TWENTY-FIFTH JUDICIAL DISTRICT COURT
FOR THE PARISH OF PLAQUEMINES
STATE OF LOUISIANA

HERO LANDS COMPANY, L.L.C.	*	
	*	**DOCKET NO. 64-320**
VERSUS	*	
	*	**DIVISION "A"**
CHEVRON U.S.A. INC., ET AL.	*	

EXPERT REPORT OF JOHN R. FRAZIER, Ph.D., CHP

I. INTRODUCTION

I have been retained by counsel for defendant Chevron U.S.A. Inc. in the matter of Hero Lands Company, L.L.C. versus Chevron U.S.A. Inc., et al. (25th Judicial District Court for the Parish of Plaquemines, State of Louisiana [Docket No. 64-320; Division "A"]), to assess the radiological conditions of a specific parcel of land in the Stella Oil and Gas Field in Plaquemines Parish, Louisiana. Specifically, I have been asked to determine whether there is naturally occurring radioactive material (NORM) due to oil and gas operations of the property. I have also been asked to review the reports by Plaintiff's experts Gregory W. Miller, Jason S. Sills, Charles R. Norman, William J. Rogers, Paul H. Templet, and Walker B. Wilson in this matter and provide opinions with respect to those reports.

II. OPINIONS

I have reached the following conclusions with a reasonable degree of scientific certainty:

1. Results of gamma radiation measurements and laboratory analysis of soil samples collected from the subject property indicate the presence of oilfield NORM in surface soil in two locations of relatively small areal extent (total area less than two square yards with a total volume of less than one cubic yard of NORM-impacted soil.

2. Results of laboratory analysis of groundwater samples from the subject property show most of the wells have concentrations of NORM radionuclides that are within the range of natural background radionuclide concentrations in Louisiana groundwater and do not indicate the presence of oilfield NORM in groundwater from those wells. However, the concentrations of radioactive

materials in groundwater from approximately six wells are consistent with the presence of oilfield NORM in old produced water from oil production activities.

3. The July 12, 2019 report by Gregory W. Miller and Jason S. Sills pertaining to the subject property contains data describing the nature and extent of oilfield NORM in soil on the subject property.

4. The low concentrations of oilfield NORM in soil on the property and the very small area of soil that is NORM-impacted show that NORM remediation of soil on the site is not required under Louisiana Department of Environmental Quality (LDEQ) regulations.

5. The August 12, 2019 report by Paul H. Templet does not present any data he generated pertaining to the current radiological conditions on the subject property. Nor does he present data or other information to support claims that there are or can be adverse health effects from oilfield NORM on the subject property.

6. The August 12, 2019 report by Charles R. Norman does not present any data he generated pertaining to the current radiological conditions on the subject property. Nor does he present data or other information to support claims that there are or can be adverse health effects from oilfield NORM on the subject property.

7. The August 12, 2019 report by Walker B. Wilson does not present any data he generated pertaining to the current radiological conditions on the subject property. Nor does he present data or other information to support claims that there are or can be adverse health effects to humans or ecological receptors from oilfield NORM on the subject property.

8. The August 26, 2019 report by William J. Rogers does not present a quantitative assessment of the areal extent, depth extent, or quantity of oilfield NORM on the subject property.

9. Based on my review of the radiological characterization data for the subject property and the absence of reasonable exposure pathways and potential exposure durations, I have concluded that there is no indication that anyone on or near the subject property can reasonably be expected to receive a radiation dose greater than the range of radiation doses from natural background radiation sources in Louisiana.

III. QUALIFICATIONS

My qualifications are detailed in Attachment A. My area of expertise is health physics – the scientific discipline of measuring radiation and protecting people from the harmful effects caused by high doses of radiation. My academic degrees include a B.A. in physics, M.S. in physics, and Ph.D. in physics (with emphasis in health physics and radiation protection). I have over forty-two (42) years of professional experience in health physics, primarily in the areas of radiation detection and measurement, radiation dose assessments, external and internal radiation dosimetry, and radiation safety standards and practice. I have extensive experience performing radiological characterization surveys of property, assessing external and internal radiation doses from natural and man-made radiation sources, and reviewing/assessing operational data generated by facilities that are licensed to possess and use radioactive materials and other radiation sources. Over the past twenty-four (24) years I have performed numerous radiological assessments of soil and groundwater on properties for oilfield NORM. I have also evaluated current and past radiation exposure conditions on properties impacted by oilfield NORM.

IV. BASIS OF OPINIONS

During preparation of my opinions presented in this report I reviewed documents related to the subject property and natural radiological conditions in the vicinity of the subject property and throughout the State of Louisiana. Specific documents that I reviewed in preparation of this report are listed in Attachment B.

