

**PIOGA/MSC NORM/TENORM SUBCOMMITTEE**  
**Observations & Questions**  
**Concerning DEP TENORM Study Scope of Work & SAP/QAPP**  
**With PA DEP Responses**

**Observations**

The industry associations recognize and support DEP's intent to undertake a comprehensive sampling and testing program to analyze potential sources of NORM and TENORM associated with oil and gas development and operations.

Overall, the proposed study design and plans appears to provide a sound approach and design to identify potential isotopes of concern and evaluate potential radiation exposure associated with oil and gas development to workers and the public as well as to insure protection of the environment.

However, the industry associations believe that for the radiation study to be a productive exercise, it must be designed and be of sufficient scope to provide sufficient representative samples to allow definitive conclusions on a statewide basis on the important issue of the extent if any of the potential radiation risk of oil and gas development, waste products generated and drilling /operating, and water treatment practices.

The industry appreciates the opportunity to ask questions and share ideas with the intent to strengthen the Department's NORM/TENORM Study scope and plans. The following are preliminary conclusions reached by the industry associations based on the review of the TENORM Scope of Work, SAP and QAPP:

1. Industry experts are concerned that the limited number of samples to be collected from the identified sources/facilities will not be representative of industry activity and practices on a statewide basis or sufficient to identify any potential significant variations between regions, facilities or waste sources. The Study is not likely to be considered comprehensive due to the limited number of samples to be collected from a limited number of well sites and facilities and appears insufficient to be used as the basis for any change in policy or regulations concerning potential radiation levels from waste materials and facilities associated with oil and gas development. The comprehensiveness of the study could be enhanced with industry participation by providing a larger number of samples from a broader list of facilities/ well sites and access to industry data on radiation sources and site background.

**Response: We agree additional samples/sites are warranted based on feedback received during the implementation of the study. The study is comprehensive in regards to the scope of the sites and operations to be surveyed and sampled considering all the potential sources of NORM/TENORM. Even prior to receipt of these comments, the Department was considering expanding the number of well sites to be evaluated.**

**Additional sites have been added. The total number will not be determined until the end of the project. Also, PA DEP welcomes the opportunity to review any and all O&G industry TENORM survey and sample/analysis information.**

2. The SAP shows that landfills leachate is the only category of sampled sites and media that will be comprehensively sampled sufficiently to be considered representative on a statewide basis.

**Response: The study is comprehensive in regards to the scope of the sites and operations to be surveyed and sampled considering all the potential sources of NORM/TENORM. We are sampling in wet gas and dry gas areas; in various geologic formations such as the Utica, Marcellus, Rhinestreet, Burket, and Oriskany; across a broad geographic region of the Commonwealth; and during all phases of well development. Additionally, we believe the number of wastewater and other downstream gas survey / sampling venues will be sufficient to examine any potential TENORM issues. When data is reviewed, sampling at additional sites and resampling of current sites may be recommended.**

3. The industry has concerns that the study is intentionally targeting “known” sites with evidence of elevated radiation levels, and selecting samples for detailed analyses based on gross alpha and beta and gamma spectroscopy. This approach to selective sampling is likely to bias the results high. A statewide comprehensive study (with a random approach for site selection and sampling/analysis) will provide a more complete and representative set of data for a meaningful assessment and definitive conclusions that are truly representative of oil and gas development activities.

**Response: The state does have knowledge of a few historical wastewater processing sites with elevated radiation levels. However, much of the anticipated survey and sampling is aimed at characterizing unknown sites in addition to some historical sites; hence, the known sites are simply part of the sample population. The goal of the study is to scope potential sources of NORM and TENORM throughout the industry. Determining averages and representativeness of the data will occur later in the study.**

4. Standard DEP waste sampling procedures require the use of composite samples prepared from a number of grab or discrete samples in order to insure the test results are representative of the source or media. The SAP indicates DEP intends to predominantly rely on single or multiple grab samples from limited sampling events to draw conclusions on the radiation levels in the selected media and facilities.

**Response: We recognize the value of statistically significant grab sampling in support of a composite sample to determine the waste characteristics of a particular waste stream prior to disposition. However, the scope of the study is not to characterize waste streams for disposal but rather to scope sources of NORM and TENORM**

throughout the industry. The study (scoping survey) is designed to survey the range of radioactivity in various media; hence, composite sampling is not necessary.

