

**BENEFITS OF THE USE OF
DEPLETED URANIUM METAL AS THE SOURCE FOR
INDUSTRIAL COUNTERWEIGHTS**

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ABSTRACT

**Uranium Research and Products Corporation (URPC), Paducah, KY
Will Launch a New Era for Industrial Lift Trucks in 1999 by Utilizing
DEPLETED URANIUM METAL FOR INDUSTRIAL COUNTERWEIGHTS**

Due to depleted uranium metal's density, the use of it as the source for industrial counterweights in forklifts, cranes, elevators, aerial devices, and other machines requiring counterbalances offers unique benefits in miniaturization. This metal is 63 percent per cent heavier than iron and 41 percent per cent heavier than lead. This not only means smaller and more compact counterweights, but also in the case of forklifts, stability and increased safety by lowering the center of gravity. Issues associated with the concept, such as regulatory burdens, cost of production, public perception, shielding criterion, continued supply, and recovery and disposal of the uranium products, are being addressed. Proposals have been submitted from private nuclear industry firms, academia, consultants and material handling engineers, all tasked to address the above issues. Proposal evaluations are being conducted by a national laboratory and by Uranium Research and Products Corporation, a company recently founded by Tom Roberts, Paducah, KY. Roberts became interested in the UF₆ Program after learning about and responding to the Department of Energy's "Request for Recommendations" published in The Federal Register, 1994. He recognized the parallel needs of DOE's reduction of the UF₆ stockpile for beneficial uses and the desires of the industrial lift truck manufacturers for physical size reduction and improved forklift stability.

Roberts is also president of Rental Enterprises, Inc., Paducah, KY, a small business firm that, among other services, sells, leases, rents, and repairs material handling equipment such as industrial forklifts. He has 27 years of experience in dealing with material handling equipment and systems and solving material handling problems for his end-use customers. Through this work Roberts has developed a practical understanding of the lift truck industry, the full array of individual products, and product capabilities and limitations. He has become actively involved in the development of modifications and improvements to equipment to enhance performance, often making the equipment safer to operate. He has consulted with manufacturers and engineers throughout the industry regarding his ideas and is known as a leader in finding innovative ways to enhance equipment performance. He is presently working with two national laboratories and private lift truck manufacturers regarding his most recent project involving the use of depleted uranium metal in industrial counterweight applications. This will result in the design, fabrication, and demonstration of industrial lift trucks using depleted uranium metal counterweights. He has become the leading proponent for the beneficial use of depleted uranium metal in industrial applications.

BACKGROUND

The Miniaturization Provides Increased Maneuverability with Added Stability and Safety

The concept of using depleted uranium metal as the source for industrial counterweights is directed at reducing the physical size of a forklift and improving the turning radius. In forklift sales, a purchaser narrows the product choices by normal buying considerations, such as capacity requirements, cost of ownership, local dealer services, parts supply, manufacturers' reputation, etc. With all values being equal, if one brand offers a shorter overall length and turning radius, most purchasers will choose the shorter product. In certain instances, one inch can make or break a sale.

Furthermore, during the initial research involving forklift consulting engineers, manufacturers, and experienced marketing personnel, other benefits emerged that equal or out-rank the importance of the length reduction efforts. Due to depleted uranium metal's high density, the physical size of the counterweight is miniaturized, and thus the counterweight may be placed lower on the forklift, which lowers the center of gravity and increases the stability of the forklift, a major desire of the forklift industry. Therefore, the miniaturization process using depleted uranium metal accomplishes a dual enhancement-increased maneuverability with added stability and safety.

LIFT TRUCK OPERATIONS AND POTENTIAL BENEFITS TO THE FORKLIFT INDUSTRY

100 Deaths and 95,000 Injuries Occur Annually and the Major Cause is Tipover / Rollover

Although reports conflict regarding the exact number of accidents and fatalities attributed to forklift operations annually, the following quotations indicate the leading cause is tipover and rollover.

