

NRRPT® NEWS

National Registry of Radiation Protection Technologists

Fall 2010 Edition

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Chairman's Message



Dave Biela

Welcome to fall, my favorite season. Living in the North East I love watching the leaves changing colors and I look forward to the upcoming hunting season; sorry for all you non-hunters. Since the next newsletter may be out after the Holidays, I want to wish you an early Happy Holidays.

Congratulations to all the individuals that passed the August Exam. I hope that

being a registered technician will help your career and that it will motivate you to advance your education. Since the material and study habits used in preparing for the exam are still fresh, I ask that you take the time to assist others who may be preparing for the next exam. They will remember the help you provide.

The industry has a very interesting year coming up. Based on the current information from the federal government, the ARRA (Stimulus) money may not be extended. So it could stop part way through next year. What this means is that the Department of Energy (DOE) may have to lay off many of the radiological staff hired over the past two years using the stimulus money. Over this period the market has favored the technicians and Engineers, but that may change. Put yourself in the best available position for the coming years. It is important to work on, not only your education, but also your reputation.

In an effort to make members of the registry more marketable, the Board and Panel has been working over the years to help with individuals education by providing scholarship money, working on

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the development of training materials and maintaining the ACE credit recommendation. Our work with numerous organizations in the U.S. and Canada, such; as the Health Physics Society, ANSI N.13 Committee and the Center For Disease Control plus the quality of work performed in the field by our members has gained the NRRPT a very positive reputation. Keep up the good work.

The 75th meeting of the Board and Panel will be held February 5-8, 2011 in Charleston, South Carolina. The meetings are open to the registry and I encourage you to attend. Contact DeeDee McNeill at (401)-637-4811 for more information.

Sincerely,
Dave Biela
NRRPT, Chairman of the Board

Welcome New Members

Congratulations to the following individuals who successfully passed the NRRPT February 20, 2010 examination. These individuals were mistakenly omitted from the Summer 2010 edition -- sorry for the error!:

Christopher V. Antimary	Gregory T. Bright
James C. Baker	Julie H. Brown
Dawn D. Bennett	Tammy E. Cagle
Daniel C. Blomquist	Richard Cantwell

Congratulations to the following individuals who successfully passed the NRRPT August 7, 2010 examination:

John Aloï, Jr.	Kori R. Escujuri	Thatcher K. Neitzer
Matthew F. Aubert	Killian M. Fischer	Diane M. Rasch
Bachir A. Badaoui	John M. Flores	James H. Reese
John E. Bako	Tommy R. Fontaine	Benjamin J. Rhoades
Thomas J. Bladow	Jeffry C. Hawkins	Stephen P. Richardson
Gary Briggs	James S. Horne	Jeffrey W. Roberts
Emily A. Brown	Charles M. Johnson	Ky E. Rowberry
Charles J. Burroughs, III	David M. Kershman	Glenn D. Sawtelle
William J. Duncan	Rhonda D. Long	Adam J. Stavola
Todd C. Echeverria	Thomas A. Machacek	Stanley Walker

New Members: If you do not have access to the "Members Only" portion of the website, please contact the Executive Secretary (nrrpt@nrrpt.org). Your email address must be on file in order for you to gain access.



Overview of the Radiation Survey and Site Investigation (RSSI) Process

by Tom Hansen

Abstract

Tom Hansen is the Corporate Radiation Safety Officer of Ameriphysics, LLC, and an expert in the field of decommissioning. He is a sought after speaker on the subject and has provided training on the MARSSIM survey approach to hundreds of US and international students including health physicists, site managers, and regulators.

The Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), NUREG-1575, provides a standardized, consensus approach for demonstrating compliance against a dose- or risk-based regulatory release criterion. Central to this approach is the RSSI process, which is comprised of investigations and surveys that are conducted at potentially contaminated sites. Each step of the process has specific goals and objectives to support a final decision regarding whether or not a site or facility complies with the appropriate regulations.

