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COMBUSTION ENGINEERING

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November 8, 1989
LD-89-124

DOCKETED USNRC NOV 09 1989 NMSS MAIL SECTION DOCKET CLERK

Docket No. 70-36
License SNM-33

Mr. Leland C. Rouse, Chief
Fuel Cycle Safety Branch
Division of Industrial and
Medical Nuclear Safety
Office of Nuclear Material
Safety and Safeguards
U. S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, D. C. 20555

Subject: Response to Request for Additional Information on Hematite License Application Amendment

Reference: (A) Letter, G. H. Bidinger (NRC) to J. A. Rode (C-E), dated October 19, 1989

(B) Letter LD-89-049, A. E. Scherer (C-E) to L. C. Rouse (NRC), dated May 1, 1989

(C) Letter LD-89-093, A. E. Scherer (C-E) to L. C. Rouse (NRC), dated August 18, 1989

Dear Mr. Rouse:

In Reference (A), the Nuclear Regulatory Commission requested additional information to support their review of the application by Combustion Engineering in References (B) and (C) for a license amendment to permit operation with enriched uranium in new buildings and equipment at the fuel manufacturing facilities in Hematite, Missouri. Enclosure I to this letter contains responses to the specific questions asked in Reference (A). Enclosure II lists the change page numbers of the license application where the additional information has been inserted. Enclosure III to this letter contains the replacement pages. Ten copies of the enclosures are provided for your use.

DF03

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addt info 26063

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DATE OF DOC. November 8, 1989
DATE RCVD. November 9, 1989
FCUF ✓ PDR ✓
FCAF LPDR
I & E REF. ✓
SAFEGUARDS ✓
FCTC OTHER
DATE 11/9/89 INITIAL SAE

If I can be of any assistance on this matter, please do not hesitate to call me or Mr. J. F. Conant of my staff at (203) 285-500 .

Very truly yours,

COMBUSTION ENGINEERING, INC.

A. E. Scherer
Director
Nuclear Licensing

AES:jeb

Enclosures: As Stated

cc: G. H. Bidinger (NRC)
G. D. France (NRC - Region III)
M. L. Horn (NRC)
D. A. McCaughey (NRC)

Enclosure I to
LD-89-124

# COMBUSTION ENGINEERING, INC.

# HEMATITE NUCLEAR FUEL MANUFACTURING FACILITY

# RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

# ANSWERS TO QUESTIONS

NOVEMBER 8, 1989

# HEMATITE NUCLEAR FUEL MANUFACTURING FACILITY

# RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

This Enclosure provides individual responses to the questions asked by the Nuclear Regulatory Commission in the letter from G. H. Bidinger (NRC) to J. A. Rode (C-E), dated October 19, 1989. The responses state how the question is answered in the license application and refer to the specific section numbers and page numbers where additional information has been inserted into the license application.

Question 1:

In Section 1.7, Part I, the application includes Building 253 as an authorized place of use. However, the NRC review and confirmation of C-E's soil survey results for Building 250/253 have not been completed. Therefore, Building 253 should be removed from the application, and Building 250 should be reinstituted as an authorized place of use.

Answer:

Per Discussion between the NRC and C-E on November 2, 1989, Building 253 will be retained in the license application amendment and temporarily the NRC will withhold authorization for its use for SNM and Source Material. Thus, there are no changes to the application amendment required by this question.

Question 2:

In Chapter 8, Part II, describe how dewpoint measurements provide information about the moisture content in the $UO_2$ powder coming out of the screw cooler. Also, describe the relationship of dewpoints of 15°C and 0°C to weight percent water.

Answer:

The dewpoint measurements provide an indication of process control and an early indication of potential moisture in the system. At the screw cooler hopper, when the process is under normal control, the oxide temperature is typically about 200°F. If moisture existed in the oxide it would vaporize into the nitrogen gas space above the oxide level where the moisture detector is located. Sufficient liquid to provide saturated vapor at 200°F would raise the partial pressure of the vapor to 11.5 psia and the dewpoint would be 200°F. Less vaporization results in a superheated vapor at 200°F with a partial pressure below 11.5 psia and a dewpoint below 200°F. When the dewpoint of the vapor is at the alarm point (15°C = 59°F), the partial pressure of vapor is 0.25 psia, equivalent to a relative humidity of 2% at 200°F.

