RESPONSES TO COMMENTS ON THE FINAL SCOPING SURVEY REPORT FOR FORMER SMELTER AREA, ALAMEDA POINT, ALAMEDA, CALIFORNIA DOCUMENT DATED: May 4, 2012

This document presents the Department of the Navy's responses to comments (RTC) provided by the California Department of Public Health (CDPH) on the "Final Scoping Survey Former Smelter Area, Alameda Point, Alameda, California," dated May 4, 2012. CDPH comments are dated June 15, 2012.

The following are responses to comments provided by Mr. Robert Wilson, CDPH.			
Comment Number	**Reference**	**Comment**	**Response**
General Comment			
1	GC #1	EMB does not use the investigation level criteria stated in Section 3.1 ("Investigation Levels") which is based, in part, on Reg. Guide 1.86, Table 1. The criteria for unrestricted release in the State of California is California Code of Regulations (CCR), Title 17, Section 30256(k) [17 CCR 30256(k)] which is based, in part, on the Department (CDPH) determining if a "reasonable effort has been made to eliminate residual radioactive contamination, if present…". Since residual radioactive contamination is an integral part of the stated surface activity limits derived, in part, from Reg.Guide 1.86, Table 1, EMB will require a detailed base-wide structural background	The investigation-level criteria stated in Section 3.1 are based on the criteria stated in Section 6 of the approved work plan for Basewide Radiological Surveys, Former Naval Air Station Alameda, Alameda, California (ChaduxTt 2010). The results of the Former Smelter Area (FSA) scoping surveys show that only background levels of radium 226 (Ra-226) that are indicative of non-impacted soil are present in the exposed soil. Attachment A to these comment responses presents further discussion on the application of reference area data obtained with the surface contamination monitor (SCM) and hand-held instruments.

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		reference areas survey results report which would include, as a minimum, descriptive statistical information relative to each construction material to be surveyed, including their ranges of background levels and for each radionuclide expected to be surveyed, sampled and analyzed for. In addition, EMB will require ranges of background for gross alpha, gross beta and gamma dose rates for each material type. Descriptive statistical information will include (1) values listed for, as a minimum, total number of survey results for each radionuclide and construction material, standard deviation, mean, median and skewness as expressed in table form, (2) histograms and cumulative frequency distribution (CFD) plots.	Attachment A addresses the application of the reference area data obtained by the SCM and hand-held survey instrumentation to any survey areas and how the applicability of the reference area data can be evaluated. Section 4.3 of the approved work plan (ChaduxTt 2010) and the reference area report which is Appendix F of the FSA scoping survey also states that for any area in which the reference area is not applicable, a different area may be identified and addressed in the area or buildings final report. Please note, this is the situation that was encountered at the FSA as is discussed in the FSA scoping survey, Section 8.1.1. Attachment A also provides the means by which the SCM output is directly suitable to determining whether the results of an area survey are "indistinguishable from background."
		Furthermore, please provide maps indicating the locations of the background reference areas and the locations of the survey sampling points within each background reference area, and the survey results from each survey instrument used,	Reference area surveys were performed in Buildings 112 and 398. The reference areas used are marked and available for CDPH use during the confirmatory surveys. The SCM and hand- held locations are marked on the various surfaces that were surveyed. However, no

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		including raw data.	drawings of the reference area surveys in Buildings 112 and 398 were prepared. Appendix F of the scoping survey presents the survey instruments and raw data. The areas were first surveyed with the SCM to verify that each area contained no outliers, but only normally distributed radioactivity representative of uncontaminated surfaces. Thousands of SCM measurements were used to verify the adequacy of the area as a reference area. Hand-held instrument measurements were then taken at random locations within the areas identified as containing normally distributed background data by the SCM. Survey results from each instrument used are provided in Appendix F of the FSA Scoping Survey Report.
		The Executive Summary of the SSR will need to express the intent to compare the relationships of the SSR results with their specific background reference areas used for the scoping survey, and the conclusion of the SSR will need to express the outcomes of the comparisons.	The Navy believes the second paragraph of the executive summary provides the intent of the survey: to identify whether activity exists in the FSA and to evaluate whether further action is needed. The executive summary states that only background levels of radioactivity exist in the FSA. The conclusion is provided in the body of the report as well as the executive summary. The report provides the comparison of survey results with

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			reference area data.
2	GC #2	The SSR has not included records of daily utilization logs and performance checks of hand-held instruments prior to and after static measurements were performed. These records were requested by EMB in the draft review comments. If the records are not available, then the SSR should inform the reader of where the records are available for inspection.	Copies of the instrument source check sheets and control charts for the SCM are included with these responses as Attachment B. All source check sheets used during the Alameda Point project are available through the Navy.
3	GC #3	The background reference surveys are to provide radiological information specific to all radionuclide types and their activities, all structural building materials and locations referenced in the Alameda NAS HRSA as non-impacted or no potential to be impacted by radioactive contamination due to historical use and evidence. What construction materials are not evident to, or in, a specific Alameda structure is not relevant to a general base-wide background reference area survey. For example, the use of asphalt throughout Alameda NAS should be as prevalent and widespread as the use of concrete. Variability of measurements within the same general category of materials should be high due to different construction methods and material production over decades of time.	See response to comment number 1.

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		The variability, or the lack of variability, of Alameda NAS structure materials, should be investigated, evaluated and reported with more than one or a few survey measurements. Therefore, EMB does not concur with the Navy RTC that one detector taking one measurement of asphalt will define the *base-wide* range and variability of one type of radioactivity (alpha) of all the asphalt in Alameda, as shown on page 5 in Appendix B of Appendix F.	
Specific Comments			
1	A	EMB Comment to Navy RTC #A2, RTC page 1 for "Appendix A, Section 2.3, "Reference Area":	Response is provided below in the responses to comments A1, A2, A2a, A2b, and A2c.
1	A 1	Which specific "analytical method" was used to measure radium 226 (Ra-226) concentrations?	The Environmental Protection Agency (EPA) method used to measure the Ra-226 concentrations in soil was EPA Method 901.1 as identified in the approved work plan (ChaduxTt 2010).
1	A 2	The section states that the "analytical procedure may (emphasis added) have introduced a small non-conservative factor". And, further states "For the purposes of this scoping survey, the non-conservative factor will be applied."	Reference area values for Ra-226 were obtained from documents previously used to establish background Ra-226 concentrations at Alameda Point (Tt ECI 2010). The analytical method used to measure the Ra-226 concentrations in soil

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			involves direct measurement by gamma spectroscopy of the low energy, low abundant gammas emitted by Ra-226. This method provides rapid assessment of the activity, but typically overestimates the Ra-226 concentration in soil.
1	A 2a	Other than "small", what is the specific value and unit of measure of the "non-conservative factor"?	The background value is "non-conservative" in that it overestimates the concentration of Ra-226. However, of the 51 soil samples obtained from the FSA and analyzed by the approved method, none exceed the criteria without even applying a background subtraction value. Four sampling points exceed the reference area value, with the maximum value from any sample exceeding the reference area by 0.2 picocuries per gram (pCi/g); therefore, all sample results were below the investigation level of 1 pCi/g without background subtraction.
1	A 2b	Why is the Navy applying a "factor" in which the Navy is unsure of its existence?	The Navy has not applied a factor, but recognizes that the reference area data have a bias. All soil sample results were below the investigation level of 1 pCi/g without background subtraction.
1	A 2c	Where in the final document describes how the Navy arrived in concluding the "factor" to be "non-conservative"?	See response to comment 1 A 2b above.