5. The SAP and QAPP are missing numerous and critical details concerning detailed procedures for collecting samples and testing methods that are essential to insure the necessary consistency to guarantee sample integrity and produce valid and comparable test results. The SAP and QAPP do not clearly identify who (PESI, DEP or subcontractors) will be responsible for collecting samples and the exact methods/procedures to be uniformly implemented to insure the consistency of the sample quality site-to-site.

**Response: The Sample and Analysis Plan (SAP) consists of two volumes, a Field Sampling Plan (FSP) and a Quality Assurance Project Plan (QAPP). Neither document is or is intended to be procedural. The details of the appropriate analytical methods, detection levels and QC for analytical analysis are included in the SAP, specifically the QAPP.**

**PESI is performing all of the survey and sampling (i.e. no subcontractors). Surveying and sampling is being performed by trained health physics technicians working from the PESI manual of procedures as appropriate. All of the surveys, samples and analyses prescribed as well as PESI procedures are based on industry standards.**

6. The industry is not aware of 22 water treatment facilities meeting the selection criteria contained in Section 2.1 of the SAP. It is unclear if the 22 facilities include temporary on-site processing facilities at unconventional well sites or the seven (7) that only process water from conventional sites. Also, the table on the last page of Appendix A shows 23 facilities (see our Question #8).

**Response: The wastewater treatment facilities were identified by DEP Waste and Water Quality Program staff. The exact number of proposed sites to be surveyed and sampled is now 23 and may further increase.**

7. To assure an accurate assessment of radiation levels at well sites, other facility infrastructure, waste pits and other identified sources, the accurate establishment of background radiation levels and background concentrations of NORM in each medium is critical. The SAP and QAPP do not provide an adequate explanation as to how background NORM levels will be calculated.

**Response: Background is not calculated but rather measured when performing surveys of gamma radiation and alpha/beta surface contamination. The determination of background is being and will continue to be made in accordance with and as appropriate for the type of survey measurement made. The results of background are recorded for each survey performed. The survey measurements including background are performed in accordance with the appropriate instrument/survey procedure(s).**

**Determination of volumetric background activity concentration for different media sampled will be determined as appropriate. Background Ra-226 activity concentrations in surface soil are about 1 pCi/g and <5 pCi/L in surface waters. The determination of background volumetric activity concentrations are critical when determining compliance with acceptance criteria approaching the ambient background activity concentration. Compliance demonstration is not part of the study, and the SAP therefore does not include specific guidance on determining volumetric background for all media sampled.**

8. The Study appears intentionally focused on a limited number of unconventional wells.

**Response: We are expanding the number of unconventional wells sites surveyed/sampled.**

9. The Study appears to be designed to focus on wastewater treatment facilities. Approximately 40% of the total samples to be collected are from wastewater treatment facilities suggesting that DEP has preliminarily concluded that this is the principal source of potential radiation risk associated with oil and gas development.

**Response: Yes, the wastewater treatment facilities are recognized as receiving the highest potential exposure to radioactive material due to the receipt of TENORM associated waste streams. TENORM primarily contained in the flow-back water, brines and produced waters, and treatment of said waters will result in the further concentration of the TENORM in waste solids. Therefore, it is prudent to perform detailed and comprehensive surveys and sampling at wastewater facilities.**

10. The Scope of work and SAP indicate DEP will use outside private "radiochemistry labs" in addition to the DEP Laboratory. The documents do not identify the private laboratories to be used, the specific test(s) they will perform or if they are DEP accredited.

**Response: The selected lab, GEL Laboratories of Knoxville, TN, is DEP accredited, and will serve as QC for the DEP's RadChem Lab. The state lab and GEL will perform the specific analytical methods provided in the QAPP.**

11. The SAP and QAPP do not identify what guidance or efforts will be developed to ensure all the laboratories are following the same internal procedures for handling of samples and testing methods including standard detection limits for each analyte and medium.

**Response: The QAPP specifies radiation measurement methods, desired detection levels and required QC/QA, resulting in consistent analysis results. Procedures used to meet the specified methods may be different, e.g. different sample containers, different**

count times, hold times, etc., but still conform to the appropriate method and results. Normalization of lab procedures is not possible or necessary.