"OSHA estimates forklifts cause about 85 fatal accidents per year; 34,900 accidents result in serious injury; and 61,800 are classified as non-serious. According to the Industrial Truck Association, there are about 855,900 forklifts in the United States. Therefore, more than 11 percent of all forklifts will be involved in some type of accident each year (assuming only one accident per forklift). Forty-two per cent of fatal accidents are caused by the vehicle tipping over." (Eagle Insurance Group, Safety Meeting Outline, SMO 96-0601, Larry Hall, Eagle Insurance Group, Seattle, WA).

"The leading category of fatal injury involving lift truck accidents is tipover or rollover, according to the National Institute for Occupational Safety and Health (NIOSH) (22 percent of deaths) and the Bureau of Labor Statistics Census of Fatal Occupational Injuries (24 percent of deaths). (Material Handling Engineering, June, 1997, "Avoiding Rollover/Tipover")

"Unfortunately, this case is not an isolated incident. The Occupational Safety and Health Administration (OSHA) estimates that 68,400 accidents involve powered industrial trucks each year. Approximately 90,000 workers suffer some type of lift truck-related injury in these incidents, resulting in lost worktime, worker's compensation claims, and productivity losses, not to mention the damage indicated upon equipment and facilities. And, although fatalities are relatively rare, 100 people die each year in lift truck accidents. Based on the OSHA study of

literally hundreds of lift truck accidents, the engineers interviewed for this article agree that most accidents are avoidable. The problem in most cases, they say, is that the people involved lacked a fundamental awareness of some of the unique operating characteristics of lift trucks, namely their stability, visibility, and operating environment." (Modern Materials Handling, February 1, 1996, "Industrial lift truck accidents: Why they happen; how they can be prevented")

The Industrial Truck Association (ITA), a consortium of major forklift manufacturers, is not standing idle on the issues of lift truck safety. After several years of evaluations and proposals to OSHA, "The Occupational Safety and Health Administration (OSHA) today (December 1, 1998) released the training standards for more than 1.5 million workers who operate such equipment (e.g. industrial trucks). The new training standards apply to operators in general industry and in the construction and maritime (shipyards, longshoring and marine terminals) industries. Each year about 100 workers are killed and almost 95,000 injured in industrial truck accidents. Providing proper training for the driver will help reduce that toll, said OSHA Administrator Charles N. Jeffress." (OSHA Trade News Release, U.S. Department of Labor, Office of Public Affairs, Trade News Release: OSHA 98-4, December 1, 1998) "Almost one million powered industrial trucks are in use in the industries covered by the OSHA standards. Industries with the largest number of powered industrial trucks include wholesale trade non-durable goods with an estimated 127,000 powered industrial trucks; and food and kindred products with an estimated 82,000 powered industrial trucks. The construction and maritime sectors are estimated to have about 46,000 and 3,240 powered industrial trucks, respectively. The methods or means of preventing accidents and protecting an employee from injury also vary for different types of trucks. For example, to protect the driver of a rider truck in tip over accident, the operator should be trained to remain in the operator's position and to lean away from the direction of fall to minimize the potential for injury." (OSHA Trade News Release, U.S. Department of Labor, Office of Public Affairs, Trade News Release: OSHA 98-4, December 1, 1998)

Also, manufacturers have included safety equipment such as seat belts, winged seats, and increased visibility in all directions from the operator's position.

