Y-12 PRODUCT IMPROVEMENTS EXPECTED TO REDUCE METAL PRODUCTION COSTS AND DECREASE FABRICATION LOSSES

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ABSTRACT

The Y-12 National Security Complex (Y-12) supplies uranium metal and uranium oxide feed material for fabrication into fuel for research reactors around the world. Over the past few years, Y-12 has continued to improve its Low Enriched Uranium (LEU) product. The LEU is produced by taking U.S. surplus Highly Enriched Uranium (HEU) and blending it with depleted or natural uranium. The surplus HEU comes from dismantled U.S. weapons parts. Those research reactors that use LEU from Y-12 are making important contributions to international nuclear nonproliferation by using LEU rather than HEU, and helping to disposition former U.S. weapons material.

It is clearly understood that the research reactor community must keep fuel costs as low as possible and Y-12 is making every effort to improve efficiencies in producing the uranium through standardizing the chemical specifications as well as the product mass and dimensional qualities. These production cost reductions allows for the U.S. to keep the LEU product price low even with the dramatic increase in the uranium enrichment and feed component market prices in the last few years. This paper will discuss a new standard specification that has been proposed to existing LEU metal customers and fuel fabricators. It will also cover Y-12's progress on a new mold-design that will result in a more uniform, higher quality product and eliminates two steps of the production process. This new product is expected to decrease fabrication losses by 5-10%, depending on the fabricator's process. The paper will include planned activities and the schedule associated with implementation of the new specification and product form.

Introduction

The two primary suppliers of enriched uranium above 5% ^{235}U enrichment are the United States and the Russian Federation. These two suppliers exist primarily as a result of their enrichment and uranium processing facilities from their nuclear weapons and naval propulsion programs. The Department of Energy (DOE) National Nuclear Security Administration's (NNSA) Y-12 National Security Complex (Y-12) is the facility that supplies the U.S. material.

Research reactors cannot perform their critical missions without fuel. The fact that research reactors use fuels of enrichments that are not part of the normal commercial light water reactor fuel cycle increases the risk of not having an assured supply. Y-12 understands these issues and the importance of the research and isotope production from research reactors and is committed to help firm up the supply. Events such as passage of the Schumer Amendment, a stand down of the Y-12 facility in 1994, uncertainties with Russian supplies, and the depletion of surplus and scrap enriched uranium inventories all caused great

concern to the research reactor community in the 1990's. Recent actions by NNSA and Y-12 such as long-term contracts, competitive pricing, and the development of product inventories have helped stabilize the supply of material from the U.S. [1]. However, continuous improvement is the goal of Y-12 and this paper discusses some of the latest actions Y-12 is taking.

Y-12 Steps to Reduce Production Costs and Improve LEU Quality

DOE/NNSA's actions have been very important in keeping the prices of enriched uranium product competitive. However, the research reactor community should be aware that the upward climb in market prices in the commercial low-enriched uranium market (≤5 wt% ^{235}U) can have impacts on the research reactor markets as well. The NNSA pricing policy requires that the uranium and enrichment component values of the product be recouped based on current market conditions. These market conditions include the commercial pricing of enrichment and uranium indices. Figure 1 shows the upward climb in these commercial indices. Research reactor customers that have signed long-term contracts with NNSA are protected from these upward trends. Since NNSA instituted its new pricing policy in 2001, both the market prices for UF_6 (uranium feed associated with the product) and separative work units (SWU - enrichment value in the product), have been on an upward trend. This upward movement is having a significant impact on the price of nuclear fuel for commercial reactors worldwide. This trend is expected to continue as worldwide uranium demand significantly exceeds current supply capacity worldwide. Closure of the Portsmouth Gaseous Diffusion Plant in the United States has also caused an upward pressure on the market SWU price.