12. It would be helpful for DEP to confirm that the Study only intends to use industry employees to collect methane samples.

**Response: The collection of natural gas samples (methane) for analysis of radon-222 in natural gas will be a joint effort between industry experts at each site and DEP staff. Industry experts provide the DEP staff with initial safety briefings, advise where appropriate sampling can be performed, set up any necessary sampling arrangement, and then allow DEP staff to take actual sample.**

13. The SAP and QAPP are silent on whether there are other documents or written procedures developed for the Study to address the essential qualifications and training for personnel who will be collecting samples, managing the Chain-of-Custody, and operating/calibrating the instruments and detectors used to record radiation levels.

**Response: Please see response to No. 5. PESI trained health physics technicians are performing the surveying and sampling using standard industry practice and procedures. There are actually very few individuals taking samples for the entire project, and they are the same individuals throughout the study.**

14. The industry associations will be encouraging its members to collect split samples at all DEP sampling events for the Study.

**Response: DEP and its contractors will collect their samples and will need the cooperation from industry. The industry is welcome to collect duplicate samples at the time of the DEP sampling assuming that this can be arranged.**

15. The industry associations intend to develop an independent SAP for a parallel sampling and testing program to be conducted by members of the associations to assure that sufficient quantity and quality data is available to augment the DEP collected data and to allow comparisons and enhance reliability of the test results.

**Response: DEP welcomes any and all validation of its sampling / survey results.**

16. The SAP does not provide an explanation of the process by which well site or water facility operators will be notified about the schedule for collecting samples from their operations or facilities, and does not indicate the extent of advanced notice that will be provided. The SAP also does not indicate if the PESI/DEP personnel will provide the facility operator/owner with some form of identification and or credentials before they request access to the site.

**Response: This is beyond the intent and scope of the SAP. Scheduling is underway and will be continuous throughout the Study. DEP and the contractor all have proper identification, as well as appropriate site-specific training, and will provide one week notice prior to sampling.**

## **Questions**

The following are a list of questions raised in the review of the DEP TENROM Scope of Work, SAP and QAPP conducted by PIOGA/MSC. Further clarification on these issues will allow the industry associations to complete its review of the documents and provide DEP constructive recommendations for improvements in the Study design and SAP/QAPP.

1. What are the specific objectives of the data collection? Do they include: (i) performing an overall risk assessment, to workers and members of the public; (ii) determining the volume and activity levels likely to be disposed of in PA landfills and water discharges to the PA water bodies and subsequent environmental impact; and (iii) to obtain a “snapshot” of the radiological characteristics of the various processes to formulate a plan for obtaining additional data for a risk assessment, which will then be used to formulate regulatory policy that may be a better approach (i.e., a “phased study program” that builds off the initial efforts and permits changes in collection methods, rather than trying to take one compressive shot at collecting and analyzing data)?

**Response: Because of the deficiency of NORM/TENORM characterization data of solids, liquids and gases associated with unconventional oil and gas production and subsequently the void in assessment of potential risks from working with and disposing of such media, the Study will begin to fill the void. Recommendations in the final report may include continued or expanded surveys and sampling of certain sites and operations.**

- 2 Will DEP consider taking larger individual sample quantities to allow the well operator, facility operator or waste source to take split samples for independent testing?

**Response: See first section, response to No. 14 above.**

3. The Scope of Work (Page 6, m) states that DEP will use outside “appropriate radiochemistry labs” in addition to the DEP lab. However the SAP (Page 7-1) states DEP lab will perform the radiological analysis of solid and aqueous samples. Why are outside labs necessary? Has DEP selected the laboratories? Will they be DEP accredited?

**Response: An accredited outside lab, GEL Laboratories of Charleston, SC, has been selected to perform as QC on the State RadChem Lab, i.e. 10% of total samples**

**analyzed by State lab will be reanalyzed by QC lab. See response to No. 10 from the first section.**

4. Section 3-1 of the SAP states that the instruments and detectors will be operated and maintained by PA DEP staff, with PESI or “a subcontractor” performing quality control (Q/C). Who are the subcontractors who will be performing this role?