However, recent trends in certain market segments have demonstrated the need for a more compact forklift, allowing for a shorter turning radius but with increased lifting capacity. (Material Handling Engineering, August, 1997, "More Than a Lift Truck for Boxcars"; letter from Gene Schwind, Executive Editor, Material Handling Engineering, December 10, 1997: letter from Clark Simpson, Director, Systems Engineering, Clark Material Handling Company, Lexington, KY, October 31, 1997) This series of forklifts are termed "box car specials" due to their use primarily in the paper industry for loading and unloading large rolls of paper into railroad cars. Although this market is still considered a "niche" market (about 665 - 700 units per year), recent surveys conducted by the industry report a growing use of these machines in the automotive industry, the lumber industry, and manufacturing mills. Also, the same report states that end users are asking for even larger rated capacities, upwards to 15,000 pounds. (Letter from Gene Schwind, Executive Editor, Material Handling Engineering, December 10, 1997) Historically, lift truck manufacturers have used iron as the source for counterweights. Consequently, a "stacked iron counterweight" emerged as the choice product. Depending upon the desired capacity rating for the forklift, the overall height of the iron counterweight was increased to obtain the required counterbalance. In some applications, this increase in height required an increase in the width of the forklift for stability. In more recent designs, lift truck manufacturers have offered lead counterweights; this trend seems to be continuing since more manufacturers are coming on line with this concept.

Although the lead counterweight is somewhat shorter in height and allows for a desired reduction in overall fork-lift length, the introduction of the denser clad (41 percent heavier) depleted uranium metal counterweight could achieve superior results by offering an even shorter length and turning radius and a reduction in counterweight height, leading to a lower center of gravity and increasing the stability of the forklift, a major desire of the forklift industry.

An industry consultant engineer, on a voluntary basis, has evaluated the concept and has expressed optimistic opinions sprinkled with management issues. Although questions such as public perception of uranium products, cost of production, and continued supply are matters of industry interest, they are not viewed as barriers to the concept. A general opinion expressed by certain manufacturers suggests that the entire forklift industry should be approached rather than specifically interested manufacturing parties. Furthermore, when the prototype forklift and subsequent evaluations are completed (see below), answers for these and other issues may be apparent.

REGULATORY ISSUES

Uranium Research and Products Corporation Promotes the Use Through a Competent Marketing Plan

As stated in the ABSTRACT, issues associated with the use of depleted uranium metal for industrial counterweights are being addressed by a consortium of interested parties. Regulatory issues regarding the licensing, use, distribution, control, and disposal of the depleted uranium metal products are viewed as management issues rather than barriers. The principals recognize that regulatory judgement will be required (see below) for this use. Dr. John F. Glenn, is a recognized national and international expert in the regulation of radiation protection and the health effects of ionizing radiation. He has 23 years of experience with the Nuclear Regulatory Commission in highly responsible positions. Glenn will conduct an in-depth regulatory analysis with specific emphasis for industrial counterweights as a portion of this project. The analysis, although under way, has not been completed as of this date. However, R. M. Bernero, a highly respected retired executive of the Nuclear Regulatory Commission, has offered a summary of the licensing iterations for the depleted uranium counterweights and the associated shielding considerations.

"The most practical way to license these devices is under a general license granted by the regulations. In this way the general licenses is obligated to register the device with the Nuclear Regulatory Commission, report changes, and maintain custody of the device until proper disposal. The regulation for this already exists in 10CFR Part 40.25, which provides for license of devices providing '...concentrated mass in a small volume..' This regulation was written for relatively small counterweights in aircraft wings, etc.; some regulatory judgement by the Nuclear Regulatory Commission will be required to apply this regulation to very large forklift counterweights. That regulatory judgement will be undertaken in the specific licensing of the manufacturer and distributor of the counterweights under 10CFR Part 40.34. This license will set the design and conditions for the generally licensed device. The general license in Part 40.25 explicitly requires that the device be manufactured or initially transferred under a Part 40.34 license. Part 40.34 is also the source of the shielding criterion, saying the '...device is not likely to cause any individual to receive in one year a radiation dose in excess of 10 percent of the annual limits specified in Part 20.1201(a) of this chapter...'. There in Part 20, one possible interpretation is an annual dose as high as 10 percent of the occupational exposure limit of 5 rem per year, or 500 mrem in a 2000-hour work year for a forklift driver. I don't think the Nuclear Regulatory Commission would approve a device at that level but would accept 10 percent of the

public exposure limit of 100 mrem per year, or 10 mrem in a 2000-hour work year." (Letter from R. M. Bernero, Subject: licensing of Depleted Uranium Counterweights, January 14, 1997) Computer modeling of dose rates for the current designs of the prototype forklifts for this project calculates the rates to be dose well under the 10 mrem per 2000-hour work year. (Argonne National Laboratory, 1998)

Furthermore, a responsible marketing plan incorporating leasing, tracking, and recycling of depleted uranium metal counterweights will complement the use and address the perceived barriers.