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1	B	EMB Comment to Navy RTC #A3, RTC page 2; EMB Comment directed at Appendix A, section 2.6 "Establishing the Number of Measurements, Page 4, next to last paragraph: The Navy may have responded to an EMB comment that may have been expressed with a lack of sufficient clarity which, in turn, may have misdirected the Navy's response. EMB apologizes for the confusion and would appreciate an opportunity to clarify its original comment: In the Final SSR FSA, Page 5 of Section 4.5 stated a "recommended value for the Lower Bound of the Gray Region (LBGR) of 1.6." As noted in page 6 of the same section, in "Equation 4-2 from the work plan", *Sign* ρ equals "random measurement probability, 0.945201", which is a value derived from MARSSIM Table 5-4. EMB requests clarification of the following:	Response is provided below in the responses to comments B1, B2, B3 and B4.
1	B 1	The value of "1.6" found in MARSSIM Table 5.4 appears to be related to relative shift ("Δ/σ") or the ratio of the "DCGL – LBGR" (Δ) to the standard deviation (σ) of contaminant measurements obtained in a survey unit.	Based on the CDPH clarification, the Navy now understands the comment and agrees with CDPH. Section 4.5 Determining the Number of Direct Measurements, second paragraph, has been revised as follows "The values used in the calculation were

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		If the stated "recommended value" of the LBGR is "1.6", then EMB's previous comment asked for the value of the DCGL since this value was not stated in the SSR for the FSA, and it is needed to derive the value for "Sign ρ", in MARSSIM Table 5-4, as it is used in Equation 4-2 on page 6 of Section 4.5.	from MARSSIM guidance (NRC 2000) and were based on a recommended value for the relative shift (Δ/σ) of 1.6. Type I and Type II decision errors were based on 0.05 false negative and 0.05 false positive rates. The associated *Z* values were obtained from MARSSIM Table 5.2 (NRC 2000). The random measurement probability, Sign ρ, is from MARSSIM Table 5.4 (NRC 2000)."
1	B 2	Please provide the reader a reference to where the "recommended value for the … (LBGR) of 1.6" is located in MARSSIM guidance.	See response to comment 1 B 1 above.
1	B 3	How is this MARSSIM LBGR "recommended value" directly related to the SSR FSA? Is the LBGR related to a specific radionuclide?	The number of direct measurements is calculated for each building in accordance with the work plan (ChaduxTt 2010). Therefore, the lower bound of the gray region (LBGR) is applicable to all buildings surveyed during the radiological survey project. Without prior survey data, both the LBGR and the coefficient of variation are expressed as functions of the derived concentration guideline limit (DCGL) such that the relative shift is unitless. Therefore, the LGBR for this project is not related to a specific radionuclide.

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1	B 4	Please provide the units used in the LBGR value of 1.6, if the term "LBGR" is insisted to be used.	See response to comment 1 B 1and B 3 above.
1	C	Provide maps of all specific locations used for all specific background reference area measurements. Specific locations do not appear to be fully evident or reported on the background reference area survey results reports for SCM and hand-held instrumentation. EMB will perform background measurements with hand-held instrumentation when EMB confirmation surveys are to be conducted. Therefore, EMB will use the background reference area maps used in the survey report as part of its confirmation survey.	Reference area surveys were performed in Buildings 112 and 398. The reference areas used are marked and available for CDPH use during the confirmatory surveys. The SCM and hand- held locations are marked on the various surfaces that were surveyed. However, no drawings of the reference area surveys in Buildings 112 and 398 were prepared. Appendix F of the scoping survey presents the survey instruments and raw data for the reference area surveys. However, please note, the concrete slab survey at the FSA identified that the reference concrete values were not applicable. Identifying an appropriate background concrete to compare to the FSA concrete is discussed in the FSA scoping survey, Section 8.1.1.
1	D	EMB COMMENT to Navy RTC R16, RTC page 9; EMB Comments directed to Final SSR FSA, Section 4.3 and Appendix F, Table 3-3:	Response is provided below in the responses to comments D1 and D2.
1	D 1	Table 3-3 cannot be located in Appendix F as stated in the Navy RTC.	Table 3-3 does not exist as previously stated in the Navy RTC R16. However, response to comment R16 presents the

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			statistics as requested by CDPH.
1	D 2	Include the background reference information for structural construction materials from the Alameda Point Basewide Radiological Survey Reports Reference Area Survey Results.	Tables 1, 2, 3, Appendix A and Appendix B of Appendix F of the Alameda Point Basewide Radiological Survey Reports Reference Area Survey includes the background reference information for structural construction materials. However, please note, the concrete slab survey at the FSA identified that the reference concrete values were not applicable. Identifying an appropriate background concrete to compare to the FSA concrete is discussed in the FSA scoping survey, Section 8.1.1.
1	E	Appendix F:	Header, no response.
1	E 1	The averages indicated at the bottoms of Tables 1 and 3 do not address EMB concerns about background reference area information:	Response is provided below in the responses to comment E 1ii.
1	E 1 i	Are the entries for each material type and instrument detector an average of all the readings by that detector?	No, the average values are the result of a minimum of ten 1-minute counts at various locations previously surveyed by the SCM and shown to be free of outliers (resulting in a normally distributed plot of activity which defines background).
1	E 1 ii	The “average” for all of the readings by all the detectors for each material type does not address EMB concerns about	The averages from Tables 1 and 3 will be removed as suggested by CDPH.

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		background and these averages at the bottom of Tables 1 and 3 will need to be removed.	
1	E 1 iii	EMB requests the following background reference area information in table form:	Response is provided below in the responses to comments E 1 iii a and E 1 iii b.
1	E 1 iii a	Hand-held instrument results for all surveys of all material types and radiation types: As a minimum: descriptive statistics, such as, mean, median, standard deviation, minimum, maximum, range.	Requested data are provided as Attachment C. Please also review Attachment A of this RTC and Appendix F the Alameda Point Basewide Radiological Survey Reports Reference Area Survey Results, which was submitted with the FSA scoping survey.
1	E 1 iii b	SCM results and CFD plots: Same as above.	The requested data were provided in Appendix E of the FSA scoping survey. Appendix E presents SCM survey results and cumulative frequency distribution (CFD) plots.
		As one phase in EMB protocol for determining a recommendation for an unrestricted release, EMB will use the survey's background reference area results and compare those results with the survey results. It would be in the best interest of the survey report that its conclusion will state that, in addition to not exceeding the survey's stated criteria, such as, a release criteria or investigation level, the survey results are found to be indistinguishable	The FSA scoping survey report stated in the executive summary and Section 9 Conclusions, "The results of the FSA scoping surveys indicate that only background levels of Ra-226 that are indicative of non-impacted soil are present in the exposed soil. The data are indistinguishable from background."

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		from background. Therefore, the SSR and other reports, such as, final status survey reports, will compare the relationship of survey results with background and will support this comparison with descriptive summary statistics, histograms and CFD plots within the survey report itself and not attached to appendices. The SSR FSA document will be made available for public interpretation, review and audit upon request by the public. Information provided within this document will be concise and accessible for the mainstream public as well as being technically defensible.	The Navy believes the FSA scoping survey report presents the survey data and reference area data in accordance with the approved work plan (ChaduxTt 2010) and the TSP (ChaduxTt 2011). The survey and reference area data have been analyzed, reviewed, and are technically defensible. Therefore, the conclusions that "The results of the scoping survey did not identify any radioactivity in soil or the concrete pad that can be associated with the Navy's former smelter operations; therefore, the site is considered non-impacted and no further actions are necessary" are justifiable.
1	F	Appendix C: "Direct Survey Data", Figures 2 and 3: Why are CFD plots of Buildings 66 and 114 used in this scoping survey? The final status survey reports for both buildings have not been fully reviewed by EMB or finalized and are not relevant to this scoping survey report.	The text of Appendix C describes the use of CFD information from other areas to more fully investigate the higher than normal alpha surface activity on the concrete slab adjacent to the FSA. The use of the CFDs from Buildings 66 and 114 is one of the tools used to establish that the elevated results from the direct measurements from the FSA concrete are caused by higher natural activity in the concrete. The SCM provides significant amounts of data that, when statistically

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			assessed, can more readily establish that there is no activity that is distinguishable from background. Use of the CFD data from the FSA, Building 66 concrete, and Building 114 courtyard area is discussed in Section 8.1.1 of the FSA scoping survey.

References

ChaduxTt. 2010. *Final Work Plan for Basewide Radiological Surveys, Former Naval Air Station Alameda, Alameda, California*. July 23.

ChaduxTt. 2011. *Final Task Specific Plan Former Smelter Area Scoping Survey, Former Naval Air Station Alameda, Alameda, California*. February 11.

Nuclear Regulatory Commission (NRC). 1992. NUREG/CR-5849, *Manual for Conducting Radiological Surveys in Support of License Termination.*

NRC. 2000. NUREG-1575, *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)*, Rev. 1.

Tetra Tech EC, Inc. 2010. *Survey Unit Project Reports Abstract Installation Restoration Sites 5 and 10, Buildings 5 and 400 Storm Drain Line, Time-Critical Removal Action, Former Naval Air Station Alameda, Alameda, California*.