**Response: The instruments and detectors will be operated and maintained by the DEP staff, PermaFix’s technician(s) or its subcontractors, and will be quality control (QC) checked as required by PESI’s operating procedure RP-300.**

5. Who will be actually collecting the solid and aqueous samples from well sites, wastewater treatment facilities and other waste sources (PESI or DEP staff)? Will DEP or PESI be responsible for the chain of custody including the preservation of samples, handling, the responsibility for completing the CoC forms and transportation to the labs? Will DEP staff always be present when sampling is performed?

**Response: PESI will sample with DEP representative(s) present. Standard CoC and protocol will be used in accordance with the SAP and PESI standard sample procedures.**

6. What criteria is being used to select the specific well sites, wastewater facilities and other sources for sampling /monitoring to insure they are representative of the waste type or typical facility on a statewide basis?

**Response: See response to No. 2 in the first section. The degree of representativeness will be evaluated as data is available.**

7. The SAP states that PESI/DEP “may” notify well operators or facility owners prior to a site visit to collect samples. Will DEP notify well site operators and facility owners prior to all site visits to collect samples or will some visits be unannounced? Will PESI or subcontractor personnel provide identification upon entering the facilities?

**Response: Again, scheduling is ongoing, and PESI will have identification. No subcontractors will be used.**

8. Has DEP considered having its teams be given briefings by facility personnel on the operations, RPAP and the available radiological data for the facility prior to implementation of the study at the facility? Will facility representatives be permitted to accompany DEP during Study execution in order to provide insight into operations, answer questions, and collect our

own data/splits? Will DEP provide, to each facility, copies of facility-specific Study raw information, including copies of logs, CoC and analytical data when available?

**Response: The O&G industry has and will continue to have ample opportunity to provide TENORM data to the state. We will welcome onsite overviews of operations. We will not provide any raw data until it is reviewed and completed in the final report. However, if findings note serious environmental, health or safety issues, facilities will be notified immediately.**

9. Section 6.4 of the SAP states that sample containers will be “stored in a secure area during the time period between collection and shipment”. Will this secure storage be located at the well site or wastewater facility? Under whose control will it be stored? Is the Department expecting the well or facility operator to provide the secure storage? How long will samples be stored at the site collected?

**Response: The SAP has two volumes, the FSP and QAPP. Section 6.4 of the FSP addresses records, not sample security. However, sample containers destined for off-site laboratory analysis will be packaged in thermally insulated rigid-body coolers and will be stored in a secure area during the time period between collection and shipment to the off-site subcontract laboratory. Samples will not be stored at the sites.**

10. The Scope of Work and SAP indicates 22 wastewater treatment facilities will be sampled. However Appendix A of the Facility/Site Survey Checklist indicates 23. Which is correct?

**Response: See response to No. 6 in the first section.**

11. Appendix A of the Facility/Site Survey appears to indicate that, for drill cuttings, only a total of three (3) conventional and four (4) unconventional well sites will be sampled. Is this correct? Can the Department explain how this will be a sufficient number of well sites to allow definitive conclusions on a statewide basis of the relative risk potentially posed by well site drill cuttings, sediments, fracking water and production water?

**Response: See response to No. 1 in the first section.**

12. Can the Department clarify the type of drill cutting samples (composite or discrete) that will be collected and tested? The description in Section 5.2.2 is unclear and suggest grab samples will not be collected from the entire depth of the well but directly from pits or tanks. The Standard protocols by both the Bureau of Waste Management and the Oil & Gas Operators Manual call for composite samples for drill cuttings from a minimum of 3-4 representatives grab samples.

**Response: See response to No. 4 in previous section. Guidance in the O&G Manual is not directly applicable to the study. The study is not characterizing waste for disposal.**

13. Will drill cuttings be sampled prior to or after stabilization on unconventional well sites?

**Response: We want to sample cuttings prior to any further alteration on the surface.**

14. How will DEP collect representative samples from the cutting tanks used for on-site storage/stabilization? The SAP only describes the procedure for open pits.

**Response: To be determined. A composite sample is expected to be taken from four corners and center of tank if accessible and at surface and depth of 12”.**

15. If composite samples are to be made from solids and sediments, what standard procedure will DEP/PESI personnel use on a consistent basis to form the composites?

**Response: An appropriate and consistent protocol will be used in the event of composite sampling; however, composite sampling is not contemplated at this time.**

16. Can the Department clarify or provide more detail on the type of samples to be taken for accumulated solids, treatment sludge, discharge sediments, flowback & produced water and wastewater treatment influent and effluent?

