SIXTEENTH JUDICIAL DISTRICT COURT
FOR THE PARISH OF ST. MARTIN
STATE OF LOUISIANA

HAROLD J. GUIDRY, ET AL.	*	**DOCKET NO. 82537**
	*	
VERSUS	*	**DIVISION "G"**
	*	
BP AMERICA PRODUCTION CO., ET AL.	*	

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

I. INTRODUCTION

I have been retained by counsel for BP America Production Co. in the matter of Harold J. Guidry, et al. versus BP America Production Company, et al., (16th Judicial District Court for the Parish of St. Martin State of Louisiana [Docket No. 82537; Division "G"]), to assess the radiological conditions of a specific parcel of land in the Anse La Butte Oil and Gas Field, in St. Martin Parish, Louisiana. I have also been asked to review the July 1, 2016 report by Gregory W. Miller and the July 27, 2016 report by Derek Pourciau in this matter and provide opinions with respect to the conclusions in those reports.

II. OPINIONS

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

1. There are three (3) pieces of NORM-impacted pipe on the subject property having a total length of approximately 90 feet, and that pipe is required to be managed in accordance with applicable regulations of the Louisiana Department of Environmental Quality.

2. There is no indication of NORM-impacted soil on the subject property.

3. The groundwater samples collected from the subject property by Plaintiffs and Defendants and analyzed for NORM radionuclides do not indicate the presence of oilfield NORM in groundwater on the property.

4. Based on my review of the radiological characterization data for the subject property and the absence of reasonable exposure pathways, I have concluded that there is no indication that anyone near the subject property or a casual visitor on the property can reasonably be expected to receive a radiation dose

greater than the range of radiation doses from natural background radiation sources in Louisiana.

5. The July 1, 2016 report by Gregory W. Miller does not present any data or other information that indicate the presence of oilfield NORM in soil or groundwater on the subject property.

6. The July 27, 2016 report by Derek Pourciau does not present any data or other information that indicate the presence of oilfield NORM in soil or groundwater on the subject property.

III. QUALIFICATIONS

My qualifications are detailed in the attached Curriculum Vitae (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 thirty-nine (39) 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 earned and continue to maintain Comprehensive Certification by the American Board of Health Physics (ABHP) and I am a diplomate and Past-president of the American Academy of Health Physics. The term "Certified Health Physicist" is a certification mark that may only be used by individuals who have received Comprehensive Certification by the ABHP. Certification in health physics by the ABHP is the same as professional certification by other recognized professional organizations, such as certification in diagnostic radiological physics by the American Board of Radiology. I am an elected Distinguished Emeritus member of the National Council on Radiation Protection and Measurements (NCRP) and a Fellow and Past-president of the Health Physics Society. 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-two 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. I visited the subject property on September 30, 2016. During my visit to the subject property I performed gamma radiation measurtements of areas on the subject property claimed to be, or suspected of being, impacted by oilfield NORM. A copy of my field notes is included in Attachment C.

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

Groundwater that contains natural solids 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). 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, external exposure rates from natural background radiation sources range from less than 5 μR/hr to over 14 μR/hr (Beck 1986).

D. Radiation Doses from Natural Background Sources

Radiation doses to persons from natural background radiation have been studied extensively for many decades. The term "dose" is used to represent the amount of radiation energy deposited in tissue per unit mass of tissue of a person exposed to ionizing radiation. External radiation doses are produced by penetrating radiation (e.g., gamma rays or x-rays) from radiation sources outside the human body. Internal radiation doses are produced by radioactive material within the body following inhalation or ingestion of that radioactive material. Natural radiation and radioactivity in the environment provide the major source of external and internal radiation doses to humans. NCRP Report No. 160 describes the radiation doses received from natural background radiation sources in the U.S. (NCRP 2009).

The NCRP notes in Report No. 160 that the average radiation dose in the United States from cosmic radiation at ground level is 0.033 rem per year (NCRP 2009). [33 millirem; 1 rem equals 1,000 millirem.] The average external radiation doses from terrestrial radionuclides in the United States is 0.021 rem (21 millirem) per year. As with soil and other terrestrial matter, the human body also contains naturally-occurring radionuclides, the most abundant of which is the primordial radionuclide potassium-40. The average internal dose from radionuclides (excluding radon and radon progeny) in the body is 0.029 rem (29 millirem) per year. Therefore, the NCRP concludes that the total natural background radiation dose (excluding radon and radon progeny) in the United States is approximately 0.083 rem (83 millirem) per year (NCRP 2009). In addition, the NCRP has determined that the average radiation dose from inhaled radon and radon progeny in the United States is approximately 0.228 rem (228 millirem) per year. Therefore, the total average annual radiation dose from all natural background radiation sources in the United States is approximately 0.311 rem (311 millirem) per year (NCRP 2009). The total average annual radiation dose from all natural background radiation sources in Louisiana is somewhat less than the average for the United States (NCRP 2009).