ATTACHMENT A

APPLICATION OF REFERENCE AREA DATA TO SURVEY RESULTS IN MULTIPLE SURVEY UNITS

APPLICATION OF REFERENCE AREA DATA TO SURVEY RESULTS IN MULTIPLE SURVEY UNITS

The Work Plan for Basewide Radiological Surveys, Former Naval Air Station (NAS) Alameda, Alameda, California (ChaduxTt 2010), requires that reference areas be identified and reference area surveys be conducted to aid in the evaluation of compliance of potentially impacted areas with release criteria. The requirement is contained in the Multi-Agency Radiological Survey and Site Investigation Manual (MARSSIM) (Nuclear Regulatory Commission [NRC] 2000) as well as prior regulatory guidance such as NUREG 5849 (NRC 1992). The work plan, Section 5.1 discusses the process of choosing and surveying reference areas. Section 5.1 also provides a method to use surface contamination monitor (SCM) measurements to evaluate whether the reference area is reasonable for the survey area. The following discussions amplify that process and establish the means of using the chosen reference area for surveys throughout the Alameda project.

Reference areas are typically chosen as locations that contain the same materials of construction as those that will be encountered at the areas to be surveyed for release and that have no history that would indicate use of radioactive materials. Data are collected in the reference areas using the same instrumentation that will be used in the impacted areas. Building or outdoor paved surfaces are surveyed with alpha- or beta-sensitive instruments to achieve the required sensitivity to show compliance with release criteria. Survey instruments will respond to several inputs during the reference area surveys. First, and of most concern, is the natural radioactivity in the surface material. Second is cosmic and terrestrial radiation. Although instruments may be operated so as to have minimal response to gamma or X-ray radiations, the response is not zero. Finally, radon and radon progeny may affect surface measurements inconsistently based on location and weather-related parameters. Although cosmic and terrestrial radiations and the impact of radon and its progeny must always be considered, the variability of natural activity in the construction material provides the greatest challenge in establishing reference area data.

The amount of natural radioactive material will vary greatly based on the materials used in the formation of concrete or asphalt. Background issues for both concrete and asphalt are similar and can be addressed in the same fashion. This report will focus on concrete since the majority of surveys at Alameda are performed on concrete surfaces. The amount of radioactive material in concrete is a function of the type of stone and sand used in the aggregate, and the wear of the surface through the years since the concrete was poured. Buildings built at the same time, but with concrete supplied from two different contractors, may vary significantly in natural radioactivity. Concrete from the same contractor, but poured several years apart, may vary greatly since the source of sand and aggregate may have changed. Additionally, a single pour from the same material source, but with areas of high erosion caused by traffic or weather compared with other areas, may show variability if the amount of exposed aggregate resulting from surface wear is high in some areas, and not apparent in others. Asphalt surfaces, typically

higher in natural radioactive materials, are affected in a similar manner. Recognizing the high degree of variability that can be confronted, reference area surveys are typically performed by obtaining a small number, 20 to 40, of measurements for each material of construction, and then calculating a statistical average. Tests are frequently performed on the data to evaluate whether the data exhibit reasonableness relative to a normal distribution. Then, a single average background value is applied to measurements collected in impacted areas to evaluate compliance with release criteria.

At the Former NAS Alameda, reference area surveys were performed with hand-held instruments — gas flow proportional counters — as required by the work plan. The addition of data obtained with the SCM and data processing performed by the survey information management system (SIMS) allows far greater statistical analysis when the application of reference area background values to surveys of impacted areas is evaluated. The processes used by the SCM data collection and the computer processing by SIMS differ when dealing with alpha and beta radiation. Both types of surveys and the application of background values are discussed below.

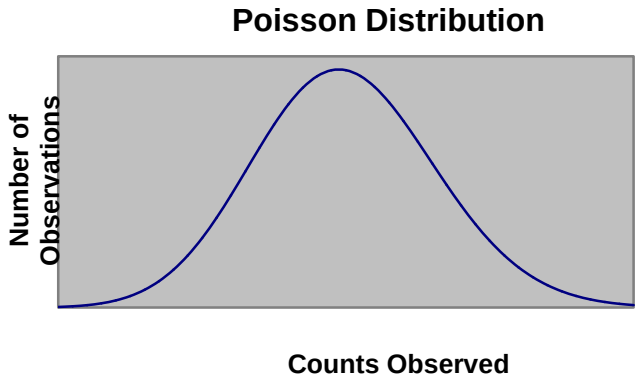
Beta Surveys – SCM/SIMS

Several key issues must be recognized to understand the process used by SCM/SIMS for beta surveys. First, the process of radioactive decay follows well-defined statistics, Poisson statistics, represented by the following equation:

$$P(x;\mu) = e^{-\mu} \mu^{x} / x!$$

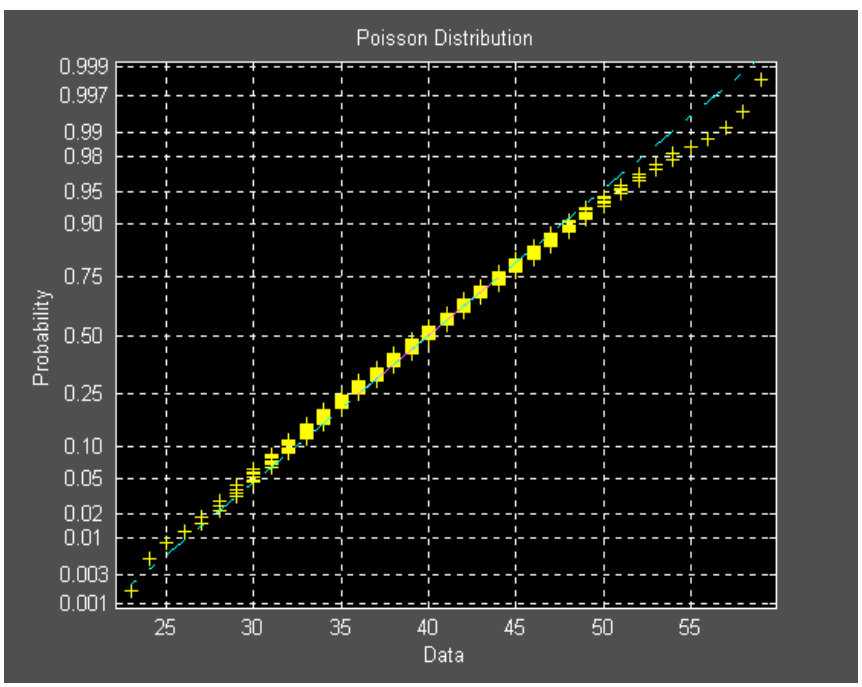
Where P represents the probability of observing x counts when the average number expected is μ. As an example, if the surface emission detected by an instrument was 600 counts per minute (cpm), the average counts per second would be 10. A 4-second count would be expected to yield an average of 40 counts. Graphically, the data can be displayed as shown in the Figure 1. The x axis represents the number of counts observed during a 4-second interval, and the y axis represents the number of times those counts are observed. The peak, representing the average value, is 40 counts. The graph appears in several references, including MARSSIM.

Figure 1



The data can also be displayed as a cumulative frequency distribution (CFD). The CFD plots can be generated using several available mathematic software programs. CFD generation is included in the SIMS software. In Figure 2, representing the same data as displayed in Figure 1, the x-axis represents counts obtained, and the y- axis is a log scale percentage of measurements that equal or exceed each value on the x- axis.

Figure 2



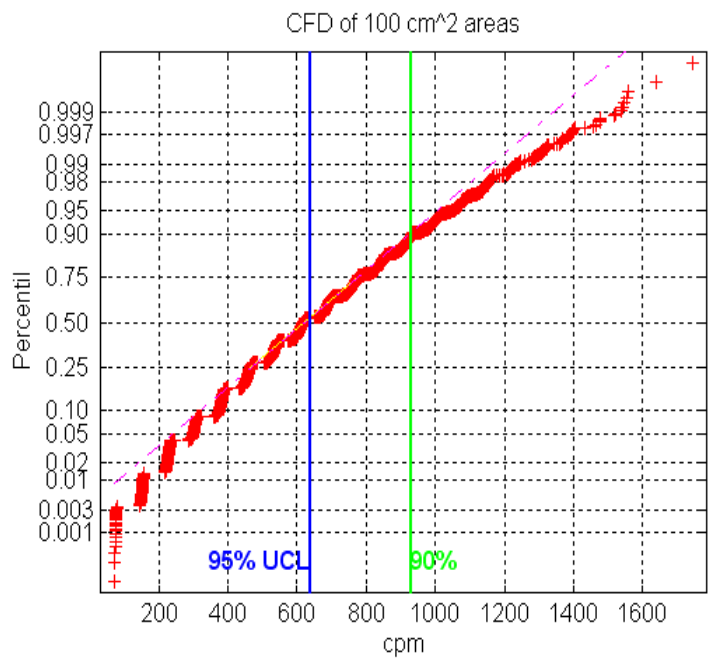
The graph shows a straight line function with a slight shoulder at the upper values, representing a normal distribution function (Poisson distribution). If a surface consisted of material that was homogenous and contained a uniform distribution of radioactivity, random spatial measurements would yield a similar result. A large number of short measurements at random locations on the

surface would result in data showing a straight line function on a cumulative frequency plot (with a slight shoulder at the upper values). The mean value from the plot (50 percent value) would represent the average value associated with measurement data. One standard deviation can be read from the graph at the probability values of 16 and 84. The standard deviation for this data set is ±6 counts.

