Enclosure 1 to
LD-90-001

COMBUSTION ENGINEERING, INC.

HEMATITE NUCLEAR FUEL MANUFACTURING FACILITY

REQUEST FOR LICENSE AMENDMENT

LIST OF AFFECTED PAGES

JANUARY 3, 1990

Hematite Nuclear Fuel Manufacturing Facility

Request for License Amendment

Combustion Engineering requests that License SNM-33 for its Nuclear Fuel Manufacturing Facility be amended with the pages in Enclosure II. These pages provide additional descriptive information on nuclear criticality analyses performed on the pelletizing lines in Building 254. These additional analytical results should allow removal of License conditions Nos. 36 and 37.

The license application pages affected by this amendment request are listed as follows. The changed pages are contained in Enclosure II.

LIST OF AFFECTED PAGES

Deleted Pages			Added Pages		
Page No.	Date	Rev.	Page No.	Date	Rev.
II.8-11m(1)	10/26/89	0	II.8-11m(1)	1/3/90	1
---	---	-	II.8-11m(2)	1/3/90	0
---	---	-	II.8-11m(3)	1/3/90	0
---	---	-	II.8-11m(4)	1/3/90	0
---	---	-	II.8-11m(5)	1/3/90	0
---	---	-	II.8-11m(6)	1/3/90	0
---	---	-	II.8-11n(1)	1/3/90	0
---	---	-	II.8-11n(2)	1/3/90	0
---	---	-	II.8-11n(3)	1/3/90	0
---	---	-	II.8-11u	1/3/90	0
---	---	-	II.8-11v	1/3/90	0
---	---	-	II.8-11w	1/3/90	0
---	---	-	II.8-11x	1/3/90	0
---	---	-	II.8-11y	1/3/90	0
---	---	-	II.8-11z	1/3/90	0
---	---	-	II.8-11aa	1/3/90	0

Enclosure II to
LD-90-001

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PROPOSED LICENSE AMENDMENT PAGES

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Based on these analyses, it is concluded that an overfill condition, should it occur, has only a small effect on the multiplication factor in a large array of hoppers on 30 inch centers. It is also concluded that a realistic size array of filled bulk storage hoppers loaded with UO_2 of 5 w/o enrichment and 1 w/o water is highly subcritical when the hoppers are in physical contact within the array.

8.3.4.4 Pelletizing Line

Criticality analyses of components of the pelletizing line supplement the overall analyses presented in Section 8.3.4.3. Their intent is to confirm that credible combinations of SNM and moderator material on the second or third floor or added into the pelletizing equipment do not cause the effective multiplication factor to exceed 0.95. Three series of criticality calculations are described in the following: 1) an array of storage containers (typically 5 gallon or less pails), 2) an isolated poreformer mixer and 3) a system analysis with explicit modeling of pelletizing equipment.

In the first series, criticality analyses for storage of SNM on the second or third floor were extended to evaluate the postulated interspersing of SNM containers with containers of mop water, poreformer and lubricant. A conservative limit calculation assumes an infinite checkerboard array of UO_2 containers and water containers. The analytical assumptions are:

a) Containers are 11 inches diameter and 13 inches high.

b) The UO_2 containers have 3.5 g/cc UO2, 5.0 w/o U-235, 1 w/o water, 1 w/o starch poreformer and 1 w/o zinc stearate lubricant.

c) The water density in the water containers is varied from 0 to 1 g/cc.

d) Containers are in contact with each other in a square array.

e) There is void between containers.

f) The array is reflected on top by 12 inches of water and on the bottom by 12 inches of concrete.

g) No structural elements are modeled.

KENO was used with the 16 group Hanson and Roach library and with the generalized geometry option to describe 4 quarter cylinders in contact with each other in a square array. Figure II.8.3-7 shows the effective multiplication factor as a function of water density in the water containers. The maximum value is less than 0.8 and occurs at a water density of 0.25 g/cc. The moderating properties of the poreformer and lubricant are encompassed by the range of water densities analyzed. Therefore, the above analyses confirm that the criticality criterion is satisfied for any combination of SNM, mop water, poreformer, and lubricant containers within the limits imposed by Section I.4.2.3.q.

The pelletizing line is shown in Figure II.8.3-8 and the pelletizing process is described in Table II.8.3-2. The process starts at the top of the line with pneumatic transfer of UO_2 powder from the blender into the poreformer mixer (PF mixer) on the third floor level. In the second series of criticality calculations, KENO analyses are made for an isolated PF mixer containing extreme quantities of poreformer and UO2 powder. (Later, an analysis of the PF mixer in a configuration including the other equipment shows the appropriateness of the isolated PF mixer analysis.) The analytical assumptions for the isolated mixer analyses are:

a) The PF mixer is a truncated cone. The top inside diameter is 30 inches and the bottom inside diameter is 8 inches. The inside height is 35.5 inches and the top side, and bottom steel walls of the cone are 0.125 inches thick.

b) The UO2 transferred into the PF mixer has 2.5 g/cc density, 5.0 w/o U-235 and 1 w/o water.

c) The poreformer added to the mixer has 0.677 g/cc density, the chemical formula is $C_6 H_{10} O_5$ and the molecular weight is 162.

