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Y-12 Past, Present, and Future Supplying Uranium

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ABSTRACT

The Y-12 National Security Complex (Y-12) has a rich history rooted in the Manhattan Project and the early nuclear era which included enriching uranium using the Calutron process. After World War II, Y-12 focused its mission on the production of weapons components. As the cold war ended, Y-12 became heavily involved in the dismantlement of secondary components. The uranium which became excess to national security needs was provided for supply. This highly enriched uranium (HEU) would also be down-blended at Y-12 to produce high assay low enriched uranium (HALEU). These excess materials have been distributed around the world for research reactors. Y-12's collective skills have assisted the broader nonproliferation mission of converting research reactors from HEU to HALEU. In addition, HEU from around the world has been repatriated to Y-12 for future peaceful uses such as the production of HALEU for research reactors and medical isotope production.

1 Introduction

The Y-12 National Security Complex (Y-12) has a rich history rooted in the Manhattan Project and the early nuclear era which included enriching uranium using the Calutron process. The construction of the Y-12 site was led by General Leslie R. Groves with ground broken in February 1943. On August 6, 1945 an atomic bomb named Little Boy was dropped on Hiroshima, Japan. Little Boy used ^{235}U electromagnetically separated by Y-12. The nuclear mission of Y-12 was key to the success of the Manhattan Project.

After World War II, Y-12 continued to be a center of nuclear weapons materials research and design. Some significant contributions in those years included the production of enriched lithium and genetic research on the effects of radiation. During the 1960s, there was a great period of expansion and steady improvements in machining capabilities at Y-12. At the forefront was precision machining and measurement. The 1970s ushered in the era of environmental concerns. Missions for Y-12 expanded and Y-12 continued to contribute to the Cold War. Y-12's height of employee population occurred during the 1980s while some 8,000 people worked feverishly to manufacture as many nuclear weapon secondaries as possible, knowing the pressure was on Y-12 to lead the way toward winning the Cold War. The end of the 1980s saw the fall of the Berlin wall and the Cold War had been won.

The 2000s were a time of renewed spirit, revitalization, and modernization. The first new production building in 30 years was completed. The Highly Enriched Uranium Material Facility (HEUMF) was constructed as the most secure location in the world. Also two new office buildings were built to house a large number of the site population. These buildings were the Jack Case Center (JCC), named after the long-time site manager, and the New Hope Center (NHC). These buildings replaced Manhattan Project vintage spaces and brought new and modern office structures to the site. Since the early 2000s, nearly 300 buildings have been demolished on the Y-12 site.

The 2010s led to focus on the construction of the new Uranium Processing Facility (UPF), which will replace the ageing 9212 facility. The security reputation of Y-12 is challenged by nuclear weapons protestors during this era. Lessons learned from an event and continued dedication to serving the nation's uranium storage, uranium processing, and nonproliferation of nuclear materials, remain at the forefront of Y-12's missions into the 2020s.

2 People

In 2018, Y-12 celebrated its 75th anniversary. From the beginning, the people at Y-12 have been the key to its success. There are more than 5,000 employees at Y-12 currently. At the height of UPF construction, an additional 2,000 employees are expected to be added on site. Approximately 2,100 employees are part of the bargaining unit. The average age of employees is 49 with 13 years of company service. At the time collected, 21% of the population of the plant were retirement eligible. Another 43% of the population are eligible for retirement within 5 years. Currently, the percentages are most likely lower but the time to retirement is also less. Employees with degrees are depicted in Table 1.

Table 1. Degree Distribution

Degree	%
Associates	15
Bachelors	39
Masters	14
Doctorate	2

3 The Mission

The mission of Y-12 is threefold. The first is to provide the nuclear deterrent for our nation and our allies. The second is to provide nuclear feedstock for the U.S. Nuclear Navy. The third, closely associated with the purpose of the RERTR conference, is to reduce the global nuclear threat.