**Response: Yes. Basic sample sets will be obtained per the SAP, and, based on surveys performed during each site visit and the availability of additional materials/containers, additional samples may be taken.**

17. The SAP indicates a “single” sample of influent and effluent will be sampled at wastewater treatment facilities on three separate occasions? In addition, only a single sample of treatment sludge and sediment will also be taken. Did DEP consider taking additional samples or sample events to insure the results are actually representative of the typical effluent, sludge or sediments produces?

**Response: Yes. Additional samples may be taken based on initial survey and sample/analysis results to better represent the specific material. Samples of the sludges and sediment have the benefit of exposure rate surveys to determine if media are different from those previously sampled.**

18. Section 5.2 of the SAP indicates both vertical and horizontal drill cuttings will be collected. Since the vertical and horizontal drill stages will be conducted over 5-7 days for each phase, will DEP staff make multiple site visits to collect samples that are representative of the entire depth of the well?

**Response: PESI technicians will make multiple trips to sites as needed.**

19. Typically flowback will occur over approximate two weeks. Will DEP visit the well site on multiple occasions to sample flowback over the entire initial period?

**Response: We recognize the flowback water character changes over time and will sample periodically or otherwise to determine differences; however, we do not plan to sample over the “entire” initial period.**

20. DEP indicates it will use radiation detectors and take swipe samples from drilling rigs and associated well site equipment. Given the fact a different rig is often used for vertical drilling, removed and replaced with the horizontal drilling rig does DEP intend to take radiation monitoring readings and swipes from both drilling rigs?

**Response: Yes. Whatever equipment is available when sites are visited will be surveyed and recorded. Surveys and smear samples of both sets of rigs are desired.**

21. How will DEP select the natural gas fired facility and private residences for sampling?

**Response: We intend, to the extent possible, to sample natural gas-fired facilities and private residences based on their use of natural gas from the Marcellus Shale formations because we believe that this gas may have the greatest potential for off-gassing radon into the structure.**

22. The SAP is silent on how and what type of sampling/testing will be performed on fresh proppant sands. Has a protocol been established for this?

**Response: No. Samples of fresh proppant sands will be taken as available and analyzed by gamma spectroscopy to determine the NORM component of the fresh sands.**

23. Will well site and other facility ownership information from sampled facilities remain confidential or will it be disclosed in the report?

**Response: Well sites and gas collection and storage site locations will be kept confidential for Homeland Security considerations.**

24. The SAP states that chain of custody seals “may” be placed on the sample containers or thermal containers used for transport. Will this be standard practice in all cases to insure the integrity of the samples?

**Response: Yes. Chain of Custody (CoC) seals will be used to the extent practicable and possible based on the type of sample and the type of sample container. For example,**

some containers cannot be CoC sealed and will be placed in another container such as a cooler and the additional container sealed. Minimally, sample coolers will have a seal placed prior to transport to the lab.

25. Has DEP finalized a schedule to complete the sampling, testing and prepare the final report?

**Response: Yes. A schedule is in place and is being implemented, but it will be flexible with respect to gaining access as needed. The sampling officially started on April 15, 2013, and the project is expected to be mostly completed in 12-14 months.**

26. When does DEP intend to commence the collection of samples?

**Response: Survey and sampling activity commenced on April 15, 2013, and is ongoing.**

27. Will owners of well sites, wastewater facilities or other waste sources sampled during the TENORM Study be given an opportunity to review the testing results from their facility prior to the finalization of the report? If so, when will the test results be provided to the well/facility owners?

**Response: Owners will not have the opportunity to review data generated on their site. However, the data will remain confidential in regards to the site when published.**

28. Will PIOGA/MSO be given the opportunity to review the TENORM Study Report prior to the independent peer review intended by the Department?

**Response: No. The peer review will occur prior to the release of the data to PIOGA/MSO and other members of the general public.**

29. Can DEP provide an explanation for the inconsistency in certain identified testing methods that exist between the SAP and QAPP?