The leasing of forklifts, by serial number, for specific periods of time to specific firms at specific locations and specific departments, (often coupled with full maintenance) has been prominent in the industry for many years and accounts for a significant share (estimated 60 percent) of the total annual production of the forklift industry. (Modern Materials Handling, "Industrial Truck Report", Gary Forger, Senior Editor, April 1, 1998) Lessees gain certain tax advantages, freedom of working capital, reduced maintenance cost and higher productivity, to name a few of the reasons for the prominence of leasing. "Lift truck manufacturers, and in particular their distributors, are encouraging users to pay better attention to lift truck costs. This enlightened self-interest stems from the fact that if users know what their costs are, they will understand that some older trucks are costing them heavily in maintenance, lost productivity or availability for work. Partnering is an increasing factor with fleet users. They want to get out of the lift truck business no matter how many trucks they operate. Fleet users want to liberate working capital and let the distributor handle everything associated with the lift truck," (Material Handling Engineering, "Lift Trucks Making Changes for 2000", October 1995). as an aid for tracking, passive detection devices will be incorporated in each counterweight as it is manufactured.

As previously stated, an industry concern is continued supply of the depleted uranium metal. Due to the massive annual volume required by the industry (1 60,000-1 tons per year as evidenced by letter from Scott Pranger, Sales & Marketing Director, Kurdziel Industries, Inc., Muskegon, MI, November 4, 1996: "annual production surpassing 140,000 tons for the material handling industry by his firm alone"), the need for recycling of the counterweights is necessary. This need for recycle of the product also addresses a regulatory issue concerning disposal of the depleted uranium metal. When the lease expires and the forklift is returned to the general-licensed leasor, the depicted uranium metal counterweight will be removed, refurbished, and recycled to a new machine similar to the aircraft counterweight industry by the nuclear industrial firm under its specific license. Or, if the forklift is still operable as a leaseable unit, it will be re-leased to a subsequent lessee by the general-licensed leasor. Finally, when the forklift has reached the end of its useable life, the depleted uranium metal counterweight will be removed and recycled to a new production machine.

Competent marketing plans, incorporating leasing, tracking, and recycling, must be directed at addressing regulatory concerns and will insure safe and reliable methods for the distribution and control of depicted uranium metal products.

POTENTIAL BENEFITS FOR DEPARTMENT OF ENERGY

Uranium Research and Products Corporation's Endeavors Provide a Viable Market With a Significant Use of the Product

As stated in Draft PEIS, December 1997(S.5), "DOE's preference for the long-term management of depleted UF₆ is to use the entire inventory of material. DOE is assisting industry in developing lower-cost UF₆ conversion technologies and is committed to continuing its support for the development of applications for depleted uranium products and, for as long as is necessary, to continue the safe management of its depleted UF₆ cylinder inventory." Presently, the lift truck industry uses 160,000+ tons of iron per year for industrial counterweights (Scott Pranger, Sales & Marketing Director, Kurdziel Industries, Inc). Given the cautious but optimistic opinions expressed by interested manufacturers, a portion of this usage may shift to depleted uranium metal. To serve as a guide, Appendix 1, United States Shipments, is a listing of the number of forklifts sold in the United States by year. For the first nine months of 1998, the internal combustion engine, sit-down rider category of U.S. Shipments was 61,415 units with an estimated 80,000 total units. (Industrial Truck Association, 1998) To estimate the annual usage of counterweight material by the forklift industry, one may use an average weight of 3,148 lbs. per counterweight although this is a conservative figure, (NOTE: This category does not include the electric sit-down rider category, which also uses counterweights). Research of uranium alloys for additional use in machinery and within this project is scheduled to begin during 1999 by national laboratories. A second prototype lift truck incorporating significant design changes that will further improve stability and turning radius issues is under discussion with engineers and national laboratories. Optimistic opinions and test results indicate depicted uranium metal usage has a bright future in commercial applications.

