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Active Interrogation Safety: DT Generator Dosimetry Measurements

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OAK RIDGE NATIONAL LABORATORY
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Nuclear Security and Isotope Technology Division

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ABSTRACT

The use of low neutron output (< 1×10^8 neutrons per second) deuterium-tritium (DT) generators for active interrogation results in a low-dose neutron exposure of personnel. The dose is sufficiently low to personnel using an associate particle imaging (API) DT neutron generator that time and distance is sufficient to minimize exposure to personnel. This type of source can be turned off when the generator has to be relocated appropriately for use. Neutron and gamma dosimetry measurements were performed at Oak Ridge National Laboratory for a generator operating at 5 × 10^7 neutrons per second. The gamma dose was almost negligible compared to the neutron dose. The measured neutron dose at 8 meters was 1.4 mrem per hour. This agrees well with measurements of the ING-27 generator at the All Russian Institute of Automatics (VNIIA) in Moscow where the neutron dose was measured to be 1.5 mrem per hour at 10 meters. Because there is no need to be close to the generator during operation, normal ALARA practice would result in negligible doses to operators compared to the natural background dose (e.g., ~350 mrem in Tennessee).

1. INTRODUCTION

When using neutron sources there is always a concern about neutron dose to personnel. The neutron and gamma dose was recently measured as a function of distance from an associated particle imaging (API) deuterium-tritium (DT) neutron generator operating at a neutron output of 5×10^7 neutrons per second. This type and intensity of a neutron source is used for fast-neutron imaging[1] for the Nuclear Material Identification System (NMIS)[2] and its fieldable version (FNMIS)[3] being developed for the US DOE Office of Nuclear Verification (ONV) and others by the US DOE Office of Defense Nonproliferation Research and Development (NA-22).

2. MEASUREMENTS

For these measurements, the neutron and gamma dose was measured up to 8 meters away from a Thermo-Fisher API-120 DT neutron generator operating at 5 × 10^7 neutrons per second. The space between the neutron and gamma dosimeters was unobstructed, and the generator and measuring equipment were 90 centimeters above the floor. A photograph of the generator and the dosimeters is shown in **Fig. 1**.

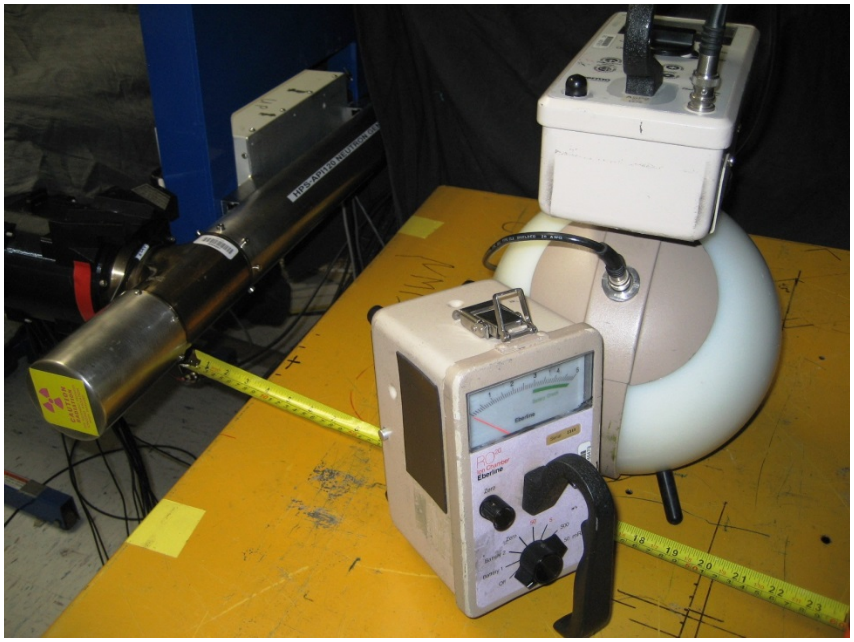

Fig. 1. The D-T neutron generator (left) with the Eberline RO20 Ion Chamber gamma dosimeter (center front), and REM Ball Eberline ASP2e by Thermo Electron Corporation neutron dosimeter (right rear).