Providing the nuclear deterrent is specifically about our Life Extension Programs (LEPs). Y-12's historical mission has been to build canned subassemblies (CSAs) for that purpose. Furthermore, we help ensure the extension of the life of our weapons. We also maintain specialized skills to support the inspection, retrofit, and surveillance of our stockpile. We build and deliver CSAs for **LEPs**, replacing certain parts and components to modify and upgrade aging weapons systems. We reprocess uranium from disassembled weapons, machine parts to exacting specifications, and carefully reassemble final CSAs. If we do not complete our portion of the LEP process, we are not able to extend the lives of these weapons, which means we cannot ensure an effective nuclear deterrent for ourselves or our allies.

Y-12 has a unique relationship with the U.S. Navy. Not only do we supply the nuclear payloads for the weapons our ballistic missile submarines carry around the globe, we also provide the highly enriched uranium used in the reactors that power those submarines and the Navy's aircraft carriers.

We also completely **dismantle** retired weapons and disposition the various components and materials. This work reduces the number of nuclear weapons in the world and ensures the nuclear material is in safe and secure storage. The unique nature of our core weapons capabilities has led to specialized skills and knowledge regarding uranium and other special materials. We use that expertise to help government agencies reduce nuclear threats around the world. Figure 1 is from a 2012 mission to recover highly enriched uranium from Mexico.

Figure 1. Material for Return in Mexico

We secure and recover nuclear materials wherever they exist. Since 1994, Y-12 has led numerous material recovery missions worldwide, most recently in Canada and Japan. In most cases, highly enriched uranium from these and other countries is brought back to Y-12, where we safely and securely store it until it can be dispositioned for peaceful uses. Figure 2 depicts the areas where material around the globe has been recovered.

Figure 2. Global Return Map

Y-12 helps **convert** research reactors globally so they can operate using low-enriched uranium rather than highly enriched uranium. We also supply their newly converted reactors with down blended LEU, which cannot be used for weapons, to help power them. These reactors are essential for researching material properties and developing medical isotopes to fight cancer.

4 Other Vital Missions

Other vital missions are conducted which provide global nuclear security and stability. As mentioned earlier, Y-12 supplies more than 80% of the research reactors around the world (excluding Russia and China designed reactors). Approximately 85% of nuclear medical procedures performed worldwide originate with uranium supplied by Y-12. More than $82M in revenues (uranium market value) supplied to the U.S. Treasury since 2010 have been proceeds from down-blending of surplus materials. A map of Foreign Research Reactor Supply is shown in Figure 3.