Once a site is identified, there are six principal steps of the RSSI Process. Excerpted directly from MARSSIM, these steps are summarized as follows.

Historical Site Assessment

The primary purpose of the Historical Site Assessment (HSA) is to collect existing information concerning the site and its surroundings.

The primary objectives of the HSA are to:

- identify potential sources of contamination
- determine whether or not sites pose a threat to human health and the environment
- differentiate impacted from non-impacted areas
- provide input to scoping and characterization survey designs
- provide an assessment of the likelihood of contaminant migration
- identify additional potential radiation sites related to the site being investigated

The HSA typically consists of three phases: identification of a candidate site, preliminary investigation of the facility or site, and site visits or inspections. The HSA is followed by an evaluation of the site based on information collected during the HSA.

Scoping Survey

If the data collected during the HSA indicate an area is impacted, a scoping survey could be performed. Scoping surveys provide site-specific information based on limited measurements.

The primary objectives of a scoping survey are to:

- perform a preliminary hazard assessment
- support classification of all or part of the site as a Class 3 area
- evaluate whether the survey plan can be optimized for use in the characterization or final status surveys
- provide input to the characterization survey design if necessary

Scoping surveys are conducted after the HSA is completed and consist of judgment measurements based on the HSA data. If the results of the HSA indicate that an area is Class 3 and no contamination is found, the area may be classified as Class 3 and a Class 3 final status survey is performed. If the scoping survey locates contamination, the area may be considered as Class 1 (or Class 2) for the final status survey and a characterization survey is typically performed.

Characterization Survey

If an area could be classified as Class 1 or Class 2 for the final status survey, based on the HSA and scoping survey results, a characterization survey is warranted. The characterization survey is planned based on the HSA and scoping survey results. This type of survey is a detailed radiological environmental characterization of the area.

The primary objectives of a characterization survey are to:

- determine the nature and extent of the contamination
- collect data to support evaluation of remedial alternatives and technologies
- evaluate whether the survey plan can be optimized for use in the final status survey
- support Remedial Investigation/Feasibility Study requirements
- provide input to the final status survey design

The characterization survey is the most comprehensive of all the survey types and generates the most data. This includes preparing a reference grid, systematic as well as judgment measurements, and surveys of different media (e.g., surface soils, interior and exterior surfaces of buildings). The decision as to which media will be surveyed is a site-specific decision addressed throughout the Radiation Survey and Site Investigation Process.

Remedial Action Support Survey

If an area is adequately characterized and is contaminated above the derived concentration guideline levels (DCGLs), a decontamination plan should be prepared. A remedial action support survey is performed while remediation is being conducted, and guides the cleanup in a real-time mode.

Remedial action support surveys are conducted to:

- support remediation activities
- determine when a site or survey unit is ready for the final status survey
- provide updated estimates of site-specific parameters used for planning the final status survey

The determination that a survey unit is ready for a final status survey following remediation is an important step in the RSSI Process. In addition, remedial activities result in changes to the distribution of contamination within the survey

unit. For most survey units, the site-specific parameters used during final status survey planning (e.g., variability in the radionuclide concentration, probability of small areas of elevated activity) will need to be reestablished following remediation. Obtaining updated values for these critical parameters should be considered when planning a remedial action support survey.

Final Status Survey

The final status survey is used to demonstrate compliance with regulations. This type of survey is the major focus of MARSSIM.

The primary objectives of the final status survey are to:

- select/verify survey unit classification
- demonstrate that the potential dose or risk from residual contamination is below the release criterion for each survey unit
- demonstrate that the potential dose or risk from small areas of elevated activity is below the release criterion for each survey unit
- The final status survey provides data to demonstrate that all radiological parameters satisfy the established guideline values and conditions.

Although the final status survey is discussed as if it were an activity performed at a single stage of the site investigation process, this does not have to be the case. Data from other surveys conducted during the Radiation Survey and Site Investigation Process—such as scoping, characterization, and remedial action support surveys—can provide valuable information for planning a final status survey provided they are of sufficient quality.