The CFD process is designed to evaluate whether a data set is distributed normally and identify whether there are any outliers. The numerical value of the mean will differ from building to building, and even within buildings that are not associated with a single continuous pour. The standard deviation of a series of measurement will be affected by the magnitude of the count rate. A section of concrete surveyed with a detector residence time of 8 seconds will have greater counts than if it were surveyed with a 4-second residence time. The higher counts obtained will result in a smaller standard deviation, in turn resulting in a higher slope (more upright) to the CFD. The normal distribution will again be represented by a straight line with a slight shoulder at the upper end.

Concrete and asphalt undergo a mixing process before they are poured that greatly homogenizes the material. The initial pour will uniformly distribute the components of the aggregate. SCM surveys performed in even small areas will produce a large number of measurements. The SCM survey process produces 400 measurements per square meter, so that surveys of even a few square meters will produce thousands of measurements. Surveys of the concrete floor in Building 112, used as the reference area, consisted of 18 square meters, resulting in 7,200 measurements. The survey results of the SCM survey of the concrete floor in Building 112 are displayed in the CFD in Figure 3.

Figure 3



CFD of surface activity in 100cm^2 areas. The horizontal scale is in cpm per 100cm^2.

The CFD has the straight- line appearance representative of normally distributed activity. The average value is 636 cpm. Note that the x-axis is given in cpm. The data obtained by the SCM are recorded in counts per unit area, and then converted to cpm by dividing by the acquisition time as measured by the computer clock. The average value is equal to the 95 percent upper confidence level, as expected for a data set with such a large number of input values. The 84 percent value is approximately 900 cpm, giving a standard deviation of ±264 cpm.

As the standard deviation provides information regarding the probability that a single additional measurement in the area will fall within a specified range relative to the mean, the standard error represents the probability of obtaining an average similar to that obtained from the data set. There is a 67 percent probability that, if the area was resurveyed, holding all survey parameters constant, the mean would fall within plus or minus one standard error of the original mean, 636 cpm. The standard error is calculated as:

$$Standard\ Error = Standard\ Deviation/\sqrt{N}$$

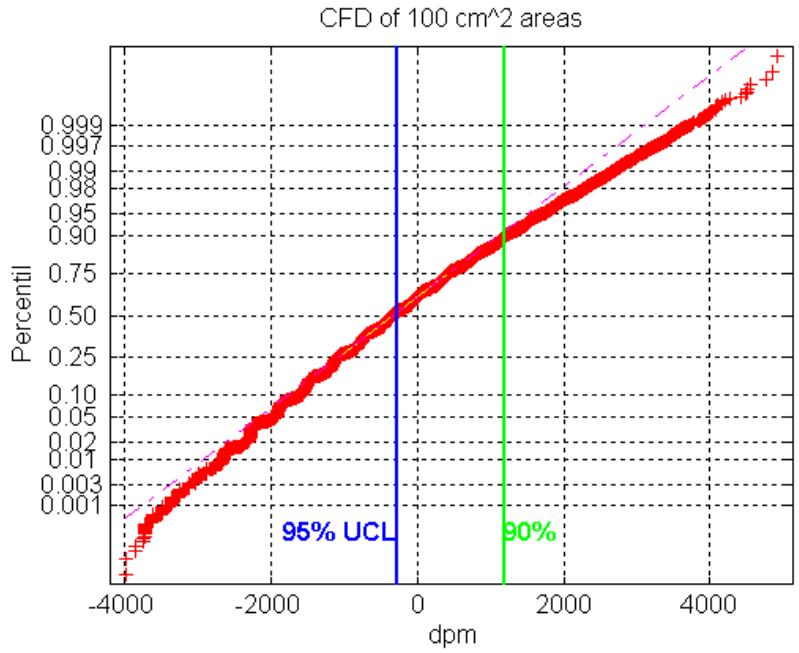
Where N = the number of measurements from the data set. For the CFD above, N equals 7,200, and the square root of N is 85. Therefore, the standard error is:

$$Standard\ Error = \pm\frac{264\ cpm}{\sqrt{7200}} = \pm 3.1\ cpm$$

As can be seen by the small standard error, the survey of the reference area provides an accurate, reproducible mean value. Resurvey of the reference area would result in an average value very close to the 636 cpm. The background value of 636 cpm, applied as an average value, is an accurate assessment. The accurate reproducible background, coupled with knowledge of the distribution of measurement data for the survey equipment and process used, allows for comparison to any concrete surface surveyed in the same manner. In any regard, the absolute value of the mean value is not critical in identifying the existence of contamination that is distinguishable from background. <u>The only constant regarding non-contaminated concrete is that there will be a normal distribution of surface activity measurements with no outliers. That is the definition of background.</u>

An example of the application of reference area SCM survey data to an impacted area survey is shown in the survey results of Building 66. Building 66 floor surveys were performed on concrete surfaces with the SCM. The total area of the SCM survey of the floor in Survey Unit (SU) 1 is 95.65 square meters. The total number of measurements made by the SCM is 38,260. The CFD for the beta survey of SU 1 is shown in Figure 4.

Figure 4



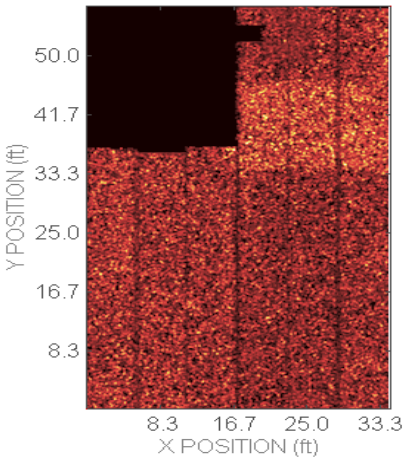
CFD of surface activity in 100cm^2 areas. The horizontal scale is in dpm per 100cm^2.

The CFD horizontal axis scale is in net disintegrations per minute (dpm). The cpm generated by SCM/SIMS has subtracted the background value of 636 cpm from every measurement and divided the result by the SCM efficiency, 21 percent. If the reference area background is identical to the SU 1 surface background, and there is no large area of contamination, the zero value would align with the 50 percentile. In this case, the 50 percentile is at the value of -260 dpm. The value of -260 dpm is equivalent to -54 cpm, or approximately -8 percent of the average background value of 636 cpm. The average value measured from the concrete floor survey in Building 66, SU 1, is close to that of the reference area and is a reasonable application for this surface. However, the more critical factor is that the data obtained from the surface measurements of the floor show a normal distribution with no outliers. The normal distribution indicates a background distribution and shows that the data from the survey area are indistinguishable from background.

These processes can be extended to any surveys performed on similar materials throughout NAS Alameda. The process described extends to any material surface, since in all cases, the randomness of radioactive decay, including the natural radioactivity within the material or external sources such as cosmic or terrestrial, will produce normally distributed data sets. Care must always be taken if areas of elevated or suppressed activity are recognized and follow-up investigations must be performed. Patches in a surface resulting from maintenance also can produce unusual results. Figure 5 is a 2-dimensional color graphic display from SIMS of an asphalt roadway. Although the roadway was originally paved more than 20 years before the

survey, a pipe that crossed under the roadway required replacement a few years prior to the survey. After the pipe was replaced and backfilled, the surface was repaved with asphalt. The asphalt was obviously from a different source and re-pavement at a later time.

