PHILOTECHNICS

April 4, 2000
00-0409

DOCKETED USNRC

'00 APR -5 A11:44

OF... ADJ...

Secretary, U.S. Nuclear Regulatory Commission
ATTN: Rulemakings and Adjudications Staff
Washington, D.C. 20555

DOCKET NUMBER
PETITION RULE PRM 40-28
(65FR3394)

REFERENCE: Docket No. PRM-40-28

SUBJECT: Comments on Proposed Rulemaking

Dear Sirs,

I am submitting these supplementary comments on the proposed rulemaking for your consideration. They are structured to correspond to the organization of PRM-40-28.

The Regulatory Situation

A more extensive examination of federal regulations indicates that the exemption from licensing and controls of Section 40.13 for depleted uranium aircraft counterweights (and other radioactive materials) only has the effect of transferring their regulation to another government agency. OSHA Standard 1910.1096 (Ionizing Radiation) establishes certain regulatory requirements for the management of radioactive materials. 1910.1096(p)(3)(i) recognizes Nuclear Regulatory Commission (or Agreement State) source material licensees as being in assumed compliance with the OSHA standard. Since the users of counter-weights (and other exempt radioactive materials) are not generally NRC or agreement state licensees, they are required to comply with the OSHA standard. This standard prescribes radiation exposure limits, radiological surveys and evaluations, signage requirements for storage areas and containers, employee information requirements, records, reports, disposal, etc. An analysis of some of its provisions specifically relevant to DU counterweights is provided as an attachment to these comments. It should be noted that the OSHA standard is based on the old system of radiation dose limits used by NRC prior to 1994 and is less restrictive than the current 10 CFR Part 20. If NRC's intent in Section 40.13 was to make the possession of DU counterweights less burdensome for users, it is not clear that much was achieved.

The question of <u>when</u> counterweights cease to be exempt is closely tied to question of <u>how</u> they are brought back under regulatory control. The possessor must somehow become a licensee, so that he will be subject to compliance with

137 UNION VALLEY ROAD • OAK RIDGE, TN • 37830
PHONE: 423.483.1551 • FAX: 423.483.1530

TEMPLATE = SECY-067

SECY-02

appropriate 10 CFR requirements. Although the amount of uranium in counterweight holdings usually exceeds the 15-lb. "small quantity" general license limit of Section 40.22, requiring possessors to apply for special licenses may not generally be practical or necessary. An alternative based on modifying Section 40.22 to include a limited duration general license for "previously exempt" quantities of source material was submitted on November 3, 1999 in response to Docket No. PRM-40-27 (received as Comment 10). The disposition of that comment should be considered in the current rulemaking.

Use of Depleted Uranium Counterweights

A further perspective on the distribution of depleted uranium counterweights being stocked, as parts, by aviation parts suppliers can be gained by examination of commercial automated databases, which are widely used by parts traders, repair organizations and operators. Since there is now a very low demand for DU counterweights, and because suppliers are charged for the line items they list in a database, these listings should not be considered a reflection of the total population of counterweight parts holdings. A recent search of a popular database revealed eighteen companies listing a total of 111 DU counterweights for the Boeing 747, nine companies listing a total of 51 DU counterweights for the DC-10, and nineteen companies listing 1,581 DU counterweights for the L-1011. Some of these companies are large businesses with substantial resources, while others are quite small. A comparison with past search results confirms little or no movement in these inventories. The condition codes associated with the counterweights are also informative. Most of the counterweights are so old that corrosion of their surfaces is probable, but it is especially likely on the many counterweights coded as "as removed" or "serviceable", which describe parts taken off aircraft and added to inventory without repair.

The rulemaking petition mentions the potential for corrosion of depleted uranium counterweights and refers to Air Force experience with the C-141 maintenance program. The subject of corrosion, personnel radiation exposures, and facilities contamination deserves elaboration. The commercial aviation organizations which use depleted uranium (DU) counterweights are exempted by the Nuclear Regulatory Commission from the requirements for possessing a radioactive material license or implementing a radiation protection program. As a result, the likelihood of radiation exposure incidents being observed, recognized and reported by these organizations is remote. Fortunately, it is possible to benefit from the reported experience of a large licensed organization that performs the same activities. The United States Air Force is an NRC licensee with a well established radiation protection program. Many of its military aircraft are equipped with depleted uranium counter-weights, and military and commercial operations involving the removal and handling of these parts are essentially identical. The Air Force has reported several instances to the NRC in which its maintenance technicians have been

137 UNION VALLEY ROAD • OAK RIDGE, TN • 37830
PHONE: 423.483.1551 • FAX: 423.483.1530

subjected to radiation overexposures while removing corroded DU counterweights. I am attaching summary NRC reports of three relevant incidents to this letter. In each case, the operations being performed by the Air Force personnel correspond closely to operations routinely performed by civilian employees of unlicensed commercial aviation organizations without any radiological oversight. It is a reasonable and prudent expectation that these identical activities, conducted in the commercial sector, will result in similar (albeit unreported) overexposures.

The first Event Description from the NRC's NMED database is designated Item No. 990519. It refers to the "possible overexposure" of an employee who was removing a DU counterweight from a C-141 aileron. Some radioactive corrosion products were dislodged, dispersed in the air, and spread by a nearby fan. The surrounding work area was surveyed and determined to be contaminated, requiring a cleanup. Several workers in the immediate vicinity were medically evaluated for internal uranium uptake. The Air Force is still in the process of providing additional information requested by the NRC. The NRC indicates informally that initial bioassays (urine analyses) of the workers confirmed the overexposure.

Event Details for Item No. 970387 describes the potential exposure of four workers who were attempting to degrease a depleted uranium counterweight from which paint was flaking. Contamination of the hands of one of the individuals was confirmed. Licensee calculations reportedly indicated that none of the workers received an uptake in excess of the NRC 's Annual Limit on Intake (ALI) from this one exposure, but apparently OSHA's 1.25 rem quarterly limit was exceeded. Without appropriate personnel monitoring equipment and records of employee radiation exposures, workers engaged in handling DU counterweights on a regular basis could easily exceed their individual annual exposure limits through a combination of a few such incidents. The exposure that was incurred in this case would have been easy to prevent.

Perhaps the most serious of the reported Air Force incidents was Item No. 940856, which resulted in an extreme overexposure from cutting wing parts away from depleted uranium counterweights, an operation common to commercial parting out and salvage activities. One individual was confirmed to have received a total effective dose equivalent of 25 rems or more. This is a significant overexposure. Appendix B to 10 CRF Part 20 facilitates the interpretation of this dose, based on the assumption that all radiation dose was from inhalation of $uranium^{238}$. The corrosion products of depleted uranium metal are UO_2 (in dry air) and UO_3 (in water)[1], which are, respectively, retention class Y and W compounds. The formation of both oxides is likely under field conditions, and they cannot practicably be distinguished other than by x-ray

[1]"Corrosion of Uranium and Uranium Alloys" by Lawrence J. Weirick, in Metals Handbook Ninth Edition, American Society for Metals, pp. 813-822.

diffraction analysis. For radiological effects, the Annual Limit on Intake (ALI) of concern for U^{238} is the class Y inhalation value of 4×10^{-2} μCi, which correlates to annual whole body committed effective dose equivalent of 5 rems. For chemical toxicity effects, however, conservative analysis should be based on the class W inhalation ALI of 8×10^{-1} μCi. The reported total effective dose equivalent of 25 rems is five times the corresponding 5 rem committed effective dose equivalent limit and therefor indicates an intake of 4 μCi of U^{238}. At this level, chemical toxicity becomes an important concern, as indicated by Footnote 3 to Appendix B. The specific activity of depleted uranium is 3.6×10^{-7} Ci/gram U. An uptake of 4 μCi represents 11,110 milligrams, which, according to 10 CFR 20.1201 (e), is over 1,100 times the 10-milligram per week intake limit for soluble uranium.

Several different radiation dose limits have been established by various government agencies. The following table compares the reported 25 rem radiation exposure from removing counterweights to the four regulatory standards. It should be borne in mind that the Nuclear Regulatory Commission ALIs in Appendix B are based on a 5 rem annual occupational dose for radiation workers. Maintenance technicians working for unlicensed aviation organizations are not radiation workers, but are members of the general public. The NRC's dose limit for members of the general public is only 0.1 rem per year. The U.S. Environmental Protection Agency advocates an annual limit of 0.01 rem for members of the general public. OSHA's exposure limit for workers in a restricted area is 1.25 rems of whole body radiation per calendar quarter (ref. Table G-18, OSHA Standard 1910.1096).

Agency	Regulatory Limit	25 Rem Exceeds Limit By
EPA	Gen. Public 0.01 rem/yr.	x 2,500
NRC	Gen. Public 0.1 rem/yr.	x 250
OSHA*	Rad Worker 1.25 rem/qtr.	x 20
NRC*	Rad Worker 5 rem/yr.	x 5

*Note: Rad worker status does not apply.

There is a reason that the removal of depleted uranium aircraft counterweights is resulting in radiation exposures to employees. Uranium is a corrosion prone material. When counterweights are manufactured, consecutive platings of nickel, cadmium and chromium are applied to inhibit the oxidation of the uranium surface. Aircraft in active service are subjected to periodic maintenance procedures and inspections. When damage to the protective plating on a counterweight is noted, the part is removed and replaced. The defective counterweight must be replated before it can be reinstalled. When aircraft are "set down" and consigned to long-term storage, "parting out" or salvage, inspection and repair of counterweights is no longer required. As the protective plating deteriorates, corrosion of counterweights becomes extensive, and deposits of easily dispersible uranium oxide accumulate on the counterweights and on adjacent structural surfaces. A dramatic instance of this phenomenon came to light in 1997 and early 1998, as the United States Air Force implemented a maintenance and upgrade program to prolong the service life of its C-141 transport fleet. Because corrosion problems with the depleted uranium counterweights had been recognized, the program managers at Robins Air Force Base elected to have the counterweights replated by a private contractor. As a pilot demonstration, eight complete flight control surfaces (four ailerons and four elevators) were shipped to the contractor, who removed, refinished, and replaced the counterweights. The contractor performed radiological surveys of the control surfaces and decontaminated them before installing the refurbished counterweights. The contractor's report to Robins Air Force Base included a set of photographs documenting the extensive corrosion of the counterweights along with the rad survey data and summarized its findings as follows:

"The RAFB flight control surfaces contained elevated levels of depleted uranium contamination. A detailed radiological survey is provided in Appendix B. As shown, the average alpha contamination is 62 times greater than the release limit for unrestricted use and 39 times greater than the release limit for beta/gamma contamination. The average contamination levels are 50 times greater than the release limits. Photographs of the contamination are provided in Figure 14."