A. Naturally Occurring Radionuclides in Native Louisiana Soil and Sediment

Naturally occurring radioactivity is present in essentially everything on, beneath, or above the earth’s surface. These radioactive materials are present as primordial radioactivity (as they have been present since the earth was formed) or as naturally produced radioactivity (e.g., cosmogenic radioactivity) that continues to be formed from interactions of cosmic rays with the earth. The most abundant radionuclides on the earth are the primordial radionuclides in three natural decay series (thorium, uranium, and actinium) and the non-series primordial radionuclide, potassium-40. The concentrations and amounts of these natural radioactive materials that comprise the natural background radioactivity in substances on or in the earth have been described in detail in various reports. The NCRP, a council of 100 eminent independent scientists chartered by Congress, has published Report No. 160, "Ionizing Radiation Exposure of the Population of the United States" (NCRP 2009), that includes information on the sources and amounts of natural background radiation exposure being received by the U.S. public. NCRP Report No. 160 notes that concentrations of each of the primordial radionuclides vary with substance (rock, soil, sediment, etc.), location, and other factors. For surface soil in the United States, each radionuclide in the uranium series and each radionuclide in the thorium series is present at a typical average concentration of one (1) picocurie per gram (pCi/g). The typical average concentration of potassium-40 in soil is in the range of approximately 10-25 pCi/g.

However, the range of concentrations of these radionuclides in native soil varies with location, depending on the components of the soil (NCRP 2009).

Natural background concentrations of selected radionuclides, including radium-226 (Ra-226) and Ra-228, in soil and sediment in Louisiana are given in several publications (DeLaune 1986; Meriwether 1988; Meriwether 1991; Meriwether 1992). The range of concentrations of Ra-226 in native Louisiana soil is approximately 0.2 pCi/g to approximately 3 pCi/g, with an average concentration of approximately 1 pCi/g. The average and range of concentrations of Ra-228 in native Louisiana soil are approximately the same as the respective concentrations of Ra-226. In native soil, both Ra-226 and Ra-228 are continually being produced in the natural radioactive decay series uranium and thorium, respectively. The environmental behavior of radium is described in various publications, such as Technical Reports of the International Atomic Energy Agency (IAEA) (IAEA 1990; IAEA 2014).

B. Natural Background Radioactive Material in Louisiana Groundwater

Natural waters contain solids from contact with soils, rocks, and other natural materials. Some solids are suspended in the groundwater and some solids are dissolved (not removed by filtration) in the groundwater. The United States Geological Survey (USGS) has summarized the following points regarding dissolved solids in water:

> The dissolved solids concentration in water is the sum of all the substances, organic and inorganic, dissolved in water. This also is referred to as “total dissolved solids”, or TDS. Calcium, magnesium, sodium, potassium, bicarbonate, sulfate, chloride, nitrate, and silica typically make up most of the dissolved solids in water. Combinations of these ions—sodium and chloride, for example—form salts, and salinity is another term commonly used to describe the dissolved solids content of water (USGS 2020).

Concentrations of dissolved solids in water can be so high that the water is unsuitable for drinking, irrigation, or other uses. Groundwater that contains natural solids (i.e., TDS) contains naturally occurring radioactive materials (NCRP 2009). Radium in groundwater has been shown to be directly proportional to the concentration of chlorides in the same water (IAEA 1990; IAEA 2014). In Louisiana, groundwater sampling has shown that the concentration of NORM radionuclides (Ra-226) is approximately directly proportional to the concentration of total dissolved solids and chlorides (and salinity) (USGS 1988, Kraemer 1984). Concentrations of Ra-228 are usually greater than, or approximately equal to, the concentrations of Ra-226 in natural background groundwater in Louisiana.

C. Natural Background External Radiation Levels in Louisiana

Every person is exposed to external radiation from natural background radiation sources every day of their lives. Natural background sources of external radiation include cosmic rays (and the external radiation from the interactions of cosmic rays with the atmosphere) and naturally occurring radioactive materials in the earth (soil, rocks, building materials, etc.). External radiation produces an external exposure rate that is often expressed in units of μR/hr (read as "microR per hour"). The external exposure rate from natural background radiation sources varies with altitude, latitude, and the natural radionuclide content of soil, rocks, building materials, etc. In the United States, the external exposure rate from natural background radiation varies from less than approximately 3 μR/hr to well over 20 μR/hr (Myrick 1981). In Louisiana, the nominal external exposure rate from natural background radiation sources has a range from less than 5 μR/hr to over 14 μR/hr (Beck 1986).

D. Oilfield NORM

During production of oil from underground geological formations, water that is co-mingled with the oil is transported to the ground surface. This water is generally referred to as "produced water". There are concentrations of NORM in some oil-bearing geologic formations that exceed the natural background concentrations of the same radionuclides in native soil. The chemical compounds that are present in produced water may include trace amounts of the natural element radium. Because radium is radioactive, produced water that contains radium compounds contains NORM. The principal radionuclides in affected produced water are Ra-226 and Ra-228 (NRC 1999). During oil production, some radium compounds in the produced water convert to sulfates or carbonates and are precipitated, or are otherwise deposited, onto surfaces as scale and sludge in tubulars, pipe, and other production equipment. The scale is primarily barium sulfate with trace amounts (by mass) of radium in the same mineral matrix (Smith 1996; NRC 1999). The chemical forms of scale that have been shown to contain oilfield NORM are highly insoluble and NORM radionuclides (i.e., Ra-226 and Ra-228) in the scale are not readily leached or transported from impacted pipe, other production equipment or soil by surface water or groundwater (IAEA 1990).

