# What is a SWU (Separative Work Unit)?

**(As published in The Oak Ridger's Historically Speaking column during the week of 1/11/2021)**

Those of you who either worked at the Oak Ridge Gaseous Diffusion Plant (K-25) or at Paducah or Portsmouth have helped produce SWU's and may even understand what it is. However, I find very few individuals who can explain the diffusion concept and meaning of the term.

One individual who has demonstrated both a high degree of technical expertise and also an understanding of the term as well as the need to explain it in terms that can be understood, is Steve Polston. Steve is retired now, but during his career he managed a gaseous diffusion plant and also worked on improving the technology to get tremendous increase in SWU's.

He has shared with me a document he wrote in July 1993, for the *Paducah Pipeline,* a Martin Marietta publication distributed to the employees at the Paducah Gaseous Diffusion Plant. Enjoy an abbreviated version of the publication and learn about SWU's!

***
WHAT'S A SWU ANYWAY? It is a measuring stick to produce and sell enriched uranium nuclear fuel. (now you know…but do you really? Ray) This is the first in a 1993 series of articles about the Paducah Uranium Enrichment Plant and the worldwide enrichment business: by Paducah Plant Manager Steve Polston.

The Separative Work Unit (SWU) has been a measuring stick the last 40+ years for production and sale of the enriched uranium product produced by Department of Energy owned plants that are located at Paducah, KY, Oak Ridge, TH, and Portsmouth, Ohio. Although those of us living in the Paducah area find our personal lives highly economically dependent on something called the "SWU," I doubt if many could accurately define it. Our Paducah Plant produces about 20,000 SWU on a typical day, but none of us have ever "seen" a SWU.

It is like watching a submarine race. You know it is happening, but progress is never directly visible. The extent of most folk's understanding is that the SWU is a measure of the effort needed to raise uranium to higher purity called assay.

Here is a thought experiment that may help you better understand. Suppose as a child you Dad told you to hurriedly fetch him a pair of black socks located in a very dimly lit bedroom sock drawer. You only know that there are about 50 black socks and 50 blue ones in the drawer and that you have time for two tries to pick a black pair.

So, you go into the bedroom and commence the first of two tries to pull a black sock. The odds are one chance in two (1:2) that you will get a black sock the first try.

This is true because there are equal numbers of both colors. When you pull out a second sock the odds are still (roughly speaking) 1:2 that you will pull a black sock. The combined odds of selecting a black pair in exactly two tries on one in four (1:2 times 1:2 = 1:4) that you will get a pair of black socks in just two tries.

Now, suppose your Dad sends you on the same errand on another day. But, this time you go to the drawer knowing there are 98 blue socks present and only two black ones. You reach in for the first sock and the odds of successfully pulling a black sock this time are radically different. It is two chances of success in one hundred tries (P2:100).

You pull the first one and then reach in the drawer for the second sock with the same odds still (roughly speaking) 2:100) you will get a second black sock. The bottom line odds of getting a pair of black socks, however, are this time only four in ten thousand chances (4:10,000 because 2:100 times 2:100 = 4:10,000) that you will pull a pair of black socks in the allotted two tries.

If you were being paid for sorting socks for your Dad, which case would you want to charge most for? Obviously, you would want to charge more for finding pairs of black socks when they are mixed with 98 blue ones because you likely would have to make many tries and do more "separative work" to get the pair of black socks.

This same type probability scenario is true of nuclear power plants who burn U-235 to generate electricity. They will pay more for enrichment at some assays because it is inherently physically harder to do that level. So, how does all this play in the Paducah enrichment cascade?

Before enrichment when uranium is first mined, there is approximately one unit of fissionable U-235 (good for reactor fuel) for each 99 units of non-fissionable U-238 (not good for reactor fuel). The former is referred to as approximately 1% assay U-235. As the gas mixture of these two components flows down one of the many thousands of tubes of separative barrier in our enrichment diffusion cascade, the likelihood of the U-235 component crossing over to the enriched side of the turb is very low. It is so because of the relatively high concentration of the U-238 that is present in the gas.

Again, the low concentration U-235 makes separative enrichment harder. The physics principle that makes gaseous diffusion enrichment work is based on the slightly lower U-235 mass compared to U-238 and the corresponding high velocity advantage U-235 has. The slightly higher U-235 velocity gives more collisions with the barrier tube microscopic holes and results in more U-235 making it across to the enriched gas side of the barrier.