To relate these quantities to the moisture content of $UO_2$, experience in powder handling is used. When $UO_2$ powder is exposed to normal room air conditions with comparable vapor content, its moisture content does not increase to 1 w/o. In air at 70°F and 70% relative humidity, the partial pressure of the superheated vapor is 0.25 psia, and the vapor density is nearly the same as at the alarm dewpoint in the screw cooler hopper. Hence, the alarm at the screw cooler hopper at a dewpoint of 15°C can provide the early indication of potential moisture in the system.

The moisture detector in the accumulator for the plant air supply alarms above a dewpoint of 0°C or 32°F. At the alarm dewpoint, the partial pressure of saturated vapor is 0.089 psia in an air-vapor mixture with a total pressure of 115 psia at approximately room temperature. Upon expansion of the mixture to atmospheric pressure, the temperature falls and the vapor pressure (and therefore dewpoint) in the expanded gas falls. There is no condensation and the moisture content of the expanded air-vapor mixture is less than normal room air so the micronizing and blending operations do not raise the moisture content of the oxide above the 1 w/o limit. Table II.8.3-1 contains the typical dewpoint values, the alarm values, the action to be taken upon an alarm and the instrument surveillance requirements.

Question 3:

In Section 8.3.4.1(d), Part II, the safety evaluation for filling the bulk storage hoppers does not provide for uranium in storage silos or blenders. However, there are no controls in place to assure that these silos and blenders will be empty. Provide these controls in Part I or reanalyze the system with full silos and blenders.

Answer:

With the two storage silos and two additional blenders filled with $UO_2$ under normal credible conditions, the effective multiplication factor is below 0.95. For postulated accident conditions, with more failures than are credible, two additional analyses have been completed with $UO_2$ in the storage silos and in three of the blenders. These new results are substituted and added to Part II in Section 8.3.4.1 on Pages II.8-11h and 11h(1).

Question 4:

Validation of the calculation methods for $k_{eff}$ calculations must be described and demonstrated. Reference to validation efforts by other organizations does not assure (a) that the codes perform the same on C-E computers, (b) that the cross-section libraries are the same, (c) that the same calculation methods are used, etc. The validation effort should be done in accordance with ANSI/ANS-8.1-1983.

Answer:

The description of the validation of the KENO code calculations was presented in the SNM-1067 license application and was included by Reference in Section II.7.7, on Page II.7-18 of this SNM-33 license application. One exception was the validation of the Hansen-Roach cross sections as employed on the C-E computers. Additional, descriptive text and results of analyses added to Section II.7.7 verify the equivalence of the C-E cross sections with published results.

Question 5:

To demonstrate implementation of the double contingency principle criteria, the following must be provided:

Question 5.a:

In Section 4.2.3, Part I, provide a commitment for calibration at specified maximum intervals of the instruments for moisture content verification. A second commitment should provide for dual, independent verifications of moisture content prior to transfer of material into non-favorable geometry containers.

Answer:

The calibration intervals for instruments that measure moisture content are listed in Table II.8.3-1 of Part II. A commitment to these intervals is added to Part I in Section I.4.2.3(n) on Page I.4-6. A second commitment, to dual independent verifications of moisture content prior to transfer, is added to Part I in Section I.4.2.3 as new item (o) on Page I.4-6a.

Question 5.b:

A commitment should be established in Chapter 4, Part I, of the application requiring that all moderation controlled vessels (e.g., bulk storage hoppers, conveyor storage cans, etc.) will be sealed to ensure maintaining dryness. Provisions to prevent introduction of moderation material when the vessels are open must be provided in Part I and described in Part II.

Answer:

A commitment that moderation controlled containers will be covered when external to protective hoods is added to Part I in Section I.4.2.3 on Page I.4-6a as a new item (p). Descriptions of the provisions are already described in Part II where each container is discussed. See also the response to Question 5.e.