The contract for this demonstration was issued by the Air Force on or about August 15, 1997. I am certain that the Air Force would provide NRC with a copy that includes the rad survey data and usable photos.

There are two aspects of this Air Force action that should be noted. First, this extensive contamination was encountered on the control surfaces of aircraft in active operation. The logical implication is that comparable contamination would be even more likely on equivalent structures of commercial aircraft and detached control surfaces retired from service and not subject to periodic inspection and maintenance. The other point is that the Air Force, a radioactive material licensee with an established radiation protection program, could have effected the removal of the counterweights at Robins Air Force Base by its own personnel and shipped them to the contractor for refinishing. Instead, they elected to incur the additional expense of packaging and shipping the intact control surfaces to their contractor so that the counterweights could be removed and the adjacent surfaces decontaminated in a more controlled work environment. It is commendable that these special measures were implemented for the protection of the Air Force technicians. The health and safety of their civilian counterparts is also deserving of consideration.

137 UNION VALLEY ROAD • OAK RIDGE, TN • 37830
PHONE: 423.483.1551 • FAX: 423.483.1530

The NRC's original regulation exempting depleted uranium counterweights from licensing and controls (effective January 1, 1969) contained a provision that restricted the exemption to counterweights that had their protective plating intact. The exemption was subsequently revised to eliminate this requirement. As a result, it is now perfectly permissible for aviation organizations to possess, remove, handle, and store corroded DU counterweights. This is, in fact, occurring as the aircraft that used these parts are withdrawn from active service. While the Air Force continues to experience and report significant overexposures from handling these counterweights, identical operations are performed, with increasing frequency, by commercial aviation workers.

NUREG-1717, Systematic Radiological Assessment of Exemptions for Source and Byproduct Materials, was issued December 1999 as a draft for comment. Section 3.17 evaluated the exemption for DU counterweights. My comments dated March 13, 2000 call out several erroneous assumptions that result in substantial underestimates of the doses to workers handling these parts. These misperceptions reflect, in part, a lack of understanding of the operational realities of the aviation industry. They seem to be consistent, however, with the low priority accorded to the regulation and control of depleted uranium counterweights.

The original petition touches on the improper disposition of DU counterweights. A search of NRC's NMED database yields 18 cases involving the activation of scrap yard portal monitors by DU confirmed as, or suspected to be, aircraft counterweights and one case of an individual purchasing a DU counterweight in a surplus store. Since only a fraction of improper disposals will be detected and reported, these known cases are another compelling confirmation that better controls are needed.

The principle of exempting unimportant quantities of radioactive materials from regulation to facilitate their use in valuable products is a sound and reasonable one. It seems clear that the terms of the existing exemption for depleted uranium aircraft counterweights are no longer appropriate to today's changed patterns of distribution and usage. Please feel free to contact me if there is any additional information that I can provide.

Sincerely,

Donald A. Barbour
Manager, Aviation Programs

Enclosures a/s

137 UNION VALLEY ROAD • OAK RIDGE, TN • 37830
PHONE: 423.483.1551 • FAX: 423.483.1530

FACT SHEET: Applicability of OSHA Standard 1910.1096 to Depleted Uranium Aircraft Counterweights

- OSHA Standard 1910.1096 (Ionizing Radiation) establishes certain regulatory requirements for the management of radioactive materials, including DU counterweights.

- Paragraph 1910.1096(p)(3)(i) recognizes Nuclear Regulatory Commission (or "Agreement State") source material licensees as being in assumed compliance with the OSHA standard. To the extent that DU counterweights are exempt from NRC licensing, compliance with the OSHA standard is required. Users should be familiar with their responsibilities under 1910.1096, which differ in some ways from analogous NRC requirements.

- Paragraph (d)(1) requires every employer to conduct surveys and evaluations of radiation hazards incident to the use and presence of radioactive material to insure compliance with the radiation exposure limits and protective measures prescribed by the standard. Depleted uranium counterweights that have had their protective plating damaged and/or exhibit corrosion could cause significant radiation exposure to employees who handle them, and the dispersible radioactive uranium oxides could contaminate adjacent surfaces and structures. Storage of large quantities of intact DU counter-weights can also expose workers in the immediate area to significant radiation doses. These possibilities need to be addressed in the surveys and evaluations of radiation hazards.

- Paragraph (e)(5)(i) requires that "Each area or room in which radioactive material is used or stored and which contains any radioactive material (other than natural uranium or thorium) in any amount exceeding 10 times the quantity of such material specified in Appendix C to 10 CFR Part 20 shall be conspicuously posted with a sign or signs bearing the radiation caution symbol described in paragraph (e)(1) of this section and the words: CAUTION, RADIOACTIVE MATERIALS." Counterweights are governed by this provision because they are made of depleted, not natural, uranium. Depleted uranium is uranium-238. The quantity of uranium-238 specified in Appendix C to 10 CFR Part 20 is 100 microCuries. 100 microCuries of uranium-238 is equivalent to 0.6 pounds. Ten times this quantity is six pounds. Therefor, any area or room where a depleted uranium counter-weight(s) weighing more than six pounds is stored must be posted with the radiation symbol and warning.

- Paragraph (e)(6)(i) requires that any container used to transport or store more than 0.6 pounds of DU counterweights must be similarly labeled and marked. Paragraph (e)(6)(iv) further requires that containers used for storage of must be labeled to indicate the quantities and kinds of radioactive materials in the containers and the date of measurement of the quantities.

- To the extent that employers possessing depleted uranium counterweights are exempt from regulation by the Nuclear Regulatory Commission, Paragraph (i)(2) requires that "All individuals working in or frequenting any portion of a radiation area shall be informed of the occurrence of radioactive materials or of radiation in such portions of the radiation area; shall be instructed in the safety problems associated with exposure to such materials or radiation and in precautions or devices to minimize exposure; shall be instructed in the applicable provisions of this section for the protection of employees from exposure to radiation or radioactive materials; and shall be advised of reports of radiation exposure which employees may request pursuant to the regulations in this section."

- Paragraph (i)(3) requires the posting of OSHA Standard 1910.1096 and "the operating procedures applicable to the work conspicuously in such locations as to insure that employees working in or frequenting radiation areas will observe these documents on the way to and from their place of employment..."

- Paragraph (k) directs that "No employer shall dispose of radioactive material except by transfer to an authorized recipient, or in a manner approved by the Nuclear Regulatory Commission" or an Agreement State.

- Other provisions of the OSHA standard deal with maintaining records of employee radiation exposures, reporting radiation exposure of employees, warning devices, and other topics. A careful evaluation should be made of 1910.1096 to insure full compliance with all of its applicable provisions.

- Philotechnics is committed to assisting the users of depleted uranium aircraft counterweights to manage this material in compliance with all regulations. We hope that you will find this information helpful and that you will call on us when you want technical program assistance or find it appropriate to dispose these items.

PHILOTECHNICS

November 3, 1999
99-1111

Secretary, U.S. Nuclear Regulatory Commission
ATTN: Rulemakings and Adjudications Staff
Washington, D.C. 20555

REFERENCE: Docket No. PRM-40-27

SUBJECT: Comments on Proposed Rulemaking

Dear Sirs,

I hope you will find it practical to consider these comments even though they were not submitted prior to September 20, 1999. I am also providing them to the Generic Actions Program Committee since they relate to a matter recently referred to them. If they are not considered in conjunction with PRM-40-27, they can be resubmitted as a separate petition for rulemaking.

I believe that the petition for a rulemaking (PRM-40-27) is well considered and should be approved. The Commission should be aware, however, that effecting this proposed rulemaking, as presented, will aggravate certain anomalies and inconsistencies in the regulation of source material that already exist in its regulations. The origin of these is Section 40.13 (c) (5), which exempts properly marked depleted uranium aircraft counterweights from licensing while they are installed on an aircraft or being stored or handled incident to installation or removal. The difficulties arise for two reasons. The first is that, unlike the exemptions for other "unimportant quantities of source material" specified in Section 40.13, the exemption for depleted uranium in counterweights is conditional upon the use of the material and terminates when the counterweights are withdrawn from use on an aircraft. The second is that the quantities of the counterweights accumulated in the aviation industry by aircraft operators, parts suppliers, tear-down operations, long-term storage facilities and salvage activities, are typically measured in thousands of pounds, which far exceed the possession limits for depleted uranium under a general license and render their description as "unimportant quantities" questionable. Although it is sometimes difficult to pinpoint the exact time that the exemption ceases to apply, it is clear that at some point every counterweight ever made will cease to be exempt. If a counterweight weighed less than fifteen pounds, its user would become a general licensee when it was taken out of service and would be susceptible to appropriate controls under Section 40.22. While a few counterweights do fall under the fifteen pound threshold (for example, a 1524834-101 counterweight from an L-1011 weighs about eleven pounds), most weigh more. An AMC-7226 counterweight from a DC-10, in contrast, weighs approximately 191 pounds. Another factor causing counterweight holdings to exceed the threshold is that they are very rarely limited to a single counterweight. A "ship set" of depleted uranium counterweights for a commercial wide-body aircraft can comprise dozens of individual weights totaling over a thousand pounds for some models, and spare parts inventories held by operators and dealers often exceed a ton. When these parts do lose their exemption from licensing, the user cannot be regulated as a general licensee because the fifteen pound possession limit will invariably be exceeded. Many aviation industry users do not have a special license (presumably the rationale behind creating the exemption). The result is licensable quantities of source material (often large) that are unregulated. The user automatically becomes the unauthorized possessor of source material in excess of the general license limit. NRC regulations and enforcement provisions are formulated to govern the actions of licensees. It is not clear what form enforcement actions against unlicensed organizations possessing licensable quantities of source material would take or what the statutory basis for such an enforcement action might be.

One simple solution that suggests itself would be to allow depleted uranium counterweights that lose their exempt status to come, for a limited period, under the authorization of a general license. By this means, the user would come under NRC jurisdiction and be afforded a reasonable time to bring the material under license controls, either by applying for a special license or by transferring the material to an appropriate special licensee. Some time limit is necessary to preclude the alternative of indefinite storage (without the appropriate controls that a special license would impose) as a means of avoiding disposal costs. These improvements in regulatory consistency and controls can be achieved by a simple modification of Section 40.22.

Section 40.22 should be re-titled and paragraph (a) amended to read as follows:
40.22 Small <u>and previously exempt</u> quantities of source material.

