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ANSI/ANS-8.15-1981 (R95): Nuclear Criticality Control of Special Actinide Elements

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Under the chairmanship of Norman L. Pruvost, a working group was formed[1] in 1996 to review and revise this standard. Its current membership includes Jacques Anno, IPSN-France; Roger Brewer, LANL; Duane Clayton, PNNL-Retired; Paul Clayton, AWE-United Kingdom; Hiroshi Okuno, JAERI-Japan; Charles Rombough, CTR Technical Services; Victor Sviridov, IPPE-Russia; Mike Westfall, ORNL; and Ken Yates, SRS. Additionally, a number of other researchers, acting as corresponding members with the working group, have participated in developing critical mass and concentration data**.** The international composition of the working group is an intentional effort to utilize the latest experimental data and analytical methods on a comprehensive and global basis. Two-day working group meetings were conducted in each of the past three years, at Lake Chelan, Washington; Oak Ridge National Laboratory; and La Hague, France.

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The primary fissile nuclides: ^{233}U, ^{235}U, and ^{239}Pu continue to be addressed in ANSI/ANS-8.1 in its recent revision.[2] Thus they are excluded from 8.15 and their exclusion has been connoted with the terminology *Special Actinides* in the title of 8.15. However, the relative importance of the primary fissile nuclides raises the question: what is special? The working group has decided that *Selected Actinides* would be more appropriate terminology in the title of the revised standard.

Other than not being one of the three primary fissile nuclides, two criteria are being applied in the selection of the revised 8.15 actinides:

1) The nuclide's half life must be at least forty days, and,
2) the single fissionable nuclide must sustain a neutron chain reaction in an infinite medium, either by itself or with materials containing no other fissionable nuclides.

As a practical matter, the status of the nuclear data (cross sections, nu, chi, etc.) for each nuclide must be adequate to demonstrate meeting criterion number two. The list of selected actinides being studied as candidates for the revised standard are: ^{232}U, ^{234}U, ^{237}Np, ^{236}Pu, ^{238}Pu, ^{240}Pu, ^{241}Pu, ^{242}Pu, ^{241}Am, ^{242m}Am, ^{243}Am, ^{243}Cm, ^{244}Cm, ^{245}Cm, ^{246}Cm, ^{247}Cm, ^{248}Cm, ^{249}Cf, ^{250}Cf, ^{251}Cf, ^{252}Cf, ^{254}Cf, and ^{254}Es. The current projection is that the revised standard will provide guidance for the fourteen nuclides in the current standard, seven of these based on revised data, and additional guidance for nine nuclides, totaling the twenty-three nuclides listed here.

The text of the revised standard will provide recommended subcritical mass limits for single units in spherical geometry. As before, the fast-spectrum single units will be metal and oxide compounds at theoretical densities and fully reflected by steel and water. The thermal-spectrum single units will be aqueous solutions fully reflected by water.

Appended material will contain the revised and enhanced data on minimum critical masses and concentrations. These data are not yet complete, but good progress has been made and several contributions[3-7] have been reviewed and presented at technical conferences. Also appended will be an update and revision of the discussion of the fission process as well as tabular information on the maximum physical densities based on crystallographic data[8] for the actinide metals and oxide compounds. Additionally, quantitative guidance will be given on the nuclide inventories[3] of the actinides generated in a typical light water reactor. This information should be useful in establishing the fissile equivalence of the higher atomic number actinides and in the consideration of probable nuclide abundance in setting subcritical limits.

Concurrent with the effort to revise 8.15 has been the emergence of OECD/NEA sponsored efforts to establish minimum critical mass values and international benchmarks. There is a consensus in the international technical community that, to the extent that these activities overlap, the technical bases should be consistent. Also, it is envisioned that an international standard on the criticality of the actinides will eventually be based on this work.

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