Figure 5



SCM/SIMS survey output

Photograph of area with asphalt patch

The elevated surface activity is displayed as a brighter area in the SIMS output. The area of approximately 10 feet by 16 feet contains approximately 6,000 measurements. Both the asphalt patch and the original asphalt yield normally distributed data, with a difference in the mean values of more than 3,000 dpm/100 cm^2.

Beta Surveys – Hand- Held Instruments

All surface beta surveys can be evaluated for normal distribution, existence of outliers, and comparison to reference area measurement data using the processes employed by SIMS on the thousands of data points generated by the SCM. The information gathered can also be extended to the limited number of surveys performed at pre-defined locations with hand-held instruments and longer count times. For the Building 66 SU 1 floor survey, 18 measurements were obtained with a gas flow proportional detector. The instrumentation consisted of a 126 square centimeter (cm^2) Ludlum 43-68 detector coupled to a Ludlum 2221 scaler/ratemeter. The average value of the 18 measurements is 131 cpm. The average reference area value for hand-held instrument measurements obtained from the same concrete floor area as in Building 112 as that surveyed by the SCM is 147 cpm. There is a 10 percent negative bias comparing the survey area with the reference area. This value compares well with the 8 percent negative bias based on thousands of measurements from the SCM.

The limited number of measurements in each survey area does not allow for clear determination of the nature of the distribution. Establishing whether the survey area is indistinguishable from

background is not possible. However, the data clearly establish that the fixed measurements taken throughout an area established to have normally distributed background radioactivity by SCM surveys are all below the release criteria.

Alpha Surveys – SCM Surveys

Alpha surveys are particularly difficult because of the small count rate associated with the release criteria of most alpha-emitting radionuclides. A few counts above background will frequently challenge the criteria. Alpha background, as with beta background described above, is not a constant, but varies with Poisson statistics. The primary challenge to any alpha survey with any instrumentation is the suppression of false positives created by background variability. False positives require further investigation with longer count times, resulting in prolonged survey time and costs.

False positives caused by background become prevalent and are the critical factor with which to contend in alpha surveys with low release criteria. Surveys for alpha-emitting radionuclides at NAS Alameda are performed with the SCM using a dual survey process that incorporates a second recount detector in the dynamic mode and a second data acquisition in the static mode. SIMS processing of the data is focused on suppressing false positives while providing a high degree of confidence that a source at the activity of the release criteria will be identified. Background subtraction is not incorporated in the SCM/SIMS process.

The sensitivity of any system to detect low concentrations of alpha-emitting radionuclides is expressed in probability of detection based on particle detection theory. The process is described in Section 6.7.2.2 of MARSSIM with additional discussion in Appendix J. SCM surveys for alpha-emitting radionuclides are performed in the detector recount mode, as stated earlier. As an example, a threshold value of two counts in a survey interval *t* will be presented for illustrative purposes. Higher or lower threshold values may be applied if required based on higher than expected surface alpha background. The probability of detecting a source by obtaining two or more counts in a 100 cm^2 area from a source is given by:

$$P(n \geq 2) = 1 - e^{-\frac{(GE+B)t}{60}} \left(1 + \frac{(GE+B)t}{60}\right)$$

Where:

P(n≥2) = Probability of getting two or more counts in the survey time interval

G = Source activity in dpm

E = Detector efficiency (4π)

B = Background in cpm

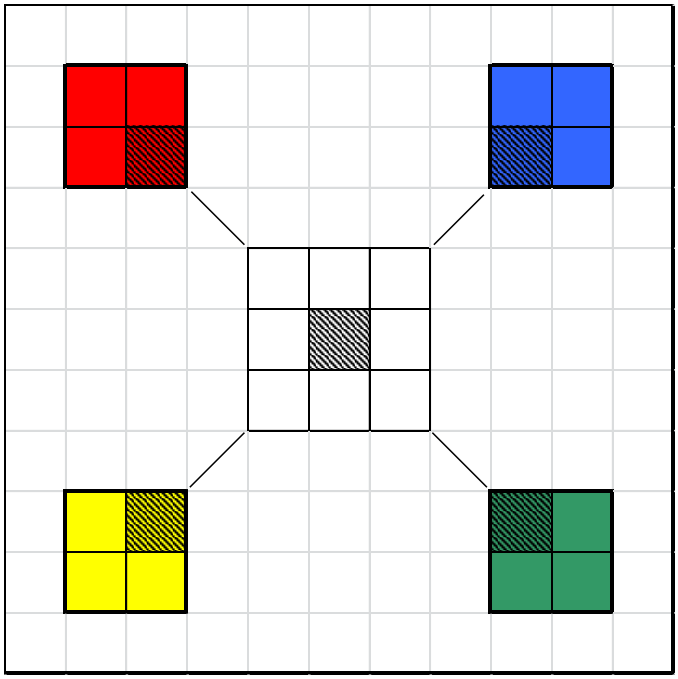
t = Time over source in seconds

Using the release limits and radionuclides of concern (ROC) at NAS Alameda, the source activity for alpha (G) is 100 dpm. The detector efficiency E is based on a point source. Point source geometry is appropriate because the physical size of 100 dpm of radium 226 (Ra-226) is minute. The specific activity of Ra-226 is 1 Curie per gram. Therefore, 100 dpm of Ra-226 is equal to 4.5 x 10^{-12} grams, and the mass equivalent of 100 dpm of Ra-226 would be best represented by a point source.

A point source would be under the detector for two data acquisitions (each occurring during 5 cm of detector travel) according to the process the SCM uses to record data; hence, the SCM will "double count" the source. SCM processing will then add the two adjacent pixels as shown below in Figure 6. The SCM provides data to SIMS in areas of 25 cm^2. SIMS sums each 25 cm^2 "pixel" of data with each combination of adjacent 25 cm^2 areas to create all possible 100 cm^2 areas within the area surveyed. Figure 6 show the process employed by SIMS.

Figure 6

When determining maximum activity, each 25 cm^2 pixel is actually 25 percent of four overlapping 100 cm^2 areas.

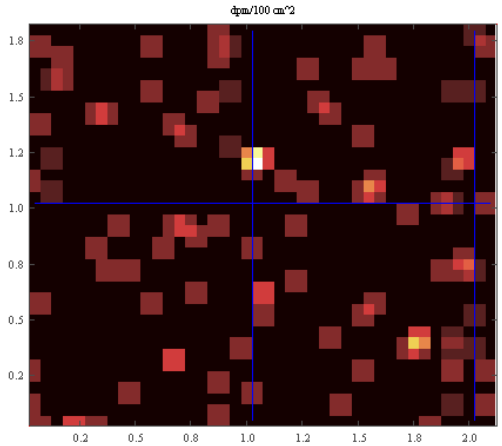


The result of the SCM/SIMS process is that the efficiency will be doubled for a point source. Typical 4π alpha efficiency for distributed sources for the SCM is approximately 25 percent. The effective efficiency for a point source would be approximately 50 percent. All SCM efficiencies for both the dynamic and static modes determined at the NAS Alameda exceeded 50 percent. A conservative value of 50 percent has been applied throughout the NAS Alameda survey.

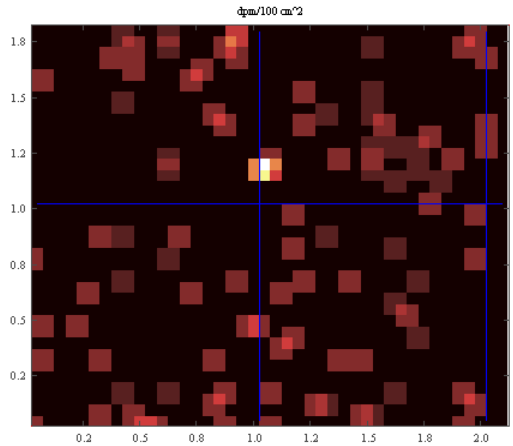
Typical alpha background that has been recorded with the SCM at locations throughout the United States is approximately 1.0 cpm/100 cm^2. The time over the source will be the equivalent of two acquisition cycles of 5 centimeters (cm) each. At 1.25 cm/second (cm/sec) survey speed, the time over the source would be 8 seconds, for 10 cm / 1.25 cm/sec.