<u>(a)</u> A general license is hereby issued authorizing commercial and industrial firms, research, educational and medical institutions and Federal, State and local government agencies to use and transfer not more than fifteen (15)

pounds of source material at any one time for research, development, educational, commercial or operational purposes. A person authorized to use or transfer source material, pursuant to this general license, may not receive more than a total of 150 pounds of source material in any one calendar year. The fifteen pound limit on use and transfer and the 150 pound annual limit on receipt do not apply to depleted uranium contained in counterweights formerly installed in aircraft, rockets, projectiles, and missiles, or stored or handled in connection with installation or removal of such counterweights, which were therefor exempt from regulation in this part and from the requirements for a license set forth in section 62 of the Act, according to the provisions of Section 40.13 (c) (5), for a period of one year after the conditions of such exemption cease to apply.

A limited duration general license for depleted uranium counterweights that have lost their exempt status from licensing would provide several benefits besides providing an orderly and compliant mechanism for bring licensable material under appropriate controls. If the rulemaking proposed in Docket No. PRM-40-27 were approved, counterweight storage areas would require posting during the duration of the general license according to Section 20.1902. Depleted uranium is not separately listed in Appendix C to Part 20, but both natural uranium and uranium 238 are assigned a labeling threshold value of 100 microCuries. 100 microCuries of depleted uranium is about 0.6 pounds, so ten times the Appendix C value, which would require posting, is 6 pounds. Almost all counterweights weigh more than this. As a result, if the proposed rulemaking and this suggested modification of Section 40.22 (a) were both adopted, counterweights that had lost their exemption and came under the provisions of a limited duration general license would also be subject to the appropriate provisions of parts 19, 20, and 21. This would impose at least some consideration of radiation protection measures and worker notification. The recent incident at Robbins Air Force Base, NRC Event No. 35964, illustrates that there are credible hazards associated with depleted uranium counter-weights. On July 26, 1999 maintenance personnel removing a DU counter-weight from a C-141 aircraft contaminated the work area with radioactive debris, necessitating a radiological survey and cleanup. Several workers in the area are being medically evaluated for internal radiation exposure. The probability of such events occurring in the unlicensed commercial sector is great, but the likelihood that they would even be recognized, much less reported, is slight.

There are three broad categories of solutions to the problem of controlling depleted uranium aircraft counterweights that have lost their exemption from

137 UNION VALLEY ROAD • OAK RIDGE, TN • 37830
PHONE: 423.483.1551 • FAX: 423.483.1530

licensing. The first alternative is to take no action. The second approach would be to eliminate or restrict the unimportant quantity exemption for the counterweights. The third option would be to bring counterweights which have lost their exemption under a general license.

The no-action alternative is inappropriate. Our studies indicate that as much as two million pounds of depleted uranium aircraft counterweights are in circulation in support of commercial and general aviation aircraft. These parts are now being withdrawn from service at an increasing rate and in quantities that cannot reasonably be deemed "unimportant." It is logically inconsistent to require general license control for a 15 pound quantity of a material, a special license for 16 pounds, and no license for a ton or more. Our informal survey of the aviation industry confirms that the lack of understanding of regulations and responsibilities noted during the NRC's study of general licensees applies with even greater force to the possessors of formerly exempt depleted uranium aircraft counterweights and that violations, exposures, and unauthorized modifications, transfers and disposals are commonplace. This situation is not surprising. As regulations are presently structured, a person or organization possessing counterweights that lose their exemption should apply for a general license, contract with a special licensee for radiation control support, or transfer the items to a special licensee for management or disposal. This is not happening. The NRC's admitted problems in communicating with general licensees indicate that it would take massive expenditures of resources to educate users to their responsibilities. It should be noted that the potential for inter-agency cooperation with the Federal Aviation Administration could facilitate communications by exploiting the FAA's excellent channels to members of the aviation industry. Once a regulatory requirement has been advertised, however, there must be an effective mechanism for enforcement. The basis for enforcement, when dealing with companies that are not even general licensees, may not be satisfactory.

There are only three regulatory conditions that can apply to radioactive material: a special license, a general license or an exemption from licensing. Modifying or restricting the current exempt status of DU aircraft counterweights would be tantamount to requiring either a general or special license. Bringing the counterweights that have lost their exemption under a limited duration general license is the recommended alternative discussed above. Requiring all counterweight users to apply for special licenses (i.e. revoking the "unimportant quantity" exemption for counterweights) would re-establish regulatory consistency with the 15 pound general license limit for depleted uranium, would eliminate questions about enforcement authority, and would provide a basis for

137 UNION VALLEY ROAD • OAK RIDGE, TN • 37830
PHONE: 423.483.1551 • FAX: 423.483.1530

insuring the protection of aviation logistics workers and the proper disposal of the material. For the conditions to which the unimportant quantity exemption properly applies (well maintained counterweights mounted on an aircraft or being handled or stored incident to installation or removal) the controls associated with a special license may be excessive and would predictably encourage the aviation industry to discontinue the use of the depleted uranium counterweights which the exemption was designed to promote.

The recommended option of applying a limited duration general license to formerly exempt counterweights appears to be the more moderate and judicious choice. It would not perturb the existing exemption or precipitate an immediate withdrawal of legitimately exempt counterweights from service. It would eliminate an ambiguous discontinuity by which an (unlicensed) user who recognized that his counterweights had lost their exemption would be without a requisite license and, in some manner, out of compliance until he could apply for and receive one. It would insure a sound transitional basis for bringing the counterweights under the control of an appropriate special licensee and a clear basis for enforcement actions. It would promote a greater degree of consistency with the general license regulation of "small quantities" of the material. It would promote a greater understanding of the potential hazards of the material and more systematic and effective measures to provide workers with appropriate information.

Sincerely,

Donald A. Barbour
Project Manager, Depleted Uranium Programs

137 UNION VALLEY ROAD • OAK RIDGE, TN • 37830
PHONE: 423.483.1551 • FAX: 423.483.1530

Event Details for Item No: 990519

EVENT DATE	DISCOVER DATE	REPORT DATE
26-JUL-99	26-JUL-99	27-JUL-99

LICENSEE INFORMATION

Name: AIR FORCE, DEPARTMENT OF THE **License Number:** 42-23539-01AF

City: BROOKS AFB **State:** TX **Region:** 4

Agreement State Status: NO **Reportable Event:** U **Abnormal Occurence:** N

ABSTRACT: The licensee reported a possible overexposure of an employee who inhaled depleted uranium (DU) dust. Licensee personnel were performing maintenance on a C-141 cargo aircraft aileron. A technician was found using a hammer and chisel to remove installed DU counterweights from the aileron. This process produced dust and debris, which was scattered by a nearby fan. The technician using a hammer and chisel on the DU was in violation of several rules. Upon discovery of this activity, the technician was told to immediately stop work. The area has been secured and decontamination procedures initiated. Bioassays of the technician and other workers in the area have been initiated. A Nuclear Research Corporation detector (model ADM-300), with a pancake probe was used to survey the area. Contamination levels in the room where the maintenance was being performed were found to be above background. The area of contamination has been confined to the Building 180 Maintenance Bay. Additional information has been requested by the INEEL for this event.

EVENT CLASSIFICATION

Event Type: EXP **Cause:** PROCEDURE NOT FOLLOWED

KEY WORD INFORMATION

Key Word: UNSEALED MATERIAL

Key Word: INTERNAL (CEDE)

EQUIPMENT INFORMATION

System Level

System ID: METAL, COUNTERWEIGHT/BALLAST — Serial Number: NA

Manufacturer: NR — Manufacture Date: NR

Model Number: NA — Consequences: FIELD NOT USED

Component Level

Component ID: UNSEALED MATERIAL, OTHER — Manufacture Date: NR

System ID: METAL, COUNTERWEIGHT/BALLAST — Isotope: U-DEP

Manufacturer: NR — Activity: NR

Model Number: NA — Leak Results: NA

Serial Number: NA — Consequences: FIELD NOT USED

REFERENCE DOCUMENTS

Report ID Number	Type of Report
EN35964	EVENT NOTIFICATION

Event Details for Item No: 970387

EVENT DATE	DISCOVER DATE	REPORT DATE
24-APR-97	24-APR-97	25-APR-97

LICENSEE INFORMATION

Name: AIR FORCE, DEPARTMENT OF THE **License Number:** 42-23539-01AF

City: BROOKS AFB **State:** TX **Region:** 4

Agreement State Status: NO **Reportable Event:** N **Abnormal Occurence:** N

ABSTRACT: The licensee reported that four individuals were potentially exposed to depleted uranium when they attempted to use chemical cleaner to degrease a painted counterweight, from which some paint was flaking. One individual was found to have contamination on his hands, and some contamination was detected on rags used to clean the counterweight. No airborne contamination was detected. Licensee calculations determined that none of the workers would have received an uptake in excess of 1 ALI for U-238 due to this event.

EVENT CLASSIFICATION

Event Type: EXP **Cause:** NOT REPORTED

KEY WORD INFORMATION

Key Word: UNSEALED MATERIAL, SNM

Key Word: METAL, COUNTERWEIGHT, U-DEP

EQUIPMENT INFORMATION

System Level

System ID: METAL, COUNTERWEIGHT/BALLAST

Serial Number: NR

Manufacturer: NR

Manufacture Date: NR

Model Number: NR

Consequences: FIELD NOT USED

Component Level

Component ID: UNSEALED MATERIAL, OTHER

Manufacture Date: NR

System ID: METAL, COUNTERWEIGHT/BALLAST

Isotope: U-DEP

Manufacturer: NR

Activity: NR

Model Number: NA

Leak Results: NA

Serial Number: NA

Consequences: FIELD NOT USED

REFERENCE DOCUMENTS

Report ID Number	Type of Report
EN32225	EVENT NOTIFICATION
R4-970515	REGION REPORT

Event Details for Item No: 940856

EVENT DATE	DISCOVER DATE	REPORT DATE
11-DEC-93	11-DEC-93	19-JAN-94

LICENSEE INFORMATION

Name: AIR FORCE, DEPARTMENT OF THE **License Number:** 42-23539-01AF

City: BROOKS AFB **State:** TX **Region:** 4

Agreement State Status: NO **Reportable Event:** N **Abnormal Occurence:** N

ABSTRACT: THE LICENSEE REPORTED A POTENTIAL CONTAMINATION OF PERSONNEL DUE TO UNAUTHORIZED INDIVIDUALS CUTTING WING PARTS AWAY FROM DEPLETED URANIUM COUNTER WEIGHTS.

EVENT CLASSIFICATION

Event Type: EXP **Cause:** INADEQUATE TRAINING

Reporting Requirements: 20.2202(a)(1)(i) - AN INDIVIDUAL RECEIVED A TOTAL EFFECTIVE DOSE EQUIVALENT OF 25 REMS (0.25 Sv) OR MORE.

