MEMORANDUM

DATE: August 22, 1967

TO: U. S. Atomic Energy Commission, Division of Materials Licensing

FROM: Neutron Products, Inc.

SUBJECT: Supplement No. 2 to Application for Approval of a Container for Transportation of 600,000 Curies of Encapsulated Co-60

Reference is made to Neutron Products' application for shipping cask approval submitted in June 1967, the supplement submitted July 29, 1967, and subsequent comments by the Commission. It is the purpose of this memorandum to correct an incorrect dimension in response to the Commission's critique, and to satisfy the Commission with respect to two matters about which the Commission still feels some uncertainty.

Heat Transfer in Mode IV

The Commission has noted that there is no provision for thermocouple measurements in Mode IV. In order to assure that the operating temperature of the cobalt pins does not exceed the limits specified for the other models, the internal temperature of the cask will be monitored by means of pressure measurements. In order to do this, the temperature of the cask purge stream will be measured during purge, and upon completion of the purge and sealing of the cask, the pressure will be noted and recorded alongside the purge temperature. The internal pressure of the cask will be monitored as the cask comes to thermal equilibrium, and a correlation developed and referenced against theoretical calculations. Then it will be assumed that the gas temperature within the cask is identical to the inner cask wall temperature, and based upon the same conservative

assumptions which were made in the analysis of source temperature in Modes I, II, and III, the temperature of the sources will be calculated to assure that they do not exceed 600°F.

Mode IV is substantially overdesigned from a heat transfer standpoint, the available heat transfer area being approximately 22% that of the cash in Mode I, and in fact it is unlikely that source temperatures in excess of 400°F will be encountered. We are prepared to place a limitation on an increase in pressure of 50% above ambient as the standard for proceeding with shipment. In the event that the pressure increases by greater than 50%, the purge will be resumed and the cask cooled down and returned to the pool for reloading with fewer sources.

In Mode IV the source will be placed within an attenuation block comprising a series of stainless steel liners encased in bronze. The block will be spring-loaded so as to effect a good mechanical fit to the bottom section of the Mode IV cask and will be held in compression by the top section.

The purpose of the block is to absorb a substantial fraction of the gamma energy and transmit the heat to the cask bottom so as to provide a means of directing the bulk of the heat released to the bottom of the cask rather than the top. This provides for a more efficient heat transfer path to the bulk of the heat transfer area of the cask surface. It also serves to hold the sources in place and provide for reducing the degree of mutual attenuation among the sources. The transfer of

heat from the sources themselves to the attenuation block and subsequently to the cask wall is comparable to the method previously considered for the cask proper.

The difference between cask surface temperature and ambient would be lower for the design rating of 100,000 curies by a factor of approximately 30% due to the higher ratio of heat transfer surface to heat load. This advantage is offset somewhat by the fact that the heat transfer surface from the attenuation block to the body of the cask is only one square foot as compared with twenty-five square feet for the full cask so that the design heat flux at this point would be approximately 3,000 BTU per hour per square foot. Even assuming a ten mill gap of helium, the temperature drop from the attenuation block to the body of the cask would only be 30°F, assuming that 60% of the gamma energy would be absorbed in the attenuation block.

Thus, based once again upon the excessively conservative assumption that heat transfer from the sources to the attenuation block is by radiation only, the maximum calculated temperature at the surface of the sources themselves is once again less than 600°F.

Again it is noted that a more accurate analysis of heat transfer from the source to the attenuation block would consider both conduction and convection, that it is unreasonably conservative to assume that the principal mechanism of heat transfer in the proposed geometry and for the designed heat fluxes would be by radiation only, and that the choice of radiation as the heat transfer mechanism for this analysis was selected deliberately to establish a substantial safety factor. To illustrate, it is noted that, for an average helium

gap of 0.020 inch, the temperature difference needed to drive the 305 BTU per hour per square foot which would derive from a premium source operating at a self-attenuation rate of 30% would be only 6°F.

Cask Plug Design

With regard to the resolidification of lead within the main cask plug, we believe it incredible that the lead would solidify from the bottom leaving the void space at the top of the cavity. Rather we believe it more appropriate (although appreciably more complicated) to assume that the lead freezes along the line of least resistance to heat transfer, and that upon resolidification the voids will be redistributed along the lines of greatest heat transfer resistance, namely in the center of the container. However, we recognize that the traditional method of analysis has been to assume that the void will become redistributed at the top of any given chamber; and out of an abundance of caution, we are proposing to add two additional protective rings to the cask plug as shown in Figure 67-0442-1, Revision 6, and Figure 67-0442-4, Revision 5.

Provision for Void Space in the Extra Cask Bottom

The Commission has correctly pointed out that the provision for void in the extra bottom section is excessive. Accordingly Drawing No. 67-0442-3, Reference 5, correctly shows this void space to be 3/4", an amount which allows for 4.5% expansion of the lead contained in this section.

It is noted that our plans for initial shipments in the casks for which approval is sought are for approximately 300,000 curies in Mode I and approximately 50,000 curies in Mode IV, and furthermore, it is noted that the original shipment in Mode I is to be escorted. Furthermore, we are prepared to record data as to the experience on these first shipments

and make it available to the Commission. With this supplement we appear to be in accord on the merits, and particularly in view of our plans to use the casks initially at one half of rated capacity, we urgently seek authorization to proceed at half rating, as the first step to full authorization, without further delay.