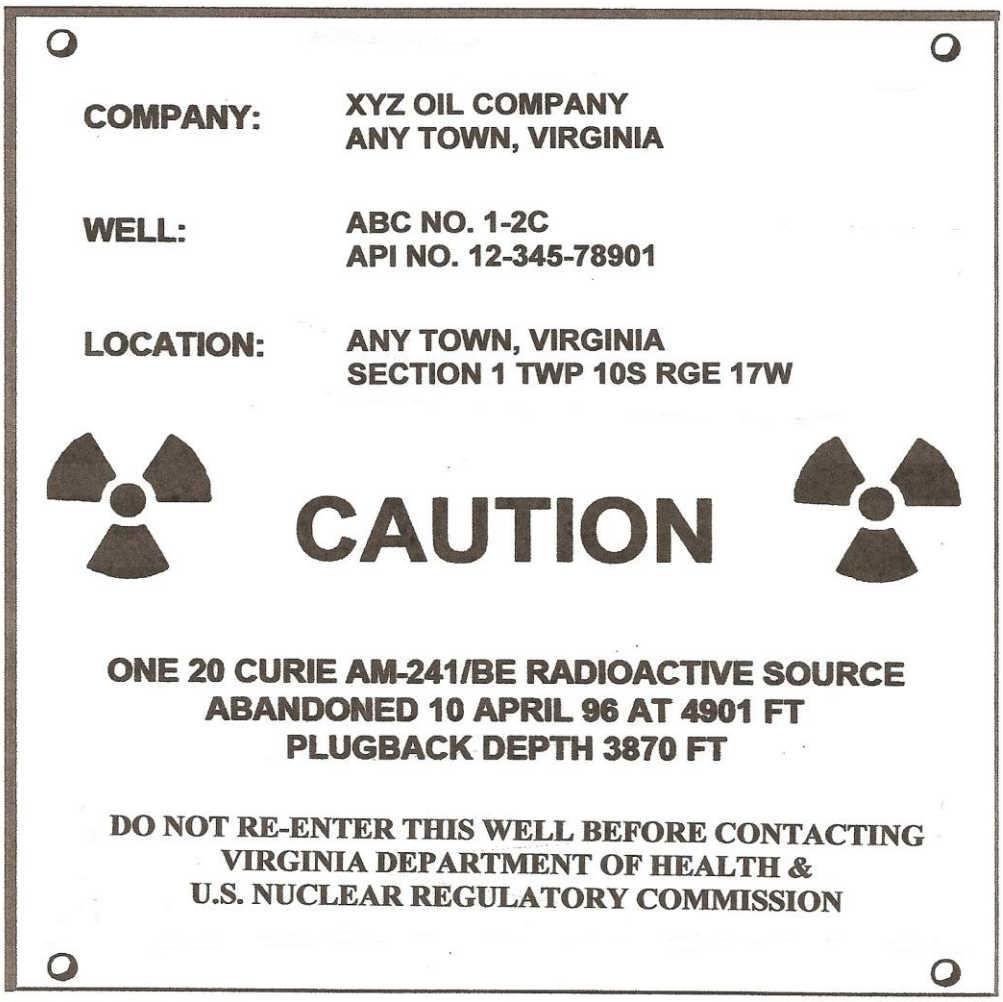


Figure 3. Permanent Identification Plaque.

Note: A written agreement is not required if the licensee and well owner or operator are part of the same corporate structure or otherwise similarly affiliated. However, all other requirements must still be met. If the requirement for a written agreement does not apply to you, then you should include a statement in your application that you will only log holes where the well owner or operator is part of your corporate structure or otherwise similarly affiliated, and you should describe the corporate affiliation.

Item 10.2 Radiation Safety Program Audit

Rule: 12VAC5-481-630, 12VAC5-481-990, 12VAC5-481-3151

Criteria: Licensees must review the content and implementation of their radiation protection programs annually to ensure the following:

- Compliance with the VDH and DOT regulations, and the terms and conditions of the license;
- Occupational doses and doses to members of the public are as low as reasonably achievable (ALARA) **(12VAC5-481-630)**; and
- Records of audits and other reviews of program content are maintained for 3 years.

Discussion: Appendix G contains a suggested audit program that is specific to the use of well logging, tracer and field studies and is acceptable to the agency. All areas indicated in **Appendix G** may not be applicable to every licensee and may not need to be addressed during each audit.

Currently the agency's emphasis in inspections is to perform actual observations of work in progress. As a part of their audit programs, applicants should consider performing unannounced audits of users in the field to determine if, for example, operating and emergency procedures are available, are being followed, etc.

It is essential that once identified, problems be corrected comprehensively and in a timely manner; NRC Information Notice (IN) 96-28, "*Suggested Guidance Relating to Development and Implementation of Corrective Action*", provides guidance on this subject. The agency will review the licensee's audit results and determine if corrective actions are thorough, timely, and sufficient to prevent recurrence. If violations are identified by the licensee and these steps are taken, the agency can exercise discretion and may elect not to cite a violation. The agency's goal is to encourage prompt identification and comprehensive correction of violations and deficiencies.

With regard to audit records, **12VAC5-481-990** requires licensees to maintain records of audits and other reviews of program content and implementation. The agency has found audit records that contain the following information to be acceptable: date of audit, name of person(s) who conducted audit, persons contacted by the auditor(s), areas audited, audit findings, corrective actions, and follow-up.

Item 10.3 Termination of Activities

Rule: 12VAC5-481-100, 12VAC5-481-450, 12VAC5-481-500, 12VAC5-481-510, 12VAC5-481-570, 12VAC5-481-571, 12VAC5-481-1161

Criteria: The licensee must do the following:

- Notify the agency, in writing, within 60 days of:
  - The expiration of its license;
  - A decision to permanently cease licensed activity at the entire site or in any separate building or outdoor area if it contains residual radioactivity making it unsuitable for release according to VDH requirements;
  - No principal activities have been conducted at the entire site under the license for a period of 24 months;
  - No principal activities have been conducted for a period of 24 months in any separate building or outdoor area if it contains residual radioactivity making it unsuitable for release according to VDH requirements.
- Submit a decommissioning plan, if required by **12VAC5-481-510;**
- Decommissioning, as required by **12VAC5-481-510 & 12VAC5-481-1161;**
- Submit to the agency, a completed VDH form 'Certificate of Disposition of Materials' (**Appendix B**) and demonstrate that the premises are suitable for release for unrestricted use (e.g. results of final survey); and
- Before a license is terminated, send the records important to decommissioning to the agency as required by **12VAC5-481-571**. If licensed activities are transferred or assigned in accordance with **12VAC5-481-500**, transfer records important to decommissioning to the new licensee.

Discussion: Before a licensee can decide whether it must notify the agency, the licensee must determine whether residual radioactivity is present and, if so, whether the levels make the building or outdoor area unsuitable for release according to VDH requirements. A licensee's determination that a facility is not contaminated is subject to verification by VDH inspection.

The permanent cessation of principal activities in an individual room or laboratory may require the licensee to notify the agency if no other licensed activities are being performed in the building. NRC Draft Regulatory Guide DG-4006, *"Demonstrating Radiological Criteria For License Termination"*, and NUREG/BR-0241,

"NMSS Handbook for Decommissioning Fuel Cycle and Materials Licenses", contain the current regulatory guidance concerning decommissioning of facilities and termination of licenses.

Appendix B of the Handbook contains a comprehensive list of NRC's decommissioning regulations and guidance. NUREG-1575, *"Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)"*, should be reviewed by licensees who have large facilities to decommission. An acceptable screening computer code for calculating screening values to demonstrate compliance with the unrestricted dose limits is D and D, Version 1; this was issued on August 20, 1998. Supplemental information on the implementation of the final rule on radiological criteria for license termination was published in the Federal Register (Volume 63, Number 222, Page 64132-64134) on November 18, 1998. This includes the acceptable license termination screening values of common radionuclides for building surface contamination (see **Table 7**).

Table 7. Acceptable License Termination Screening Values of Common Radionuclides for Building Surface Contamination

Radionuclide	Symbol	Acceptable Screening Levels*
Hydrogren-3 (Tritium)	H-3	1.2 x 108
Carbon-14	C-14	3.7 x 106
Sodium-22	Na-22	9.5 x 103
Sulfur-35	S-35	1.3 x 107
Iron-55	Fe-55	4.5 x 106
Cobalt-60	Co-60	7.1 x 103
Nickel-63	Ni-63	1.8 x 106
Strontium-90	Sr-90	8.7 x 106
Cesium-137	Cs-137	2.8 x 104
Iridium-192	Ir-192	7.4 x 104

* Screening levels are based on the assumption that the fraction of removable surface contamination is equal to 0.1. For cases when the fraction of removable contamination is undetermined or higher then 0.1, users may assure, for screening purposes, that 100% of surface contamination is removable; and therefore the screening levels should be decreased by a factor of 10. Alternatively, users may have site-specific data on the fraction of removable contamination (e. g., within 10% to 100% range) may calculate site-specific screening levels using D and D Version 1, based on site-specific re-suspension factor. For Unrestricted Release (dpm/100 cm^2). 1 dpm is equivalent to 0.0167 becquerel (Bq). The screening values represent surface concentrations of individual radionuclides that would be deemed in compliance with the 0.25 mSv/yr (25 mrem/yr) unrestricted released dose limit in **12VAC5-481-1161 B**. For radionuclides in a mixture, the 'sum of fractions' rule applies; refer to NRC Draft Guidance DG-4006 for further information on application of the values in this table.

Reference: VDH form, 'Certificate of Disposition of Materials', is included in **Appendix B**.

Item 10.4 Radiation Monitoring Instruments

Rule: 12VAC5-481-450, 12VAC5-481-750, 12VAC5-481-900, 12VAC5-481-1000, 12VAC5-481-1161, 12VAC5-481-3070, 12VAC5-481-3200.

Criteria: Licensees must possess radiation monitoring instruments that are necessary to protect health and minimize danger to life or property. Instruments used for quantitative radiation measurements must be calibrated for the radiation that it is used to measure at least every 6 months. For the purposes of this document, survey instruments are defined as any device used to measure the radiological conditions at a licensed facility, field station, or temporary job site.

Discussion: For well logging and tracer operations, instruments must be capable of measuring 0.001 millisievert (0.1 mrem) per hour through at least 0.5 millisievert (50 mrem) per hour. Licensees shall possess operable and calibrated radiation detection/measurement instruments to perform the following: surveys of

package(s), vehicle(s), tracer material equipment, vehicles, personnel, and sites, unrestricted areas, and sealed sources.

The choice of instrument should be appropriate for the type of radiation to be measured, and for the type of measurement to be taken (count rate, dose rate, etc.). Applications should include descriptions of the instrumentation available for use and instrumentation intended to purchased prior to starting licensed activities. The description should include type of instrument and probe, and the instrument's intended purpose. The agency requires that calibrations be performed by the instrument manufacturer or a person specifically authorized by VDH, the NRC or another Agreement State. Authorization to perform survey instrument calibrations shall be accompanied by procedures. **Appendix N** provides information about instrument specifications and model calibration procedures.

Note: Alternative responses will be reviewed using the criteria listed above.

Item 10.5 Material Receipt and Accountability

Rule: 12VAC5-481-100, 12VAC5-481-450, 12VAC5-481-500, 12VAC5-481-570, 12VAC5-481-571, 12VAC5-481-840, 12VAC5-481-900, 12VAC5-481-980, 12VAC5-481-1060, 12VAC5-481-1080, 12VAC5-481-3091, 12VAC5-481-3100, 12VAC5-481-3220, 12VAC5-481-3230, 12VAC5-481-3261

Criteria: Licensees must do the following:

- Develop procedures for ordering and safely opening packages of licensed material;
- Maintain records of receipt, transfer, and disposal of sealed sources, including tracer material;
- Conduct physical inventories at intervals not to exceed 6 months (or some other interval justified by the applicant) to account for all sealed sources; and
- Maintain utilization records.

Discussion: Licensed materials must be tracked from 'cradle to grave' in order to ensure accountability, identify when licensed material is lost, stolen, or misplaced, and to ensure that possession limits listed on the license are not exceeded. Physical inventories include locating, verifying the physical presence, and/or accounting for materials by the use of material receipt and transfer records.

'Cradle to Grave' Accountability refers to maintaining the radioactive material from the moment it becomes a part of your organization (whether through creation there, delivered to company, etc) through performing the physical inventories (ensuring the material's location, etc) until it leaves your organization (through shipment, disposal on/off site, etc)

Maintain inventory records that contain the following types of information:

- Radionuclide and amount (in units of Bq or curies) of radioactive material in each sealed source;
- Manufacturer's name, model number, and serial number of each sealed source;
- Manufacturer's name, model number, and serial number of each device containing depleted uranium or radioactive material;
- Location of each sealed source and device;
- Date of the inventory; and
- Name of individual performing inventory; and
- For materials transferred or disposed of, the date of the transfer or disposal, name and license number of the recipient, description of the affected radioactive material (e.g., radionuclide, activity, manufacturer's (or distributor's) name and model number, serial number).

These records should include the above information for all licensed material possessed, including sealed sources, tracer material on hand (including waste), and depleted uranium in sinker bars.

Note: Physical inventory records may be combined with leak test records.

Maintain utilization records that contain the following types of information:

- Make, model number, and a serial number or a description of each source of radiation used;
- The identity of the well-logging supervisor responsible for the source and the logging assistant present;
- Locations where used and dates of use; and
- In cased of tracer materials and radioactive markers, indicate the radiolnuclide and activity used in a particular well.

Item 10.6 Leak Tests

Rule: 12VAC5-481-740, 12VAC5-481-750, 12VAC5-481-1010, 12VAC5-481-1150, 12VAC5-481-3151, 12VAC5-481-3210

Criteria: VDH requires testing of sealed sources containing greater than 3.7 MBq (100 microcuries) of beta/gamma or 0.37 MBq (10 microcuries) of alpha radioactive material in order to determine whether there is any radioactive leakage from sealed sources. Requirements for leak tests are based on the type of radiation (beta/gamma/alpha) escaping from the inner capsule. Records of test results must be maintained per **12VAC5-481-3210**.

Discussion: VDH licenses will require the performance of leak tests on sealed sources authorized for well logging at intervals approved by the agency and as specified in the SSD Registration Sheet. The measurement of the leak test sample is a quantitative analysis requiring that instrumentation used to analyze the sample be capable of detecting 185 becquerels (0.005 microcuries) of radioactivity.

Manufacturers, consultants, and other organizations may be authorized by VDH, NRC, or another Agreement State either to perform the entire leak test sequence for other licensees or to provide leak test kits to licensees. In the latter case, the licensee is expected to take the leak test sample according to the manufacturer's and the kit supplier's instructions and return it to the kit supplier for evaluation and reporting results. Licensees may also be authorized to conduct the entire leak test sequence themselves.

Note: Requests for authorization to perform leak testing and sample analysis will be reviewed on a case-by-case basis and, if approved, VDH staff will authorize via a license condition. Alternative procedures will be evaluated against **Appendix R** criteria.

References: NRC Draft Regulatory Guide FC 412-4, *"Guide for the Preparation of Applications for the Use of Radioactive Materials in Leak-Testing Services"*, is available from NRC upon request.

Item 10.7 Occupational Dosimetry

Rule: 12VAC5-481-640, 12VAC5-481-650, 12VAC5-481-700, 12VAC5-481-710, 12VAC5-481-740, 12VAC5-481-750, 12VAC5-481-760, 12VAC5-481-3290, 12VAC5-481-3690

Criteria: According to **12VAC5-481-3290**, logging supervisors and logging assistants must wear either film badges or thermoluminescent dosimeters (TLDs) during the handling or use of licensed radioactive material. This requirement applies to personnel using dosimeters for whole body measurements. Although not included in **12VAC5-481-3290**, VDH and some other Agreement States have authorized Optically Stimulated Luminescence (OSL) dosimetry devices approved by the National Voluntary Laboratory Accreditation Program

(NVLAP). Licensees must provide to employees, either a film, OSL, or TLD that is processed by an accredited entity under NVLAP operated by the National Institute of Standards and Technology (NIST).

Appendix O provides guidance for determining if individuals other than the RSO, logging supervisors, or logging assistants require dosimetry.

Bioassay services must be provided to individuals using tracer materials in subsurface studies if required by the license.

Table 8. Occupational Dose Limits for Adults.

Occupational Dose Limits for Adults (12VAC5-481-640)	
Body Location	Dose (Annual)
Total Effective Dose Equivalent (TEDE)	0.05 Sv (5 Rem)
Dose to the skin of the whole body or any extremity*	0.5 Sv (50 Rem)
Dose to lens of the eyes	0.15 Sv (15 Rem)
**Extremities includes the arms below the elbows and the legs below the knees*	

Discussion: The licensee may not permit any individual to act as a logging supervisor or logging assistant unless, at all times during the handling of licensed radioactive material, each individual wears on the trunk of the body a NVLAP-approved film badge, TLD, or OSL/personnel dosimeter (if specifically approved by VDH) that is sensitive to the type of radiation(s) to which the individual is exposed. If neutron sources are to be used, a commitment to provide neutron sensitive dosimetry devices is required. Film badges must be replaced at intervals not to exceed 1 month and TLDs or OSL must be replaced at intervals not to exceed 3 months.
For purposes of internal dosimetry, bioassays are required when individuals work with volatile radioactive material in the quantities, chemical and physical forms, and activities that make it likely that the radionuclide will be ingested, inhaled, or absorbed resulting in an intake in excess of 10% of the applicable annual limit on intakes (ALIs) in **12VAC5-481-3690**. One ALI results in a committed effective dose equivalent (CEDE) of 5 rems or a committed dose equivalent (CDE) of 50 rems.

When using individually packaged 'ready to use' quantities of Iodine-131 tracer materials in well logging operations, bioassays are required for individuals using more than 50 millicuries at any one time, or using a total of 50 millicuries within any 5-day period. Guidance on bioassay programs for Iodine-131, including the levels and types of handling for which bioassays are indicated, is provided in the NRC Regulatory Guide 8.20, *"Applications of Bioassay for iodine-125 and iodine-131"*. Copies may be obtained from NRC's Regional Offices or online at http://www.nrc.gov. Bioassay services are available and provided by local hospitals, universities, or other vendors specifically approved to provide such services.

Bioassay programs should include an acceptable interval or schedule for conducting bioassays, identify action levels or guidelines, and describe specific actions to be taken when action levels are exceeded. Because of the complex nature of bioassay and corresponding data analysis, it is acceptable for applicants to make reference to the procedures in VDH or NRC guidance documents.

To obtain a copy of the NIST Publication 810, *"National Voluntary Laboratory Accreditation Program, 1997 Directory"*, contact the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402-9225. (For information on the program, call NIST at 301-975- 3679.) Also, NVLAP maintains a

directory of accredited laboratories on the Internet (updated quarterly); the URL for NVLAP's home page on the Internet is http://ts.nist.gov/nvlap.

Item 10.8 Public Dose

Rule: 12VAC5-481-630, 12VAC5-481-720, 12VAC5-481-730, 12VAC5-481-840, 12VAC5-481-1050, 12VAC5-481-3070, 12VAC5-481-3190, 12VAC5-481-3250, 12VAC5-481-3280, 12VAC5-481-3300

Criteria: Licensees must do the following: ensure that licensed material will be used, transported, stored, and disposed of in such a way that members of the public will not receive more than 1 mSv (100 mrem) in one year, and the dose in any unrestricted area will not exceed 0.02 mSv (2 mrem) in any one hour, from licensed operations; control and maintain constant surveillance of licensed material when in use and not in storage; and secure stored licensed material from access, removal, or use by unauthorized personnel.

Discussion: Members of the public include persons who work in or may occupy locations where licensed material is used or stored. Employees whose assigned duties do not include the use of licensed material and work in the vicinity where it is used or stored are also included as members of the public. Public dose is controlled, in part, by ensuring that licensed material is secured (e.g., located in a locked area) to prevent unauthorized access or use. Well logging sealed sources and tracer materials are usually restricted by controlling access to the keys needed to gain access to storage locations, including downhole storage bunkers.

Public dose is also affected by the choice of storage and use locations at the field stations and at temporary job sites. Licensed material must be located so that the resulting public dose in an unrestricted area (e.g., an office or the exterior surface of an outside wall) does not exceed 1 mSv (100 mrem) in a year or 0.02 mSv (2 mrem) in any one hour. Applicants should use the concepts of controlling time, distance, and shielding when choosing storage and use locations. Decreasing the time that an individual is exposed, increasing the distance from the radioactive material, and adding shielding that is appropriate for the specific type of radiation (e.g., brick, concrete, lead, hydrogenous materials, etc.) will reduce the radiation exposure.

Information provided by the manufacturer or vendor on anticipated radiation levels of sealed sources and tracer materials, both inside their respective transport containers and outside the transport container at given distances, is the type of information needed to make public dose calculations. Licensees may assess radiation levels located in adjacent areas to radioactive material either by making calculations or by using a combination of direct measurements and calculations. After obtaining anticipated radiation levels or by making direct radiation measurements using an appropriate survey instrument, use the 'inverse square' law to evaluate the effect on the public and develop operating and emergency procedures for using radioactive materials. See **Appendix P** for an example demonstrating that individual members of the public will not receive doses exceeding the allowable public limits.

If, after making an initial public dose evaluation, a licensee changes the conditions used for the evaluation (e.g., relocates radioactive material within a designated storage area, increases the amount of radioactive materials in storage, changes the frequency radioactive material is in use, or changes the occupancy of adjacent areas), the licensee must perform a new evaluation to ensure that the public dose limits are not exceeded and take corrective action, if required.

See **Appendix P** for examples of methods to demonstrate compliance.

Item 10.9 Maintenance

Rule: 12VAC5-481-1080, 12VAC5-481-3180, 12VAC5-481-3190, 12VAC5-481-3250, 12VAC5-481-3260, 12VAC5-481-3261, 12VAC5-481-3280, 12VAC5-481-3300

Criteria: The licensee shall have written procedures for visually inspecting and for maintaining source holders, logging tools, and source handling tools in an operable condition, including labeling. If equipment problems are found, the equipment must be withdrawn from service until repaired. Records of this inspection program are required.

Discussion: Each licensee shall visually check source holders, logging tools, and source handling tools for defects prior to each use to ensure that the equipment is in good working order and that required labeling is present. If defects are found, the equipment must be removed from service until repaired and a record made of the defect and the repairs made prior to returning the equipment for use. At intervals not to exceed 6 months, licensees shall conduct a visual inspection to ensure that no physical damage to equipment is visible and the required labeling is present. Licensees must establish a program for the routine maintenance of source holders, logging tools, inspection tools, source handling tools, storage containers, transport container, injection tools, and uranium sinker bars. If defects are found during the visible inspection or during the routine maintenance, the equipment must be removed from service until repaired and a record made of the defect and any repairs made prior to returning the equipment for use.

Non-routine and special maintenance (e.g., change of O rings on sealed sources or removal of a stuck sealed source) in a manner that could potentially damage or rupture the source, can only be performed by those licensees that have specifically received authorization from the VDH, NRC or another Agreement State. If defects are found as a result of the inspection and maintenance programs, the equipment must be removed from service until repairs are made, and a record of the defect must be retained for 3 years after the defect is found.

Item 10.9.1 Daily Maintenance

Rule: 12VAC5-481-880, 12VAC5-481-3180, 12VAC5-481-3190, 12VAC5-481-3250, 12VAC5-481-3260, 12VAC5-481-3280

Criteria: The licensee must have written procedures for visually inspecting and maintaining source holders, logging tools, and source handling tools for defects prior to use. This visual inspection is necessary to ensure that the equipment remains in good working condition and is labeled as required.

Discussion: 12VAC5-481-3260 A requires that logging tools, source holders, and source handling tools be checked visually for defects prior to use to ensure that the equipment is in good working condition and is labeled as required. Labeling requirements are specified in **12VAC5-481-3250**. Instructions in the operating procedures provided to personnel must clearly reflect the regulatory requirement—visual inspections are performed prior to use. Record, after the inspection,: the date, inspector, equipment involved, any defects found, or repairs made. Equipment that fails the inspection and cannot be repaired must be removed from service and returned only after it is successfully repaired.

The licensee must develop, implement, and maintain procedures for visually inspecting and maintaining source holders, logging tools, and source handling tools.

Item 10.9.2 Semi-Annual Visual Inspection and Routine Maintenance

Rule: 10 CFR 21.21, **12VAC5-481-880, 12VAC5-481-3180, 12VAC5-481-3190, 12VAC5-481-3250, 12VAC5-481-3260**

Criteria: Licensees must have written procedures for semiannual visual and routine maintenance of source holders, logging tools, injection tools, source handling tools, storage containers, transport containers, and uranium sinker bars to ensure that the labeling required by **12VAC5-481, 'Virginia Radiation Protection Regulations'** is legible and that no physical damage to the equipment is visible. Requirements in **10 CFR 21.21** specify, in part, that licensees adopt appropriate procedures to notify the NRC of any equipment that is defective or could result in a substantial safety hazard, and additionally, that management be informed as soon as practicable, within 5 working days, after the completion of the evaluation.

Discussion: Logging supervisors or assistants are expected to conduct visual inspections and provide routine maintenance activities on source holders, logging tools, injection tools, source handling tools, storage containers, transport containers, and uranium sinker bars to ensure that the labeling required by **12VAC5-481-880** and **12VAC5-481-3250** for sealed sources and for uranium sinker bars is legible, and that no physical damage is visible. If defects are found, the equipment must be removed from service and a record must be made listing: the defects, inspection and maintenance operations performed, and the actions taken to correct the defects. As noted in **12VAC5-481-3280 9**, instructions for conducting these activities must be included as part of the operating and emergency procedures. Instructions should be tailored to your specific program and to the equipment possessed and used.

Reporting defects, in accordance with **10 CFR 21.21**, is a management responsibility. The specific mechanism or procedures for reporting to the agency need not be covered in instructions to personnel.

Item 10.9.3 Maintenance Requiring Special Authorization

Rule: 12VAC5-481-500, 12VAC5-481-3260, 12VAC5-481-3280

Criteria: Certain maintenance procedures on sealed sources or holders that contain sealed sources are prohibited, unless a written procedure has been approved and the licensee is specifically authorized by the VDH, NRC or another Agreement State to perform these operations.

Discussion: Activities that are prohibited, unless a written procedure has been reviewed and approved by VDH, NRC, or another Agreement State, include:

- Removing a sealed source from a source holder or logging tool
- Preventive maintenance activities on sealed sources or holders that may be necessary when using certain types of logging tools, including removing and replacing O-rings
- Removing a sealed source that is stuck in a source holder or logging tool, e.g., any situation where tools are required to remove the stuck source.

Note: Equipment manufacturers can provide information concerning maintenance and source removal procedures. In some cases, certain maintenance operations should only be performed by the manufacturer or individuals who are licensed by VDH, NRC, or another Agreement State to provide these services.