KENO was used with the 16 group Hanson and Roach library and with the generalized geometry option to describe the mixer as a truncated cone. The density of the UO_2 - poreformer mixture in the PF mixer is calculated for the various assumed combinations by assuming that as poreformer is added to UO_2 powder it first fills the voids between UO_2 particles as determined from the volume difference of theoretical density UO_2 at 10.96 g/cc and UO_2 powder density at 2.5 g/cc. When the poreformer exceeds the amount needed to fill the voids, the UO_2 is assumed dispersed in the poreformer and the total mixture volume increases.

Two situations were analyzed. In the first, a typical sized batch of 100 Kg of UO_2 powder is in the mixer and poreformer is added. Typically the poreformer is 0.15 to 0.25 w/o of the UO_2, or about 0.2 Kg per batch. At about 21 Kg poreformer the UO_2 voids are filled. Thereafter, the mixture volume increases with added poreformer until the mixer is filled at 118 Kg of poreformer. Table II.8.3-3 and Figure II.8.3-9 show the results. The effective multiplication factor increases with poreformer to a maximum value of 0.70 when the mixer is full.

In the second situation analyzed, the mixer is assumed filled. Three selected mixtures of UO_2 powder and poreformer are analyzed. The UO_2 loading is varied from 75 Kg to 200 Kg while the poreformer loading varies from 119.5 Kg to 111.8 Kg to maintain a constant, full mixer volume. The effective multiplication factor increases with UO_2 loading to 0.76 at 200 Kg UO_2 - twice the normal UO_2 loading. Table II.8.3-4 and Figure II.8.3-10 show these results.

The conclusion is that any credible combination of UO_2 overload and poreformer addition satifies the criticality criterion.

In the third series of criticality calculations, the entire front end of the pelletizing line is modeled. The overall system modeled is similar to that modeled for the analyses described previously in Section II.8.3.4.3, but here the pelletizing equipment is modeled in a credible manner. The analytical assumptions are:

a) The bulk storage hoppers contain 1000 Kg UO_2 and the blenders contain 4200 Kg UO_2. They all have 3.5 g/cc UO_2 density, 5 w/o U-235 and 1 w/o water.

b) The pelletizing line components contain a mixture of UO_2 and poreformer in the proportions 100 Kg UO_2 to 118 Kg poreformer, which is the mixture that produced the maximum k-effective for an isolated poreformer mixer. Structural materials are not modeled here. (Previously the steel walls of the isolated poreformer mixer were modeled.)

c) The system is reflected on top with 12 inches of water, on bottom with 12 inches of concrete, on the west and north by 12 inches of concrete and on the south by 12 inches of water (see Figure II.8.3-11).

KENO was used with 16 group Hanson and Roach library and with the generalized geometry option. Figure II.8.3-11 shows a plan view of the overall arrangement. Figure II.8.3-12 shows the model for the bulk storage hoppers and Figure II.8.3-5 shows the model for the blenders. Figure II.8.3-13 shows the detailed model for the vertical arrangement of components of the pelletizing equipment that may contain significant volumes of UO_2.

Table II.8.3-5 contains KENO calculated eigenvalues for several different situations. In the first case an isolated conical screw mixer was simulated. (This mixer is labeled "A" in Figure II.8.3-13.) In the second case all of the hoppers, blenders, and the conical screw mixer were simulated. In the last case the hoppers, blenders and all of the described pelletizing line were simulated. As indicated by these results, there is very little interaction between the mixer or the entire pelletizing line and the hoppers and blenders. Also indicated is that the eigenvalues for this system are far below the safe limit of 0.95 even with the conical mixer filled with 118 kilograms of poreformer.

8.3.5 Building 254 Dewaxing and Sintering

The boats of randomly loaded pellets pass through two furnace steps; dewaxing to burn off additives and sintering. A controlled atmosphere is maintained in the furnaces. The boats meet the requirements of I.4.2.4 for slab limits.

8.3.6 Building 254 Grinding

The wet grinding process, grinder sludge control and criticality control are similar to that described for Building 255 in Section 8.2.8. Finished pellet inspection may include an alternate optical measurement of pellet dimensions.

8.3.7 Building 254 Packaging

Pellets may be arranged onto corrugated trays or loaded randomly into pans that are stacked in a lifting cradle. The cradle is weighed and then lowered into a vertically oriented shipping container through a transfer port that separates Building 254 from the clean warehouse Building 256. Alternatively, the randomly filled pans may be loaded into horizontally oriented shipping containers as is done for the pellet line in Building 255. The pellets are packaged in licensed shipping containers in accordance with the applicable certificate of compliance.