The measured dose as a function of distance out to 8 meters is given in Table 1.

Table 1. Measured dose as a function of distance from a Thermo-Fisher API-120 DT generator

Distance (cm)	Dose Rate (mrem/hour)		
	Neutron	Gamma	Total
30	250	35	285
100	45	10	55
200	12	1	13
400	5	0.3	5.3
600	2.5	0.1	2.6
800	1.4	0.1	1.5

The total dose rate is plotted in **Fig. 2** and fitted to the equation shown in the insert, where y is the dose rate (mrem/hr) and x is the distance to the generator (cm).

A typical distance for location of personnel during operation of the generator operating at 5×10^7 neutrons per second is 8 meters**.** In addition, personnel could be located such that the interrogated object is between the generator and the personnel, thus shielding personnel from the generator and reducing their neutron dose considerably.

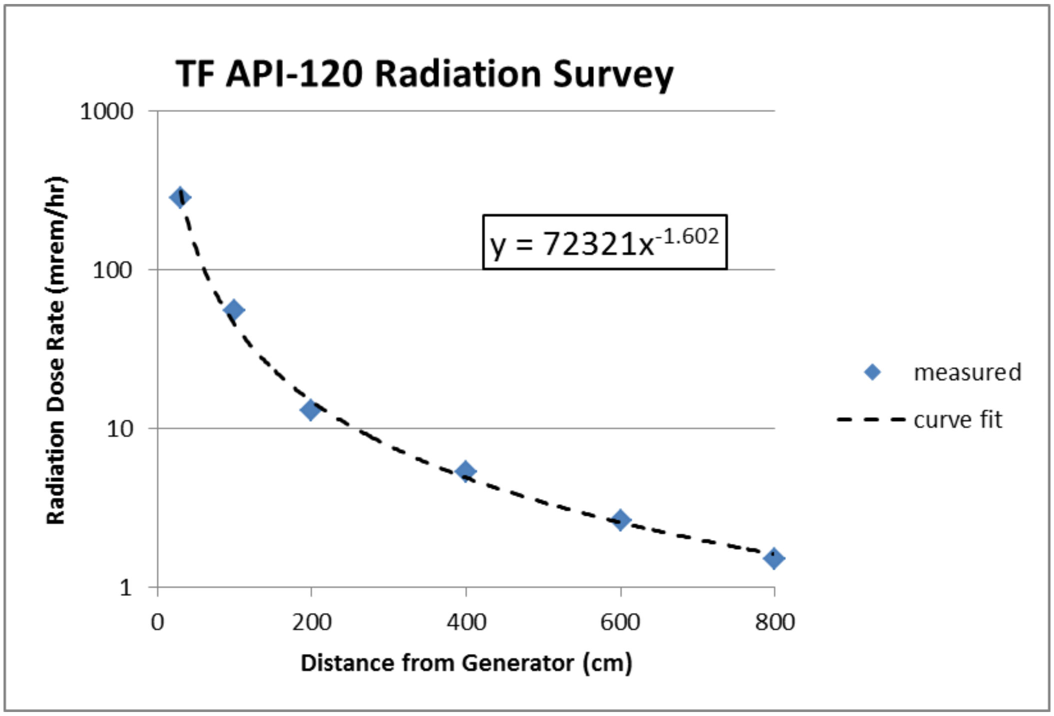

Fig. 2. Total dose as a function of distance from a DT generator operation at5×10^7 neutrons per second.

3. CONCLUSIONS

Utilization of an API-DT neutron generator for fast-neutron imaging can result in very low radiation exposure rates to the operators. Dose rates are about 2 mrem per hour at a reasonable standoff distance, so normal ALARA practice would result in negligible doses to operators compared to the natural background dose (e.g., ~350 mrem in Tennessee).

The generator's effect on the interrogated object is assessed in another report[4].

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