E. Radiation Doses from Ingestion of Ra-226 and Ra-228

Every person ingests an average of approximately 1-2 pCi of Ra-226 in food and water every day of our lives (Carter 1988; NCRP 1984). Similarly, we also ingest an average of approximately 1-2 pCi of Ra-228 in food and water every day. Over a year, the radiation dose from ingestion of 1-2 pCi of Ra-226 and Ra-228 each day is approximately 1-2 millirem per year (EPA 1988) and this dose is included in the average total radiation dose from natural background radiation sources. The average annual dose from ingestion of natural background Ra-226 and Ra-228 in our food and water is less than 1 percent of the average annual dose we receive from all natural background radiation sources.

F. 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 all natural 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 total dissolved solids (TDS) in the water.

G. Description of the Subject Property

The property that is the subject of this radiological assessment is a parcel of land located in the Anse La Butte Oil & Gas Field in St. Martin Parish, east of Lafayette, Louisiana. Descriptions of the location and history of oil production operations on the subject property are given in reports listed in Attachment B.

H. External Radiation Measurements on the Subject Property

Measurements of external radiation levels on the property were made by personnel with ICON on June 23, 2016, and those measurements indicated NORM impacts only of approximately 90 feet of "tubing near GC-1 & concrete slabs" (Pourciau 2016). The "meter readings ranged 50 - 140 μR/hr on approximately ninety feet of oilfield flowlines" (Pourciau 2016).

On September 30, 2016, I performed measurements of the external gamma radiation levels on the subject property with a Ludlum "MicroR Meter" (Model 19, Ludlum Measurements Inc., Sweetwater, Texas). The measurements that I made indicated average background radiation readings over soil areas on the property to be between approximately 8 μR/hr and 12 μR/hr at the ground surface and at a height of one meter (approximately 3 feet) above the ground surface. These measurements are consistent with published reports of background gamma radiation levels in Louisiana (Beck 1986). The radiation measurements that I performed on September 30, 2016, indicated that the above-background gamma radiation levels on the subject property were from three joints of oilfield pipe (total length of approximately 90 feet). The highest reading I found in contact with the pipe was approximately 110 μR/hr. Gamma radiation readings at all other locations I measured were at natural background gamma radiation levels (Attachment C; Beck 1986).

The greatest gamma radiation level at a distance of one meter from the NORM-impacted pipe was approximately 25 μR/hr (Attachment C) and decreased rapidly to natural background radiation levels (8-12 μR/hr) within a couple of meters from the pipe. The measured gamma radiation levels at a height of one meter above the ground (and the pipe) are used when assessing potential external radiation dose rates at the measurement locations.

I. Collection and Analysis of Soil Samples

There were no indications from gamma radiation measurements reported by Plaintiffs' representatives (ICON) or myself that there was oilfield NORM in soil on the subject property (Pourciau 2016). Consequently, there were no soil samples collected from the subject property for analysis of oilfield NORM in soil (Miller 2016; Pourciau 2016).

J. Collection and Analysis of Water Samples

Four water samples were collected on July 6, 2011, by ICON from four wells on land in the vicinity of the subject property. The samples were shipped under chain of custody to Pace Analytical Services, Inc. (Pace) in Greensburg, Pennsylvania, for measurement of concentrations of Ra-226 and Ra-228 in each sample. Results of analysis of the samples are given in one report of analysis (Pace 2011). Results of the Pace analyses are summarized below in Table 1.

Table 1. Results of Laboratory Analysis of Water Samples Collected by ICON in 2011

	Ra-226			Ra-228		
Sample ID	**Result (pCi/g)**	**CU (pCi/g)**	**MDC (pCi/g)**	**Result (pCi/g)**	**CU (pCi/g)**	**MDC (pCi/g)**
AB-1	2.75	1.12	0.87	3.92	1.01	0.86
AB-2	0.38	0.46	0.69	0.57	0.40	0.78
AB-3	1.04	0.71	0.81	1.57	0.61	0.93
AB-4	0.72	0.58	0.67	0.64	0.45	0.86

where "CU" = Counting Uncertainty (2 sigma) and "MDC" = Minimum Detectable Concentration.

Splits of the samples collected on July 6, 2011, were shipped under chain of custody by defendants' representative, Hydro-Environmental Technology, Inc. (HET), to Eberline Analytical Corporation (Eberline) in Oak Ridge, Tennessee, for analysis of concentrations of Ra-226 and Ra-228 in each sample. Results of analysis of the samples are given in one report of analysis (Eberline 2011). Results of the Eberline analyses are summarized below in Table 2.

Table 2. Results of Laboratory Analysis of Split Samples Collected by HET in 2011

	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)
AB-4	0.56	0.32	0.34	0.26	0.60	0.66	0.67	1.34
AB-3	0.91	0.37	0.41	0.26	1.00	0.54	0.59	1.05
AB-2	0.25	0.18	0.19	0.22	0.60	0.55	0.57	1.12
AB-1	3.04	0.76	0.99	0.23	1.69	0.53	0.66	0.95

where "CU" = Counting Uncertainty, "CSU" = Combined Standard Uncertainty (2 sigma), and "MDC" = Minimum Detectable Concentration.

According to records produced by ICON, 28 groundwater samples were collected from locations in the vicinity of the subject property during January and February, 2013. The locations of groundwater wells sampled by ICON are shown in Figure 1 of the July 1, 2016 report by Gregory W. Miller (Miller 2016). The samples were shipped under chain of custody to Pace for measurement of concentrations of Ra-226 and Ra-228 in each sample. Results of analysis of the samples are given in three reports of analysis (Pace 2013a-c). Results of the Pace analyses are summarized below in Table 3.