Professional judgment and biased sampling are important for locating contamination and characterizing the extent of contamination at a site. However, the MARSSIM focus is on planning the final status survey which utilizes a more systematic approach to sampling. Systematic sampling is based on rules that endeavor to achieve the representativeness in sampling consistent with the application of statistical tests.

Regulatory Agency Confirmation and Verification

The regulatory agency responsible for the site often confirms whether the site is acceptable for release. This confirmation may be accomplished by the agency or an impartial party. Although some actual measurements may be performed, much of the work required for confirmation and verification will involve evaluation and review of documentation and data from survey activities.

The evaluation may include site visits to observe survey and measurement procedures or split sample analyses by the regulatory agency's laboratory. Therefore, accounting for confirmation and verification activities during the planning stages is important to each type of survey. In some cases, post-remedial sampling and analysis may be performed by an impartial party. The review of survey results should include verifying that the data quality objectives are met, reviewing the analytical data used to demonstrate compliance, and verifying that the statistical test results support the decision to release the site. Confirmation and verification are generally ongoing processes throughout the RSSI Process.

A General Review of Health Physics Calculations

By Augustinus Ong

The purpose of this review, in the format of questions and answers, is to remind ourselves of some of the basic aspects of health physics calculations.

- (1) A 35 gram of ^{59}Co is placed in a reactor's core and it is exposed to a neutron beam, whose flux is 10^5 neutrons/cm² sec. The cross section for ^{59}Co is 36 barns. The half life is 5.3 years. What is the activity of the ^{59}Co sample after 2 years of constant exposure? What is the maximum activity of this sample? When does the sample activity reach 75% of its maximum activity?

Answer:

- a. Calculate the activity, in bequerels, of the ^{59}Co sample after 2 years of constant exposure:

N = number of atoms

N = (sample weight) x $(6.02 \times 10^{23}$ atoms/gram-atomic mass) / (sample atomic weight)

N = 35 g $(6.02 \times 10^{23}$ atoms/gram-atomic mass) / (59 g/atom-atomic mass)

N = 5.93×10^{22} atoms

The activity of a sample bombarded for a time t , assuming no radioactivity when $t = 0$, is calculated as

$$A = \phi N \sigma (1 - e^{-0.693/T_{1/2}t})$$

where

A = Activity

ϕ = average neutron flux

σ = absorption cross section

t = duration of exposure

$T_{1/2}$ = half life

$$A = (10^5 \text{ neutrons/cm}^2 \text{ sec}) \times (5.93 \times 10^{22} \text{ atoms}) \times (36 \times 10^{-24} \text{ cm}^2) \times [1 - e^{-0.693/5.3 \text{ years} \times 2 \text{ years}}]$$

$$A = 4.89 \times 10^4 \text{ Bq}$$

- b. Calculate the maximum activity of this sample:

When the bombardment time t is greater than $T_{1/2}$, the above equation can be reduced to

$$A_{\text{max}} = \phi N \sigma$$

$$A_{\text{max}} = (10^5 \text{ neutrons/cm}^2 \text{ sec}) \times (5.93 \times 10^{22} \text{ atoms}) \times (36 \times 10^{-24} \text{ cm}^2)$$

$$A_{\text{max}} = 2.13 \times 10^5 \text{ Bq}$$

- c. Calculate time t the sample activity reaches 75% of its maximum activity:

$$A_{\max} (\% \text{ of maximum activity}) = A_{\max} [1 - e^{-(0.693/T_{1/2}) t}]$$

$$(2.13 \times 10^5 \text{ Bq}) \times (0.75) = (2.13 \times 10^5 \text{ Bq}) \times [1 - e^{-(0.693/5.3 \text{ years}) t}]$$

$$1.59 \times 10^5 \text{ Bq} = (2.13 \times 10^5 \text{ Bq}) - (2.13 \times 10^5 \text{ Bq}) \times e^{-(0.693/5.3 \text{ years}) t}$$

