NOCLEAR FUEL CYCLE DATA NEEDS

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This paper describes a general perspective of the nuclear data needs required to support various aspects of the nuclear fuel cycle. A U. S. perspective is described; however, many elements are likely to be shared by other countries. The basis of this paper includes References 1 through 6 as well as the study of Reference 7 of which the author was a contributor.

Past efforts in obtaining nuclear data were largely focused on weapons development, and later reactor (fission & fusion) development. Accuracy requirements were in turn predicated upon fulfilling the missions of the times. These efforts resulted in the Evaluated Nuclear Data Files, or ENDF/B files, as part of the overall Data Compilation Program. Initiated in the 1950s by the Atomic Energy Commission, this effort is now maintained by the Department of Energy (DOE) in the U. S.

Today DOE priorities have changed substantially. The original mission no longer coincides with the previous priorities. Use of the nuclear data files has been expanded world wide to include a wide variety of fields including forensics, nuclear medicine, waste management, health physics, safeguards, food irradiation, plus other uses. Additionally, *routine* exchanges of evaluated nuclear data occur among the four major nuclear data centers around the world, including the National Nuclear Data Center (NNDC) at the Brookhaven National Laboratories for the U. S., the Nuclear Energy Agency (NEA) of the OECD in Saclay for Western Europe and Japan, the Nuclear Data Center in Obninsk for the CIS, formerly the USSR, and the Nuclear Data Section of the IAEA.

Nuclear data needs related to current fuel cycles are largely in the areas of improvements in power production and waste management. Known uncertainties for key isotopes need to be reduced to improve safety margins in support higher burnups that would improve the economics of current fuel cycles. In the U. S. alone, margins that add only a few roils per kWhr of electricity generated amount to millions of dollars in added costs per year. For example, in the case of the familiar ^{238}U isotope, values that are recorded in the ENDF/B-V data set yield a delayed neutron fraction that is too low. Furthermore, uncertainties are in the range of plus or minus 10%. Additionally, integral testing suggests that the resonance absorption cross section may be over predicted by as much as 3%. Determination of the later parameter is central to predicting power coefficients for reactor operation and may result in an even greater uncertainty than the 3% mismatch in the resonance integral suggests. These plus other uncertainties in nuclear data result in margin allowances in burnup calculations that translate into substantial industry wide refueling *costs.*

Significant uncertainties also exist for several isotopes of importance in waste management. Affected calculations include source term, shielding, delayed neutron yield and long term waste form integrity. Uncertainties of 50% or more are not uncommon for data of interest. In the case of ^{90}Sr, the assumed neutron absorption cross section was found to be as much as a factor of 10 too low. For the higher actinides, the delayed neutron yields are only poorly known as are the neutron capture cross sections of long-lived fission products. These values are significant as related to the integrity of high-level waste forms over the 10,000 year design lifetime.

The outlook for future nuclear data needs is driven by many diverse factors. Included is the perceived need for closure of the fuel cycle, new fuel and reactor designs, the availability of experimental facilities and expertise, the desire to burn weapons grade material as fuel and the availability and economics of new technologies . Increased accuracies will be required for fuel cycle closure due to the shift toward heavier isotopes in fuel. This also will impact the need for improvements in extended nuclear interaction chain data. Data improvements also will be required to support critical issues relating to cycle economics, assay requirements, safety margins and extended decay heat calculations. Likewise, for newer reactor designs, increased emphasis will likely be placed on inherent nuclear and physical design rather than engineered safeguards. Economic factors also will place demands for better precision as newer fuels with extended burnups are utilized.

The interest in burnup of weapons grade material will likewise place additional demands on improved data for Pu. For example, *cross* sections are known to be in error as indicated by over-estimates in reactivity based on critical assembly testing.

Future programs in fusion will need to address significant uncertainties that could adversely affect both the economics and safety margins. Data for fusion reaction cross sections, particularly D-T, D-D and D-^{3}He need *to* be improved upon. Other limitations may similarly affect calculations for blanket 3_{H} production, nuclear heating, component activation and decay heat and material damage (atomic displacements and gas production) .

Finally data needs remain for newer waste management concepts such as the actinide burner projects (OMEGA, Reference 3; ALMR, Reference 4; ATW, Reference 5). The significance of these approaches is the potential to economically reduce the environmental isolation requirements for high-level waste to hundreds of years instead of 10,000 years.

Aside from these needs, what is the outlook for the nuclear data program in the U. S. in view of the foreseeable budgetary pressures? The U. S. effort appears to be headed towards an increased reliance upon physics modeling and calculational techniques for nuclear data generation. This will likely be supported by limited benchmarks using selected experimental data points.

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