The presence (or absence) of oilfield NORM at the ground surface (in soil, pipe, or other production equipment) is determined by measurement of external radiation levels near the ground surface or production equipment (as NORM radionuclides emit measurable gamma radiation) and by analysis of soil samples and/or samples of the contents of production equipment (e.g., scale). The presence (or absence) of oilfield NORM in groundwater is determined by collection of representative samples of groundwater from suspect locations and analysis of the water samples for the concentrations of Ra-226, Ra-228, and TDS in the water.

E. Description of the Subject Property

The property that is the subject of this radiological assessment is a parcel of land located in the Stella Oil and Gas Field in Plaquemines Parish, Louisiana. Descriptions of the location and history of oil production operations on the subject property are given in reports listed in Attachment B.

F. External Radiation Measurements on the Subject Property and Reference Locations

Gamma radiation measurements were performed by ICON Environmental Services (ICON) personnel on behalf of Plaintiff on May 7-8, 2019, on the subject property (Miller 2019). Results of the gamma radiation survey showed most of the surveyed areas of the subject property had radiation readings that were within the range of natural background radiation levels for the area and for Louisiana (Beck 1986) and do not indicate the presence of oilfield NORM in those areas. However, some of the radiation measurement data acquired by ICON on behalf of Plaintiff on May 7-8, 2019 indicated that there is NORM-impacted equipment and soil in very small areas on the subject property (Miller 2019). Coordinates of the gamma radiation locations where soil samples were collected are given in Table 3 of the July 12, 2019 report by Miller and Sills (Miller 2019).

The approximate aerial extent of above-background gamma radiation readings was also recorded by ICON personnel on behalf of Plaintiff on Table 3 of the July 12, 2019 report by Miller and Sills (Miller 2019). Based on the radiation measurement data reported by ICON personnel, the total area of soil impacted with oilfield NORM on the subject property is less than approximately two square yards (0.0004 acres), a very small fraction of the land area (164 acres) that reportedly comprises the subject property (Templet 2019 at page 1).

G. Collection and Analysis of Soil Samples

Plaintiff's representatives with ICON collected six soil samples from the subject property on May 8, 2019, for analysis for oilfield NORM radionuclides (Miller 2019). The locations where each soil sample was collected are shown in Figure 44 of the July 12, 2019 report by Miller and Sills (Miller 2019). The coordinates of the sample locations are listed in Table 2 of the 2019 ERG report (ERG 2019). Each of the six soil samples was double-bagged, assigned a unique sample identification, and shipped under chain of custody to Pace Analytical Services, LLC (Pace) in Greensburg, Pennsylvania for measurement of concentrations of Ra-226 and Ra-228 in each sample. Results of Pace's laboratory analysis of the samples were reported in one report of analysis (Pace 2019c). The Pace results are summarized in Table 3 of the July 12, 2019 Miller and Sills report (Miller 2019).

Split samples of the six soil samples were collected on May 8, 2019, by Defendants' representatives with ERM. The samples were double-bagged, assigned a unique sample identification, and shipped under chain of custody to Eberline Analytical Corporation (Eberline) in Oak Ridge, Tennessee, for measurement of concentrations of Ra-226 and Ra-228 in each sample. Results of Eberline's laboratory analysis of the six samples (and one laboratory duplicate sample) were reported in one report of analysis (Eberline 2019d). This laboratory report is included as Attachment C5. The Eberline results are summarized in Table 1.

Table 1. Results of Laboratory Analysis of Split Samples Collected on May 8, 2019

	Ra-226				Ra-228			
	Result	CU	CSU	MDC	Result	CU	CSU	MDC
Sample ID	(pCi/g)	(pCi/g)	(pCi/g)	(pCi/g)	(pCi/g)	(pCi/g)	(pCi/g)	(pCi/g)
R1 0-6 DUP	1.31	0.23	0.24	0.26	1.09	0.28	0.29	0.82
R1 0-6	1.31	0.23	0.24	0.24	1.37	0.29	0.29	0.54
R1 6-12	1.03	0.20	0.21	0.27	1.22	0.33	0.33	0.54
R1 12-18	1.20	0.25	0.26	0.35	1.47	0.40	0.40	0.73
R2 0-6	17.71	1.33	1.61	0.78	4.87	0.86	0.89	1.59
R2 6-12	1.61	0.22	0.23	0.31	1.51	0.40	0.41	1.02
R3 0-6	5.84	0.55	0.63	0.49	3.08	0.40	0.43	0.74

where "CU" = Counting Uncertainty, "CSU" = Combined Standard Uncertainty, and "MDC" = Minimum Detectable Concentration.