Question 5.c:

Section 8.2.1, Part II, establishes that scrap recycle materials, which are to be charged to the Building 255 mill from 5-gallon pails, may contain up to 5 w/o weight percent moisture. However, in Section 8.3.1, Part II, the moisture control criteria on pails of recycle material to be charged to the recycle hopper is 1 weight percent moisture. The use of the same pails with different sets of moisture control criteria is not a recommended nuclear criticality safety practice. Use of uniform criteria should be implemented. Please revise accordingly.

Answer:

The moisture limits in the pails are made uniform at 1 w/o by changing Part II in Section II.8.2.1 on Page II.8-6a.

Question 5.d:

Section 8.3.3, Part II, describes the use of moisture detectors in the screw cooler hopper and the plant air supply. However, the application should describe actions to be taken in the event of moisture detector failure and actions to be taken in the event of an alarm of the moisture detector located at the exit of the dryer. Parts I and II should be revised accordingly.

Answer:

The principal failure mode of the moisture detector located in the screw cooler hopper and in the plant air supply causes a false high indication. Thus, the action to be taken for a true alarm or a detector failure is the same. That is, the process is stopped and the source of the alarm is determined and eliminated. An equivalent statement is added to Section 4.2.3(k) on Page I.4-6 of Part I and to Section 8.3.3.1 on Page II.8-11d and Section 8.3.3.3 on Page II.8-11g of Part II.

Question 5.e:

Section 8.3.3.2, Part II, does not describe the moderator barrier controls while loading the recycle hopper into the transfer hood. Identify the barrier controls during recycle hopper loading and provide license commitments in Part I.

Answer:

Additional details of the process of loading the recycle hoppers are added to Section 8.3.3.2 on Page II.8-11f of Part II. The additional description demonstrates that the recycle hoppers will be loaded only with verified dry $UO_2$ and will be handled in a manner that prevents moisture addition. The criterion in Section 4.2.3(n) on Page I.4-6 of Part I is augmented to include a commitment to barrier controls during recycle hopper loading.

Question 5.f:

In Section 8.3.3.1, Part II, describe how representative ... ing for moderator content in the receiver vessel will be performed and assured.

Answer:

At intervals of about two hours, batches of $UO_2$ granules are transferred from the screw cooler to the receiver. Batches are typically 100 Kg each, but may vary from about 80 Kg to about 130 Kg. After each batch is transferred, the transfer air is turned off and a sample of the batch is manually withdrawn from a sampling port near the bottom of the receiver vessel. The moisture content in the sample is measured and recorded.

A second person, who is not an operator, overchecks the sample analysis results. If the moisture content is no higher than 1 w/o, the second person allows dumping of the oxide from the receiver into the bulk storage hopper. Engineered means positively prevent dumping of oxide until a satisfactory overcheck is made and release is permitted. Typically, ten dumps of ten batches are made to a bulk storage hopper. Excessive water in one single batch would wet the entire batch and be observed in a sample taken near the bottom. Bottom sampling of a batch conceivably may not assure that the upper region of that batch has less than 1 w/o moisture. However, a moisture problem that initiates while a batch is being transferred into the receiver would likely continue and would be measured in the next batch.

Measurement on each batch before each of ten sequential dumps to the hopper provides assurance that a moisture level above 1 w/o in a significant quantity of the oxide in the hopper does not occur. The above amplification of the transfer step is added to the text of Section 8.3.3.1 on Page II.8-11d.

Question 5.g:

The analysis in Section 8.3.4.3, Part II, limits the storage of buckets of $UO_2$ on the second and third floors of Building 254 to 1 w/o water, 1 w/o starch, and 1 w/o zinc sterate. License commitments must be established in Chapter 4, Part I, to control the use and storage of hydrogenous materials on the second and third levels.

