UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

MAR 18 1991

MEMORANDUM FOR: James M. Taylor
Executive Director
for Operations

FROM: Robert M. Bernero, Director
Office of Nuclear Material Safety
and Safeguards

SUBJECT: NUCLEAR REGULATORY COMMISSION (NRC) LICENSING OF MILITARY USE OF DEPLETED URANIUM (DU)

The Middle East conflict raises timely questions about the issue of NRC's regulatory jurisdiction over U.S. military use of DU abroad. These questions were highlighted by an incident that arose on the front line in Saudi Arabia, involving a tank fire containing DU ammunition. The tank was subsequently returned to the U.S., where it (or its DU-contaminated components) will be prepared for disposal. To address this regulatory jurisdictional issue, the Nuclear Material Safety and Safeguards (NMSS) staff conducted a review of NMSS licensing procedures, the current types of licenses for DU for military use, current license conditions on military DU licenses, Office of General Counsel (OGC) views on NRC jurisdiction over U.S. Armed Forces bases abroad, and NRC waste-disposal requirements. Based upon this review, the staff concludes that NRC regulations and licensing procedures do not extend to, nor hamper, the military use of DU abroad.

A. Military Uses of DU

Currently, military applications of DU include ordnance application for various munitions, armor for tanks, and, to a limited extent, ballast for missiles. Enclosure 1 describes the properties of DU. Enclosure 2 describes various commercial and military applications of DU. Currently, NRC licenses the U.S. Army's use of DU at specific locations in the U.S. (see Enclosure 3). The license conditions on the U.S. Army licenses are limited to radiation safety requirements and do not preclude DU use in military action abroad. Department of the Navy and Department of the Air Force uses of DU are covered under their master materials licenses, which are broad-scope and not limited to DU.

B. NRC Jurisdiction

NRC has no jurisdiction over material exported from the U.S. (except as provided in NRC physical protection regulations in 10 CFR Part 73). The material overseas that U.S. military forces possess is presently subject to military regulatory stipulations regarding its use.

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C. Disposal of DU

Based on discussions with the Army, it is the staff's understanding that some DU waste will be returned to the United States from Saudi Arabria and Kuwait for disposal. Under 10 CFR Part 61, depleted uranium is, by definition, Class A radioactive waste. Accordingly, DU waste is theoretically acceptable for disposal at any one of the three currently operating low-level radioactive waste disposal facilities.

The military might need to negotiate with the appropriate State compact or licensee that will dispose of DU waste from the Middle East conflict. However, to our knowledge, such a disposal issue has not yet arisen. An NRC specific import license would not be required; imports of this DU would be permitted under the General License in 10 CFR 110.27(a)(3).

OGC has reviewed this paper and has no legal objection.

I trust that this information will be helpful to you. My staff and I are available to meet with you if you have additional questions on this subject.

Robert M. Bernero, Director
Office of Nuclear Material Safety
and Safeguards

Enclosures: As stated

PROPERTIES OF DEPLETED URANIUM

Chemically, depleted uranium (DU) is identical to natural uranium. Uranium is silver-white, lustrous, dense radioactive metal, with an atomic weight of 238.029 and a specific gravity of 19.01 $\pm$ 0.02 at 25°C. Uranium melts at 1132°C and boils at 3818°C. Uranium is a reactive metal and exists in two oxidation states - +4 and +6. The general chemical character is that of a strong reducing agent, particularly in aqueous systems. It oxidizes slowly in air at room temperatures. It first assumes a golden-yellow color, then becomes black, as oxidation proceeds for several days.

Natural uranium is primarily composed of three isotopes: U-238 (99.275 percent), U-235 (0.72 percent), and U-234 (0.0057 percent). In DU, the isotope composition is approximately U-238 (99.75 percent), U-235 (0.25 percent), and U-234 (0.000037 percent).

DU is considered a low activity radioactive material (e.g., approximately 2.5 metric tons of DU are equal to approximately 1 curie of radioactive material.) The principal radiation emissions from DU are alpha and beta particles and gamma rays. The specific activities of DU, including the decay type, half-life, and component energy levels of those nuclides that contribute most significantly to radiation dose, are listed in Table 1. The non-uranium isotopes listed in Table 1, are daughter decay products.

Table 1. Radiation from Principal DU Nuclides

Nuclide	Decay	Half-life	Alpha Energy (MeV)	Beta Energy (MeV)	Gamma Energy (MeV)*
U-238	Alpha	4.51×10^9 yr	4.19	-	0.048
U-235	Alpha	7.10×10^8 yr	4.18 - 4.56	-	0.074 -0.38
U-234	Alpha	2.50×10^5 yr	4.717 (28%) 4.768 (72%)	-	0.051
Th-234	Beta	24.1 days	-	0.10 (35%)	0.029 - 0.091
Th-231	Beta	25.6 hr	-	$\leq$0.30	0.017 - 0.31
Pa-234	IT*(1%) Beta(99%)	1.8 min	-	2.31(<90%) 1.50(<9%) others	0.043 - 1.83 0.043 - 1.83

*Isomeric transition to PA-234, which decays with 6.6-hour half-life to U-234.

Enclosure 1

PRESENT AND PAST USES OF DEPLETED URANIUM*

COMMERCIAL APPLICATIONS

Ballast and Counterweights

Depleted uranium (DU) has been used in ballast and counterweight applications. In addition to its high density characteristic, DU can be readily fabricated into very large components by melting and casting. The mechanical properties of DU also permit its use as a structural material. The use of DU as a counterweight is listed as "Unimportant quantities of source material," in 10 CFR 40.13.