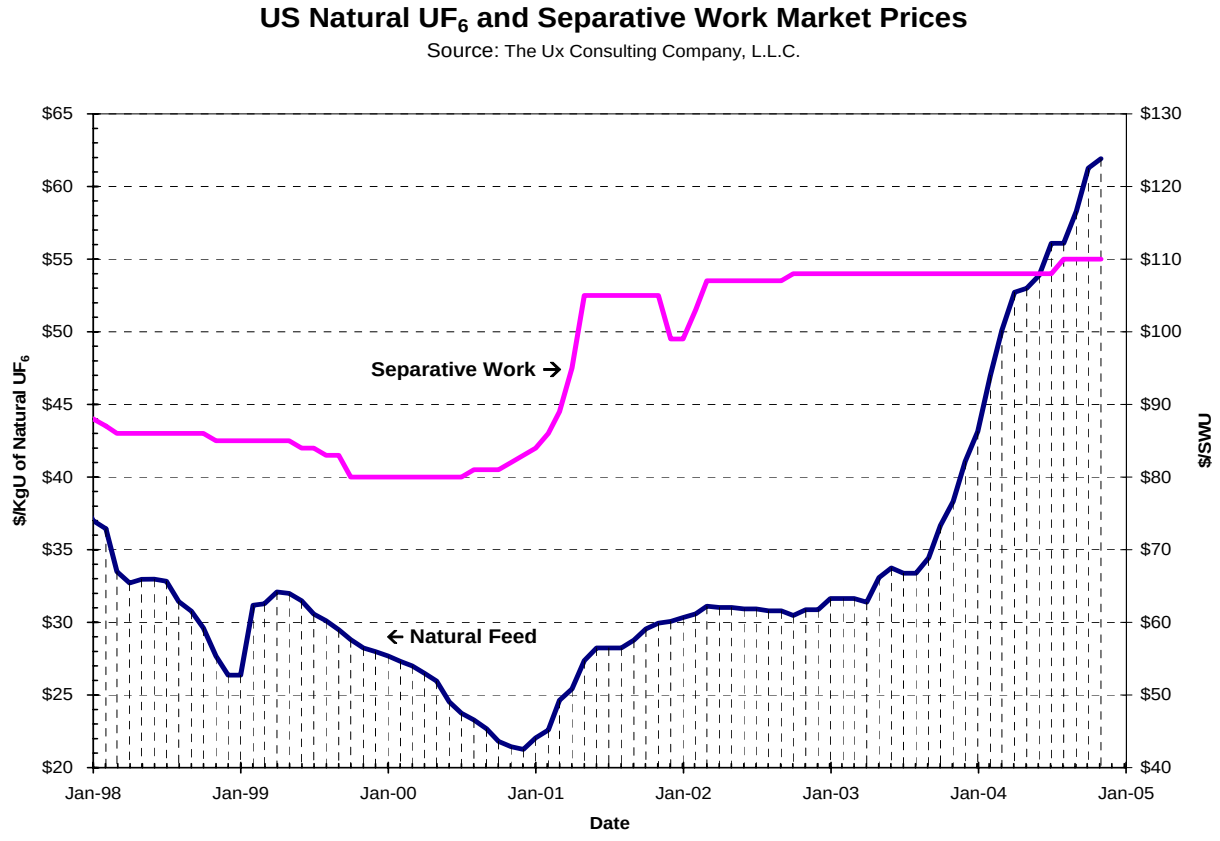

Figure 1. Enriched Uranium Component Pricing Trend [2]

NNSA will continue to make its best efforts to minimize the impact of these market increases through improved production efficiencies; however, there will come a point where LEU price increases will be required to cover the increase in market values. Y-12 has several initiatives that will further efficiency improvements and help to mitigate these market trends.

Standardization of chemical specifications: Y-12 is moving toward standardization of the chemical specifications of its product with the agreement of its customers and fabricators. The purpose of this proposed specification is to standardize the specifications for LEU metal supplied by Y-12 to research and test reactor customers. Table 1 shows the proposed Y-12 standard specification.

Table 1. Y-12 Standard Chemical Specification of Uranium Metal

Element	Symbol	Units	LEU	EBC Factor
Uranium (Metal)	U	wt %	99.880%	
U-232[1]	U-232	µg/gU	0.002	
U-234	U-234	wt %	0.260%	
U-235 ± 0.20 wt%	U-235	wt %	19.75%	
U-236	U-236	µg/gU	4600	
Trans-U (Alpha)	TRU	Bq/gU	100.0	
Activation Product	ActProd	Bq/gU	100.0	
Fission Products	Gamma	Bq/gU	600.0	
Aluminum	Al	µg/gU	150.0	0.0000
Arsenic	As	µg/gU	TBR[2]	0.0008
Beryllium	Be	µg/gU	1.0	0.0000
Boron	B	µg/gU	1.0	1.0000
Cadmium	Cd	µg/gU	1.0	0.3172
Calcium	Ca	µg/gU	100.0	0.0002
Carbon	C	µg/gU	350.0	0.0000
Chromium	Cr	µg/gU	50.0	0.0008
Cobalt	Co	µg/gU	5.0	0.0089
Copper	Cu	µg/gU	50.0	0.0008
Dysprosium	Dy	µg/gU	5.0	0.0818
Europium	Ey	µg/gU	5.0	0.4250
Gadolinium	Gd	µg/gU	5.0	4.3991
Iron	Fe	µg/gU	250.0	0.0006
Lead	Pb	µg/gU	5.0	0.0000
Lithium	Li	µg/gU	2.0	0.1439
Magnesium	Mg	µg/gU	50.0	0.0000
Manganese	Mn	µg/gU	24.0	0.0034
Molybdenum	Mo	µg/gU	100.0	0.0004
Nickel	Ni	µg/gU	100.0	0.0011
Niobium	Nb	µg/gU	TBR	0.0002
Nitrogen	N	µg/gU	TBR	0.0019
Phosphorus	P	µg/gU	50.0	0.0000
Potassium	K	µg/gU	TBR	0.0006
Samarium	Sm	µg/gU	5.0	0.5336
Silicon	Si	µg/gU	100.0	0.0000
Silver	Ag	µg/gU	TBR	0.0083
Sodium	Na	µg/gU	25.0	0.0003
Tin	Sn	µg/gU	100.0	0.0000
Tungsten	W	µg/gU	100.0	0.0014
Vanadium	V	µg/gU	30.0	0.0014
Zinc	Zn	µg/gU	TBR	0.0002
Zirconium	Zr	µg/gU	250.0	0.0000
Total Impurities		µg/gU	1,200	
Equivalent Boron Content[3]			3.0	