Answer:

Additional analyses have shown that there is no limit on the amount of water that may be accumulated on the second and third floors. In one analysis, the space above the third floor was filled with water and in the other analysis the space above the third floor and also between the second and third floors was filled with water. The effective multiplication factor was 0.8828 $\pm$ 0.0042 for the first analysis and 0.8161 $\pm$ 0.0048 for the second analysis. Other assumptions are as stated in the August 18, 1989 supplement to the license application amendment. These analytical results will be added to Section 8.3.4.3 on Page II.8-111 of Part II.

Even though the results indicate that there is no need to limit hydrogeneous materials on the second and third floors, the following item (q) will be added to Section 4.2.3 on Page I.4-6a

q) The number of five gallon or less mop buckets shall be limited to 4 on the second floor and 4 on the third floor of Building 254. The combined number of five gallon or less containers of lubricant and of poreformer shall be limited to 6 on the second floor and six on the third floor of Building 254 for each of the two pellet lines for a maximum total of 24 containers.

Enclosure II to
LD-89-124

**COMBUSTION ENGINEERING, INC.**

**HEMATITE NUCLEAR FUEL MANUFACTURING FACILITY**

**RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION**

**LIST OF AFFECTED PAGES**

**NOVEMBER 8, 1989**

## HEMATITE NUCLEAR FUEL MANUFACTURING FACILITY

## RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

The license application pages affected by responses to the request for additional information are listed below.

| DELETED PAGE | | ADDED PAGE | |
|---|---|---|---|
| **PAGE NO.** | **REV.** | **PAGE NO.** | **REV.** |
| I.4-6 | 4 | I.4-6 | 4 |
| I.4-6a | 2 | I.4-6a | 2 |
| II.7-18 | 2 | II.7-18 | 3 |
| ------ | - | II.7-19 | 0 |
| II.8-6a | 0 | II.8-6a | 0 |
| II.8-11d | 0 | II.8-11d | 0 |
| II.8-11e | 0 | II.8-11e | 0 |
| II.8-11f | 0 | II.8-11f | 0 |
| II.8-11g | 0 | II.8-11g | 0 |
| II.8-11h | 0 | II.8-11h | 0 |
| ------- | - | II.8-11h (1) | 0 |
| ------- | - | II.8-11h (2) | 0 |
| II.8-11l | 0 | II.8-11l | 0 |
| II.8-11m | 0 | II.8-11m | 0 |

Enclosure III to
LD-89-124

COMBUSTION ENGINEERING, INC.

HEMATITE NUCLEAR FUEL MANUFACTURING FACILITY

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

PROPOSED LICENSE APPLICATION CHANGE PAGES

NOVEMBER 8, 1989

4.2.3 <u>Safety Margins for Individual Units</u> (continued)

j) (continued)

4. $NO_x$ Scrubber
5. Centrifuge Supernate Recycle
6. $UO_4$ Precipitate Overflow Vessel

k) The hygrometers on the plant air to the Air Mix Blenders in the Oxide Building and to the micronizers and blenders in Building 254 will be set to alarm at a dewpoint no higher than 0°C and checked on a six month interval. The hygrometer on the cooler hopper at the exit of the screw cooler in the oxide building will be set to alarm at a dewpoint no higher than 15°C and checked on a six month period. Upon alarm, automatic or manual action stops the process until the source of alarm is eliminated and the process can be safely continued.

l) The water content will be verified to be less than one weight percent in storage cans in the conveyor storage area on a production lot basis (contents of two air mix blenders).

m) The R-2 steam line will have two (redundant) fail-safe shut-off valves, each activated by two independent high and low temperature alarms setpoints on the R-2 reactor. The operability of this system will be ascertained at least once every six months.

n) The moisture content of the $UO_2$ powder transferred into the bulk storage hoppers and the recycle storage hoppers will be verified as being $\leq 1$ w/o. The instruments used for measuring moisture in $UO_2$ shall be calibrated on a six month interval. Loading and unloading of hoppers shall be done with hoods that prevent water ingress.

o) Dual independent verifications of moisture content in $UO_2$ shall be made prior to transfer of material into the bulk storage hoppers or into the blenders in Building 254.

p) All moderation controlled containers shall be covered such that no moderator can enter the container when external to protective hoods.

q) The number of five gallon or less mop buckets shall be limited to 4 on the second floor and 4 on the third floor of Building 254. The combined number of five gallon or less containers of lubricant and of poreformer shall be limited to 6 on the second floor and six on the third floor of Building 254 for each of the two pellet lines for a maximum total of 24 containers.