Balancing Control Services on Aircraft

DU is used to balance the weight of an aircraft control surface (i.e., rudder, aileron, elevator) around its hinge points. This requires a dense material as a counterweight, because of space limitations, particularly in the case of high-performance jet aircraft, with their relatively thin wings and empennage. DU counterweights for this application are produced in a variety of shapes and sizes and can weigh from a few ounces to several hundred pounds. Counterweight usage on the larger aircraft can total several hundred pounds.

Balancing and Vibration Damping on Aircraft

In addition to use as specific control surface counterweight, DU has been used for structural vibration damping, for weights on leading edges of helicopter rotors, and for counterweighting items other than control surface on aircraft.

Machinery Ballast and Counterweights

DU has been used as balance weights for drill collars, tool holders, momentum wheels, and crankshafts, to enhance vibration damping during the machining of work pieces, and to apply greater pressure on drill bit edges, thereby increasing drilling rates. DU is also used in certain testing machines and on some large crushing machinery.

Gyrorotors and Other Electromechanical Counterweights

DU is used in a number of electromechanical devices where high density material is required for gimbal weights and similar applications. It has also been used for the rim of gyrorotors, where its density is important, and because certain of its alloys are compatible with the other gyroconstruction materials.

*See U. S. Army Armament, Munitions, and Chemical Command, "Environmental Overview for Depleted Uranium," October 1985.

Enclosure 2

Radiation Shielding

The high density of DU and, in certain applications, the high atomic number, make DU a nearly ideal gamma and X-radiation shielding material. It has been used in radiation shields of all sizes, ranging from those weighing a few ounces to multi-ton shields. DU is currently used in areas where lower density and less expensive shielding materials are not feasible; typical among these are the small isotope radiography devices. The use of DU in large shields has been limited to areas where weight or space limitations are critical.

Use of DU as Catalyst

The plastics industry uses DU as a catalyst for the production of acrylonitrile. Successful research on the direct catalytic oxidation of propylene and ammonia, to form acrylonitrile, led to the first bismuth phosphomolybdate catalyst developed for commercial use in 1960.

Miscellaneous Uses

DU has been used in glass and ceramics to produce brilliant colors, in X-ray tubes for producing hard X-rays of short wave length at a high efficiency, and in electrodes as a source of ultraviolet light. Other uses for DU compounds include analytical reagents, radiation sources in metering devices, as silk mordants, as electrodes in an ionic centrifuge, as metallographic aid in electron microscope work for shadow casting, in insect repellents, and as DU salts in combating certain tropical diseases.

MILITARY APPLICATIONS

Ballast for Missiles

DU has been used to a limited extent, in the missile airframe, in a way similar to that described for commercial aircraft. DU has also been used for payload simulation, on test and practice reentry vehicles, in conjunction with the space program.

Ordnance Applications

DU alloys are well-suited for various munitions. These DU projectiles are formed into slender rods, often tipped with hard tungsten alloys, called penetrators. The high sectional density provided by the small contact area and high mass of uranium generates very large kinetic energy transfer to the impacted surface to maximize penetration. Included in these munitions are the armor piercing (AP) projectiles. In addition to the excellent AP characteristics, the DU penetrator changes to a highly pyrophoric state after breaking up into small particles on target impact. DU is being used by the Army, Navy, and Air Force for ordnance applications.

Armor for Tanks

DU high-density characteristics, and the fact that it can be readily fabricated into very large components by melting and casting, make it ideal for armor-plating in tanks.

Research and Development

Research and development on DU is conducted at several Army installations with facilities for machining, melting, pouring, and casting, as well as at outdoor test ranges, in support of various Army programs, including production acceptance tests of DU munitions.

Presently, the Army conducts tests against soft and hard targets under Nuclear Regulatory Commission (NRC) licenses. It has outdoor impact areas for soft-impact testing and containment enclosures for testing against projectiles fired from guns against armor targets.

Field Testing and Training

Development and acceptance of Army DU ammunition is presently conducted on a lot-by-lot basis. Acceptance testing includes armor penetration, dispersion, and metal-parts integrity tests.

DU munitions are not used for training exercises.

DEPARTMENT OF ARMY SOURCE MATERIAL LICENSES
FOR MILITARY APPLICATIONS OF DEPLETED URANIUM

(1) SUB-1435, "Department of the Army, U.S. Army Jefferson Proving Ground, Madison, IN

MAJOR USE: Projectiles testing

(2) SUB-734, "Department of the Army, White Sands Missile Range, White Sands, New Mexico

MAJOR USE: Ballast in small missile systems and projectiles testing

(3) SUB-834, "Department of the Army, Commander U.S. Army Combat Systems Test Activity, Aberdeen Proving Ground, MD*

MAJOR USE: Projectile testing

(4) SMB-1411, "Department of the Army, Commander Yuma Proving Ground, U.S. Army Yuma Proving Ground, Arizona

MAJOR USE: Projectiles testing

(5) SUB-1536, "Department of the Army, Warren, MI

MAJOR USE: Manufacture and use of Abrams M1 Series Tank Turrets

(6) SUC-1380, "Department of the Army, HQ, U.S. Army Armament Munitions and Chemical Command, Rock Island, IL*

MAJOR USE: Receipt, storage, and transfer of military device containing depleted uranium components

*Licenses for Numbers 3 and 6 are attached as examples.

Enclosure 3