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Mr. L.C. Rouse, Chief
Fuel Fabrication and Reprocessing
Branch No. 1
Directorate of Licensing
U.S. Atomic Energy Commission
Washington, D.C. 20545

Gentlemen:

Supplements I and II to this letter are our responses to questions raised in your letters dated October 3, 1974 and November 13, 1974.

We would also like to amend our original license application to allow a polyethylene plug to be placed in the radiography collimator during activation analysis operations. This has been experimentally determined to have a negligible effect on the system reactivity; however, it does change the neutron flux in the activation analysis region by 11%.

Yours truly,

C. A. Preskitt

C.A. Preskitt, Vice President

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Enclosures

RAD TECH

Supplement 1

1) The shielding experiment with hydrogenous reflectors was repeated with a fuel loading for a reactivity of -$1.53 (keff = .989). We now find a small but measureable effect on reactivity with an additional 4" to 6" thick hydrogenous reflector tightly packed around approximately 70% of the permanent polyethylene reflector surf[illegible]. The change in reactivity was measured to be $\Delta\rho$ = $0.06. This same experiment was also conducted for concrete blocks packed as tight as possible around the reflector surface. The results were essentially the same with a $\Delta\rho$ = $0.06. Consequently the shielding (increased reflector) does cause a measurable increase in reactivity however the effect is small and can easily be accounted for in the initial fuel loading.

2) Each of the four fuel boxes in the CFX core has an access port through the top reflector. When the pressure plates are tightened down after loading fuel in a box the bottom of the pressure plate is tightened first and the top of the fuel box is visually monitored for voids. We also compared reactivity measurements when the pressure plates were tightened down with a torque wench to 10 in - lbs (much tighter than torque necessary to eliminate voids). There was no noticeable difference in reactivity for the loadings that used the torque wrench and those that did not. In order to create a measureable difference a large total void approximately 1/4" wide was left between the plates, and compared with the same loading without the voids. The difference in reactivity amounted to $0.24. Consequently, since the total amount of room in the fuel boxes is limited, a really significant change in reacitivity is not possible and the small changes that are possible have a small or negligible effect on the reactivity.

3) Procedural controls for routine commercial use

a) Fuel Handling. For routine commercial usage it will not be necessary to perform any operations involving fuel handling; once installed there is no ready access to the fuel region. Therefore procedural controls for fuel handling are not applicable.

b) Control Instrumentation. Daily check out procedures and operational check lists are employed which require that information regarding instrumentation response to the source be logged routinely. This serves as an operational test of each channel. The control panel is equipped with built-in calibration check circuits for the log and period channels. Linear channel calibration would be accomplished by means of an external current source since it is equipped with only a "zero" calibration check. The calibration check is also a part of the daily checkout scheme. The control instrumentation is solid state and essentially maintenance free and the only required maintenance of the system would be periodic checks on power supply voltages.
An instruction manual will be supplied with this unit covering the system check out and operation.

c) There are no specific limits as to the type and amounts of materials which can be irradiated. The volume of the two activation ports are the primary restriction as to the amount of material which can be irradiated. Samples are pneumatically transferred to the ports in 2 dram vials thereby limiting the volume to about 7.4 cm^3 in each port. Since enriched uranium is the only material which will significantly increase the system reactivity it is recommended that U-235 not be placed in the core unless special provision is made for a specific installation. All materials which are placed in the core are contained in sealed plastic or metal vials and therefore present no problems regarding chemical reaction with the aluminum tubing in the Fast Port or polycarbonate tube in the Thermal Port.

4) In order to assure that a multiplication factor in excess of 0.99 cannot be attained with the safety rods fully withdrawn, each specific system will have a fixed fuel loading such that the maximum k_{eff} with the safety rods withdrawn is 0.99 regardless of the material being irradiated. For a normal installation irradiation of fissile material would be strictly excluded. Fissile material can have a significant effect upon the system and if a specific system is authorized

to irradiate fissile material the initial fuel loading will be adjusted such that a k_{eff} of 0.99 cannot be exceeded with the largest sample allowed by the specific installation license.

If and when a sample of fissile material is used in the system a determination of the system multiplication factor would be made at an interim safety rod position to assure that a k_{eff} of 0.99 will not be exceeded with the safety rods fully withdrawn. This can be done by observing the instrumentation readings and determining the reactivity from reactivity-current calibration curves developed for a given loading of fuel in the specific CFX.

