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PHILOTECHNICS

65FR 3259
Jan. 20, 2000

RECEIVED

March 13, 2000
00-0328

2000 APR -3 PM 3:05

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US NRC

Chief, Rules Review and Directives Branch
U.S. Nuclear Regulatory Commission
Mail Stop T6-D59
Washington, DC 20555-0001

Dear Sirs,

I would like to offer some comments on draft NUREG-1717. This document is comprehensive and well organized. It can be a valuable reference tool. It will be improved if individuals with current knowledge of the various materials and products and their patterns of use are willing to comment on the draft. My comments pertain to Section 3.17, Uranium in Counterweights. This letter comprises some general observations and recommendations. A set of detailed comments keyed to the individual paragraphs of Section 3.17 will be forwarded separately.

The application of the basic methodology of the study to aircraft counterweights ignored some operational and technical factors. The study correctly identifies maintenance personnel engaged in installing and removing the counterweights as the critical group, but the resultant individual effective dose equivalent estimate of 20 mrem is unrealistically low. While several relevant industry studies were identified and considered, other pertinent sources of information were not taken into account. In summary, effective dose estimates were modeled using an excessive thickness of protective plating, EDEs did not consider the effects of damaged, de-plated surfaces or the internal uptake of uranium oxide corrosion products, the study did not consider the documented exposure experience reported by the U.S. Air Force resulting from similar operations, and EDEs did not consider the effects of changing patterns of distribution and use of counterweights e.g. growing activity involving the "parting-out" and salvage of overaged aircraft.

Plating Thickness

One aspect of the modeling that bears review involves the assumptions about the thickness of plating on the counterweights. The objective in plating is to coat the DU with cadmium. Since cadmium does not adhere well to uranium, an initial plating of nickel is applied because the cadmium will bond better to the nickel. According to Section

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3.17.4, the modeling assumes a 5.1×10^{-3} cm. layer of nickel and a 2.5×10^{-3} cm. layer of cadmium. The nickel layer applied during refinishing is nominally 1.0 to 1.5 mils (2.5×10^{-3} to 3.8×10^{-3} cm.). The selection of a 5.1×10^{-3} cm. value for modeling appears to be excessive and inconsistent with the manufacturer's data provided by Michel (see discussion below). The re-plating process is controlled by regulating operating parameters such as electrolyte strength, voltage and residence time. Direct measurements of plating thickness are not routinely made, so nominal thickness values should treated with circumspection. If dose equivalent estimates are sensitive to plating thickness, NRC should use low range thickness values or confirm representative values by independent measurement. Section 3.17.3.1 cites a National Lead Study including measurements of a "typical" counterweight with a "2.5×10^{-3} cm. nickel-cadmium" plating thickness. The description of the "typical nickel-cadmium plated (0.001 inch) counterweight" in the first column of Table 3.17.2 is consistent with the interpretation that this thickness applies to both the nickel and cadmium plating combined. If this is correct, the MicroShield modeling based on a combined plating thickness of 7.6×10^{-3} cm. (5.1×10^{-3} Ni plus 2.5×10^{-3} Cd) is using a thickness that exceeds the plating on an actual representative counterweight by a factor of three. This could result in an unrealistically high attenuation estimates for the radiation from counterweights and yield low dose predictions.

Plating Deterioration

Estimates of effective dose equivalents for aircraft supply and maintenance workers have also been underestimated because of erroneous assumptions about industry practice. One of these is articulated in Section 3.17.4, Present Exemption Analysis. It is basically an assumption of symmetry for the operations of installing and removing counterweights from aircraft. For both operations, dose rates were calculated on the basis of a nickel-cadmium plated counter-weight. In general, the reason that counterweights are removed from an aircraft is because the plating is no longer intact, and the counterweight requires refurbishment to restore it to airworthy condition. A conservative model for counterweight removal should assume a significant area of bare uranium exposed. The cited Boeing study indicates typical damage areas of from 1% to 50% of the exposed surface. The data from the National Lead study cited indicate that beta/gamma dose rates from the bare uranium are over six times greater than from a plated surface at 15 cm and over ten times greater at 31 cm. These data also indicate that the gamma dose rate is 15 times greater at 15 cm. and 25 times greater at 31 cm. These differences suggest that refined modeling to account for the presence of unplated areas on counterweights during removal would result in increased individual and collective dose estimates.

There is an important corollary to this because the presence of unplated DU implies the existence of corrosion products. As a result, the potential exposure of workers would not be solely external but would also include ingestion and inhalation of uranium oxide particles, which are far more serious health concerns (see below).

Available Contamination and Exposure Data

Since DU counterweights in the commercial sector are exempt from licensing and controls, removal and handling operations take place in unlicensed facilities under supervision that is not sensitive to the potential hazards of the material. As a result, there is little documentation of worker exposures or of the occurrence of uranium corrosion products. There is relevant information available, however, which the NRC can obtain to improve its understanding of these issues. The U.S. Air Force initiated a program last year to refurbish all the depleted uranium counterweights on its fleet of C-141 transport aircraft. Because initial inspections had confirmed that serious contamination problems would be encountered during removal of the counterweights, the Air Force elected to ship the control surfaces intact to a contractor with a radioactive material license and a radiation protection program so that the counterweights could be removed, re-plated and reinstalled in a controlled radiation area. Initial studies of the control surfaces during a pilot refurbishment operation revealed the presence of large amounts of uranium oxide corrosion products. The Air Force's contractor performed a demonstration of his processes on four C-141 ailerons and four C-141 elevators and furnished a report to Robbins Air Force Base. As part of the demonstration contract deliverables, the contractor provided a detailed radiological survey of the flight control surfaces and a set of photographs documenting the extensive corrosion of counterweight surfaces. The report summarized their findings by stating: "As shown, the average alpha contamination is 62 times greater than the release limits for unrestricted use and 39 times greater than the release limit for beta/gamma contamination. The average contamination levels are 50 times greater than release limits."