Table 3. Results of Laboratory Analysis of Water Samples Collected by ICON in 2013

	Ra-226			Ra-228		
	Result	CU	MDC	Result	CU	MDC
Sample ID	(pCi/g)	(pCi/g)	(pCi/g)	(pCi/g)	(pCi/g)	(pCi/g)
Lampson Well	0.12	0.37	0.71	0.38	0.40	0.81
Broussard	0.28	0.36	0.60	0.76	0.37	0.64
WW 7362Z	0.30	0.37	0.60	0.98	0.43	0.72
WW 6262Z	0.52	0.36	0.38	0.50	0.38	0.76
WW 6879Z	0.60	0.42	0.50	0.46	0.36	0.71
Ostrich #2	0.20	0.31	0.53	0.57	0.34	0.64
WW 6663Z	0.00	0.26	0.57	0.39	0.40	0.82
C Bundricks	0.62	0.48	0.68	0.79	0.40	0.69
WW 6360Z	0.00	0.25	0.57	0.27	0.39	0.85
WW 7377Z	0.23	0.27	0.42	0.53	0.36	0.68
WW 7151Z	0.42	0.38	0.56	0.27	0.34	0.74
WW 5101Z	0.05	0.32	0.64	0.56	0.36	0.67
WW 5248Z	0.36	0.42	0.67	0.69	0.40	0.73
WW 7339Z	0.51	0.40	0.55	0.34	1.28	2.40
D&M #1	0.00	0.26	0.56	0.14	0.29	0.64
WW 7019Z	0.28	0.23	0.13	0.28	0.34	0.72
WW 7591Z	0.48	0.38	0.49	0.12	0.32	0.72
Jean Baptiste	0.87	0.44	0.42	0.45	0.34	0.66
G Meats	0.28	0.26	0.34	0.61	0.38	0.70
Castille #2	0.21	0.29	0.48	0.53	0.32	0.59

DB-1	0.79	0.50	0.57	0.59	0.32	0.57
WW 7551Z	0.10	0.23	0.36	0.14	0.30	0.67
WW 5410Z	0.62	0.42	0.51	0.73	0.38	0.67
WW 6403Z	0.05	0.23	0.49	0.22	0.31	0.67
WW 259	0.40	0.37	0.54	0.64	0.36	0.64
Dwayne Grossie	1.08	0.51	0.46	0.54	0.32	0.59
WW 5298Z	0.34	0.29	0.36	0.46	0.31	0.58
Willie Lester WW	0.29	0.30	0.45	0.53	0.31	0.56

where "CU" = Counting Uncertainty (2 sigma) and "MDC" = Minimum Detectable Concentration.

One water sample was collected from a well on land in the vicinity of the subject property on January 6, 2015. The sample and an "Equipment Blank" sample were shipped under chain of custody by HET to Eberline for analysis of concentrations of Ra-226 and Ra-228 in each sample. Results of analysis of the samples are given in one report of analysis (Eberline 2015). Results of the Eberline analyses are summarized below in Table 4.

Table 4. Results of Laboratory Analysis of Samples Collected by HET in 2015

	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)**
AB-1	2.94	0.70	0.94	0.31	2.18	0.62	0.79	1.10
Equip. Blank	0.07	0.10	0.10	0.15	0.46	0.57	0.58	1.17

where "CU" = Counting Uncertainty, "CSU" = Combined Standard Uncertainty (2 sigma), and "MDC" = Minimum Detectable Concentration.

Three water samples were collected by ICON from three wells on land in the vicinity of the subject property on March 17-18, 2016. The locations of the three wells are shown in Figure 9 of the 2017 HET report (HET 2017). The samples were shipped under chain of custody by ICON to Pace for analysis of concentrations of Ra-226 and Ra-228 in each sample. Results of analysis of the samples are given in one report of analysis (Pace 2016c). Results of the Pace analyses are summarized below in Table 5.

Table 5. Results of Laboratory Analysis of Water Samples Collected by ICON on March 17-18, 2016

	Ra-226			**Ra-228**		
	Result	**CU**	**MDC**	**Result**	**CU**	**MDC**
Sample ID	**(pCi/g)**	**(pCi/g)**	**(pCi/g)**	**(pCi/g)**	**(pCi/g)**	**(pCi/g)**
HMW-1A	0.20	0.44	0.81	0.35	0.59	1.27

HMW-2A	-0.15	0.42	0.99	0.77	0.41	0.74
HMW-3A	-0.21	0.52	0.98	0.53	0.45	0.91

where "CU" = Counting Uncertainty (2 sigma) and "MDC" = Minimum Detectable Concentration.

Splits of the samples from the three wells sampled on March 17-18, 2016, were collected by HET. The samples and an "Equipment Blank" sample were shipped under chain of custody by HET to Eberline for analysis of concentrations of Ra-226 and Ra-228 in each sample. Results of analysis of the samples are given in one report of analysis (Eberline 2016c). Results of the Eberline analyses are summarized below in Table 6.