$$(2.13 \times 10^5 \text{ Bq}) \times e^{-(0.693/5.3 \text{ years}) t} = (2.13 \times 10^5 \text{ Bq}) - 1.59 \times 10^5 \text{ Bq}$$

$$e^{-(0.693/5.3 \text{ years}) t} = 5.40 \times 10^4 \text{ Bq} / 2.13 \times 10^5 \text{ Bq}$$

$$e^{-(0.693/5.3 \text{ years}) t} = 0.25$$

$$0.131 t = 1.39$$

$$t = 10.9 \text{ years to reach 75% of the maximum activity}$$

- (2) A collimated beam of 10,000 mono-energetic photons, I_0 , is decreased to half of the number of photons, I , after penetrating through a 0.04 m thick copper plate. What is the total linear attenuation coefficient of the copper plate for this beam?

What are the atomic (μ_a), electronic (μ_e), and total mass (μ_m) attenuation coefficients of the copper plate (density, ρ , is $9 \times 10^3 \text{ kg/m}^3$; atomic weight, M , is 63.6; and Z for copper is 29)?

What is the thickness x_e in electrons per m^2 for the 0.04 m copper plate?

Answer:

- a. Calculate the total linear attenuation coefficient, μ , of the copper plate:

$$I = I_0 e^{-\mu x}$$

$$I / I_0 = e^{-\mu x}$$

$$\ln(I_0 / I) = \mu x$$

$$\mu = \ln(I_0 / I)$$

$$\mu = \ln(10,000 \text{ photons} / 5,000 \text{ photons}) / 0.04 \text{ m}$$

$$\mu = 17.3 \text{ m}^{-1}$$

- b. Calculate the atomic (μ_a), electronic (μ_e), and total mass (μ_m) attenuation coefficients of the copper plate:

$$\mu_a = \mu M / \rho N$$

$$= (17.3 \text{ m}^{-1}) \times (63.6 \text{ g/gram-atomic mass}) \times (10^{-3} \text{ kg/g}) /$$

$$(9 \times 10^3 \text{ kg/m}^3) \times (6.02 \times 10^{23} \text{ atoms/gram-atomic mass})$$

$$= 2.03 \times 10^{28} \text{ m}^2/\text{atom}$$

$$\begin{aligned}\mu_e &= \mu_a / Z \\ &= (2.03 \times 10^{-28} \text{ m}^2/\text{atom}) / (29 \text{ electrons/atom}) \\ &= 7.0 \times 10^{-26} \text{ m}^2/\text{electron}\end{aligned}$$

$$\begin{aligned}\mu_m &= \mu / r \\ &= 17.3 \text{ m}^{-1} / 9 \times 10^3 \text{ kg/m}^3 \\ &= 0.0019 \text{ m}^2 / \text{kg}\end{aligned}$$

c. Calculate the thickness x_e in electrons per m^2 for the 0.04 m copper plate:

$$\begin{aligned}x_e &= x_a Z \\ &= (x N_a \rho Z) / M \\ &= [(0.04\text{m}) (6.02 \times 10^{23} \text{ atoms/gram-atomic mass}) (9 \times 10^3 \text{ kg/m}^3) \\ &\quad (29 \text{ electrons/atom})] / [(63.3\text{g/gram-atomic mass}) (10^{-3}\text{kg/g})] \\ &= 9.88 \times 10^{28} \text{ electrons/ m}^3\end{aligned}$$

Erratum:

In the last issue in "A General Review of Health Physics Calculations" by Augustinus Ong, the correct answer for Question No. 3 is $r_1 = 2 \text{ m}$.

Testing, testing...

By Todd Davidson

Welcome again to the feature "Testing, testing." As stated previously, this feature will present test questions as well as general test-taking strategies and advice. Please share the questions and solutions with other workers in the field who have not passed the NRRPT test.