In spite of these precautions, the Air Force reported an instance of worker exposure to DU from a counterweight removal operation last summer at Robbins Air Force Base. This incident was reported in NRC's Daily Events Report as Event Number 35964. It occurred on 26 July 1999 when maintenance personnel were removing a corroded DU counterweight from a C-141 aileron. Radioactive dust and debris was dislodged and was further dispersed by a nearby fan. Detectable contamination levels were documented in the work area, and bioassays of several workers in the area revealed uranium uptake.

The final report on this incident has yet to be filed, as the Air Force reportedly pursues further tests to determine whether the elevated internal uranium levels were due to inhalation or ingestion.

Two other reported incidents involving radiation exposure of Air Force personnel working with depleted uranium counterweights are relevant. In one case (NRC Item No. 940856), an airman cutting wing parts away from DU counterweights received an exposure of 25 rems or more. NRC Item No. 970387 describes the potential exposure of four individuals who attempted to use a chemical cleaner to degrease a painted counterweight, from which some paint was flaking. One individual was found to have contamination on his hands, and contamination was detected on rags used to clean the counterweight. (The exemption for counterweights does authorize unlicensed personnel to "repair or restore any plating or other covering" [10 CFR 40.13 (c) (5) (iv)].)

Although the Air Force is a radioactive material licensee with an established radiation protection program, DU counterweights are exempt items subject to less stringent controls, and it is unlikely that all incidents of potential personnel exposure are noted and reported. Since the same counterweight removal operations that resulted in the radiation exposure of military personnel are performed with a much higher frequency by employees of unlicensed commercial maintenance, part-out and salvage activities, the occurrence of similar exposures to these workers can be reasonably expected. Many of the Boeing 747 Classics, L-1011 Tri Stars, and DC-10s that used DU counterweights have now exceeded their 20-year design service life and are being sold for part-out and salvage at a rate of dozens per month. These are the very activities that harbor the greatest potential for worker exposures.

There are real world contamination and exposure problems associated with depleted uranium counterweights. Modeling is no substitute for actual experience and data when it is reasonably available. NRC should obtain relevant information from the U.S. Air Force, and this information should become a major basis for a revised assessment of the effective dose equivalent for maintenance workers removing and handling these items. The Air Force, a major government radioactive material licensee, has determined that its own personnel are better protected by sending DU-bearing control surfaces to a specialized outside contractor for counterweight removal. They continue to record instances of maintenance worker radiation exposure from activities involving depleted uranium counterweights. In spite of this experience, workers of unlicensed commercial organizations are allowed to perform identical operations on DU counterweights with no radiological protection under the present NRC exemption policy for these items. Either the Air Force's concerns for the health and safety of its personnel are excessively conservative, or the NRC's exemption policy is not providing appropriate protection to aviation industry workers. A serious reexamination of the potential for the radiation exposure of workers removing DU aircraft counterweights under current regulations appears warranted to resolve this apparent inconsistency.

Changing Patterns of Distribution and Use

Another implicit assumption that may result in erroneous dose projections is that there is some kind of equilibrium condition in the overall distribution and use of DU counterweights. The study assumes, for example, a small, constant stream of counterweights shipped for repair as their plating becomes defective and reduced amounts of counterweights in storage facilities as they are gradually replaced with tungsten parts (see 3.17.4.4.2). The reality is that the amount of commercial counterweights being sent for repair is disappearing while the quantities in storage facilities are growing rapidly. The demand for DU counterweights has essentially disappeared, as the operational fleet of older wide-body planes which used them is being rapidly retired from service. (Over 100 of these planes were "set down" by operators last year.) Concurrently, the supply of counterweights from "parted out" and scrapped planes and from discarded spares floats of operators burgeons. Quantities of several tons are commonly held indefinitely by operators, parts suppliers, and tear-down facilities in order to defer or avoid the costs of authorized disposal, since 10 CFR 40.13 does not specify any time limit for the storage exemption. Increasing quantities of DU counterweights are being abandoned, transferred to unlicensed parties, and disposed of by unauthorized means. This latter observation receives corroboration from the fact that a search of NRC's NMED data base yields 19 cases involving the activation of scrap yard portal monitors by DU confirmed as, or suspected to be, aircraft counterweights. There are other confirmed cases. Clearly, the patterns of distribution and usage today are very different from what they were when the exemption was adopted, and continuation of the exemption in its current form may no longer be appropriate.

To the extent that the current study is not based on today's realities, it is perhaps consistent that it ends with a whimsically hypothetical example of "misuse" -- a DU counterweight "fishing weight"! It would have been more realistic to have considered one of the many reported cases of illegal cutting of counterweights to make "bucking bars" to set rivets or trimming weights for racing car chassis'.

The principle of exempting unimportant quantities of radioactive materials from regulation to facilitate their use in valuable products is a sound one. At one time such an exemption for DU counterweights may have been warranted. One reason for studies such as NUREG 1717 is to revisit the initial assumptions and situational factors to determine whether they were sound at the time and whether they are still valid. The evidence is compelling that the existing exemption for aircraft counterweights is no longer appropriate under current conditions. An objective and conscientious reevaluation of the effective dose equivalents associated with the removal and management of depleted uranium aircraft counterweights will be a useful first step in bringing radiation protection regulations into line with realities of the aviation industry workplace.

Sincerely,

Donald A. Barbour
Manager, Aviation Programs