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Thorium Research in the Manhattan Era

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Thesis

Degree Name

Master of Science

Major

Nuclear Engineering

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Abstract

Research on thorium as an energy source began in 1940 under Seaborg at the University of California, Berkeley. Following the discovery of ²³²Th and its fissile qualities, similar experiments demonstrated

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from thorium was also fissile. Seaborg viewed uranium-233 as plutonium-239, whose production was one of the Manhattan Project's goals. The central appeal of U-233 was that the chemistry of uranium was unlike plutonium, but plutonium-239 had the potential to be produced in a critical nuclear reactor. Natural thorium lacked the ability to sustain a critical nuclear reactor (to produce U-233) from thorium alone. It was not until the X-10 graphite reactor was constructed at Oak Ridge in 1943 that it was created to conclusively assess its nuclear properties, which were found to produce Pu-239 in a thermal-spectrum reactor. Early production of plutonium was significantly contaminated by Pu-240, which made plutonium unsuitable for "gun-type" nuclear weapons. Researchers in the Metallurgical Laboratory at the University of Chicago, which included Seaborg's chemistry group, suggested that the plutonium produced be used as a fuel in a special reactor to convert thorium into plutonium. This effort encountered many severe difficulties in the process of thorium dissolution. Seaborg also recognized the severe issue that uranium-233 would play in any effort to use uranium-233 for weapons. Theorists and weapons designers at Los Alamos were able to design workable nuclear weapons on the implosion principle, which accommodated for the impure plutonium. The use of U-233 for weapons effectively disappeared by 1945, but the project continued to investigate the potential of a thorium-U-233 "breeder" reactor as a homogeneous mixture of uranium salts in heavy water. This effort was abandoned in early 1945. With the end of World War II, the United States continued to grow its nuclear weapons stockpile, and thorium/uranium research was a part of that mission as the Manhattan Project concluded at the end of the war.

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