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AVNG System Demonstration

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Abstract

An attribute measurement system (AMS) measures a number of unclassified attributes of potentially classified material. By only displaying these unclassified results as red or green lights, the AMS protects potentially classified information while still generating confidence in the measurement result. The AVNG implementation that we describe is an AMS built by RFNC - VNIIEF in Sarov, Russia. To provide additional confidence, the AVNG was designed with two modes of operation. In the secure mode, potentially classified measurements can be made with only the simple red light/green light display. In the open mode, known unclassified material can be measured with complete display of the information collected from the radiation detectors.

The AVNG demonstration, which occurred in Sarov, Russia in June 2009 for a joint US/Russian audience, included exercising both modes of AVNG operation using a number of multi-kg plutonium sources. In addition to describing the demonstration, we will show photographs and/or video taken of AVNG operation.

Introduction

The AVNG [1-3] is a detector system designed to make measurements on sealed canisters of plutonium using a neutron multiplicity counter (NMC) and an HPGe gamma detector. The results of these measurements can be used to confirm declarations that have been made concerning the contents of the canisters. Since the full results of these measurements may be classified, the results are reduced to a set of unclassified 'attributes.' An attribute might simply be an indication that a quantity is above or below a previously agreed-upon threshold, rather than the value of the quantity itself. For the AVNG, the three attributes of "plutonium presence," "plutonium mass >2 kg," and "plutonium isotopic ratio (^{240}Pu to ^{239}Pu) <0.1" were implemented.

To assure that no potentially classified information can be observed, the measurement and computational components of the system are enclosed in an information barrier (IB). The IB

assures that, , only the unclassified attributes are displayed to the user when measuring potentially sensitive items. Figure 1 shows the physical layout of the AVNG.
The AVNG was designed and built at VNIIEF in Sarov, Russia. All the components were tested individually and were assembled into a complete system in 2009. [4] This paper describes the demonstration of the AVNG that was held in June 2009 at VNIIEF with both US and Russian observers present.

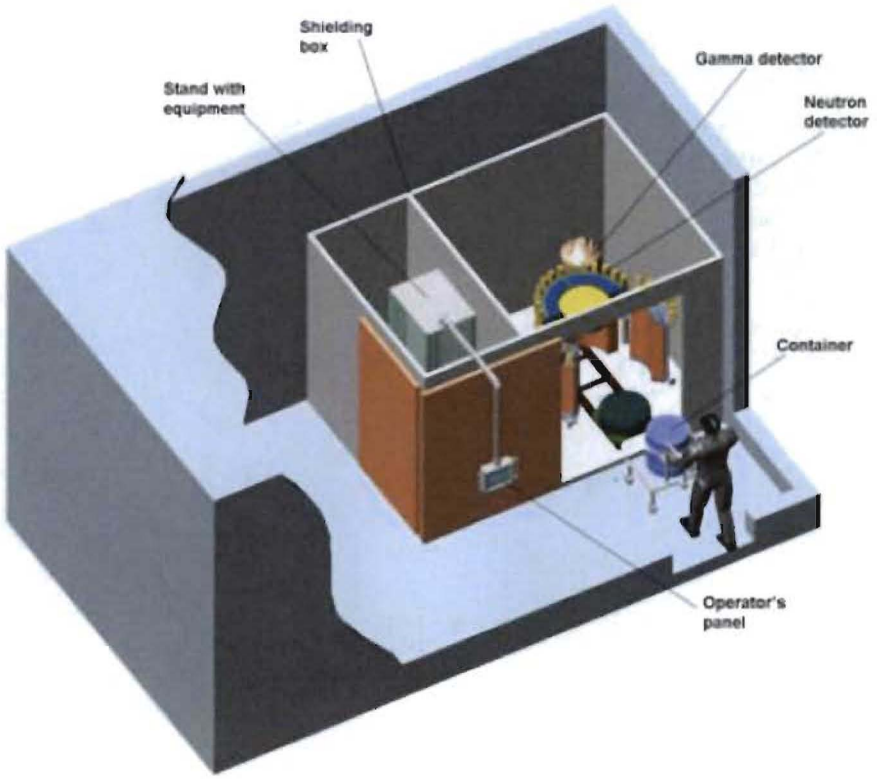

Figure 1 This drawing shows the AVNG system enclosed in its RF-shielded room to prevent accidental information release. Containers of plutonium are loaded into the measurement subsystem and the enclosure door is closed before the measurement begins.

Goals

The AVNG demonstration served a number of purposes.

- Show the full sequence of measurements: calibration, background, and assay measurements.
- Show that measurements performed on known plutonium items produced the expected results.
- Show that the AVNG could operate correctly in both a secure and an open mode, and that moving between them can only occur in the proper circumstances. The secure mode is used for potentially classified items, while the open mode can be used for known unclassified items to check the system operation.

