APPENDIX L - Review and Evaluation of the Dose Rates to Vehicle Crewmembers From Uploaded DU Munitions

L.1 Introduction

The military services have conducted studies assessing the radiological characteristics of various DU cartridges since the 1970s. The external dose rates from various DU munitions have been determined by Bartlett et al., (1979); Hooker et al., (1983b); Parkhurst and Soldat (1989); Hadlock and Parkhurst (1990); and Parkhurst et al., (1991). These assessments primarily evaluated the exposure rate or dose rate during the handling, storage and shipping of DU munitions.

Parkhurst and Scherpelz (1993) and (1994a) measured the dose rates in vehicles uploaded with DU munitions. The PNNL refined the dose algorithm to increase the accuracy of DU dose rates where DU shielding was a factor. Parkhurst and Scherpelz (1994a) used the new algorithm to recalculate dose rates measured by dosimeters in studies of the 120mm M829 and M829A1 and the 105mm M833 and M900 cartridges. They also reanalyzed the dose rates in two tanks, the M1 and the M60A3, uploaded with 105mm M900 cartridges.

L.2 Summary of Dose Rates to Crewmembers

Parkhurst and Scherpelz (1994a) reported the radiation dose rates measured inside and outside two tanks, an M60A3 and an M1, combat loaded with 105mm M900 cartridges. Table L-1 lists

measured data for the M60A3 tank, and Table L-2 lists the data for the M1 tank that did not have DU armor. These tables show measured dose rates for normal crewmember positions and various additional locations in the tank interior and exterior. These results reflect the maximum rather than the average measured dose rates.

With both tanks, the positioning of the bustle and the ammunition load during the dose rate measurements was chosen to maximize the dose rates to crewmembers, but is not representative of routine tank operations. With a realistic combat mix of DU and non-DU rounds and the turret positioned with the gun above the driver's head, the study determined that the dose rate to the driver would not be distinguishable from background rates. However, it would be reasonable to use a dose rate of 0.2 millirem (mrem)/hr to the driver, which is the maximum average value found during these measurements.

The H_d can be estimated from measured or estimated dose rates in the area of concern in the vehicle and the length of exposure.

Table L-1. Measured Deep Dose Rates for the M60A3 Tank

DOSIMETER LOCATION	DOSE RATES (mrem/hr)
Crewmembers	
Driver	
Head	0.15
Torso	0.18
Left Leg	0.21
Average (including Leg)	0.18
Loader	
Head	0.09
Torso	0.13
Groin	0.18
Average	0.04
Gunner	
Average	0.04
Commander	
Head	0.03
Chest	0.04
Groin	0.04
Average	0.04
Tank Structures	
Steering Column	0.19
Ledge behind Commander	0.05
Ammunition stacked 3 High on Floor	
Top	0.33
Front	0.14
Between Unpackaged Cartridges	1.99
Top Hatch above Driver	0.11
Back Chassis below Bustle	0.12

Table L-2. Measured Deep Dose Rates for the M1 Tank

DOSIMETER LOCATION	DOSE RATES (mrem/hr)
Crewmembers	
Driver	
Head	0.15
Back	0.05
Groin	0.12
Average	0.11
Loader	
Head	0.01
Back	0.01
Average	0.01
Gunner	
Torso	0.01
Commander	
Head	0.01
Torso	0.01
Tank Structures	
Steering Column	0.19
Ammunition Stacked 3 High on Floor	0.47
Support Between Ready Boxes	0.00
Top of Bustle, Penetrator End	0.30
Back End of Bustle	0.09
Underside of Bustle above Driver	0.31
Running Board	0.01

The dose rate from an unshielded DU slab is about 0.24 rad/hr when in contact with the bare skin[46]. About 90 percent of this dose is from beta radiation, and 10 percent is due to low energy photons[46]. The contact dose rate on an intact DU penetrator is about 0.2 rad/hr[25].