4.2.4 Limits for Safe Individual Units (SIUs)

Table 4.2.4

Safe Individual Unit Limits for ≤ 5.0% enriched $UO_2$ at optimum moderation. All Mass and Volume limits have been adjusted to provide constant spacing areas for the enrichment shown. Heterogeneous limits have been developed with optimum rod sizes taken to allow for pellet chips, etc.

| Nominal Enrichment | MASS LIMITS HOMOGENEOUS KgUO2 | f(1) | MASS LIMITS HETEROGENEOUS KgUO2 | f(1) |
|---|---|---|---|---|
| - 2.5% U-235 | 54 | .19 | 50 | .26 |
| >2.5 - 3.0% U-235 | 41 | .23 | 38 | .29 |
| >3.0 - 3.2% U-235 | 36 | .23 | 36 | .29 |
| >3.2 - 3.4% U-235 | 35 | .25 | 33 | .29 |
| >3.4 - 3.6% U-235 | 32 | .26 | 30 | .30 |
| >3.6 - 3.8% U-235 | 28 | .26 | 27 | .29 |
| >3.8 - 4.1% U-235 | 24 | .25 | 24 | .27 |
| >4.1 - 4.3% U-235 | 22 | .26 | 22 | .27 |
| >4.3 - 4.5% U-235 | 20 | .27 | 20 | .27 |
| >4.5 - 4.7% U-235 | 18 | .26 | 18 | .27 |
| >4.7 - 5.0% U-235 | 16 | .27 | 16 | .27 |

## 7.7 Validation of Criticality Calculational Methodology

The calculational methodology used on this license, other than for the use of Hansen and Roach 16 group cross-sections in KENO, is as described and validated in License SNM-1067.

Validation of the method used on criticality analysis of homogeneous fuel configurations is described in a report entitled "Validation of the KENO Code for Nuclear Criticality Safety Calculations of Moderated Low-Enrichment Uranium Systems", (Y-1948) by G. W. Handley and C. M. Hopper dated June 13, 1974.

The KENO code, [L. M. Petrie and N. F. Landers, "KENO IV/5 - An Improved Monte Carlo Criticality Program", NUREG/CR-0200, Oct. 1981], was obtained from Oak Ridge and made operational on C-E computer along with the same Hansen and Roach cross-sections set. Sample problems were run on the C-E computer system. The results were compared with the ORNL results which are as follows:

COMPARISON OF KENO-IV CALCULATED EIGENVALUES FOR SAMPLE PROBLEMS

| Sample Problem | CE-Calculated | ORNL-Calculated |
|---|---|---|
| 1 | 1.00387 +/- .00448 | 1.00569 +/- .00446 |
| 2 | 0.99733 +/- .00426 | 1.00099 +/- .00442 |
| 10 | 0.74638 +/- .00446 | 0.75215 +/- .00436 |
| 11 | 0.99846 +/- .00457 | 0.99330 +/- .00515 |
| 12 | 0.92957 +/- .00449 | 0.93089 +/- .00419 |
| 13 | 2.26645 +/- .00603 | 2.26172 +/- .00566 |
| 14 | 0.98487 +/- .00625 | 0.98060 +/- .00558 |
| 19 | 0.99726 +/- .00452 | 1.00014 +/- .00567 |

The comparison shows good agreement for Monte Carlo calculated results. A further check was made on the Hansen and Roach cross section set. There was perfect agreement. Both the KENO Code and the Hansen and Roach cross-section set were cataloged into the computer system, which has a unique creation date, and cannot be altered. Therefore, the validation done by Handley and Hopper is applicable to C-E's analysis using this method. The bias and deviation used with the Hansen and Roach KENO analysis is as described in the Handley and Hopper report.

in that the recycle material may contain no more than one weight percent moisture.