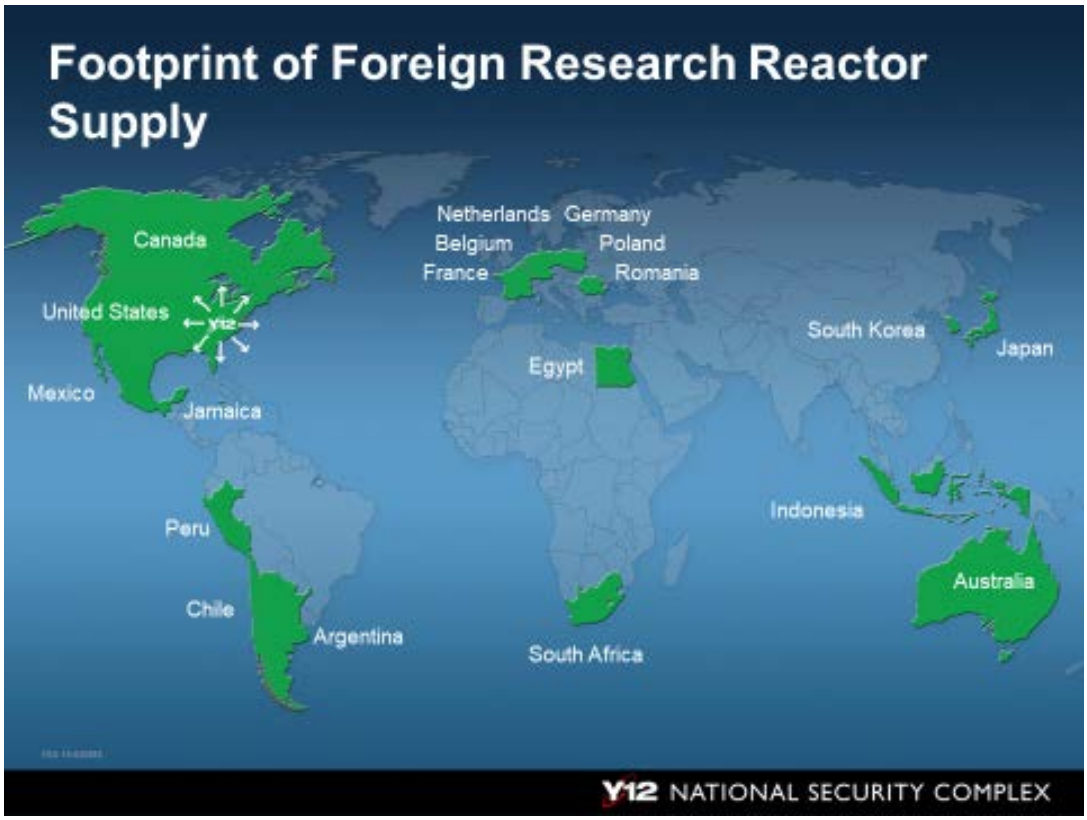

Figure 3. Global Supply

5 Revitalization/Technology

In the spirit of revitalization, a number of new technologies are being pursued by Y-12 to further enhance global security and further advance the nuclear industry. Recently, coating technologies have not been needed for Y-12's core mission. As such, equipment has become outdated or impractical. In order to meet customer needs, Y-12 is reconstituting its Physical Vapor Deposition capabilities. This will allow standard and novel coating materials to be applied to fuels and other nuclear needs. Another capability often requested has been the ability to manufacture significant quantities of oxide. Such materials are often needed for feedstock for advanced reactor fuels. A bulk metal oxidizer is being installed in order to increase capacity and keep up with demands of reactor and Mo99 producers. Additive and advanced manufacturing are becoming the norm in manufacturing. There are a number of practical applications which could enhance Y-12's core capabilities. To support the future, Y-12 is evaluating a number of approaches which could be used for feedstock for additive manufacturing. One is atomized powder production. The other is wire drawing or pulling. Both are being investigated for production and both processes have inherent safety risks that are being evaluated for mitigation.

6 Infrastructure

Over the past decade a large push to revitalize the infrastructure of Y-12 has occurred. Both the JCC and the NHC provide modern, efficient work, meeting, and gathering locations for not only Y-12, but the larger Oak Ridge community. NHC offers a large auditorium for public meetings and conferences. The Zach Wamp Auditorium is named after a former Tennessee representative who was a staunch supporter for the revitalization of Y-12. JCC is home to more than 1,200 employees, a cafeteria, a fitness center, and a medical clinic. Both sites help to recruit and retain the workforce necessary for the future of Y-12.

HEUMF opened in 2010 and has been referred to as the Fort Knox of uranium. The facility is larger than an American football field and provides secure, efficient storage of weapons-grade uranium. This state-of-the art facility meets all seismic and hazard analysis for current standards. It is an excellent complement to the soon-to-be constructed UPF.

UPF sustains long-term uranium capabilities, provides significant safety and security improvements, and reduces long-term operating costs. It is a first-of-its-kind complex for enriched uranium operations in support of Y-12 missions. The multiple-building complex will provide significant safety and security improvements and reduce long-term operating costs. It is to be built by 2025 for no more than $6.5B through a series of seven subprojects. When completed, it will replace all of the process performed in the ageing 9212 facility. This will allow the 9212 Complex to prepare for decommissioning and decontamination activities. A depiction of HEUMF and UPF is shown in Figure 4.

Figure 4. Y-12 Future State

7 Conclusion

Y-12 has executed its mission for 75 years and maintains the nuclear deterrent that undergirds global security, as well as reducing global threats. Y-12 reduces the number of nuclear weapons in the world and ensures this material is in safe and secure storage. Y-12 partners with many countries to ensure nuclear nonproliferation, and takes seriously these commitments to our allies and partners. Like most in the nuclear industry, change is inevitable as we progress through the 21st century. Y-12 is positioning itself for the future by reinvesting in its people, technology, and infrastructure. Y-12 is committed to sustaining its mission and partnerships for the next 75+ years.