Based on the probability equation above, a single detector will record at least two counts while traversing a 100 dpm Ra-226 source 99.1 percent of the time. Both detectors will record at least two counts 98.3 percent of the time (square of a single detector probability). Figure 7 contains a 2-dimensional color graphic display of an SCM survey of a source of approximately 100 dpm. Background is not subtracted from the primary or recount detector. Background counts are observed as randomly distributed throughout the survey area. Since the two detectors are hard-mounted with a known offset, the two images can be superimposed so each represents the same area surveyed. The coincidence logic applied by the SIMS computer process evaluates each 100 cm^2 area of each detector. Those in which the number of counts does not exceed the threshold value in both detectors have a null value in the associated area in the coincidence survey. Calculations are performed for those that exceed the threshold value in both detectors based on the total counts from both detectors and the total time of survey from both detectors. The detector efficiency is then applied to determine the activity within that 100 cm^2 area. The survey area is approximately 4 square meters with a total of 1,600 individual measurements.

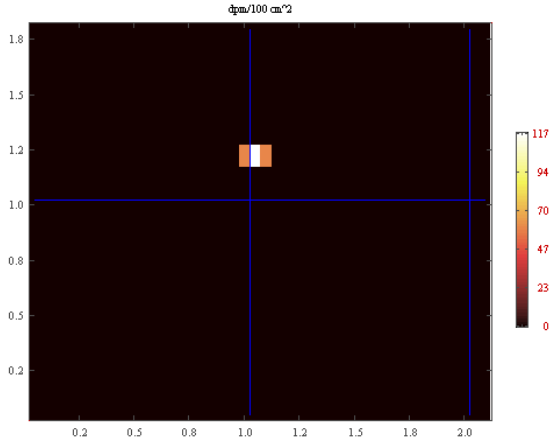
Figure 7



Primary Detector



Recount Detector



Coincidence logic

SIMS evaluation of the survey identified a source of 118 dpm at the location shown (X= 105 cm, Y= 120 cm from the southwest corner of the survey area). More critical is the elimination of false positives through use of "two out of two" logic.

Using the probability of detection equation above, setting the source value to zero, maintaining the background at 1 cpm, and holding the efficiency at 50 percent and maintaining a survey speed at 0.5 inch per second (t = 8 seconds), a single detector will record at least two counts from background 0.8 percent of the time. Both detectors recording at least two counts in the same 100 cm^2 area as a result of background will occur 0.0064 percent of the time. Therefore, a false positive requiring investigation will occur at the rate of 1 every 150 square meters and is to be

compared with an average rate of two to three false positives per square meter experienced with a 582 cm^2 probe using a two count per detector width threshold and a single count in the following 5-second interval. Use of larger detectors will result in an increase in the false positive rate. Similarly, increases in the surface alpha background will increase the number of false positives under any application. Increases in average background can be compensated by increasing the threshold to three counts with a small decrease in the probability of detection of the 100 dpm source. (A threshold of three will result in a probability of detection of 96.6 percent for a 100 dpm source and a false positive rate of 0.000014 percent.)

Alpha Surveys – Hand- Held Instrument

Reference area alpha values are subtracted from those obtained in the direct measurements obtained at predefined measurement locations in each survey unit. The alpha values obtained in the reference area ranged from 1 cpm to 4.2 cpm for all materials of construction except asphalt. The asphalt value was 5 cpm. If the background value is reasonable, approximately half of the direct measurements are expected to be zero or negative values. Conversely, a series of measurements that are all positive would indicate a higher background in the survey area than in the reference area. Because of the low release criteria, background can play a significant factor in evaluation of compliance with release criteria. Every cpm above the reference value will result in approximately 10 dpm to the measurement value for a single 2-minute count with a 126 cm^2 detector. Even with background values as low as 1 cpm, a few counts per minute, 2 to 4 cpm, are within the variability expected in a 2-minute interval. If the actual background in the survey area is 3 or 4 cpm greater than the reference area as a result of material differences, some of the direct measurements may approach the release criteria without any added radioactivity.

If a more thorough assessment is necessary, the actual background can be obtained from the SIMS processing of the SCM data in the survey area. The SIMS program has the capability of assessing the average value in any chosen area through a subroutine named "snooper." The processor has the capability of banding an area on the computer screen. SIMS will provide the average activity within any area banded on the computer screen as well as other statistical data. From a SCM survey of the area of interest, an area can be chosen from either the primary or recount detector where no 100 cm^2 area is greater than the threshold in both detectors as identified on the coincidence report. Snooper will provide an average value from that area. Based on the SCM/SIMS determination that all measurements in the banded area are associated with the random distribution of background, the average is an accurate assessment of background. The results can be shown in cpm or dpm per 100 cm^2. Although there is a difference in the sensitive area of the detectors (the SCM expresses data in 100 cm^2 areas, the hand-held detectors are 126 cm^2), the introduced error is small and conservative. The assessment of background from the SCM/SIMS process can then be applied to the direct measurement data for comparison to the release criteria.

Summary

Backgrounds from construction materials that affect both alpha and beta material surface surveys are widely variable throughout any facility. Concrete and asphalt will vary based on the materials used to form the surface, the period of construction, and the wear of the surface through the years. The only constant is that intact concrete and asphalt surfaces without any added radioactivity from local operations will display a normal, random distribution of activity. Selecting an appropriate reference area for each area to be surveyed spanning many buildings from different construction eras located throughout a large facility is an extremely difficult and expensive task.

The SCM/SIMS process provides for a direct assessment of each survey area for beta surveys using thousands of measurements to evaluate whether a normal random distribution of radioactivity exists or whether outliers indicating the presence of added radioactivity exist. The process also allows for an assessment of whether the reference area value as applied to the survey area is reasonable. The assessment allows for consideration of the adequacy of data from both the SCM and hand-held instrument measurements. The reference area value can be adjusted, as necessary. The SCM/SIMS process is also insensitive to changes in cosmic or terrestrial radiation, or impacts from radon progeny, as none of those will alter the normal distribution of measurements from material surfaces.

A bigger challenge exists for background values applied to alpha surveys. Alpha background values of even a few counts per minute are close to release criteria typically applied to alpha-emitting nuclides. A challenge in alpha surveys is to develop a process with adequate instrument efficiency and survey speed (residence time) to detect at the release criteria at least 95 percent of the time. A bigger challenge is to reduce or eliminate the false positives created by background radiation. False positives will result in areas being identified as exceeding the limit, but are actually the result background radiations at the high end of the Poisson distribution. Large area detectors without position sensitivity are prone to large numbers of false positives. The SCM uses a position sensitive proportional counter to capture measurements in 25 cm^2 areas, summing those areas to create 100 cm^2 areas, thus lowering the background impact. The SCM/SIMS process described above and using guidance from MARSSIM has been shown to detect at the required release criteria, but greatly reduce the number of false positives per unit area. The process clearly establishes an area as background, if no locations are shown to be above the threshold values in the two-detector array. The process can determine what average value can be applied to a survey area and can be used to compare values with those established in reference areas using either the SCM or hand-held instrumentation.

ATTACHMENT B

INSTRUMENT SOURCE CHECKS

LUDLUM MODEL 2221 DAILY RESPONSE CHECK FORM

Instrument Serial # 190181 **Probe Serial #** 43-68 #PR-149768 44-9 #PR-209686

High Voltage Setting 43-68 α 1200 / β1650 V & Threshold 50 44-9 β 900V & Threshold 600

Acceptance Criteria

43-68 Alpha Source Check: 4406 to 6609cpm on Source Serial # D7-928

43-68 Beta Source Check: 61729 to 92593 cpm on Source Serial # D7-932

Efficiencies: Alpha 0.11 Beta 0.077 cpm/dpm

44-9 Beta Source Check: __8546 to __12819_ cpm on Source Serial # A1892 – Lettering side out

Efficiencies: Alpha N/A Beta 0.06 cpm/dpm

Date 2011	In Cal (Y/N)	HV (volts)	Alpha			Beta			Comment	Tech Initials
			Gross cpm	Bkgd (cpm)	Net cpm	Gross cpm	Bkgd (cpm)	Net cpm		
2-1	Y	900	N/A	N/A	N/A	11215	44	11171	Good	EP
2-8	Y	1200	4947	2	4945	N/A	N/A	N/A	PASS	KC
2-9	Y	1200	4825	2	4823	N/A	N/A	N/A	PASS	KC
2-10	Y	1200	4899	2	4897	N/A	N/A	N/A	PASS	KC
2-14	Y	1200	4898	1	4897	NA	NA	NA	Good	[illegible]
2-15	Y	1200	5189	3	5186	NA	NA	NA	Good	[illegible]
2-16	Y	1200	4839	0	4839	NA	NA	NA	Good	[illegible]
2-18	Y	1200	5239	2	5237	NA	NA	NA	Good	[illegible]
2-21	Y	1200	4949	0	4949	NA	NA	NA	Good	[illegible]
2-22	Y	1200	4625	1	4624	NA	NA	NA	Good	[illegible]
2-23	Y	1200	4699	2	4697	NA	NA	NA	Good	[illegible]
2-24	Y	1200	4704	1	4703	NA	NA	NA	Good	[illegible]
2-25	Y	1200	5096	2	5094	NA	NA	NA	Good	[illegible]
2-28	Y	1200	4718	2	4716	NA	NA	NA	Good	[illegible]
3-1	Y	1200	4798	5	4793	NA	NA	NA	Good	[illegible]
3-2	Y	1200	5108	1	5107	NA	NA	NA	Good	[illegible]

