INTELCOM RAD TECH

August 28, 1974

United States Atomic Energy Commission
Attn: Mr. L. C. Rouse, Chief
Fuel Fabrication and Reprocessing Branch
Directorate of Licensing
Washington, D. C. 20545

Gentlemen:

In response to requests in your letter of June 19, 1974 authorizing Amendment No. 1 to SNM-1405 we submit the following experimental information. These data were obtained in loading the subcritical CFX assembly with up to 1261.04 grams of ^{235}U. The minimum reactivity was determined to be -\$8.14 which corresponds to k_{eff} of .946 assuming $\beta_{eff} = .007$.

The reactivity effects of additional shielding or reflectors was determined by covering the 4 inch thick polyethylene reflector with from 4 to 6 inches of additional poly or parafin over 50% of the area. The reactivity effect was measured to be negligible with a change of $\Delta\rho$ of \$0.01 ($\Delta k/k = 0.00007$).

The radiation levels around the operating subcritical assembly ($k_{eff} \approx .95$) were measured with only a portion of the final shielding present. The final shield configuration, which will primarily consist of a concrete block wall, will allow 10 mr/hr or less radiation into the position of the cell where authorized personnel have access. The measured radiation levels were not made with the additional concrete wall in place, only with the lead and blocks of water-extended-polyester (WEP) mixed with boron that are immediately adjacent to the reflector. Scaling the measured data, which was taken with a 108μ gram ^{252}Cf source in the assembly, to a 1 m gram ^{252}Cf source we determined the following doses:

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Position	Dose γ mr/hr	n mrem/hr
20' from assembly	7.7	18.5
6' from assembly	35.2	120.4
front edge of assembly	315	833
top of assembly	259	93

Assuming the assembly is finally loaded to a reactivity that corresponds to a k_{eff} of 0.990, these doses should be multiplied by a factor of 5.4 for a system with the same shielding configuration. The additional concrete shield is expected to be adequate based on these measurements.

The function of the fail-safe features of the Californium Flux Multiplier (CFX) is to shut down the CFX (i.e. scram the safety rods and remove the ^{252}Cf source from the core) if the high level flux trips on either the linear or log channel is exceeded, if the period on the log channel is too short, or if power is lost. In addition, the safety rod drive motors are in series with a low level flux trip that must be exceeded before the safety rods can be withdrawn from the core to increase the reactivity of the assembly. These features have been checked daily and found to be functional every day that the CFX has been operated. There have been no malfunctions of the fail-safe features during this period.

The effect of accident considerations was experimentally considered by measuring the change in reactivity when the radiography port was completely filled with hi-density polyethylene and the fast neutron activation port with a lucite rod. This corresponds to flooding of these ports with water. The reactivity of the system was found to change by 62¢ -- much less than the $1.44 needed to go critical with the assembly loaded to a k_{eff} of 0.99. The effect of adding ^{235}U to the central region of the CFX was measured by placing a poly vial of UO_2 in the central flux trap. Total amount of ^{235}U was 16.21 grams. (The maximum amount a standard 2 dram poly vial can hold of 93% enriched UO_2 would be somewhat less than this, approximately 14 grams). The total change in reactivity was found to be 66¢ or 4.1¢ per gram of ^{235}U. Again this reactivity change is insufficient to cause criticality even at the full loading of the CFX. Indeed, all of these effects taken simultaneously are insufficient to cause criticality.

The thickness of the polyethylene moderator plates were varied to investigate the optimum moderation conditions for fuel loading. The reactivity results listed below were obtained for the hydrogen to uranium ratios listed.

H/U	ρ($)
511	-8.84
426	-8.68
342	-10.87

It appears that the broad peak in the optimum hydrogen to uranium ratio for the CFX is slightly less than the 500 to 1 that we had originally calculated. The final loading of fuel to a k_{eff} of 0.990 will be made at a H to U ratio of 426. to 1. These data substantiate our claim that either the addition (flooding) or loss (disassembly) of moderation will result in a loss of reactivity.

During the initial loading and operating period of the CFX the structural integrating of the components has been found to be adequate. The technique of applying a small amount of pressure to one end of each fuel box has worked very well in maintaining an absence of voids in the fuel region yet allowing for an efficient fuel loading operation.

At the present k_{eff} the accurate measurement of the temperature coefficient is a very difficult task since it is expected to be on the order of $-1.6 \times 10^{-4}/C^{o}$. We would like to defer this measurement until the CFX is loaded to its design value of $k_{eff} = 0.990$. The thermal power produced in the CFX was determined from neutron flux measurements to 0.8 watts. Consequently, the thermal power output at full fuel loading should be approximately 4.3 watts.

The additional information requested in your letter is listed below in the same order as the questions.

1) The ^{252}Cf source drive mechanism assembly drawing is contained in Appendix 2 (RT048J0011A) of the CFX Description and Safety Analysis that was submitted with our license application dated January 24, 1974. The function of this mechanism is to move the Cf source from a lead storage pig located in the WEP shielding to the central core region and back again. During a scram or when the operate key is turned off the

the source automatically moves to the storage postion. During a scram that is caused by a power failure the Cf source may be moved by a manual crank located on top of the assembly above the WEP shielding.

The radiation shielding for the CFX is described above. The remaining component of the shielding is the concrete block wall that will have a surface radiation level of 10 mr/hr or less when the CFX is operating.

2) The shutter door of the CFX can be open when the CFX is operating. However, the shutter door interlock is in parallel with the interlock on the cell door and the personnel plug interlock. If either of these interlocks are opened with the shutter door open then the CFX will scram. The personnel plug interlock is an adminstrative feature that requires all personnel entering the limited acess cell to pull a plug and return it for the duration of the stay in the cell. This adminstrative control is in addition to the access door interlock.

3) There is no automatic control on the safety rods other than the high level flux trips, the period trip and the low level trip. The intent is to load the CFX to a k_{eff} of 0.990. This k_{eff} will be achieved only at the full out position of the safety rods and no further increases can be made by an operator. We have shown that even in the most extreme cases, i. e. insertion of hi-density polyethylene in the ports to simulate flooding, or insertion of a sample activation analysis vial containing pure enriched uranium oxide, the increase in reactivity is less than half that needed to take the system to criticality. Of course, these extreme conditions will be precluded by other controls; however, they do illustrate that the CFX, once it is loaded to its design k_{eff}, cannot be taken to criticality under any credible operating conditions.

We suggest that the data and experience obtained to date with the CFX confirms the inherent safety of the system as discussed in our license application. Therefore, we respectfully request authorization to load the assembly to its design multiplication, $k_{eff} = 0.990$. At that loading we will reconfirm the reactivity effects reported above, and will in addition be able to confirm that the expansion and temperature coefficients are within safe limits.

We will be pleased to present any further details required to complete your review, including a technical presentation to your staff in Bethesda if desired.

Sincerely yours,

C. A. Preskitt

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Group Vice President

CAP/km