Problem

How many half-value layers of shielding are required to reduce a radiation field of 300 R/h at 30 cm from an object such that a member of the public may work for 40 hours next to the object?



Sample and Analysis Protocol for Field Measurements of ^{14}C in Gaseous Effluents from Nuclear Power Plants

By James R. Holtzclaw, Ph.D., C.I.H.

For many years ^{14}C was not included in gaseous and liquid effluent measurements used for effluent dose calculations. However, recent revision of USNRC Regulatory Guide 1.21 has focused attention on ^{14}C and its impact on nuclear plants' effluent releases. Based on the revisions to the Regulatory Guide and NRC guidance to licensees, ^{14}C activity will need to be reported and evaluated for dose contribution based on the chemical form of the ^{14}C in the release. While ^{14}C releases may be estimated, the measurement of actual ^{14}C emissions provides a more reliable and accurate means of reporting facility emissions. To this end, The GEL Group, Inc. has developed and tested a sample collection and analysis methodology for measurement of ^{14}C in gaseous effluents.

A successful ^{14}C sampling and analysis protocol must meet several requirements:

- be able to capture and differentiate between organic ^{14}C , inorganic ^{14}C , and particulate ^{14}C
- be able to capture and accurately analyze ^{14}C over a wide range of activity
- be sufficiently adaptable so that samples can be collected from gas decay tanks, containment atmosphere, plant vent effluent, and other areas of interest
- be able to handle atmospheres that are potentially flammable and/or have low oxygen content
- have sufficient analytical sensitivity so that samples can be collected in practical sample times
- be free from interference by other radionuclides,
- employ hardware that can be reliably and conveniently transported to facilities