H. Collection and Analysis of Groundwater Samples

Forty-two (42) groundwater samples were collected from wells on the subject property by ICON personnel on behalf of Plaintiff from August 28, 2018 to April 9, 2019 (Miller 2019). The locations (coordinates) of the groundwater sampling wells are given in Appendix E of the July 12, 2019 report by ICON (Miller 2019). Each sample was sealed in a sample container, marked with a unique identification code, and shipped under chain of custody to the Pace laboratory for measurement of concentrations of Ra-226 and Ra-228 in each sample. Results of Pace's laboratory analysis of the samples were reported in three reports of analysis (Pace 2018; Pace 2019a; Pace 2019b). The Pace results are summarized in Table 2 of the July 12, 2019 Miller and Sills report (Miller 2019).

Split samples of the 42 groundwater samples were collected from August 28, 2018 to April 9, 2019, by Defendants' representatives with ERM. Each sample was appropriately sealed in a sample container, marked with a unique identification code, and shipped under chain of custody to the Eberline laboratory for measurement of concentrations of Ra-226, Ra-228, and TDS in each sample. Results of Eberline's laboratory analysis of the 42 samples (and four laboratory duplicate samples) were reported in four reports of analysis (Eberline 2018; Eberline

2019a; Eberline 2019b; Eberline 2019c). These laboratory reports are included as Attachments C1 through C4.

I. Analytical Results for Groundwater Samples

Results reported by Pace for the 42 groundwater samples (results and the corresponding combined standard uncertainties) suggest there are possibly six wells (BC-2A, BC-3A, BC-7A, BC-8A, BC 23, and BC 26) that have concentrations of Ra-226 and Ra-228 that are consistent with aged produced water. Results for the remaining wells are consistent with only natural background concentrations of Ra-226 and Ra-228 in solids (i.e., TDS) in groundwater samples.

Results reported by Eberline for the 42 split samples of groundwater (i.e., results, the corresponding combined standard uncertainties, and TDS concentrations) suggest there are possibly six wells (BC-2A, BC 10, BC 13, BC 16, BC 23, and BC 26) that have concentrations of Ra-226 and Ra-228 that are consistent with aged produced water. Results for the remaining wells are consistent with only natural background concentrations of Ra-226 and Ra-228 in TDS in groundwater samples.

These conclusions follow from observation that the natural concentration of Ra-226 is approximately equal to the natural concentration of Ra-228 in groundwater samples (taking into account the overall uncertainty of the laboratory measurements) having the respective TDS concentrations (IAEA 1990; IAEA 2014; USGS 1988; Kraemer 1984).

The national secondary standard for TDS in drinking water is 500 milligrams per liter (mg/L). Samples of groundwater from the subject property exhibit a wide range of TDS concentrations and all the samples have TDS concentrations greater than 500 mg/L. The lowest concentration of TDS in the 42 samples analyzed by Eberline was nearly twice the secondary standard of 500 mg/L. The measured TDS concentrations in the groundwater samples from the subject property bring into question whether the groundwater is potable (USGS 2020; LDNR 2020).

J. U.S. Environmental Protection Agency Maximum Contaminant Levels

The Radionuclides Rule (65 FR 76707), promulgated by the U.S. Environmental Protection Agency (US EPA) on December 7, 2000, specifies a Maximum Contaminant Level (MCL) of 5 pCi/L for combined Ra-226 and Ra-228 in Community Water Systems (CWS) (USEPA 2000b). The Radionuclides Rule applies to all CWSs; however, the regulations do not apply to non-community water systems (US EPA 2002, page I-4). A CWS is defined as:

> "a public water system which serves at least 15 service connections used by year-round residents or regularly serves at least 25 year-round residents."

I can find no indication that the water (treated or untreated) from the aquifers on the subject property serves as a source for a CWS. Additionally, the MCL for combined radium (Ra-226 and Ra-228) applies to water which is delivered to any user of a public water system (US EPA 2000b).

K. Review of the July 12, 2019 Report by Gregory W. Miller and Jason S. Sills

I have reviewed the July 12, 2019 ICON report and find that the presence of oilfield NORM in groundwater is identified in a few wells on the subject property (Miller 2019). Radiation measurements performed by ICON personnel on the subject property are included in Appendix B of the July 12, 2019 ICON report and indicate two very small areas of soil that had gamma radiation levels greater than the range of natural background levels for Louisiana (Miller 2019). As noted previously in this report, the total area of NORM-impacted soil is reported to be approximately two square yards (Miller 2019).

Based on the results of laboratory analysis of soil samples from the property and on the borehole gamma radiation measurements (Miller 2019 at Appendix B), the NORM-impacted depth of soil to be less than one foot below ground surface(Miller 2019 at Appendix B), leading to a volume of less than approximately one cubic yard of soil. The low concentration of oilfield NORM in soil on the property and the very small area that is NORM-impacted show that NORM remediation of soil on the site is not required under Louisiana Department of Environmental Quality (LDEQ) regulations (LADEQ 2015). Additionally, ICON does not include an estimate of costs to remediate oilfield NORM from soil on the subject property (Miller 2019 at Appendix F).