**Response: The SAP is a two-volume document containing the FSP (Volume I) and the QAPP (Volume II). Section 7 of the FSP presents the analytical analyses methods to be used. Likewise, Section 6 of the QAPP provides the analytical methods. Both list the same methods, primarily USEPA 900.0 for gross alpha/beta, USEPA 901.1 modified for gamma spectroscopy and HASL 300 for alpha spectroscopy.**

30. What are the specific detection limits and other lab procedure guidelines that DEP will require labs conducting testing to follow to insure consistency in the testing results for both solid and aqueous samples and particularly as it relates directly to gamma spectroscopy tests?

**Response: Detection limits and specific methodologies are specified in the QAPP. Lab procedures to comply with method and produce the appropriate detection levels are specific to each lab and not specified by the State.**

31. How does DEP intend to determine or calculate background rad levels at sites where samples or monitoring readings will be collected?

**Response: See response to No. 7 in the first section.**

32. Will DEP personnel collecting samples seek to obtain information from site/facility operators regarding site history and rad background information available or company rad test results that could be critical in the analysis of test results from these sites? For example, will they attempt to obtain information on the rad tracers used in the frac sands or background information, the source of wastewater and any rad monitoring/test results performed by the operator?

**Response: Submittal of additional information and data is appreciated. All information is welcome and will be evaluated and considered for the study.**

33. While the overall purpose of the study appears to be to quantify TENORM in various media associated with oil and gas activities, are there more specific purposes such as standards/regulation development, radiation protection action plan standardization, etc.? We want to be sure we fully understand the implications of the way DEP intends to use the data collected.

**Response: The purpose of the study is to identify sources of NORM/TENORM, scope the magnitude of activity concentrations of NORM/TENORM radionuclides and the potential volumes of materials impacted with NORM/TENORM, and their current impact on workers, the public and the environment.**

34. The SAP introduces the ANSI standard but does not detail how it will be incorporated into future decisions. For example, the ANSI standard excludes radon from the dose-based criteria and handles it separately. Does PADEP plan to do this as well? If so, will this separation extend to the landfill solid waste disposal criteria?

**Response: The TENORM ANSI Standard is noted as a reference in this FSP of the Study. There will be many references and literature reviewed as part of this Study. We do include the radon pathway in our assessment of public dose from TENORM disposal. We do not see that changing.**

35. The study indicates that leachate testing will be done on active landfill cells, but numerous hydrogeological parameters (water infiltration, transport times, etc.) for an active cell will likely be different than for the same cell post-closure. How will this be accounted for?

**Response: The landfill leachate sampling will be a grab sample and noted as such. Samples from closed cells may also be taken.**

36. While filtering water samples at the lab is a common protocol, it is not clear how the filtered/unfiltered/filtrate samples will be managed or applied in the study. Because solids reside in the flowback waters as both dissolved and suspended solids, and typically the radionuclide (primarily radium) concentrations in the suspended solids are lower (even though these suspended solids ultimately end up in the process sludge along with the dissolved solids), how does DEP intend to avoid the filtration resulting in overestimating the radionuclide concentrations?

**Response: Filtering and comparing the results of filtered and unfiltered samples is one technique used to shed additional light on this phenomenon. Any information you have regarding the observed phenomenon associated with the dissolved and suspended fractions of solids may be submitted to PA DEP.**

37. With respect to non-radiological analyte assessments, the default assumption appears to be that the labs will be expected to perform radium analysis on solids by gamma spectroscopy, requiring extensive ingrowth periods. Waiting for analytical results may not be practical. Has any thought been given to using non-radiological surrogate analytes such as barium that can be analyzed in-house on a short turn? We understand that DEP has not found a consistent direct correlation between barium and radium, but is there updated information on this? If a reliable correlation between radium and barium (chemical analogs) can be established, facilities could use in-house barium analysis to report radium concentrations on a daily basis and perform QC sampling at an acceptable frequency for off-site lab radiological analysis.

**Response: 21-day ingrowth periods are not unreasonable over a 14-month study.**

38. One action level that has been considered by DEP is based on the USDOT exemption limits for radioactive materials. The exemption level of 270 pCi/g for radium (49 CFR 173.436) has been included in the study documents as the action level for allowing or prohibiting transport, but 49 CFR § 173.401(b)(4) increases this exemption value by a factor of 10 for natural material not intended to be processed for the use of the radionuclides. So, is the actual applicable exempt concentration from radium 2,700 pCi/g?