- Show that the AVNG security system responded correctly to non-normal situations: attempted intrusion, power failure, and an emergency abort.
- Fulfill the requirement for the final deliverables for the contract to design and build the AVNG. This contract was between the US and Russia nuclear laboratories.

Procedure

The demonstration was performed over 3 days, at VNIIEF, according to a plan and procedure that had been previously agreed to by the US and Russian representatives. The AVNG system and the large plutonium test sources [5] were in a secure area at VNIIEF. The US observers were in a conference room in an open area. A telephone connection provided communication between the two areas allowing the US observers to stay apprised of the progress of the demonstration and provide input to the proceedings. Measurements and tests were performed in the mornings and thorough videos were made of the entire proceedings. The video camera ran continuously and included commentary by the Russian operators on what was happening and why. In the afternoon the US observers watched the video with Russian experts present to answer questions. Copies of the video were sent to the US after the appropriate reviews had been completed.

Measurements were made using a variety of sources all of which were packaged in the AT-400R canisters (see Figure 2), for which the AVNG had been designed. The AT-400R containers used for the test sources were modified with grooves so that the AVNG would recognize them as unclassified materials that could be run in the open mode. A calibration container had been assembled that held a ^{252}Cf source to check the neutron system and a ^{137}Cs source(^{60}Co??) to check and calibrate the gamma-measurement system. An empty container was used to make background measurements. Four plutonium sources [5] had been manufactured under a separate US-Russian contract and had received certificates as State Reference Materials (SRM) stating their isotopic composition and mass. The plutonium sources had been made to cover the range of parameters ($^{240}Pu/^{239}Pu$ ratio and total plutonium mass) that would be needed to test the AVNG. Table 1 shows the characteristics of these four sources. The plutonium sources had previously been measured at IPPE after which they were placed into the AT-400R containers and had a seal applied. Figure 3 shows these seals being checked during the demonstration. A final source had been constructed called the 'imitator' that contained ^{252}Cf to produce neutrons from fissions and europium to produce a wide range of gamma-ray energies, which, however, did not correspond to those of plutonium.

Figure 2 Photograph of a modified AT-400R. The grooves in the sides were used to indicate to the AVNG that this container contained unclassified material. For this demonstration the grooves could be filled in to simulate a measurement on a classified item (see Figure 6).

Table 1 Parameters for the set of Standard Reference Materials produced for testing and demonstrating the AVNG.

	Pu №0.07-11	Pu №0.07-12	Pu №0.25-21	Pu №0.1-31
$^{240}Pu/^{239}Pu$	0.07 ± 0.01		0.25 ± 0.02	0.10 ± 0.01
^{239}Pu (%)	91.5 ± 1.5		70 ± 3.0	86.5 ± 1.5
^{240}Pu (%)	6.6 ± 0.6		17.2 ± 1.3	8.65 ± 0.45
Total Pu (g)	1000 ± 5	3500 ± 5	1000 ± 5	2000 ± 5