Item 10.10 Operating and Emergency Procedures

Rule: 12VAC5-481-450, 12VAC5-481-840, 12VAC5-481-900, 12VAC5-481-1090, 12VAC5-481-1100, 12VAC5-481-1110, 12VAC5-481-2980, 12VAC5-481-3091, 12VAC5-481-3151, 12VAC5-481-3200, 12VAC5-481-3260, 12VAC5-481-3280, 12VAC5-481-3290, 12VAC5-481-3340, 12VAC5-481-3370

Criteria: The licensee must develop, implement, and maintain operating and emergency procedures or submit a summary of the procedures that addresses the important radiation safety aspects of each procedure to the agency as part of the application package. Additionally, if well logging and tracer personnel perform specific operations such as leak-testing, semi-annual inspection and maintenance of equipment, and removal and replacement of a sealed source O-ring, appropriate procedures and instructions for these operations should be included in the applicant's operating and emergency procedures.

Each licensee must develop, implement, and maintain operating and emergency procedures. Operating and emergency procedures' elements must include the items outlined in **12VAC5-481-3280**. The following is provided as a checklist of important items:

- Instructions for handling and using licensed materials, including sealed sources in wells, without surface casing for protecting fresh water aquifers
- Instructions for maintaining security during storage and transportation
- Instructions to keep licensed material under control and under immediate surveillance during use
- Steps to take to keep radiation exposures ALARA
- Steps to maintain accountability during use
- Steps to control access to work sites
- Steps to take and whom to contact when an emergency occurs
- Instructions for using remote handling tools when handling sealed sources, except low-activity calibration sources and radioactive tracer materials
- Methods and occasions for conducting radiation surveys, including surveys for detecting contamination, as required by **12VAC5-481-3340**.
- Procedures to minimize personnel exposure during routine use and in the event of an incident, including exposures from inhalation and ingestion of licensed tracer materials
- Methods and occasions for locking and securing stored licensed materials
- Personnel monitoring, including bioassays, and the use of personnel monitoring equipment
- Transportation of licensed materials to field stations or temporary job sites, packaging of licensed materials for transport in vehicles, placarding of vehicles when needed, and physically securing licensed materials in transport vehicles during transportation to prevent accidental loss, tampering, or unauthorized removal
- Procedures for picking up, receiving, and opening packages containing licensed materials, in accordance with **12VAC5-481-900**.
- Instructions for the use of tracer materials, including how to decontaminate the environment, equipment, and personnel
- Instructions for maintaining records in accordance with the regulations and the license conditions
- Steps for the use, inspection, and maintenance of sealed sources, source holders, logging tools, injection tools, source handling tools, storage containers, transport containers, and uranium sinker bars, as required by **12VAC5-481-3260**.
- Actions to be taken if a sealed source is lodged in a well
- Procedures and actions to be taken if a sealed source is ruptured, including actions to prevent the spread of contamination and minimize inhalation and ingestion of licensed materials and actions to obtain suitable radiation survey instruments, as required by **12VAC5-481-3200 B**.
- Instructions for the proper storage and disposal of radioactive waste
- Procedures for laundering contaminated clothing and for decontaminating equipment and vehicles
- Procedures to be followed in the event of uncontrolled release of radioactive tracer material to the environment, including notification of the RSO, the agency, and other state and federal agencies.

Discussion: The purpose of operating and emergency procedures is to provide well logging and tracer personnel, including field flood study personnel, with specific guidance for all operations they will perform. Each topic of importance should be included in the operating and emergency procedures and need not be presented in order. Instructions for non-routine operations, for example, inspection and maintenance of well logging and tracer equipment or conducting calibration of survey instruments, should be included as separate appendices in the application.

Operating and emergency procedures need not specify a particular make and model of survey instrument. Procedures should provide sufficient guidance and instruction for each specific type of well logging or associated equipment. For example, you may submit a single operating procedure for using sealed sources, tracer materials, and isotopes used in field flood operations, provided the unique variances in each operation are addressed in the application.

Operating and emergency procedures or a summary of the procedures that addresses the important radiation safety aspects of each must be submitted to the agency for review as a part of the application.

Item 10.11 Transportation

Rule: 12VAC5-481-100, 12VAC5-481-570, 12VAC5-481-571, 12VAC5-481-630, 12VAC5-481-880, 12VAC5-481-960, 12VAC5-481-1060, 12VAC5-481-1080, 12VAC5-481-2980, 12VAC5-481-3000, 12VAC5-481-3010, 12VAC5-481-3070, 12VAC5-481-3130, 12VAC5-481-3170, 12VAC5-481-3180, 12VAC5-481-3190, 12VAC5-481-3250, 49 CFR Parts 171-178

Criteria: Applicants must develop, implement, and maintain safety programs for transport of radioactive material to ensure compliance with VDH and Department of Transportation (DOT) regulations.

Discussion: Licensees should consider the safety of all individuals who may either handle or come into contact with transport containers or packages containing licensed material. The primary consideration in packaging licensed material should be to ensure that the package integrity is not compromised during transport and that the radiation levels or removable contamination levels at the package surfaces meet the regulatory requirements of **12VAC5-481-3070** and **12VAC5-481-3190**.

In all cases, ALARA concerns are addressed prior to, during, and after transporting any radioactive material.

Note: Licensees shipping radioactive waste for disposal must prepare appropriate documentation as specified in **12VAC5-481-960** and **Appendix S**.

Discussion: Ensuring radioactive materials are properly packaged in labeled containers that are braced and blocked, secured, and away from the driver while the shipping papers are kept in the cab with the driver illustrates some DOT requirements often overlooked by well logging, tracer, and field flood study licensees. During an inspection, the agency uses the provisions of **12VAC5-481-2980** and appropriate DOT regulations to examine and enforce transportation requirements applicable to well logging, tracer, and field flood study licensees. **Appendix S** lists major DOT regulations and provides a sample shipping paper.

References: *"A Review of Department of Transportation Regulations for Transportation of Radioactive Materials (1983 revision)"* can be obtained be calling DOT's Office of Hazardous Material Initiatives and Training at (202) 366-4425.

Item 11 Well Logging, Tracer, and Field Flood Study Operations

Item 11.1 Drill-to-Stop Large Sealed Sources

Rule: 12VAC5-481-3151, 12VAC5-481-3240, 12VAC5-481-3280, 12VAC5-481-3300, 12VAC5-481-3350, 12VAC5-481-3360, 12VAC5-481-3370

Criteria: Licensee must develop and follow instructions to be followed by logging personnel when using licensed sealed radioactive sources in drill-to-stop well logging operations. Unlike measurement while drilling (MWD) or logging while drilling (LWD) operations where well logging operations occur concurrent with the drilling operations, drill-to-stop (DTS) well logging operations require that all drilling operations cease and that parts of the drilling apparatus, including all of the drill stem, be removed to provide access to the well bore. The well logging tool containing one or more sealed sources is then lowered into the well bore to obtain information about the well or adjacent oil, gas, mineral, groundwater, or geological formations.

Discussion: Operating and emergency procedures that cover the use of sealed sources in DTS well logging operations must be developed and implemented.

Applicants who request authorization to use sealed sources in DTS well logging operations in well bores without a surface casing should describe the procedures to be followed necessary to ensure that a sealed source does not become lodged in the well bore. Examples of acceptable procedures include:

- Obtaining specific knowledge of the borehole conditions from the drilling team or company
- First running a caliper log to show the hole is open or to find problem areas
- First running a tool without a radioactive source to show it can be freely removed
- Placing a temporary casing in sections of the hole giving problems.

Instructions in DTS well logging activities should include procedures for using appropriate remote handling tools for handling sealed sources. If only certain handling tools are to be used with particular sealed sources, instructions should clearly address which handling tool is required for each specific sealed source.

Item 11.2 Measurement While Drilling, Logging While Drilling

Rule: 12VAC5-481-3151, 12VAC5-481-3240, 12VAC5-481-3280, 12VAC5-481-3300, 12VAC5-481-3350, 12VAC5-481-3360, 12VAC5-481-3370

Criteria: Licensees must develop and follow procedures to be followed by logging personnel when using licensed sealed radioactive sources in Measurement While Drilling (MWD) or Logging While Drilling (LWD) well logging operations. MWD or LWD well logging operations occur during the drilling of the well bore and do not require that the drill stem or other equipment be removed from the well. MWD or LWD requires that the well logging tool containing one or more sealed sources be located above the drilling stem to obtain information about the well or adjacent oil, gas, mineral, groundwater, or geological formations while the well drilling operation continues uninterrupted. Both MWD and LWD activities can be conducted at the same time drilling operations are occurring. Downhole recorded data from MWD or LWD sensors is transmitted to the surface through the use of mud telemetry.

Discussion: Operating and emergency procedures that cover the use of sealed sources in MWD or LWD well logging operations must be developed and implemented. Instructions in MWD and LWD well logging activities should include procedures for using appropriate remote handling tools for handling sealed sources. If only certain handling tools are to be used with particular sealed sources, instructions should clearly address which handling tool is required for each specific sealed source.

Item 11.3 Energy Compensation Sources

Rule: 12VAC5-481-500, 12VAC5-481-3151, 12VAC5-481-3210, 12VAC5-481-3220, 12VAC5-481-3230, 12VAC5-481-3240, 12VAC5-481-3280, 12VAC5-481-3350, 12VAC5-481-3360, 12VAC5-481-3370

Criteria: Energy compensation sources (ECSs) used in well logging operations are low-activity special form singly or doubly encapsulated sources containing less than or equal to 3.7 MBq (100 microcuries) of byproduct material. ECSs are used as reference or calibration standards for stabilizing and calibrating conventional, LWD, or MWD well logging tools.

Discussion: ECSs are not considered well logging sealed sources and are not required to satisfy the requirement for well logging sealed sources. As a result, ECSs are:

- Exempt, in most instances, from leak testing requirements, per **12VAC5-481-3210 E**, ECSs requiring leak testing must be tested at intervals not to exceed 3 years.
- Exempt from abandonment requirements when only ECSs less than or equal to 3.7 MBq (100 microcuries) remain in the abandoned tool.
- Exempt from the performance requirements of sealed sources used in well logging operations.
- Exempt from the monitoring requirements during source recovery operations when only ECSs less than or equal to 3.7 MBq (100 microcuries) remain in a well logging tool that is lodged in a well.
- Exempt from all requirements in **12VAC5-481, 'Virginia Radiation Protection Regulations', Part XIV, 'Radiation Safety Requirements for Wireline Service Operations and Subsurface Tracer Studies'**, with the exceptions of physical inventory and records of use. Requirements established in other parts of VDH regulations (e.g., **12VAC5-481, 'Virginia Radiation Protection Regulations', Part III** and **Part IV**) are still applicable to possession and use of byproduct material contained in ECSs.
- If a surface casing is not used to protect fresh water aquifers, see **12VAC5-481-3240 D** for applicable requirements.

Item 11.4 Use of Sealed Sources or Neutron Generators in Fresh Water Aquifers

Rule: 12VAC5-481-3241, 12VAC5-481-3280

Criteria: The licensee is prohibited from using sealed sources or neutron generators in fresh water aquifers unless the licensee requests and receives written permission from the agency.

Discussion: Use of radioactive materials in fresh water aquifers is a prohibited activity. Authorization to use sealed sources or neutron generators in fresh water aquifers requires that operating and emergency procedures include the following information:

- Obtaining specific knowledge of the borehole conditions from the drilling team or company
- First running a caliper log to show the hole is open or to find problem areas
- First running a tool without a radioactive source to show it can be freely removed
- Placing a temporary casing in sections of the hole giving problems.

Item 11.5 Tracer Studies in Single Well Applications

Rule: 12VAC5-481-640, 12VAC5-481-720, 12VAC5-481-750, 12VAC5-481-840, 12VAC5-481-900, 12VAC5-481-1090, 12VAC5-481-1100, 12VAC5-481-1110, 12VAC5-481-1161, 12VAC5-481-2980, 12VAC5-481-3190, 12VAC5-481-3200, 12VAC5-481-3260, 12VAC5-481-3280, 12VAC5-481-3290, 12VAC5-481-3320, 12VAC5-481-3340, 12VAC5-481-3350, 12VAC5-481-3360, 12VAC5-481-3370

Criteria: Applicants must develop, implement, and maintain safety programs for the use of unsealed material for tracer studies in single wells.

Discussion: Applicants' operating and emergency procedures should address the following concerns:

- Methods and occasions for conducting radiation surveys
- Methods and occasions for locking and securing tracer materials
- Personnel monitoring and the use of personnel monitoring equipment
- Transportation to temporary job sites and field stations, including the packaging and placing of tracer materials in vehicles, placarding of vehicles, and securing of tracer materials during transportation
- Procedures for minimizing exposure to members of the public and occupationally exposed individuals in the event of an accident
- Maintenance of records at field stations and temporary job sites
- Use, inspection, and maintenance of equipment (injector tools, remote handling tools, transportation containers, etc.)
- Procedures to be used for picking up, receiving, and opening packages containing radioactive material
- Decontamination of the environment, equipment, and personnel
- Notifications of proper personnel in the event of an accident.

Item 11.6 Field Flood and Secondary Recovery Applications (Tracer Studies in Multiple Wells)

Rule: 12VAC5-481-450, 12VAC5-481-500, 12VAC5-481-570, 12VAC5-481-640, 12VAC5-481-720, 12VAC5-481-840, 12VAC5-481-900, 12VAC5-481-1090, 12VAC5-481-1100, 12VAC5-481-1110, 12VAC5-481-1150, 12VAC5-481-1161, 12VAC5-481-2980, 12VAC5-481-3151, 12VAC5-481-3160, 12VAC5-481-3260, 12VAC5-481-3280, 12VAC5-481-3290, 12VAC5-481-3300, 12VAC5-481-3320, 12VAC5-481-3340, 12VAC5-481-3350, 12VAC5-481-3360, 12VAC5-481-3370

Criteria: Applicants must develop, implement, and maintain safety programs for the use of unsealed material for tracer studies in multiple wells (field flood studies). Refer to **Appendix F** in developing step-by-step instructions for tracer personnel in performing field flood tracer studies for multiple wells. Field flood study activities where licensed material is intentionally released into the environment require an environmental assessment (EA) in accordance with the provisions of appropriate United States Code of regulation and Virginia Administrative Code regulations.

Reference: NUREG/CR-3467, *"Environmental Assessment of the Use of Radionuclides as Tracers in the Enhanced Recovery of Oil and Gas"*. For copies of NUREG/CR-3467, available at the NRC website: http://www.nrc.gov.

Discussion: Applicants should address the following when requesting field flood and secondary recovery applications:

- Agreement with well operator or owner
- Field flood study project design
- Pre-injection phase of the field flood project
- Injection phase
- Post-injection phase

- Emergency procedures
- Reporting and record keeping requirements
- Waste management
- Methods and occasions for conducting radiation surveys
- Methods and occasions for locking and securing tracer materials
- Personnel monitoring and the use of personnel monitoring equipment
- Transportation to temporary job sites and field stations, including the packaging and placing of tracer materials in vehicles, placarding of vehicles, and securing tracer materials during transportation
- Procedures for minimizing exposure to members of the public and occupationally exposed individuals in the event of an accident
- Maintenance of records at field stations and temporary job sites
- Use, inspection, and maintenance of equipment (injector tools, remote handling tools, transportation containers, etc.)
- Procedures to be used for picking up, receiving, and opening packages containing radioactive material
- Decontamination of the environment, equipment, and personnel
- Notifications of proper personnel in the event of an accident.

Item 11.7 Tracer Studies in Fresh Water Aquifers

Rule: 12VAC5-481-3320

Criteria: Applicants must develop, implement, and maintain a safety program for using tracer materials in fresh water aquifers. Licensees may not knowingly inject licensed material into a freshwater aquifer unless specifically authorized to do so by the VDH license.

Discussion: VDH, in accordance with **12VAC5-481-3320 B**, prohibits the intentional injection of licensed tracer material into a fresh water aquifer unless the individual is specifically authorized by the license to perform this activity. VDH staff position concerning the intentional injection of licensed tracer material authorized under **12VAC5-481, 'Virginia Radiation Protection Regulations', Part XIV, 'Radiation Safety Requirements for Wireline Service Operations and Subsurface Tracer Studies'** into a fresh water aquifer requires the preparation of an environmental report by the licensee or applicant. Well logging applicants and applicants requesting field flood studies should refer to the appropriate United States Code (**10 CFR Part 51.45**) or Virginia Administrative Code (9VAC15-20) and prepare an environmental report. Authorizing an applicant to conduct tracer studies in accordance with **12VAC5-481, 'Virginia Radiation Protection Regulations', Part XIV, 'Radiation Safety Requirements for Wireline Service Operations and Subsurface Tracer Studies'** in fresh water aquifers would require an assessment of an environmental report and a "*finding of no significant impact*".

Authorizing field flood studies that require the applicant to intentionally inject licensed tracer material into a fresh water aquifer would require that an environmental report be prepared by the applicant and an environmental assessment be made by an authorized party.

Regulation specifies criteria for categorical exclusions. When one or more of the criteria for a categorical exclusion are satisfied, the applicant or licensee is relived from the requirements for preparing an environmental impact statement. This then relieves the requirement of preparing an environmental assessment prior to the issuance, amendment, or renewal of licenses authorizing the use of radioactive tracers in well logging procedures authorized under **12VAC5-481, 'Virginia Radiation Protection Regulations', Part XIV, 'Radiation Safety Requirements for Wireline Service Operations and Subsurface Tracer Studies'**. However, the intentional release of licensed radioactive material directly to the environment as a result of a research or other study is not categorically excluded. In special circumstances or on the request of any interested

individual or party, an environmental assessment on an action normally covered by a categorical exclusion could be required.

Note: Completion of an environmental assessment, based on the level of complexity, can require several months to review, approve, and publish for comments.

Radioactive Markers

Item 11.8 Radioactive Collar and Subsidence or Depth Control Markers

Rule: 12VAC5-481-3220, 12VAC5-481-3261, 12VAC5-481-3280, 12VAC5-481-3730

Criteria: Radioactive markers are usually used as pipe collar markers include wires, tape, nails, etc. Applicants can use radioactive markers only where each individual marker contains quantities of licensed material not exceeding the quantities identified in **12VAC5-481-3730**. Radioactive markers must be physically inventoried at intervals not to exceed 6 months, as specified in **12VAC5-481-3220**.

Discussion: Operating and emergency procedures must include a commitment that radioactive markers can be used only where each individual marker contains quantities of licensed material not exceeding the quantities identified in **12VAC5-481-3730**. However, licensees are not restricted to using only one marker, and may use multiple markers in each pipe joint, provided each individual marker (wires, tape, nails, etc.) is not greater than the quantities identified in **12VAC5-481-3730**. Additionally, provisions must be included in the operating and emergency procedures to ensure that radioactive markers undergo physical inventories at intervals not to exceed 6 months, as specified in **12VAC5-481-3220**.

Note: Subsidence or depth control markers that use quantities greater that those authorized by **12VAC5-481-3261** must be approved or registered by the VDH, NRC or another Agreement State in an SSD Registration Certificate.

Item 11.9 Neutron Accelerators using Licensed Material

Rule: 12VAC5-481-720, 12VAC5-481-730, 12VAC5-481-780, 12VAC5-481-790, 12VAC5-481-3241, 12VAC5-481-3280, 12VAC5-481-3340

Criteria: Applicants authorized to use a neutron generator (particle accelerator) containing a tritium source, should include operating and emergency procedures for the proper handling and use of the accelerator targets or tubes containing radioactive materials.

Discussion: Neutron generators (accelerators) are used in the well logging industry as a source of neutrons. Most accelerators use tritium gas sealed in a glass tube or plated on a target or disc. Neutron generator target sources, in most instances, contain less than 1,110 GBq (30 curies) of tritium.

Neutron generator tubes are not considered well logging sealed sources and are not required to satisfy the requirement for well logging sealed sources. As a result, neutron generator tubes containing less than 1,110 GBq (30 curies) of tritium are:

- Exempt from abandonment requirements
- Exempt from leak test requirements
- Exempt from the performance requirements of sealed sources used in well logging operations
- Not exempt if a tritium neutron generator for target source is greater than 1,110 GBq (30 curies) or is used in a well without a surface casing to protect fresh water aquifers.

Applicants using a neutron generator (particle accelerator) should include handling procedures that address contamination. Operating and emergency procedures should instruct individuals in the handling of contamination resulting from the routine use, initial installation, replacement, or accidental damage of the targets or glass tubes. Refer to **12VAC5-481-3241** for applicable requirements for using neutron generators.

Item 11.10 Depleted Uranium Sinker Bars

Rule: 12VAC5-481-420, 12VAC5-481-570, 12VAC5-481-3250, 12VAC5-481-3260, 12VAC5-481-3340

Criteria: Depleted uranium sinker bars are both generally licensed and specifically licensed. Most well logging licensees acquire depleted uranium sinker bars under the provisions of **12VAC5-481-420 C** and then file with VDH. Specifically licensed material must be physically inventoried and visually inspected for labeling and physical damage.

Discussion:

Depleted Uranium Sinker Bars Authorized Under General License

Certain devices are authorized by VDH for distribution to persons who are generally licensed for the use of certain industrial products or devices containing depleted uranium for the purpose of providing a concentrated mass in a small volume. Uranium sinker bar devices can be acquired by the users under the provisions of **12VAC5-481-420 C** without obtaining a specific license from VDH; however, when acquired under the provisions of a general license, individuals must file with VDH.

Generally licensed sinker bars are exempt from **12VAC5-481, 'Virginia Radiation Protection Regulations', Part IV** and **Part X**. Regulatory requirements that apply to such devices possessed under a general license are stated in **12VAC5-481-420 C**. While operating under the provision of a general license for these types of devices, general licensees must:

- Not introduce uranium sinker bars into a chemical, physical, or metallurgical treatment or process, except as a treatment for restoration of any plating or covering
- Not abandon uranium sinker bars
- Transfer only to individuals authorized under the provisions of **12VAC5-481-570**
- Notify the agency within 30 days of the transfer of depleted uranium sinker bars.

Depleted Uranium Sinker Bars Authorized under a Specific License

While operating under the provision of a specific license for these types of devices, specific licensees must:

- Physically inventory the uranium sinker bars at intervals not to exceed 6 months.
- Visually inspect before use for proper labeling, "*CAUTION RADIOACTIVE DEPLETED URANIUM*" and "*NOTIFY CIVIL AUTHORITIES (or COMPANY NAME) IF FOUND*", at intervals not to exceed 6 months.
- Visually inspect for physical damage and conduct routine maintenance at intervals not to exceed 6 months, as specified in **12VAC5-481-3260**.
- Remove bars from use if found defective, until repaired or disposed.
- Record information specified in **12VAC5-481-3260**.

Item 12: Waste Management

Rule: 12VAC5-481-100, 12VAC5-481-570, 12VAC5-481-571, 12VAC5-481-840, 12VAC5-481-880, 12VAC5-481-910, 12VAC5-481-920, 12VAC5-481-930, 12VAC5-481-940, 12VAC5-481-950, 12VAC5-481-960, 12VAC5-481-970, 12VAC5-481-971, 12VAC5-481-1060, 12VAC5-481-1890, 12VAC5-481-2571, 12VAC5-481-2572, 12VAC5-481-2980, 12VAC5-481-3690

Criteria: Radioactive waste must be disposed of in accordance with regulatory requirements and license conditions and/or transferred to an authorized recipient. Authorized recipients are the original manufacturer, distributor, a commercial firm licensed by VDH, NRC, or another Agreement State to accept radioactive waste from other persons, or in the case of sealed sources, transferred to another specific licensee authorized to possess the licensed material (i.e., a transferees' license specifically authorizes the same radionuclide, chemical or physical form, and in most instances, the same use). Records of transfer and waste disposal must be maintained per **12VAC5-481-1060**.

Before transferring any radioactive material, including radioactive waste, a licensee must verify that the recipient is properly authorized to receive the specific type of material using one of the methods described in **12VAC5-481-570**. In addition, all packages containing radioactive waste must be prepared and shipped in accordance with VDH and DOT regulations. Records of transfer and disposal must be maintained as required by **12VAC5-481-100** and **12VAC5-481-571**.

Discussion: Radioactive waste generated when conducting licensed activities may include: sealed sources, used or unused radioactive tracer materials, and unusable items contaminated with radioactive tracer materials (e.g., absorbent paper, gloves, bottles, etc.). Unsealed radioactive waste must be stored in strong, tight containers (e.g., thick plastic bags, boxes, barrels, etc.) to prevent the spread of contamination, and sealed sources should be stored in their corresponding transport containers or in a downhole storage bunker until their disposal. The integrity of the radioactive waste containers must be assured, and the containers, while in storage, must have the appropriate warning label specified in **12VAC5-481-880**. Radioactive waste must be secured against unauthorized access or removal. Depending on the radioactive half-life of the material, VDH requires disposal of well logging sealed sources and tracer materials generated at licensees' facilities by one or more of the following methods:

Tracer Material with a Half-Life of 120 Days or Less:

- Decay-in-storage (DIS)
- Transfer to an authorized recipient
- Release into sanitary sewerage
- Obtaining prior approval from VDH of any alternate method
- Release in effluents to unrestricted areas, other than into sanitary sewerage
- Incineration.

Tracer Material with a Half-Life Greater Than 120 Days:

- Transfer to an authorized recipient
- Release into sanitary sewerage
- Extended interim storage
- Obtaining prior approval from VDH of any alternate method
- Release in effluents to unrestricted areas, other than into sanitary sewerage
- Incineration.

Sealed Sources with a Half-Life of 120 Days or Less:

- Transfer to an authorized recipient
- DIS
- Extended interim storage.

Sealed Sources with a Half-Life Greater Than 120 Days:

- Transfer to an authorized recipient.

Licensees may choose any one or more of these methods to dispose of their radioactive waste. The agency's experience indicates that most well logging tracers are stored or disposed of by a combination of methods, transfer to an authorized recipient and DIS being the most frequently used. Applicants requesting authorization to dispose of radioactive tracer waste by incineration should first refer to NRC's Policy and Guidance Directive PG 8-10, *"Disposal of Incinerator Ash as Ordinary Waste"*, for guidance. Applicants should note that compliance with VDH regulations does not relieve them of their responsibility to comply with any other applicable local, state, or federal regulations. Some types of radioactive waste used in tracer operations and in 'labeled frac sands' may include additional chemical hazards. This type of waste is designated as 'mixed waste' and requires special handling and disposal.

Applicants should describe, in detail, their program for management and disposal of radioactive waste, including mixed waste, if applicable. A waste management program should include procedures for handling waste; specify the requirements for safe and secure storage; and describe how to characterize, minimize, and dispose of all types of radioactive waste, including, where applicable, mixed waste. Appropriate training should be provided to waste handlers. **12VAC5-481-1060** requires, in part, that licensees maintain all appropriate records of disposal of radioactive waste. The U.S. Environmental Protection Agency (EPA) issued guidance for developing a comprehensive program to reduce hazardous waste that, in many instances, may also include radioactive waste as a contaminant. NRC transmitted these guidelines to licensees in NRC IN-94-23, *"Guidance to Hazardous, Radioactive, and Mixed Waste Minimization Program"*,.