Milling equipment in the Oxide Building is spaced at least four feet edge-to-edge from other SNM bearing equipment. The Nuclear Safety Evaluation is provided in Section II.9.1.

8.2.2 <u>Building 255 Blending</u>

The four blenders located in the Oxide Building are 14 inches in diameter. Blenders No. 1 and No. 2 are employed for blending powder intended for further processing in Building 255. Blender No. 4 is employed for holding and transferring granules into hoppers intended for further processing in Building 254. Blender No. 3 is not used. At any one time, the silos and blender vessels in the oxide building are employed for processing $UO_2$ either for Building 255 or for Building 254. Thus, at least two of the blender vessels are always empty.

The blending operation involves no hydrogeneous material. The atmosphere is continuously monitored for humidity and an increase in moisture will cause an alarm and subsequent cessation of the blending operation. The Nuclear Safety Evaluation is provided in Section II.9.5.

8.3.3.1 Moderation Control During Bulk Storage Hopper Loading and Transport

The first moisture measurement is made in the hopper at the exit of the water jacketed screw cooler in the oxide building. At intervals of about two hours, batches of $UO_2$ granules are transferred from the screw cooler to the receiver. If the dewpoint in the screw cooler hopper rises above 15°C, a moisture detector signal initiates an alarm in the oxide building and an automatic shutoff of the vacuum transfer blower to the receiver vessel. The cause of the alarm shall be eliminated prior to restart.

The next moisture check is a procedural requirement on the Operation Sheet. The operator first verifies that the bulk storage hopper is empty by weighing it. Then a backup measurement of moisture content is made on the batch of oxide in the receiver before loading it into the bulk storage hopper. Batches are typically 100 Kg each, but may vary from about 80 Kg to about 130 Kg. After each batch is transferred to the receiver, the transfer air is turned off and a sample of the batch is manually withdrawn from a sampling port near the bottom of the receiver vessel. The moisture content in the sample is measured and recorded. A second person, who is not an operator, overchecks the sample analysis results. If the moisture content is no higher than 1 w/o, the second person allows dumping of the oxide from the receiver into the bulk storage hopper. Engineered means positively prevent dumping of oxide until a satisfactory overcheck is made and release is permitted.

8.3.3.1 Moderation Control During Bulk Storage Hopper Loading and Transport (continued)

Typically, ten dumps of ten batches are made to a bulk storage hopper. Excessive water in one single batch would wet the entire batch and be observed in a sample taken near the bottom. Bottom sampling of a batch conceivably may not assure that the upper region of that batch has less than 1 w/o moisture. However, a moisture problem that initiates while a batch is being transferred into the receiver would likely continue and would be measured in the next batch. Measurement on each batch before each of ten sequential dumps to the hopper provides assurance that a moisture level above 1 w/o in a significant quantity of the oxide in the hopper does not occur.

After the hopper is loaded, moisture in the hopper is controlled by equipment design. The hood arrangement at the connection between the receiver and the bulk storage hopper blocks water entrance while the top flange cover is off during loading. The mechanically sealed flange cover prevents moisture entrance after the hopper is disconnected. There are no other top openings into the all-welded stainless steel hopper.

Design also minimizes the potential for rupture of the bulk storage hopper during transport to Building 254. The hopper walls are 1/4 to 5/16 inch thick stainless steel, a tough, ductile material. The wheeled transporter is manually operated by a walking operator, thereby limiting the potential impact velocity.

By these means, the criterion I.4.2 3(n) is satisfied for the bulk storage hoppers.

8.3.3.2 <u>Moderation Control During Recycle Hopper Loading</u>

Recycle hoppers, both empty and full, will be stored in the bulk recycle storage room. This is a moderator controlled, closed area within Building 253, free of any water sources.

