APPENDIX M - Tank Battle Scenario

M.1 Theoretical Example I - Part A - Soldier DU Exposure Due to Resuspension on the Battlefield

- **Introduction**

The largest tank battle recorded prior to 1991 was in the 1973 Arab-Israeli War. This battle was an armor engagement with 150 tanks over a 50-hectare (ha) battlefield.

- **Estimation of Resuspension of DU on the Battlefield**

Using this scenario as a unit of tank battle, the following assumptions are made to estimate a soldier's exposure from resuspended DU in a THEORETICAL tank battle using current DU kinetic energy penetrators (KEPs):

- The largest 120mm penetrators are used (4.7 kg each).
- Thirty-five percent of each penetrator is aerosolized on impact or perforation.
- Ninety-six percent of the DU particles were in the respirable range (<10 μm) and 53 percent of the particles were ≤ 1 μm.
- BR (or ventilation rate) (light exercise) is 1.5 m^3/hr (25 L/min).
- DU source solubility is Class Y (or Type S).
- DU particle size of 1 μm.

- Two DU rounds strike each tank.
- All tanks are killed.
- All aerosolized DU settles on the surface of the 50-ha battlefield (50 ha = 5 x 10^5 m^2).
- The soil is mixed to a depth of 0.001 meter.
- The soil bulk density is 2.6 x 10^3 kg/m^3.
- Ninety percent of the aerosol particles are deposited within 1.6 x 10^2 feet (50 meters) of each perforated tank.
- One-hour exposure duration.
- Exposure frequency is one.
- A resuspension factor of 0.0001 per meter (1 x 10^{-4}/meter) is used.

The resulting maximum DU contaminant level at the soil surface is 9.7 x 10^{-4} kg/m^2. This DU-contaminant level is consistent with the DU contamination level of 2.2 x 10^{-3} kg/m^2 at 5 meters from the target. The 5-meter contamination level was calculated using data from Fliszar et al., (1989) Test 5A. Until the first rainfall, the movement of ground troops or ground vehicles can resuspend settle aerosol. For a 1-hour exposure duration with light exercise, an individual CEDE is estimated to be 0.50 rem. (Note: The CEDE is the internal radiation dose received from an intake of radioactive material by an individual during the 50-year period following the intake. For DU, about 75 percent of this dose will be received in the first year following the intake of a 1 μm AMAD aerosol.)

The quantity of non-aerosolized fragments generated when the DU penetrators perforate tank armor is (4.7 kg/DU round) x (2 DU rounds/tank) x [150 tanks x (0.65) non-aerosolized fragments] ≅ 920 kg of DU fragments scattered over the battlefield.

The remaining 920 kg of DU fragments are assumed to solubilize at the rate of 1 percent per year, so that 9.2 kg of DU will be released to the surface soil layer each year, equivalent to a concentration of—

$$[(9.2 \text{ kg of DU}) * (10^6 \text{ mg/kg})]/[(50 \text{ ha} \times 10^4 \text{ m}^2/\text{ha}) * (1 \times 10^{-3} \text{ meter}) * (2.6 \times 10^3 \text{ kg/m}^3)] = 7.1 \text{ mg/kg}$$

Note: 1 ha = 1 x 10^4 m^2; therefore, 50 ha = 5 x 10^5 m^2.

M.2 Theoretical Example I - Part B - Individual's DU Exposure Downwind of the Battlefield

The assumptions in Part A are incorporated in this part. The following additional assumptions are made to estimate an individual's exposure downwind, due to resuspension from track vehicle operations within the 50-ha area, five days following the armor engagement.

- Effective release height is zero (0)
- Effective wind speed is 3 meter/sec
- Effective radius is 50 meters
- Stability class is F

- Deposition velocity is 1 cm/sec
- Effective source term is 1.6×10^{-5} Ci/sec
- Effective resuspension factor is 9.3×10^{-4}/meter
- Effective material that is available for transport is 3.4×10^{-7}/pCi of DU
- Time after deposition is 5 days
- Weathering half time is 50 days

The Gaussian plume model is used to calculate the estimated dose from the inhaled contaminant when employing the HOTSPOT computer code. If D is the calculated dose 50 percent of the time, the true dose will be between D/3 and 3 * D, and 80 percent of the time, the dose will be between D/8 and 8 * D[47].

Therefore, for more accurate dose estimates, the sophisticated modeling available from Lawrence Livermore National Laboratory's ARAC computer codes must be used.

Based on a DU contaminant level of 9.7×10^{-4} kg/m^2 and the effective resuspension factor of 9.3×10^{-4}/meter, the following ionizing radiation doses (CEDE), using models discussed in NCRP Report No. 76 and Appendix I, are calculated and provided in Table M-1.

Table M-1. Projected Doses (CEDE) at Distances Beyond 50 Meters

Distance from Effective Radius (50 meters) in (km)	Dose (CEDE) in rem
0.1	0.02
1.0	0.003
10.0	0.0001
100.0	0.0000002