Table 6. Results of Laboratory Analysis of Samples Collected by HET on March 17-18, 2016

	Ra-226				Ra-228			
Sample ID	Result (pCi/g)	CU (pCi/g)	CSU (pCi/g)	MDC (pCi/g)	Result (pCi/g)	CU (pCi/g)	CSU (pCi/g)	MDC (pCi/g)
HMW-1A	0.85	0.39	0.43	0.27	1.15	0.56	0.62	1.07
Field Dupl.	0.27	0.24	0.24	0.31	0.68	0.53	0.55	1.06
HMW-2A	0.51	0.30	0.32	0.23	0.15	0.57	0.56	1.19
Equip. Blank	0.07	0.17	0.17	0.33	0.48	0.47	0.49	0.96
HMW-3A	0.63	0.34	0.36	0.25	0.39	0.52	0.53	21.06

where "CU" = Counting Uncertainty, "CSU" = Combined Standard Uncertainty (2 sigma), and "MDC" = Minimum Detectable Concentration.

ICON collected 26 groundwater samples from the subject property during March-June, 2016. The locations of groundwater wells sampled by ICON are shown in Figure 1 of the July 1, 2016 report by Gregory W. Miller (Miller 2016). The samples were shipped under chain of custody to Pace for measurement of concentrations of Ra-226 and Ra-228 in each sample. Results of analysis of the samples are given in four reports of analysis (Pace 2016a-b, d-e). Results of the Pace analyses are summarized below in Table 7.

Table 7. Results of Laboratory Analysis of Water Samples Collected by ICON in 2016

	Ra-226			Ra-228		
Sample ID	Result (pCi/g)	CU (pCi/g)	MDC (pCi/g)	Result (pCi/g)	CU (pCi/g)	MDC (pCi/g)
GC-6	2.04	0.85	0.23	1.53	0.48	0.60
GC-5	1.14	0.63	0.72	2.14	0.61	0.72
GC-1	0.50	0.43	0.58	0.49	0.35	0.69
GC-2	0.43	0.32	0.17	0.70	0.37	0.65

GC-4	1.16	0.64	0.76	2.77	0.74	0.82
GC-3	0.31	0.44	0.74	0.54	0.35	0.67
GC-9	0.43	0.57	0.96	0.62	0.42	0.79
GC-8	0.45	0.58	0.96	0.66	0.39	0.70
GC-12	0.52	0.53	0.80	0.69	0.38	0.70
GC-12D	2.94	1.00	0.67	2.08	0.63	0.79
GC-8D	3.94	1.19	0.96	3.50	0.91	0.92
GC-13	1.10	0.73	0.91	0.23	0.33	0.71
GC-7	1.55	0.77	0.80	1.58	0.60	0.92
GC-10	0.90	0.69	0.98	0.78	0.40	0.70
GC-11	0.20	0.44	0.82	0.29	0.36	0.76
GC-14	0.30	0.36	0.55	0.46	0.34	0.65
GC-4D	0.65	0.55	0.75	1.03	0.43	0.69
GC-7D	0.82	0.71	1.00	1.48	0.52	0.71
GC-16	0.46	0.48	0.72	0.51	0.43	0.86
GC-9D	0.41	0.65	0.96	0.95	0.41	0.66
GC-9B	0.18	0.55	0.98	0.58	0.39	0.75
GC-5B	0.58	0.67	0.98	0.46	0.38	0.75
GC-12DD	0.51	0.60	0.95	1.51	0.50	0.67
GC-7B	0.49	0.62	0.96	0.30	0.40	0.85
GC-4B	0.27	0.65	0.99	0.67	0.43	0.83
GC-14B	-0.03	0.46	0.98	0.70	0.43	0.80

where “CU” = Counting Uncertainty (2 sigma) and “MDC” = Minimum Detectable Concentration.

ICON collected 11 groundwater samples from the subject property during August 22-25, 2016, and 11 groundwater samples on September 26-29, 2016. The locations of groundwater wells sampled by ICON are shown in Figure 1 of the July 1, 2016 report by Gregory W. Miller (Miller 2016) or in Figure 9 in the 2017 report by HET (HET 2017). The samples were shipped under chain of custody to Pace for measurement of concentrations of Ra-226 and Ra-228 in each sample. Results of analysis of the samples are given in two reports of analysis (Pace 2016f-g). Results of the Pace analyses are summarized below in Table 8.

Table 8. Results of Laboratory Analysis of Water Samples Collected by ICON in August-September 2016

	Ra-226			Ra-228		
	Result	**CU**	**MDC**	**Result**	**CU**	**MDC**
Sample ID	**(pCi/g)**	**(pCi/g)**	**(pCi/g)**	**(pCi/g)**	**(pCi/g)**	**(pCi/g)**
GC-5B	0.35	0.41	0.65	1.77	0.55	0.74
GC-5	1.67	0.80	0.84	2.83	0.69	0.65
GC-8	0.58	0.59	0.90	1.19	0.41	0.58
GC-8D	3.33	1.06	0.66	6.54	1.32	0.59
GC-12	0.73	0.58	0.78	1.47	0.46	0.61