TABLE II.8.3-2

STEPS IN PELLETIZING LINE PROCESS

Step No.	Component	Action
1.	Blender (Figure II.8.3-3)	Manually open bottom valve to drop about 100 Kg oxide into transparent pipe above rotary valve.
2.	Vacuum Transfer System (Figure II.8.3-8)	Manually operate blower and rotary valve to transfer first half of 100 Kg oxide batch to receiver from which it flows down to poreformer mixer (PF mixer) where weight is measured. Alternatively, fines from the granulator and pellet press may be substituted for an oxide batch. Steps 2,3 and 4 are then omitted.
3.	PF Mixer	Manually add preweighed charge of poreformer to half batch of oxide in PF mixer. Typically 3 charges (150 to 400 grams each) may be stored in 1 liter containers on the third floor level. (Satifies I.4.2.3.q)
4.	Vacuum Transfer System	Manually operate blower to transfer second half of 100 Kg oxide batch to PF mixer and weigh.
5.	PF Mixer	Operate PF mixer to mix poreformer and oxide.

TABLE II.8.3-2 (Continued)

STEPS IN PELLETIZING LINE PROCESS

Step No.	Component	Action
6.	Slugging Press and Granulator	Open valve at bottom of PF mixer to release mixed oxide to operating slugging press and granulator. Granulated oxide flows down into Lubricant mixer (Lub mixer).
7.	Lubricant Mixer (Lub Mixer)	Manually add pre-weighed charge of lubricant to Lub mixer. Typically 6 charges (150 grams each) may be stored in 0.5 liter containers on the second floor level. (Satifies I.4.2.3.q)
8.	Pellet Press	Manually open Lub mixer discharge to release oxide mixture to fill pellet press hopper. Operate the press and collect the pellets in randomly loaded boats for the furnaces.
9.	Repeat	Start again with step 1.

TABLE II.8.3-3

EFFECTIVE MULTIPLICATION FACTOR FOR AN ISOLATED MIXER
100 Kg OF UO2 POWDER

Loading of Poreformer, Kgs	Mixture Height, cm.	K-effective
1	42.87	0.08809 +/- .00097
51	63.00	0.57431 +/- .00549
75	74.29	0.63239 +/- .00525
100	84.05	0.67746 +/- .00502
118	90.17 (mixer filled)	0.70070 +/- .00488

TABLE II.8.3-4

EFFECTIVE MULTIPLICATION FACTOR FOR AN ISOLATED MIXER
MIXER FILLED WITH UO2 POWDER AND POREFORMER

UO2 Loading, Kgs.	Poreformer Loading, Kgs.	K-effective
75	119.51	0.65334 +/- .00516
100	117.96	0.70070 +/- .00488
200	111.79	0.76165 +/- .00615

TABLE II.8.3-5

EFFECTIVE MULTIPLICATION FACTOR FOR BUILDING 254 SYSTEMS

Uranium Components Modeled	K-effecitve
1) Isolated Conical Screw Mixer	0.67526 +/- .00376
2) Hoppers, Blenders, Conical Screw Mixer	0.67698 +/- .00416
3) Hoppers, Blenders, Pelletizing Line	0.68173 +/- .00385