By standardizing the chemical specification, Y-12 can provide a product that can be used by its customers and that is more closely aligned with the uranium commonly produced at Y-12. Standardization will

[1] The "Alpha activity" reflects measured *transuranium* elements to include: Americium 241, Curium 243/244, Neptunium 237, Plutonium 238, and Plutonium 239/240. Such measurement will be in picocuries per gram (pCi/g). An arithmetic conversion will result in a converted upper limit of 6757 pCi/g.

[2] TBR means value "To Be Reported."

[3] EBC Factors are taken from ASTM C1233-97, "Standard Practice for Determining Equivalent Boron Contents of Nuclear Materials." EBC calculation will include: Boron, Cadmium, Dysprosium, Europium, Gadolinium, Lithium, and Samarium.

enable Y-12 to better respond to urgent customer needs for uranium by maintaining an "on-the-shelf" inventory of standardized LEU. Additionally, simplification of production requirements and quality control will improve Y-12 efficiency.

Enhancements in product form: The NNSA Y-12 facility has always provided high-quality enriched uranium in various forms. The primary uranium feed form for research reactor fuel is uranium metal. The Y-12 uranium metal product is currently in the form of broken metal pieces ranging in size from 80-300 grams. As an enhancement in form consistency, NNSA will be offering sized material with less variation between pieces and fewer "jagged edges" as seen in Figure 2. Although Y-12 is able to offer a variety of forms and uranium metal alloys if requested, standardization is the ultimate goal in order to obtain the best production efficiencies. Figure 3 shows a surrogate material representation of the standard form and dimensions that Y-12 is considering. This new form is approximately 200 grams in mass and is 2.56 cm in maximum diameter and 3.21 cm in height. NNSA has been discussing this new design with individual customers and fabricators to assure that it will be acceptable to their equipment and processes.

Figure 2. Current Y-12 Uranium Metal Form

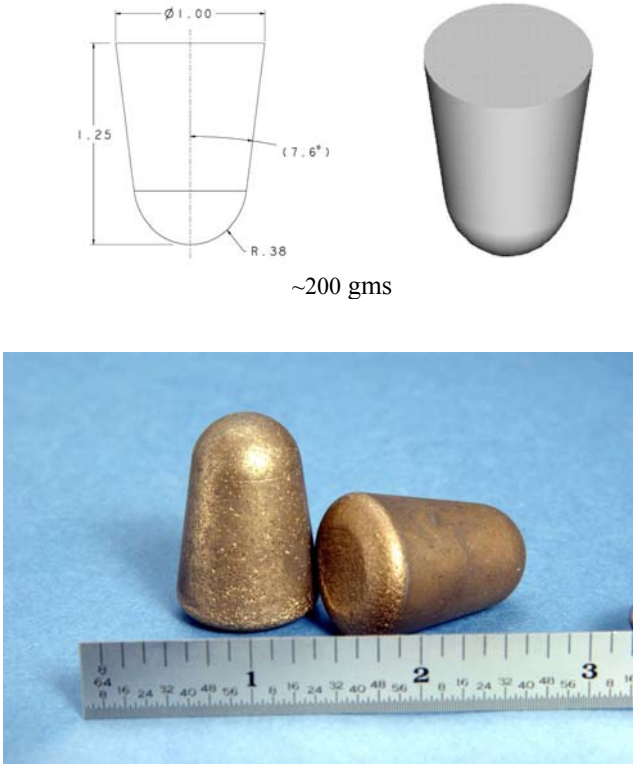

Figure 3. New Y-12 Uranium Metal Form

Repatriating excess fuel or scraps: As part of the efforts of the new Global Threat Reduction Initiative, NNSA is currently looking for ways to help research reactors and fuel fabricators return HEU or other weapon-usable materials back to the place of origin or to a final disposition location. Reduction of these inventories can help reduce costs to the sites holding these excess inventories. In some cases, the economic value of the material can be realized once the material is transferred and/or processed for reuse. Y-12 and NNSA will be working with various sites and organizations to assist them in removing material that may be weapons-usable.

Conclusion

Although the overall uranium and enrichment markets are on an upward trend, Y-12 is continuously looking for more efficient ways to do business, such as standardizing the chemical and dimensional properties of its LEU product. Y-12 will continue to work with its customers and their fuel fabricators to look at additional ways to minimize fuel costs. Additionally, Y-12 and NNSA will work with various sites to reduce any inventories of special nuclear materials that may be a nuclear proliferation risk.

References

[1] Dean R. Tousley, Firming Up the Supply of Enriched Uranium for Research Reactors of the World: A Core U.S. National Nuclear Security Administration Mission, (RRFM'04), Munich, Germany, March 21-24, 2004.

[2] Source: The Ux Consulting Company, LLC