CURRENT OBJECTIVES

Uranium Research and Products Corporation Will Produce a Prototype in 1999

Uranium Research and Products Corporation is designing a prototype forklift retrofitted with a depleted uranium metal counterweight; its production is expected during 1999. The selected application is a 10,000-pound capacity cushion-tired model that does not have a stacked iron counterweight. However, the manufacturer is in the process of designing a model incorporating a lead counterweight. The prototype retrofitted model using a depleted uranium counterweight clad in mild steel achieved a 10-inch length reduction and a reduction in height by four inches. Computer models conducted by Argonne National Laboratory (1998) indicate a 7.2 mrem dose rate based on a 2000-hour work year to the driver. Furthermore, upon inspection of the forklift by the laboratory radiological engineer and after physically viewing the existing shielding (e.g. engine, hood, steering components, radiator, etc.), further reductions in the dose rates are apparent. The completed prototype forklift will be evaluated by an independent testing laboratory for American National Standards Institute (ANSI) tests and other industry standards, including stability tests and braking tests. After these tests are concluded, a national laboratory will conduct tests measuring accurate dose readings from the emitting material and investigate future shielding criterion.

Ultimately, the fully certified prototype forklift will be placed for daily use, demonstration, and continued evaluation in a DOE facility.

PREAMBLE OF THE FUTURE

Depleted Uranium Metal: **A Bright Spot on a Close Horizon**

Exciting times for an old product are at hand. Depleted uranium metal will soon become a highly useful product with significant benefits to society and industry. Through research and innovative applications, coupled with cost effective production methods, other uses will develop. The research of uranium alloys is especially exciting, and initial studies offer tantalizing opportunities for product development in the industrial marketplace, which could revolutionize stagnant products. Private and public funding is coming forth to continue the research efforts. An outreach educational program, designed to inform the public of the unique property values and to dispel the much maligned reputation and public perception of uranium, is already in process. Universities and national laboratories are taking lead roles to assist the private sector in developing methods for the safe and beneficial use of uranium products and applications. The near-term and long-term beneficial use of uranium metal products is a bright spot on a close horizon.

APPENDIX I

UNITED STATES SHIPMENTS

YEAR	ELEC. RIDER	MOTOR HAND	INT. COMB. ENG.
1970	14,811	14,579	41,194
1971	14,621	13,816	36,645
1972	16,902	12,644	40,698
1973	21,917	15,492	52,014
1974	26,049	21,387	55,124
1975	19,381	15,063	36,388
1976	16,152	15,786	33,930
1977	21,409	18,000	43,289
1978	25,119	20,994	51,986
1979	29,654	24,183	55,782
1980	23,988	20,495	39,448
1981	19,784	18,734	31,885
1982	14,859	13,988	18,553
*1983	16,227	16,237	26,245
*1984	23,983	21,958	45,339
*1985	26,400	22,493	47,844
*1986	25,818	24,589	46,195
*1987	24,928	24,857	47,945
*1988	29,202	27,205	48,535
*1989	31,010	29,838	55,104
*1990	27,877	26,941	47,702
*1991	24,565	23,599	38,406
*1992	28,277	27,700	46,183
*1993	29,210	28,492	49,947
*1994	36,747	34,127	65,027
*1995	44,087	37,746	72,685
*1996	42,263	35,375	60,287
*1997	42,675	38,538	64,946
**1998	36,117	30,167	61,415

* Includes shipments of Japanese Members

** NINE MONTH TOTALS ONLY

Electric Rider = Classes 1 and 2 (counterbalanced sit-down and narrow-aisle rider)

Motorized Hand = Class 3 (electric-powered pallet trucks)

Int. Comb. Eng = Class 4, 5, and 6 (IC powered counterbalanced rider lift trucks and tow tractors)