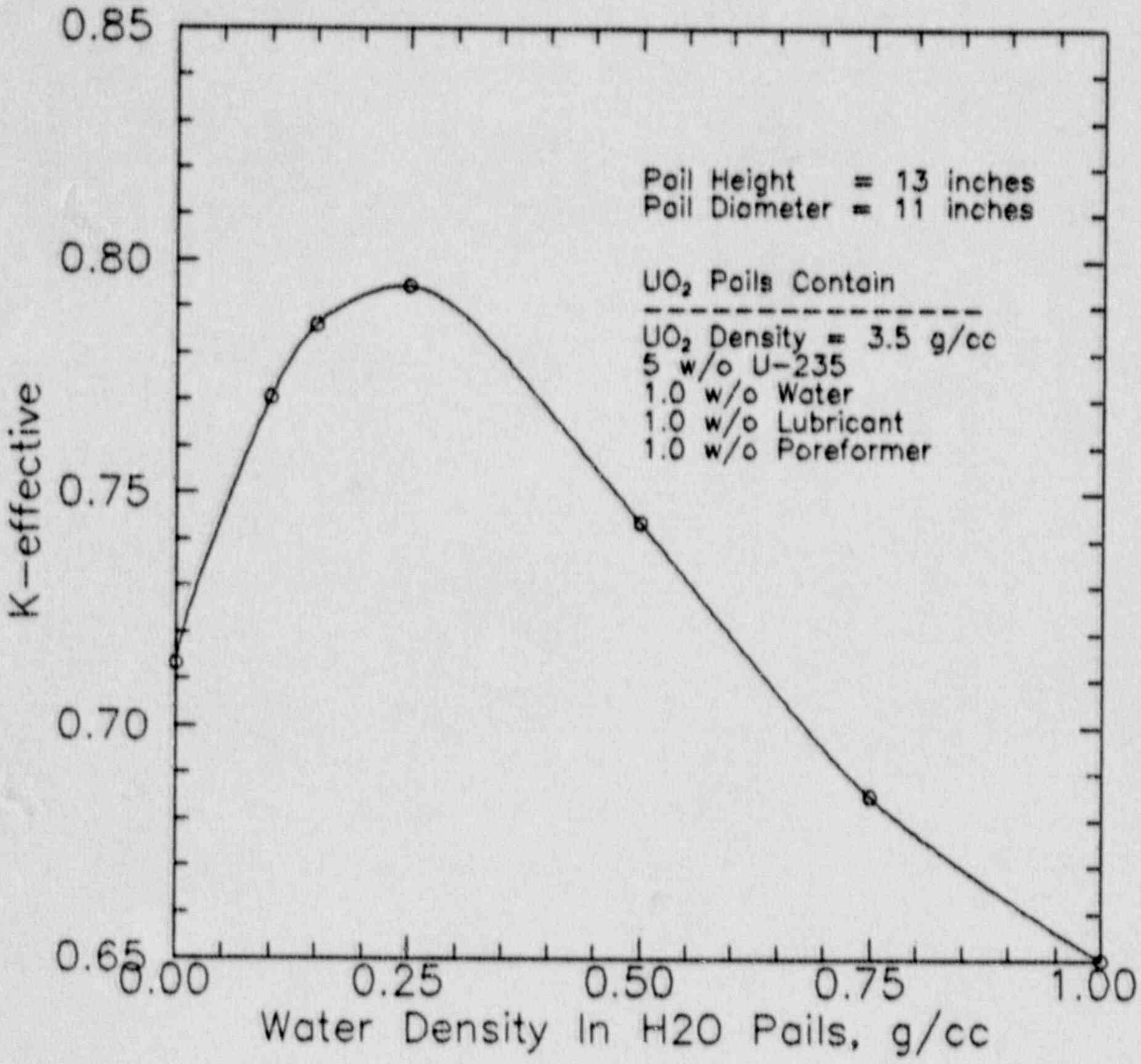


FIGURE II.8.3-7

EFFECTIVE MULTIPLICATION FACTOR vs. WATER DENSITY