Disposal By Decay-in-Storage (DIS)

The agency has concluded that materials with half-lives of less than or equal to 120 days are appropriate for DIS. The minimum holding period for decay is ten half-lives of the longest-lived radioisotope in the waste with a half-life of 120 days or less. Such waste may be disposed of as ordinary trash if radiation surveys (performed in a low background area and without any interposed shielding) of the waste at the end of the holding period indicate that radiation levels are indistinguishable from background. All radiation labels must be defaced or removed from containers and packages prior to disposal as ordinary trash. If the decayed waste is compacted, all labels that are visible in the compacted mass must also be defaced or removed.

Applicants should assure that adequate space and facilities are available for the storage of such waste. Licensees can minimize the need for storage space, if the waste is segregated according to physical half-life. Waste containing radioisotopes with physical half-lives 120 days or less may be segregated and stored in a container and allowed to decay for at least ten half-lives based on the longest-lived radioisotope in the container. Waste management procedures should include: methods of segregating waste by physical half-lives of 120 days or less, greater than 120 days, methods of surveying waste prior to disposal to confirm that waste above background levels is not inadvertently released, and maintenance of records of disposal. Disposal records for DIS should include the date when the waste was put in storage for decay, date of disposal, and results of final survey taken prior to disposal as ordinary trash. Additionally, a model procedure for disposal of radioactive waste by DIS, which incorporates the above guidelines, is provided in **Appendix T**.

Release Into Sanitary Sewerage

12VAC5-481-930 authorizes disposal of radioactive waste by release into sanitary sewerage if each of the following conditions is met:

- Material is readily soluble (or is easily dispersible biological material) in water

- Quantity of licensed material that the licensee releases into the sewer each month averaged over the monthly volume of water released into the sewer does not exceed the concentration specified in **12VAC5-481-3690**, Table 3.
- If more than one radioisotope is released, the sum of the ratios of the average monthly discharge of a radioisotope to the corresponding limit in **12VAC5-481-3690**, Table 3 cannot exceed unity
- Total quantity of licensed material released into the sanitary sewerage system in a year does not exceed 185 GBq (5 Ci) of H-3, 37 GBq (1 Ci) of C-14, and 37 GBq (1 Ci) of all other radioisotopes combined.

Licensees are responsible to demonstrate that licensed materials discharged into the sewerage system are indeed readily dispersible in water. NRC IN 94-07, *"Solubility Criteria for Liquid Effluent Releases to Sanitary Sewerage Under the Revised 10 CFR 20"*, provides the criteria for evaluating solubility of liquid waste. Careful consideration should be given to the possibility of re-concentration of radioisotopes that are released into the sewer. NRC alerted licensees to the potentially significant problem of re-concentration of radionuclides released to sanitary sewerage systems in NRC IN 84-94, *"Reconcentration of Radionuclides Involving Discharges into Sanitary Sewerage Systems Permitted Under 10 CFR 20.203 (now 10 CFR 20.2003)"*,.

Applicants electing to use this type of disposal should provide procedures that will ensure that all releases of radioactive waste into the sanitary sewerage meet the criteria stated in **12VAC5-481-930** and do not exceed the monthly and annual limits specified in VDH regulations. Licensees are required to maintain accurate records of all releases of licensed material into the sanitary sewerage. A model program for disposal of radioactive waste via sanitary sewer is described in **Appendix T**.

Note: 12VAC5-481, 'Virginia Radiation Protection Regulations' prohibits the disposal of radioactive materials via a sewage treatment facility, septic system, or leach field owned or operated by the licensee.

Transfer to an Authorized Recipient

Licensees may transfer radioactive waste to an authorized recipient for disposal. However, it is the licensee's responsibility to verify that the intended recipient is authorized to receive the radioactive waste prior to making any shipment. Waste generated at well logging and tracer facilities generally consists of low specific activity (LSA) material. The waste must be packaged in DOT-approved containers for shipment, and each container must identify the radioisotopes and the amounts contained in the waste. Additionally, packages must comply with the requirements of the particular burial site's license requirements. Each shipment must comply with all applicable VDH and DOT requirements. In some cases, the waste handling contractor may provide additional guidance and requirements to licensees for packaging and transportation; however, the licensee is ultimately responsible for ensuring compliance with all applicable regulatory requirements.

The shipper must provide all information to VDH and transfer this recorded manifest information to the intended recipient. Each shipment manifest must include a certification by the waste generator. Each person involved in the transfer for disposal and disposal of waste, including waste generator, waste collector, waste processor, and disposal facility operator, must comply with appropriate VDH and DOT regulations..

Licensees should implement procedures to reduce the volume of radioactive waste for final disposal in an authorized low-level radioactive waste (LLW) disposal facility. These procedures include volume reduction by segregating, consolidating, compacting, or allowing certain waste to decay in storage. Waste compaction or other treatments can reduce the volume of radioactive waste, but such processes may pose additional radiological hazards (e.g., airborne radioactivity) to workers and members of the public. The program should include adequate safety procedures to protect workers, members of the public, and the environment.

Applicants may request alternate methods for the disposal of radioactive waste generated at their facilities. Such requests will be handled on a case-by-case basis and require that the applicant provide additional site-specific information. In most instances, requests for alternate methods of disposal must describe the types and quantities

of waste containing licensed material, physical and chemical properties of the waste that may be important to making a radiological risk assessment, and the proposed manner and conditions of waste disposal. Additionally, the applicant must submit its analysis and evaluation of pertinent information specific to the affected environment, including the nature and location of other affected facilities, and provide an outline of its procedures to ensure that radiation doses are maintained ALARA and within VDH limits. Because of the difficulties and costs associated with disposal of sealed sources (e.g., sealed sources containing Americium-241) applicants should preplan disposal. Applicants may want to consider contractual arrangements with the source supplier as part of a purchase agreement.

Extended Interim Storage

Prior to requesting extended interim storage of radioactive waste materials, and this only as a last resort, licensees should exhaust all possible alternatives for disposal of radioactive waste. The protection of occupationally exposed workers and the public is enhanced by disposing of radioactive waste, rather than storing it. In addition, licensees may find it more economical to dispose of radioactive waste than to store it on-site. As available burial ground capacity decreases, cost of disposal of radioactive waste most likely will continue to increase. Other than DIS, LLW should be stored only when disposal capacity is unavailable and for no longer than is necessary. NRC IN 90-09, *"Extended Interim Storage of Low-Level Radioactive Waste by Fuel Cycle and Materials Licensees"*, and NRC IN 93-50, *"Extended Storage of Sealed Sources"*, provides guidance to VDH licensees for requesting an amendment to authorize extended interim storage of both sealed and unsealed LLW.

Note: Applicants do not need to provide information to the agency if they plan to dispose of LLW via transfer to an authorized recipient. Alternative responses will be reviewed using the criteria listed above.

References: A copy of all of the below is available on the NRC's website at: http://www.nrc.gov.
1. NRC Policy and Guidance Directive PG 8-10, "*Disposal of Incinerator Ash as Ordinary Waste*",
2. NRC Policy and Guidance Directive PG 94-05, "*Updated Guidance on Decay-In-Storage*",
3. NRC Information Notice 94-23, "*Guidance to Hazardous, Radioactive, and Mixed Waste Minimization Program*",
4. NRC Information Notice 94-07, "*Solubility Criteria for Liquid Effluent Releases to Sanitary Sewerage Under the Revised 10 CFR 20*",
5. NRC Information Notice 84-94, "*Reconcentration of Radionuclides Involving Discharges into Sanitary Sewerage Systems Permitted Under 10 CFR 20.203 (now 10 CFR 20.2003)*",
6. NRC Information Notice 90-09, "*Extended Interim Storage of Low-Level Radioactive Waste by Fuel Cycle and Materials Licensees*",
7. NRC Information Notice 93-50, "*Extended Storage of Sealed Sources*",.

Item 13: License Fees

For a listing of application fees, please see **12VAC5-490**. On VDH form, 'Application for a Radioactive Material License Authorizing the Use of Material in Well Logging, Tracer, and Field Flood Study', enter the fee category and the amount.

Note: Applicants who wish to perform field flood tracer studies should review the applicable Virginia Administrative Code or United States Code regulation for further information concerning the environmental information needed to prepare an environmental assessment.

Item 14: Certification

Individuals acting in a private capacity are required to date and sign VDH form, 'Application for a Radioactive Material License Authorizing the Use of Material in Well Logging, Tracer, and Field Flood Study' (**Appendix A**). Otherwise, representatives of the corporation or legal entity filing the application should sign and date VDH form, 'Application for a Radioactive Material License Authorizing the Use of Material in Well Logging, Tracer, and Field Flood Study' (**Appendix A**). **Representatives signing an application must be authorized to make binding commitments and sign official documents on behalf of the applicant**. The agency will return all unsigned applications for proper signature.

Note:

- It is a violation of **12VAC5-481-30** to make a willful false statement or representation on applications or correspondence.
- When the application references commitments, those items become part of the licensing conditions and regulatory requirements.

Appendix A

VDH Form,
‘Application for a Radioactive Material License Authorizing the Use of Material in Well Logging, Tracer, and Field Flood Study’

Virginia Department of Health
Radioactive Materials Program
(804) 864-8150

APPLICATION FOR A NEW RADIOACTIVE MATERIAL LICENSE AUTHORIZING THE USE OF MATERIAL IN WELL LOGGING, TRACER, AND FIELD FLOOD STUDY

The Virginia Department of Health (VDH) is requesting disclosure of all information for the purpose of obtaining a radioactive material license. Failure to provide any information may result in denial or delay of a radioactive material license.

Instructions – Complete all items. Refer to VAREG 'Guidance for Well Logging, Tracer and Field Flood Study'. Use supplementary sheets where necessary. Retain one copy and submit original of the entire application to: Virginia Department of Health, Radioactive Materials Program, 109 Governor Street, Room 730, Richmond, VA 23219.

APPLICATION TYPE

Item 1 Type Of Application (Check box)

☐ New License

CONTACT INFORMATION

Item 2 Name and Mailing Address Of Applicant:	**Item 3 Person To Contact Regarding Application:**
, -	
Applicant's Telephone Number (Include area code): ( ) - x	**Contact's Telephone Number** (Include area code): ( ) - x

LOCATION OF RADIOACTIVE MATERIAL

Item 4 Location of Radioactive Material (Do not use Post Office Box):

(Attach additional pages if necessary)

☐ Used ☐ Stored ☐ Used and Stored	Address: , -	Telephone Number (Include area code): ( ) - x
☐ Used ☐ Stored ☐ Used and Stored	Address: , -	Telephone Number (Include area code): ( ) - x
☐ Used ☐ Stored ☐ Used and Stored	Address: , -	Telephone Number (Include area code): ( ) - x

Are sources going to be used and/or stored at field stations? ☐ Yes ☐ No

Are sources going to be used and/or stored at temporary jobsites?: ☐ Yes ☐ No

If yes, check the following boxes:

- ☐ We will perform and maintain documentation of radiation surveys to ensure that radiation levels are less than 2 mR in any one hour and 100 mR/yr at all temporary job site storage locations.
- ☐ We will store the source(s) at the temporary job site in a locked room, trailer, or other secure location to prevent unauthorized removal.
- ☐ We will minimize exposures for occupational and non-occupational workers when selecting storage location.
- ☐ We will limit storage at a temporary job site to 180 days per calendar year.

RADIATION SAFETY OFFICER

Item 5 Radiation Safety Officer (RSO) (Check all that apply)

☐ The name of the proposed RSO and other potential designees who will be responsible for ensuring that the licensee's radiation safety program is implemented in accordance with approved procedures.

NAME: _____ TELEPHONE NUMBER (Include area code): (_____) _____ - _____ x _____

AND

☐ We will demonstrate that the RSO has sufficient independence and direct communication with responsible management officials by providing a copy of an organizational chart by position and will confirm that the RSO has day-to-day oversight of the radiation safety activities.

AND EITHER

☐ We have included documentation showing the RSO's qualifications and experience.

OR

☐ We will provide alternative information demonstrating that the proposed RSO is qualified by training and experience (e. g., listed by name as an authorized user or the RSO on an VDH, NRC, or another Agreement State license that requires a radiation safety program of comparable size and scope) including documentation to show that the RSO has obtained formal training in the establishment and maintenance of a radiation protection program.

TRAINING FOR LOGGING SUPERVISORS AND LOGGING ASSISTANTS

Item 6 Training For Logging Supervisors, Logging Assistants, and Tracer/Field Flood Study Users (Check box and attach requested information)

☐ We will submit an outline of the training to be given to prospective logging supervisors and logging assistants and have enclosed our training procedures given to experienced logging supervisors. We have also submitted a typical examination given, the correct answers to the questions, and the passing grade.

AND

☐ We have included the qualifications of our instructors and their experience with well logging activities or have included the course title, name, course outline (if available), address, and telephone number of the company who will provide training.

AND

☐ We have submitted a description of the field examination given to prospective logging supervisors and assistants.

AND

☐ We have submitted an description of our program including the annual refresher training with the topics and how they will be covered, and the inspection of each logging supervisor and logging assistants job performance, as described in **12VAC5-481-3151**.

RADIOACTIVE MATERIAL

Item 7 Radioactive Material (Attach additional pages if necessary)
Include sealed sources activity greater then 3.7 MBq (100 μCi)

Element and mass number	Sealed source manufacturer and model number
Maximum activity per source and total maximum activity in possession	Source changer manufacturer and model number

Are unsealed tracer materials used? ☐ Yes (complete below information) ☐ No

Element name and mass number	Chemical/physical form
Maximum activity per tracer material and total maximum activity in possession Maximum amount per study by physical/chemical form	If volatile, anticipated rate of volatility or dispersion Intended use

Are energy compensation sources used? ☐ Yes (complete below information) ☐ No

Element name and mass number	Manufacturer's name and model number

FINANCIAL ASSURANCE AND RECORDKEEPING FOR DECOMMISSIONING

Item 8 Financial Assurance And Recordkeeping For Decommissioning (Check both boxes)

☐ We shall maintain drawings and records important to decommissioning and will transfer these records to a new licensee before licensed activities are transferred in accordance with **12VAC5-481-500 B** or assign the records to the agency before the license is terminated.

AND

☐ If financial assurance is required, submit evidence per **12VAC5-481-450 C**.

FACILITIES AND EQUIPMENT

Item 9 Facilities And Equipment (Check box and attach requested information)

☐ We will submit the required information as listed in the section titled 'Facilities and Equipment' of VAREG 'Guidance for Well Logging, Tracer, and Field Flood Study'.

RADIATION SAFETY PROGRAM

Item 10 Radiation Safety Program (Check box)

☐ We have included our radiation safety program for agency review.

Item 10.1 Well Owner/Operator Agreement (Check box)

☐ We will obtain a written agreement prior to commencement of operating any well logging operation with a sealed source as specified in **12VAC5-481-3160**.

Item 10.2 Radiation Safety Audit Program

The applicant is not required to, and should not, submit its audit program to the agency for review during the licensing phase. This matter will be examined during an inspection.

Item 10.3 Termination of Activities (Check box)

☐ We will notify VDH, in writing, within 60 days of the decision to permanently cease radioactive material use (**12VAC5-481-510**).

Item 10.4 Radiation Monitoring Instruments (Check all boxes that apply)

☐ We will possess and use radiation survey meter(s) that meets the Criteria in the section titled 'Radiation Monitoring Instruments' in VAREG 'Guidance for Well Logging, Tracer, and Field Flood Studies'. We reserve the right to upgrade our survey instruments as necessary.

AND EITHER

☐ If calibration is performed by a person or firm outside the applicant's organization, the calibration will be performed by a VDH, NRC or another Agreement State licensee specifically authorized to perform instrument calibration.

OR

☐ We will follow the survey meter calibration procedures in accordance with Appendix N in VAREG 'Guidance for Well Logging, Tracer, and Field Flood Study'.

OR

☐ We will submit alternate procedures. (Procedures are attached)

Note: Identify the qualifications of the individuals who will perform the calibrations if performed by the applicant.

Item 10.5 Material Receipt And Accountability (Check box)

☐ Semi-annual physical inventories will be conducted of all licensed material, including byproduct, tracer materials, and depleted uranium and the information contained in the discussion section titled 'Material Receipt and Accountability' in VAREG 'Guidance for Well Logging, Tracer, and Field Flood Studies' will be documented.

Item 10.6 Leak Tests (Check one box)

☐ Leak tests will be performed by an organization authorized by VDH, the NRC or another Agreement State to provide leak testing services to other licensees; or by the licensee using a leak test kit supplied by an organization licensed by VDH, the NRC or another Agreement State to provide leak test kits to other licensees according to kit suppliers' instructions.

List the name and license number of organization authorized to perform or analyze leak test (Specify whether VDH, NRC, or another Agreement State):

Organization Name _____ License Number _____

Issuing Entity _____

Note: An alternate organization may be used to perform or analyze leak test, without amending the license, provided the organization is specifically authorized by VDH, the NRC or another Agreement State.

OR

☐ We will perform our own leak testing and sample analysis. We will follow the procedures in Appendix R of VAREG 'Guidance for Well Logging, Tracer, and Field Flood Study'.

OR

☐ We will submit alternative procedures. (Procedures are attached)

Item 10.7 Occupational Dosimetry (Check all boxes that apply)

☐ We will provide required dosimetry that will be processed and evaluated by a NVLAP-approved processor that is exchanged monthly or quarterly, as appropriate, and worn by well logging personnel.

AND/OR

☐ We will provide a bioassay program when using unsealed tracer materials.

OR

☐ We will provide a commitment that no individual will use more than 50 millicuries of Iodine-131 at any one time or in any 5-day period at field stations or temporary job sites.

Note: If intend to use an excess of amounts described or request permission to repackage or process Iodine-131 tracer materials at field stations, it is necessary to describe in detail the bioassay program

OR

☐ We will contract a vendor for bioassay services who is licensed or otherwise authorized by VDH, NRC, or another Agreement State to provide required bioassay services.

Item 10.8 Public Dose

No response is required, in this license application, however the licensee's evaluation of public dose will be examined during an inspection.

Item 10.9 Maintenance

Item 10.9.1 Daily Maintenance (Check both boxes)

☐ We have included procedures for conducting daily visual inspection.

OR

☐ Visual daily inspection will be conducted and records maintained in accordance with the criteria listed in 'Daily Maintenance' of the VAREG 'Guidance for Well Logging, Tracer, and Field Flood Study' to ensure that well logging equipment is in good working condition and is labeled as required.

Item 10.9.2 Semi-Annual Visual Inspection and Routine Maintenance (Check both boxes)

☐ We have included procedures for semi annual visual inspection and routine maintenance of source holders, logging tools, injection tools, source handling tools, storage containers, transport containers, and uranium sinker bars to ensure that the labeling required by **12VAC5-481-3250** is legible and that no physical damage is visible.

AND

☐ Semiannual inspections and routine maintenance will be conducted and records maintained for source holders, logging tools, injection tools, source handling tools, storage containers, transport containers, and uranium sinker bars in accordance with the criteria in 'Semi-Annual Visual Inspection and Routine Maintenance' of VAREG 'Guidance for Well Logging, Tracer, Field Flood Study' to ensure that well logging equipment is in good working condition with no physical damage evident and that required labeling is present.

Item 10.9.3 Maintenance Requiring Special Authorization (Check both boxes)

☐ Prohibited activities described in 'Maintenance Requiring Special Authorization' of VAREG 'Guidance for Well Logging, Tracer, Field Flood Study' will not be conducted unless approved by VDH.

OR

☐ Submit detailed procedures of each different tasks (including source removal procedures) for any prohibited activities, including radiation safety precautions that individuals will be expected to follow when performing these tasks and the minimum qualifications of these individuals.

Item 10.10 Operating and Emergency Procedures

☐ Operating and emergency procedures or an outline or summary as described in **12VAC5-481-3151** and **12VAC5-481-3280** have been attached for agency review.

Item 10.11 Transportation

No response is needed from applicants during licensing phase. This matter will be examined during an inspection.

WELL LOGGING, TRACER, AND FIELD FLOOD STUDY OPERATIONS

Item 11. Well Logging, Tracer, and Field Flood Study Operations

Item 11.1 Drill-to-Stop Large Sealed Sources (Check box)

☐ We have submitted procedures for conducting Drill-to-Stop well logging operations or an outline or summary that addresses important radiation safety aspects in the operating and emergency procedures.

Item 11.2 Measurement While Drilling, Logging While Drill (Check box)

☐ We have submitted procedures for conducting Measurement While Drilling, Logging While Drilling well logging operations or an outline or summary that addresses important radiation safety aspects in the operating and emergency procedures.

Item 11.3 Energy Compensation Sources (Check box)

☐ We have submitted operating and emergency procedures for using and handling energy compensation sources.

OR

☐ We have submitted an outline or summary of the operating and emergency procedures for using and handling energy compensation sources including instructions for leak testing energy compensation sources, if required, at intervals not to exceed 3 years, instructions for conducting physical inventories at least every 6 months, maintaining records of inventories required by **12VAC5-481-3220** and records of use for energy compensation sources.

OR

☐ We have submitted alternative procedures for agency review.

OR

☐ Energy compensation sources will not be used

Item 11..4 Use of Sealed Sources or Neutron Generators in Fresh Water Aquifers (Check box)

☐ We will not conduct this prohibited activity.

OR

☐ We are requesting authorization for this prohibited activity and have included the required procedures as stated in 'Use of Sealed Sources or Neutron Generators in Fresh Water Aquifers' of VAREG, 'Guidance for Well Logging, Tracer, and Field Flood Study'.

Item 11.5 Tracer Studies in Single Well Applications (Check box)

No response is required for this section provided that the elements in the 'Tracer Studies in Single Well Applications' of VAREG 'Guidance for Well Logging, Tracer, and Field Flood Study' are contained in other sections.

Item 11.6 Field Flood and Secondary Recovery Applications (Tracer Studies in Multiple Wells) (Check box)

☐ Field flood studies using tracer materials will not be conducted unless authorized specifically by license conditions.

OR

☐ We are requesting authorization to conduct field flood studies in the enhanced recovery of oil and gas wells using the information provided in Appendix F of the VAREG 'Guidance for Well Logging, Tracer, and Field Flood Study'.

Item 11.7 Tracer Studies in Fresh Water Aquifers (Check box)

☐ We will not knowingly inject tracer material into a fresh water aquifer.

OR

☐ We are requesting authorization to inject licensed radioactive materials into a fresh water aquifer and are providing the reason(s) for this study and procedures to protect the worker(s) and the public. **Note:** Tracer and field flood studies require an environmental report.

Item 11.8 Radioactive Collar and Subsidence or Depth Control Markers (Check box)

☐ We will only use radioactive markers where each individual marker contains only quantities of licensed material not exceeding the quantities identified in **12VAC5-481-3730**.

OR

☐ We have submitted procedures for using radioactive markers that in excess of quantities listed in **12VAC5-481-3730**.

Item 11.9 Neutron Accelerators using Licensed Material (Check box)

☐ We will not use neutron generators (accelerators) in our well logging operations.

OR

☐ We will use neutron generators (accelerators) in accordance with the criteria in 'Neutron Accelerators using Licensed Material' of VAREG 'Guidance for Well Logging, Tracer, and Field Flood Study'.

Item 11.10 Depleted Uranium Sinker Bars (Check box)

☐ Depleted uranium sinker bars will be obtained under the provisions of a general license (**12VAC5-481-420 C**) and the appropriate VDH form will be filed, as required.

OR

☐ Depleted uranium sinker bars will not be obtained under provisions of a general license (**12VAC5-481-420 C**).

AND

Uranium sinker bars will be possessed and inspected as specified in **12VAC5-481-3260.**

AND

We request _____ kilograms of material.

OR

☐ Depleted uranium sinker bars will not be used.

WASTE MANAGEMENT

Item 12 Waste Management

☐ We will use Appendix T of VAREG 'Guidance for Well Logging, Tracer, and Field Flood Study'.

OR

☐ We will use Decay-In-Storage model waste procedure in Appendix T of VAREG, 'Guidance for Well Logging, Tracer, and Field Flood Study'.

AND/OR

☐ We will use Disposal of Liquids Into Sanitary Sewage (**12VAC5-481-930**) model waste procedure in Appendix T of VAREG, 'Guidance for Well Logging, Tracer, and Field Flood Study'.

OR

☐ We have attached our procedures for waste collection, storage, and disposal by any of the authorized methods and request authorization for the methods described.

SPECIFIC LICENSE FEE

Item 13 License Fees (Refer to **12VAC5-490**).

Application Fee Enclosed:

☐ Yes Amount Enclosed $

CERTIFICATION (To be signed by an individual authorized to make binding commitments on behalf of the applicant.)

Item 14

I hereby certify that this application was prepared in conformance with **12VAC5-481, 'Virginia Radiation Protection Regulations'** and that all information contained herein, including any supplements attached hereto, is true and correct to the best of my knowledge and belief.

SIGNATURE - Applicant Or Authorized Individual	Date signed

Print Name and Title of above signatory

Virginia Department of Health
Radioactive Materials Program
(804) 864-8150

APPLICATION FOR RENEWAL OF A RADIOACTIVE MATERIAL LICENSE AUTHORIZING THE USE OF MATERIAL IN WELL LOGGING, TRACER, AND FIELD FLOOD STUDY

The Virginia Department of Health (VDH) is requesting disclosure of all information for the purpose of renewing a radioactive material license. Failure to provide any information may result in denial or delay of a radioactive material license.

Instructions – Complete all items. Refer to VAREG 'Guidance for Well Logging, Tracer and Field Flood Study'. Use supplementary sheets where necessary. Retain one copy and submit original of the entire application to: Virginia Department of Health, Radioactive Materials Program, 109 Governor Street, Room 730, Richmond, VA 23219.

APPLICATION TYPE

Item 1 Type Of Application (Check box**)**

☐ Renewal License Number

CONTACT INFORMATION

Item 2 Name and Mailing Address Of Applicant:	**Item 3 Person To Contact Regarding Application:**
, -	
Applicant's Telephone Number (Include area code):	**Contact's Telephone Number** (Include area code):
( ) - x	**(** **)** - x

LOCATION OF RADIOACTIVE MATERIAL

Item 4 Location of Radioactive Material (Do not use Post Office Box):

(Attach additional pages if necessary)

☐ as listed on current license.

OR

☐ as listed on current license and please add the listed additional locations.

OR

☐ see provided information for current locations.

☐ Used ☐ Stored ☐ Used and Stored	Address: , -	Telephone Number (Include area code): ( ) - x
☐ Used ☐ Stored ☐ Used and Stored	Address: , -	Telephone Number (Include area code): ( ) - x

Are sources going to be used and/or stored at field stations? ☐ Yes ☐ No

Are sources going to be used and/or stored at temporary jobsites?: ☐ Yes ☐ No

If yes, check the following boxes:

- ☐ We will perform and maintain documentation of radiation surveys to ensure that radiation levels are less than 2 mR in any one hour and 100 mR/yr at all temporary job site storage locations.
- ☐ We will store the source(s) at the temporary job site in a locked room, trailer, or other secure location to prevent unauthorized removal.
- ☐ We will minimize exposures for occupational and non-occupational workers when selecting storage location.
- ☐ We will limit storage at a temporary job site to 180 days per calendar year.