L. Review of the August 12, 2019 Report by Charles R. Norman

I have reviewed the August 12, 2019 report by Charles R. Norman in this matter and find that he does not present any data he generated pertaining to the current radiological conditions on the subject property (Norman 2019). Nor does he present data or other site-specific information to support claims that there are or can be adverse health effects from oilfield NORM on the subject property.

M. Review of the August 26, 2019 Report by William J. Rogers, Ph.D.

I have reviewed the August 26, 2019 by William J. Rogers (Rogers 2019). He does not present a quantitative assessment of the areal extent, depth extent, or quantity of oilfield NORM on the subject property. The site-specific measurements of the radiological conditions of the subject property by ICON contradict the exaggerated conditions assumed by William J. Rogers in his August 26, 2019 report regarding his claims of radiological impacts on humans or ecological receptors on or near the subject property.

N. Review of the August 12, 2019 Report by Paul H. Templet, Ph.D.

I have reviewed the August 12, 2019 report by Paul H. Templet in this matter and find that he does not present any data he generated pertaining to the current radiological conditions on the subject property (Templet 2019). Nor does he present data or other site-specific information to support claims that there are or can be adverse health effects from oilfield NORM on the subject property.

O. Review of the August 12, 2019 Report by Walker B. Wilson

I have reviewed the August 12, 2019 report by Walker B. Wilson in this matter and find that he does not present any data he generated regarding the presence of oilfield NORM in any environmental medium on the subject property (Wilson 2019). Neither does he present any site-specific claims regarding oilfield NORM on the subject property.

The observations, conclusions, and opinions noted in this report are based on my personal knowledge and experience and are consistent with accepted practice in the field of health physics. I reserve the right to amend this report should additional data or other information become available to me in the future.

V. RATE OF COMPENSATION

I am being compensated at a rate of $250 per hour for my time to work on this project, including sworn testimony at deposition and trial.

VI. PRIOR TESTIMONY

A list of cases in which I have given sworn testimony at deposition or at trial during the past four years is included in Attachment D.

Prepared and submitted by:

John R. Frazier, Ph.D., CHP

Date: May 8, 2020

ATTACHMENT A

CURRICULUM VITAE OF JOHN R. FRAZIER, PH.D.

JOHN R. FRAZIER, Ph.D., CHP

Professional Qualifications

Dr. Frazier has over 42 years of health physics experience in external and internal dosimetry, environmental dose assessment, radiation risk assessment, radiation spectroscopy, health physics training, bioassay, radiation detection and measurement, and radiological site characterization. Numerous federal agencies including the Nuclear Regulatory Commission (NRC), Environmental Protection Agency (EPA), U.S. Department of Agriculture (USDA), U.S. Department of Defense (DOD), and U.S. Department of Justice (DOJ) have sought his advice on a wide range of health physics and radiation protection topics from operational health physics program design to environmental radiation dose and risk assessments. He has also served as a consultant to private companies and individuals on numerous health physics issues. He is a Distinguished Emeritus member of the National Council on Radiation Protection and Measurements (NCRP). Dr. Frazier has made presentations on introductory and advanced health physics and radiation protection topics for professional society meetings, student groups, and public interest forums. His publications are in the areas of fundamental interactions of radiation with matter, radiation detection instrumentation, radiological site assessments, and external and internal radiation dosimetry.

Education

Ph.D., Physics, University of Tennessee, Knoxville, Tennessee; 1978.

M.S., Physics, University of Tennessee, Knoxville, Tennessee; 1973.

B.A., Physics, Berea College, Berea, Kentucky; 1970.

Registrations/Certifications

Certification by the American Board of Health Physics in 1981; recertified through 2021.

Experience and Background

2004 - *Present* — *Independent Health Physics Consultant*

Dr. Frazier provides consultation services to individuals, private companies, and government agencies on a wide range of radiation protection topics. His principal areas of expertise are internal and external radiation exposure assessments, environmental radiation dose and radiological risk assessments from occupational and environmental exposures, and evaluations and assessments of all aspects of operational health physics programs.

1993 - 2004 ***Senior Radiological Scientist, Auxier & Associates, Inc., Knoxville, Tennessee.***

Dr. Frazier served as senior consultant on radiation protection issues for private companies and government agencies. He performed assessments of internal and external radiation exposures, environmental radiation doses and radiological risks from occupational and environmental exposures. He also performed evaluations and assessments of all aspects of operational health physics programs. Dr. Frazier served as technical advisor to organizations that performed environmental radiological assessments and risk assessments and that provided occupational radiation protection services in government and industry.