INFINITE CHECKERBOARD ARRAY OF UO2 AND WATER CONTAINERS

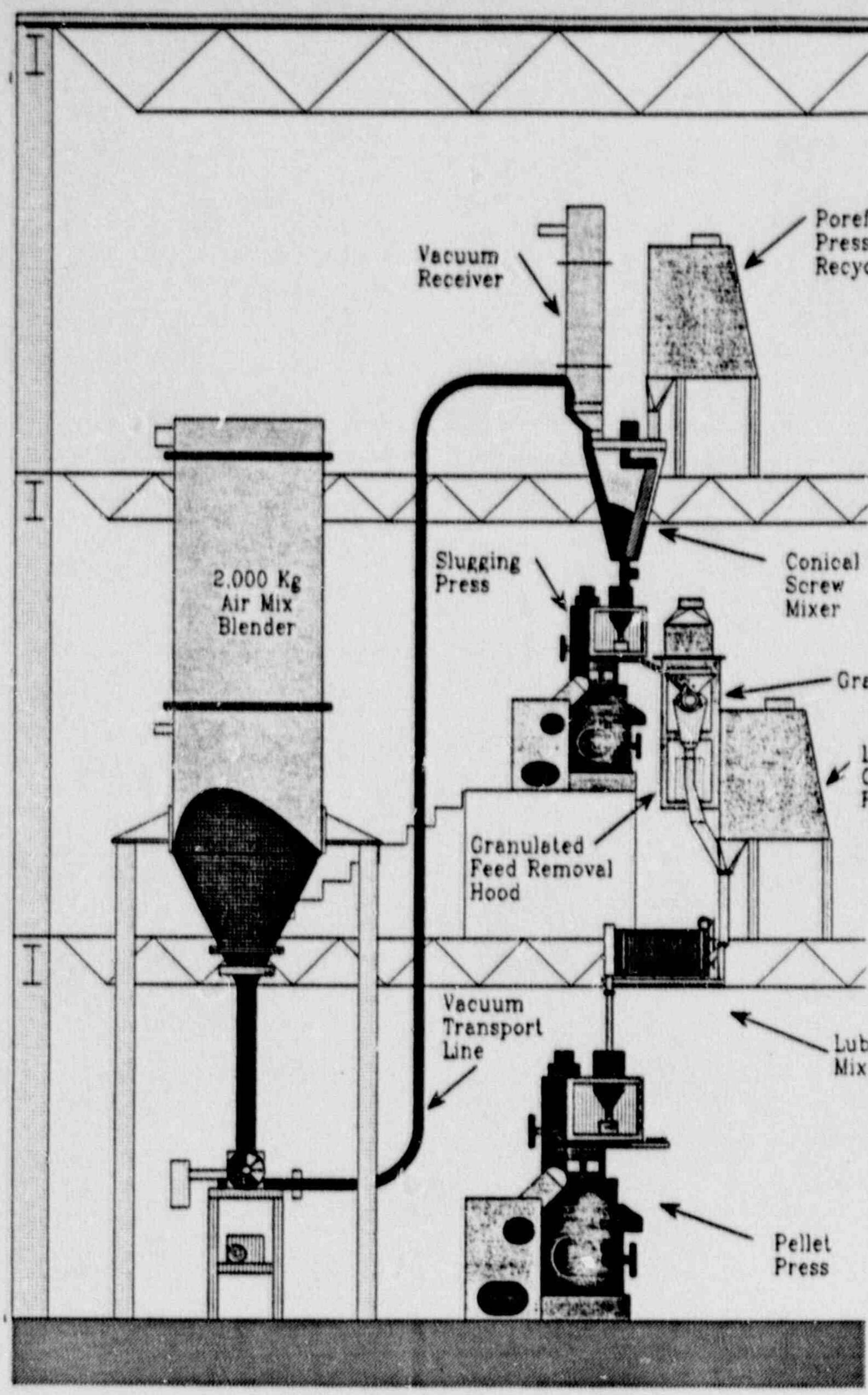


FIGURE II.8.3-8

BUILDING 254 PELLETIZING LINE EQUIPMENT