KEY WORD INFORMATION

Key Word: UNSEALED MATERIAL

Key Word: WHOLE BODY

EQUIPMENT INFORMATION

System Level

System ID: AIRCRAFT PART, ENGINE PART | Serial Number: NR

Manufacturer: NR | Manufacture Date: NR

Model Number: NR | Consequences: FIELD NOT USED

Component Level

Component ID: METAL, COUNTERWEIGHT/BALLAST | Manufacture Date: NR

System ID: AIRCRAFT PART, ENGINE PART | Isotope: U-DEP

Manufacturer: NR | Activity: 0.065200 Curie(s)

Model Number: NR | Leak Results: NA

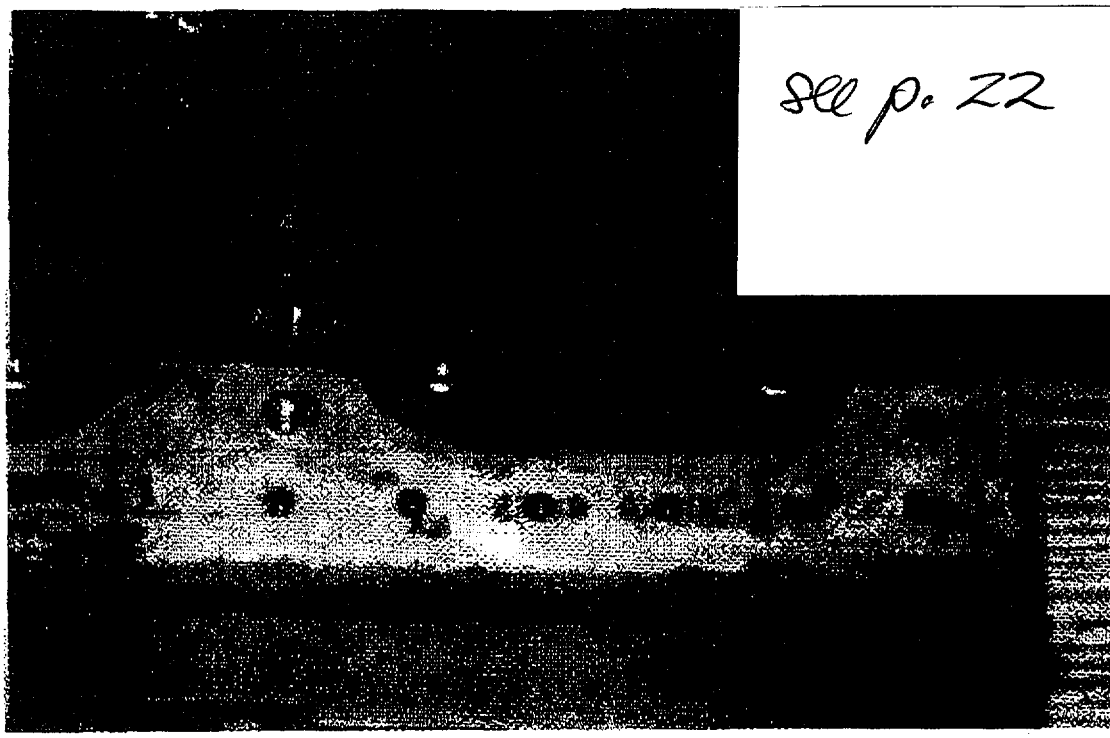
Serial Number: NR | Consequences: FIELD NOT USED

REFERENCE DOCUMENTS

Report ID Number	Type of Report
EN26635	EVENT NOTIFICATION

Department of the Air force
Robins Airforce Base

Report: Repair and Refurbishment of Aircraft Counterweights



see p. 22

Starmet CMI
P.O. Box 1366
365 Metal Drive, Hwy 80
Barnwell, SC 29812

Table of Contents

1.0 Introduction

The C-141 aircraft located at Robins Airforce Base (RAFB) contain depleted uranium (DU) counterweights located in the elevator and aileron sections of the flight control surfaces. Through several years of operation, the depleted uranium counterweights have corroded and contaminated the interior surfaces of these wing sections. The contamination is in the form of depleted uranium oxide. Periodically, maintenance is required on the elevator sections and, therefore, maintenance personnel are required to open this section of the wing. The uranium oxide contamination located inside these areas has created a personnel exposure and contamination control concern. When the elevator and/or aileron sections of the wings are opened, maintenance personnel are exposed to radioactive contamination and the spread of uranium oxide is a serious concern due to the potential to contaminate the surrounding maintenance areas.

The Department of the Air Force contracted Starmet to refurbish depleted uranium counterweights on several flight control surfaces and provide a detailed report summarizing the work performed and associated pricing. The wing sections of the aircraft were shipped intact to Starmet CMI's facility in Barnwell, SC for refurbishment. Since Starmet is licensed to handle radioactive material, all of the required controls are in-place and the work is controlled to ensure personnel exposure is minimized and the depleted uranium oxide is removed from the wing sections, collected, stabilized, and shipped to an approved disposal facility. The primary goal of this work is to control the spread of contamination, minimize exposure to RAFB maintenance personnel, properly handle the disposition of the depleted uranium oxide contamination, and refurbish the counterweights to prevent future problems.

Starmet CMI successfully performed the refurbishment of the wing sections and depleted uranium counterweights. This technical report summarizes the steps performed during the refurbishment work and provides a detailed cost report.

2.0 Scope of Work

The scope of work is to provide cost and delivery information to disassemble, repair and reassemble counterweights on eight (8) flight control surfaces (4 ailerons/4 elevators). In addition, cost data, including estimated cost to repair each remaining C-141 aircraft, is required. This work is in response to inquiry number 970666 from the Department of the Air Force WRALC/LJK.

Additional requirements written in the inquiry are listed below. This list includes the referenced section of the inquiry and specific requirements of the Statement of Objectives:

Section 1.3) Background

Some depleted uranium counterweights have excessive corrosion problems that would pose potential health concerns with maintenance personnel working with and around the contaminated weights.

Section 1.4) Purpose

To develop and document the process of refurbishing the depleted uranium counterweights located on the aileron and elevator flight control surfaces. This task will provide WR-ALC/LJ with two (2) complete sets of refurbished depleted uranium counterweights to serve as prototype exhibits. This will restore the counterweights to their original condition and prevent potential health hazards from arising. The prototype exhibits will establish the standard for future depleted uranium counterweight rework.

Section 3.1.b) Requirements

Repair depleted uranium counterweights as required to comply with drawings listed in paragraph 2.0 and with EPA requirements.

Section 3.1.c) Requirements

Install refurbished depleted uranium counterweights on control surface in accordance with I.O. 1C-141B-4-2. The maximum number of depleted uranium strip balance weights (two per shipment) shall be installed on elevator control surface regardless of the number installed when delivered to contractor's facility.

Section 3.3) Requirements

The contractor shall estimate the cost required to repair the depleted uranium counterweights for each remaining C-141 aircraft and provide a cost analysis.

Section 3.4) Requirements

The contractor shall document all efforts performed in paragraphs 3.1/3.2 and provide to the government a technical report detailing all procedures. The contractor data requirement list shall include as part of the technical report two subtitles (1) Condition Assessment and (2) Cost Analysis Report.

3.0 Condition Assessment

This technical report summarizes the steps performed during refurbishment of the depleted uranium counterweights located on the aileron and elevator flight control surfaces of the C-141 aircraft. A detailed description of the tasks performed is provided in the following subsections:

3.1 Project Planning
3.2 Unpacking
3.3 Disassembly
3.4 Counterweight Refurbishment
3.5 Re-assembly

Four (4) elevator and four (4) aileron flight control surfaces were shipped to Starmet CMI and successfully refurbished. A detailed schedule was not developed due to unknown conditions of the flight control surfaces. However, using the data gathered during this demonstration, a detailed schedule was developed for refurbishment of future flight control sets.

All work at Starmet CMI is performed under South Carolina Radioactive Materials License No. 322 and in accordance with applicable internal plans, procedures and work instructions.

3.1 Project Planning

A contract to perform the scope of work listed in Section 2.0 was received on August 15, 1997. Following contract award, Starmet personnel began reviewing the project requirements and developing detailed questions to be addressed during the Robins Airforce Base visit.

On August 19th Starmet personnel traveled to RAFB and met with Robins Airforce Base personnel. During the visit, the flight control surfaces were inspected and the Balance Technician was questioned about specific removal and assembly operations. Information collected during the site visit was used to develop a list of required tools and supplies. These tools and supplies were procured once Starmet personnel returned from the site visit.

3.2 Unpacking

The four (4) elevator flight control surfaces were shipped to Starmet CMI via a commercial freight carrier. The shipment was received on August 25, 1997. Starmet had difficulty removing the crates from the trailer. In the future, if commercial freight carriers are used, a maximum of three (3) crates should be carried on a single trailer. Once offloaded from the trailer, the crates were moved inside the Starmet CMI facility and staged for inspection and unloading.

The four (4) aileron flight control surfaces were shipped to Starmet CMI on a lowboy trailer. The shipment arrived on October 7, 1997. The crates were moved inside the Starmet CMI facility and staged for inspection and unloading. This shipment also presented a problem in offloading because the lowboy trailer was not compatible with the receiving dock. It is recommended that lowboy trailers not be used in the future and only three (3) crates should be placed in each enclosed transport trailer.

Prior to removing the flight control surfaces, four (4) wheel dollies are placed under each crate to enable the boxes to be easily moved while inside Starmet CMI's facility. The crates are then positioned under a hoist for unloading. The hoist was specifically designed with a spreader lifting bar to enable the flight control surfaces to be removed without damaging the units. The bolts/nails are removed from the top lid and side panel of each crate. The crane is then used to remove the lid from the crate. Once the lid is removed, the flight control unit is strapped to the lifting bar and removed from the crate using the crane. While suspended, the crate is rolled away and a worktable is rolled under the flight control unit. The flight control unit is then lowered onto the worktable and the hoist is disconnected. Any other parts located in the crates are also removed and placed on the worktable.

The worktable is then transported to the disassembly area and an inspection is performed to document any unusual conditions, note any damaged parts, and make a list of missing parts. The table, flight control unit and any other parts are labeled with the same unique identification number. The identification number will facilitate tracking during the refurbishment process. The flight control surfaces are now ready for disassembly.

It was noted that one of the flight control surfaces was damaged prior to arrival at Starmet CMI. Metal was disfigured and some of the paint was scrapped from the exterior surfaces. The damage is shown on photographs provided as Figure 1 and Figure 2. The damage to the flight control surfaces was probably due to uncontrolled movement of the flight control surfaces while inside the crate. If so, this can be prevented in the future by properly securing the item inside the crate.