Page 1 **of** 2

2221 43-68

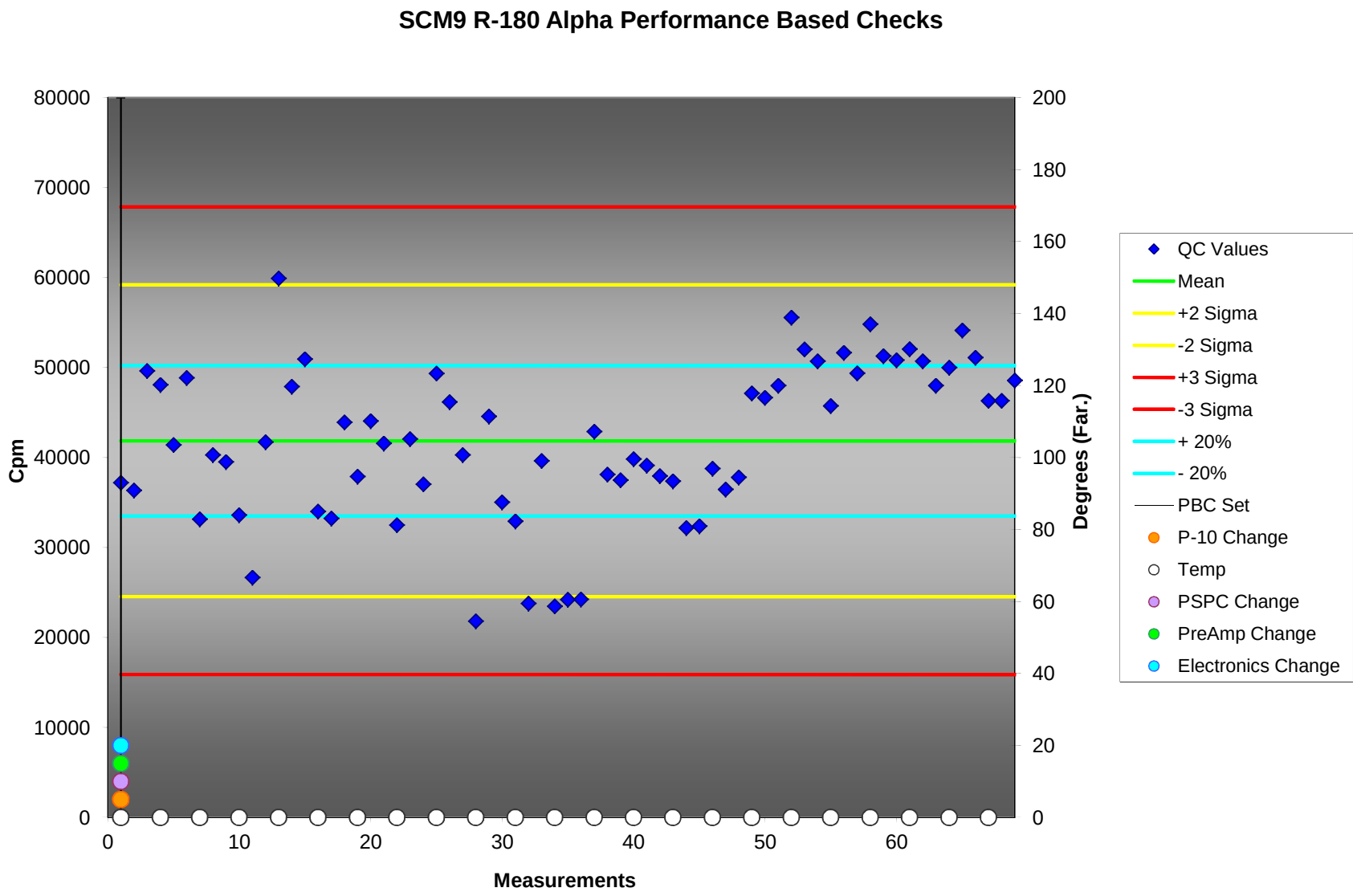
d 190181 w/ 149768 β

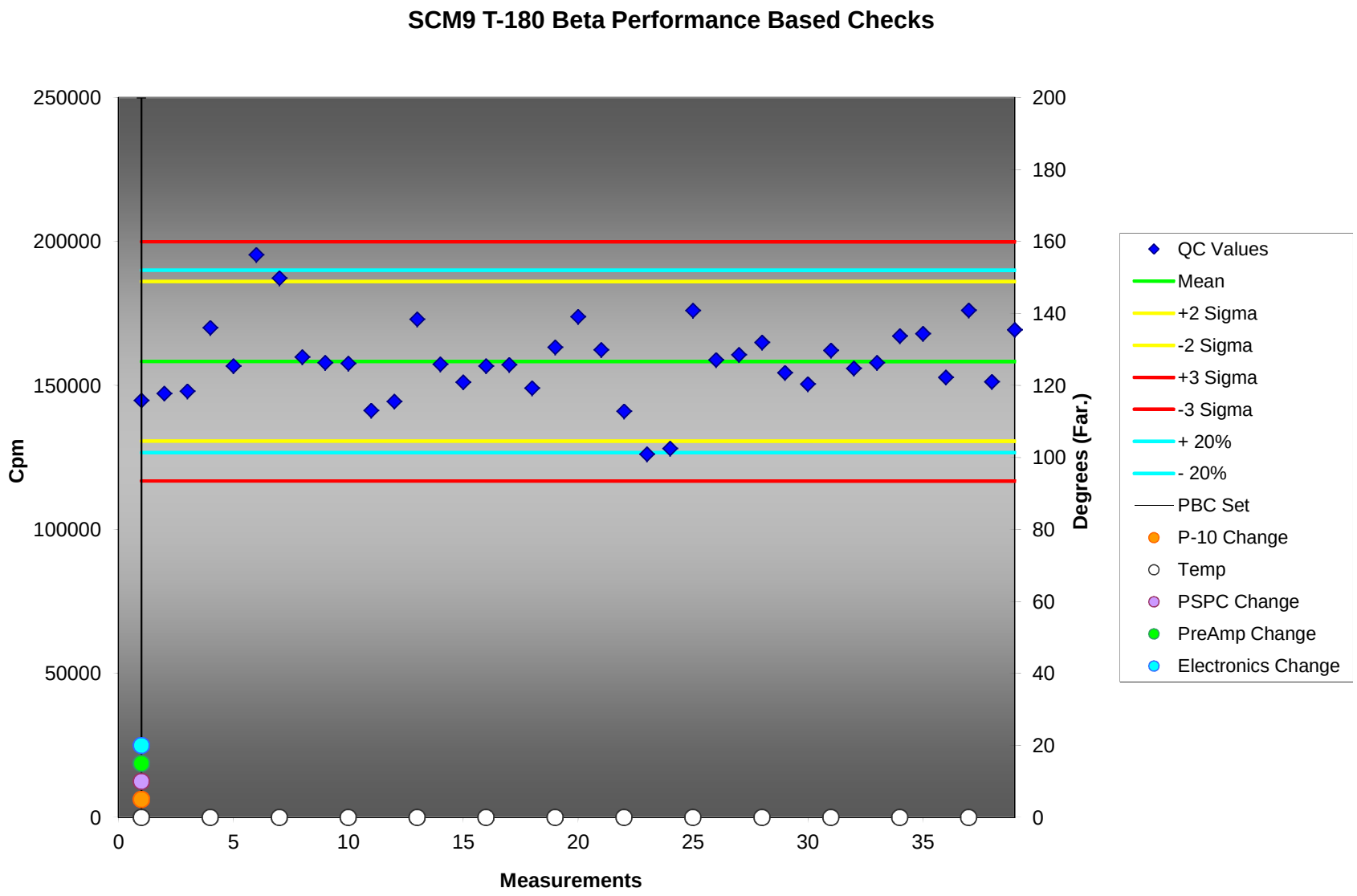
4406-6609 61,729 - 92,593

DAILY RESPONSE CHECK FORM (CONT.)