GC-10	0.80	0.55	0.59	1.47	0.45	0.55
GC-4	1.73	0.78	0.58	2.09	0.57	0.63
GC-3	0.23	0.30	0.47	0.89	0.39	0.63
GC-12D	4.04	1.22	0.58	2.54	0.61	0.49
GC-7D	0.89	0.59	0.69	1.40	0.43	0.53
GC-7	2.22	0.87	0.56	2.57	0.65	0.62
MW1 (80-90)	1.37	0.63	0.48	1.42	0.52	0.80
MW4 (80-90)	1.50	0.69	0.53	2.13	0.65	0.81
MW2 (80-90)	0.81	0.57	0.69	1.86	0.59	0.78
MW2 (50-60)	0.78	0.58	0.77	1.40	0.50	0.72
MW5 (80-90)	0.59	0.54	0.79	0.99	0.44	0.72
MW3 (50-60)	0.64	0.40	0.17	0.88	0.39	0.62
MW3 (80-90)	1.07	0.55	0.19	1.64	0.54	0.69
MW7 (80-90)	0.27	0.31	0.18	1.06	0.48	0.79
MW6 (80-90)	0.13	0.30	0.49	1.24	0.45	0.62
MW6 (55-65)	0.35	0.37	0.52	2.90	0.94	1.15
MW7 (58-63)	1.04	0.65	0.64	1.35	0.50	0.72

where “CU” = Counting Uncertainty (2 sigma) and “MDC” = Minimum Detectable Concentration.

Defendants’ representative, HET, collected 26 splits of the ICON groundwater samples in March-June, 2016. The split samples were shipped by HET under chain of custody to Eberline for analysis of concentrations of Ra-226, Ra-228 and total dissolved solids (TDS) in each sample. Results of analysis of the samples are given in four reports of analysis (Eberline 2016a-b, d-e). Results of Eberline’s analyses are summarized below in Table 9.

Table 9. Results of Laboratory Analysis of Split Samples Collected by HET in 2016

	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)**
GC-4	0.73	0.36	0.40	0.34	1.95	0.45	0.63	0.73
GC-3	0.66	0.34	0.37	0.27	1.17	0.46	0.53	0.86
GC-9	0.24	0.26	0.27	0.40	0.81	0.44	0.48	0.86
GC-8	0.42	0.25	0.26	0.22	0.98	0.53	0.58	1.03
GC-2	0.40	0.28	0.29	0.22	1.10	0.46	0.53	0.87
GC-5	1.05	0.44	0.49	0.29	1.74	0.47	0.61	0.80
GC-1	0.35	0.30	0.31	0.35	1.16	0.58	0.63	1.09
GC-6	0.96	0.43	0.48	0.33	2.00	0.50	0.67	0.86
GC-12 28-38	0.57	0.31	0.34	0.24	0.77	0.45	0.48	0.88
GC-12D 50-60	3.88	0.86	1.19	0.27	2.38	0.57	0.79	0.99
GC-8D 50-60	3.86	0.88	1.20	0.34	3.52	0.55	0.97	0.83
GC-13 28-38	0.70	0.38	0.41	0.40	1.51	0.53	0.63	0.98
GC-7 28-38	1.71	0.55	0.65	0.28	1.17	0.63	0.68	1.22
GC-10 28-38	0.62	0.33	0.36	0.28	0.78	0.52	0.55	1.02
GC-11 28-38	0.50	0.30	0.32	0.25	1.09	0.50	0.56	0.95

GC-14 30-40	0.24	0.24	0.24	0.34	1.10	0.50	0.56	0.96
GC-4D 80-90	0.68	0.35	0.38	0.27	1.58	0.55	0.66	1.01
GC-7D 80-90	1.97	0.60	0.73	0.26	1.13	0.41	0.48	0.75
GC-16 30-40	0.65	0.35	0.37	0.29	0.70	0.44	0.47	0.87
GC-9D 80-90	0.49	0.29	0.31	0.22	1.14	0.40	0.48	0.73
GC-9B 50-60	0.43	0.30	0.32	0.30	1.45	0.39	0.51	0.65
GC-5B 50-60	1.29	0.51	0.58	0.31	1.75	0.46	0.61	0.81
GC-12DD 80-90	0.49	0.32	0.34	0.36	0.88	0.41	0.45	0.77
GC-7B 50-60	0.34	0.24	0.25	0.18	0.58	0.35	0.38	0.69
GC-4B 50-60	0.17	0.21	0.21	0.32	0.71	0.36	0.40	0.69
GC-14B 50-60	0.15	0.18	0.18	0.25	0.81	0.38	0.42	0.72

where "CU" = Counting Uncertainty, "CSU" = Combined Standard Uncertainty (2 sigma), and "MDC" = Minimum Detectable Concentration.

HET collected 37 additional groundwater samples in August-November 2016. The locations of these additional wells sampled by MP&A are shown in figures in the 2017 HET report in this matter (HET 2017). The 37 samples were shipped under chain of custody to Eberline for measurement of concentrations of Ra-226, Ra-228, and TDS in each sample. Results of the Eberline analyses for the HET samples are given in nine reports of analysis (Eberline 2016f-k; Eberline 2017a-c). Results of Eberline's analyses are summarized below in Table 10.