RADIATION SAFETY OFFICER

Item 5 Radiation Safety Officer (RSO) (Check all that apply)

☐ As listed on current license

OR

☐ See attached for qualifications of the proposed Radiation Safety Officer.

NAME: _____

TELEPHONE NUMBER (Include area code): (_____) _____ - _____ x _____

TRAINING FOR LOGGING SUPERVISORS AND LOGGING ASSISTANTS

Item 6 Training For Logging Supervisors, Logging Assistants, and Tracer/Field Flood Study Users (Check box and attach requested information)

☐ We will submit an outline of the training to be given to prospective logging supervisors and logging assistants and have enclosed our training procedures given to experienced logging supervisors. We have also submitted a typical examination given, the correct answers to the questions, and the passing grade.

AND

☐ We have included the qualifications of our instructors and their experience with well logging activities or have included the course title, name, course outline (if available), address, and telephone number of the company who will provide training.

AND

☐ We have submitted a description of the field examination given to prospective logging supervisors and assistants.

AND

☐ We have submitted an description of our program including the annual refresher training with the topics and how they will be covered, and the inspection of each logging supervisor and logging assistants job performance, as described in **12VAC5-481-3151**.

RADIOACTIVE MATERIAL

Item 7 Radioactive Material (Attach additional pages if necessary)
Include sealed sources activity greater than 3.7 MBq (100 μCi)

☐ As listed on current license.

OR

☐ As listed on current license and see attached for additional requested material.

OR

☐ See attached for material requested.

Element and mass number	Sealed source manufacturer and model number
Maximum activity per source and total maximum activity in possession	Source changer manufacturer and model number

Are unsealed tracer materials used? ☐ Yes (complete below information) ☐ No

Element name and mass number	Chemical/physical form
Maximum activity per tracer material and total maximum activity in possession Maximum amount per study by physical/chemical form	If volatile, anticipated rate of volatility or dispersion Intended use

Are energy compensation sources used? ☐ Yes (complete below information) ☐ No

Element name and mass number	Manufacturer's name and model number

FINANCIAL ASSURANCE AND RECORDKEEPING FOR DECOMMISSIONING

Item 8 Financial Assurance And Recordkeeping For Decommissioning (Check both boxes)

☐ We shall maintain drawings and records important to decommissioning and will transfer these records to a new licensee before licensed activities are transferred in accordance with **12VAC5-481-500 B** or assign the records to the agency before the license is terminated.

AND

☐ If financial assurance is required, submit evidence per **12VAC5-481-450 C**.

FACILITIES AND EQUIPMENT

Item 9 Facilities And Equipment (Check box and attach requested information)

☐ We will submit the required information as listed in the section titled 'Facilities and Equipment' of VAREG 'Guidance for Well Logging, Tracer, and Field Flood Study'.

RADIATION SAFETY PROGRAM

Item 10 Radiation Safety Program (Check box)

☐ We have included our radiation safety program for agency review.

Item 10.1 Well Owner/Operator Agreement (Check box)

☐ We will obtain a written agreement prior to commencement of operating any well logging operation with a sealed source as specified in **12VAC5-481-3160**.

Item 10.2 Radiation Safety Audit Program

The applicant is not required to, and should not, submit its audit program to the agency for review during the licensing phase. This matter will be examined during an inspection.

Item 10.3 Termination of Activities (Check box)

☐ We will notify VDH, in writing, within 60 days of the decision to permanently cease radioactive material use (**12VAC5-481-510**).

Item 10.4 Radiation Monitoring Instruments (Check all boxes that apply)

☐ We will possess and use radiation survey meter(s) that meets the Criteria in the section titled 'Radiation Monitoring Instruments' in VAREG 'Guidance for Well Logging, Tracer, and Field Flood Studies'. We reserve the right to upgrade our survey instruments as necessary.

AND EITHER

☐ If calibration is performed by a person or firm outside the applicant's organization, the calibration will be performed by a VDH, NRC or another Agreement State licensee specifically authorized to perform instrument calibration.

OR

☐ We will follow the survey meter calibration procedures in accordance with Appendix N in VAREG 'Guidance for Well Logging, Tracer, and Field Flood Study'.

OR

☐ We will submit alternate procedures. (Procedures are attached)

Note: Identify the qualifications of the individuals who will perform the calibrations if performed by the applicant.

Item 10.5 Material Receipt And Accountability (Check box)

☐ Semi-annual physical inventories will be conducted of all licensed material, including byproduct, tracer materials, and depleted uranium and the information contained in the discussion section titled 'Material Receipt and Accountability' in VAREG 'Guidance for Well Logging, Tracer, and Field Flood Studies' will be documented.

Item 10.6 Leak Tests (Check one box)

☐ Leak tests will be performed by an organization authorized by VDH, the NRC or another Agreement State to provide leak testing services to other licensees; or by the licensee using a leak test kit supplied by an organization licensed by VDH, the NRC or another Agreement State to provide leak test kits to other licensees according to kit suppliers' instructions.

List the name and license number of organization authorized to perform or analyze leak test (Specify whether VDH, NRC, or another Agreement State):

Organization Name _____ License Number _____

Issuing Entity _____

Note: An alternate organization may be used to perform or analyze leak test, without amending the license, provided the organization is specifically authorized by VDH, the NRC or another Agreement State.

OR

☐ We will perform our own leak testing and sample analysis. We will follow the procedures in Appendix R of VAREG 'Guidance for Well Logging, Tracer, and Field Flood Study'.

OR

☐ We will submit alternative procedures. (Procedures are attached)

Item 10.7 Occupational Dosimetry (Check all boxes that apply)

☐ We will provide required dosimetry that will be processed and evaluated by a NVLAP-approved processor that is exchanged monthly or quarterly, as appropriate, and worn by well logging personnel.

AND/OR

☐ We will provide a bioassay program when using unsealed tracer materials.

OR

☐ We will provide a commitment that no individual will use more than 50 millicuries of Iodine-131 at any one time or in any 5-day period at field stations or temporary job sites.

Note: If intend to use an excess of amounts described or request permission to repackage or process Iodine-131 tracer materials at field stations, it is necessary to describe in detail the bioassay program

OR

☐ We will contract a vendor for bioassay services who is licensed or otherwise authorized by VDH, NRC, or another Agreement State to provide required bioassay services.

Item 10.8 Public Dose

No response is required, in this license application, however the licensee's evaluation of public dose will be examined during an inspection.

Item 10.9 Maintenance

Item 10.9.1 Daily Maintenance (Check both boxes)

☐ We have included procedures for conducting daily visual inspection.

OR

☐ Visual daily inspection will be conducted and records maintained in accordance with the criteria listed in 'Daily Maintenance' of the VAREG 'Guidance for Well Logging, Tracer, and Field Flood Study' to ensure that well logging equipment is in good working condition and is labeled as required.

Item 10.9.2 Semi-Annual Visual Inspection and Routine Maintenance (Check both boxes)

☐ We have included procedures for semi annual visual inspection and routine maintenance of source holders, logging tools, injection tools, source handling tools, storage containers, transport containers, and uranium sinker bars to ensure that the labeling required by **12VAC5-481-3250** is legible and that no physical damage is visible.

AND

☐ Semiannual inspections and routine maintenance will be conducted and records maintained for source holders, logging tools, injection tools, source handling tools, storage containers, transport containers, and uranium sinker bars in accordance with the criteria in 'Semi-Annual Visual Inspection and Routine Maintenance' of VAREG 'Guidance for Well Logging, Tracer, Field Flood Study' to ensure that well logging equipment is in good working condition with no physical damage evident and that required labeling is present.

Item 10.9.3 Maintenance Requiring Special Authorization (Check both boxes)

☐ Prohibited activities described in 'Maintenance Requiring Special Authorization' of VAREG 'Guidance for Well Logging, Tracer, Field Flood Study' will not be conducted unless approved by VDH.

OR

☐ Submit detailed procedures of each different tasks (including source removal procedures) for any prohibited activities, including radiation safety precautions that individuals will be expected to follow when performing these tasks and the minimum qualifications of these individuals.

Item 10.10 Operating and Emergency Procedures

☐ Operating and emergency procedures or an outline or summary as described in **12VAC5-481-3151** and **12VAC5-481-3280** have been attached for agency review.

Item 10.11 Transportation

No response is needed from applicants during licensing phase. This matter will be examined during an inspection.

WELL LOGGING, TRACER, AND FIELD FLOOD STUDY OPERATIONS

Item 11. Well Logging, Tracer, and Field Flood Study Operations

Item 11.1 Drill-to-Stop Large Sealed Sources (Check box)

☐ We have submitted procedures for conducting Drill-to-Stop well logging operations or an outline or summary that addresses important radiation safety aspects in the operating and emergency procedures.

Item 11.2 Measurement While Drilling, Logging While Drill (Check box)

☐ We have submitted procedures for conducting Measurement While Drilling, Logging While Drilling well logging operations or an outline or summary that addresses important radiation safety aspects in the operating and emergency procedures.

Item 11.3 Energy Compensation Sources (Check box)

☐ We have submitted operating and emergency procedures for using and handling energy compensation sources.

OR

☐ We have submitted an outline or summary of the operating and emergency procedures for using and handling energy compensation sources including instructions for leak testing energy compensation sources, if required, at intervals not to exceed 3 years, instructions for conducting physical inventories at least every 6 months, maintaining records of inventories required by **12VAC5-481-3220** and records of use for energy compensation sources.

OR

☐ We have submitted alternative procedures for agency review.

OR

☐ Energy compensation sources will not be used

Item 11..4 Use of Sealed Sources or Neutron Generators in Fresh Water Aquifers (Check box)

☐ We will not conduct this prohibited activity.

OR

☐ We are requesting authorization for this prohibited activity and have included the required procedures as stated in 'Use of Sealed Sources or Neutron Generators in Fresh Water Aquifers' of VAREG, 'Guidance for Well Logging, Tracer, and Field Flood Study'.

Item 11.5 Tracer Studies in Single Well Applications (Check box)

No response is required for this section provided that the elements in the 'Tracer Studies in Single Well Applications' of VAREG 'Guidance for Well Logging, Tracer, and Field Flood Study' are contained in other sections.

Item 11.6 Field Flood and Secondary Recovery Applications (Tracer Studies in Multiple Wells) (Check box)

☐ Field flood studies using tracer materials will not be conducted unless authorized specifically by license conditions.

OR

☐ We are requesting authorization to conduct field flood studies in the enhanced recovery of oil and gas wells using the information provided in Appendix F of the VAREG 'Guidance for Well Logging, Tracer, and Field Flood Study'.

Item 11.7 Tracer Studies in Fresh Water Aquifers (Check box)

☐ We will not knowingly inject tracer material into a fresh water aquifer.

OR

☐ We are requesting authorization to inject licensed radioactive materials into a fresh water aquifer and are providing the reason(s) for this study and procedures to protect the worker(s) and the public. **Note:** Tracer and field flood studies require an environmental report.

Item 11.8 Radioactive Collar and Subsidence or Depth Control Markers (Check box)

☐ We will only use radioactive markers where each individual marker contains only quantities of licensed material not exceeding the quantities identified in **12VAC5-481-3730**.

OR

☐ We have submitted procedures for using radioactive markers that in excess of quantities listed in **12VAC5-481-3730**.

Item 11.9 Neutron Accelerators using Licensed Material (Check box)

☐ We will not use neutron generators (accelerators) in our well logging operations.

OR

☐ We will use neutron generators (accelerators) in accordance with the criteria in 'Neutron Accelerators using Licensed Material' of VAREG 'Guidance for Well Logging, Tracer, and Field Flood Study'.

Item 11.10 Depleted Uranium Sinker Bars (Check box)

☐ Depleted uranium sinker bars will be obtained under the provisions of a general license (**12VAC5-481-420 C**) and the appropriate VDH form will be filed, as required.

OR

☐ Depleted uranium sinker bars will not be obtained under provisions of a general license (**12VAC5-481-420 C**).

AND

Uranium sinker bars will be possessed and inspected as specified in **12VAC5-481-3260.**

AND

We request _____ kilograms of material.

OR

☐ Depleted uranium sinker bars will not be used.

WASTE MANAGEMENT

Item 12 Waste Management

☐ We will use Appendix T of VAREG 'Guidance for Well Logging, Tracer, and Field Flood Study'.

OR

☐ We will use Decay-In-Storage model waste procedure in Appendix T of VAREG, 'Guidance for Well Logging, Tracer, and Field Flood Study'.

AND/OR

☐ We will use Disposal of Liquids Into Sanitary Sewage (**12VAC5-481-930**) model waste procedure in Appendix T of VAREG, 'Guidance for Well Logging, Tracer, and Field Flood Study'.

OR

☐ We have attached our procedures for waste collection, storage, and disposal by any of the authorized methods and request authorization for the methods described.

SPECIFIC LICENSE FEE

Item 13 License Fees (Refer to **12VAC5-490**).

CERTIFICATION (To be signed by an individual authorized to make binding commitments on behalf of the applicant.)

Item 14

I hereby certify that this application was prepared in conformance with **12VAC5-481, 'Virginia Radiation Protection Regulations'** and that all information contained herein, including any supplements attached hereto, is true and correct to the best of my knowledge and belief.

SIGNATURE - Applicant Or Authorized Individual	Date signed

Print Name and Title of above signatory

Attachment A
Well Logging Applicant's Checklist

Yes	No	Item	Material Needed
		Application	Used the correct form (New for new licensees or Renewal for renewing licensees)
		Application	Checked at least one box and filled in all the required information, as needed, for all Items
		Item 5	Attached training information
		Item 6	Attached training information
		Item 8	Attached financial assurance documentation, if needed
		Item 9	Attached facility diagram
		Item 10	Attached radiation safety program
		Item 10.4	Checked box or attached alternate procedures, if needed
		Item 10.6	Checked box or attached alternate procedure, if needed, including instrumentation for analysis
		Item 10.9.2	Attached procedures for semi-annual visual inspection and maintenance
		Item 10.9.3	Checked box or attached procedures requesting different tasks
		Item 10.10	Attached operating and emergency procedure(s)
		Item 11.1	Attached Drill-to-Stop procedure
		Item 11.2	Attached Measurement While Drilling procedure
		Item 11.3	Attached use of energy compensation sources procedure or checked box
		Item 11.4	Checked box or attached authorization request
		Item 11.6	Checked box or attached authorization request
		Item 11.7	Checked box or attached authorization request
		Item 11.8	Checked box or attached authorization request
		Item 11.9	Checked box or attached authorization request
		Item 11.10	Checked box or attached authorization request
		Item 12	Checked box or, if needed, attached alternate procedure

Appendix B

VDH Form,
‘Certificate of Disposition of Material’

Virginia Department of Health
Radioactive Materials Program
(804) 864-8150

CERTIFICATE OF DISPOSITION OF MATERIALS

Completion of this form is required to complete termination of a Radioactive Material License as outlined in **12VAC5-481-500**. Failure to provide information will result in this request for termination of a specific license not being processed.

Instructions – Complete all items. Retain one copy and submit original to Virginia Department of Health, Radioactive Materials Program, 109 Governor Street, Room 730, Richmond, VA 23219.

CONTACT INFORMATION

Item 1 Name and Mailing Address of Applicant:	**Item 2 Virginia Radioactive Material License Number**
	Item 3 Contact Person – Name
	Contact Person - Telephone Number (Include area code) ( ) - x

TERMINATION AND DISPOSITION INFORMATION

The following information is provided in accordance with **12VAC5-481-510.** (Check all that apply)

☐ **Item 4** All use of radioactive material authorized under the above referenced license has been terminated.

☐ **Item 5** Radioactive contamination has been removed to the levels outlined in **12VAC5-481-1161 B.**

☐ **Item 6** All radioactive material previously procured and/or possessed under the authorization granted by the above referenced license has been disposed of as follows. (Check all that apply)

☐ Transferred to: Name Address

Who is (are) authorized to possess such material under Licensed Number:

Issued by (Licensing Agency):

☐ Decayed, surveyed and disposed of as non-radioactive waste.

☐ No radioactive material has ever been procured and/or possessed by the licensee under the authorization granted by the above referenced license.

☐ Other (Attach additional pages)

☐ **Item 7** Attached are radiation surveys or equivalent as specified in **12VAC5-481-510 L**. Specify the survey instrument(s) used and certify that each instrument is properly calibrated as required in **12VAC5-481-510 K**.

☐ **Item 8** Records required to be maintained for the license termination requested are available at the following location(s):

Name:

Address:

Contact Person Telephone Number: ( ) - x

Additional remarks (Attach additional pages if necessary.)

CERTIFICATION (To be completed by an individual authorized to make binding commitments on behalf of the applicant.)

Item 10.

The undersigned, on behalf of the licensee, hereby certifies that licensable quantities of radioactive material under the jurisdiction of the Virginia Department of Health are not possessed by the licensee. It is therefore requested that the above referenced radioactive material license be terminated.

SIGNATURE - Applicant or Authorized Individual	**Date signed**
Print Name and Title of above signatory	

Appendix C

Sample Correspondence Delegation Letter

SAMPLE CORRESPONDENCE DELEGATION LETTER

[date]

Virginia Department of Health
Radioactive Materials Program
109 Governor Street, Room 730
Richmond, VA 23219

To Radioactive Material Program Director:

As [job title] of [name of licensee], I have delegated authority for all matters pertaining to our Virginia Radioactive Material License to [name of designee]. [Name of designee] has management approval to sign and submit amendment requests to the Virginia Department of Health on behalf of [name of licensee]. I understand that license renewals must still be signed by a representative of upper management.

[This document must be signed by a management representative who has independent authority to reassign job duties and/or provide finances, if necessary, to support an effective radiation safety program.]

_____ _____ _____

Signature Title Date

_____

Print Name

Appendix D

Reserved

Appendix E

Reserved

Appendix F

Field Flood Studies/Enhanced Recovery of Oil and Gas Wells

Field Flood Studies/Enhanced Recovery of Oil and Gas Wells

A formal contractual agreement with well operator or owner should specify control points at which samples will be taken, establish criteria for setting minimum sample requirements, and confirm the willingness of the client company to abide by effluent restrictions and undertake remedial action, if required. The following is an example: samples of recovered fluids or gas will be collected and measured according to the established sampling schedule and appropriate remedial action will be taken if accidents or incidents occurred that may result in the release of licensed materials to the environment. For example, if the concentration in the recovered fluid or gas approaches or exceeds the design limits, remedial action should be taken, such as reducing the injection pressure, temporarily shutting in the well, or diluting with non-tracer-bearing gas.

Planning Stage

Reservoir Information
Describe the reservoir information that you need in order to design a radioisotope tracer study for a field flood operation. Examples of reservoir information are shown below:

- Reservoir volume
- Reservoir thickness
- Porosity
- Injected volumes (liquids/gases)
- Oil/water saturation ratios

Project Design
Outline the design of the tracer application requested. Examples of items to consider are the following:

- Choice of radionuclides and method used to determine (1) the amount of radionuclide to be injected, and (2) the expected concentration of radionuclide in the fluids (gas, water, oil) at a recovery well site. Indicate your adherence to the ALARA principle
- How breakthrough time is predicted
- How tracer concentrations in the recovered liquids and gases are estimated
- How the sampling schedule at production wellheads is determined. Include a description of how you would determine when sampling could be discontinued. As an example, monitoring of samples may be ended when the design life of the project is completed, unless the effluent concentration at the control point is above a specified fraction of the maximum permissible concentration (as listed for unrestricted areas in **12VAC5-481, 'Virginia Radiation Protection Regulations', Part IV, 'Standards for Protection Against Radiation'**) and is increasing. In that case, the control point will be monitored until the concentration is below the specified fraction of the annual average concentration specified in **12VAC5-481-3690.**

Pre-injection Stage

Transportation of licensed materials.
State that the applicant will comply with VDH and DOT regulations pertaining to the transportation of licensed material. Particular attention should be directed to monitoring requirements upon receipt of packages containing licensed materials.

Integrity of wellhead assembly and wellbore.
Describe the test procedures used to ensure that the wellhead assembly, including injection equipment, will not leak under operating conditions. Describe the procedures used to ensure that the wellbore will not leak underground. For example, if the injection well operates properly for a 2-week period, integrity of the wellbore may be considered ensured.

Injection Stage

Outline radiation safety practices during injection process. Following are examples of practices:

- Remain upwind, if practical.
- Keep nonessential personnel at a distance.
- Use personnel monitoring devices (TLD, OSL, film badges, finger badges, pocket dosimeters, etc.) and other radiation detection instruments in your monitoring and surveillance programs.
- Use special tools and devices to handle licensed material and to facilitate the injection process.
- Perform visual inspection, check pressure gauge, etc., to assure absence of leaks and proper delivery of injection liquid or gas.
- Continuously or intermittently monitor radiation levels outside the injection assembly to assure that the injection is proceeding according to the plan. Allow sufficient time before opening wellhead assembly.

Post-injection Stage

Outline radiation safety practices that will be put into place after the injection phase is completed. Examples of practices include the following:

- Check exposure rate at wellhead assembly for residual activity.
- Take smear samples to detect removable contamination on wellhead assembly.
- Clean reusable tools and check for residual activity before securing for reuse.
- Collect contaminated materials or contaminated tools and package them into an appropriate waste container.
- Establish schedule for taking samples for bioassay when, for example, handling tritium (H-3) exceeding 3.7 Gbq (0.1 Ci) or gaseous H-3 exceeding 3,700 Gbq (100 Ci), or handling radioiodine exceeding 1.85 Gbq (50 mCi) of Iodine-131 or Iodine-125.
- Provide instructions to well operator's personnel for taking post-injection samples and shipping the samples to your facilities for analysis. Include handling, packaging, and shipping procedures.
- Package waste materials for transportation, prepare appropriate labels and shipping papers, and check for radiation level and removable contamination outside the package.
- Measure concentrations of radionuclides in recovered liquids or gases, according to your established sampling schedule.
- Take corrective measures if the concentrations in the recovered liquids or gas approach or exceed design levels.
- Conduct area and personnel monitoring before leaving injection site.

Emergency Procedures

Outline procedures that you will follow in the event of incidents or accidents that release radioactive materials to the environment. Following are examples of incidents and accidents:

- Discovering a leaking source in a shipping container
- Dropping and breaking a source container, thereby spilling the source on the ground
- Detecting leakage of radioactive materials from wellhead assembly
- Measuring concentrations in liquids or gas from production wells exceeding limits specified in **12VAC5-481-3690**, Table 2.

Reporting, Record Keeping, and Notification

Outline the report that will be submitted to the agency and the records maintained regarding the field flood injections. Following are examples of releases to include: records on the identification of wells, radionuclides, and quantities injected; concentrations of radionuclides in liquids or gases produced at production wells; and concentrations of radionuclides in products released from the field. Also outline the procedures you will follow in case of accidents; and procedures for notifying the proper persons or organizations, such as your company management (RSO), well operator or owner, and state, federal, or municipal governmental agencies involved with the control and oversight of affected wells.

Waste Management

The applicant should outline the procedures for disposing of licensed material. Wastes from tracer operations such as unused materials, and contaminated wipes, gloves, tools, clothing, containers, etc., should be disposed of in accordance with **12VAC5-481, 'Virginia Radiation Protection Regulations', Part IV, 'Standards for Protection Against Radiation'**. Recovered waste fluids that contain radioactive tracers should either be re-injected or treated as radioactive waste. A commonly used method of disposal is transfer to a commercial firm licensed by VDH, NRC, or another Agreement State to accept radioactive wastes. In dealing with these firms, prior contact is needed to determine the specific services they can provide. If commercial services will be used, this should be specified.

Appendix G

Suggested Well Logging and Field Flood Audit Checklist

Suggested Well Logging and Field Flood Audit Checklist

Note: All areas indicated in audit notes may not be applicable to every license and may not need to be addressed during each audit. For example, licensees do not need to address areas that do not apply to the licensee's activities, and activities that have not occurred since the last audit need not be reviewed at the next audit.

Licensee's Name: _____ License #: _____

Date of This Audit _____ Date of Last Audit_____

Next Audit Date_____

Auditor Date (Signature) _____ Date: _____

Management Review Date (Signature) _____ Date: _____

Summary of Findings and Actions

[ ] No violations cited
[ ] Self-identified Violation(s)
[ ] Concerns

Note: Detailed information on any violation(s) or concern(s) is recorded in Section S of this form.

A. AUDIT HISTORY

1. Were previous audits conducted annually (**12VAC5-481-630**)?

2. Are records of previous audits being maintained for three years (**12VAC5-481-990**)?

3. Were any deficiencies identified during the previous audit?

4. Were corrective actions taken? (**Note**: Look for repeated deficiencies)

B. ORGANIZATION AND SCOPE OF PROGRAM

1. Describe the organization (specify any change such as ownership, bankruptcy, mailing address change, etc.) and scope of the program (matches license requirements, staff size, number of job sites, types of equipment, types of use and frequency, etc).

2. Multiple places of radioactive material use?
   a. List all field stations:

   b. Is licensed material used or stored at temporary job sites? Is storage authorized by license?

   c. Was a written agreement with each well owner obtained prior to commencement of operation (**12VAC5-481-3160**)?

3. Radiation Safety Officer (RSO)
   a. If the RSO position has changed, was the license amended?
      1) Does the new RSO's meet the agency's training requirements?
      2) Is the written agreement in place for the new RSO?
   b. Is the RSO fulfilling all of his/her duties?
   c. Does the RSO have involvement of senior management?
      1) To whom does the RSO report?
   d. Does the RSO have sufficient time and staffing to support the radiation protection program?

4. License material is only used by authorized users?

   a. All authorized users meet the training requirements (**12VAC5-481-3270**)?

   b. Training for all authorized users is current (**12VAC5-481-2270**)?

5. ALARA concepts are implemented and actively used for both users and members of the public (**12VAC5-481-630**)?

C. FACILITIES

1. Are facilities as described in the license application?

2. Storage
   a. Are all areas where licensed material is stored adequately secured (**12VAC5-481-840**)?
   b. Does each radiation source have a storage or transport container that is either locked or has a tamper seal (**12VAC5-481-3180**)?
   c. Are sources stored in a manner that minimizes the danger from explosion or fire (**12VAC5-481-3180**)?

3. Posting & Labeling
   a. Does the facility meet the posting requirements (**12VAC5-481-860**)?
      1) If so, are the facilities adequately posted?
   b. Do the storage areas meet posting requirements (**12VAC5-481-860**)?
      1) If so, is the storage area adequately posted?
   c. Is each source, source holder, and logging tool labeled appropriately (**12VAC5-481-880, 12VAC5-481-3250**)?
   d. Is each transport container adequately labeled (**12VAC5-481-3250, 49 CFR**)?
   e. Are uranium sinker bars adequately impressed (**12VAC5-481-3250**) or N/A?
   f. Is a Notice to Employees posted in an appropriate location (**12VAC5-481-2260**)? Does this include a notation of the location of the regulations and license or are these posted as well (**12VAC5-481-2260**)?

