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TITLE: Performance Checks with the Alpha Sentry CAM

AUTHOR(S): John C. Rodgers

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Los Alamos National Laboratory
Los Alamos, New Mexico 87545

Performance Checks with the Alpha Sentry CAM

John Rodgers, Los Alamos National Laboratory

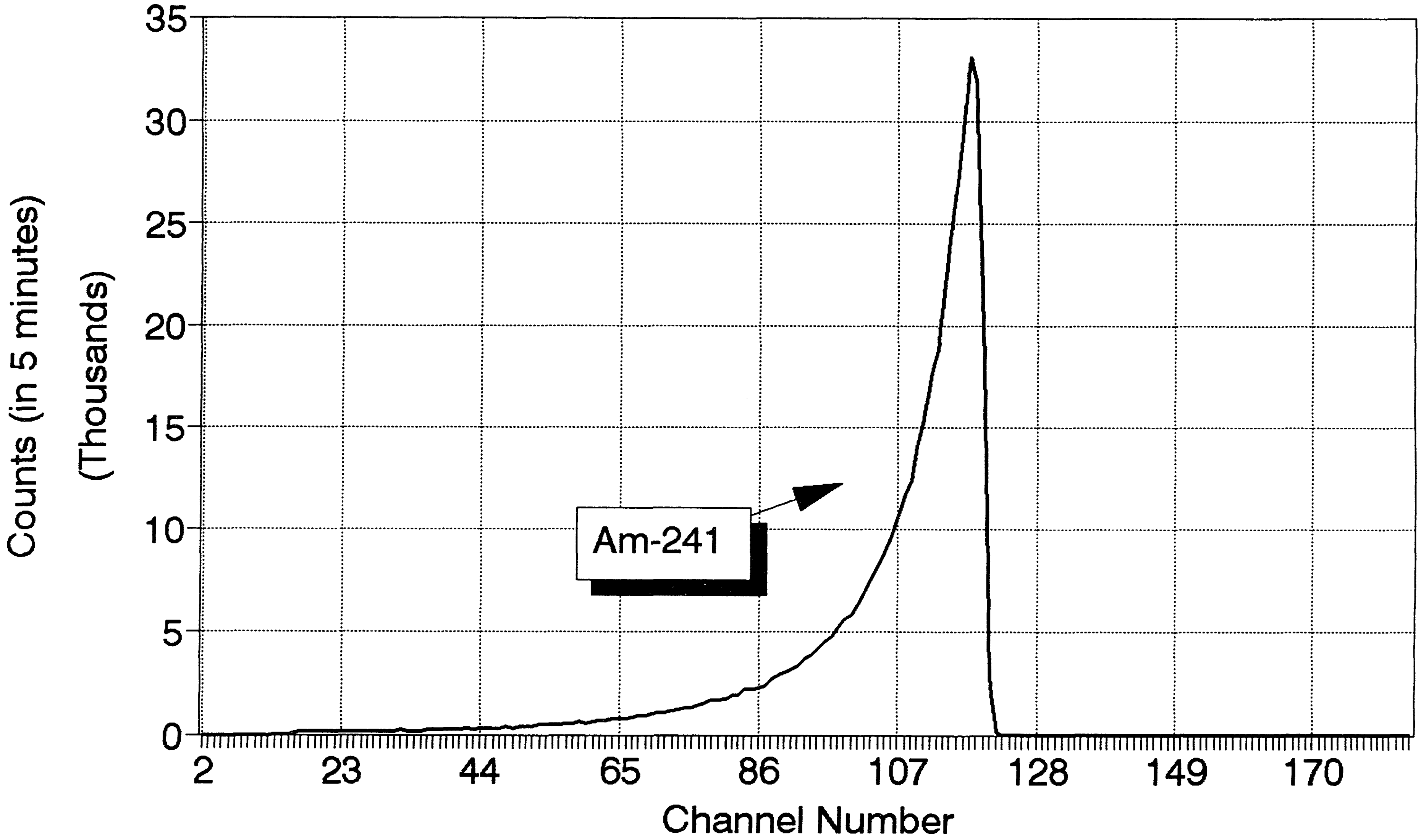
Before a CAM is put into service, it must be calibrated. The flow meter and detector must be calibrated with an external flow meter to provide accurate flow data, and the detector must be calibrated to produce accurate DPM data. Both flow and DPM data enter into the calculation of the Derived Air Concentration exposure (DAC-hr) by the CAM software. The focus of this report is on methods for checking that the DAC-hr alarm functionality has been properly calibrated and available in installed CAM instruments.

The process begins with detector calibration. In order to calibrate the detector, the Alpha Sentry CAM is placed in an off-line calibration mode and detector effeciency calibration is selected. The user is prompted to enter the calibration source DPM and place the source in the CAM head. Upon latching the filter door with the source in place, a count is automatically initaited and completed. From the count data and the user entered DPM data, an efficiency is determined in the Alpha Sentry Manager (ASM) and stored in non-volatile memory in the CAM head electronics. This source is typically a plated ^{239}Pu or ^{241}Am source diffused into a stainless steel planchet (Fig. 1 illustrates a typical Am spectrum).