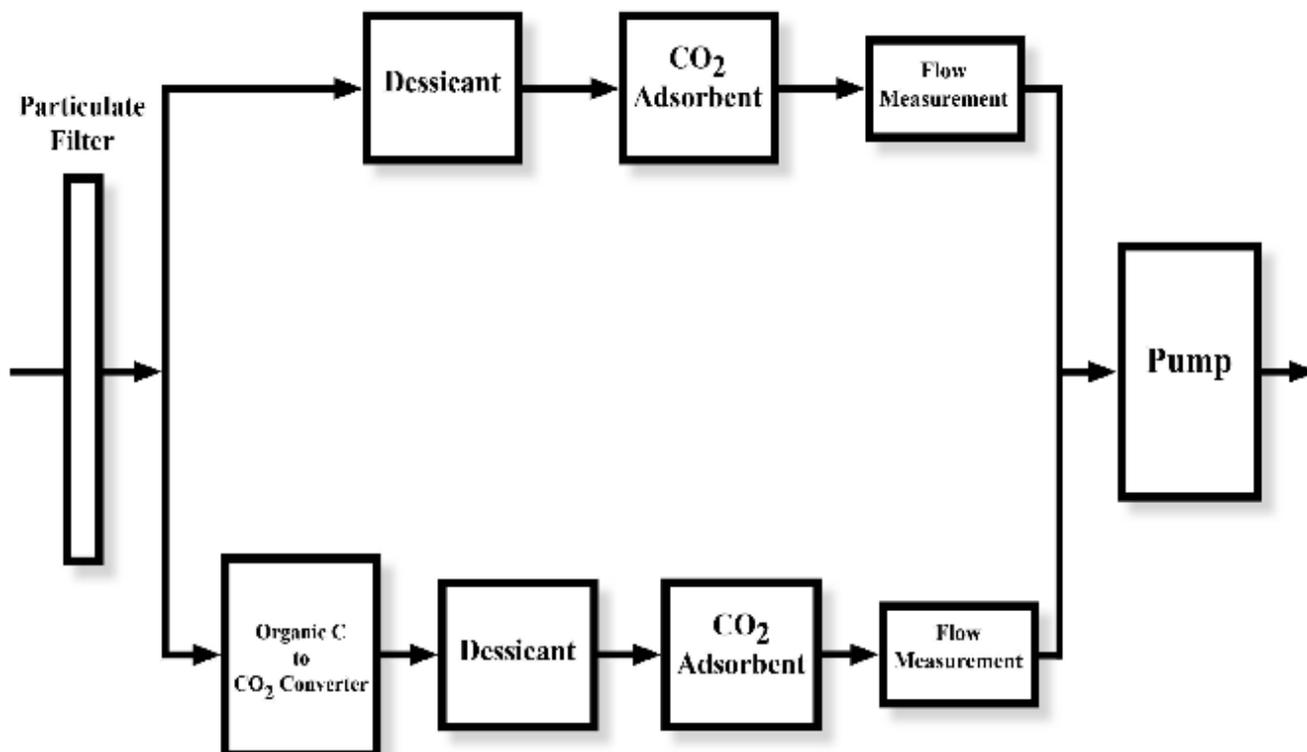
SAMPLE COLLECTION

A sampling system that can meet the above requirements is diagramed in Figure 1. The system consists of a particulate filter followed by two separate parallel sampling pathways. The top pathway contains a desiccant for adsorbing water (including any tritiated water), an adsorbent for capturing CO_2 and $^{14}\text{CO}_2$, a flow meter, and an air sample pump. This pathway will collect $^{14}\text{CO}_2$ (inorganic ^{14}C) but not organic ^{14}C . The bottom pathway is identical to the top pathway except that it has an organic carbon-to- CO_2 converter. The converter is used to oxidize organic ^{14}C to $^{14}\text{CO}_2$, which can then be captured by the CO_2 adsorbent. Thus the bottom pathway collects both organic ^{14}C and $^{14}\text{CO}_2$. The difference between the amounts of ^{14}C adsorbed in the two pathways is the amount of organic ^{14}C present in the effluent gas stream.

Proper operation of the ^{14}C sampling system requires a high efficiency for the organic carbon-to- CO_2 conversion as well as quantitative collection of CO_2 on the CO_2 adsorbent. The performance of the converter was determined by measuring the conversion efficiency of methane to CO_2 . The conversion efficiency was found to be >95% over a sample flow rate of 300 milliliters (ml) per minute up to 3 liters per minute (lpm). No reduction in conversion efficiency was observed as a function of methane concentration or flowrate.

The collection efficiency for the CO_2 adsorber was determined by measuring the adsorption of CO_2 in ambient air. The collection efficiency was found to be >95% for a sample flow rate range of 300 ml per minute up to 3 lpm. Additionally, the >95% collection efficiency was maintained over a sample period of 7 hours.

The amount of adsorber used in the tube is greatly oversized to ensure that the CO_2 in the sample gas stream is quantitatively adsorbed. On a theoretical basis, sufficient adsorber is present to sample for > 200 hours.

Figure 1. ^{14}C Sampling Train

SAMPLE ANALYSIS

GEL Laboratories has extensive experience in analyzing ^{14}C in a variety of matrices. The method selected for analysis has proven rugged and adaptable when tested on difficult materials. The method employs the wet oxidation of carbon compounds to volatile CO_2 which is sparged through a dilute acid solution for trapping tritiated water, which may be present in the sample. After sparging through dilute acid, the CO_2 is trapped in a sorbing solution which is added to a liquid scintillation cocktail and finally counted in a liquid scintillation counter. For the samples collected during this study, the ^{14}C is already in the CO_2 form adsorbed onto the Ascarite column. The Ascarite is added to the digestion flask (see Figure 2) and the CO_2 distilled by acidifying the Ascarite.

MARLAP guidance was followed for the validation of the method according to performance based criteria. ^{14}C standards with a range of activity traceable to NIST were used to validate the performance of the sample analysis methodology, sample collection, and analysis procedure. Results are summarized in Table 1. Additional performance parameters are included as Table 2.

2011 NRRPT Sustaining Dues

Don't forget to pay your 2011 Sustaining Dues!