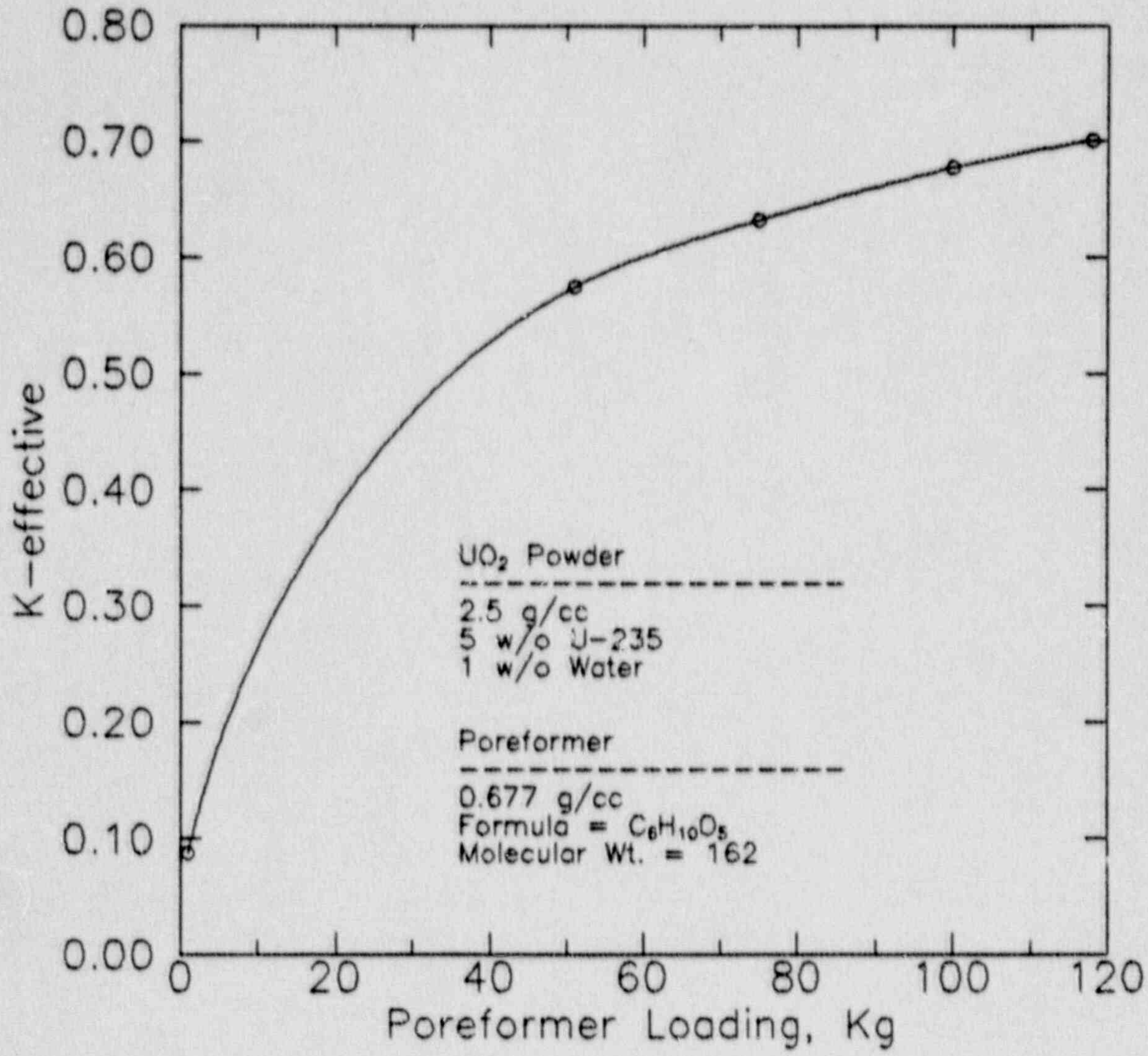


FIGURE II.8.3-9

EFFECTIVE MULTIPLICATION FACTOR FOR AN ISOLATED MIXER