**Response: No. The actual DOT radioactive material designation for radium is 270 pCi/g. The times 10 exemption is not directly applicable to the 173.436 value of 270 pCi/g listed for Ra-226 but rather applies to the 173.436 value listed for natural uranium (U-nat) of 27 pCi/g from which the Ra-226 encountered on the sites comes from, i.e. Ra-226 separate**

from the natural uranium series does not appear naturally and the 10X exemption is therefore not applicable.

39. As all data collected will be evaluated by one or more academic institutions, will representatives of these institutions be directly involved in the data collection process, to decrease the potential to misinterpret the data?

**Response: PA DEP's contractor, PESI, has over 30 years of survey/sample/analysis and risk assessment of radioactive material and 15 years of experience specific to NORM and TENORM over a variety of industrial settings likely exceeding the collective experience of potential academic institutions involved in the study. The PESI staff includes trained and experienced certified health physicists, radiological engineers and health physics technicians with multiple post-graduate degrees and published papers on radioactive material risk assessment. There is little probability of misinterpretation of data. However, the data and conclusions will be peer reviewed including representatives from academia.**

40. What criteria or action level determines when radon samples will be collected? Will any validation work such as varying sample time be employed for different weather and time of year conditions? In taking radon readings, how will DEP resolve potential differences since different methods for collecting and determining radon concentrations will be used?

**Response: Radon samples will be taken when we determine that there is a potential chance for worker exposure at the various facilities encompassed within the TENORM Study. We will use numerous measurement techniques appropriate for the particular circumstances. Grab sampling will be employed for radon in natural gas samples and other areas where a rapid assessment is required. Grab sample results will help us determine if subsequent sampling is required. Where this is the case, longer term, integrated sampling will be deployed, such as electret ion chambers or alpha track detectors. Long-term testing, greater than 90 days, will help to incorporate weather and time-of-year influences. In private residences using Marcellus shale gas for cooking or heating we can also use the above-mentioned methods as well as continuous radon monitors to incorporate the time variation of radon concentration with gas usage.**

**All devices are properly calibrated and should be comparable one to another with the exception of differences that we could see when sampling was not performed simultaneously. At least for homes and buildings, measurement conditions and calibration frequency can be found in Indoor Radon and Radon Decay Product Measurement Device Protocols, EPA 402-R-92-004, July 1992.**

**Weather and time of year are well known causes of variability within homes or buildings. However, some of the off-gassing systems that we may sample are not expected to be affected by these factors.**

41. Will DEP calibrate their instruments to Ra-226? What calibration sources will they use for the Ludlum instruments listed in the SAP?

**Response: The gamma detection instruments in use are calibrated to Cs-137. PADEP and subcontractor recognize the gamma energy dependence of NaI detectors used to measure gamma exposure rate, normally calibrated to high energy gamma (Cs-137 at 662 keV). The overestimation of the exposure rate due to Ra-226 only (no progeny) is recognized. However, the actual exposure rate measured will be to Ra-226 + progeny and Ra-228 + progeny. The total gamma flux from all gamma emitters in the radium + progeny series approaches that of the high energy calibration. A much larger potential source of error in these measurements is the degree to which Ra-226 is in equilibrium with the high gamma energy/high gamma yield progeny. A review of current thermoluminescent dosimetry (not energy dependent) and gamma exposure rate measurements with NaI detectors on drilling sites reveals nominal difference, indicating the actual gamma flux from all radium and progeny present is close to the high energy calibration of the exposure rate meters.**

42. Since wipe samples can be problematic, how does DEP intend to determine whether materials are adhered tightly or loosely to the surfaces a factor that can affect the interpretation of results?

**Response: Smear (wipe) samples of removable alpha and beta surface contamination using a 47 mm filter paper to wipe approximately 100 cm<sup>2</sup> of surface area using moderate force is the industry standard for determining the removable fraction of total alpha and beta surface contamination. The difference between the measurement of total alpha and beta surface contamination, measured by placing an appropriate alpha/beta detector directly on top of the surface, and the smear sample count result of removable alpha and beta contamination is the fixed fraction of alpha and beta surface contamination. Moisture on the smear sample can interfere with the counting for alpha and beta contamination and steps will be taken to dry filters prior to counting. In addition, the decay of radon gas/progeny on the filter will be accounted for. We believe that we have adequately addressed this issue; however, should you have additional information relevant to this issue, we would be glad to review it.**