DPSPU-88-272-21

Safe Thickness for D1 Dissolver with 1500 GM Plutonium

by

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MASTER

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INTER-OFFICE MEMORANDUM
SAVANNAH RIVER PLANT

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INFORMATION ONLY

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SAFE THICKNESS FOR D1 DISSOLVER WITH 1500 GM PLUTONIUM

SUMMARY

There is some concern that the FB-Line D1 dissolver may have been pressurized above the liquid head pressure by a reaction that occurred in the dissolver. The D1 Pu limit of 8.8 kg is based on a tank with an inner slab thickness of 3.34" and a wall thickness of 0.40" for a total slab thickness of 4.14". When the incident occurred there was less than 1500 gm Pu (1323 gm) in the dissolver. Some calculations were made to determine the safe slab thickness for 1500 gm Pu in the D1 dissolver. Calculations show that 1500 gm Pu can be safely contained in a 6" thick D1 dissolver provided the cabinet panels are in place.

DISCUSSION

The D1 dissolver was treated as a 6 ft by 8 ft slab 6" thick. The wall was ignored and the Pu solution thickness was taken as 6". The back surface of the dissolver was taken as 5" away from the maintenance panel unless otherwise noted and the front surface of the dissolver was taken as 25" from the operating panel. Full water reflection was assumed at the panel faces.

Calculations were made using the computer codes HRXN and KENO as described in DPSOP 131 Section IV E. Code bias was based on the bias determined in H. K. Clark's Memo DPST-79-524. K-effective critical is taken as 0.99 with K-effective safe taken as 0.94. Three times the KENO K-effective standard deviation was added to the K-effective to determine K-effective max. This K-effective max must be 0.94 or less to be safe. Materials used in the calculations are shown in the attached Table. The 1500 gm of Pu was conservatively assumed to be in the shape of a right circular cylinder 6" thick. The K-effective was determined for cylinders of various radii to determine a maximum and to verify that this maximum does not exceed a safe value.

Results are presented in the attached Figure. When the 6" slab is 5" from the maintainence panel and 25" from the operating panel the K-effective is less than 0.90 and is safe. Moving the dissolver 2" from the maintenance panel is still safe with a K-effective of 0.94. When the dissolver is against a fully water reflected maintenance panel the delta K-effective is less than the required margin of 0.05 but does not calculate as critical. In summary, a D1 dissolver increased in width to 6" is safe under operating conditions provided it contains no more than 1500 gm of Pu.

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MATERIALS USED IN KENO CALCULATIONS

---> MIXTURE NO. 1 DENSITY = 1.0874E+00 G/CC AT 20.0 DEG C
DENSITIES OF U AND PU COMPOUNDS ARE: 1.9600E+01

TYPICAL Pu SOLUTION

NUCLIDE	ID	ATOM DENSITY	CONC(G/L)	WT %
PU40	50	1.1790E-05	4.6995E+00	4.3216E-01
PU39	49	2.2494E-04	8.9290E+01	8.2110E+00
H	1	6.6418E-02	1.1117E+02	1.0223E+01
O	10	3.3209E-02	8.8229E+02	8.1134E+01

