Y-12
OAK RIDGE
Y-12
PLANT

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ATTRIBUTES AND TEMPLATES FROM ACTIVE MEASUREMENTS WITH ^{252}CF

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Active neutron interrogation is useful for the detection of shielded HEU and could also be used for Pu. In an active technique, fissile material is stimulated by an external neutron source to produce fission with the emanation of neutrons and gamma rays. The time distribution of particles leaving the fissile material is measured with respect to the source emission in a variety of ways. A variety of accelerator and radioactive sources can be used. Active interrogation of nuclear weapons/components can be used in two ways: template matching or attribute estimation. Template matching compares radiation signatures with known reference signatures and for treaty applications has the problem of authentication of the reference signatures along with storage and retrieval of templates. Attribute estimation determines for example, the fissile mass from various features of the radiation signatures and does not require storage of radiation signatures but does require calibration, which can be repeated as necessary.

A nuclear materials identification system (NMIS) has been in use at the Oak Ridge Y-12 Plant for verification of weapons components being received and in storage by template matching and has been used with calibrations for attribute (fissile mass) estimation for HEU metal. NMIS employs a ^{252}Cf source of low intensity ($< 2 \times 10^6$ n/sec) such that the dose at 1 m is approximately twice that on a commercial airline at altitude. The use of such a source presents no significant safety concerns either for personnel or nuclear explosive safety, and has been approved for use at the Pantex Plant on fully assembled weapons systems.

A typical measurement with a radioactive source ^{252}Cf in an ionization chamber is shown in Fig. 1 for a fully assembled weapons system at the Pantex Plant. The source is on the right and four (at least one is required) detectors are on the left. Radiation emanating from the source is transmitted through the system, scattered by the system, and induces fission in the system with the resulting radiation from all three processes reaching the detectors. The use of this method for HEU metal at the Oak Ridge Plant is shown in Fig. 2 where the ^{252}Cf source being located near the part where the uranium mass and enrichment of HEU metal in birdcages was determined to within ± 5% (3 sigma).

Presently three of these systems are in routine use at the Oak Ridge Y-12 Plant for confirmation or verification of weapons components in containers. This methodology has been demonstrated to three visiting Russian delegations at the Oak Ridge Y-12 Plant in 1997 and 1998 (as shown in Fig. 3 for one such visit) where the ^{252}Cf source and detectors are being located around a container with a weapons component. One such system has been exported to VNIIEF at Sarov, Russia and is in use there with weapons components.

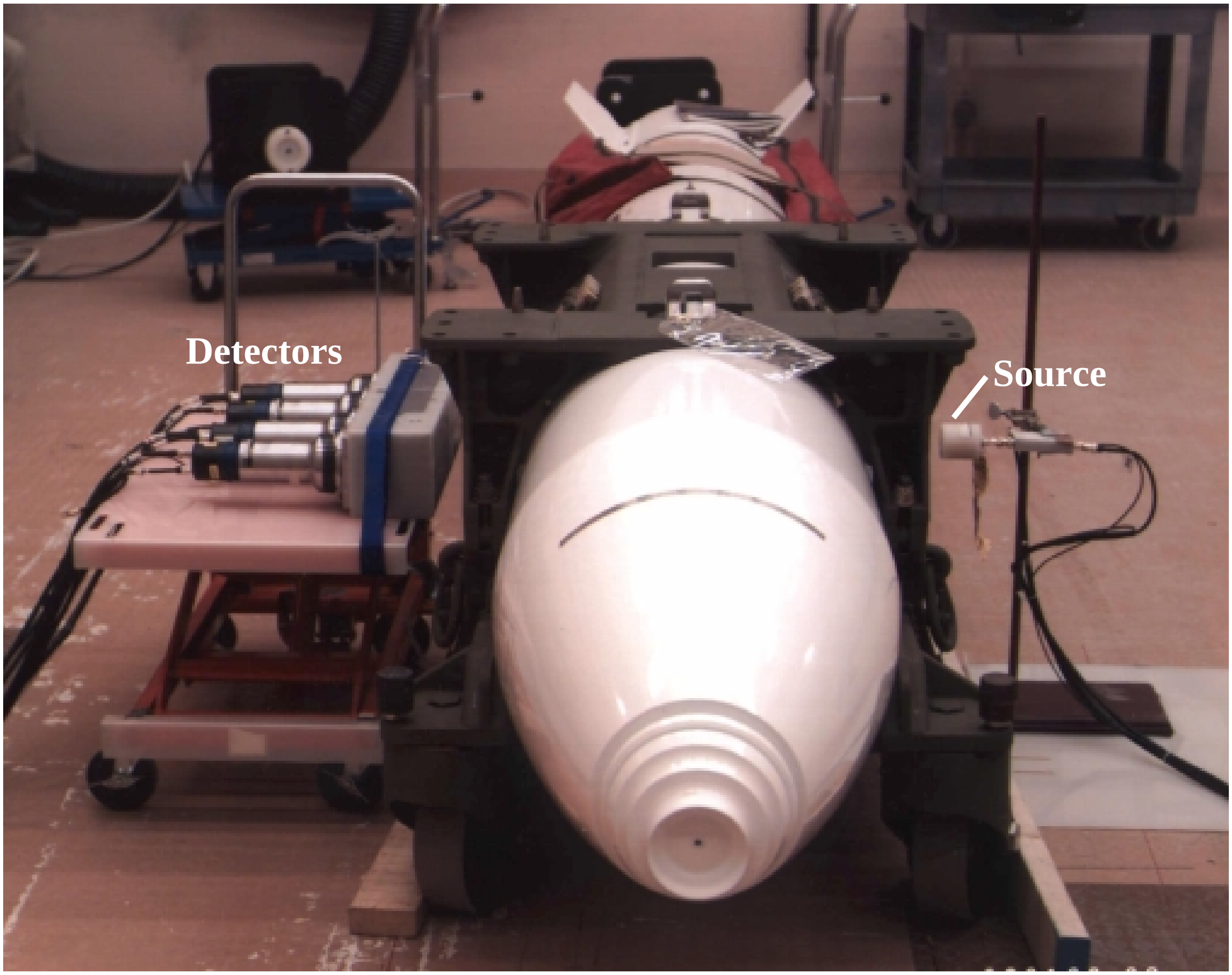

Figure 1. Active Measurements Using ^{252}Cf for a Nuclear Weapon at Pantex.

Figure 2. Equipment Set Up for Verification of HEU Metal.

Figure 3. One of Three Demonstrations of NMIS Interrogation of Weapon Component at the Oak Ridge Y-12 Plant for Russian Delegation (1997-1998).