Table 10. Results of Laboratory Analysis of Water Samples Collected by HET in August-November 2016

	Ra-226				Ra-228			
Sample ID	Result (pCi/g)	CU (pCi/g)	CSU (pCi/g)	MDC (pCi/g)	Result (pCi/g)	CU (pCi/g)	CSU (pCi/g)	MDC (pCi/g)
GC-5B 56-66	1.25	0.47	0.54	0.30	1.18	0.36	0.45	0.63
GC-5 30-40	2.22	0.66	0.81	0.30	1.42	0.45	0.56	0.82
GC-8 26-36	1.24	0.55	0.61	0.39	1.28	0.48	0.56	0.87
GC-8D 50-60	3.56	0.79	1.09	0.36	5.56	0.59	1.39	0.77
EQUIP. BLANK	0.01	0.09	0.09	0.25	0.24	0.39	0.39	0.80
FIELD DUPL.	1.14	0.45	0.51	0.32	1.01	0.41	0.47	0.77
GC-12 28-38	1.54	0.52	0.61	0.21	1.50	0.54	0.57	0.81
GC-7D 80-90	1.60	0.56	0.65	0.29	1.44	0.52	0.61	0.97
GC-7 28-38	2.21	0.66	0.81	0.26	1.63	0.43	0.57	0.74
GC-10 28-38	0.10	0.20	0.20	0.37	1.26	0.37	0.47	0.63
GC-4 26-36	1.25	0.49	0.56	0.40	1.50	0.42	0.54	0.72
GC-3 28-38	0.90	0.36	0.40	0.22	0.15	0.42	0.42	0.87
GC-12D 50-60	3.18	0.75	1.01	0.24	2.86	0.55	0.85	0.92
GC-6 26-36	1.26	0.47	0.54	0.21	1.26	0.52	0.59	0.98
EQUIP. BLANK	0.00	0.10	0.10	0.28	0.67	0.47	0.50	0.95
MW1 80-90	0.79	0.40	0.43	0.24	1.89	0.47	0.64	0.80
FIELD DUPL.	0.76	0.37	0.40	0.27	1.20	0.53	0.59	1.01
MW4 80-90	1.59	0.56	0.65	0.30	6.98	0.66	1.71	0.85

MW2 80-90	0.67	0.37	0.39	0.26	1.01	0.42	0.48	0.80
MW2 50-60	0.32	0.27	0.28	0.36	1.26	0.45	0.53	0.83
MW5 80-90	0.25	0.23	0.23	0.28	1.10	0.42	0.49	0.79
MW3 50-60	0.90	0.39	0.44	0.26	1.43	0.44	0.55	0.79
MW3 80-90	1.45	0.52	0.60	0.28	6.36	0.59	1.55	0.64
MW7 80-90	0.73	0.37	0.40	0.30	0.51	0.42	0.44	0.85
MW6 80-90	0.47	0.30	0.32	0.28	1.21	0.43	0.51	0.79
MW6 55-65	0.72	0.37	0.40	0.29	2.02	0.45	0.64	0.75
MW7 58-63	1.47	0.56	0.64	0.33	1.67	0.48	0.61	0.86
MW1 80-90	1.67	0.63	0.72	0.46	1.34	0.52	0.60	0.98
MW2 50-60	1.71	0.70	0.79	0.48	1.06	0.46	0.52	0.86
MW2 80-90	0.88	0.49	0.52	0.48	0.54	0.49	0.50	0.99
MW4 80-90	1.14	0.46	0.52	0.29	9.05	0.79	2.20	0.97
MW7 58-63	4.02	1.08	1.38	0.63	1.41	0.52	0.61	0.97
EQUIP. BLANK	0.22	0.28	0.29	0.43	0.45	0.43	0.44	0.87
FIELD DUPL.	0.80	0.42	0.45	0.37	0.23	0.49	0.49	1.01
GC-5B	0.80	0.44	0.47	0.38	0.13	0.52	0.52	1.09
GC-8D	3.73	0.87	1.18	0.39	7.01	0.69	1.73	0.85
GC-6	1.13	0.48	0.54	0.34	0.91	0.41	0.46	0.78

where “CU” = Counting Uncertainty, “CSU” = Combined Standard Uncertainty (2 sigma), and “MDC” = Minimum Detectable Concentration.

Analytical results for the groundwater samples showed only naturally-occurring concentrations of Ra-226 and Ra-228 for the amounts of solids in the water samples. None of the groundwater samples indicated the presence of oilfield NORM in groundwater on the subject property. This observation is based on the measured concentrations of Ra-226 and Ra-228 in each sample (including split samples). The concentrations of Ra-226 and Ra-228 per unit mass of solids (TDS) in the groundwater samples are within the range of natural background concentrations for the amounts of solids in the water samples.

K. Review of the July 1, 2016 report by Gregory W. Miller and the July 27, 2016 report by Derek Pourciau

I have reviewed the July 1, 2016 report by Gregory W. Miller and the July 27, 2016 report by Derek Pourciau in this matter and find that neither report presents any data or other information that indicate the presence of oilfield NORM in soil or groundwater on the subject property.

As I have noted previously in this report, Pourciau found above-background gamma radiation readings from approximately 90 feet of oilfield pipe (3 pieces of flowline) on the subject property. However, he did not indicate any above-background readings for the remainder of the property (Pourciau 2016).

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:

_____________________________ Date: January 13, 2017

John R. Frazier, Ph.D., CHP

ATTACHMENT A

CURRICULUM VITAE OF JOHN R. FRAZIER, Ph.D., CHP

JOHN R. FRAZIER, Ph.D., CHP

Professional Qualifications

Dr. Frazier has over 39 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 an elected 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 2017.