WT % PU238, PU239, PU240, PU241, PU242 IN PU: 0.0 95.0000 5.0000 0.0 0.0

RATIO OF HYDROGEN ATOMS TO FISSIONABLE ATOMS = 2.806E+02
RATIO OF HYDROGEN ATOMS TO FISSILE ATOMS = 2.953E+02

TOTAL CONCENTRATION OF FISSIONABLE NUCLIDES = 9.399E+01 G/L
TOTAL CONCENTRATION OF FISSILE NUCLIDES = 8.929E+01 G/L

MACROSCOPIC POTENTIAL SCATTERING CROSS SECTION = 1.48362E+00 CM**-1

FISSION SPECTRUM 0.0 % U235, 100.0 % PU239

@ KEFF = 1.0000, AFTER 4 ITERATIONS, B**2 = 2.43292E-02 CM-2, M**2 = 2.89047E+01 CM2, K = 1.7032

---> MIXTURE NO. 2 DENSITY = 9.9823E-01 G/CC AT 20.0 DEG C

WATER

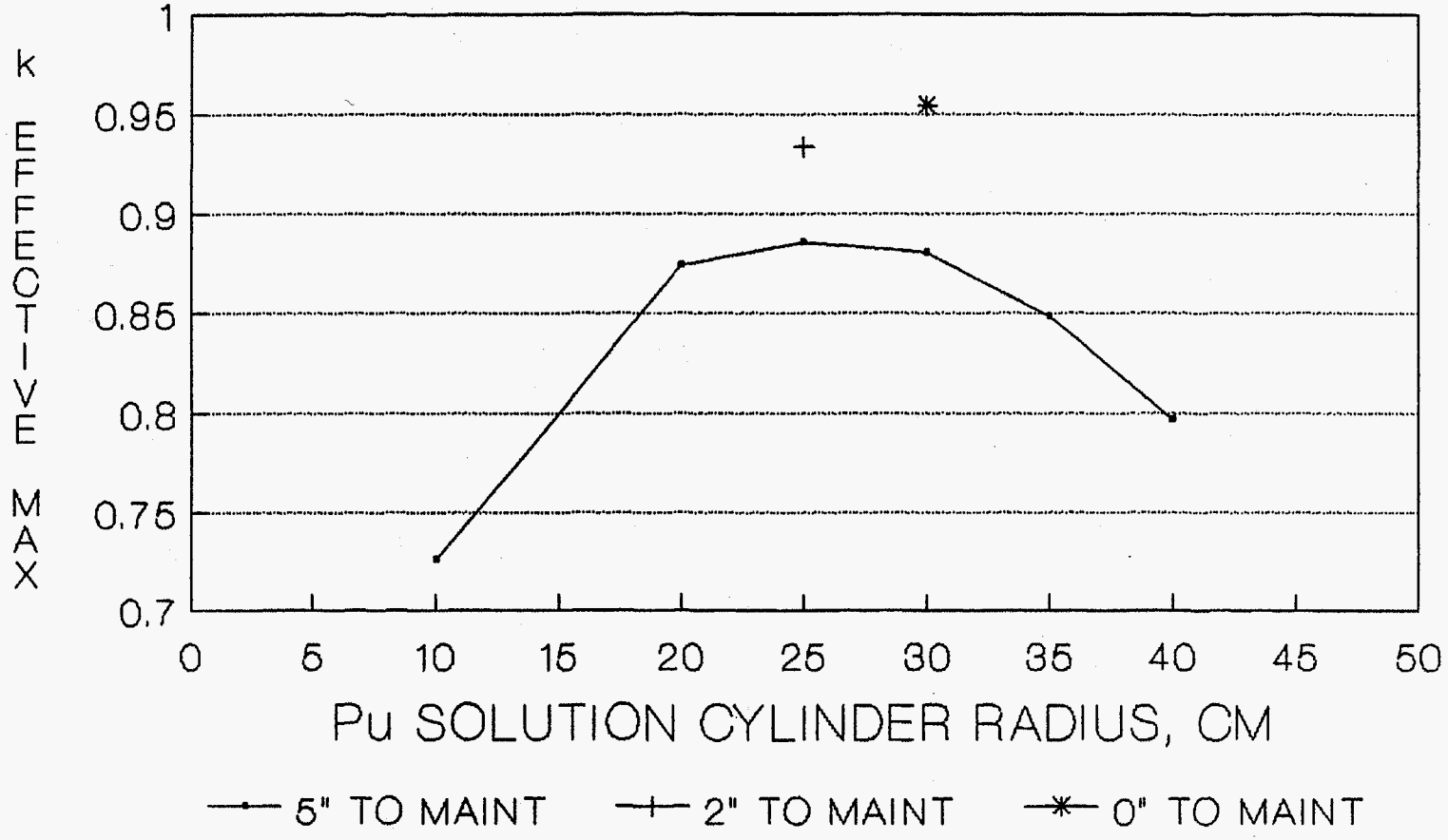
NUCLIDE	ID	ATOM DENSITY	CONC(G/L)	WT %
H	1	6.6738E-02	1.1170E+02	1.1190E+01
O	10	3.3369E-02	8.8653E+02	8.8810E+01

MACROSCOPIC POTENTIAL SCATTERING CROSS SECTION = 1.48825E+00 CM**-1

FISSION SPECTRUM 100.0 % U235, 0.0 % PU239

@ KEFF = 0.0, AFTER 0 ITERATIONS, B**2 = 0.0 CM-2, M**2 = 3.48398E+01 CM2, K = 0.0

D 1 DISSOLVER WITH 1500 GM PLUTONIUM
SIX INCH THICK SLAB; 5% PU-240



NO DISSOLVER WALL
DIST TO MAINT PANEL NOTED, 25" TO OPER PANEL; FULL WATER REFL AT PANEL FACE