When a hopper is selected to be filled, the hopper is opened, inspected for water or other extraneous material, and positioned in the hopper fill hood. Pails of recycle, which have been analyzed and released as containing less than 1 w/o water, will be brought into the bulk recycle storage room, one at a time, and be transferred into the recycle hopper. After the recycle hopper is filled, the lid will be closed and secured. The hopper will then be transferred to the hopper blender and be blended. After blending, the hopper will be sampled and analyzed for moisture, among other constituents, to confirm the material is still less than 1 w/o water, and then released. The closed containers will remain in the bulk recycle storage room until ready for use in Building 254. By these means, criterion I.4.2.3(n) is satisfied for the recycle hoppers.

8.3.3.3 <u>Moderation Control During Milling and Blending</u>

By design of the unload hood, water is prevented from entering the oxide stream during unloading of the bulk storage and recycle hoppers, even though there is no water source in the vicinity of the unload hoods. The only other entrance path for moisture at the unload step is via the plant air supply employed for milling. The air compressor employs moisture separators and dryers that lower the exit air dewpoint to -40°C.

8.3.3.3 Moderation Control During Milling and Blending (continued)

Two independent moisture detectors measure moisture in the plant air supply. A detector located at the exit of the air dryer alarms in Building 254 if the dewpoint rises above 0°C. The second detector, located ahead of the blenders at the exit of the air accumulator, monitors plant air delivered for milling, blending and pulsed filter cleaning. The second detector alarms at a dewpoint of 0°C and also automatically stops the vibratory feeders and shuts off air to the oxide blender. The cause of the alarm shall be eliminated prior to restart. Thus, design and independent measurements and automatic instrument action assure that moisture is not injected into the blenders during unloading or processing the oxide.

Building 254 containing the blenders is a free standing steel frame structure designed using a BOCA seismic zone 2 earthquake occupancy importance factor of 1.5, thereby limiting potential damage to the oxide vessels by structural failure. By these means, criterion I.4.2.3(n) is satisfied for the blenders in Building 254.

8.3.4 Nuclear Safety Evaluation for In-Process Storage, Milling and Pellet Fabrication

The $UO_2$ granules processed in Building 254 are stored during processing in bulk storage hoppers that are filled in the Oxide Building, transported through the north corridor of Building 255 and stored in the north corridors of Buildings 254 and 255 and/or in the vicinity of the blenders in Building 254. The safety evaluation addresses three stages of the process: 1) filling, 2) transporting, and 3) storage. Storage evaluation is combined with the overall analysis of the front-end of the pelletizing line, i.e., milling through pressing.

8.3.4.1 Filling of Bulk Storage Hoppers

The bulk storage hoppers are wheeled into the oxide conversion room one at a time on the transporter, filled from the receiver and wheeled to Building 254. The filling process is analyzed by a KENO analysis of the oxide room. In this mode of operation of the oxide room, the three reactors and $UO_2$ cooler are functional; a piping change at the outlet of the $UO_2$ cooler is made to bypass the two silos and to feed the receiver.

The following conservative assumptions are used in the calculational model of the $UF_6$ to $UO_2$ conversion equipment analysis:

a) Reactors R-1 and R-2 are assumed to be filled in the 10" portion (i.e., no overfill) with $UO_2$ containing 1 w/o $H_2O$ at 2.5 g/cc density of powder and 5.0 w/o $U^{235}$. All structures consisting of .375" steel wall, 7.75" of 37.5 lbs/$ft^3$ firebrick insulation and 0.25" steel casing are included in the model. The reactor details are shown in Figures II.9-1 and II.9-2.

b) The R-3 reactor is assumed to be filled in both the 10" and 12" portions (i.e., overfilled) with wet $UO_2$ at 2.5 g/cc powder density and 5.0 w/o $U^{235}$. The $UO_2$ - water mixture is equivalent to a $UO_2$ volume fraction of 0.23 and a water volume fraction of 0.77. All structures consisting of .375" steel wall, 7.75" firebrick insulation and .25" steel casing are included in the model.

c) The cooler is assumed to contain $UO_2$ at 3.5 g/cc containing 5 w/o $H_2O$ and is surrounded by 1/2" of water. The steel structure is not modelled.

d) The silos are filled with $UO_2$ at 3.5 g/cc containing 1 w/o $H_2O$. The .125" steel walls are modelled.