Now that we perhaps have a better street understanding of the SWU, let's look at enriched uranium from the eyes of the paying customers. Market research indicates nuclear power utilities in eleven different countries currently buy our product. (Remember, Steve wrote this in 1993, imagine the worldwide scope of this endeavor that included Oak Ridge, which operated from 1945 to 1987, Paducah and Portsmouth, both still operating at the time this was written…did you realize that? – Ray)

# What is a SWU (Separative Work Unit)?

**(As published in The Oak Ridger's Historically Speaking column during the week of 1/11/2021)**

That is why you see flags of eleven countries flying in front of our Paducah Administration Building. Out total annual sales are over a billion dollars each year.

Japan alone buys over $300,000,000/year of our enriched uranium SWU's. These customers understand our low assay separative work task is harder. They are willing to pay prices of around $100 per SWU because they realize how hard separation is starting as we do at a 1 percent assay. (This is an important concept…getting enriched uranium from its natural state of 0.7 % U-235 to just over 1% is the hardest as the assay gets higher the process gets easier and faster – Ray)

I hope you can see how our ability to compete and keep our jobs is by no means assured and is dependent on the price of our product compared to the competing price of alternative European and Russian SWU sources. I also hope you can see that the Plant expense to make product determines our final selling price.

So, it is essential that we allow no waste (especially in allowing unnecessary equipment outages) that force us to consume non-optimized, wasted cascade use of electricity. It is Plant expense such as outages and overhead that plays a big role in survival and this continuing to be a great place to work. That is why our management team has set a diffusion challenge target of ultimately producing at direct cost of $50/SWU!

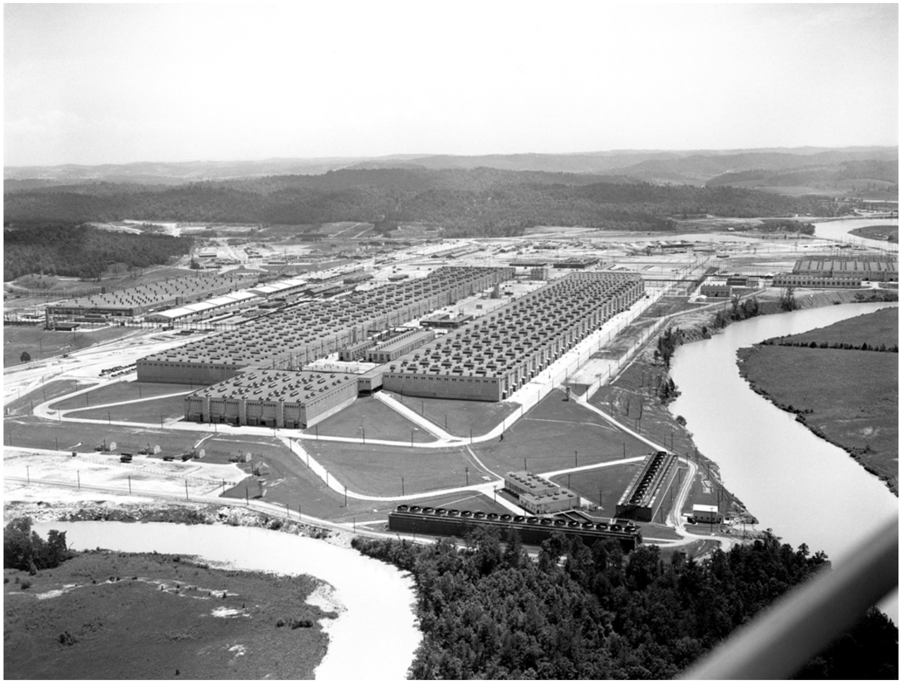
***

There you have it. Now you know the definition of a SWU! During the 1990's nuclear fuel for reactors producing heat to generate electricity was a major factor leading advancement of civilization. The Nuclear Age began with the Manhattan Project and Oak Ridge was an integral part then and continues to be among the world leaders in technological advancement.

Gaseous diffusion began here and could well be considered among the first use of nanoscience on an industrial scale. Thanks to Steve Polston for explaining the term "SWU" in terms we can all understand…socks!

# What is a SWU (Separative Work Unit)?

**(As published in The Oak Ridger's Historically Speaking column during the week of 1/11/2021)**



It all started here in Building K-25 at the Manhattan Project's K-25 Gaseous Diffusion Plant and expanded to include four more process buildings on that site and later to gaseous diffusion plants in Paducah, KY, and Portsmouth, OH.