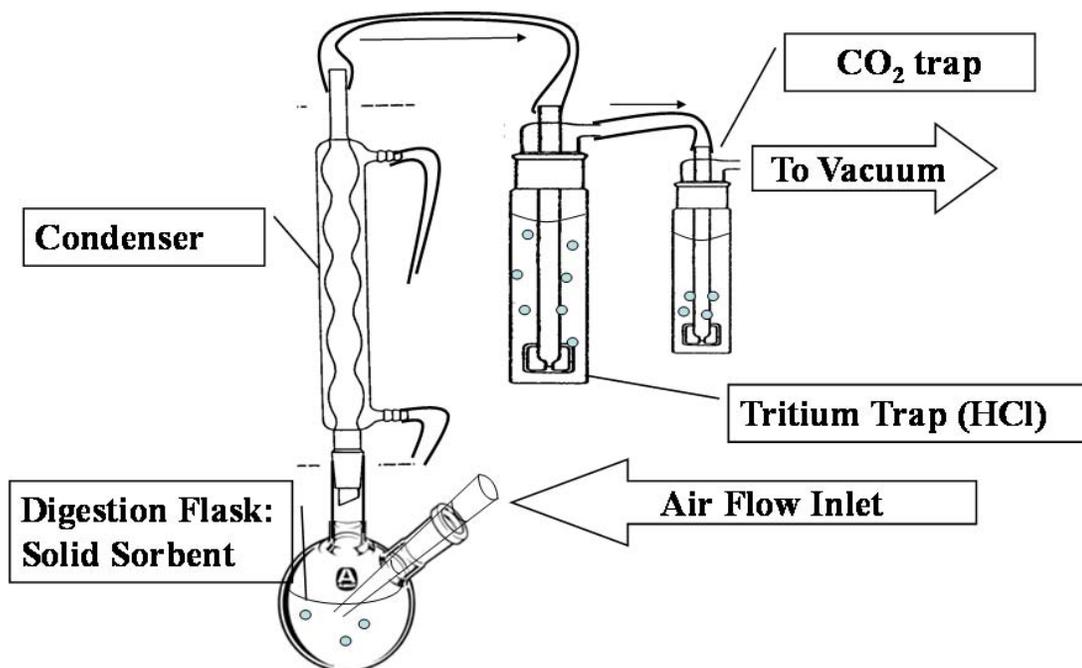


Figure 2. Carbon 14 Laboratory Distillation Apparatus

Table 1 - ¹⁴C VALIDATION RESULTS	
	Average Spike Recovery
Laboratory Analysis: 10 samples at 72 pCi	95 ± 3%
Full Sample Collection and Analysis Procedure 12 samples over the range of 72 – 10468 pCi	93 ± 3%

Table 2 - Equipment Performance Parameters	
Organic Carbon to CO ₂ Conversion Efficiency	>95%
CO ₂ Capture Efficiency	>95%
¹⁴ C Measurement Range (to Date)	7e ⁻¹¹ to 4 ⁻³ uCi/ml
Sample Rate (typical, other sample rates can be used)	0.1 - 3 liters per minute
Power Requirements	120V 20 amp
Sample Collection Interface	uses an interface adaptor that can appropriately extract sample gas from plant systems under a wide range of plant gas flow and pressure conditions

Continued on page 19

Professional Pool

By Todd Davidson

As I complete my current project and transition into my next job, I have been struck by the importance of the administration of a project or a program, particularly for some of the more time consuming tasks. From my experience facing the challenges on this project I have learned and grown. Hopefully, those challenges can be avoided/reduced in the future by designing a proactive program. I hope to hear from you with your own bit of wisdom, whether it be from horror stories or unparalleled successes.

Problem

The administration of a radiological protection program can be difficult, but there is a chaos at the beginning – and most particularly at the end – of a project. What is the most challenging problem that you or your colleagues have faced at the end of a project? Be as specific or as broad as you would like when listing the problem. If possible, include the solutions, or even failed attempts, that were used to overcome the problem.