3.3 Disassembly

Depleted uranium counterweights are removed from the flight control surfaces by removing the bolts and/or screws. Some counterweights are located inside covers. For these counterweights, the covers must first be removed. Broken or sheared bolts/screws are removed from the counterweight or housing by being drilled out or pressed out. Care is taken when removing the counterweights to prevent the spread of depleted uranium oxide contamination. Photographs of the counterweights following removal from the four (4) elevator sections of the flight control surfaces are provided as Figure 3, Figure 4, Figure 5, and Figure 6.

Following removal of all counterweights, the surfaces of the flight control unit are vacuumed to remove any loose depleted uranium oxide. Following removal of loose oxide, the covers, inside bays and other accessible surfaces are wiped down to decontaminate the flight control surfaces. The accessible surfaces are decontaminated to the release limits for unrestricted use as specified in Regulatory Guide 1.86. Since the contamination levels cannot be monitored in the inaccessible areas, Starmet CMI cannot guarantee that these areas are free-released for unrestricted use. Figure 7 shows the cover of the one of the elevator sections prior to being removed. Figure 8 shows the amount and extent of depleted uranium oxide contamination in each elevator following counterweight removal.

The following discrepancies were noted on the received flight control surfaces:

1. The T.O.C. indicates one (1) of P/N 3T53066-105 per assembly. Three (3) were found as indicated in the diagram. In addition, the diagram incorrectly shows the positions of P/N 3T53066-105 and 3T53066-101.
2. The T.O.C. indicates two (2) of P/N 3T53070-103 per assembly. Three (3) were found as indicated in the diagram.
3. The T.O.C and diagram do not indicate inboard strip balance weights in bay eight (8) of the elevator. Three (3) were found per assembly with P/N 3T53067-101. One (1) inboard strip balance weight was damaged.
4. Five (5) defective counterweights were found with P/N 3T53066-107.
5. Two (2) counterweights were missing.

Items 1 and 2 must be addressed by RAFB. The T.O.C. should be modified by RAFB to reflect the actual number of counterweights. In addition, the diagram for Item 1 should be modified to reflect the correct position of P/N N 3T53066-105 and 3T53066-101.

Item 3 requires modification of the T.O.C and fabrication of a new counterweight to replace the damaged strip balance weight. The T.O.C. should be modified by RAFB to reflect the inboard strip balance weights. Starmet replaced the damaged inboard strip balance weight with a new counterweight. Starmet manufactured one (1) inboard strip weight as needed for bay eight (8) using recycled depleted uranium.

For Item 4, Starmet repaired the defective counterweights. In addition to the defective counterweights, Starmet could not place a chamfer in the base of the counter bore of the inboard counterweight on one (1) of the five (5) defective counterweights, P/N 3T53066-107. Starmet submitted a deviation/waver from the specifications for RAFB approval. Following fabrication, the counterweight was inspected, assigned a unique tracking number and sent for refurbishment in accordance with Section 3.4.

As indicated in Item 5, two (2) inboard counterweights were missing from CMI 1 or elevator number 1560.00.128.9001, counterweight part numbers 3T53070-101 and 3T53064-101. Starmet replaced the missing pieces by manufacturing new counterweights using drawings provided by RAFB. The new counterweights were inspected, assigned a unique tracking number, and sent for refurbishment in accordance with Section 3.4.

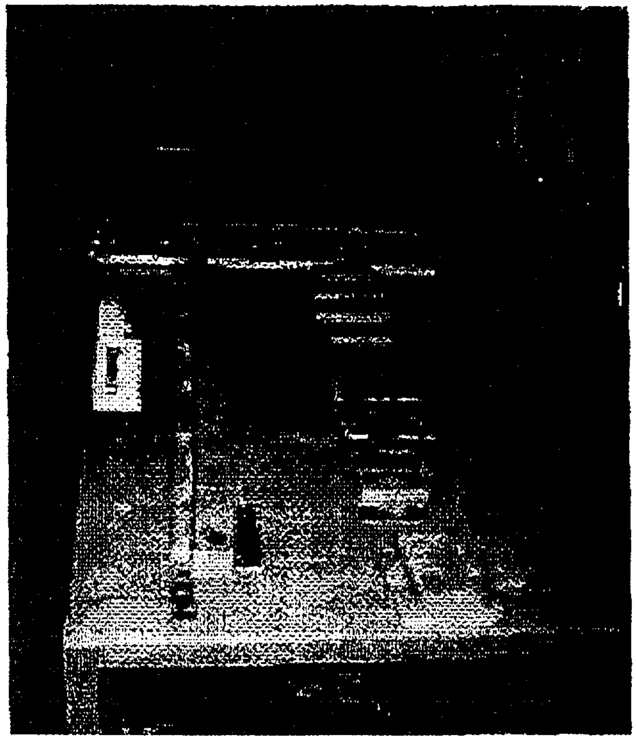
RAFB requested that Starmet fabricate outboard strip weights. Starmet contracted LMITCO to fabricate the outboard strip weights from depleted uranium. Upon inspection at Starmet CMI, the weights were found defective due to the rough and sharp edges. In addition, the holes were cut thermally and therefore were not perfectly round. Starmet machined the edges and sent the weights for refurbishment in accordance with Section 3.4. Even though the holes were not perfectly round, they met the specifications. In the future, Starmet will require LMITCO to mechanically cut the holes and repair any rough and/or sharp edges.

One of the interior counterweights was previously incorrectly installed by RAFB. Figure 9 provides a photograph of two (2) screws that were installed to connect the counterweight. Apparently, the weight was turned over and did not properly fit the original bolt hole locations. Therefore, RAFB personnel increased the bolt hole sizes and installed the counterweight upside down. Washers were used to cover the enlarged bolt hole locations. Following refurbishment, Starmet installed the counterweight in the correct position with washers. Starmet could not repair the enlarged bolt hole openings.

Figure 1, Metal Disfigured During Transport

Figure 1, Paint Damaged During Transport

Figure 3, Counterweights Removed From Elevator 1



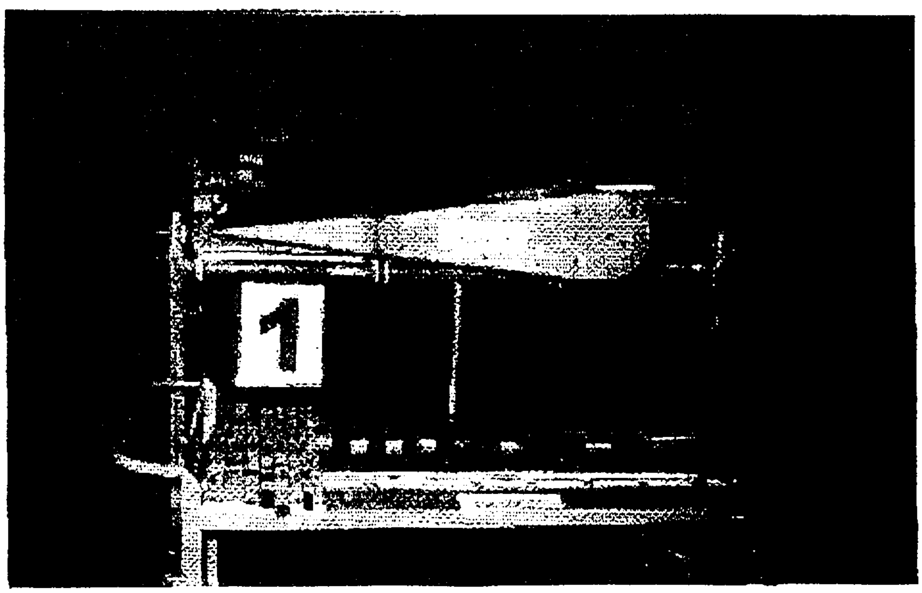
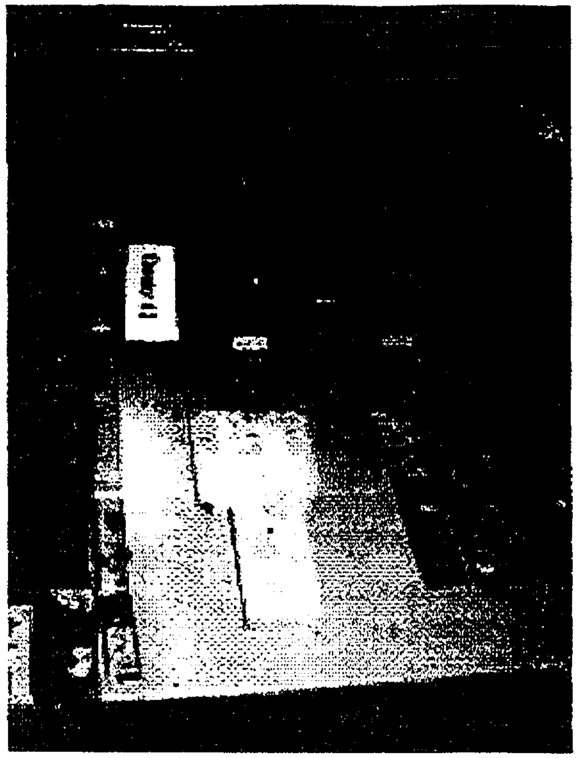


Figure 4, Counterweights Removed From Elevator 2



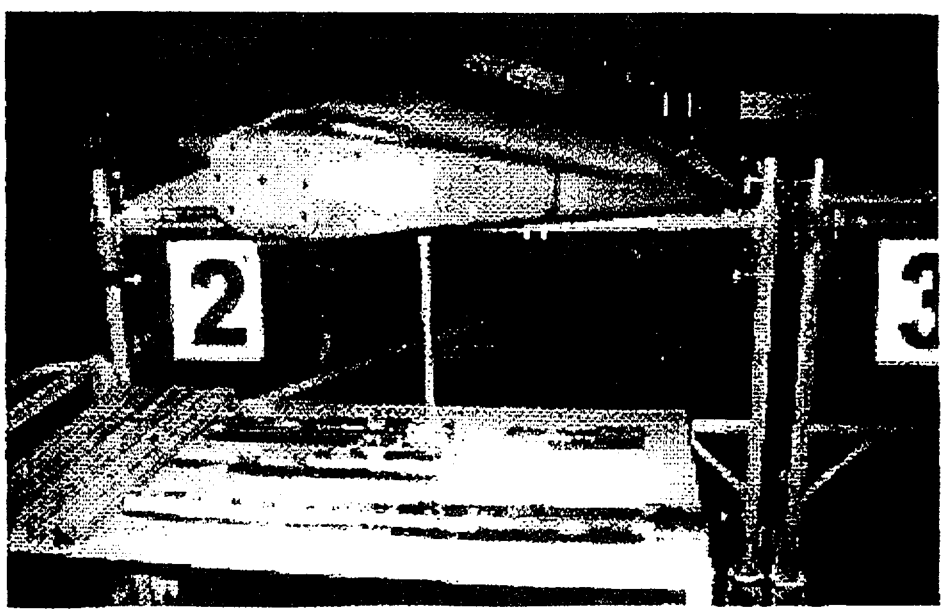
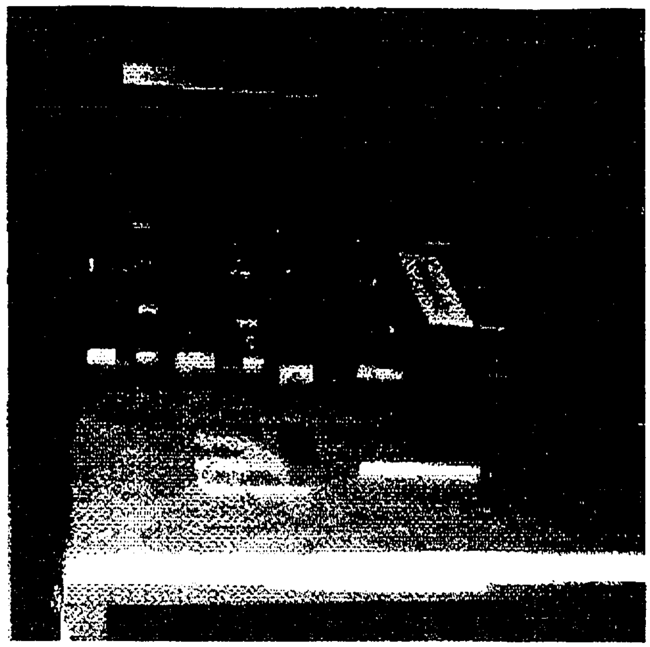


