External Exposure

Only health hazard is radiation.

If bare skin *not* in contact with bare DU:

Theoretical maximum	2.5	mrem/hr
Inside DU-loaded tank	0.2	mrem/hr
Ground contaminated with 1 t/km^2 (1 g/m^2)	1	mrem/yr
Ground near impact with 100 g/m^2	30	mrem/yr

Compare to:

Limit for unrestricted occupational access	2.5	mrem/hr
Limit for public	100	mrem/yr
Natural background	300	mrem/yr
Occupational limit	5000	mrem/yr
Risk of cancer death	$\frac{1 \text{ in } 2{,}000{,}000}{\text{mrem}}$	

Bare skin in contact with bare DU:

Dose to skin	230 mrem/hr

Compare to:

Limit for unrestricted occupational access	25 mrem/hr
Threshold for short-term health effects	300,000 mrem (in 1-2 days)
Risk of skin cancer from DU bracelet	≈1% per year of exposure

Population Dose:

If 300 tons of DU dispersed in area with population density of 50/km^2…

…50-year dose ≈ 200 person-rem

≈ 10% chance of 1 extra cancer death

Internal Exposure

Hazards: radiation (insoluble)
heavy-metal toxicity (soluble)

Inhalation worse than ingestion

	Inhalation	Ingestion
Radiation effects		
5 rem	100 mg_{ins}	50,000 mg_{sol}
respiratory impairment*	40,000 mg_{ins}	
Renal damage		
transient	8 mg_{sol}	80 mg_{sol}
permanent	40 mg_{sol}	400 mg_{sol}

*3000 rem to the lungs in one year.

	Impacts on hard targets	Fires
% converted to respirable aerosol	3–70%	<0.05%
% aerosol in soluble form	15–45%	3–7%

	aerosols inhaled from	
	Impacts	Fires
Radiation effects		
cancer death	<0.2% risk per 100 mg	
Renal damage		
transient	>20 mg	>100 mg
permanent	>100 mg	>500 mg

Outside Struck Vehicles

Dose to nearby soldiers is low:

Even very close to an impact or fire, doses are very low—factor of 50 to 1000 below threshold for toxic effects

Even if an individual was 10 km downwind from the impact *every* round used in the Gulf (or 1 km from 1 percent of these impacts), dose < 10 mg.

Dose to surrounding population is low:

If 30 tons respirable aerosol dispersed in area with pop. density of 50/km^2…

…50-year dose ≈ 4,000 person-rem

≈ 2 extra cancer deaths

individual risk < 0.001%

Inside Struck Vehicles

During impact:

Inhaled dose could be > 50 mg

Dose from shrapnel below threshold for toxic effects, but moderate radiation doses possible (few rem per gram).

After impact:

Clean-up, repair without protective gear could result in very high doses

Rescuers, souvenir hunters could inhale possibly worrisome amounts of DU

Best way to evaluate is urine test soon after exposure.

This wasn't done in the Gulf, so difficult to determine how many people were heavily exposed: tens? hundreds? more?

Environmental Effects

Uranium is ubiquitous in environment

1–4 ppm in soil = 2–8 tons/km^2 in top m

3 ppb in seawater = 3 tons/km^3

Compare to <1 ton/km^2 for DU in battlefield areas

Natural uranium more radioactive than DU

Much of the DU not biologically accessible

Conclusions

- Risks associated with DU exposure are very small, except for
  - soldiers in vehicles when struck
  - people who enter struck vehicles with respiratory protection (rescuers, clean-up and repair crews, scavengers)
  - people who have continuous contact of bare skin with bare DU
- DU unlikely to be a cause of Gulf War illness or public-health problems in Iraq
- Environment effects of DU comparable to natural variations in U concentrations
- Nevertheless, steps should be taken to minimize exposure:
  - educate soldiers, public
  - restrict access to contaminated vehicles
  - collect, bury penetrators