e) $UO_2$ blenders Nos. 1 and 2 are filled with $UO_2$ at 2.5 g/cc containing 1 w/o $H_2O$ and No. 4 contains $UO_2$ at 3.5 g/cc with 1.0 w/o water. Blender No. 3 is empty. The .125" steel walls are modelled.

f) The $UF_6$ scrubber is empty.

g) The R-1 hopper is assumed to be filled with $UO_2$ at 3.5 g/cc with 1 w/o $H_2O$. Steel structures are not modelled.

h) An external mist of 0.001 g/cc is assumed.

i) A bulk storage hopper containing 1000 Kg of $UO_2$ at 3.5 g/cc with 1 w/o $H_2O$ is modelled below blender No. 4.

j) 12 inch concrete walls and floor and 12 inch water roof were assumed.

The KENO-IV code with Hansen-Roach cross-sections is used to determine the criticality of the system. With the above conservative assumptions, the $K_{eff}$ is 0.9709 $\pm$0.0029.

8.3.4.1 Filling of Bulk Storage Hoppers (continued)

Another analysis of the $UF_6$ to $UO_2$ conversion system was done using the same model and assumptions as above, but with a more realistic $UO_2$ density of 3.5 g/cc in the R-3 reactor. The $k_{eff}$ is 0.9518 ± 0.0029.

8.3.4.2 Transporting of the Loaded Bulk Storage Hopper Through Building 255.

The east-west corridor between the north wall of building 255 and the virgin powder can storage conveyors is 110 inches wide. Eight and one half feet above the corridor floor on a one-quarter inch thick steel mezzanine floor are the storage rings for positioning the sealed agglomerated feed buckets on 24 inch centers. The number of storage positions is 48. To assess the criticality safety of the combined arrays of: (1)

f) A significant fraction of the bulk storage hoppers are clustered closer to the blenders than practical from an orderly access point of view so as to maximize the interaction between hoppers and blenders.

g) Thirteen inch slabs of $UO_2$ enriched to 5 w/o U-235 were assumed on the second and third floors of the building. The slabs contained 1.0 w/o water, 1.0 w/o starch, and 1.0 w/o zinc sterate. The 13 inch slab conservatively represents buckets of $UO_2$ that may be stored on these floors.

The multiplication factor for the above set of conservative nominal conditions was 0.860 ± 0.004.

Additional analyses show that there is no limit on the amount of water that may be accumulated on the second and third floors. In one analysis, the space above the third floor was filled with water and in the other analysis the space above the third floor and also between the second and third floors was filled with water. Other assumptions are as stated above. The effective multiplication factor was 0.8828 ± 0.0042 for the first analysis and 0.8161 ± 0.0048 for the second analysis. Even though there is no need to limit hydrogeneous materials on the second and third floors, item (q) of Section 4.2.3 in Part I provides limits on mop buckets and containers of lubricant and poreformer.

KENO calculations are carried out for infinite and finite arrays of bulk storage hoppers to examine possible limitations on storage configurations. The following assumptions are employed in the KENO models.

a) Figure II.8.3-4 shows the KENO model for an individual hopper. No structural materials are included.

b) Hoppers are spaced on 30 inch centers.

c) Each hopper is assumed to contain 1000 Kg $UO_2$. The $UO_2$ is taken to be of 3.5 g/cc density, 5.0 w/o U-235, and 1 w/o water.

d) The model employs a one foot thick ordinary concrete floor and a 12 inch water region at ceiling height (35.5 feet).

Results of the KENO calculations are as follows.

| | | | |
|---|---|---|---|
| a) | An infinite planar array | - | $k = 0.833 \pm 0.004$ |
| b) | An infinite planar array with hoppers overfilled to 1378 Kg $UO_2$ | - | $k = 0.867 \pm 0.004$ |
| c) | A 7 x 7 array of bulk storage hoppers at 1000 Kg / hopper reflected by concrete walls | - | $k = 0.686 \pm 0.004$ |
| d) | Isolated hopper surrounded by a one foot radial water reflector | - | $k = 0.571 \pm 0.003$ |