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
John C. Villforth Lecture, Conference of Radiation Control Program Directors, 2007
Joyce P. Davis Memorial Award, American Academy of Health Physics, 2016
Distinguished Technical Associate, IT Corporation, 1990
National Council on Radiation Protection and Measurements (NCRP)
  Distinguished Emeritus Member, 2014
  Council Member, 2002-2014
  Scientific Committee 46, 1999-2006
  Scientific Committee 2-1, 2004-2006
  PAC-2 Committee 2006-20015

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

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

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ATTACHMENT B

LIST OF DOCUMENTS REVIEWED

ATTACHMENT B

Documents Reviewed by John R. Frazier, Ph.D., CHP

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Eberline 2016a Eberline Analytical Corporation, "Final Report of Analysis," Work Order No. 16-03089-OR, Oak Ridge, Tennessee, April 28, 2016.

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Eberline 2016d Eberline Analytical Corporation, "Final Report of Analysis," Work Order No. 16-05050-OR, Oak Ridge, Tennessee, July 13, 2016.

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ATTACHMENT C

FIELD NOTES OF JOHN R. FRAZIER
SEPTEMBER 20, 2016

Field Notes of John R. FRAZIER September 30, 2016

~ 11:15 AM Arrive at site with Hunter Chauvin
Clear, sunny day
met by Don Watts of HET
I checked out gamma radiation survey meter
Ludlum Model 19 (S/N 144050)
Battery OK ; Check Source OK.
I surveyed around parking area - 8-10 μR/hr @ ground level
and at 1 m above ground
Went with Don Watts and Hunter Chauvin to location
identified by Derek Pourciau (ICON Report/Field Notes)
as having above-background gamma readings. (6/23/2016)
This area/location is near "GC-1" on ICON Figure No. 1

All readings in the area were at background gamma radiation
levels 8-12 μR/hr at ground surface and @ 1 meter height
except for 3 pieces of pipe
each ~ 30 ft long (joints)
Maximum reading in contact with the pipe 110 μR/hr
Maximum reading @ 1 meter from pipe 25 μR/hr

This is the only location identified by ICON as having
any above-background gamma radiation readings.
Watts, Chauvin and I then went to all other "GC"
locations shown on ICON Figure 1.
~ 1:35 PM Check out Model 19 - Battery OK and Check Source OK.
~ 1:40 PM Left site John R. Frazier 9/30/2016

Designer and Manufacturer of Scientific and Industrial Instruments

CERTIFICATE OF CALIBRATION

LUDLUM MEASUREMENTS, INC.
501 Oak Street, 325-235-5494, Sweetwater, TX 79556, U.S.A.
☑ 10744 Dutchtown Road, 865-392-4601, Knoxville, TN 37932, U.S.A.

CUSTOMER JOHN R. FRAZIER ORDER NO. 20003025

Mfg. Ludlum Measurements, Inc. Model 19 Serial No. 144050
Mfg. Model Serial No.

Cal. Date 23-Dec-15 Cal Due Date 23-Dec-16 Cal. Interval 1 Year Meterface 202-016

Check mark ☑ applies to applicable instr. and/or detector IAW mfg. spec. T. 74 °F RH 49 % Alt 667.0 mm Hg

☐ New Instrument Instrument Received ☐ Within Toler. +-10% ☐ 10-20% ☐ Out of Tol. ☐ Requiring Repair ☐ Other-See comments

☑ Mechanical ck. ☑ Meter Zeroed ☐ Background Subtract ☐ Input Sens. Linearity
☑ F/S Resp. ck ☑ Reset ck. ☐ Window Operation ☑ Geotropism
☑ Audio ck. ☐ Alarm Setting ck. ☑ Batt. ck. (Min. Volt) 2.2 VDC
☐ Calibrated in accordance with LMI SOP 14.8 rev 12/05/89. ☐ Calibrated in accordance with LMI SOP 14.9 rev 02/07/97.

Instrument Volt Set 700 V Input Sens. 31 mV Det. Oper. V at mV Threshold Dial Ratio = mV

☑ HV Readout (2 points) Ref./Inst. / V Ref./Inst. / V

COMMENTS:
Repairs preformed between the "as found" readings and the final instrument readings.

Gamma Calibration: GM detectors positioned perpendicular to source except for M 44-9 in which the front of probe faces source.