Figure 5, Counterweights Removed From Elevator 3



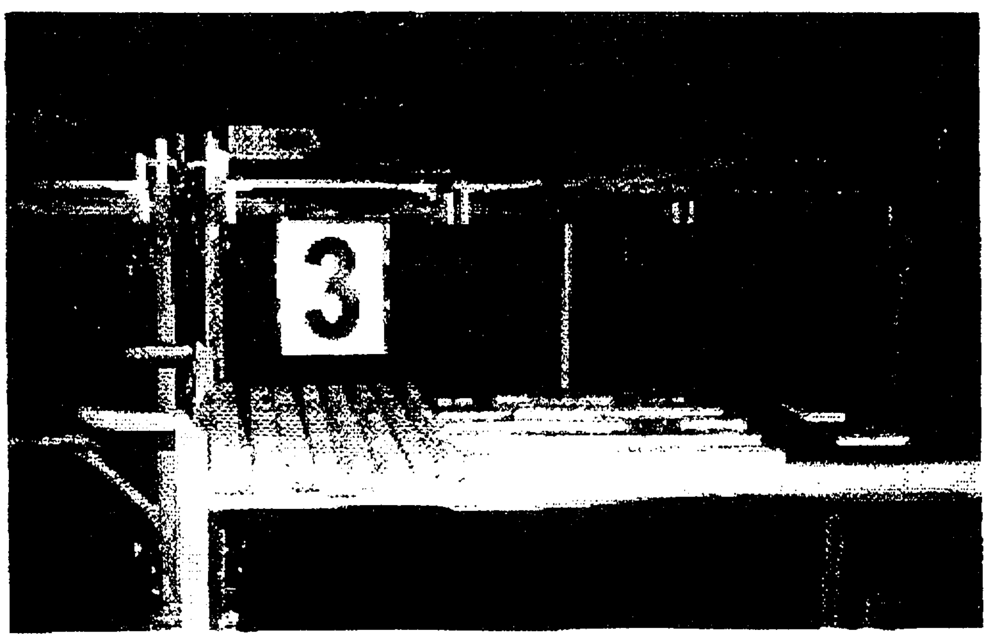
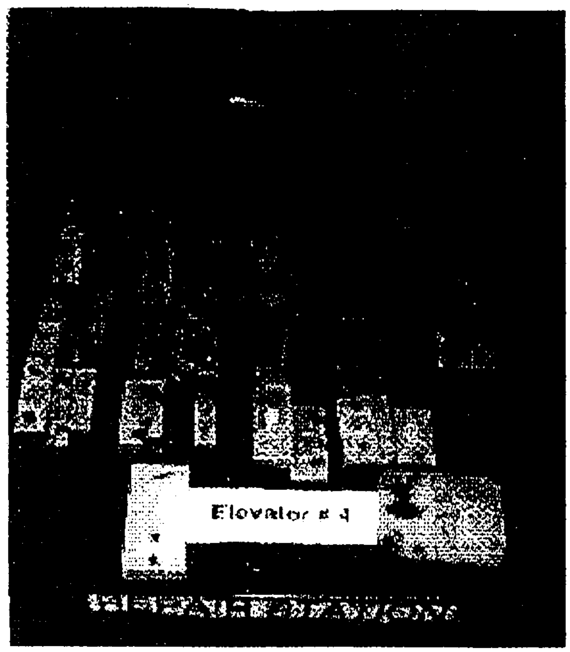


Figure 6, Counterweights Removed From Elevator 4



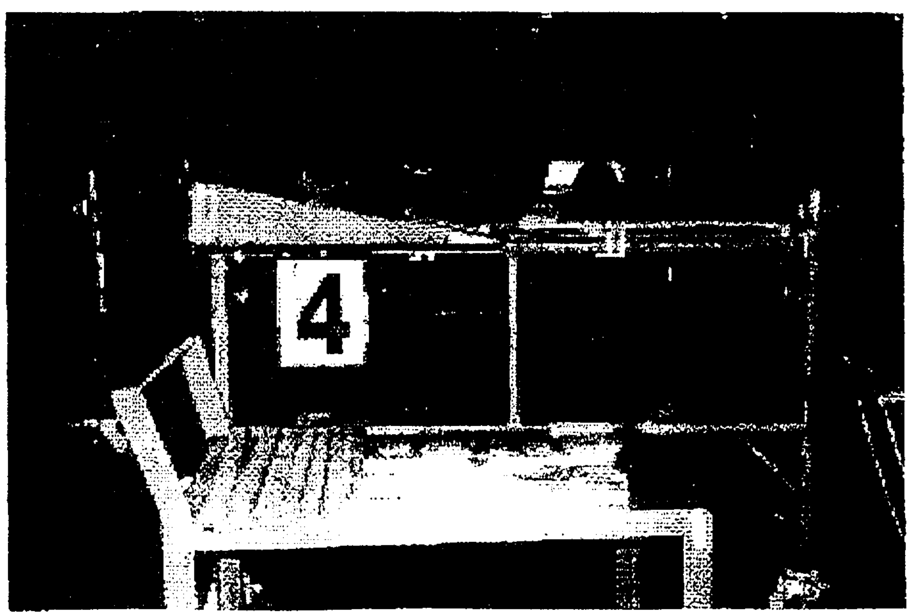


Figure 7, Elevator Cover Being Being Removed

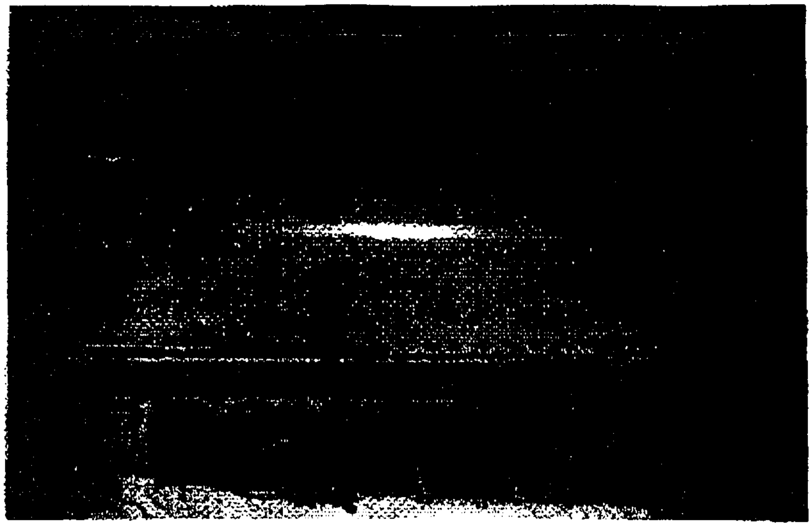
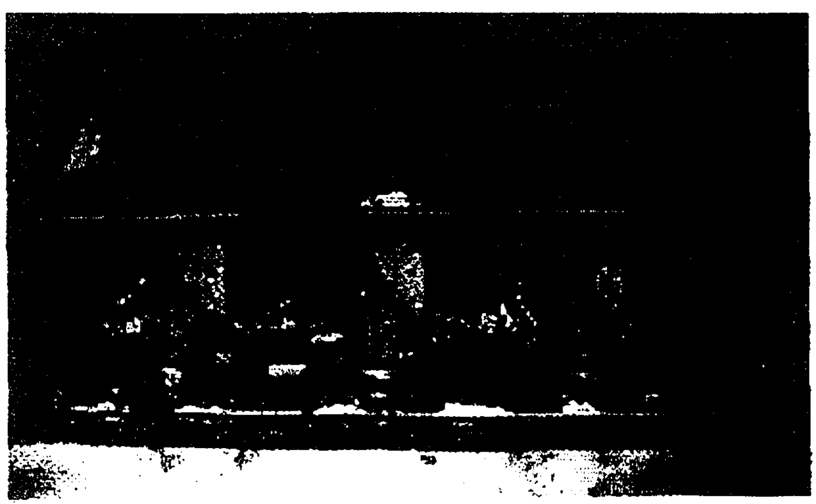


Figure 8, View of Elevator Interior Following Cover Removal



3.4 Counterweight Refurbishment

Once the depleted uranium counterweights are removed from the flight control surfaces, they are ready to be refurbished. The first step in the refurbishment process is to remove any oxides or coatings from the counterweights. This is done by abrasive decontamination followed by an acid etching process. Once the counterweights are clean, they are plated with a protective metallic layer. The counterweights are loaded into plating solutions and nickel and cadmium coatings are applied. Following the plating steps, the counterweights are flashed with chromate. Surface imperfections on the counterweights are then fared and detailed to create a smooth surface. The counterweights are then primed and painted. The final step is to label each counterweight with a unique identification number. Photographs showing the counterweights during installation are provided as Figures 10 through 13.

Following refurbishment, the counterweights undergo a series of inspections to ensure the counterweights meet the quality requirements. Dimensional, weight and surface quality are checked against the requirements to ensure compliance with the specifications. For this demonstration, all counterweights met the weight, surface quality, and dimensional specifications.