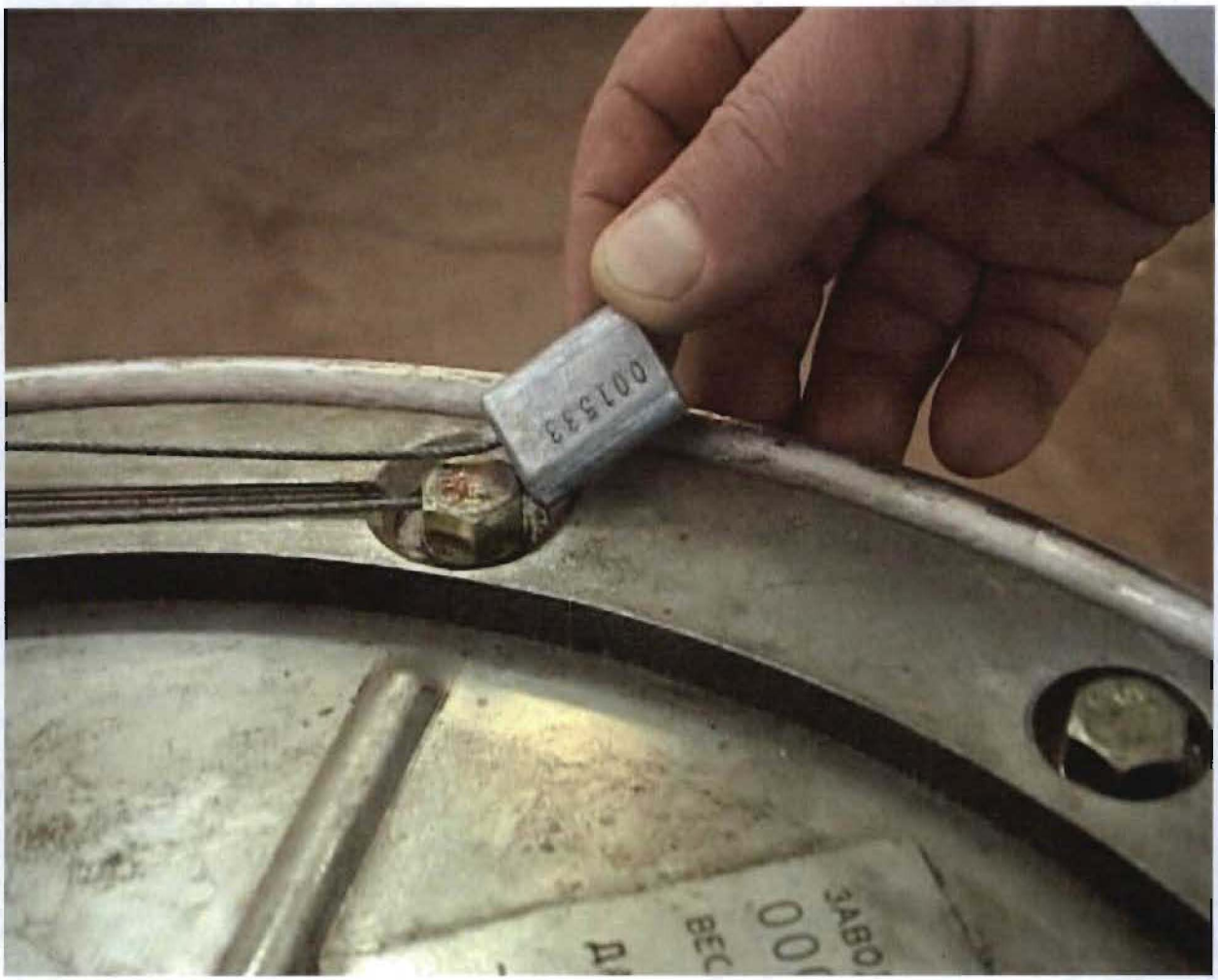

Figure 3 The seals that had been applied after the acceptance test at IPPE were checked before the SRM were measured at the demonstration.

Several procedures were implemented to assure the observers in the open location that the video they watched actually corresponded to the measurements being performed in the classified area of VNIIEF. The telephones calls between the two locations were recorded on the video; notes, with time stamps, taken by the observers could later be correlated with the video. Telephoned requests at specific times, such as "smile and wave at the camera", could later be seen on the video. At the beginning of each day the US observers presented the Russians with some 'markers' that could not have been predicted beforehand (e.g. an airline baggage tag). This marker was then seen in that day's video. For measurements that were made in the open mode, information about the measurements was displayed on an external monitor. This display was printed out and brought to the US observers to examine and compare to the video. At one point the observers were allowed to choose which plutonium source would be measured next, and again the video confirmed this choice.

Measurements and Tests

The first day began with a video tour and explanation of the various sections of the AVNG. The AVNG was then put through its start-up procedure of making a calibration measurement followed by a background one (as it would be at the start of each day.) **Figure 4** shows the calibration container being loaded into the NMC. Two assay measurements were performed in the open mode: the 1kg plutonium source with 0.07^{240}Pu/^{239}Pu, and the 3.5kg source also with 0.07^{240}Pu/^{239}Pu.

Figure 5 shows results for the 3.5kg, 0.07 ^{240}Pu/^{239}Pu source displayed on the external control panel.

