GLASS FIBER SENSORS FOR DETECTING SPECIAL NUCLEAR MATERIALS AT PORTAL AND MONITOR STATIONS

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Nuclear Safeguards and Security Systems LLC (NucSafe) participated in the Illicit Trafficking Radiation Assessment Program (ITRAP) recently conducted by the Austrian Research Center, Seibersdorf (ARCS) for IAEA, INTERPOL, and the World Customs Organization (IAEA, *in press*). This presentation reviews ITRAP test results of NucSafe instrumentation. NucSafe produces stationary, mobile, and hand-held systems that use neutron and gamma ray sensors to detect Special Nuclear Materials (SNM). Neutron sensors are comprised of scintillating glass fibers (trade name 'PUMA' for Pu Materials Analysis), which provide several advantages over ^{3}He and $^{10}BF_3$ tubes. PUMA ^{6}Li glass fiber sensors offer greater neutron sensitivity and dynamic counting range with significantly less microphonic susceptibility than tubes, while eliminating transport and operational hazards. PUMA sensors also cost less *per* active area than gas tubes, which is important since rapid neutron detection at passenger, freight, and vehicle portals require large sensor areas to provide the required sensitivity.

Two PUMA glass fiber neutron and gamma ray sensor systems were designed that exceed the ITRAP detection and ancillary requirements for continuous SNM monitoring of: *1)* vehicles and *2)* pedestrians. Monte Carlo and first principal calculations were applied to model detection limits for both systems; *e.g.*, Figure 1 displays modeling results for the glass fiber neutron sensors evaluated for the Vehicle Monitoring System. Accounting for Poisson variability of data (± 3.29 sigma) and an alarm set point of 5.2 sigma over background, required for reasonably low false alarm rate, at 3 meters WGPu is unquestionably detected in <4 seconds.

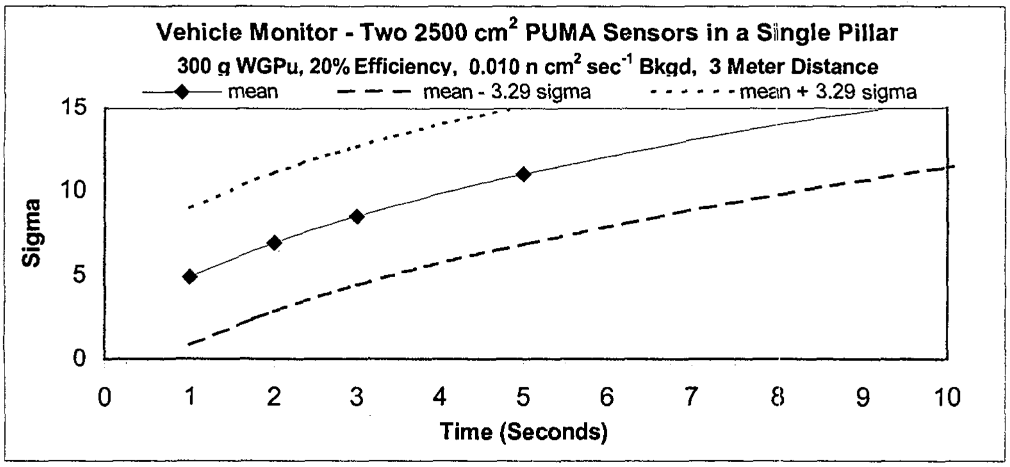

Figure 1. A plot of net counts divided by background standard deviation (Sigma) *versus* time shows that neutrons from 300 grams of WGPu can be detected at a distance of 3 meters within 1 second and is unquestionably detected in < 4 seconds.

Additional modeling results (not shown) demonstrate that a Pedestrian Portal Monitor with a 2500 cm^2 PUMA detector detects 20 grams of WGPu at a distance of 50 cm in 1 second, 10 grams in 2 seconds, and 5 grams of WGPu in 8 seconds. Assumptions used in these models include a neutron background flux of 0.010 n cm^{-2} sec^{-1}, an intrinsic neutron efficiency of 20%, a 5.2 sigma false alarm rate, which represents one false alarm *per* month, and Poisson variability. These model results confirmed the designed systems are capable of reliably detecting SNM and other radionuclides within seconds. Neutron measurements collected with ^{252}Cf in elevated gamma ray fluxes validated the calculated data. Vehicle and Pedestrian SNM Monitors based on these designs then were produced and submitted for ITRAP evaluation.

Both NucSafe "fixed installed" portal monitors were evaluated during ITRAP laboratory and field testing. The gamma ray detection sub-systems were evaluated in laboratory tests using a 0.2 μSv hr^{-1} ^{137}Cs background and required the sensitivity to detect an increase of 0.1 μSv hr^{-1} over a gamma energy range of 60 to 1500 keV for duration of 1 second (tested with ^{241}Am, ^{137}Cs and ^{60}Co). Laboratory neutron testing was with a gamma-shielded 0.01 g ^{252}Cf source emitting ~20000 n sec^{-1}. This ^{252}Cf source had to be detected over a 5 second duration at a distance of 2 meters. False positives had to be <1 *per* 10000 measurements and false negatives <1 *per* 1000. Systems that passed all laboratory tests were then field tested. Field testing the vehicle monitor at the Austrian Nickelsdorf border station required detection of both gamma rays and neutrons from vehicles that could maintain speeds of 8 km hr^{-1}, ~3 meters from the single pillar detection system. The NucSafe Pedestrian Portal SNM monitor was field tested at the Vienna International Airport. Pedestrians could walk past the monitor without slowing their pace. NucSafe vehicle and pedestrian SNM monitors passed or exceeded all ITRAP test requirements (Figure 2).


International Atomic Energy Agency

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CERTIFICATE

This document certifies that the *PUMA* fixed installed monitoring system developed and produced by *NUCSAFE, Clinton, Tennessee, USA* was tested during the Illicit Trafficking Radiation Detection Assessment Program (ITRAP) conducted by the Austrian Research Centers Seibersdorf (ARCS) in co-operation with the International Atomic Energy Agency (IAEA), the World Customs Organization (WCO) and the International Criminal Police Organization (INTERPOL), between September 1997 and June 2000. The test procedures were performed in accordance with the ITRAP minimum requirements laid down in the IAEA Technical Manual on Detection of Radioactive Material at Borders.

This instrument has met or exceeded all ITRAP minimum requirements for the detection of nuclear and other radioactive material as set forth in the IAEA Technical Manual on Detection of Radioactive Material at Borders.

Austrian Research Centers, Seibersdorf, AUSTRIA

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Figure 2. Certificate issued by Austrian Research Centers, Seibersdorf (ARCS) to NucSafe for "fixed installed" systems, which met or exceeded all ITRAP testing requirements for the detection of nuclear materials as set forth in the *IAEA Technical Manual on Detection of Radioactive Materials at Borders (in press).*

REFERENCE

IAEA, in press, Detection of Radioactive Materials at Borders, IAEA-TECD0C XXXX, Final