Starmet CMI performed the counterweight refurbishment in accordance with internal procedure number 500-1000, Carolina Metals, Inc., Aircraft Ballast Plating Process Operating Manual. Starmet CMI is licensed by the Federal Aviation Administration (FAA) to perform refurbishment of depleted uranium and tungsten aircraft counterweights, License No. M61R928J.

3.5 Re-assembly

The exterior and strip weights are installed and secured for shipping purposes. RAFB personnel shall re-inspect and verify proper installation prior to reuse. Photographs are provided which show the condition of the counterweights during installation.

Once the depleted uranium counterweights are installed, the flight control surfaces are loaded into the transportation crates. The flight control surfaces are secured in the crate, the side panel and top lid of the crate are replaced and secured. The crate is ready for return shipment to RAFB.

Figure 9, Modified Bolt Hole Locations

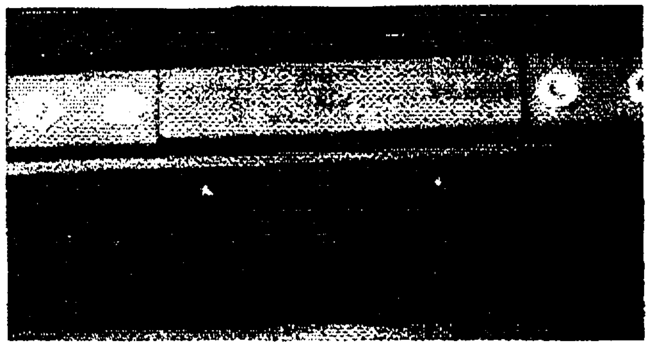


Figure 10, Re-Assembly of Counterweights

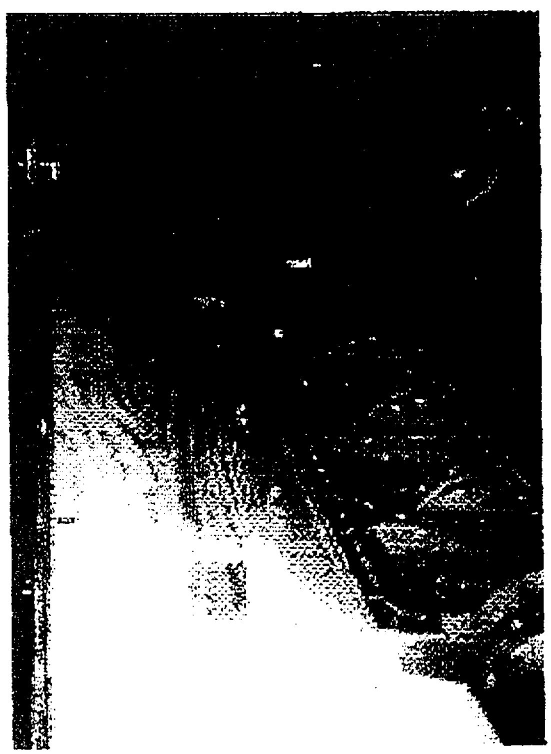
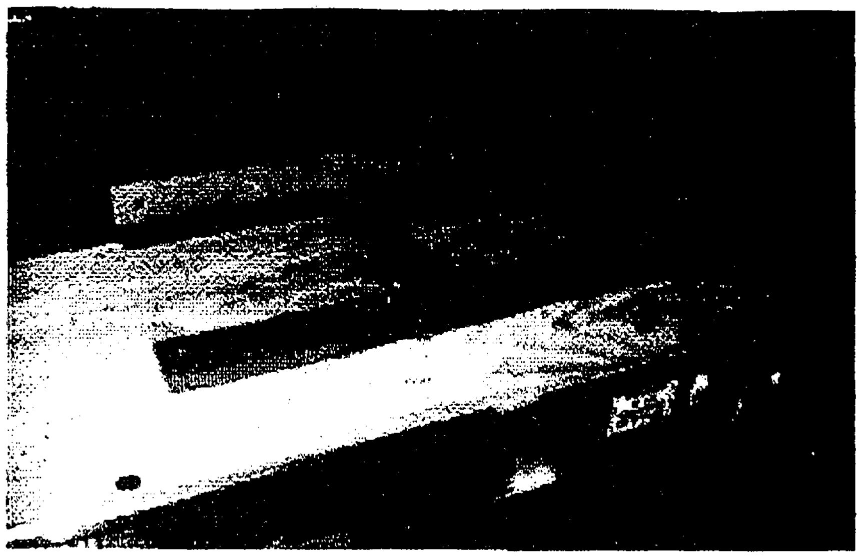


Figure 11, Photographs Taken During Installation of the Elevator Counterweights



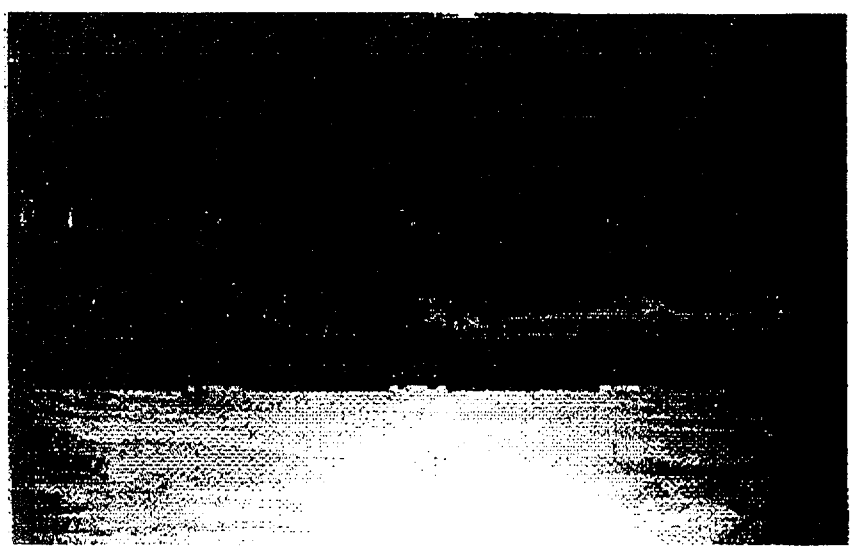
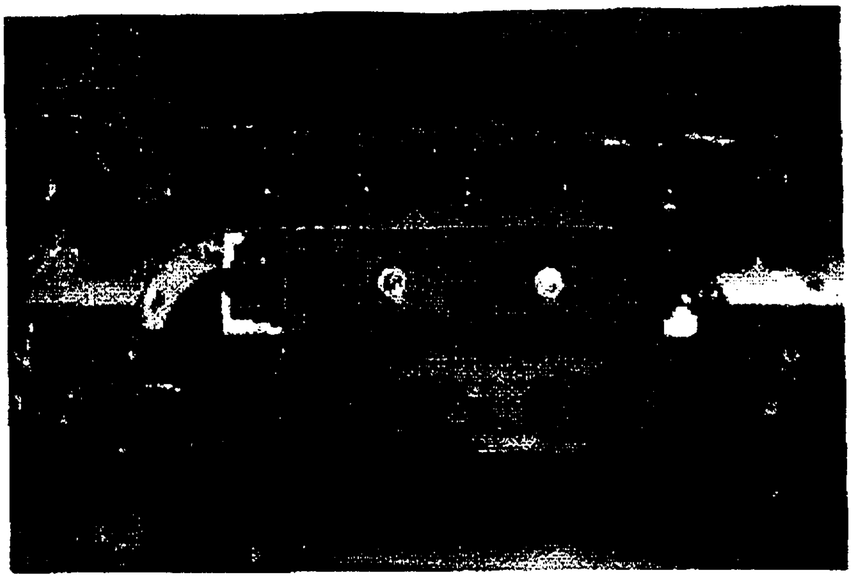
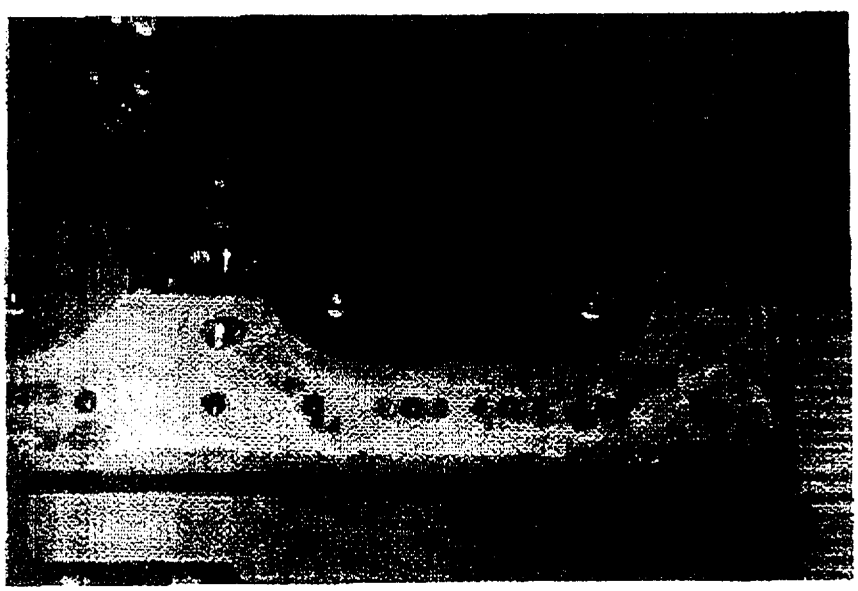


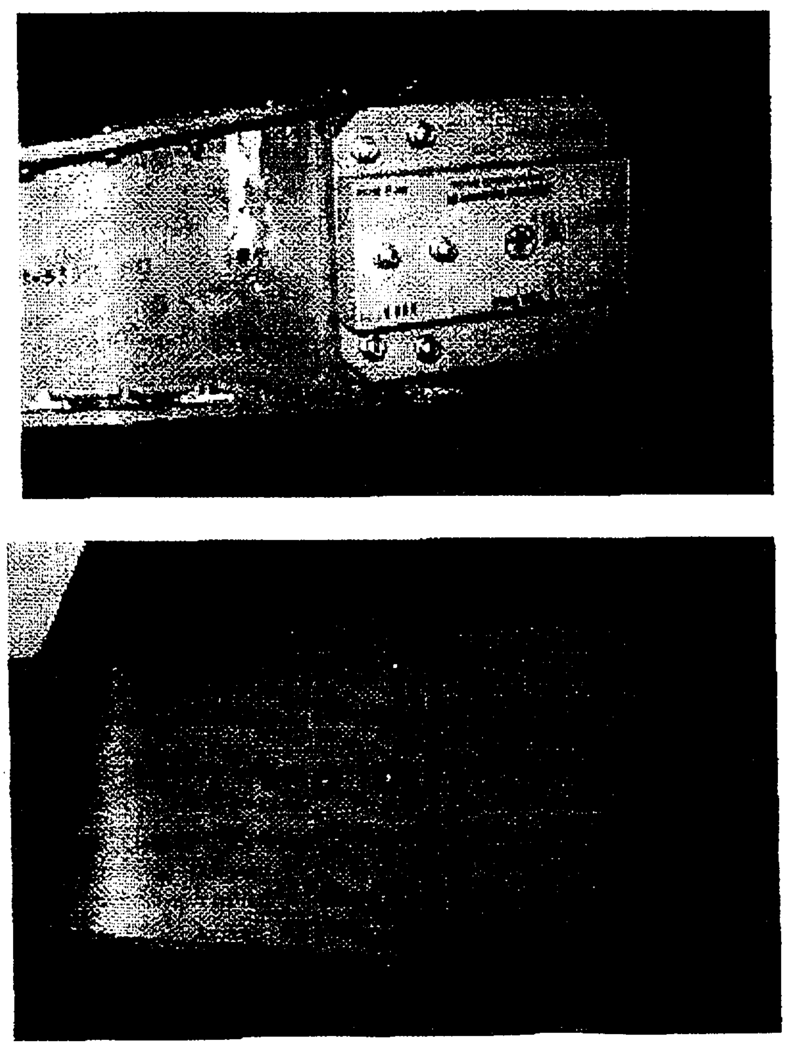
Figure 12, Closeup of Installed Elevator Counterweights