1986 - 1993 ***Senior Radiological Scientist, Nuclear Sciences, IT Corporation, Knoxville, Tennessee.***

Dr. Frazier served as senior radiological scientist and technical manager of the health physics consulting group within IT. He was responsible for health physics professional services provided by IT for federal, state, and local agencies, contractors, and private companies. These services included development of all aspects of the health physics programs for nuclear facilities, technical assessments and evaluations of existing health physics programs, and environmental and occupational radiation dose assessments. He served as technical advisor and task manager for radiological aspects of remedial investigations and feasibility studies (RI/FSs). He also served as manager and technical director for specific projects in areas that included design and implementation of environmental monitoring and sampling programs, assessment of operational health physics programs, and radiation dose and risk assessments for occupational exposures and environmental releases. Previous responsibilities included serving as senior technical consultant for upgrading Environmental Health and Safety Programs at the Department of Energy Rocky Flats Plant, Oak Ridge National Laboratory, and the Oak Ridge Y-12 Plant.

1980 - 1986 ***Health Physicist, Oak Ridge Associated Universities, Oak Ridge, Tennessee.***

Dr. Frazier developed and coordinated Oak Ridge Associated Universities (ORAU) health physics training programs. He taught health physics and radiation protection courses for several hundred students each year at ORAU Professional Training Programs. He developed new lectures, laboratory exercises, and training materials for health physics training for the Nuclear Regulatory Commission, Department of Energy, and corporate clients. In addition to his training responsibilities, Dr. Frazier served as division health physicist for the Manpower Education, Research, and Training Division of ORAU. He served as technical consultant to federal and state agencies, other training institutions, and ORAU clientele on environmental, health and safety issues. He evaluated radiation measurement and radiation protection instrumentation equipment.

1978 - 1980	***Chief Radiation Physics Section, Bureau of Radiological Health, Rockville, Maryland.*** Dr. Frazier supervised research and support activities of a staff of seven health physics professionals and technicians. He planned and implemented radiation research projects pertaining to ionizing radiation detection/ measurement. He scheduled personnel requirements in accordance with the scope of such projects. He coordinated support for external radiation dosimetry by the Radiation Physics Section for all other branches in the Division of Electronic Products. He supervised and performed multi-point calibrations of radiation detection/ measurement instruments per month. Dr. Frazier also assisted in planning radiation dosimetric surveys of large numbers and types of ionizing radiation sources to reduce population exposure. He coordinated environmental radiation dosimetry for extended geographical areas using external radiation dosimeters.
1977- 1980	***Research Physicist, Bureau of Radiological Health, Rockville, Maryland.*** Dr. Frazier calibrated X-ray detection/measurement instruments. He maintained radiation calibration secondary standards traceable to the National Bureau of Standards. He evaluated new X-Ray detection/measurement instruments with radio-frequency fields under controlled environmental conditions and a wide range

of ionizing radiation fields. He also developed external radiation dosimetry techniques with both active and passive dosimeters.

Awards/Activities

Fellow, Health Physics Society, 2000
Elda E. Anderson Award, Health Physics Society, 1988
Joyce P. Davis Memorial Award, American Academy of Health Physics, 2016
John C. Villforth Lecture, Conference of Radiation Control Program Directors (CRCPD), 2007
Distinguished Technical Associate, IT Corporation, 1990
National Council on Radiation Protection and Measurements (NCRP)
  Distinguished Emeritus Member, 2014-2019
  Council Member, 2002-2014
  Scientific Committee 46, 1999-2006
  Scientific Committee 2-1, 2004-2006
  PAC-2 Committee 2006-20018

Professional Affiliations

Health Physics Society
  (Plenary Membership since 1981; President, 2002-3; President-Elect, 2001-2; Board of Directors, 1992-5; Treasurer-Elect, 1997-8; Treasurer, 1998-2000)
American Academy of Health Physics (Past-president 2013; President 2012; President-elect, 2011; Secretary, 1996-1997, Director, 1998)
East Tennessee Chapter of the Health Physics Society (Past President)
International Radiation Protection Association (Plenary Membership)

Publications

Dr. Frazier has prepared or contributed to over 120 reports and publications in the fields of health physics and environmental science.

List of Publications

Frazier, J. R., "Negative Ion Resonances in the Fluorobenzenes and Biphenyl" Ph.D. Dissertation, University of Tennessee, Knoxville, Tennessee, 1978.

Frazier, J. R., "Low-Energy Electron Interactions with Organic Molecules: Negative Ion States of Fluorobenzenes," Journal of Chemical Physics, Vol. 69, No. 3807, 1978.

Frazier, J. R., "Performances of X-ray Measurement Instruments in RF Fields," HEW Publication (FDA) 78-8065 Rockville, Maryland, 1978.

Frazier, J. R., "A Dosimetry System for Evaluating Chest X-Ray Exposures," HEW Publication (FDA) 79-I 107, 1979.

Film Badge Dosimetry in Atmospheric Nuclear Tests, National Academy Press, Washington, D.C., 1989.

Operational Radiation Safety Training, NCRP Report No. 134, National Council on Radiation Protection and Measurements, Bethesda, Maryland, October 13, 2000.

Key Elements of Preparing Emergency Responders for Nuclear and Radiological Terrorism, NCRP Commentary No. 19, National Council on Radiation Protection and Measurements, Bethesda, Maryland, December 31, 2005.