Please contact me with your input directly so that I may sort through and include details for presenting in the next edition of the NRRPT Newsletter.

You may contact me at t-davidson@sbcglobal.net. Please note "Professional Pool" in the subject line.

Response to "Interview With A Chairman" Summer Issue

Hi friends at **NRRPT**,

I just read the subject article with pleasure and memories and thought that I would just let you know about it. The article said that there were 83 of us that sat for the first exam and 62 of us that passed that first exam. I just want to add a little more to the background about the start of the Registry. At the time (1974-1975) there was a growing consensus among employers, technicians and alert entrepreneurs about the desirability and need for a standard acceptable registry or similar body that could test and certify a technician's competency. This would "weed out" some of the riff-raff that was getting into the industry through contract companies that would hire anybody they could find (from gas station workers to seasonal migrant workers) and calling them qualified technicians.

I had already been in the industry several years when this interest in a registry began. I was watching the developments closely. For about 2 to 4 years there were four or five entities that proposed they were starting such a registry. But in the shuffle for first place the **NRRPT** emerged as the leader and, to my knowledge, the rest of them went by the wayside and did not survive.

Today, I am proud to be one of the original 62 registered technologists in the Registry. I have written a few articles for the newsletter in the past called "Musings Of An Old RPT". I commend Mr. Todd Davidson for a good, well-written and interesting article. It did stir some memories and names that I recall.

Just an old RPT,
Maynard Wright



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San Onofre Nuclear Generating Station is proud to have over 30 registered NRRPT members in our Health Physics, Training, Chemistry, Engineering, Operations, Oversight, and Maintenance organizations. We are especially proud that Kelli Gallion of our HP Planning group was a member of the Panel of Examiners, Board of Directors, and was formerly the NRRPT Chairman.

San Onofre is a three unit site with two operating 1170 MWe Combustion Engineering reactors and one early Westinghouse unit in decommissioning. The station is located in Southern California on the Pacific Ocean and midway between San Diego and Los Angeles.

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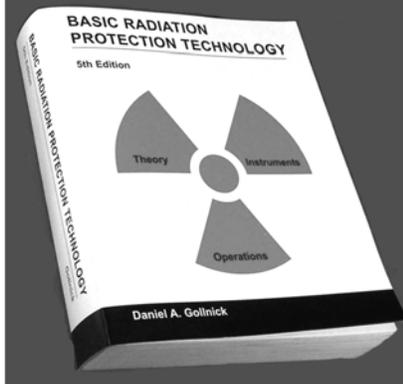
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Continued from page 11

SUMMARY

GEL has developed a procedure for sampling and analysis of ^{14}C in gaseous effluents. A prototype sampling device was constructed and its performance validated in accordance with MARLAP guidance. The sample collection and analysis procedure allows for differentiation and quantitation of organic, inorganic, and particulate forms of ^{14}C . This protocol can also accommodate a wide range of ^{14}C activities. Sample collection times are dependent upon the ^{14}C concentration in the gas system sampled and sample flowrate through the sampling device. Practical sample times range from 0.5 hours to more than 10 hours. Current results indicate that a sample time of 2 hours or less is sufficient in most circumstances (for example: plant vents, waste gas decay tanks, containment atmospheres, etc).

The sample collection device has been deployed to several nuclear power plants where gaseous effluent samples were collected and subsequently transported to our laboratory for analysis. Measured ^{14}C activities and ratios of organic to inorganic ^{14}C are consistent with values previously reported in the literature.

Watch for these Articles in our Next NRRPT News:

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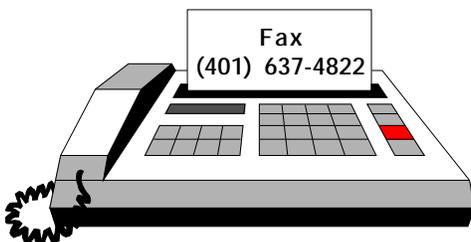
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