D. EQUIPMENT AND INSTRUMENTATION

1. Is there an adequate number of radiation survey instruments in proper operation and current calibration at each field station (**12VAC5-481-3200**)?
   a. Is the instrumentation capable of measuring 0.1 mR/hr through 50 mR/hr?

   b. Are the instruments calibrated every six months and after each instrument servicing, as appropriate, and calibrations records maintained for three years (**12VAC5-481-3200**)?

2. Is the utilized sources, sources holders, and well logging tools as specified in the license?

   a. Does use of this equipment meet the 'Conditions and/or Limitations of Use' on the SSDR?

3. Are remote handling tools provided and, if so, are they used in accordance with **12VAC5-481-3310**?

E. MATERIAL USE, CONTROL, AND TRANSFER

1. Licensed Material
   a. Does all licensed material and authorized uses meet the authorization of the license?

      1) Does each sealed source and energy compensation source, except those containing radioactive material in gaseous form, used in downhole operations meet the design, performance, and certification criteria (**12VAC5-481-3240**)?
      2) Are tritium neutron generator target sources used appropriately (**12VAC5-481-3241, 12VAC5-481-3280**)?
      3) Are radioactive markers used appropriately (**12VAC5-481-3261, 12VAC5-481-3280**)?
      4) Are subsurface tracer studies being performed (**12VAC5-481-3280, 12VAC5-81-3320**)?
      5) Are particle accelerators used appropriately (**12VAC5-481-3280, 12VAC5-481-3330**)?

   b. Does the total amount of radioactive material possessed require financial assurance (**12VAC5-481-450 C**)?
      1) If so, is the financial assurance adequate?

2. Security and Control
   a. Are the appropriate areas designated as restricted, if necessary (**12VAC5-481-10**)?

   b. Is security maintained of all licensed material through constant surveillance or adequately stored (**12VAC5-481-840**)?

   c. Is a logging supervisor physically present at the temporary job site when licensed material is being handled or are not stored and locked (**12VAC5-481-3300**)?

   d. Does the logging supervisor (or designate another individual to) maintain direct surveillance of the well logging operation to prevent unauthorized entry into the restricted area (**12VAC5-481-10, 12VAC5-481-3300**)?

3. Receipt and Transfer of Licensed Material
   a. Describe how packages are received, where, and by whom.

   b. Are written package opening procedures established and followed (**12VAC5-481-900**)?

c. Are incoming package(s) surveyed within the time specified (**12VAC5-481-900**)?

d. Are transfer(s) performed per **12VAC5-481-570**?

e. Are source(s) surveyed prior to shipment and transfer (**12VAC5-481-750, 49 CFR 173.475(i)**)?

f. Are appropriate records of surveys and receipt/transfer maintained (**12VAC5-481-100, 12VAC5-481-571, 12VAC5-481-1000**)?

g. Package receipt/distribution activities evaluated for compliance with **12VAC5-481-720**?

4. Material Accountability
   a. Are semi-annual physical inventories conducted and records with all required information maintained for three years from the date of the inventory (**12VAC5-481-3220**)?
      1) Does this inventory include all radioactive markers (**12VAC5-481-3261**)?

   b. Do utilization logs contain all required information and are being maintained for three years (**12VAC5-481-3230**)?

5. Operating and Emergency Procedures
   a. Are operating and emergency procedures current, available, and contain all relevant information (**12VAC5-481-3151**)?

F. INSPECTION AND MAINTENANCE

1. Is each source holder, logging tools, and source handling tool visually checked for defects and proper labeling before each use (**12VAC5-481-3260**)?
   a. If a defect is found, is the item(s) removed from service until repaired and a record made with all appropriate information (**12VAC5-481-3260**)? Are these records maintained for three years (**12VAC5-481-3260**)?
   b. If a defect is found, is appropriate notification made (**10 CFR 21.21**)?

2. Are all source holders, logging tools, source handling tools, storage containers and injection tools visually checked for defects and proper labeling at least every six months (**12VAC5-481-3260**)? Are appropriate records maintained (**12VAC5-481-3260**)?

3. Is non-routine maintenance, repair, opening or modification of any source holders, logging tools, or source handling tools being performed (**12VAC5-481-3260**)?
   a. If so, are they being performed by an authorized licensee or by agency approved procedures (**L/C**)?

G. AREA RADIATION SURVEYS AND CONTAMINATION CONTROL

1. Equipment and work related surveys
   a. Are surveys performed and recorded for radiation levels in occupied positions and on the exterior of each vehicle used to transport material (**12VAC5-481-2980, 12VAC5-481-3340**)? Do these surveys include the information on the sources or combination of sources being transported (**12VAC5-481-3340**)?

   b. Are logging tool detectors energized and a survey meter used to assure that logging tools are free of contamination if the source assembly is removed before departing the jobsite (**12VAC5-481-3340**)?

c. If contamination was detected at any time, were appropriate actions taken in accordance with emergency procedures and all notifications made (**12VAC5-481-3340**)?
   1) Did these actions include decontamination of all work area equipment and personnel before releasing the site (**12VAC5-481-3160, 12VAC5-481-3340**)?

d. If a source was lodged in a well during welling operations, was the circulating fluids from the well continuously monitored with an appropriate instrument or logging tool with a detector (**12VAC5-481-3340**)?

e. Are surveys made and recorded at the jobsite for each tracer operation (**12VAC5-481-3340**)?

f. Do records created for surveys include all of the required information and are maintained for the appropriate length of time (**12VAC5-481-3340**)?

2. Area Surveys
   a. Are surveys performed in each area where material is used or stored (**12VAC5-481-750, 12VAC5-481-3340**) and performed with operable and currently calibrated survey instruments (**12VAC5-481-750**)?
   b. Are records of surveys maintained with all required information for the appropriate length of time (**12VAC5-481-1000**)?
   c. Do surveys demonstrate compliance with public dose limits during use and transportation (**12VAC5-481-720, 12VAC5-481-730**)?
   d. Are records of surveys performed for public dose evaluation completed, maintained, and contain all required information (**12VAC5-481-1050**)?

3. Leak Tests
   a. Are all sources currently leak tested in accordance with **12VAC5-481-3210**?
   b. Have any sources indicated leakage? If so, have appropriate actions and notifications been made? (**12VAC5-481-740, 12VAC5-481-3210**)

4. Tracer Studies
   a. Are tracer studies performed? If so, is protective clothing and equipment worn and utilized by all personnel handling tracer material (**12VAC5-481-3320**)?
      1) Are precautions taken to prevent ingestion or inhalation of material (**12VAC5-481-3320**)?

   b. Is written authorization obtained prior to injection into potable aquifers or have injections into potable aquifers been prohibited (**12VAC5-481-3320**)?

   c. Do sealed sources used in downhole operations meet the design, performance, and certification criteria of **12VAC5-481-3240?**

H. TRAINING AND INSTRUCTIONS TO WORKERS

1. Training requirements
   a. Have all individuals designated as logging supervisors been trained in accordance with **12VAC5-481-3270** and adequately demonstrated an understanding and competence in performing all work, including adequate use of survey instruments?
      1) Do all well logging supervisors have copies of the appropriate regulations, license conditions, and operating and emergency procedures (**12VAC5-481-3270**)?

      2) Did interviews with these individuals indicate an understanding of work performed and knowledge of regulations and license conditions?

      3) HAZMAT training provided initial and every three years, as required (**49 CFR Part 172, Subpart H**)?

b. Have all individuals designated as logging assistants been trained in accordance with **12VAC5-481-3270** and adequately demonstrated an understanding and competence in performing all work, including use of survey instruments?
   1) Do all well logging assistants have copies of the operating and emergency procedures (**12VAC5-481-3270**)?

   2) Did interviews with these individuals indicate an understanding of work performed and knowledge of regulations and license conditions?

   3) HAZMAT training provided initially and every three years, as required (**49 CFR Part 172, Subpart H**)?

c. Are safety reviews performed on all individuals at least once during each calendar year (**12VAC5-481-3270**) and include observations of actual work being performed?
   1) Were job performances conducted of, at least, each well logging supervisor (**12VAC5-481-3151**)?
   2) During these observations, was all work performed adequately? If not, was additional instruction provided to address the area of concern?
   3) Are records of these reviews and job performances maintained for three years?

d. Are all workers likely to exceed 100 mrem in a year instructed per **12VAC5-481-2270** and refresher training provided?

e. Are records maintained of initial and recurrent training (**12VAC5-481-2270, 12VAC5-481-3270**)?

I. PERSONNEL RADIATION PROTECTION

1. Are all individuals designated as logging supervisors or logging assistants provided with and wear dosimetry (**12VAC5-481-3290**)?
   a. Did any individuals job duties change during the year which could cause them to exceed 10% of the annual dose limit? If so, was a new evaluation performed or dosimetry provided?
2. Is external dosimetry required and provided to appropriate individuals (**12VAC5-481-640, 12VAC5-481-650, 12VAC5-481-3290**)?
   a. Is the dosimetry supplier NVLAP certified? (**12VAC5-481-750**)
   b. Are the dosimeters exchanged on a frequency determined by **12VAC5-481-3290**?
   c. Are dosimetry reports reviewed by the RSO?
   d. Are the records VDH forms or equivalent? (**12VAC5-481-1040**)
   e. If a worker has declared her pregnancy, was compliance with **12VAC5-481-710** achieved and records kept of the embryo/fetus dose? If a worker is a minor, was compliance with **12VAC5-481-700** met and records maintained of the dose to the minor?
   f. Are records of exposures, surveys, monitoring, and evaluations maintained? (**12VAC5-481-990, 12VAC5-481-1000, 12VAC5-481-1040, 12VAC5-481-1080**)
   g. Are annual exposure reports given to employees who receive greater than 100 mrem per year (**12VAC5-481-2280**)?
3. Is there any exposure received from airborne contamination? If so, is appropriate controls maintained (**12VAC5-481-810, 12VAC5-481-820, 12VAC5-481-830**)?

4. Was there any occurrence of ingestion for any individual? If so, has an evaluation been conducted and exposure and exposure control measures been adjusted accordingly (**12VAC5-481-670, 12VAC5-481-760**)?

5. Did any individual receive exposure from any other employment? If so, have records been acquired and an evaluation made to ensure limits are not exceeded by culminating the exposures received (12VAC5-**481-680, 12VAC5-481-1040**)?

J. RADIOACTIVE WASTE MANAGEMENT

1. All material sent for disposal is transferred only to authorized individuals per **12VAC5-481-570**?
   a. Are all containers are labeled per **12VAC5-481-880** and appropriate DOT regulations?

2. Waste disposal requirements of **12VAC5-481-910** are met?
   a. Is release of circulating water into sanitary sewerage authorized per **12VAC5-481-930**, as appropriate.

3. All surveys performed for transfer or other means of disposal are recorded, contained all required information, and are maintained for the appropriate length of time (**12VAC5-481-1000, 12VAC5-481-1060**)?

4. Effluents
   a. Has any material been released to the environment? If so, were all releases into the environment from work performed maintained to ALARA levels?

   b. Has any material been released to a septic tank? If so, have calculations been performed for all releases to septic tanks (as defined by 'sanitary sewerage' in **12VAC5-481-10**) to ensure compliance is maintained with **12VAC5-481-3690**?

   c. Has any waste been incinerated? If so, have calculations been performed to ensure compliance with **12VAC5-481-940?**

   d. Has any waste been released into the air (through ash, etc.)? If so, have calculations been performed to ensure compliance with **12VAC5-481-640** and **12VAC5-481-720** or additional controls taken (**12VAC5-481-810**)?

5. Waste Management
   a. Has all waste been handled in compliance with **12VAC5-481-910**?
   b. Has any waste been compacted? If so, were appropriate controls met per license conditions?
   c. Have all areas designed as waste storage areas been properly posted and all equipment and/or containers labeled (**12VAC5-481-860, 12VAC5-481-880**)?
      1) Is proper control maintained of these areas and access granted only to those individuals with a need (**12VAC5-481-840**)?

   d. Packaging, Control, and Transfer
      1) Has any material been sent for transfer to a waste disposal site? If so, were all the requirements of **12VAC5-481-910** and **12VAC5-481-3710** met?
         a) Was the waste properly classified (**12VAC5-481-2571**) and characterized (**12VAC5-481-2572**)?

         b) Was the transfer provided and records maintained per **12VAC5-481-960?**

   e. Were records maintained of surveys and all waste disposals (**12VAC5-481-1000, 12VAC5-481-1060**)?

K. DECOMMISSIONING

1. Are records of information important to the safe and effective decommissioning of the facility maintained in an independent and identifiable location (**12VAC5-481-450 C, 12VAC5-481-510)?**

2. Has any area been released? If so, were the conditions of **12VAC5-481-1161** met?

L. TRANSPORTATION (also see Attachment A)

1. Shipments are:
   a. Delivered to common carriers;
   b. Transported in own private vehicle;
   c. Both;
   d. No shipments since last audit.

2. HAZMAT Training is current? (**49 CFR 172.700-172.704**)

3. Packages:
   a. Authorized packages used (**49 CFR 173.415, 173.416**)?
   b. Performance test records on file?
      1) DOT-7A packages (**49 CFR 173.415(a)**)
      2) Special form packages (**49 CFR 173.476(a), 49 CFR 173.421**)
   c. Certificates of Compliance(s) on file with NRC for Type B packages? (**12VAC5-481-3000**)
   d. Two labels with Transport Index, Nuclide, Hazard Class on each package (**49 CFR172.403, 172.441**)
   e. Each package properly marked (shipping name, UN number, package type, RQ, Name and address of cosignee) (**49 CFR 172.301, 172.310, 172.324, 172.101**)
   f. Each package closed and sealed during transport (**49 CFR 173.475(f)**)
4. Shipping papers
   a. Prepared and used (49 **CFR 172.200(a)**)
   b. Proper (shipping name, hazard class, UN number, quantity, package type, nuclide, RQ, radioactive material, physical and chemical form, category of label, TI, shipper's name, certification and signature, emergency response phone number, "Limited Quantity", "Cargo Aircraft Only", if applicable) (**49 CFR 172.200-204, 175.700**)
   c. Readily accessible during transport.

5. Vehicles
   a. Placarded (**49 CFR 172.504**)
   b. Cargo blocked and braced (**12VAC5-481-3190**, **49 CFR 177.842(d)**)
   c. Proper overpacks (shipping name, UN number, statement of inner packaging complies with specification packaging) (**49 CFR 171.15, 171.16**)
6. Any transportation incidents reported to DOT National Response Center (**49 CFR 171.15, 171.16**)

M. NOTIFICATIONS AND REPORTS

1. Were reports provided to individuals, public and occupational workers (**12VAC5-481-2280**)?
2. Was any material lost or stolen? Were notifications made (**12VAC5-481-1090**)?
3. Did any incidents occur? Were notifications made (**12VAC5-481-1100**)?
4. Did any other unusual event occur? Were notifications made (**12VAC5-481-1110**)?
5. Were any defects found? Were notifications made (**10 CFR 21.21**)?

N. FIELD STATIONS AND TEMPORARY JOB SITES

1. Does each field station have all of the documents and records for the specific devices and sources used under the license (**12VAC5-481-3350**)?

2. Do temporary job sites have all required documentation and records during operation (**12 VAC5-481-3360)?**

O. ABANDONMENT OF SOURCES

1. Has there been any abandoned sources? If so, were the actions taken appropriate and in keeping with the agreement made per **12VAC5-481-3160** and **12VAC5-481-3370**?
   a) Were notifications made (**12VAC5-481-3370**)?

P. INDEPENDENT AND CONFIRMATORY MEASUREMENTS

1. Survey Instrument Used:
   Serial Number:
   Last Calibration Date:

2. Auditor's measurements were compared with audited person's measurements?

3. Describe the type, location, and results of measurements (include diagram)

Q. BULLENTINS AND INFORMATION NOTICES

1. Information is being received from agency, reviewed, and appropriate actions taken?

R. SPECIAL LICENSE CONDITIONS OR ISSUES

1. Are there any special license conditions? Were these properly evaluated during this audit?

2. Did any special or unusual issues arise during this audit period? Were appropriate actions taken, notifications made and compliance maintained?

S. DEFICIENCES IDENTIFIED IN AUDIT; CORRECTIVE ACTIONS

1. Summarize problems identified during the audit:

2. Were corrective actions planned or taken? If so, describe and specify if these actions were taken at ALL locations:

3. Provide any recommendations for improvement:

TRANSPORTATION

A. Is transportation of radioactive material being performed in accordance with:
49 CFR, Hazard Communication for Class 7 (Radioactive) Materials.
12VAC5-481-2980 Transportation of licensed material.
Implementation of Revised **49 CFR Parts 100-179** and **12VAC5-481, 'Virginia Radiation Protection Regulations', Part XIII.**

B. Shippers - Requirements for Shipments and Packaging

1. General Requirements

49 CFR Part 173, Subpart I	Class 7 (radioactive) materials.
49 CFR 173.24	General requirements for packaging and packages.
49 CFR 173.448	General transportation requirements.
49 CFR 173.435	Table of A_1 and A_2 values for radionuclides.

2. Transport Quantities

12VAC5-481-10	Definitions.

a. All quantities

12VAC5-481-10	Definitions.
49 CFR 173.410	General design requirements.
49 CFR 173.441	Radiation level limitations.
49 CFR 173.443	Contamination control.
49 CFR 173.475	Quality control requirements prior to each shipment of of Class 7 (radioactive) materials.
49 CFR 173.476	Approval of special form Class 7 (radioactive) materials.

b. Limited quantities

49 CFR 173.421	Excepted packages for limited quantities of Class 7 (radioactive) materials.
49 CFR 173.422	Additional requirements for excepted packages containing Class 7 (radioactive) materials.

c. Type A quantities

49 CFR 173.412	Additional design requirements for Type A packages.
49 CFR 173.415	Authorized Type A packages.
49 CFR 178.350	Specification 7A; general packaging, Type A.

d. Type B quantities

e. LSA material and SCO

49 CFR 173.403	Definitions.
49 CFR 173.427	Transport requirements for low specific activity (LSA) Class 7 (radioactive) materials and surface contaminated objects (SCO).

3. HAZMAT Communication Requirements

49 CFR 172.200-205	Shipping papers.
49 CFR 172.300-338	Marking.
49 CFR 172.400-450	Labeling.

49 CFR 172.500-560	Placarding.
49 CFR 172.600-604	Emergency response information.

C. HAZMAT Training

49 CFR 172.702	Applicability and responsibility for training and testing.
49 CFR 172.704	Training requirements.

D. Transportation by Public Highway

49 CFR 171.15	Immediate notice of certain hazardous materials incidents.
49 CFR 171.16	Detailed hazardous materials incident reports.
49 CFR 177.800	Purpose and scope of this part and responsibility for compliance and training.
49 CFR 177.816	Driver training.
49 CFR 177.842	Loading and unloading: Class 7 (radioactive) material.

Appendix H

Information Needed for Transfer of Control Application

Information Needed for Transfer of Control Application

Control: Control of a license is in the hands of the person or persons who are empowered to decide when and how that license will be used. That control is to be found in the person or persons who, because of ownership or authority explicitly delegated by the owners, possess the power to determine corporate policy and thus the direction of the activities under the license.

Transferee: A transferee is an entity that proposes to purchase or otherwise gain control of an VDH licensed operation.

Transferor: A transferor is an VDH licensee selling or otherwise giving up control of a licensed operation.

Licensees must provide full information and obtain VDH's **prior written consent** before transferring control of the license. Provide the following information concerning changes of control by the applicant (transferor and/or transferee, as appropriate). If any items are not applicable, so state.

1. Provide a complete description of the transaction (transfer of stocks or assets, or merger). Indicate whether the name has changed and include the new name. Include the name and telephone number of a licensee contact who the agency may contact if more information is needed.

2. Describe any changes in personnel or duties that relate to the licensed program. Include training and experience for new personnel.

3. Describe any changes in the organization, location, facilities, equipment, or procedures that relate to the licensed program.

4. Describe the status of the surveillance program (surveys, wipe tests, quality control) at the present time and the expected status at the time that control is to be transferred.

5. Confirm that all records concerning the safe and effective decommissioning of the facility will be transferred to the transferee or to VDH, as appropriate. These records include documentation of surveys of ambient radiation levels and fixed and/or removable contamination, including methods and sensitivity.

6. Confirm that the transferee will abide by all constraints, conditions, requirements and commitments of the transferor or that the transferee will submit a complete description of the proposed licensed program.

Appendix I

Guidance on Decommissioning Funding Plan and Financial Assurance

Guidance on Decommissioning Funding Plan and Financial Assurance

Determining Need for a Decommissioning Funding Plan and Financial Assurance

Table 9 and the worksheet in **Table 10** are used to determine the need for certification of financial assurance (F/A) for decommissioning or a decommissioning funding plan (DFP), as required by **12VAC5-481-450 C**. **Table 9** is a listing of isotopes with a half-life of greater than or equal to 120 days used in well logging and tracer operations. If the applicant proposes to use isotopes with a half-life greater than or equal to 120 days, divide the requested possession limit (in millicuries for unsealed material and curies for sealed sources) of the isotope by the value for that isotope in **Table 9**. If the material requested is in an unsealed form, use the value in the unsealed column. If the material requested is in a sealed form, use the value in the sealed column. Place the fraction in the proper column in **Table 10**. Add the fractions in the column and place the total in the row labeled total (i.e., 'sum of the ratios').

Table 9. Isotopes With Half-lives Greater Than or Equal to 120 Days

Isotope	Quantity in Millicuries Requiring $225,000 Financial Assurance	Quantity in Millicuries Requiring $1,125,000 Financial Assurance	Quantity in Curies Requiring That a Decommissioning Funding Plan Be Submitted
Unsealed Licensed Material			
Calcium-45	10	100	1000
Carbon-14	100	1000	10000
Hydrogen-3	1000	10000	100000
Krypton-85	100	1000	10000
Nickel-63	10	100	1000
Silver-110m	1	10	100
Any alpha-emitting radionuclide not listed above with a half-life greater then or equal to 120 days.			

Sealed Sources		
Isotope		**Quantity in Curies Requiring $113,000 of Financial Assurance**
Americium-241		100
Cesium-137		100000
Cobalt-60		10000
Hydrogen-3		10000000

Note: 1 Curie = 37 gigabecquerels

Table 10. Sample Worksheet for Determining Need for a Decommissioning Funding Plan or Financial Assurance

Isotope	Unsealed Material Activity (Millicuries) ÷ Unsealed Value from Table 8	Sealed Material Activity (Curies) ÷ Sealed Value from Table 8
Total		
Funds required		
	If < 1.0, enter $0 If > 1.0 but < 10.0, enter first level of financial assurance specified in **12VAC5-481-450 C 5** If > 10.0, but < 100.0, enter second level of financial assurance specified in **12VAC5-481-450 C 5** If > 100.0, enter "DFP only"	If < 1.0, enter $0 If > 1.0, enter sealed source financial assurance specified in **12VAC5-481-450 C 5**

If the sum of the fractions is less than 1 for each category (unsealed and sealed), the applicant does not need to submit certification of F/A or a DFP. If the sum of the fractions is greater than 1 for either category (sealed or unsealed), but less than 100, the applicant will need to submit certification of F/A (in the level I or in the level II amount specified in **12VAC5-481-450 C 5**) or a DFP. If the sum of the fractions is greater than 100 for unsealed material, the applicant must submit a DFP.

Reference: "*Criteria Relating to Use of Financial Tests and Parent Company Guarantees for Providing Reasonable Assurance of Funds for Decommissioning*" can be found in **10 CFR 30**, Appendix A. "*Criteria Relating to Use of Financial Tests and Self Guarantees for Providing Reasonable Assurance of Funds for Decommissioning*" can be found in **10 CFR 30**, Appendix C. NRC Regulatory Guide 3.66, "*Standard Format and Content of Financial Assurance Mechanisms Required for Decommissioning Under 10 CFR Parts 30, 40, 70, and 72*", provides sample documents for financial mechanisms.

Appendix J

NRC Letter Dated August 10, 1989, Transmitting Temporary Generic Exemptions to Well Logging Licensees

NRC Letter Dated August 10, 1989, Transmitting Temporary Generic Exemptions to Well Logging Licensees

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555

AUG 10 1989

TO: Well Logging Licensees

FROM: John E. Glenn, Chief Medical, Academic, and Commercial Use Safety Branch
Division of Industrial and Medical Nuclear Safety, NMSS

SUBJECT: **10 CFR PART 39.41(A)(3)** TEMPORARY GENERIC EXEMPTION

Attached (Enclosure 1) is a notice of generic exemption that exempts Nuclear Regulatory Commission (NRC) well logging licensees from the requirement to use only sealed sources that meet the prototype testing requirements specified in paragraph 39.41(a)(3) of 10 CFR Part 39 in well logging operations. The exemption applies only to sealed sources that meet certain alternate prototype testing criteria.

Section 39.41 of 10 CFR Part 39 prohibits licensees from using, after July 14, 1989, a sealed source in well logging unless the source is doubly encapsulated; contains licensed material whose chemical and physical forms are as insoluble and non-dispersible as practical; and is prototype performance tested and found to maintain its integrity after each of the following tests: temperature, impact, vibration, puncture, and pressure. These prototype performance tests are the same as the tests specified for well logging sources in American National Standard Institute (ANSI) N542-1977, "*Sealed Radioactive Sources, Classification*", published by the National Bureau of Standards (NBS Handbook 126) in 1978. The notice also provides that NRC intends, through rulemaking, to reevaluate the requirements in Section 39.41(a)(3) for prototype testing of sealed sources. The generic exemption will allow continued use of sealed sources that were prototype tested in accordance with an earlier national standard [United States of America Standards Institute (USASI) N5.10-1968] while NRC reevaluates these requirements.

Also attached are three enclosures that list various sealed source models common to well logging and identifies their suitability for continued use in well logging operations. Enclosure 2 lists those source models which appear to meet Section 39.41 requirements and are approved for continued use. Enclosure 3 identifies those source models whose continued use is authorized under the temporary generic exemption. Enclosure 4 lists those source models that do not meet the requirements of Section 39.41 or the generic exemption and whose use in well logging must be discontinued upon receipt of this letter. When a sealed source is contained (and normally stored) within a device (logging tool), the sealed source manufacturer and model number is shown below the entry. When NRC has been able to determine that a sealed source model was manufactured/ distributed by another company, or more than one model designation may have been used, this information is shown in parentheses below the entry. Neutron generators are shown by the designation "Nu GEN." An asterisk(*) indicates that the source is used within the logging tool's electronics package.

These lists may not be all inclusive; therefore, if you are authorized to use a sealed source model that is not identified on one of the lists, you should contact the individual noted below so that NRC can determine the status of the source. Upon receipt of this letter, the use of any source not listed on either Enclosure 2 or 3 must be discontinued until its suitability for continued use is determined.

Because many manufacturers are located in Agreement States, NRC relied on information from its Sealed Source and Device Registry to determine a source model suitability for continued use. The Registry only summarizes the more detailed information the manufacture/distributor provides to NRC or an Agreement State when registering its sources. If you have information that shows that a source model listed on Enclosure 4 meets the requirements of Section 39.41 or the generic exemption, you may provide this information to NRC and request that the source's status be reconsidered. Alternatively, NRC will reconsider a source's status if such sources are tested and certified by a qualified testing organization as meeting Section 34.91, 10 CFR Part 39 criteria.