Radiation Protection in Educational Institutions, NCRP Report No. 157, National Council on Radiation Protection and Measurements, Bethesda, Maryland, June 25, 2007.

Self Assessment of Radiation-Safety Programs, NCRP Report No. 162, National Council on Radiation Protection and Measurements, Bethesda, Maryland, June 3, 2009.

Radiological Health Protection Issues Associated with Use of Active Detection Technology Systems for Detection of Radioactive Threat Materials, NCRP Commentary No. 22, National Council on Radiation Protection and Measurements, Bethesda, Maryland, 2011.

Investigation of Radiological Incidents, NCRP Report No. 173, National Council on Radiation Protection and Measurements, Bethesda, Maryland, September 14, 2012.

Radiation Safety of Sealed Radioactive Sources, NCRP Report No. 182, National Council on Radiation Protection and Measurements, Bethesda, Maryland, April 5, 2019.

Naturally Occurring Radioactive Material (NORM) and Technologically Enhanced NORM (TENORM) from the Oil and Gas Industry, NCRP Commentary No. 29, National Council on Radiation Protection and Measurements, Bethesda, Maryland, April 22, 2020.

ATTACHMENT B

LIST OF DOCUMENTS REVIEWED

ATTACHMENT B

Beck 1986 Beck, J.N., et al., "Environmental Radiation Exposure Rate in Louisiana," Journal of Environmental Quality, Vol. 15, 1986.

Eberline 2018 Eberline Analytical Corporation, "Final Report of Analysis," Work Order No. 18-09025-OR, Oak Ridge, Tennessee, October 10, 2018.

Eberline 2019a Eberline Analytical Corporation, "Final Report of Analysis," Work Order No. 19-02131-OR, Oak Ridge, Tennessee, April 25, 2019.

Eberline 2019b Eberline Analytical Corporation, "Final Report of Analysis," Work Order No. 19-04089-OR, Oak Ridge, Tennessee, June 3, 2019.

Eberline 2019c Eberline Analytical Corporation, "Final Report of Analysis," Work Order No. 19-04087-OR, Oak Ridge, Tennessee, July 2, 2019.

Eberline 2019d Eberline Analytical Corporation, "Final Report of Analysis," Work Order No. 19-05060-OR, Oak Ridge, Tennessee, September 3, 2019.

IAEA 1990 International Atomic Energy Agency (IAEA), "The Environmental Behaviour of Radium, Volumes 1 & 2," Technical Reports Series No. 310, Vienna, Austria, 1990.

IAEA 2003 International Atomic Energy Agency (IAEA), "Extent of Environmental Contamination by Naturally Occurring Radioactive Material (NORM) and Technological Options for Mitigation," Technical Reports Series No. 419, Vienna, Austria, 2003.

IAEA 2014 International Atomic Energy Agency (IAEA), "The Environmental Behaviour of Radium: Revised Edition," Technical Reports Series No. 476, Vienna, Aust ria, 2014.

Kocher 1981 Kocher, David C., "Radioactive Decay Data Tables," DOE/TIC-11026, U.S. Department of Energy, Washington, DC, 1981.

Kraemer 1984 Kraemer, Thomas F., and David F. Reid, "The Occurrence and Behavior of Radium in Saline Formation Water of the U.S. Gulf Coast Region," Isotope Geoscience, Vol. 2, pp. 153-174, Elsevier Science Publishers, Netherlands, 1984.

LADEQ 2015 State of Louisiana Department of Environmental Quality, LAC Title 33, Environmental Quality, Part XV. Radiation Protection, Chapter 14. Regulations and Licensing of Naturally Occurring Radioactive Material (NORM), July 2015.

LDNR 2020 State of Louisiana Department of Natural Resources, "Ground Water Resources Program Glossary of Terms," accessed 2020. (http://www.dnr.louisiana.gov/index.cfm?md=pagebuilder&tmp=home&pid=477)

Miller 2019 Miller, Gregory W., and Jason S. Sills, "Expert Report and Restoration Plan for the Landowners Hero Lands Company LLC v Chevron USA Inc., et al; Docket #64320Div "A"; 25th JDC Stella Oil Field, Plaquemines Parish, LA," ICON Environmental Services, Inc., Port Allen, Louisiana, July 12, 2019.

NCRP 2009 National Council on Radiation Protection and Measurements, NCRP Report No. 160, "Ionizing Radiation Exposure of the Population of the United States," Bethesda, Maryland, March 3, 2009.

Norman 2019 Norman, Charles R., "Engineering and Operations Report on Stella Oil Field (Properties of Hero Lands Company LLC), Operated by Chevron USA Inc., et al; Assessment Report in the Case of Hero Lands Company LLC Vs. Chevron USA Inc., et al; 25th Judicial District Court for the Parish of Plaquemines, State of Louisiana, Docket No. 64320, Division A; Report No. 1," Plaquemines, Louisiana, August 12, 2019.

Pace 2018 Pace Analytical Services, LLC, "Project: Hero Lands, Pace Project No.: 30264148," Greensburg, Pennsylvania, September 20, 2018.