4.0 DU Contamination

Figure 13, Photograph of Installed Counterweights on End of Flight Control Surface



4.0 DU Contamination

4.1 Health Effects

The health effects of uranium are moderate when compared to those of other industrial material and radionuclides. The primary hazard associated with uranium depends upon its degree of enrichment, chemical form, and physical form. The enrichment level determines the gamma radiation intensity and the overall specific activity. Chemical and physical form determines solubility and consequent transportability in body fluids. The transportability of uranium, whether inhaled or ingested, determines its fate within the body and therefore, the resulting dose or chemical effect.

As uranium potentially poses both a radiological and chemical (toxic) hazard, determinations must be made as to which hazard is the most limiting. When radiological hazards are limiting, chemical hazards can generally be neglected. When chemical hazards are limiting, radiological hazards (i.e., organ doses and effective dose equivalent) can be neglected only when radiation doses are below regulatory concern as defined by the controlling regulation. The controlling regulations may be either the 10CFR series for Nuclear Regulatory Commission (NRC) licensees or Department of Energy Order 5480.11 for most governmental activities. In general, these regulations require radiological monitoring for individuals who might exceed 10% of an established limit. For this reason, it is prudent to calculate organ doses and effective dose equivalent for all significant intakes, as additional exposures in the same year may result in a total dose in excess of 10% of the applicable dose limit. Even in low potential exposure situations, it is advisable to provide sufficient monitoring to demonstrate comprehensive dosimetry/control, which is invaluable in possible future legal litigation in addition to providing basic worker protection.

Aircraft counterweights are typically made of depleted uranium, where the chemical form of the uranium is an oxide with the International Congress of Radiation Protection (ICRP) solubility class of "D" or "W" (i.e., the uranium remains in the body on the order of days or weeks respectively). Therefore, the radiological hazards are minimal but still regulated relative to the larger chemical toxicity hazard. The NRC and the Conference of Governmental Industrial Hygienists (ACGIH) have established an airborne concentration limit of 0.2 mg/m3. The Occupational Safety and Health Administration (OSHA) has adopted a limit of 0.050 mg/m3. (As a comparison, the ACGIH has established similar limits for lead at 0.15 mg/m3 and arsenic at 0.2 mg/m3.) These limits generally preclude any likelihood of individuals demonstrating the toxic effects (i.e., renal dysfunction) of uranium intake.

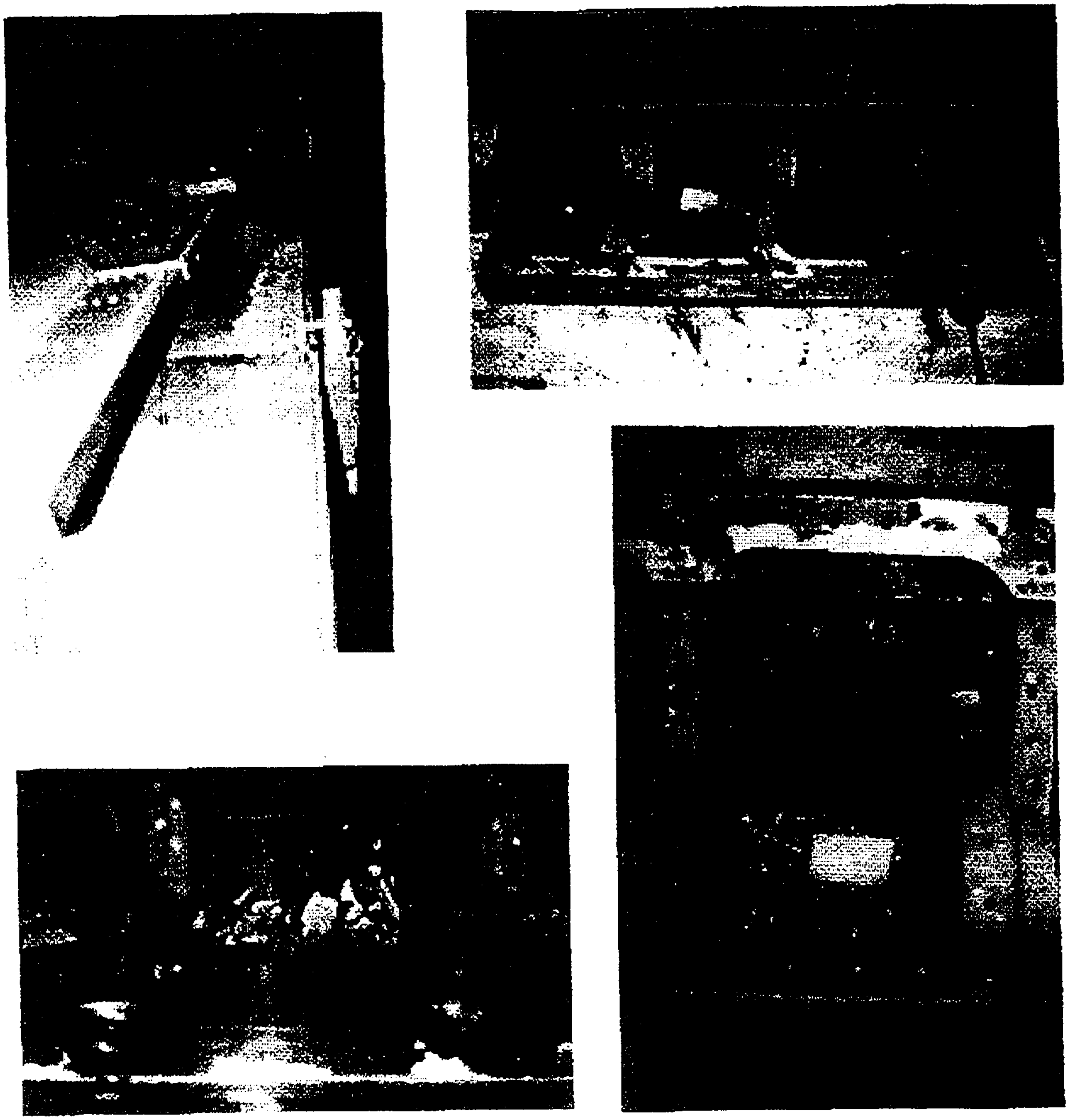
Uranium intakes greater than about 5.9 mg have been demonstrated to result in transient albuminuria, presence of red blood cells and casts in the urine, retention of urea and non-protein nitrogen in the blood. Proteinuria to 50% of a healthy population has been demonstrated at intakes of about 300 mg. The urinary and blood abnormalities are the result of inhibited resorption in the renal tubules.

4.2 Contamination Levels

The RAFB flight control surfaces contained elevated levels of depleted uranium contamination. A detailed radiological survey is provided in Appendix B. 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 the release limits. Photographs of the contamination are provided in Figure 14.

Following removal of the depleted uranium counterweights, the accessible surfaces were cleaned to free-release limits.

Figure 14, Photographs Demonstrating the Extent of Contamination Present in the Elevators



5.0 Cost Analysis Report

This section provides detailed pricing for processing each flight set for RAFB. A summary of the pricing for each flight set is provided in Table 1. As shown, the overall price for each aircraft is ???. Pricing for fabrication of new counterweights due to missing or damaged counterweights will be provided upon request.

Table 1, Pricing Breakdown

Task	Price
Unpacking	$442.00
Disassembly	$947.00
Counterweight Refurbishment	$70,512.00
Fabrication of Strip Weights	$???.00
Re-assembly	$482.00
Total	$???.00

5.1 Unpacking

Unpacking of each flight set requires 11 man-hours. The price to unpack each flight set is $442.

5.2 Disassembly

Disassembly of each flight set requires 23 man-hours. In addition to the manpower, screws and bolts are replaced. The replacement cost for these materials equates to approximately $24 per flight set. The price to disassemble each flight set is $947.

5.3 Counterweight Refurbishment

Pricing for counterweight refurbishment is provided in accordance with Starmet's published price list. This price list is provided in Appendix B. The total price for each flight set is $70,512.

5.4 New Strip Weights

Pricing for fabrication of the strip weights for each flight set is ???.

5.5 Re-assembly

Re-assembly of each flight set requires 12 man hours. The price to re-assemble each flight set is $482.

5.6 Transportation

Transportation arranged by Starmet CMI will be performed at cost plus a 7.5% markup.

6.0 Schedule

Starmet has developed a detailed schedule for startup and refurbishment of RAFB flight sets. The detailed schedule is provided in Appendix C. The schedule is based upon receiving the first flight set no later than March 1, 1998. As shown, Starmet will begin by processing one (1) flight set per month and work up to processing four (4) flight sets per month until all of RAFB flight sets are refurbished.

PHILOTECHNICS

March 13, 2000
00-0328

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

137 UNION VALLEY ROAD • OAK RIDGE, TN • 37830
Phone: 865.483.1551 • Fax: 865.483.1530

3.17.4, the modeling assumes a $5.1x10^{-3}$ cm. layer of nickel and a $2.5x10^{-3}$ cm. layer of cadmium. The nickel layer applied during refinishing is nominally 1.0 to 1.5 mils ($2.5x10^{-3}$ to $3.8x10^{-3}$ cm.). The selection of a $5.1x10^{-3}$ 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 "$2.5x10^{-3}$ 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 $7.6x10^{-3}$ cm. ($5.1x10^{-3}$ Ni plus $2.5x10^{-3}$ 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