WITH 100 Kg UO2 POWDER vs. POREFORMER LOADING

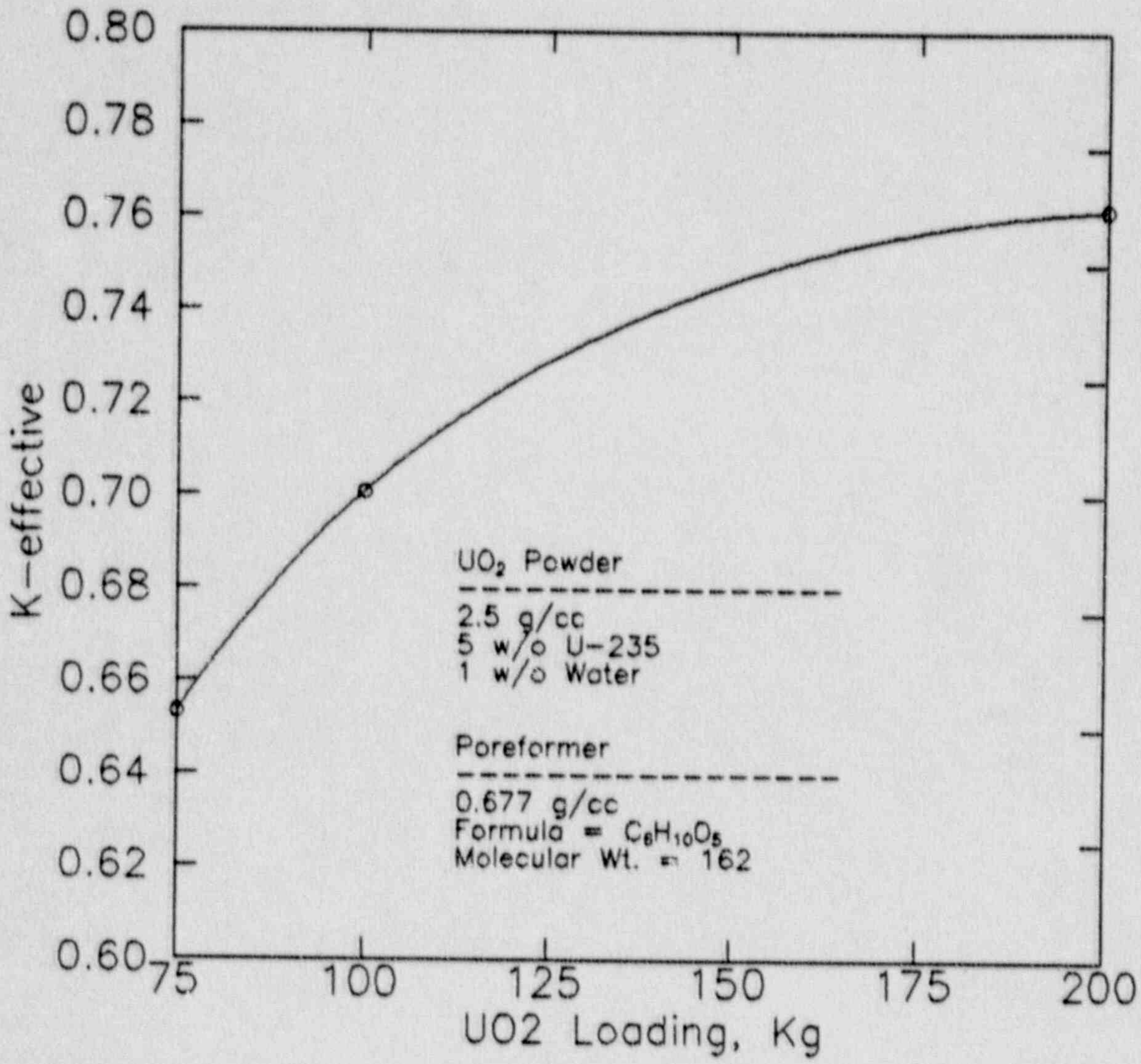
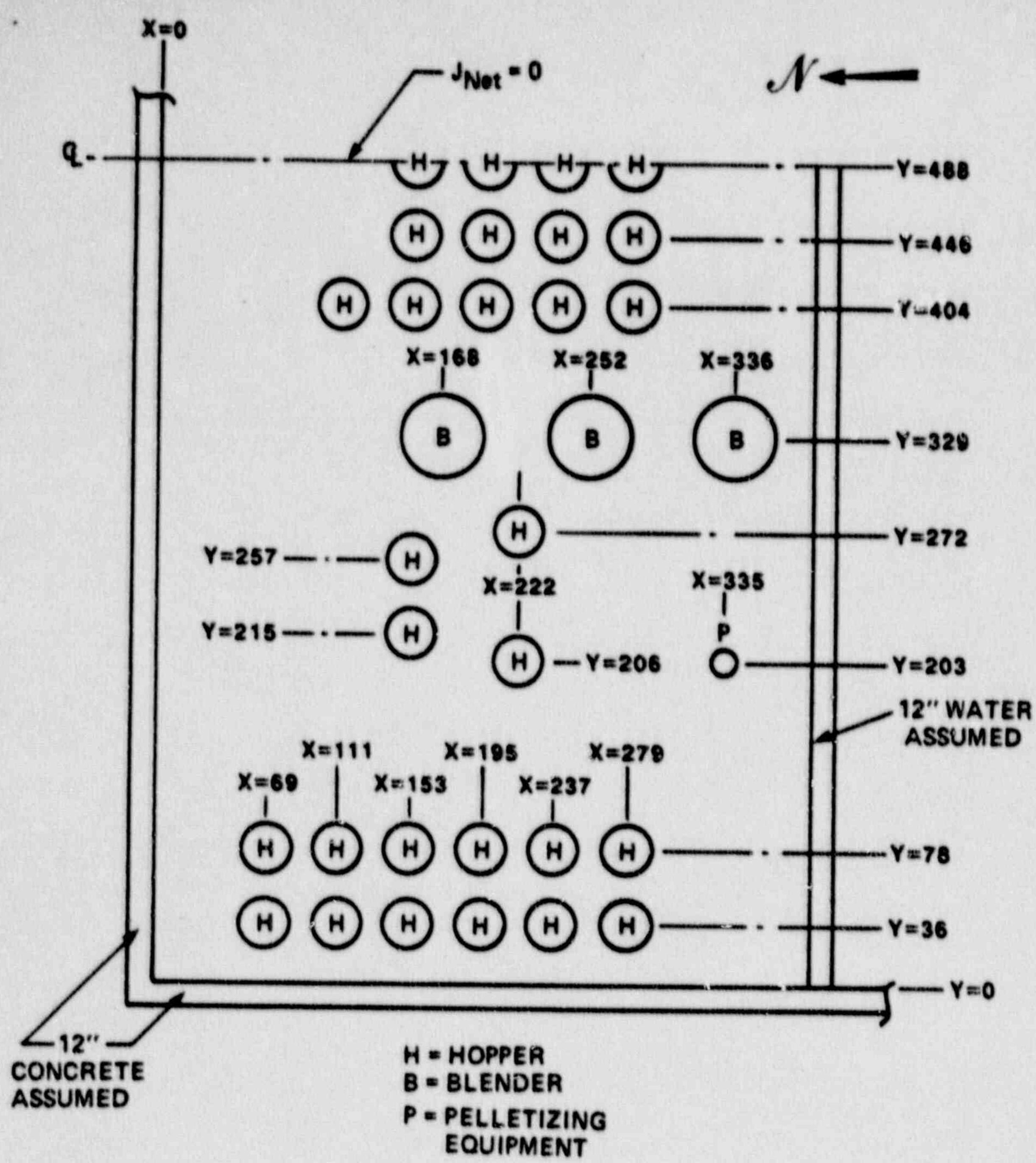