Pace 2019a Pace Analytical Services, LLC, "Project: Hero Lands, Pace Project No.: 30282089," Greensburg, Pennsylvania, March 18, 2019.

Pace 2019b Pace Analytical Services, LLC, "Project: Hero Lands, Pace Project No.: 30289801," Greensburg, Pennsylvania, May 2, 2019.

Pace 2019c Pace Analytical Services, LLC, "Project: Hero Lands, Pace Project No.: 30294260," Greensburg, Pennsylvania, June 14, 2019.

Rogers 2019 Rogers, William J., "Toxicological Evaluation and Risk Assessment Associated with Oil and Gas Operations on Hero Lands Company, L.L.C. Property within Stella Oil and Gas Field, Plaquemines Parish, Louisiana," Omega EnviroSolutions, Inc., Canyon, Texas, August 26, 2019.

Snavely 1989 Snavely, Earl S., Jr., "Radionuclides in Produced Water: A Literature Review," Arlington, Texas, August 1989.

Templet 2019 Templet, Paul H., "An Expert Report by Paul H. Templet, Ph.D., Hero Lands Co. LLC v Chevron USA Inc., et al; Docket #64320, Div. A; 25th JDC; Stella Oil Field, Plaquemines Parish, LA," Templet Resources, Inc., Ranchos de Taos, New Mexico, August 12, 2019.

US EPA 2000a **"**Radionuclides Notice of Data Availability Technical Support Document", US EPA Office of Ground Water and Drinking Water and Office of Indoor Air and Radiation, Washington, DC, March 2000.

US EPA 2000b National Primary Drinking Water Regulations; Radionuclides; Final Rule, 40 CFR Parts 9, 141, and 142, Federal Register 65 FR 76707, Vol. 65, No. 236, Washington, DC, December 7, 2000.

US EPA 2002 "Implementation Guidance for Radionuclides," EPA 816-F-00-002, Office of Ground Water and Drinking Water (4606M), Washington, DC, March 2002.

USGS 2012 U.S. Geological Survey (USGS), "Principal Aquifers Can Contribute Radium to Sources of Drinking Water Under Certain Geochemical Conditions," Fact Sheet 2010-3113, Washington, DC, 2012.

USGS 1988 U.S. Geological Survey (USGS), "Radiochemical Analyses of Ground Water in Louisiana – Water Resources Technical Report No. 44," by John L Snider and Fary N. Ryals (USGS), Published by Louisiana Department of Transportation and Development, Baton Rouge, Louisiana, 1988.

USGS 2020 U.S. Geological Survey (USGS), "Dictionary of Terms," Washington, DC, (https://www.usgs.gov/special-topic/water-science-school/science/dictionary-water-terms?qt-science_center_objects=0#P), accessed 2020.

Wilson 2019 Wilson, Walker B., "Ecological Impacts Associated with Oil and Gas Exploration and Production Activities on Hero Lands Company, L.L.C. Property Within Stella Oil and Gas Field, Plaquemines Parish, Louisiana,", Coastal Environments, Inc., Baton Rouge, Louisiana, August 12, 2019.

ATTACHMENT C1: EBERLINE WORK ORDER #18-09025-OR
ATTACHMENT C2: EBERLINE WORK ORDER #19-02131-OR
ATTACHMENT C3: EBERLINE WORK ORDER #19-04087-OR
ATTACHMENT C4: EBERLINE WORK ORDER #19-04089-OR
ATTACHMENT C5: EBERLINE WORK ORDER #19-05060-OR

(in separate electronic files)

ATTACHMENT D

LITIGATION IN WHICH DR. JOHN R. FRAZIER HAS PROVIDED SWORN TESTIMONY SINCE MAY 8, 2016

LITIGATION IN WHICH DR. JOHN R. FRAZIER HAS PROVIDED SWORN TESTIMONY SINCE MAY 8, 2016

LAW FIRM	CASE	CLIENT	DATE
Kean Miller	State of Louisiana and The Iberville Parish School Board v. BP America Production Company, et al.	BP America Production Company, et al.	June 8, 2016
Gunster Yoakley	Richard Cotromano, et al. v. United Technologies Corporation, et al.	United Technologies Corporation, et al.	September 22, 2016
Shook Hardy & Bacon	Scott D. McClurg, et al. v. Mallinckrodt, Inc., et al.	Mallinckrodt, Inc., et al.	October 31, 2017
Gunster Yoakley	Richard Cotromano, et al. v. United Technologies Corporation, et al.	United Technologies Corporation, et. al.	January 11, 2018
Kean Miller	New 90, LLC and Louisiana Wetlands, LLC v. Grigsby Petroleum, Inc. and Chevron U.S.A., Inc.	Grigsby Petroleum, Inc. and Chevron U.S.A., Inc.	October 29, 2018
Jose	Estate of Jeffrey H. Ware v. Hospital of the University of Pennsylvania, et al.	Hospital of the University of Pennsylvania, et al.	December 18, 2018