If you have any questions about Section 39.41, 10 CFR Part 39 regulatory requirements, the generic exemption, or the suitability of a sealed source for continued use in well logging, you should contact Bruce Carrico at (301) 492-0634.

John E. Glenn, Chief
Medical, Academic, and Commercial Use Safety Branch
Division of Industrial and Medical Nuclear Safety, NMSS

Enclosures: As stated

WELL LOGGING SEALED SOURCES APPROVED UNDER PART 39 REQUIREMENTS

MANUFACTURER	MODEL
AMERSHAM CORPORATION	AMN.CYn (n = 1 to 14)
AMERSHAM CORPORATION	AMN.CY1
AMERSHAM CORPORATION	AMN.PEn (n = 1 to 4)
AMERSHAM CORPORATION	CDC.CYn (n = 2 to 12)
AMERSHAM CORPORATION	CKC.CDn (n = 2 to 12)
AMERSHAM CORPORATION	CKC.800 SERIES
AMERSHAM CORPORATION	CVN.CDn (n = 2 to 12)
AMERSHAM CORPORATION (GAMMA INDUSTRIES, GENERAL NUCLEAR)	VD (HP)
ANADRILL, INC* ISOTOPE PRODUCTS MODEL 174 SEALED SOURCE	SGS-AA, SGS-BA, OR SGS-CA
COMPROBE, INC. GAMMA INDUSTRIES MODEL VD-HP SEALED SOURCE GULF NUCLEAR, INC. MODEL VL-1 SEALED SOURCE	1203 DENSITY PROBE
DRESSER INDUSTRIES INC. (Nu GEN)	C-58301, C-1O7298
E.I.DUPONT DE NUMOURS & CO. (NEW ENGLAND NUCLEAR)	NER-571
GEARHART INDUSTRIES, INC. (Nu GEN)	013-1004-000
GENERAL ELECTRIC. CO.	GE(N)-Cf-100 SERIES
GULF NUCLEAR, INC. (NEEI)	VL-1
GULF NUCLEAR, INC. (NEEI)	71-1 (NEEI-AMBE-71-1)
KAMAN SCIENCES CORPORATION (Nu GEN)	A-3061
KAMAN SCIENCES CORPORATION (Nu GEN)	A-320
KAMAN SCIENCES CORPORATION (Nu GEN)	A-520

MANUFACTURER	MODEL
KAMAN SCIENCES CORPORATION (Nu GEN)	E-3010 AND E-3020
MONSANTO CO., DAYTON LABORATORY	H-245258 (NSR-M)
MONSANTO CO., DAYTON LABORATORY	24113
MONSANTO CO., DAYTON LABORATORY	24154-C
MONSANTO CO., DAYTON LABORATORY	24174
MONSANTO CO., DAYTON LABORATORY	24181
MONSANTO CO., DAYTON LABORATORY	24183
P.A. INCORPORATED (MONSANTO)	H-245258 (NSR-M)
P.A. INCORPORATED*	P-194693
UNC NUCLEAR INDUSTRIES	PA2A, PA2B, PT2A, PT2B, PS2A, PS2B (OLD: SM-100)
E.I. DUPONT DE NUMOURS & CO. (NEN) MODEL 478C SEALED SOURCE	
US DEPARTMENT OF ENERGY	SR-CF-100 SERIES

WELL LOGGING SEALED SOURCES APPROVED UNDER THE GENERIC EXEMPTION

MANUFACTURER	MODEL
COMPROBE, INC. GULF NUCLEAR, INC. MODEL CSV SEALED SOURCE	1203 DENSITY PROBE
COMPROBE, INC. GAMMA INDUSTRIES (GAMMATRON) MODEL AN-HP SEALED SOURCE	2103 DENSITY PROBE
E.I.DUPONT DE NUMOURS & CO. (NEW ENGLAND NUCLEAR)	NER-572, NER-582
GAMMA INDUSTRIES (GENERAL NUCLEAR, INC.)	CS-1000 (HP)
GAMMA INDUSTRIES (GENERAL NUCLEAR, INC.)	GNI-NB (HP)
GAMMA INDUSTRIES	NB (HP)
GAMMA INDUSTRIES (GENERAL NUCLEAR, INC.)	NHP-A-#
GAMMA INDUSTRIES	WLG-1
GAMMATRON, INC. (NUCLEAR SOURCES AND SERVICES, INC.)	AN-HP
GAMMATRON, INC. (NUCLEAR SOURCES AND SERVICES, INC.)	AN-HPG, RN-HP
GAMMATRON, INC. (NUCLEAR SOURCES AND SERVICES, INC.)	DA-20
GAMMATRON, INC. (NUCLEAR SOURCES AND SERVICES, INC.)	DA-5
GAMMATRON, INC. (NUCLEAR SOURCES AND SERVICES, INC.)	GT-GHP
GULF NUCLEAR, INC. (NEEI)	AMBE-71-2A
GULF NUCLEAR, INC. (NEEI)	0-73-2
GULF NUCLEAR, INC. (NEEI)	CS-2

MANUFACTURER	MODEL
GULF NUCLEAR, INC. (NEEI)	CSV
MONSANTO CO., DAYTON LABORATORY	24112
MONSANTO CO., DAYTON LABORATORY	24120
PARKWELL LABORATORIES, INC.	PL-104

KNOWN SEALED SOURCES NOT APPROVED FOR USE IN WELL LOGGING

MANUFACTURER	MODEL
AMERSHAM CORPORATION	CD CQ 5987
AMERSHAM CORPORATION	CDC.800 SERIES (.801 TO .811)
DRESSER ATLAS	B89596, B89587, B89598
FRONTIER TECHNOLOGY CORP.	100
GAMMA INDUSTRIES (GENERAL NUCLEAR, INC.)	GNI-DL-4
GAMMA INDUSTRIES (GENERAL NUCLEAR, INC.)	GNI-NB-S-5. 0
GAMMA INDUSTRIES	NB-S-S, NB-S-20
GAMMA INDUSTRIES (GENERAL NUCLEAR, INC.)	PL-AMBE-2.7
GAMMA INDUSTRIES	RC-1 (HP)
GAMMA INDUSTRIES	S-14
GAMMATRON, INC. (NUCLEAR SOURCES AND SERVICES, INC.)	GT-G
GENERAL NUCLEAR, INC.	GNI-C(G)M-5
GULF NUCLEAR, INC. (NEEI)	CO-50
GULF NUCLEAR, INC. (NEEI)	CS-50
GULF NUCLEAR, INC. (NEEI)	TG-1
GULF NUCLEAR, INC. (NEEI)	72-CO-200
HASTINGS RADIOCHEMICAL WORKS	CS-Ill-A-l00
ICN PHARMACEUTICAL, INC. (US NUCLEAR)	373
ICN PHARMACEUTICAL, INC. (US NUCLEAR)	374

MANUFACTURER	MODEL
ICN PHARMACEUTICAL, INC. (US NUCLEAR)	376
ICN PHARMACEUTICAL, INC. (US NUCLEAR)	3146
ISOTOPES SPECIALTIES	0-0037
LFE CORPORATION (TRACERLAB)	CS-15
MINNESOTA MINING AND MANUFACTURING	4F6B
MINNESOTA MINING AND MANUFACTURING (REDESIGN OF MODEL 4F68)	4F6H
MINNESOTA MINING AND MANUFACTURING	4F6S
MINNESOTA MINING AND MANUFACTURING	4P6F
MINNESOTA MINING AND MANUFACTURING	4P6U
MINNESOTA MINING AND MANUFACTURING	4P6W
MONSANTO CO., DAYTON LABORATORY (SCHLUMBERGER WELL SERVICES)	H-142525
MONSANTO CO., DAYTON LABORATORY (SCHLUMBERGER WELL SERVICES)	H-207947
MONSANTO CO., DAYTON LABORATORY	MRC
MONSANTO CO., DAYTON LABORATORY	MRC-N-SS-W-AMBE(R)
MONSANTO CO., DAYTON LABORATORY	NS-WELEX
MONSANTO CO., DAYTON LABORATORY	2410
MONSANTO CO., DAYTON LABORATORY	24154-B
NUCLEAR MATERIALS AND EQUIPMENT CORP.	NUMEC-AM-62, 63, 100, 123, 154
NUCLEAR MATERIALS AND EQUIPMENT CORP.	NUNEC DWG. 11-B-208
PARKWELL LABORATORIES, INC.	PL-AMBE
SCHLUMBERGER	DWG H-1061850
SCHLUMBERGER (MONSANTO, NUMEC)	DWG H-115686

MANUFACTURER	MODEL
SCHLUMBERGER	DWG H-123515
SCHLUMBERGER	DWG H-123837
SCHLUMBERGER	DWG H-142108
SCHLUMBERGER	DWG H-218733
SCHLUMBERGER	DWG H-239681
SCHLUMBERGER	DWG X-113176
SCHLUMBERGER WELL SERVICES	NSR-R
SCHLUMBERGER WELL SERVICES*	P-194693
WELL RECONNAISANCE, INC.	10411
WSI	A4794

Appendix K

Typical Duties and Responsibilities of the Radiation Safety Officer

Typical Duties and Responsibilities of the Radiation Safety Officer

The RSO's duties and responsibilities include ensuring radiological safety and compliance with VDH and DOT regulations and the conditions of the license (see **Table 3**). Typically, these duties and responsibilities include ensuring the following:

- Secure from management the authorization to stop activities involving licensed material considered unsafe by the RSO.
- Maintain radiation exposures ALARA.
- Develop, distribute, implement, and maintain up-to-date operating and emergency procedures.
- Ensure that the possession, installation, relocation, use, storage, repair, and maintenance of licensed material and well logging equipment are consistent with the limitations in the license, the Sealed Source and Device Registration Certificate(s), and manufacturer's recommendations and instructions.
- Ensure that evaluations are performed to demonstrate that individuals who are not provided personnel monitoring devices will be unlikely to receive, in one year, a radiation dose in excess of 10% of the allowable limits or that personnel monitoring devices are provided.
- Ensure that personnel monitoring devices for well logging supervisors and assistants are used and exchanged at the proper intervals, and records of the results of such monitoring are maintained.
- Determine that licensed materials are maintained secure when not under the constant surveillance of logging personnel.
- Maintain documentation to demonstrate, by measurement or calculation, that the total effective dose equivalent to the individual likely to receive the highest dose from licensed operations does not exceed the annual limit for members of the public.
- Ensure that proper authorities are notified of incidents such as fire, theft, or damage to sealed sources, loss of well logging sources downhole, and non-routine levels of radioactive contamination at well logging, tracer, and field study operations.
- Ensure that unusual occurrences are investigated, cause(s) and appropriate corrective action(s) are identified, and timely corrective action(s) are taken.
- Perform and document radiation safety program audits annually.
- Identify violations of regulations, license conditions, or program weaknesses, and develop, implement, and document corrective actions.
- Ensure that licensed material is transported in accordance with all applicable VDH and DOT requirements.
- Ensure that licensed material is disposed of properly.
- Keep license up-to-date by amending and renewing, as required. Ensure that renewals are made in a timely manner.
- Serve as the licensee's liaison officer with the agency on license or inspection matters.
- Control procurement and disposal of licensed material, maintain associated records, and ensure that licensed materials that are possessed or used by the applicant are limited to those specified in the license.
- Establish and conduct the training program for logging supervisors and logging assistants.
- Examine and determine the competence of logging personnel.
- Ensure that the licensed materials are used only by those individuals who have satisfactorily completed appropriate training programs or who are authorized by the license.
- Establish and maintain a personnel monitoring program and ensure that all users wear personnel monitoring equipment, such as film badges, OSL, or TLD.
- Establish and maintain storage facilities.
- Establish and maintain the leak test program and supervise leak testing of sealed sources.
- Procure and maintain radiation survey instruments.

- Establish and maintain a survey instrument calibration program.
- Develop and maintain up-to-date operating and emergency procedures.
- Conduct physical inventories and maintain utilization logs.
- Review and ensure maintenance of records.
- Conduct radiation safety inspections of licensed activities periodically to ensure compliance with the regulations and license conditions.
- Serve as a point of contact and give assistance in case of emergency (well logging tool damage, theft, fire, etc.) to ensure that the proper authorities are notified.
- Investigate the cause of incidents and determine necessary preventative action.
- Act in an advisory capacity to the licensee's management and logging personnel.
- Establish a procedure for evaluating and reporting equipment defects and noncompliance pursuant to **10 CFR Part 21**.

Appendix L

Well Logging Supervisor and Logging Assistant Training Requirements

Well Logging Supervisor and Logging Assistant Training Requirements

Table 11. 12VAC5-481, Part XIV Training Requirements

Requirement		Training Criteria
12VAC5-481-3270 A		**Logging Supervisor**
A.	Receive Training in **12VAC5-481-3270 A** Topics (Classroom Training – Approximately 24 hours in length)	Topics in **12VAC5-481-3270 A** **Fundamentals of Radiation Safety** • Characteristics of gamma radiation • Units of radiation dose and quantity of radioactivity • Hazards of exposure to radiation • Levels of radiation from licensed material • Methods of controlling radiation dose (time, distance, shielding) • Radiation safety practices, including prevention of contamination, and methods of decontamination **Radiation Detection Instruments** • Use, operation, calibration, and limitations • Survey techniques • Use of personnel monitoring equipment **Equipment to be Used** • Operation of equipment, including source handling equipment and remote handling tools • Storage, control, and disposal of licensed material • Inspection and maintenance of equipment **Requirements of Pertinent State and Federal Regulations** **Case histories of accidents in well logging operations**

Table 11. 12VAC5-481, Part XIV Training Requirements

Requirement		Training Criteria
12VAC5-481-3270 A		**Logging Supervisor**
B.	On-the-Job Training – using sealed sources 160 hours for mineral logging licensee, or a licensee using sealed sources with activities less than 500 millicuries **OR** 3 months or 520 hours for gas or oil well logging operations using sealed sources with activities greater then 500 millicuries	Under the supervision of a qualified logging supervisor
C.	On-the-Job Training – using tracer materials **Single Well Tracer Operations** 3 months or 520 hours or completion of 50 tracer operations **Field Flood Operations** 3 months or 520 hours or completion of 3 field flood tracer operations involving multiple wells	Under the supervision of a qualified logging supervisor
D.	Completion of a Written Examination	Complete a written examination submitted and approved by VDH
E.	Must receive Copies of and Instruction in: (Classroom Training – Approximately 8 hours in length)	VDH Regulations • Applicable sections of **12VAC5-481, Part IV, X, and XIV.** • The VDH license under which the logging supervisor will perform well logging • The operating and emergency procedures required by **12VAC5-481-3280**
F.	Receive Equipment Training (Approximately 4 hours in length)	Training includes: • Well Logging Equipment • Sealed Sources • Handling Equipment • Survey meters • Daily inspection
G.	Demonstrate Understanding in Use of Well Logging Equipment by Passing Practical Field Exam	Questions on topics determined by the licensee Use the Well Logging Supervisor/Logging Assistant Inspection Checklist as a potential source of questions

Table 11. 12VAC5-481, Part XIV Training Requirements

	Requirement	Training Criteria
	12VAC5-481-3270 A	**Logging Supervisor**
I.	Annual Refresher Training	Review the following: • Annual radiation safety program review • New procedures, equipment, or techniques • New regulations • Observations and deficiencies during audits of well logging supervisor and logging assistants and discussion of any significant incidents or accidents involving well logging • Employee questions
J.	Records	To be maintained in accordance with **12VAC5-481-3270 D**

	Requirement	Training Criteria
	12VAC5-481-3270 B	Logging Assistant
A.	Must receive Copies of and Instruction in: (Classroom Training – Approximately 8 hours in length)	VDH Regulations • Applicable sections of **12VAC5-481, Part IV, X, and XIV** • Operating and emergency procedures required by **12VAC5-481-3280**
B.	Pass Oral or Written Exam	Complete a written examination submitted and approved by VDH
C.	Receive Equipment Training (Approximately 2-4 hours in length)	Training under the supervision of a qualified well logging supervisor appropriate for the logging assistant's intended job responsibilities: • Well logging equipment • Sealed sources • Handling equipment • Survey meters • Daily inspection
D.	Annual Refresher Training	Review the following: • Any significant item identified in the annual review of the radiation safety program • New procedures or equipment • New regulations • Observations and deficiencies during audits and discussion of any significant incidents or accidents involving well logging operations • Employee questions
E.	Records	To be maintained in accordance with **12VAC5-481-3270 D**

Appendix M

Annual Internal Job Performance Inspection Checklist for Well Logging Supervisors and Well Logging Assistants

Annual Internal Job Performance Inspection Checklist for Well Logging Supervisors and Well Logging Assistants

Well Logging Location _____

Date _____ **Time** _____

Logging Supervisor _____

Logging Assistant _____

Inspector _____

Yes No Questions

1. Film, TLD, or OSL badge available and properly worn?

2. Individuals working within the restricted area wearing TLD, OSL, or film badges or dosimeters?

3. Restricted areas properly controlled to prevent unauthorized entry?

4. Calibrated and properly operating survey meter and evidence of its latest calibration available?

5. Latest survey records as required by **12VAC5-481-3350** or **12VAC5-481-3360** available?

6. Measurements taken of positions occupied in transport vehicle?

7. Measurement taken of vehicle exterior?

8. Contamination check performed of well logging tool prior to transport?

9. Measurements taken before and after subsurface tracer use?

10. Shipping papers for transportation of radioactive material available and properly filled out?

11. Utilization log properly filled out?

12. Defective well logging equipment being used?

13. Copy of the applicant's operating and emergency procedures available at the site?

14. Radioactive isotopes stored and secured properly to prevent unauthorized removal?

15. Storage area properly posted with "*Caution…"* or *"Danger Radioactive Material*" signs?

16. Additional items of noncompliance noted during this audit? (If any, explain, in remarks.)

Remarks:

Appendix N

Radiation Monitoring Instrument Specifications and Model Survey Instrument Calibration Program

Radiation Monitoring Instrument Specifications and Model Survey Instrument Calibration Program

Radiation Monitoring Instrument Specifications

The specifications in **Table 12** will help applicants and licensees choose the proper radiation detection equipment for monitoring the radiological conditions at their facilities.

Table 12. Typical Survey.

Portable Instruments Used for Contamination and Ambient Radiation Surveys			
Detectors	Radiation	Energy Range	Efficiency
Exposure Rate Meters	Gamma, X-Ray	μR-R	N/A
Count Rate Meters			
GM	Alpha	All energies (dependent on window thickness)	Moderate
	Beta	All energies (dependent on window thickness)	Moderate
	Gamma	All energies	< 1%
NaI Scintillator	Gamma	All energies (dependent on crystal thickness)	Moderate
Plastic Scintillator	Beta	Carbon-14 or higher (dependent on window thickness)	Moderate
Stationary Instruments Used to Measure Wipe, Bioassay, and Samples from Tracer/Field Flood Study Job Sites			
Detectors	Radiation	Energy Range	Efficiency
Liquid Scintillation Counter*	Alpha	All energies	High
	Beta	All energies	High
	Gamma		Moderate
Gamma Spectroscopy System using a (NaI)* detector	Gamma	All energies	High
Gas Proportional	Alpha	All energies	High
	Beta	All energies	Moderate
	Gamma	All energies	< 1%

Note: Table adapted from The Health Physics & Radiological Health Handbook, Revised Edition, Edited by Bernard Shleien, 1992 (except for * items).

Model Instrument Calibration Program

Training

Before allowing an individual to perform survey instrument calibrations, the RSO will ensure that he or she has sufficient training and experience to perform independent survey instrument calibrations. Classroom training may be in the form of lecture, videotape, or self-study and will cover the following subject areas:

- Principles and practices of radiation protection
- Radioactivity measurements, monitoring techniques, and using instruments
- Mathematics and calculations basic to using and measuring radioactivity
- Biological effects of radiation.

Appropriate on-the-job training consists of the following:

- Observing authorized personnel performing survey instrument calibration
- Conducting survey meter calibrations under the supervision and in the physical presence of an individual authorized to perform calibrations.

Facilities and Equipment for Calibration of Dose Rate or Exposure Rate Instruments

- To reduce doses received by individuals not calibrating instruments, calibrations will be conducted in an isolated area of the facility or at times when no one else is present
- Individuals conducting calibrations will wear assigned dosimetry
- Individuals conducting calibrations will use a calibrated and operable survey instrument to ensure that unexpected changes in exposure rates are identified and corrected

Model Procedure for Calibrating Survey Instruments

A radioactive sealed source(s) used for calibrating survey instruments will:

- Approximate a point source
- Have its apparent source activity or the exposure rate at a given distance traceable by documented measurements to a standard certified to be within ± 5% accuracy by National Institutes of Standards and Technology (NIST)
- Approximate the same energy and type of radiation as the environment in which the calibrated device will be employed or develop energy curves to compensate for differing energies
- For dose rate and exposure rate instruments, the source should be strong enough to give an exposure rate of at least about 7.7×10^{-6} coulombs/kilogram/hour (30 mR/hr) at 100 cm [e.g., 3.1 gigabecquerels (85 mCi) of cesium-137 or 7.8×10^{2} megabecquerels (21 mCi) of cobalt-60]

The three kinds of scales frequently used on dose or dose rate survey meters are calibrated as follows[3]:

- Linear readout instruments with a single calibration control for all scales should be adjusted at the point recommended by the manufacturer or at a point within the normal range of use. Instruments with calibration controls for each scale should be adjusted on each scale. After adjustment, the response of the instrument should be checked at approximately 20% and 80% of full scale. The instrument's readings should be within ±15% of the conventionally true values for the lower point and ±10% for the upper point.
- Logarithmic readout instruments, which commonly have a single readout scale spanning several decades, normally have two or more adjustments. The instrument should be adjusted for each scale according to site specifications or the manufacturer's specifications. After adjustment, calibration should be checked at a minimum of one point on each decade. Instrument readings should have a maximum deviation from the conventionally true value of no more than 10% of the full decade value.
- Meters with a digital display device shall be calibrated the same as meters with a linear scale

- Readings above 2.58 x 10^{-4} coulomb/kilogram/hour (1 R/hr) need not be calibrated, but such scales should be checked for operation and response to radiation
- The inverse square and radioactive decay laws should be used to correct changes in exposure rate due to changes in distance or source decay.

Surface Contamination Measurement Instruments

- A survey meter's efficiency must be determined by using sealed sources with similar energies and types of radiation that the survey instrument will be used to measure or by developing energy curves to compensate for differing energies.
- If each scale has a calibration potentiometer, the reading should be adjusted to read the conventionally true value at approximately 80% of full scale, and the reading at approximately 20% of full scale should be observed. If only one calibration potentiometer is available, the reading should be adjusted at mid-scale on one of the scales, and readings on the other scales should be observed. Readings should be within 20% of the conventionally true value.

Model Procedures for Calibrating, Liquid Scintillation Counters, Gamma Counters, Gas Flow Proportional Counters, and Multichannel Analyzers

A radioactive sealed source used for calibrating instruments will do the following:

- Approximate the geometry of the samples to be analyzed
- Have its apparent source activity traceable by documented measurements to a standard certified to be within ± 5% accuracy by NIST.
- Approximate the same energy and type of radiation as the samples that the calibrated device will be used to measure.

Calibration

- Calibration of survey instruments used in well logging procedures for assessing dose or exposure rates must be conducted at least every 6 months or after instrument servicing
- Calibration must produce readings within ±20% of the actual values over the range of the instrument
- Calibration of liquid scintillation counters will include quench correction.

Calibration Records

Calibration reports, for all survey instruments, should indicate the procedure used and the data obtained. The calibration record should include:

- The owner or user of the instrument
- A description of the instrument, including the manufacturer's name, model number, serial number, and type of detector
- A description of the calibration source, including the exposure rate at a specified distance or activity on a specified date
- For each calibration point, the calculated exposure rate or count rate, the indicated exposure rate or count rate, the deduced correction factor (the calculated exposure rate or count rate divided by the indicated exposure rate or count rate), and the scale selected on the instrument
- For instruments with external detectors, the angle between the radiation flux field and the detector (i.e., parallel or perpendicular)
- For instruments with internal detectors, the angle between radiation flux field and a specified surface of the instrument
- For detectors with removable shielding, an indication whether the shielding was in place or removed during the calibration procedure
- The exposure rate or count rate from a check source, if used
- The name of the person who performed the calibration and the date it was performed.

The following information should be attached to the instrument as a calibration sticker or tag:

- For exposure rate meters, the source isotope used to calibrate the instrument (with correction factors) for each scale
- The efficiency of the instrument, for each isotope the instrument will be used to measure (if efficiency is not calculated before each use)
- For each scale or decade not calibrated, an indication that the scale or decade was checked only for function but not calibrated
- The date of calibration and the next calibration due date
- The apparent exposure rate or count rate from the check source, if used.

References:

1. Draft Regulatory Guide FC 413-4, "*Guide for the Preparation of Applications for Licenses for the Use of Radioactive Materials in Calibrating Radiation Survey and Monitoring Instruments*", dated June 1985.
2. "*The Health Physics & Radiological Health Handbook, Revised Edition*", edited by Bernard Shleien, dated 1992.
3. ANSI N323A-1997, "*Radiation Protection Instrumentation Test and Calibration*".
Copies may be obtained from the American National Standards Institute, 1430 Broadway, New York, NY 10018 or ordered electronically at the following address: www.ansi.org.

Appendix O

Guidance for Demonstrating that Unmonitored Individuals are Not Likely to Exceed 10 Percent of the Allowable Limits

Guidance for Demonstrating that Unmonitored Individuals are Not Likely to Exceed 10 Percent of the Allowable Limits

Dosimetry is required for individual adults who are likely to receive in 1 year an occupational dose from sources external to the body in excess of 10% of the applicable regulatory limits in **12VAC5-481-630**. However, logging supervisors or logging assistants are required by **12VAC5-481-3290** to wear either a film badge, optically stimulated luminescent (OSL) badge, or a thermoluminescent dosimeter (TLD) when handling licensed tracer materials or sealed sources. In instances where pocket chambers are used instead of film badges or TLDs to assess radiation dosage of personnel who are not logging supervisors or logging assistants, a check of the response of the dosimeters to radiation should be made every 12 months. Acceptable pocket dosimeters should read within plus or minus 20% of the true radiation dose. To demonstrate to the agency that dosimetry is **not** required for non-logging personnel, a licensee needs to have available an evaluation demonstrating that these non-monitored workers are not likely to exceed 10% of the applicable annual limits — 5 mSv (500 millirems) per year.

The applicable Total Effective Dose Equivalent (whole body) limit is 50 mSv (5 rems) per year, and 10% of that value is 5 mSv (500 millirems) per year.

Three common ways that individuals may exceed 10% of the applicable limits are mishandling tracer radioisotopes, logging tools, or any devices containing sealed sources. However, most routine well logging or tracer activities result in minimal doses to well logging and tracer personnel. A licensee will need to conduct an evaluation of doses to occupationally exposed workers who could, in performing tasks involving the handling of radioactive materials, have a need for dosimetry.