Date 2011	In Cal (Y/N)	HV (volts)	Alpha Gross cpm	Alpha Bkgd (cpm)	Alpha Net cpm	Beta Gross cpm	Beta Bkgd (cpm)	Beta Net cpm	Comment	Tech Initials
3-3	Y	1204 ~~1650~~	4895	2	4893	7473 ~~NA~~	125 ~~NA~~	7478 ~~NA~~	Good	[illegible]
3-4	Y	1200 ~~1650~~	—	0		—			won't source	[illegible]
						after mylar changeout				
			4766							

Page 2 of 2


SCM9 R-180 Alpha Performance Based Checks
Cpm
80000
70000
60000
50000
40000
30000
20000
10000
0
Degrees (Far.)
200
180
160
140
120
100
80
60
40
20
0
0
10
20
30
40
50
60
Measurements
QC Values
Mean
+2 Sigma
-2 Sigma
+3 Sigma
-3 Sigma
+ 20%
- 20%
PBC Set
P-10 Change
Temp
PSPC Change
PreAmp Change
Electronics Change


SCM9 T-180 Beta Performance Based Checks
Cpm
250000
200000
150000
100000
50000
0
Degrees (Far.)
200
180
160
140
120
100
80
60
40
20
0
0
5
10
15
20
25
30
35
Measurements
QC Values
Mean
+2 Sigma
-2 Sigma
+3 Sigma
-3 Sigma
+ 20%
- 20%
PBC Set
P-10 Change
Temp
PSPC Change
PreAmp Change
Electronics Change

ATTACHMENT C

STRUCTURAL BACKGROUND STATISTICS

Alpha Reference Background

Date	Instrument	Serial #	Probe	Serial #	Cal Due
10/12/2010	2221	148426	43-68	PR149773	2/15/2011

Detector	Concrete	Wood	Glass	Drywall	Concrete Block	Steel	Asphalt	Instrument	Serial #
149773	2.700	2.400	2.500	2.500	4.200	3.800		2221	148426
149768	1.100	1.100	1.400	1.000	1.000	1.000		2221	190181
177646	1.800	2.200	1.700	3.000	4.100	2.600	5.000	2221	148451
148835	2.400	3.000	2.500	3.000	3.500	3.200		2221	183194
Mean	2.000	2.175	2.025	2.375	3.200	2.650	5.000		
Median	2.100	2.300	2.100	2.750	3.800	2.900	5.000		
SD	0.707	0.793	0.562	0.946	1.499	1.204	2.236		
Min	1.100	1.100	1.400	1.000	1.000	1.000	5.000		
Max	2.700	3.000	2.500	3.000	4.200	3.800	5.000		
Range	1.1 - 2.7	1.1 - 3.0	1.4 - 2.5	1.0 - 3.0	1.0 - 4.2	1.0 - 3.8	5		

Beta Reference Background

Date	Instrument	Serial #	Probe	Serial #	Cal Due
11/29/2010	2221	183194	43-68	PR148835	2/15/2011

Material	Concrete	Wood	Glass	Drywall	Concrete Block	Steel
	120	116	123	122	132	165
	141	110	112	117	137	129
	124	124	117	127	140	117
	127	110	131	117	139	141
	154	114	129	121	132	127
	110	118	130	128	147	134
	117	127	133	142	146	139
	111	140	125	119	133	140
	123	127	134	119	114	135
	136	111	123	125	139	140
Mean	126.3	119.7	125.7	123.7	135.9	136.7
Median	123.5	117	127	121.5	138	137
SD	13.8	9.7	7.1	7.5	9.3	12.5
Min	110	110	112	117	114	117
Max	154	140	134	142	147	165
Range	110 - 154	110 - 140	112 - 134	117 - 142	114 - 147	117 - 165

Date	Instrument	Serial #	Probe	Serial #	Cal Due
11/5/2010	2221	148451	43-68	PR177646	2/15/2011

Material	Concrete	Wood	Glass	Drywall	Concrete Block	Steel
	157	98	106	112	217	111
	162	94	108	105	218	108
	151	99	121	116	196	97
	151	117	102	103	218	103
	146	98	117	126	188	127
	145	126	112	103	191	118
	161	101	99	106	188	109
	123	118	116	127	196	92
	143	95	123	107	194	126
	131	117	118	95	202	122
Mean	147	106.3	112.2	110	200.8	111.3
Median	148.5	100	114	106.5	196	110
SD	12.5	11.8	8.2	10.3	12.3	11.9
Min	123	94	99	95	188	92
Max	162	126	123	127	218	127
Range	123 - 162	94 - 126	99 - 123	95 - 127	188 - 218	92 - 127

Date	Instrument	Serial #	Probe	Serial #	Cal Due
10/12/2010	2221	148426	43-68	PR149773	2/15/2011

Material	Concrete	Wood	Glass	Drywall	Concrete Block	Steel
	199	147	137	164	267	145
	195	164	155	166	318	140
	188	153	165	150	248	131
	193	147	159	150	273	134
	206	147	159	183	275	154
	213	136	173	167	279	152
	214	152	157	150	291	141
	206	165	151	142	291	151
	233	163	178	181	270	148
	184	191	155	169	268	131
Mean	203.1	156.5	158.9	162.2	278	142.7
Median	202.5	152.5	158	165	274	143
SD	14.5	15.2	11.4	13.9	18.7	8.7
Min	184	136	137	142	248	131
Max	233	191	178	183	318	154
Range	184 - 233	136 - 191	137 - 178	142 - 183	248 - 318	131 - 154

Date	Instrument	Serial #	Probe	Serial #	Cal Due
10/12/2010	2221	190181	43-68	PR149768	2/15/2011

Material	Concrete	Wood	Glass	Drywall	Concrete Block	Steel
	137	101	104	109	240	112
	137	83	123	105	243	98
	122	102	119	104	251	92
	126	105	110	104	225	104
	131	101	113	121	218	89
	125	86	88	120	210	119
	122	103	121	101	229	110
	142	98	98	104	229	112
	104	96	100	98	224	95
	118	85	98	111	210	117
Mean	126.4	96	107.4	107.7	227.9	104.8
Median	125.5	99.5	107	104.5	227	107
SD	11.1	8.2	11.6	7.7	13.6	10.7
Min	104	83	88	98	210	89
Max	142	105	123	121	251	119
Range	104 - 142	83 - 105	88 - 123	98 - 121	210 - 251	89 - 119

Date	Instrument	Serial #	Probe	Serial #	Cal Due
11/5/2010	2221	190181	44-9	PR169468	2/15/2011

Material	Concrete	Wood	Glass	Drywall	Concrete Block	Steel
	451	337	304	448	605	408
	430	400	348	447	618	430
	533	351	409	431	578	500
	621	357	400	401	545	487
	613	408	452	531	586	472
	615	413	338	461	496	480
	563	422	375	412	488	489
	575	441	342	442	492	410
	520	293	333	412	462	440
	510	408	331	380	469	402
Mean	543.1	383	363.2	436.5	533.9	451.8
Median	548	404	345	436.5	520.5	456
SD	67.1	46.2	45.0	41.5	59.2	37.9
Min	430	293	304	380	462	402
Max	621	441	452	531	618	500
Range	430 - 621	293 - 441	304 - 452	380 - 531	462 - 618	402 - 500

Date	Instrument	Serial #	Probe	Serial #	Cal Due
11/5/2010	2221	148426	44-9	PR147890	2/15/2011

Material	Concrete	Wood	Glass	Drywall	Concrete Block	Steel
	313	287	189	320	328	383
	385	186	204	292	423	333
	377	250	211	317	387	371
	401	251	176	331	468	247
	406	215	256	276	369	311
	264	296	213	295	485	283
	426	204	199	313	304	341
	349	247	183	321	417	270
	436	237	201	281	432	267
	420	265	226	269	427	334
Mean	377.7	243.8	205.8	301.5	404	314
Median	393	248.5	202.5	304	420	322
SD	54.6	34.9	23.0	21.7	57.5	46.1
Min	264	186	176	269	304	247
Max	436	296	256	331	485	383
Range	264 - 436	186 - 296	176 - 256	269 - 331	304 - 485	247 - 383