RANGE/MULTIPLIER	REFERENCE CAL. POINT	INSTRUMENT REC'D "AS FOUND READING"	INSTRUMENT METER READING*
5000	4000 µR/hr	4400	4000
5000	1000 µR/hr	1100	1000
500	400 µR/hr = 78000cpm	420	400
500	100 µR/hr	110	100
250	200 µR/hr = 38500cpm	210	200
250	100 µR/hr	110	100
50	7800 cpm	39.5	40
50	1950 cpm	10	10
25	3850 cpm	20	20
25	960 ~~1930~~ BC cpm	4.8	5

*Uncertainty within ± 10% C.F. within ± 20% 50, 25 **Range(s) Calibrated Electronically**

	REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*		REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*
Digital Readout				Log Scale			

Ludlum Measurements, Inc. certifies that the above instrument has been calibrated by standards traceable to the National Institute of Standards and Technology, or to the calibration facilities of other International Standards Organization members, or have been derived from accepted values of natural physical constants or have been derived by the ratio type of calibration techniques.
The calibration system conforms to the requirements of ANSI/NCSL Z540-1-1994 and ANSI N323-1978 State of Texas Calibration License No. LO-1963

Reference Instruments and/or Sources: ☐ 059 ☐ 280 ☐ 720 ☐ 734 ☐ 781 ☐ 1131 ☐ 1616 ☐ 1696 ☐ 5105 ☐ 5717CO ☐ 5719CO ☐ 60646 ☐ 70897 ☐ 73410 ☐ E551 ☐ E552 ☐ G112 ☐ M565 ☐ S-394 ☐ S-1054 ☐ T-304 ☐ T879 ☐ T10081 ☐ T10082 ☐ Y982

☐ Alpha S/N ☐ Beta S/N ☑ Other Am-241: 1637-72-2

☑ m 500 S/N 285609 ☐ Oscilloscope S/N ☐ Multimeter S/N

Calibrated By: Jennifer Warren Date 23Dec15

Reviewed By: Brittney Crowder Date 23 December 15

This certificate shall not be reproduced except in full, without the written approval of Ludlum Measurements, Inc.
FORM C22A 02/26/2013 Page 1 of 1

AC Inst. Only ☐ Passed Dielectric (Hi-Pot) and Continuity Test ☐ Failed:

ATTACHMENT D

TESTIMONY SINCE JANUARY 13, 2013

LITIGATION IN WHICH DR. JOHN R. FRAZIER HAS PROVIDED SWORN TESTIMONY SINCE JANUARY 13, 2013

LAW FIRM	CASE	CLIENT	DATE
Liskow & Lewis	Avahoula Resources, L.L.C. v. Exxon Mobil Corporation, et al.	Exxon Mobil Corporation, et al.	March 22, 2013
Arnold & Porter	Michelle McMunn, et al. v. Babcock & Wilcox Power Generation Group, Inc., et al.	Atlantic Richfield Co.	June 14, 2013
Liskow & Lewis	Agri-South Group, LLC, et al. v. Exxon Mobil Corporation, et al.	Exxon Mobil Corporation, et al.	July 18, 2013
King & Spalding	Olivia Bailey, et al., v. ExxonMobil Corporation, et al.	ExxonMobil Corporation, et al.	August 21, 2013
Woolf McClane	Naomi Guzman v. ExxonMobil Corporation, et al.	ExxonMobil Corporation, et al.	August 23, 2013
Kean Miller	The Sweet Lake Land and Oil Company, LLC v. Oleum Operating Company, L.C., et al.	Oleum Operating Company, L.C., et al.	November 20, 2013
Kean Miller	Agri-South, LLC, et al. v. Exxon Mobil Corporation, et al.	Exxon Mobil Corporation, et al.	December 11, 2013
Johnson Gray McNamara	Warren Lester, et al. v. Exxon Mobil Corporation, et al. (Bredero Price Flight)	Exxon Mobil Corporation, et al.	December 13, 2013
Liskow & Lewis	Agri-South Group, LLC, et al. v. Exxon Mobil Corporation, et al.	Exxon Mobil Corporation, et al.	August 20, 2014
Kean Miller	State of Louisiana Vermilion Parish School Board v. Louisiana Land & Exploration Company	UNOCAL	September 16, 2014
Jeansonne & Remondet	Clyde A. Tucker, et al. v. Shell Oil Company, et al.	Murphy Oil	December 17, 2014

Adams & Reese	Dwayne Chauvin and Brenda Chauvin v. Exxon Mobil Corporation, et al.	Exxon Mobil Corporation, et al.	March 13, 2015
Liskow & Lewis	Henry Leon Sarpy, et al. v. Exxon Mobil Corporation, et al.	Exxon Mobil Corporation, et al.	March 19, 2015
Kean Miller	State of Louisiana Vermilion Parish School Board v. Louisiana Land & Exploration Company	UNOCAL	April 30, 2015
Kean Miller	The Sweet Lake Land and Oil Company, LLC v. Oleum Operating Company, L.C., et al.	Oleum Operating Company, L.C., et al.	May 22, 2015
Liskow & Lewis	Sterling Sugars, Inc. v. Amerada Hess Corporation, et al.	Amerada Hess Corporation, et al.	June 19, 2015
Jones Walker	State of Louisiana and The Cameron Parish School Board v. Apache Corporation, et al.	Apache Corporation, et al.	September 30, 2015
Adams & Reese	Brittany Roache, et al. v. Alpha Technical Services, et al.	Alpha Technical Services, et al.	October 7, 2015
Liskow & Lewis	Frank B. Allain, et al. v. Exxon Mobil Corporation, et al.	Exxon Mobil Corporation, et al.	November 12, 2015
Liskow & Lewis	Sterling Sugars, Inc. v. Amerada Hess Corporation, et al.	Amerada Hess Corporation, et al.	November 13, 2015
King & Spalding	Patricia Lennie, et al. v. Exxon Mobil Corporation, et al.	Exxon Mobil Corporation, et al.	April 11, 2016
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