Example: A careful radiation measurement using a survey meter of the location producing the highest dose rate at the rear of the logging truck where radioactive material is stored in its transport compartment and where mechanics routinely work, is found to be 0.015 mSv/hr (1.5 mrem/hr). Mechanics are not expected to spend any more than a total of 3 hours per week at the location near the storage containers where the sealed sources are housed at the rear of the truck. Based on this measured dose rate, the annual dose is expected to be less than 2.34 mSv (234 mrem). Specifically, 3 hr/wk x 1.5 mrem/hr x 52 wk/yr = 234 mrem. Based on the above, if any mechanic works in the area less than 6.4 hours per week, no dosimetry is required.

Note: 6.4 hours is the total amount of hours it would take for an individual to meet the 5 mSv (500 millirems) per year limit.

Appendix P

Guidance for Demonstrating that Individual Members of the Public will not Receive Doses Exceeding the Allowable Limits

Guidance for Demonstrating that Individual Members of the Public will not Receive Doses Exceeding the Allowable Limits

Licensees must ensure that:

- The radiation dose received by individual members of the public does not exceed 1 mSv (100 mrem) in one calendar year resulting from the licensee's possession and/or use of licensed materials.

  Members of the public include persons who live, work, or may be near locations where licensed material is used or stored and employees whose assigned duties do not include the use of licensed materials and who work in the vicinity where it is used or stored.

- The radiation dose in unrestricted areas does not exceed 0.02 mSv (2 mrem) in any one hour.

  Typical unrestricted areas may include offices, shops, laboratories, areas outside buildings, property, and non-radioactive equipment storage areas. The licensee does not control access to these areas for purposes of controlling exposure to radiation or radioactive materials; however, the licensee may control access to these areas for other reasons, such as security.

Licensees must demonstrate compliance with both of the above regulations. For areas adjacent to facilities where licensed material is used or stored, calculations or a combination of calculations and measurements (e.g., using an environmental TLD) are often used to show compliance.

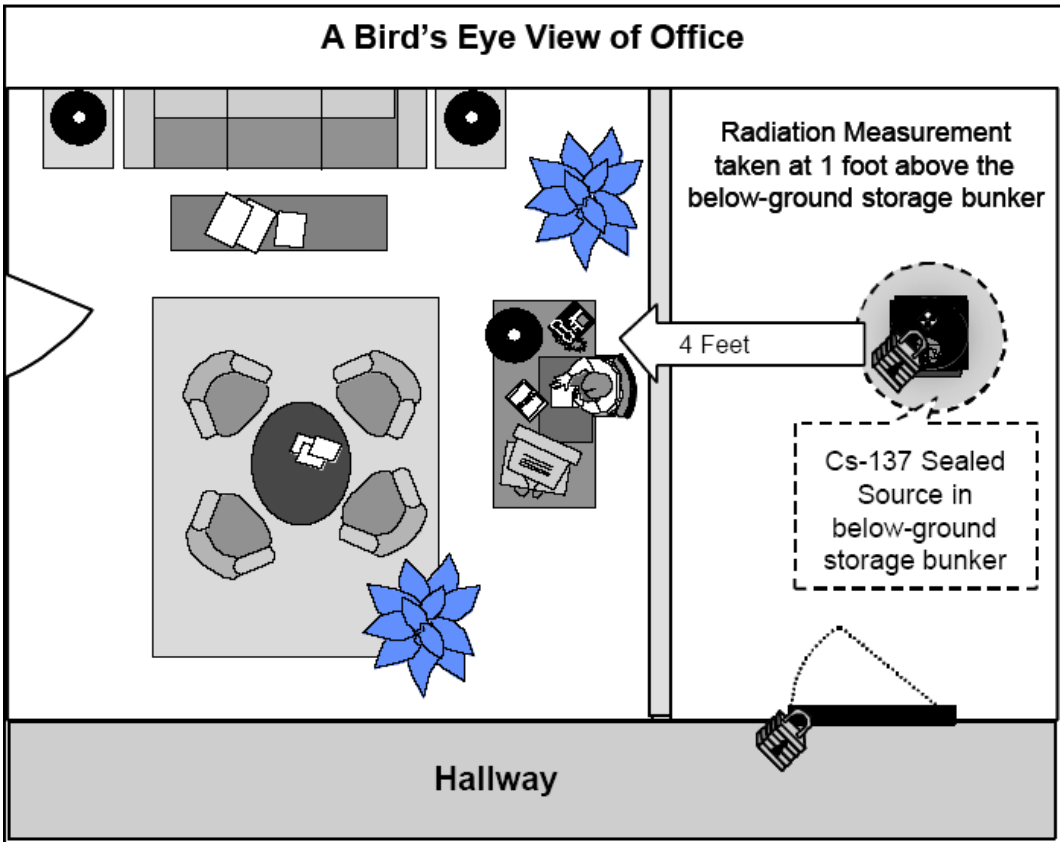


Figure 4. Bird's Eye View of Office.

Calculation Method

These measurements must be made with calibrated survey meters sufficiently sensitive to measure background levels of radiation. However, licensees must exercise caution when making these measurements, and they must use currently calibrated radiation survey instruments. A maximum dose of 1 mSv (100 mrem) received by an individual over a period of 2080 hours (i.e., a 'work year' of 40 hr/wk for 52 wk/yr) is equal to less than 0.5 microsievert (0.05 mrem) per hour.

This rate is well below the minimum sensitivity of most commonly available GM survey instruments.

Instruments used to make measurements for calculations must be sufficiently sensitive. An instrument equipped with a scintillation-type detector (e.g., NaI(Tl)) or a micro-R meter used in making very low gamma radiation measurements should be adequate.

Licensees may also choose to use environmental TLDs in unrestricted areas next to the downhole source storage area for monitoring. This direct measurement method would provide a definitive measurement of actual radiation levels in unrestricted areas without any restrictive assumptions. Records of these measurements can then be evaluated to ensure that rates in unrestricted areas do not exceed the 1 mSv/yr (100 mrem/yr) limit.

TLDs used for personnel monitoring (e.g., LiF) may not have sufficient sensitivity for this purpose. Generally, the minimum reportable dose received is 0.1 mSv (10 mrem). Suppose a TLD monitors dose received and is changed once a month. If the measurements are at the minimum reportable level, the annual dose received could have been about 1.2 mSv (120 mrem), a value in excess of the 1 mSv/yr (100 mrem/yr) limit. If licensees use TLDs to evaluate compliance with the public dose limits, they should consult with their TLD supplier and choose more sensitive TLDs, such as those containing CaF_2 that are used for environmental monitoring.

The combined measurement-calculation method may be used to estimate the maximum dose to a member of the public. The combined measurement-calculation method takes a tiered approach, going through a two-part process, starting with a worst case situation and moving toward more realistic situations. It makes the following simplifications: (1) each Cesium-137 logging source is a point source; (2) typical radiation levels are encountered when the source is in the unshielded position; and (3) no credit is taken for any shielding found between the source storage area and the unrestricted areas. The method is only valid for the source activity at the time of measurement and must be repeated if the source strength or shielding is changed.

Part 1 of the combined measurement-calculation method is simple but conservative. It assumes that an affected member of the public is present 24 hours a day and uses only the inverse square law to determine if the distance between the downhole storage area and the affected member of the public is sufficient to show compliance with the public dose limits. Part 2 considers not only distance, but also the time that the affected member of the public is actually in the area under consideration. Using this approach, licensees make only those calculations that are needed to demonstrate compliance. The results of these calculations typically result in higher radiation levels than would exist at typical facilities, but they provide a method for estimating conservative doses that could be received.

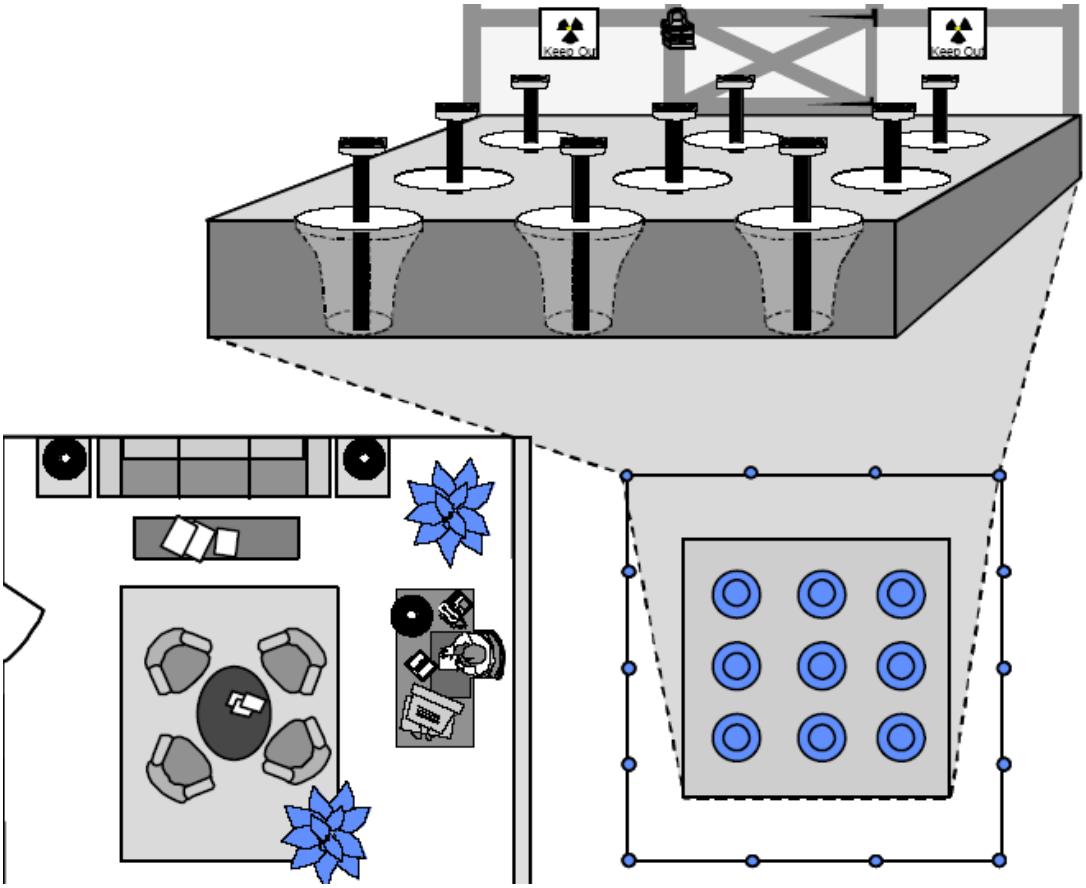


Figure 5. Downhole Storage Array.

Example
To better understand the combined measurement-calculation method, we will examine EZ Well Logging, Inc., a well logging licensee. Yesterday, the company's president noted that the top shield of the downhole storage area is close to an area used by workers whose assigned duties do not include the use of licensed materials, and he asked Joe, the Radiation Safety Officer (RSO), to determine if the company is complying with VDH's regulations.

The area in question is near the floor under the workers' desks, which constitutes the primary shield of the downhole storage area. Joe measures the distance from the shield to the center of the area in question and, using a calibrated survey instrument, measures the highest dose rate at one foot from the shield to be 2 mrem per hour.

Summary of Information
This is the information Joe has or has acquired on the downhole storage area: the dose rate at 1 foot from the top of the shield is 2 mrem/hr and the nearest occupied work area to the face of the shield is 4 ft.

Example: Part 1
Joe's first thought is that the distance between the downhole storage area shield and the area in question may be sufficient to show compliance with the regulation in **12VAC5-481-720**. So, taking a worst case approach, he assumes: 1) the Cesium-137 is constantly located in downhole storage area (i.e., 24 hr/d), and 2) the workers are constantly in the unrestricted work area (i.e., 24 hr/d). Joe proceeds to calculate the dose the workers might receive hourly and yearly from the source, as shown in **Table 13** below.

Table 13. Calculation Method, Part 1: Hourly and Annual Doses Received from a Logging Source Stored in Above Ground Transportation Container.

Step No.	Description	Input Data	Results
1	Multiply the measured dose rate measured at 1.0 ft from the face of the shield floor in mrem/hr by the square of the distance (ft) at which the measurement was made (e. g., 1 foot from the face of the shield)	$2 \times (1)^2$	2
2	Square the distance (ft) from the face of the shield to the nearest unrestricted area, in ft^2	$(4)^2$	16
3	Divide the result of Step 1 by the result of Step 2 to calculate the dose received by an individual in the area near the shield. **HOURLY DOSE RECEIVED FROM SOURCE**, in mrem in an hour	2/16	**0.125**
4	Multiply the result of Step 3 by 40 hr/work week x 52 weeks/year = **MAXIMUM ANNUAL DOSE RECEIVED FROM Cs-137 Source**, in mrem in a year	0.125 x 40 x 52	**260**

Note: The result in Step 3 demonstrates compliance with the 2 mrem in any one hour limit. Re-evaluate if assumptions change. If the result in Step 4 exceeds 100 mrem/yr, proceed to Part 2 of the calculation method.

At this point, Joe is pleased to see that the total dose that an individual could receive in any one hour is only 0.125 mrem in an hour, less than the 2 mrem in any one hour limit but notes that an individual could receive a dose of 260 mrem in a year, higher than the 100 mrem limit.

Example: Part 2

Joe reviews the assumptions and recognizes that the workers are not in area near the shield all of the time. A realistic estimate of the number of hours the workers spend in the area is made, keeping the other assumptions constant (i.e., the source is constantly in the downhole storage area (i.e., 24 hr/d). The annual dose received is then recalculated.

Table 14. Calculation Method, Part 2: Annual Dose Received from a Logging

Step No.	Description	Results
7.	A. Average number of hours per day an individual spends in area of concern (e.g., a non-radiation worker spends 1.5 hr/day in area near the shield; the remainder of the day the workers are away from the area assigned to jobs unrelated to radiation)	1.5552
	B. Average number of days per week in area	5
	C. Average number of weeks per year in area (e.g., full time workers)	52
8.	Multiply the results of Step 7.A. by the results of Step 7.B. by the results of Step 7.C. = **AVERAGE NUMBER OF HOURS IN AREA OF CONCERN PER YEAR**	1.5 x 5 x 52 = **390**
9.	Multiply the results in Step **3** by the results of Step 8 = **ANNUAL DOSE RECEIVED FROM CESIUM-137 LOGGING SOURCE CONDSIDERING REALISTIC ESTIMATE OF TIME SPENT IN AREA OF CONCERN**, in mrem in a year	0.125 x 390 = **49**

Joe is pleased to note that the calculated annual dose received is significantly lower, and does not exceed the 100 mrem in a year limit. Had the result in Step 9 been higher than 100 mrem in a year, then Joe would have not been in compliance and could have done one or more of the following:

- Consider whether the assumptions used to determine occupancy are accurate, revise the assumptions as needed, and recalculate using any new assumptions
- Calculate the effect of any shielding located between the storage area and the floor of the public area — such calculation is beyond the scope of this Appendix
- Take corrective action (e.g., change work patterns to reduce the time spent in the area near the shield) and perform new calculations to demonstrate compliance
- Designate the area inside the use area as a restricted area and the workers as occupationally exposed individuals. This would require controlling access to the area for purposes of radiation protection and training the workers as required by **12VAC5-481-2270**.

Reference: National Council on Radiation Protection and Measurements (NCRP) Report No. 49, "*Structural Shielding Design and Evaluation for Medical Use of X Rays and Gamma Rays of Energies Up to 10 MeV*", contains helpful information. It is available from NCRP, 7910 Woodmont Avenue, Suite 800, Bethesda, Maryland 20814. NCRP's telephone numbers are: (301) 657-2652 or 1-800-229-2652.

Note that in the example, Joe evaluated the unrestricted area outside only one wall of the downhole storage area. Licensees also need to make similar evaluations for other unrestricted areas and to keep in mind the ALARA principle, taking reasonable steps to keep radiation dose received below regulatory requirements. In addition, licensees need to be alert to changes in situations (e.g., adding sources to the storage area, changing the work habits of the workers, or otherwise changing the estimate of the portion of time spent in the area in question) and to perform additional evaluations, as needed.

RECORD KEEPING: 12VAC5-481-1050 requires licensees to maintain records demonstrating compliance with the dose limits for individual members of the public.

Appendix Q

Notification of Proper Persons in the Event of an Accident

Notification of Proper Persons in the Event of an Accident

Emergency Procedure

Notify the persons listed below of the situation, in the order shown.

Name*	Work Phone Number*	Home Phone Number*
Radiation Safety Officer (RSO)		
Senior Logging Supervisors		
Manufacturers/Distributors		
Consultant		

* Fill in with (and update, as needed) the names and telephone numbers of appropriate personnel (e.g., the Radiation Safety Officer (RSO) or other knowledgeable licensee staff, licensee's consultant, device manufacturer, etc.) to be contacted in case of emergency. Follow the directions provided by the person contacted above.

RSO and Licensee Management

Discuss emergency operating procedures, and ensure no operations are conducted until the situation has been discussed with and approved by the RSO or other knowledgeable staff, consultants, or the device manufacturer. Management should have access to emergency equipment to keep doses as low as reasonably achievable. Emergency equipment may include special survey equipment.

Notify local authorities as well as the agency, as required. (Even if notification is not required, ANY incident may be reported to the agency by calling the emergency number at (804) 864-8150 during business hours or (800) 468-8892, which is staffed 24 hours a day; identify emergency as radiological.) Agency notification is required when sources or devices containing licensed material are lost or stolen and when sealed or unsealed radioactive material or equipment is involved in incidents that may have caused or that threaten to cause an exposure in excess of **12VAC5-481-1100** limits. Reports to the agency must be made within the reporting time frames specified by the regulations. Notification and reporting requirements are found in **12VAC5-481-1090, 12VAC5-481-1100, 12VAC5-481-1110**, **10 CFR Part 21.21**, and **12VAC5-481-3370**.

Notifications

Table 15. VDH Notifications.

Event	Telephone Notification	Written Report	Rule Requirement
Theft or loss of material	Immediate	30 days	**12VAC5-481-1090**
Whole body dose greater then 0.25 Sv (25 rems)	Immediate	30 days	**12VAC5-481-1100**
Extremity dose greater then 2.5 Sv (250 rems)	Immediate	30 days	**12VAC5-481-1100**
Whole body dose greater then 0.05 Sv (5 rems) in 24 hours	24 hours	30 days	**12VAC5-481-1100**
Extremity dose greater then 0.5 Sv (50 rems) in 24 hours	24 hours	30 days	**12VAC5-481-1100**
Whole body dose greater then 0.05 Sv (5 rems)	None	30 days	**12VAC5-481-1110**
Dose to individual member of public greater then 1 mSv (100 rems)	None	30 days	**12VAC5-481-1110**
Defect in equipment that could create a substantial safety hazard	2 days	30 days	**12VAC5-481-1100, 12VAC5-481-1110**
Event that prevents immediate protective actions necessary to avoid exposure to radioactive materials that could exceed VDH limits	Immediate	30 days	**12VAC5-481-1110**
Equipment is disabled or fails to function as designed when required to prevent radiation exposure in excess of VDH limits	24 hours	30 days	**12VAC5-481-1110**
Unplanned fire or explosion that affects the integrity of any licensed material or device, container, or equipment with licensed material	24 hours	30 days	**12VAC5-481-1110**
Rupture of sealed source	Immediate	30 days	**12 VAC-5-481-3370**
Sealed source becomes lodged in well bore and becomes classified as irretrievable, or licensee is requesting an extension to complete abandonment procedures	24 hours	30 days	**12VAC5-481-3370 B & C**
Leak test of sealed source resulting in leakage greater then 185 Bq (0.005 microcuries)	None	5 days	**12VAC5-481-3210 D**
Failure of any component to perform its intended function	None	30 days	**10 CFR 21.21**

Note: Telephone notifications shall be made to the agency at (804) 864-8150 during business hours; (804)674-2400 or (800) 468-8992, which is staffed 24 hours a day. Identify the emergency as radiological.

Appendix R

Model Leak Test Program

Model Leak Test Program

Training

Before allowing an individual to perform leak test analysis independently, the RSO will ensure that the individual has sufficient classroom and on-the-job training to show competency in performing leak test analysis.

Classroom training in the performance of leak test analysis may be provided in the form of lecture, videotape, or self-study. This should cover the following subject areas:

- Principles and practices of radiation protection
- Radioactivity measurements, monitoring techniques, and using instruments
- Mathematics and calculations basic to using and measuring radioactivity
- Biological effects of radiation.

Appropriate on-the-job training consists of:

- Observing authorized personnel collecting and analyzing leak test samples
- Collecting and analyzing leak test samples under the supervision and in the physical presence of an individual authorized to perform leak tests and leak test analysis

Facilities and Equipment

- To ensure the required sensitivity of measurements, leak tests will be analyzed in a low-background area.
- Before leak test swipes are analyzed, individuals conducting leak tests will use a calibrated and operable survey instrument to check leak test samples for gross contamination. If the sensitivity of the counting system is unknown, the minimum detectable activity (MDA) needs to be determined. The MDA may be determined using the following formula:

$$MDA = \frac{3 + 4.65(BR)^{*½}}{Et}$$

where MDA = activity level in disintegrations per minute (dpm)
BR = background rate in counts per minute (cpm)
t = counting time in minutes
E = detector efficiency in counts per disintegration (cpd)

For example:
where BR = 200 cpm
E = 0.1 cpd (10% efficient)
t = 2 minutes

$$MDA = \frac{3 + 4.65(200\ cpm)^{*½}}{(0.1\ cpd)(2\ minutes)}$$

A NaI(Tl) well counter system with a single or multi-channel analyzer will be used to count samples from sealed sources containing gamma-emitters (e.g., Cesium-137, Cobalt-60). A liquid scintillation, gas-flow proportional, or solid state counting system will be used to count samples containing alpha-emitters (e.g., Americium-241).

Frequency for Conducting Leak Tests of Sealed Sources

Leak tests on well logging sealed sources will be conducted at intervals not to exceed 6 months, or, for Energy Compensation Sources (ECS) requiring leak tests, at intervals not to exceed 3 years.

Procedure for Performing Leak Testing and Analysis

- For each source to be tested, list identifying information such as the manufacturer's name, model number, serial number, radionuclide, and activity of the sealed source(s).
- Prepare a separate wipe sample (e.g., cotton swab or filter paper) for each source.
- Number each wipe to correlate with identifying information for each source.
- If available, use a survey meter to monitor exposure.
- Wipe the most accessible area (but not directly from the surface of the source) where contamination would accumulate if the sealed source were leaking, (e.g., the leak test can be taken of the part that connects to the source or the inside of the transport container that has recently transported the source).
- Select an instrument that is sensitive enough to detect 185 Bq (0.005 mCi) of the radionuclide of the sealed source.
- Using the selected instrument, count and record background count rate.
- Check the instrument's counting efficiency using a standard source of the same radionuclide as the source being tested or one with similar energy characteristics. Accuracy of standards should be within ±5% of the stated value and traceable to primary radiation standard, such as those maintained by the National Institutes of Standards and Technology (NIST).
- Calculate efficiency.

  For example: $\frac{\text{[(cpm from std) - (cpm from bkg)]}}{\text{activity of std in Bq}}$ = efficiency in cpm/Bq

  where: cpm = counts per minute
  std = standard
  bkg = background
  Bq = Becquerel
- Count each wipe sample; determine net count rate.
- For each sample, calculate and record estimated activity in Bq (or Ci).

  For example: $\frac{\text{[(cpm from wipe sample) - (cpm from bkg)]}}{\text{efficiency in cpm/Bq}}$ = Bq on wipe sample
- Sign and date the list of sources, data, and calculations. Retain records for 5 years (**12VAC5-481-1000**).

If the wipe test activity is 185 Bq (0.005 microcurie) or greater, notify the RSO, so that the source can be withdrawn from use and disposed of properly. Also notify the agency.

Appendix S

Transportation - Major DOT Regulations; Sample Shipping Documents, Placards and Labels

Transportation - Major DOT Regulations; Sample Shipping Documents, Placards and Labels

The major areas in the DOT regulations that are most relevant for transportation of licensed material shipped as Type A quantities are as follows:

- Hazardous Materials Table, **49 CFR 172.101**, App. A, list of hazardous substances and reportable quantities (RQ), Table 2: Radionuclides
- Shipping Papers **49 CFR 172.200-204**: General entries, description, additional description requirements, shipper's certification
- Package Markings **49 CFR 172.300, 49 CFR 172.301, 49 CFR 172.303 49 CFR 172.304, 49 CFR 172.310, 49 CFR 172.324**: General marking requirements for non-bulk packaging, prohibited marking, marking requirements, radioactive material, hazardous substances in non-bulk packaging
- Package Labeling **49 CFR 172.400, 49 CFR 172.401, 49 CFR 172.403, 49 CFR 172.406, 49 CFR 172.407, 49 CFR 172.436, 49 CFR 172.438, 49 CFR 172.440**: General labeling requirements, prohibited labeling, radioactive materials, placement of labels, specifications for radioactive labels
- Placarding of Vehicles **49 CFR 172.500, 49 CFR 172.502, 49 CFR 172.504, 49 CFR 172.506, 49 CFR 172.516, 49 CFR 172.519, 49 CFR 172.556**: Applicability, prohibited and permissible placarding, general placarding requirements, providing and affixing placards: highway, visibility and display of placards, specifications for RADIOACTIVE placards
- Emergency Response Information, **Subpart G**, **49 CFR 172.600, 49 CFR 172.602, 49 CFR 172.604**: Applicability and general requirements, emergency response information, emergency response telephone number
- Training, **Subpart H**, **49 CFR 172.702, 49 CFR 172.704**: Applicability and responsibility for training and testing, training requirements
- Shippers - General Requirements for Shipments and Packaging, **Subpart I**, **49 CFR 173.403, 49 CFR 173.410, 49 CFR 173.412, 49 CFR 173.415, 49 CFR 173.431, 49 CFR 173.433, 49 CFR 173.435, 49 CFR 173.441, 49 CFR 173.443, 49 CFR 173.448, 49 CFR 173.475, 49 CFR 173.476**: Definitions, general design requirements, additional design requirements for Type A packages, authorized Type A packages, activity limits for Type A packages, requirements for determining A_1 and A_2 values, table of A_1 and A_2 values for radionuclides, radiation level limitations, contamination control, general transportation requirements, quality control requirements prior to each shipment, approval of special form radioactive materials
- Carriage by Public Highway - General Information and Regulations, **Subpart A, 49 CFR 177.816, 49 CFR 177.817, 49 CFR 177.834(a), 49 CFR 177.842**: Driver training, shipping paper, general requirements (secured against movement), Class 7 (radioactive) material.