Once the CAM head is placed into service, a periodic check of CAM performance is necessary to verify continued functionality. This usually takes the form of a field check of the previously determined efficiency. In this process, the CAM heads supported by an ASM in service are placed into a performance check mode which primes them for the performance tests. The user enters the check source radioactivity data and then sequentially places the source in each head. An efficiency check count is initialized when a CAM head filter door is opened and then closed with the filter replaced by the check source. When the count is completed a new efficiency is calculated from the count data and automatically compared with the stored value for that head. If the new value agrees with the calibration value (± 10%) the unit passes the test; otherwise the unit fails the efficiency test and must be serviced.

At this point the user knows that the CAM has a functional detector and electronics and is operating at the calibrated efficiency, but not whether the CAM would properly alarm if challenged by sufficient activity on the filter since that involves additional hardware and software functionality that has not been tested. For example, at Los Alamos, some of the old CAMs are subject to a cruder functionality test based on placing a check source into the CAM head and

Fig. 1. CAM Efficiency Check Source
Americium-241 Plated Source



observing if, in about the right time, a CAM alarm is triggered. This simple alarm test is registered locally and is communicated to the control room . So there must be good coordination between the HP conducting the test, the control room operators, and the nearby workers so that the test is not confused with an actual radiation alarm. A much more sophisticated alarm test has been devised for the Alpha Sentry CAM.

The alarm test is programmed to follow the efficiency test, provided that test is positive. It is based on activating the fast acute alarm algorithm that operates independently of the ASM in the CAM head firmware. With the CAM head in the performance test mode, after a successful efficiency test, the registers are cleared, the CAM head is placed back on line, alarm functionality is restored, and a new count is initiated and alowed to proceed until an acute alarm is registered or a time-out is reached. If the unit times out the acute alarm test fails. In a functional CAM head the acute alarm DAC-hr threshold is quickly reached, whereupon a short alarm is sounded, successfuly concluding the test. The control center also receives a signal over the network that a high radiation alarm has been logged, but since the performance check flag is set, the event is reported as a successful alarm test. No special coordination is required here since a true radiation alarm and a performance check alarm have different electronic data signatures.

Note that the acute alarm test is based on an analysis of the alpha spectrum from a "ratio of ROI counts" perspective, not on the basis of a spectral analysis as in the case of the chronic alarm. A chronic alarm test requires another sort of analysis: this one involves spectral analysis to compensate for the overlap of counts from the radon daughter peaks into the plutonium region of interest. Such an analysis is carried out in the ASM rather than the heads themselves. A different source is obviously needed for such a test, one which contains spectral peaks of the principal radon daughters in addition to plutonium or americium activity. Ordinarily such a spectrum would have to be obtained by collecting radon daughters and plutonium aerosol at the same time, or a combination of a plated Pu source and a filter on which radon daughters can be collected. However, a very interesting alternative has been developed from a most unusual source: we have demonstrated that it is possible to plate ^{226}Ra and its long lived daughter ^{210}Po onto stainless steel in such a manner as to capture ^{222}Rn and its short lived daughters ^{218}Po and ^{214}Po as well. The somewhat unexpected capture of radon in the very thin diffused layer of the source is the critical feature here, since what is wanted is the combination of the radium parent *together* with the short lived daughters and the ^{210}Po daughter. The resultant spectrum (Fig. 2) has the requisite Rn daughter peaks at 6.0 MeV and 7.68 Mev, and in addition, the peaks of ^{226}Ra and ^{210}Po in the plutonium window at 4.78 and 5.3 Mev (there may also be some contribution from ^{222}Rn at 5.49 MeV). The source spectrum compares very well with a spectrum obtained from an actual radon daughter sample colleced on a filter. Thus we have a unique portable, plated source which meets all of the requisites for checking the chronic alarm capability of a CAM:

1.) The source has alpha-activity in the uranium, plutonium, americium energy window between 4.4 and 5.5 MeV, which provides a constant, known, target transuranic radionuclide source analogue without sampling a tranuranic aerosol.

