Decreasing the material attractiveness of uranium and plutonium will aid the nonproliferation community. This increases the difficulty of transferring the use of nuclear materials from peaceful energy purposes to weapons purposes. The International Atomic Energy Agency implements safeguards across the world on a limited budget. Not only does decreasing material attractiveness reduce the possibility of proliferation, but also may lighten the burden on the IAEA if safeguards can be reduced. Two particular isotopes that have low material attractiveness traits are \(^{238}\text{Pu}\) and \(^{232}\text{U}\). Without isotopic separation technology, these isotopes cannot be removed from plutonium and uranium materials respectively. Both \(^{238}\text{Pu}\) and \(^{232}\text{U}\) have high alpha decay heat, which is a primary component of material attractiveness. This decay heat causes significant challenges during weaponization and can render the high explosives in a weapon useless and cause failure in the materials if high enough temperatures are reached. \(^{238}\text{Pu}\) also releases the highest number of spontaneous fission neutrons per mass of the plutonium isotopes. Higher numbers of spontaneous fission neutrons within a weapons core can cause pre-detonation which will prevent a weapon from reaching its maximum yield. In addition to high alpha decay heat, \(^{232}\text{U}\)’s daughter products give a relatively high dose rate over time. Both the dose rate and heat generation increase over time, reaching a maximum after 10 years. \(^{232}\text{U}\) will also create difficulty during the enrichment process. Considering \(^{232}\text{U}\) has a smaller atomic mass than \(^{235}\text{U}\), its concentration will increase at a higher rate during enrichment. The decay of \(^{232}\text{U}\) in gaseous UF\(_6\) can destroy UF\(_6\) molecules creating a variety of lighter molecules that must be separated from the enrichment stream. This presentation will highlight the work being done at Virginia Commonwealth University to quantify the effects of \(^{238}\text{Pu}\) and \(^{232}\text{U}\) on material attractiveness.

Bio

Dr. Braden Goddard is an Assistant Professor in the Department of Mechanical and Nuclear Engineering at Virginia Commonwealth University. He has 8 years of domestic and international professional experiences in industry, national laboratories, and academia. His work is focused on nuclear safeguards, security, and nonproliferation and he has evaluated proliferation resistance characteristics for different materials. Dr. Goddard received his B.S., M.S. and Ph.D. in Nuclear Engineering from Texas A&M University. He is a member of the Institute of Nuclear Materials Management (INMM) Strategic Planning Committee and serves as the founding faculty member for the INMM-VCU student chapter.