The following are the major areas in DOT regulations most relevant for transporting licensed material that is shipped as Type B quantities in addition to the applicable requirements stated above:

A. Package Markings

49 CFR 172.310 - Radioactive material [Type B]

B. Shippers - General Requirements for Shipments and Packaging - **49 CFR 173**

1. **49 CFR 173.25** - Requirements for use and labeling of overpacks
2. **49 CFR 173.403** - Definitions
3. **49 CFR 173.411** - General design requirements
4. **49 CFR 173.413** - Additional design requirements for Type B packages
5. **49 CFR 173.416** - Authorized Type B packages [includes packaging certification requirements]
6. **49 CFR 173.471** - Additional requirements for Type B packages approved by NRC

Sample Shipping Documents, Placards and Labels

Hazard Communications for Class 7 (Radioactive) Materials

DOT Shipping Papers (49 CFR 172.200-205)

NOTE: IAEA, ICAO, and IMO may require additional hazard communication information for international shipments
This table must not be used as a substitute for the DOT and NRC regulations on the transportation of radioactive materials

Entries Always Required Unless Excepted	Additional Entries Sometimes Required	Optional Entries
! The basic description, in sequence: **Proper Shipping Name**, **Hazard Class (7),** **U.N. Identification Number** ! 24 hour **emergency response telephone number** ! Name of **shipper** ! Proper page numbering (Page 1 of 4) ! Except for empty and bulk packages, the **total quantity** (mass, or volume for liquid), in appropriate units (lbs, mL....) ! If not special form, **chemical and physical form** ! The **name of each radionuclide** (95% rule) and total package activity. The activity must be in SI units (e.g., Bq, TBq), or both SI units and customary units (e.g., Ci, mCi). However, for domestic shipments, the activity *may* be expressed in terms of customary units only, until 4/1/97. ! For each labeled package: - The **category of label** used; - The **transport index** of each package with a Yellow-II or Yellow-III label ! Shipper's **certification** (not required of private carriers)	Materials-Based Requirements: ! If hazardous substance, "RQ" as part of the basic description ! The LSA or SCO group (e.g., LSA-II) ! "Highway Route Controlled Quantity" as part of the basic description, if HRCQ ! Fissile material information (e.g., "Fissile Exempt," controlled shipment statement [see §172.203(d)(7)]) ! If the material is considered hazardous waste and the word waste does not appear in the shipping name, then "waste" must precede the shipping name (e.g., Waste Radioactive Material, nos, UN2982) ! "Radioactive Material" if not in proper shipping name Package-Based Requirements: ! Package identification for DOT Type B or NRC certified packages ! IAEA CoC ID number for export shipments or shipments using foreign-made packaging (see §173.473) Administrative-Based Requirements: ! "Exclusive Use-Shipment" ! Instructions for maintenance of exclusive use-shipment controls for LSA/SCO strong-tight or NRC certified LSA (§ 173.427) ! If a DOT exemption is being used, "DOT-E" followed by the exemption number	! The type of packaging (e.g., Type A, Type B, IP-1, ...) ! The Technical/chemical name may be included (if listed in §172.203(k), in parentheses between the proper shipping name and hazard class; otherwise inserted in parenthesis after the basic description) ! Other information is permitted (e.g., functional description of the product), provided it does not confuse or detract from the proper shipping name or other required information ! For fissile radionuclides, except Pu-238, Pu-239, and Pu-241, the weight in grams or kilograms may be used *in place of* activity units. For Pu-238, Pu-239, and Pu-241, the weight in grams or kilograms may optionally be entered *in addition to* activity units [see § 172.203(d)(4)] ! Emergency response hazards and guidance information (§§ 172.600-604) may be entered on the shipping papers, or may be carried with the shipping papers [§ 172.602(b)]

Some Special Considerations/Exceptions for Shipping Paper Requirements

! Shipments of Radioactive Material, excepted packages, under UN2910 (e.g., Limited Quantity, Empty packages, and Radioactive Instrument and Article), are excepted from shipping papers. For limited quantities (§173.421), this is only true if the limited quantity is not a hazardous substance (RQ) or hazardous waste (40 CFR 262)

! Shipping papers must be in the pocket on the left door, or readily visible to person entering driver's compartment and within arm's reach of the driver

! For shipments of multiple cargo types, any HAZMAT entries must appear as the first entries on the shipping papers, be designated by an "X" (or "RQ") in the hazardous material column, or be highlighted in a contrasting color

Hazard Communications for Class 7 (Radioactive) Materials

Marking Packages (49 CFR 172.300-338)

NOTE: IAEA, ICAO, and IMO may require additional hazard communication information for international shipments
This table must not be used as a substitute for the DOT and NRC regulations on the transportation of radioactive materials

Markings Always Required Unless Excepted	Additional Markings Sometimes Required	Optional Markings
Non-Bulk Packages ! Proper shipping name ! U.N. identification number ! Name and address of consignor or consignee, *unless*: - highway only and no motor carrier transfers, or - part of carload or truckload lot or freight container load, and entire contents of railcar, truck, or freight container are shipped from one consignor to one consignee [see §172.301(d)] Bulk Packages (i.e., net capacity greater than 119 gallons as a receptacle for liquid, or 119 gallons and 882 pounds as a receptacle for solid, or water capacity greater than 1000 lbs, with no consideration of intermediate forms of containment) ! U.N. identification number, on orange, rectangular panel (see §172.332) - some exceptions exist	Materials-Based Requirements: ! If in excess of 110 lbs (50 kg), Gross Weight ! If non-bulk liquid package, underlined double arrows indicating upright orientation (two opposite sides) [ISO Std 780-1985 marking] ! If a Hazardous substance in non-bulk package, the letters "RQ" in association with the proper shipping name Package-Based Requirements: ! The package type if Type A or Type B (½" or greater letters) ! The specification-required markings [e.g., for Spec. 7A packages: "DOT 7A Type A" and "Radioactive Material" (see §178.350-353)] ! For approved packages, the certificate ID number (e.g., USA/9166/B(U), USA/9150/B(U)-85, ...) ! If Type B, the trefoil (radiation) symbol per Part 172 App. B [*size*: outer radius ≥ 20 mm (0.8 in)] ! For NRC certified packages, the model number, gross weight, and package ID number (10 CFR 71.85) Administrative-Based Requirements: ! If a DOT exemption is being used, "DOT-E" followed by the exemption number ! If an export shipment, "USA" in conjunction with the specification markings or certificate markings	! "IP-1," "IP-2," or "IP-3" on industrial packaging is recommended ! Both the name and address of consignor and consignee are recommended ! Other markings (e.g., advertising) are permitted, but must be sufficiently away from required markings and labeling

Some Special Considerations/Exceptions for Marking Requirements

! Marking is required to be: (1) durable, (2) printed on a package, label, tag, or sign, (3) unobscured by labels or attachments, (4) isolated from other marks, and (5) be representative of the hazmat contents of the package

! Limited Quantity (§173.421) packages and Articles Containing Natural Uranium and Thorium (§173.426) must bear the marking "radioactive" on the outside of the inner package or the outer package itself, and are excepted from other marking. The excepted packages shipped under UN 2910 must also have the accompanying statement that is required by §173.422.

! Empty (§173.428) and Radioactive Instrument and Article (§173.424) packages are excepted from marking

! Shipment of LSA or SCO required by §173.427 to be consigned as exclusive use are excepted from marking except that the exterior of each nonbulk package must be marked "**Radioactive-LSA**" or "**Radioactive-SCO**," as appropriate. Examples of this category are domestic, strong-tight containers with less than an A_2 quantity, and domestic NRC certified LSA/SCO packages using 10 CFR 71.52.

! For bulk packages, marking may be required on more than one side of the package (see 49 CFR 172.302(a))

Hazard Communications for Class 7 (Radioactive) Materials

Labeling Packages (49 CFR 172.400-450)

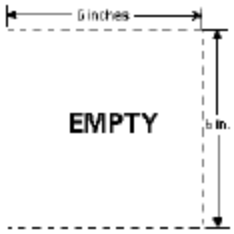
NOTE: IAEA, ICAO, and IMO may require additional hazard communication information for international shipments
This table must not be used as a substitute for the DOT and NRC regulations on the transportation of radioactive materials

Placement of Radioactive Labels

! Labeling is required to be: (1) placed near the required marking of the proper shipping name, (2) printed or affixed to the package surface (not the bottom), (3) in contrast with its background, (4) unobscured by markings or attachments, (5) within color, design, and size tolerance, and (6) representative of the HAZMAT contents of the package

! For labeling of radioactive materials packages, two labels are required on opposite sides excluding the bottom

Determination of Required Label

Size: *Sides:* ≥ 100 mm (3.9 in.) *Border:* 5-6.3 mm (0.2-0.25 in.)	 49 CFR 172.436	 49 CFR 172.438	 49 CFR 172.440	 49 CFR 172.450
Label	**WHITE-I**	**YELLOW-II**	**YELLOW-III**	**EMPTY LABEL**
Required when:	Surface radiation level < 0.005 Mev/hr (0.5 mem./hr)	0.005 Mev/hr (0.5 mem./hr) < surface radiation level ≤ 0.5 Mev/hr (50 mem./hr)	0.5 Mev/hr (50 mem./hr) < surface radiation level ≤ 2 Mev/hr (200 mem./h) [Note: 10 Mev/hr (1000 mem./hr) for exclusive-use closed vehicle (§173.441(b)]	The EMPTY label is required for shipments of empty Class 7 (radioactive) packages made pursuant to **§173.428.** It must cover any previous labels, or they must be removed or obliterated.
Or:	**TI = 0** [1 meter dose rate < 0.0005 Mev/hr (0.05 mem./hr)]	**TI ≤ 1** [1 meter dose rate < 0.01 Mev/hr (1 mem./hr)]	**TI ≤ 10** [1 meter dose rate < 0.1 Mev/hr (10 mem./hr)] [Note: There is no *package* TI limit for exclusive-use]	
Notes:	! Any package containing a Highway Route Controlled Quantity **(HRCQ) must bear YELLOW-III label** ! Although radiation level transport indices (TIs) are shown above, **for fissile material**, the TI is typically determined on the basis of criticality control			

Content on Radioactive Labels

! RADIOACTIVE Label must contain (entered using a durable, weather-resistant means):
(1) The radionuclides in the package (with consideration of available space). Symbols (e.g., Co-60) are acceptable
(2) The activity in SI units (e.g., Bq, TBq), or both SI units with customary units (e.g., Ci, mCi) in parenthesis. However, for domestic shipments, the activity *may* be expressed in terms of customary units only, until 4/1/97.
(3) The Transport Index (TI) in the supplied box. The TI is entered *only* on YELLOW-II and YELLOW-III labels

Some Special Considerations/Exceptions for Labeling Requirements

! For materials meeting the definition of another hazard class, labels for each secondary hazard class need to be affixed to the package. The subsidiary label *may* not be required on opposite sides and must not display the hazard class number

! Radioactive Material, excepted packages, under UN2910 (e.g., Limited Quantity, Empty packages, and Radioactive Instrument and Article), are excepted from labeling. However, if the excepted quantity meets the definition for another hazard class, it is re-classed for that hazard. Hazard communication requirements for the other class are required

! Labeling exceptions exist for shipment of LSA or SCO required by § 173.427 to be consigned as exclusive use

! The "Cargo Aircraft Only" label is typically required for radioactive materials packages shipped by air [§ 172.402(c)]

Hazard Communications for Class 7 (Radioactive) Materials

Placarding Vehicles (49 CFR 172.500-560)

NOTE: IAEA, ICAO, and IMO may require additional hazard communication information for international shipments
This table must not be used as a substitute for the DOT and NRC regulations on the transportation of radioactive materials

Visibility and Display of Radioactive Placard

! Placards are required to be displayed:
  ! on four sides of the vehicle
  ! visible from the direction they face (for the front side of trucks, tractor-front, trailer, or both are authorized)
  ! clear of appurtenances and devices (e.g., ladders, pipes, tarpaulins)
  ! at least 3 inches from any markings (such as advertisements) which may reduce placard's effectiveness
  ! upright and on-point such that the words read horizontally
  ! in contrast with the background, or have a lined-border which contrasts with the background
  ! such that dirt or water from the transport vehicle's wheels will not strike them
  ! securely attached or affixed to the vehicle, or in a holder.

! Placard must be maintained by carrier to keep color, legibility, and visibility.

Conditions Requiring Placarding

! Placards are required for any vehicle containing package with a RADIOACTIVE Yellow-III label

! Placards are required for shipment of LSA or SCO required by §173.427 to be consigned as exclusive use. Examples of this category are domestic, strong-tight containers with less than an A_2 quantity, and domestic NRC certified LSA/SCO packages using 10 CFR 71.52. Also, for bulk packages of these materials, the orange panel *marking* with the UN Identification number is not required.

! Placards are required any vehicle containing package with a Highway Route Controlled Quantity (HRCQ). In this case, the placard must be placed in a square background as shown below (see §173.507(a))

Radioactive Placard

Size Specs:

Sides: ≥ 273 mm (10.8 in.)

Solid line Inner border: About 12.7 mm (0.5 in.) from edges

Lettering: ≥ 41 mm (1.6 in.)

Square for HRCQ: 387mm (15.25 in.) outside length by 25.4 mm (1 in.) thick

49 R .556 CF 172

RADIOACTIVE PLACARD (Domestic)

Base of yellow solid area: 29 ± 5 mm (1.1 ± 0.2 in.) above horizontal centerline

IAE 5 5) s. 443-444 A SS (198 para

RADIOACTIVE PLACARD (International)

See CF 172.527 AND 556 49 R

RADIOACTIVE PLACARD FOR HIGHWAY ROUTE CONTROLLED QUANTITY
(either domestic or international placard could be in middle)

Some Special Considerations/Exceptions for Placarding Requirements

! Domestically, substitution of the UN ID number for the word "RADIOACTIVE" on the placard is prohibited for Class 7 materials. However, some import shipments may have this substitution in accordance with international regulations.

! Bulk packages require the orange, rectangular panel marking containing the UN ID number, which must be placed adjacent to the placard (see §172.332) [NOTE: except for LSA/SCO exclusive use under §173.427, as above]

! If placarding for more than one hazard class, subsidiary placards must not display the hazard class number. Uranium Hexaflouride (UF_6) shipments ≥ 454 kg (1001 lbs) require both RADIOACTIVE and CORROSIVE (Class 8) placarding

! For shipments of radiography cameras in convenience overpacks, if the overpack does not require a RADIOACTIVE - YELLOW III label, vehicle placarding is not required (regardless of the label which must be placed on the camera)

Minimum Required Packaging For Class 7 (Radioactive) Materials

This table must not be used as a substitute for the DOT and NRC regulations on the transportation of radioactive materials

Quantity:	< 70 Bq/g (< 0.002 µCi/g)	Limited Quantity (§173.421)	A_1/A_2 value (§173.435)	1 rem/hr at 3 m, unshielded (§173.427)
Non-LSA/SCO:	Excepted	Type A	Type B [3]	
Domestic or International LSA/SCO: LSA-I solid, (liquid)[1] SCO-I	Excepted	IP-I		Type B [3]
LSA-I Liquid LSA-II Solid, (liquid or gas)[1] (LSA-III)[1] SCO-II		IP-II		Type B [3]
LSA-II Liquid or Gas LSA-III		IP-III		Type B [3]
Domestic (only) LSA/SCO: LSA-I, II, III; SCO-I, II	Excepted	Strong-tight [2]	DOT Spec. 7A Type A	Type B [3] / NRC Type A LSA [3,4]

1. For entries in parentheses, exclusive use is required for shipment in an IP (e.g., shipment of LSA-I liquid in an IP-I packaging would require exclusive use consignment)
2. Exclusive use required for strong-tight container shipments made pursuant to §173.427(b)(2)
3. Subject to conditions in Certificate, if NRC package
4. Exclusive use required, see §173.427(b)(4). Use of these packages expires on 4/1/99 (10 CFR 71.52)

Package and Vehicle Radiation Level Limits (49 CFR 173.441) [A]

This table must not be used as a substitute for the DOT and NRC regulations on the transportation of radioactive materials

Transport Vehicle Use:	Non-Exclusive	Exclusive		
Transport Vehicle Type:	Open or Closed	Open (flat-bed)	Open w/Enclosure [B]	Closed
Package (or freight container) **Limits:**				
External Surface	2 Mev/hr **(200 mem./hr)**	2 Mev/hr **(200 mem./hr)**	10 Mev/hr **(1000 mem./hr)**	10 Mev/hr **(1000 mem./hr)**
Transport Index (TI) [C]	10	no limit		
Roadway or Railway Vehicle (or freight container) **Limits:**				
Any point on the outer surface	N/A	N/A	N/A	2 Mev/hr **(200 mem./hr)**
Vertical planes projected from outer edges		2 Mev/hr **(200 mem./hr)**	2 Mev/hr **(200 mem./hr)**	N/A
Top of . . .		load: 2 mSv/hr **(200 mem./hr)**	enclosure: 2 Mev/hr **(200 mem./hr)**	vehicle: 2 Mev/hr **(200 mem./hr)**
2 meters from. . .		vertical planes: 0.1 Mev/hr **(10 mem./hr)**	vertical planes: 0.1 Mev/hr **(10 mem./hr)**	outer lateral surfaces: 0.1 Mev/hr **(10 mem./hr)**
Underside		2 Mev/hr **(200 mem./hr)**		
Occupied position	N/A [D]	0.02 Mev/hr **(2 mem./hr)** [E]		
Sum of package TI's	50	no limit [F]		

A. The limits in this table do not apply to excepted packages - see 49 CFR 173.421-426
B. Securely attached (to vehicle), access-limiting enclosure; package personnel barriers are considered as enclosures
C. For nonfissile radioactive materials packages, the dimensionless number equivalent to maximum radiation level at 1 m (3.3 feet) from the exterior package surface, in millirem/hour
D. No dose limit is specified, but separation distances apply to Radioactive Yellow-II or Radioactive Yellow-III labeled packages
E. Does not apply to private carrier wearing dosimetry if under radiation protection program satisfying 10 CFR 20 or 49 CFR 172 Subpart I
F. Some fissile shipments may have combined conveyance TI limit of 100 - see 10 CFR 71.59 and 49 CFR 173.457

Package and Vehicle Contamination Limits (49 CFR 173.443)

This table must not be used as a substitute for the DOT and NRC regulations on the transportation of radioactive materials

NOTE: All values for contamination in DOT rules are to be averaged over each 300 cm^2
Sufficient measurements must be taken in the appropriate locations to yield representative assessments

•• means the sum of beta emitters, gamma emitters, and low-toxicity alpha emitters
A• means the sum of all other alpha emitters (i.e., other than low-toxicity alpha emitters)

The Basic Contamination Limits for All Packages: 49 CFR 173.443(a), Table 11	**General Requirement:**	**Non-fixed (removable) contamination must be kept as low as reasonably achievable (ALARA)**
	•• : 0.4 Bq/cm^2 = 40 Bq/100 cm^2 = 1x10^{-5} • Ci/cm^2 = 2200 dpm/100 cm^2	
	A: 0.04 Bq/cm^2 = 4 Bq/100 cm^2 = 1x10^{-6} • Ci/cm^2 = 220 dpm/100 cm^2	

The following exceptions and deviations from the above basic limits exist:

Deviation from Basic Limits	Regulation 49 CFR §§	Applicable Location and Conditions Which must Be Met:
10 times the basic limits	173.443(b) and 173.443(c) Also see 177.843 (highway)	On any external surface of a package in an **exclusive use shipment, during transport** including end of transport. Conditions include: (1) Contamination levels at beginning of transport must be below the basic limits. (2) Vehicle must not be returned to service until radiation level is shown to be ≤ 0.005 Mev/hr (0.5 mem./hr) at any accessible surface, and there is no significant removable (non-fixed) contamination.
10 times the basic limits	173.443(d) Also see 177.843 (highway)	On any external surface of a package, at the beginning or end of transport, if a closed transport vehicle is used, solely for transporting radioactive materials packages. Conditions include: (1) A survey of the interior surfaces of the empty vehicle must show that the radiation level at any point does not exceed 0.1 Mev/hr (10 mem./hr) at the surface, or 0.02 Mev/hr (2 mem./hr) at 1 meter (3.3 ft). (2) Exterior of vehicle must be conspicuously stenciled, **"For Radioactive Materials Use Only"** in letters at least 76 mm (3 inches) high, on both sides. (3) Vehicle must be kept closed except when loading and unloading.
100 times the basic limits	173.428	Internal contamination limit for **excepted package-empty packaging**, Class 7 (Radioactive) Material, shipped in accordance with 49 CFR 173.428. Conditions include: (1) The basic contamination limits (above) apply to **external** surfaces of package. (2) Radiation level must be ≤ 0.005 Mev/hr (0.5 mem./hr) at any external surface. (3) Notice in §173.422(a)(4) must accompany shipment. (4) Package is in unimpaired condition & securely closed to prevent leakage. (5) Labels are removed, obliterated, or covered, and the "empty" label (§172.450) is affixed to the package.

In addition, **after any incident** involving spillage, breakage, or suspected contamination, the modal-specific DOT regulations (§177.861(a), highway; §174.750(a), railway; and §175.700(b), air) specify that vehicles, buildings, areas, or equipment have "no significant removable surface contamination," before being returned to service or routinely occupied. The carrier must also notify offeror at the earliest practicable moment after incident.

	DATE **SHIP DATE**	P.O. NO.	SHIPPER NO.

CONSIGNEE	SHIPPER/CONSIGNOR (FROM)
RED E. WAITING	**ABC PAVING COMPANY**
DEF PAVING INTERNATIONAL	**456 MAIN STREET**
123 DIRT ROAD	**ANY OTHER TOWN, USA 67890**
ANYTOWN, USA 12345	

PHONE NO.	EMERGENCY RESPONSE NUMBER (REQUIRED IN HM COLUMN MARKED)	ROUTE
	123-456-7890	

Number of Packages	HM *	Kind of Packaging, Description of Articles, Special Marks and Exceptions	Weight (lb)	Class or Rate Ref.	Cube (Optional)
1	**x**	**RQ, Radioactive Material, Type A package,**			
		Special Form, 7, UN3332			
		Cs-137, 0.30 GBq (8.0 mCi)			
		Am-241, 1.48 GBq (40 mCi)			
		Radioactive Yellow II Label, TI = 0.3			
		Dim 35 x 45 x 78 cm			
		Emergency Contact: (123) 456-7890			

THIS IS TO CERTIFY THAT THE ABOVE-NAMES MATERIALS ARE PROPERLY CLASSIFIED, DESCRIBED, PACKAGED, MARKED, AND LABELED AND ARE IN PROPER CONDITION FOR TRANSPORTATION ACCORDING TO THE APPLICABLE REGULATIONS OF THE DEPARTMENT OF TRANSPORTATION.

SHIPPER/CONSIGNOR	CARRIER
WANDA SHIPPITT	**SB FREIGHTWAYS**
AUTHORIZED SIGNATURE DATE	AUTHORIZED SIGNATURE

Appendix T

Model Waste Management Procedures

Model Waste Management Procedures

Model Waste Disposal Program

General Guidelines

A. All radioactivity labels must be defaced or removed from containers and packages prior to disposal. If non-radioactive waste is compacted, all radioactivity labels that are visible in the compacted mass must be defaced or removed.
B. Remind workers that non-radioactive waste should not be mixed with radioactive waste.
C. Occasionally monitor all procedures to ensure that radioactive waste is not created unnecessarily. Review all new procedures to ensure that waste is handled in a manner consistent with established operating and emergency procedures.
D. Evaluate the entire impact of various available disposal routes. Consider occupational and public exposure to radiation, other hazards associated with the material and routes of disposal (e.g., toxicity, carcinogenicity, pathogenicity, flammability), and costs.
E. Waste management program should include waste handling procedures. Also, procedures should be available for well logging personnel who may collect waste from areas of use to bring to the storage area for eventual disposal.

Model Procedure for Disposal by Decay-in-Storage (DIS)

A. Only short-lived waste (physical half-life of less than or equal to 120 days) may be disposed of by DIS.
B. Short-lived waste should be segregated from long-lived waste (half-life greater than 120 days) at the source.
C. Waste should be stored in suitable well-marked containers and the containers should provide adequate shielding.
D. Liquid and solid wastes must be stored separately.
E. When the waste container is full, it should be sealed. The sealed container should be identified with a label affixed or attached to it.
F. The identification label should include the date when the container was sealed, the longest lived radioisotope in the container, date when ten half-lives of the longest-lived radioisotope will have transpired, and the initials of the individual who sealed the container. The container may be transferred to the DIS area.
G. The contents of the container should be allowed to decay for at least 10 half-lives of the longest-lived radioisotope in the container. The decay interval beginning at the time the radioactive waste container is sealed and placed in storage for DIS should be used for calculations and projected removal times.
H. Prior to disposal as ordinary trash, each container should be monitored as follows:
    1. Check the radiation detection survey meter for proper operation.
    2. Survey the contents of each container in a low background area.
    3. Remove any shielding from around the container.
    4. Monitor all surfaces of the container.
    5. Discard the contents as ordinary trash only if the surveys of the contents indicate no residual radioactivity, i.e., surface readings are indistinguishable from background.
    6. If the surveys indicate residual radioactivity, return the container to DIS area and contact the RSO for further instructions.
I. If the surveys indicate no residual radioactivity, record the date when the container was sealed, the disposal date, type of waste (used or unused material, gloves, etc.), survey instrument used, and the initials of the individual performing surveys and disposing of the waste.

Model Procedure for Disposal of Liquids into Sanitary Sewerage

A. Confirm that the liquid radioactive waste containing radioactive material being discharged is soluble or readily dispersible in water.
B. Calculate the amount of each radioisotope that can be discharged by using the information from prior, similar discharges and the information in **12VAC5-481-3690**.
C. Make sure that the amount of each radioisotope does not exceed the monthly and annual discharge limits specified in **12VAC5-481-930** and **12VAC5-481-3690**.
D. Record the date, radioisotope(s), estimated activity of each radioisotope, location where the material is discharged, and the initials of the individual discharging the radioactive waste.
E. Liquid radioactive waste must be discharged only via designated locations.
F. Discharge radioactive liquid waste slowly with water running from the faucet to dilute it.
G. Survey the designated disposal locations and surrounding work surfaces to confirm that no residual material or contamination remains.
H. Prior to leaving the area, decontaminate all areas or surfaces, if found to be contaminated.
I. Maintain disposal records that identify each radioisotope and its quantity and the concentration that is released into the sanitary sewer system.

Appendix U

Reserved

Appendix V

Actions to be Taken if a Sealed Source is Ruptured

Actions to be Taken if a Sealed Source is Ruptured

12VAC5-481-3340 F requires immediate initiation of emergency procedures if there is evidence that a sealed source has ruptured or that licensed materials have caused contamination.

Your procedures should instruct logging personnel to:

- Immediately notify the RSO or other appropriate management personnel.
- Notify the well owner or operator as soon as possible.
- Notify the agency at the appropriate telephone number ((804) 864-8150 during business hours; (804) 674-2400 or (800) 468-8992 after hours. Identify the emergency as radiological).
- Secure and restrict access to the area until responsible individuals arrive.
- Instruct individuals on site not to take any unnecessary actions that could spread contamination.
- Minimize inhalation or ingestion of licensed material by using protective clothing and respirators.
- Discuss procedures for preventing the spread of contamination and for minimizing inhalation or ingestion with any potentially exposed personnel.
- Obtain suitable radiation survey instruments.