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Title:

AMERICAN NATIONAL STANDARD ANSI/ANS-8.15-1983: NUCLEAR CRITICALITY CONTROL OF SPECIAL ACTINIDE ELEMENTS

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DISCLAIMER

American National Standard ANSI/ANS-8.15-1983: Nuclear Criticality Control of Special Actinide Elements, R. W. Brewer, LANL, N. L. Pruvost (Galaxy Computer Services, Inc.), and C. T. Rombough (CTR Technical Services, Inc.)

The American National Standard, "Nuclear Criticality Safety in Operations with Fissionable Materials Outside Reactors" ANSI/ANS-8.1-1983 (Ref. 1) provides guidance for the nuclides ^{233}U, ^{235}U, and ^{239}Pu. These three nuclides are of primary interest in out-of-reactor criticality safety since they are the most commonly encountered in the vast majority of operations. However, some operations can involve nuclides other than ^{233}U, ^{235}U, and ^{239}Pu in sufficient quantities that their effect on criticality safety could be of concern. The American National Standard, "Nuclear Criticality Control of Special Actinide Elements" ANSI/ANS-8.15-1983 (Ref. 2), provides guidance for fifteen such nuclides. The Standard was approved for use by the American Standards Institute on November 9, 1981. When it received its first 5-year review, no changes were made, and it was reaffirmed effective October 30, 1987. The Standard was again reviewed and reaffirmed without changes in December 1995. The next five year review of the Standard is due in December 2000.

Tables I and II are taken directly from the Standard. Table I provides subcritical mass limits for seven non-fissile nuclides. The limits are provided for the nuclides in metallic form or, in six cases, the nuclide in compound with Oxygen. Table II provides subcritical mass limits for eight fissile nuclides in aqueous solution. Both tables are applicable to single units and are arrived at by assuming that the unit is composed of a spherical core surrounded by a reflector of effectively infinite thickness. Comparison of the mass limits in Tables I and II illustrate the effect of non-fissile versus fissile nuclides - the units in Table I are kilograms whereas the units in Table II are grams. The subcritical limit allows for uncertainties in calculations used in its derivation but not for the operational contingencies such as double batching or failure to accurately assess the range of other process variables.

Composition of the work group supporting the Standard is changing to include new US members and International members from the United Kingdom and Russia. The work group chair has changed from E. D. Clayton to N. L. Pruvost, with Clayton remaining active as a work group member. The group plans to start an active review of the Standard in the near future. These plans include the incorporation of experimental results from Russia, analysis performed by the International Criticality Safety Benchmark Evaluation Project, and experimental results from the Los Alamos Critical Experiment Facility. A document being prepared by three group members (N. L. Pruvost, E. D. Clayton, and C. T. Rombough) will provide additional support for the next review. This document will include analysis for guidance on the nuclides ^{231}Pa and ^{234}U. The document is scheduled for publication within the next year.

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1. "Nuclear Criticality Safety in Operations with Fissionable Materials Outside Reactors," ANSI/ANS-8.1-1983, reaffirmed 1988, American Nuclear Society (1983).

2. "Nuclear Criticality Control of Special Actinide Elements," ANSI/ANS-8.15-1981, reaffirmed 1987, American Nuclear Society (1981).

Table I
Subcritical Mass Limits for Single Units
Reflected by Infinitely Thick Water or Steel

Non-Fissile Nuclide	Chemical Form	Subcritical Mass Limit (kg)	
		Water Reflector[a]	Steel Reflector[b]
^{237}Np	Np	30	20
	NpO_2	140	90
^{238}Pu	Pu	4	3
	PuO_2	11	7
^{240}Pu	Pu	20	15
	PuO_2	70	45
^{242}Pu	Pu	60	40
^{241}Am	Am	24	16
	AmO_2	40	32
^{243}Am	Am	35	25
	Am_2O_3	50	37
	AmO_2	60	45
^{244}Cm	Cm	5	3
	Cm_2O_3	7	5
	CmO_2	7	5

[a] The mass limits for water reflectors may also be applied to combinations of steel and water (steel backed by water) for a steel thickness $\leq$ 1 cm.

[b] The steel reflector thickness is 20 cm, i.e., effectively infinite.

Table II
Subcritical Mass Limits for Single Units of
Aqueous Solution Reflected by Infinitely Thick Water

Fissile Nuclide	Subcritical Mass Limit (g)
^{239}Pu	450
^{241}Pu	200
^{242m}Am	13
^{243}Cm	90
^{245}Cm	30
^{247}Cm	900
^{249}Cf	10
^{251}Cf	5