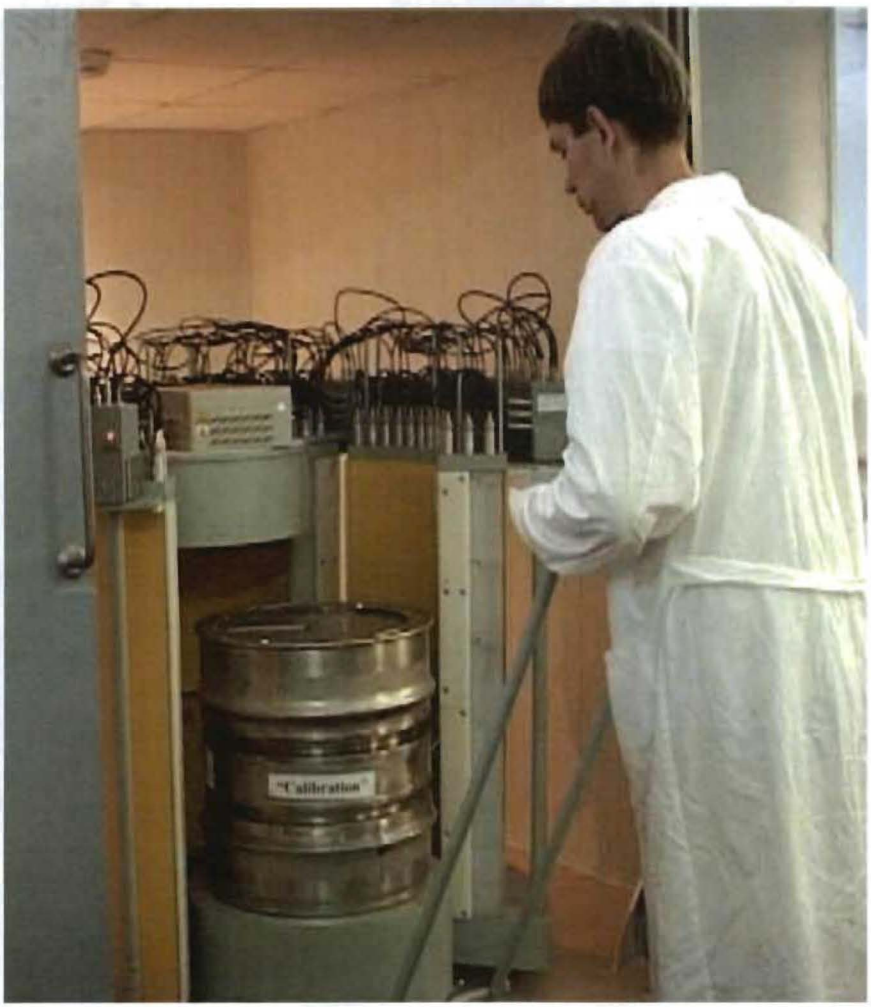

Figure 4 The calibration container being loaded into the AVNG NMC.

Figure 5 The results for the 3.5kg, 0.07 $^{240}Pu/^{239}Pu$ source displayed on the external control panel as seen in the video. The 3 upper green lights indicate that the item: 1) contains plutonium, 2) has $^{240}Pu/^{239}Pu$ <0.1, and 3) that the total plutonium mass is >2kg. The lower green lights indicate where in its measurement sequence the AVNG currently is. The clock used for timestamps on the video is also shown.

The second day an assay of the 1kg, 0.25$^{240}Pu/^{239}Pu$ source was performed. This was followed by the ^{252}Cf Imitator, and then the 1kg, 0.07$^{240}Pu/^{239}Pu$ source was measured again. All these assays were in the open mode.

The third day's assay started again with the 1kg, 0.25$^{240}Pu/^{239}Pu$ source in the open mode. The groove which identified this item as unclassified was then filled in so that it would simulate a classified item. Figure 6 shows the groove being filled. After removing the external monitor, closing all the AVNG doors, and arming the intrusion alarms, another measurement was made.

The rest of the third day was spent testing the AVNG response to non-normal situations.

- The door to the electronics room was opened while in classified mode – an intrusion situation.
- An open mode measurement of the calibration container was started and the NMC was opened during the run.
- A calibration measurement was interrupted by pushing the emergency stop button.

- The circuit breaker to the whole AVNG was switched off during another calibration measurement.
- The background (empty) container was put into the NMC and the AVNG was instructed to do a calibration measurement.

Figure 6 This photograph shows the groove in the modified AT-400R being filled so that the container would simulate a classified source.

Results

The AVNG responded as designed to all the measurement conditions and tests that were performed during the demonstration. All the calibration and background measurements were successful (except the test of making a calibration measurement with the background container, which, properly, failed.) All the assay measurements produced the correct pattern of lights on the control panel corresponding to their attributes. For the assays performed in the open mode, the information on the external monitor showed results in agreement with the item being measured. The tests of the non-normal occurrences resulted in the AVNG computers performing a controlled shutdown and then powering off the system.

References

[1] Pucket, J., *et.al.*, "General Technical Requirements and Function Specifications for an Attribute Measurement System for the Trilateral Initiative," *Proceedings of the 42nd INMM Annual Meeting, Indian Wells, CA, July 2001.*

[2] Budnikov, D., *et.al.*, "Progress of the AVNG System – Attribute Verification System with Information Barriers for Mass and Isotopics Measurements," *Proceedings of the 46th INMM Annual Meeting, Phoenix, AZ, July 2005.*

[3] Modenov, A., *et. al.*, "AVNG System Software – Attribute Verification System with Information Barriers for Mass and Isotopics Measurements," *Proceedings of the 46th INMM Annual Meeting, Phoenix, AZ, July 2005.*

[4] Razinkov, S., *et. al.*, "The Design and Implementation of the AVNG Measurement System," *Proceedings of the 51st INMM Annual Meeting, Baltimore, MD, July 2010.*

[5] Livke, A., *et. al.*, "Reference Material Manufacture and Certification," *Proceedings of the 51st INMM Annual Meeting, Baltimore, MD, July 2010.*