5) The CFX is designed with a certain minimum shielding to ensure that any additional material, shielding or otherwise, in the immediate vicinity of the unit will have zero effect upon the system reactivity. Atop the core is approximately 24 inches of WEP and on the sides and back of the core there is a minimum of 4 inches of WEP. The front of the core with the radiography port is shielded with 6 inches of lead. The collimator assembly has 15 inches of WEP shielding and the shutter over the end of the radiography port has 4 inches of polyethylene, 4 inches of lead, and 60 mils of cadmium as shielding material. Any shielding recommendations for a particular installation would depend upon the location and needed accessibility to the unit. Regarding containment, ventilation, and fission produce leakage, there are no specific recommendations. The fuel is uranium aluminum alloy with aluminum cladding and fission produce leakage is not a likely problem with a system operating at essentially room temperature at low power. After receipt of the cold fuel and prior to shipment and installation of the CFX each of the fuel plates is wiped to determine if there is any smearable contamination (fission product leakage). We have not detected any leakage from any of the present plates. Since the multiplying system operates at only four watts it is not credible that pressures would build up sufficient to crack the cladding and/ or the fuel alloy. If and when the system is dismantled the core and fuel plates would be surveyed.

6) The amount of ^{235}U needed to reach criticality, if added in the same way as the fuel plates, is 72.9 grams of ^{235}U. Or stated another way it would

take approximately 7 more large fuel plates (nominally 10.3 grams ^{235}U per plate) to reach criticality. If the uranium were added in the central flux trap region in a polyvial in the form of 93% enriched UO_2 the amount needed to take the system to criticality would be 33.26 grams of ^{235}U.

We have been especially pleased with the reliability and consistancy of the control instrumentation during the testing period. We have had no malfunctions during this period. Moreover we have found, by doing a daily check, that the electronic level trips have not drifted a noticeable amount. We have not had a problem with our period scram once the initial noise problems were suppressed. We have found it to be of some operational use in indicating the reactivity of the system by checking the minimum period the system reaches when the safety rod is withdrawn (minimum period for $k_{eff} = 0.99$ is approximately 22 seconds).

The calibrating features on the linear, log, and period circuits have proven to be easy to use and are checked before each days operation. The drift in the circuits have been minimal with only minor adjustments every two to three weeks. This may be due to the fact that instrument power is on at all times with the separate control power on only when operating the CFX.

We have found that the placement of large amounts of hydrogen i.e. enough to completely fill the radiography collimator and the thermal neutron activation analysis port with lucite or polyethylene, does not change the reactivity of the system. Consequently unless the material to be irradiated contains fissionable material it will not have a positive effect on the reactivity. Of course any neutron poison in sufficient quantities in the central flux trap region could have a significant negative reactivity effect.

Although we have not operated the CFX over an extended period of time under the same operating conditions we have found the operating conditions to be quite reproducable. In some cases reactivity measurements on a reference configuration made over a period of several weeks time, and with a significant core change at a time period between the measurements, have agreed to within 1 cent in reactivity.

We have experimentally measured the reactivity temperature coefficient by heating the entire CFX core and reflector to approximately 127°F. The temperature coefficient was determined to be negative and to have the value

$$\frac{\Delta k}{k} \Big/ {}^{o}C = -8.82 \times 10^{-5}$$

Supplement II

The scram mechanism is to interrupt the current to the magnet which couples the safety rod drive mechanism to the safety rods. This is accomplished through a series of interlocks. The interlocks include cell door, personnel safety plug, and the flux level interlock. The flux level interlock is associated with the high level linear trip, the high level log trip and the period trip; any of these will activate the flux interlock. This series of trips must be reset manually when tripped in order to complete the interlock chain to allow the system to operate. There is no holding relay as such that is common in reactor systems. Any interlock break or flux trip will effect a scram of the safety rods. There is an additional secondary interlock on the control system associated with the flux level. This is in the form of a flux up interlock i.e. the safety rods cannot be moved unless the flux is above a preset level. (There is an additional interlock directly associated with this in that the source must also be in the in position before the rods can be moved.)

The control panel, shown in the polaroid picture included, has meter indications of safety rod position and source position. In addition there are limit lights for the out position and scram position (in) for the safety rods, and in and out lights for the extremes of the source position.

The safety rods are driven in at a constant rate and not stepped in; however, the reactivity rate is not constant due to the nature of the effective worth of the control rods as a function position within the core. The maximum rate occurs between 50% withdrawn and 75% withdrawn and is 44 cents/sec and at 90% withdrawn the rate is reduced to approximately 7.5 cents/sec and as the rods leave the core and enter the reflector the rate is ~ 3¢/sec. Over the last bit of travel the reactivity rate is reduced to zero.

The source is indeed effective in its withdrawn position and the base current reading will be of the order of 8×10^{-10} amperes for a 1 mg ^{252}Cf source. The low limit interlock which prevents rod movement unless the flux is above a set value would be set above this level consistant with the source in level.