FIGURE II.8.3-10

EFFECTIVE MULTIPLICATION FACTOR FOR AN ISOLATED MIXER FILLED WITH UO2 POWDER AND POREFORMER



(NOTE: DIMENSIONS GIVEN IN INCHES)

FIGURE II.8.3-11

KENO MODEL FOR FRONT-END OF DETAILED PELLET LINE

(FOR GENERALIZED GEOMETRY OPTION)

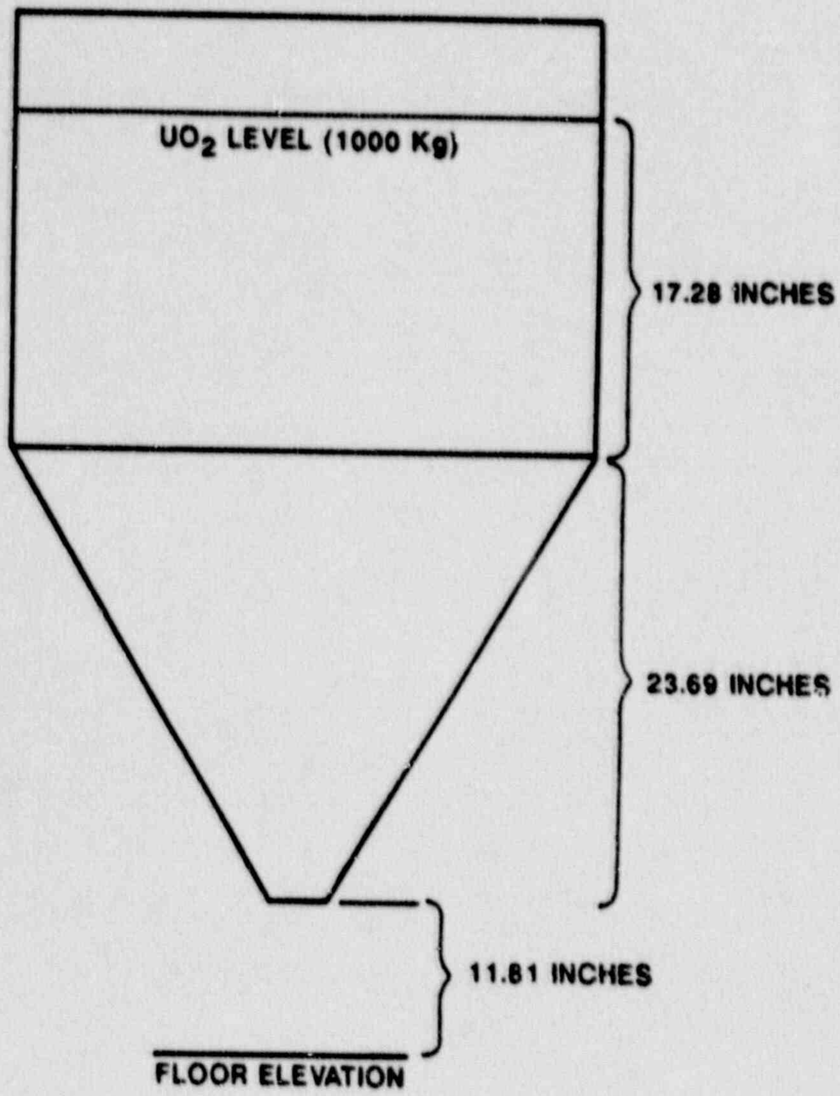


FIGURE II.8.3-12

KENO MODEL FOR BULK STORAGE HOPPER

(FOR GENERALIZED GEOMETRY OPTION)

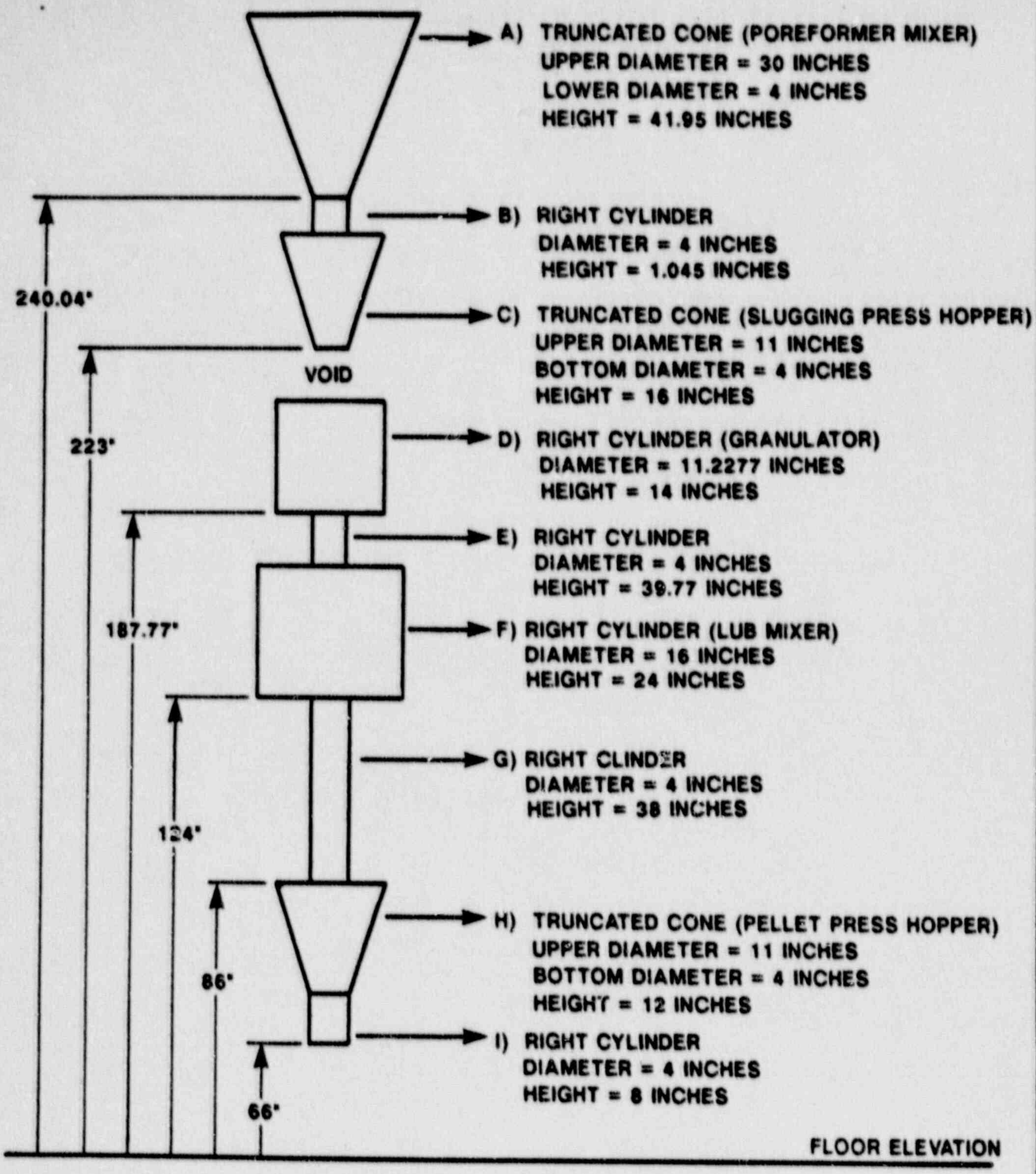


FIGURE II.8.3-13

KENO MODEL FOR PELLETIZING LINE

(FOR GENERALIZED GEOMETRY OPTION)

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CHECK FOR APPLICATION FEE

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