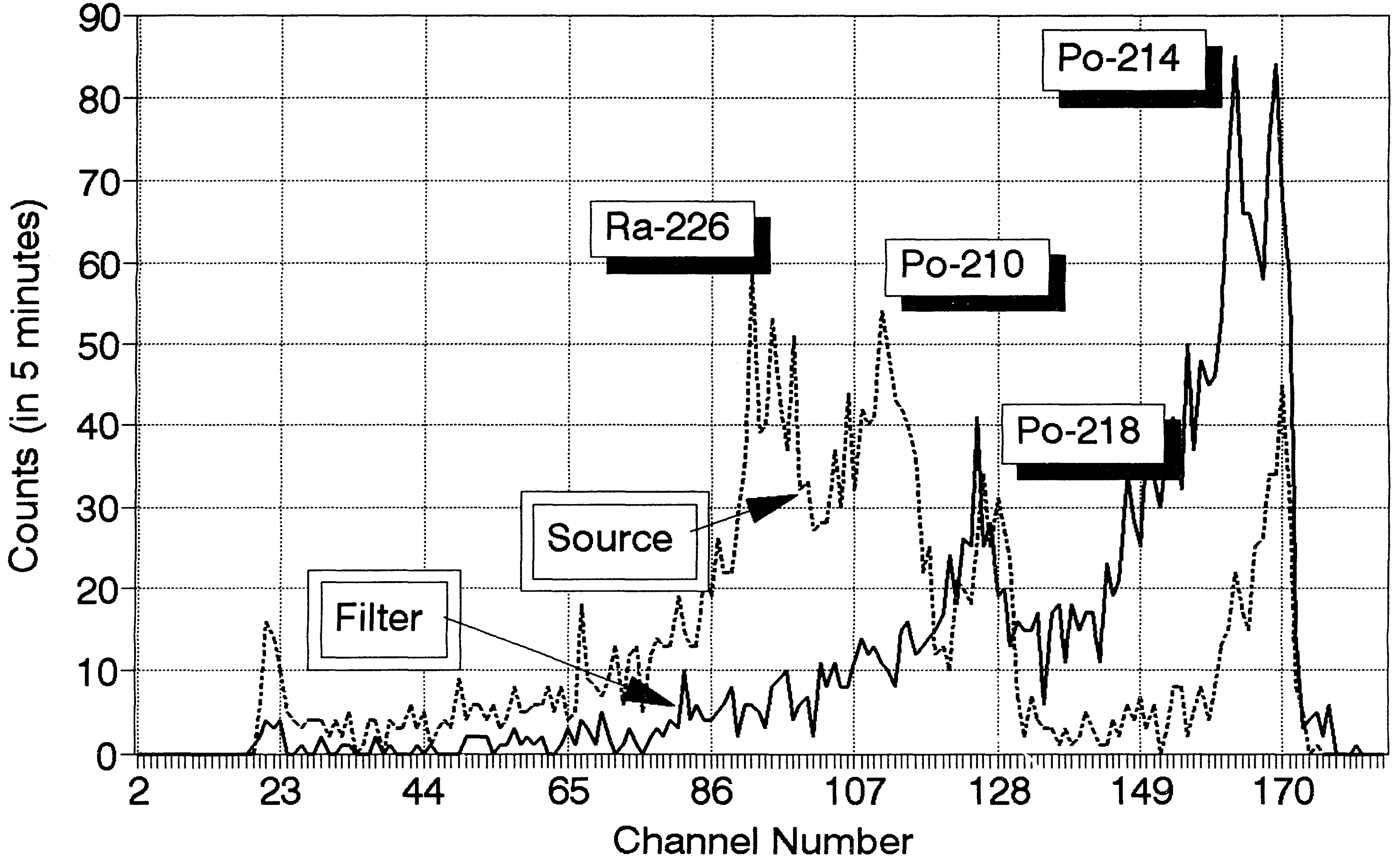
2.) The source has radon daughter alpha activity constantly available at known levels without sampling an atmosphere containing radon daughters. The spectra are quite comparable with radon daughters collected on a filter.

3.) The source is plated onto a stainless steel screen which can be placed over a filter in the CAM filter cartridge to provide the proper conditions for flow measurement through a filter during the count integration, which are needed for a DAC-hr computation.

To check chronic alarm functionality with this source, the CAM is placed in an operational mode in the maintenance and calibration laboratory with a sampling pump attached and operating. The new check source (which I have dubbed the "CAM-Ra"© source) mounted over a filter in a CAM cartridge is inserted into the CAM head in the ususal manner as would a fresh filter, and a normal count cycle is initiated. At the end of the count cycle, 5 minutes at a minimum, the CAM should report a chronic alarm. At this point the reported DAC-hr can be compared with the standard calibration value for the DAC equivalent of the source. All of the calibration characteristics of the CAM head (efficiency of the detector, sample flow response of the flow meter), and all of the background compensation parameter settings (plutonium energy window, DAC-hr conversion constant, energy calibration,etc.) are brought together in a single output parameter in this test, which makes it a unique and powerful tool for demonstrating complete calibration and functionality of a CAM system (sampling head plus user interface).

At the present time, it is thought that such a chronic alarm test would not be conducted as a routine field test, and there is no provision in the CAM firmware for a special performance test cycle that supports chronic alarm testing. Perodic test and maintenance of the ASM will provide sufficient opportunity for testing this functionality. But in a stand-alone mode (a CAM head connected to an ASM and a pump) under circumstances where settings may be changed it would be easy to verify a planned DAC-hr exposure response from the CAM.

Fig. 2. CAM Chronic Alarm Check Source
Radon Daughters Plus Pu Surrogates



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